Advantage

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Contents

Management of harvesting debris in northern Alberta

Abstract

The Forest Engineering Research Institute of Canada (FERIC) reviewed forty years of historical fire data for the northern region of Alberta. Based on these data, the expected costs are presented for the two conventional approaches to managing harvesting debris: burn the debris piles or leave them unburned within the cutblock. Recommendations on the management of this debris are also made to forest operators within this region. This report is the last of four Advantage reports that address the harvesting debris issues for different regions of the province.

Keywords

Fire history, Harvesting debris, Top piles, Debris management, Alberta.

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Introduction

The fire history of harvesting debris in Alberta was explored by Baxter (2002a) and showed different trends for different regions of the province. Four regions were identified for more in-depth fire history studies and debris management recommendations: the eastern slopes of the Rocky Mountains, the east-central and west-central regions, and northern Alberta. Each region has specific characteristics and different fire histories associated with harvesting debris. This report is the last in a series of four Advantage reports, and addresses the harvesting debris issues for the northern region.[1] The first three reports (Baxter 2002b, 2004a, b) examined the eastern slopes of Alberta's Rocky Mountains, the east-central region, and the west-central region, respectively, and made suggestions for the management of harvesting debris in those areas.

As in other areas of the province, the northern region has its own distinct concerns and problems regarding debris management. In this region, harvesting operations include both coniferous and deciduous species, and large, stand-replacing fires are the norm. Most of these fires are ignited by lightning, and the probability of fires involving cutblocks and harvesting debris can be considered high. Operators working in deciduous operations can refer to the recommendations provided in the FERIC report specific to aspen debris management (Baxter 2004a).[2] These recommendations are also applicable to non-timber industries and private landowners.

This report presents recommendations for the management of harvesting debris for northern Alberta. As well, an expected monetary value (EMV) analysis is performed to estimate the costs of various debris management options.

Objective

The objective of this study was to develop debris management recommendations specific to the northern region of Alberta. To accomplish this, the fire history of slash fuels is quantified. These results are synthesized

[1] The area from 56.5° N latitude to the 60th parallel and from the eastern to western border.

[2] Baxter (2004a) provides recommendations for top-pile management for east-central Alberta where aspen is the primary harvested species.

with a compilation of observations of current management techniques, and discussions with regional forest industry and agency personnel to develop recommendations specific to the unique conditions of the area.

Methods

All fires occurring in the northern region and involving slash[3] as a fuel type were compiled from the provincial fire history database. The data were sorted according to the number of fires, the month the fires occurred, and the size, cause, and cost of the fires. The fire history data were combined with observations made during field trips, a workshop held at High Level in January 2003, and discussions with forestry personnel working in the northern region. From this information, several strategies were developed to address the concerns of those operating in the area.

Expected value theory was used to illustrate the economic outcomes associated with the two management options for handling harvesting debris. Expected value is developed using the probability of debris fires by size and cost. This includes the probability of fires escaping from debris piles and of wildfires involving debris piles. Probabilities were derived from the provincial fire history data and anecdotal evidence from industry personnel. The outcomes from the expected value calculations were used to develop the recommendations for debris management.

Definitions used in this report

Industry-caused fire: any fire involving slash fuels where the fuel accumulation was created by industrial activity, and where the ignition agent or cause was linked to industrial activities. This includes forestry, oil and gas, highways, railroads, and hydro-electric development.

Probability of fire: the calculated chance of a fire occurring, based on 40 years of fire history data, e.g., P(fire) = 0.37.

Expected monetary value (EMV): the product obtained by multiplying the probability of an outcome occurring and the conditional value (or worth) that is received if the outcome does occur. EMV is also the weighted arithmetic average of the profit that can be expected if the decision was repeated over a series of trials (Newendorp 1975). In this report, all values are negative, i.e., they are costs.

Results and discussion

Fire history

From 1961 to 2000, there were 782 reported wildfires that involved debris in this region. Although provincial fire reporting requires the identification of debris when appropriate, it is a possibility that this information is not recorded for many fires.

Very few fires involving debris are identified in the provincial database for the northern region before 1966 (Figure 1). Before that time, little harvesting was taking place and homesteading in the region was just beginning. Many of the fires in the late 1960s and early 1970s burned in debris piles created by homesteaders and land clearing activities, and the peak in the early 1980s resulted in many large wildfires in those years. Since 1986, the number of fires involving debris has decreased. This trend is similar to that along the eastern slopes region of the province, and may be the result of changing from at-the-stump to roadside processing practices.

The time of year or season when debris fires occur in the northern region is slightly different than in the southern region. In the

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[3] Any fire identified in the fire history reports as having slash (i.e., piles, slash, Canadian Forest Fire Behavior Prediction [FBP] System Fuel Type S-1 [jack or lodgepole pine slash], FBP System Fuel Type S-2 [white spruce/balsam slash], windrows, debris, brush pile, cutblocks, etc.) as either the primary or secondary fuel type, or included as a comment. Fuel types as defined by Forestry Canada Fire Danger Group (1992).

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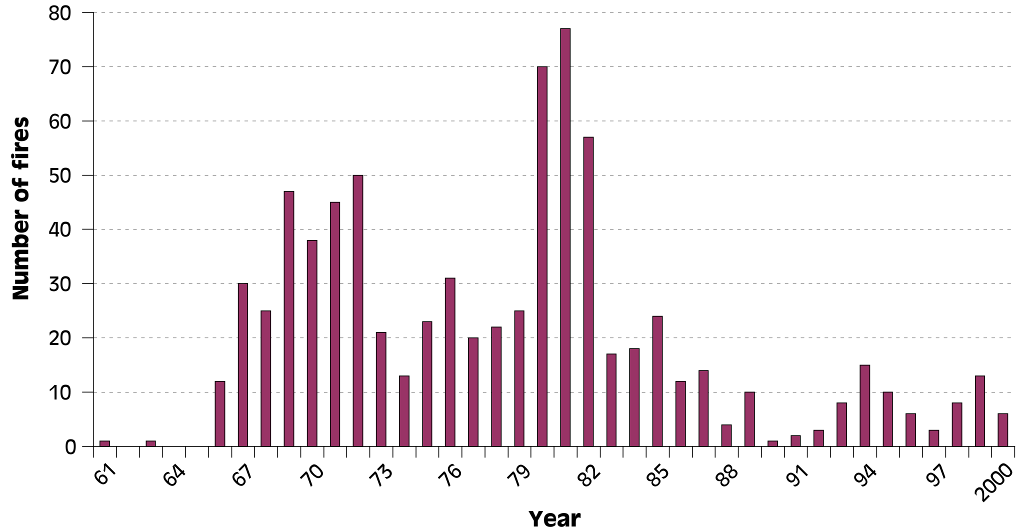


Figure 1. The number of fires per year involving debris for the northern region of Alberta, for 1961–2000.

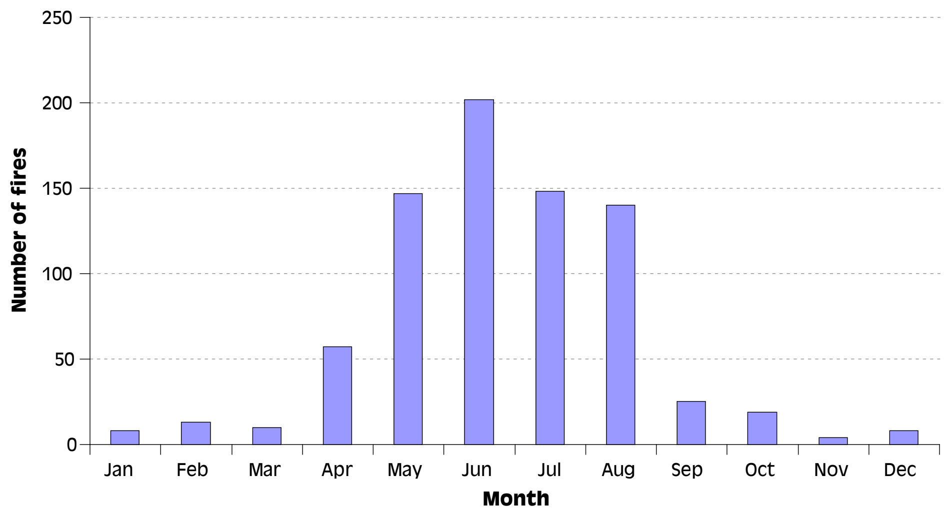


Figure 2. The average number of fires per month over the period from 1961 to 2000 involving debris in the northern region of Alberta.

northern region, spring conditions tend to occur later, which pushes the beginning of the active fire season into June. Unfortunately, June coincides with the start of the lightning season in the province. Twenty-five percent of all debris fires in the region occur in June and lightning is responsible for 57% of those ignitions.

Only 5% of debris fires in the northern region occurred from November to March (Figure 2). This percentage is well below those in other regions of the province, and is a reflection of the more consistent winter weather conditions in the northern region. June experienced the most fires in the northern region, whereas other regions tended to peak in April and May. The northern region also experienced proportionally more debris fires in July and August than in the other regions.

Causes of fires

Lightning ignited almost 50% of all fires involving slash (Figure 3), well above the provincial average of 30%. The debris involved in these fires was created by various sources—forest industry, other industries, and private landowners. Because lightning fires are common, special considerations should be made to minimize these fires. Baxter (2004b) suggested investigating techniques for lowering the risk of piles or windrows being struck by lightning for the west-central region. This research would benefit the entire province.

Only 2% of all wildfires involving debris were directly caused by the forest industry. Fires caused by residents and other industries, including the oil and gas sector, accounted for 27%. Residents and other industries need

Figure 3. Cause of fires involving debris in the northern region of Alberta from 1961 to 2000, by number. The public project was discontinued in 1983.

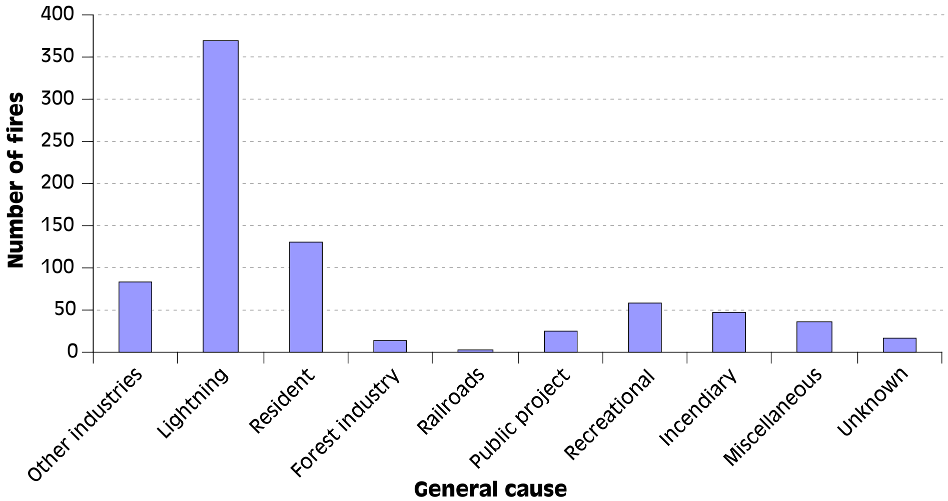
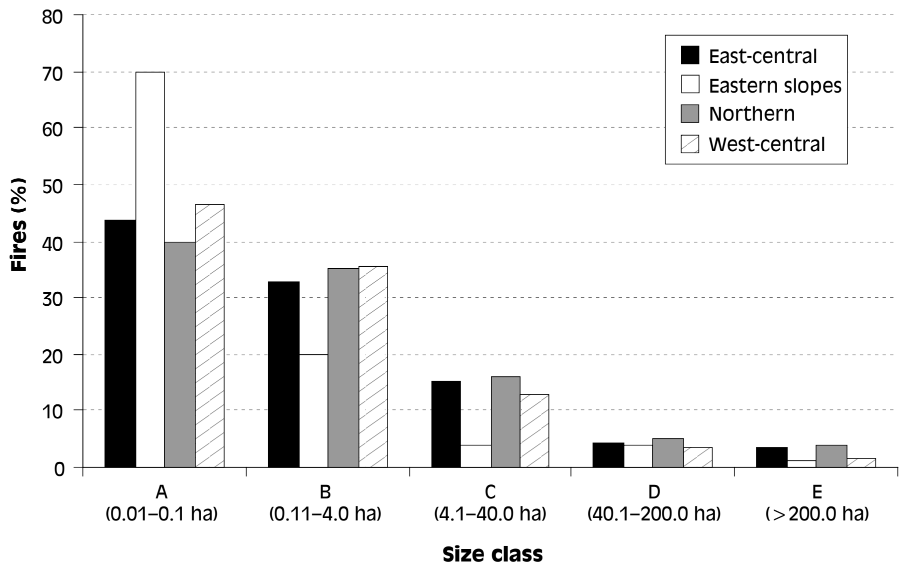


Figure 4. Percentage of wildfires involving debris based on fire size class for the eastern slopes, east-central, west-central, and northern regions, for the period 1961–2000.



to develop an awareness of the role of debris in wildfires if the number of these fires is to be decreased.

Fire size

Figure 4 compares fire size class for the eastern slopes, east-central, west-central, and northern regions. Fire size distribution in the east-central, west-central, and northern regions are similar, with more large fires compared to the eastern slopes. This can be attributed to a greater proportion of lightning-caused fires and the fire growth potential due to topography and fuel types. Size of the protection area and difficult access can also contribute to larger fire sizes.

Weather conditions

Wind speeds were lower during ignition of wildfires involving debris in the northern region than in the west-central and eastern slopes regions. Therefore, wind speeds at the time of ignition did not play as critical a role in the northern region.

Current debris management practices

Both coniferous and deciduous species are harvested in the northern region of the province. The majority of debris is burned during the winter in accordance with Alberta's Timber Harvest Planning and Operating Ground Rules. Aspen debris is also burned, but alternatives such as chipping are being used by some operators. Chipping results in small compact piles being left in the cutblocks. This is a new strategy and results with respect to both fire hazard and regeneration should be monitored. Private landowners are also involved in this. During the winter of 2003/04, a private landowner disposed of hog fuel in January and experienced a hold-over fire during the spring.

Fire behaviour characteristics

Fire behaviour characteristics in coniferous debris have been understood since timber harvesting and land clearing began in the province. These residues have a high risk of ignition during the first few years after harvest due to the high amounts of fine fuels such as needles and twigs. After these fine fuels have fallen to the ground, the heavy loading of debris can exhibit extreme fire behaviour (spotting, high flame lengths, etc.). This debris can remain on the landscape for 20 years or longer, and can contribute to problematic fire behaviour during wildfires. The fuel is elevated which increases potential spotting distances. The elevated position improves the drying of the fuels compared to residues in direct contact with the ground surface.

For a description of potential fire behaviour in aspen debris, see Baxter (2003, 2004a).

Concerns about fires in slash in northern Alberta

A one-day debris management workshop and tour were held in High Level in January 2003. Attendees included both forest industry and agency personnel.[4] The following issues were raised regarding debris disposal practices in the region. Some of these concerns require additional research and are discussed in the *Recommendations and implementation* section of this report.

The following major concerns were raised:

- An investigation of the relationship between the holdover fire and two Canadian Forest Fire Weather Index (FWI) fuel moisture codes—the DMC (Duff Moisture Code) and DC (Drought Code)—is required to determine acceptable thresholds for burning.
- Better burn techniques are required, as it is difficult to burn fresh aspen piles due to pile structure, composition, and fuel moisture.
- The choice of appropriate burn locations can decrease the probability of holdover fires, i.e., burn on roads, or in smaller piles on bare soil.
- The harvest technique used can influence fire hazard. For example, cut-to-length harvesting is more expensive but it decreases the fire hazard by leaving less debris in the cutblock.
- Decreasing the amount of invading grass following harvest is a priority to the province as well as the oil and gas industry. Less grass would reduce the scarification intensity required to achieve acceptable regeneration.
- Trappers and biologists would like debris piles as habitat for small fur-bearing mammals. It was suggested that some deciduous debris could be left for this.
- Creating pile-free areas around communities is now a provincial priority. This is intended to control and reduce the amount of fuel close to values at risk.
- Oil and gas industry debris disposal is a concern to Alberta Sustainable Resource Development (SRD).
- Cutblock size matters. Large cutblocks are easier to manage.
- Determine fire risk over time based on species harvested and technique.

The following comments were also made:

- Fire-salvaged debris is difficult to burn due to the lack of fine fuels.
- Scanning problems exist. There is an increasing number of fires resurfacing throughout the province where the fires were believed to be extinguished. The

[4] This included personnel from Tolko Industries Ltd., a forest consultant, Alberta Sustainable Resource Development (SRD) fire prevention personnel, and a wildlife biologist.

heat is not visible to the scanner. This may be due to the quality of the scanner or the technique used. Piles should be scanned every second week until fire season begins to ensure piles are extinguished.

Some of the concerns listed have already been addressed in previous FERIC reports dealing with fuel management (Baxter 2002b, 2004a, b). The concerns described below are those distinct to this area or those that have not been raised elsewhere.

FWI relationship

The percentage of debris-related fires that are directly caused by the forest industry is relatively small (approximately 2%). Because the winter weather in the northern region is less variable than in the southern and central regions, the forest industry is able to burn its debris under stable conditions and on a season-long snow base. In these conditions, piles are usually ignited and left to burn out with little risk of escape.

Wildfires involving slash during the winter do occur occasionally. For example, in January 2003, a 100-ha fire originated in debris piles near Manning when an unexpected wind blew the fire out of control. The winter followed the drought conditions of the summer of 2002, and dry early-winter conditions resulted in light snowpack. The process of determining burning thresholds based on FWI values comes from conditions similar to those experienced in the example. Both industry and government are interested in fuel moisture conditions and the resulting influence on debris burning. Combining DMC and DC values with monthly precipitation anomalies may provide a tool to predict the likelihood of problems when burning debris piles. Baxter (2004b) analyzed end-of-season FWI values during winters where excursions occurred for the west-central region, and no significant relationship between the FWI value and excursions was found.

A stronger relationship was found using "snow-on-ground" data (Figure 5). FWI values combined with snow-on-ground amounts may provide a tool for the public and industry when burning debris piles.

End-of-season FWI values can assist when monitoring moisture conditions of the fuels heading into the winter season. These values can be combined with snow-on-ground data to help assess burning conditions. This information and long-term weather forecasts may increase the safety margin for burning. Because very few winter fires occurred over this six-year time period, the threshold values to identify low-risk burning conditions could not be accurately determined. For example, 1998 had the highest end-of-season DC values (Table 1), and theoretically, burning should have required extra caution. However, that winter also had a high snowfall, influenced by El Niño, producing good

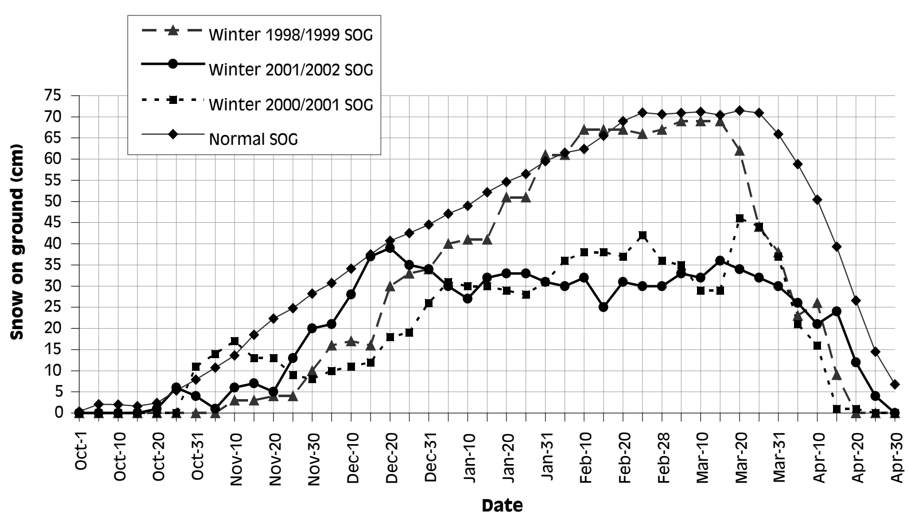


Figure 5. Snow-on-ground data for High Level. Once snow is on the ground, it generally remains until April 1.

Table 1. End-of-season DC values for five fire towers in the Upper Hay Management Area, 1996–2002[a]

Tower ID	Year							
	1996	1997	1998	1999	2000	2001	2002	Average
FG	192.1	182.1	210.9	79.9	286.1	307.7	424.8	240.5
RT	189.3	241.3	389.3	187.0	301.0	379.8	188.8	268.1
WT	149.2	99.5	246.9	156.1	190.9	216.0	243.5	186.0
WU	86.5	10.6	345.7	270.1	253.9	204.6	408.7	225.7
ZA	156.0	127.3	362.6	30.7	189.5	299.6	208.5	196.3
Average	154.6	132.2	311.1	144.8	244.3	281.5	294.9	223.3

[a] Because these towers usually close at the end of August or early September, these values reflect the moisture conditions only until closing.

burning conditions. End-of-season values generally are calculated at the end of August or early September, and therefore fall precipitation amounts have to be accounted for. The DC can be monitored until freeze-up by using one or two representative automatic weather stations.

Determining burning thresholds requires a larger dataset. Although the number of winter fires in the region is low and strong relationships may not be apparent, this may still be a worthwhile undertaking that may benefit all regions of the province.

Burning techniques for aspen debris

The difficulty with burning aspen debris, compared to coniferous debris, was raised as being problematic. Pile structure and fuel composition are critical for the successful burning of aspen. It was suggested that aspen piles require at least two years to dry successfully. Alberta's Forest and Prairie Fire Protection Act states that piles must be burned within 24 months of harvest if burning is done to reduce the fuel loads, otherwise, an extension from the Regional Fire Manager is required. This additional time required for drying must be balanced with the risk of a wildfire involving debris piles before the debris can be burned and the risk of the piles becoming ignition sites themselves.

Industry personnel presented a potential solution to the problem of igniting and successfully burning aspen piles. If piles are built high and contain a significant amount of coniferous fine fuels in the lower portion of the pile, the burning of the piles within the legislated 24-month period may be easier.

Location of burning sites

Skidder trails in the cutblock become compacted due to travel, and regeneration may be poor on these trails. Regeneration may also be poor on sites where pile burning has taken place. These areas are usually noticeable years later as small openings in young forests. To reduce the overall loss of plantable land within a cutblock, the debris can be hauled onto and burned on the road system. This requires extra work following harvest, but may reduce productivity loss and lower the probability of the fire holding-over during the winter in organic soils. Unfortunately, placing piles on roads increases access to the piles and may increase human-caused fires.

Organic soils in the northern region create problematic burning situations as fire is able to burn down into the soil profile. This makes scanning difficult and allows the fire to smoulder and re-surface when burning conditions become favourable, usually in the spring when conditions tend to be dry and windy. Better information on soils would assist in planning cutblock layout and potential debris burning locations.

Soil moisture may be monitored throughout the fire season using soil moisture probes. This information could be used by the forest industry along with FWI values to monitor the amount of water in the soils and fuels.

Harvest technique and hazard

The amount and distribution of logging debris remaining in the cutblock is related to the harvest technique used. Cut-to-length harvesting creates debris distributed over the cutblock, while skidding to roadside accumulates processing debris in piles. The cost of cut-to-length harvesting can be more expensive than conventional techniques, but the fire risk may be reduced due to increased decomposition rates and fewer concentrations of heavy fuels. Spending more initially may reduce overall costs and reduce fire risk, especially if a fire starts in or involves piled debris (Baxter 2002b). The few fire behaviour studies available, such as Alexander (1982), show fire spread and intensities in spread aspen debris to be less than that experienced in forests or coniferous debris under the same burning conditions. Because coniferous debris is so flammable, it should be disposed of in the cutblocks. The influence of debris piles on fire behaviour has been documented recently in reports on several high profile fires (Baxter 2003). These studies have illustrated the difficulty when fighting fires involving piles, due to their spotting capabilities and night-time fire behaviour. Fire managers in the north stated that grass contributes heavily to fires in cleared areas and is as much a problem in this region as in the east-central region (Baxter 2003).

Wildlife piles

High importance is placed by trappers and wildlife officials on the use of debris piles by wildlife. Marten, in particular, is a valuable species that benefits from piles attracting smaller mammals. The importance of these piles is understood, but a compromise is required to balance wildlife needs and fire risk. Some trappers would like piles within 6 m (20 feet) of the forest edge, but when fire risk is considered, 6 m is too close because of spotting potential and radiation intensity. Also, trappers would like to see a stem leading from the pile into the forest. This stem would provide cover in the winter and a transportation route during summer months for the animals to travel from the forest to the pile. However, this stem is not acceptable in terms of fire risk. Wildlife studies to determine how far animals will venture into a cutblock to utilize these piles are needed before the questions around acceptable pile locations can be determined. Current research indicates that martens will utilize debris piles up to 30 m from a block edge.[5]

Oil and gas industry debris disposal

Concerns were raised regarding the oil and gas industry and its debris disposal practices on seismic lines. New, less destructive techniques are reducing the fire risk, but thousands of kilometres of old lines will continue to cause fire control problems. While reclaiming well sites and cutlines, the industry spreads grass seed to revegetate sites and decrease erosion. This grass can invade the cutblocks and create a fire hazard that can last up to ten years until the regenerating trees provide shade over the grass.

The timber industry may be able to help by readily accepting more salvage so less fuel is left on the disturbances.

The amount of timber harvested by the oil industry in the creation of their well sites and the seismic lines is believed to be almost equal to that harvested by some forest companies in their Forest Management Areas (Schneider 2001). The oil and gas industry is not required to submit fire control plans for the disposal of debris. While this legislation is beyond the scope of this report, the oil and gas industry could use the recommendations in this report to assist in safe debris disposal. Pile size and location are the main concerns raised regarding the oil and gas industry. The number of fires attributed to Other Industry–caused fires in the fire history database would support the requirement of fire plans (Figure 3). Most companies in the oil and gas industry, however, are cooperative and assist with the suppression or prevention of wildfires.

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5 Steve Therrien, consulting biologist, personal communication, May 2004.

Scanning

The re-ignition of piles that have been scanned and believed extinguished is a problem not only for the forest industry, but also private landowners. Scanning techniques and the frequency and timing of scanning were raised as being inadequate. While data indicate that the problem is greater further south, there have been debris fires resulting from piles in the north believed to have been extinguished. Standards for equipment, scanning technique, and frequency may lead to better debris management and reduce the number of re-ignitions. Other solutions include utilizing new technology to monitor piles thought to be extinguished, e.g., experimental systems are available that can alert the fire protection officer of a heat source in areas believed to be cold.[6]

Development of aids to improve burning effectiveness

During the workshop in High Level, suggestions were made for the development and use of three aids to improve the effectiveness of pile burning:

- pile-burning checklist
- questionnaire for debris fires
- soils map and soil moisture monitoring

Pile-burning checklist

A pile-burning checklist in pamphlet format would be of benefit to both industry and the private landowner. This checklist would include DMC and DC burning thresholds developed from research, combined with snow-on-ground data. The checklist would also include the influence of species type, pile shape, pile structure, soil type, weather forecasts, etc. It would allow people to list and rate the risks involved in burning and assist them in making appropriate debris disposal decisions.

Development of a questionnaire for debris fires

It would be beneficial to collect data on fire behaviour in debris fuels. Those involved in suppressing debris fires could provide information, and then use the summary results developed from questionnaire responses. The questionnaire could be a supplemental form attached to the required FP-48 Fire Report form. If "debris" is checked as a fuel type, or included as a comment, then the questionnaire would be filled out. The questionnaire would collect information on:

- species type
- block description
- physical arrangement of fuels: piles, windrows, or spread debris
- fire behaviour observations such as flame length and rate of spread
- estimated grass or ground cover percentage and fuel load
- control difficulties
- other comments (e.g., Did fire originate in block or piles? What was ignition cause?)

Weather observations could be collected from the fire report and included in the summaries.

If a form was developed for all fire protection offices, data could be collected on up to 100 fires, including both summer and winter fires, in an average year (Figure 1). This information would increase knowledge of fire behaviour and tactics in cutblocks containing harvesting debris.

Soils map and soil moisture monitoring

A soils map could be used by industry to locate areas where piles can be burned more safely than if burned over organic soil. This would reduce the probability of fire moving into the ground and escaping detection. Soil moisture monitoring would assist industry in following the conditions of the fuels. This would be particularly important in drought conditions.

Expected economic outcomes of current practices

An expected value analysis is presented to illustrate the potential economic consequences

[6] See the Ambient Control Systems Inc. website (www.ambientalert.com) for an example of this technology.

of current debris management practices. For a description of expected outcomes theory, refer to Baxter (2002b).

Economic outcomes for the northern region are similar to those for the east-central region. Table 2 was derived from the fire history of the northern region, and includes fire size and costs for debris fires occurring from 1961 to 1995.

The decision tree (Appendix I) shows calculated EMVs similar to the east-central region due to a similar number of fires and expected fire sizes.

The decision tree shows that, on any given year, it costs more to burn debris than to pile and not burn. The expected cost of burning debris is $1 497 157, whereas the expected cost to pile and not burn is $1 082 721. With these costs over a 19-year period, which is the duration period that the probability calculations are based on, the exposure to a company can be high. Minimum exposure is $78 709 (based on one year in 19 having one debris fire). Mean exposure on an annual basis is $944 508, which is based on an average of 12 fires per year. Maximum exposure is $4 486 413, based on one year in the study period with 57 fires. These values are calculated using mean fire sizes and the cost per hectare of these fires. Burning debris may be more expensive than piling and leaving, but given the costs associated with debris fires and the potential size of these fires, over the long term burning is the best economic decision.

Table 2. Fires involving debris in the northern region of Alberta, 1961–1995

Size class (ha)	Fires (no.)	Probability of fire size	Cost ($/fire)	Cost ($/ha)
A (≤0.1)	299	0.40	1 549	1 549 [a]
B (0.11–4.0)	265	0.35	2 626	1 614
C (4.1–40.0)	121	0.16	5 816	469
D (40.1–200)	37	0.05	26 972	265
E (>200)	24	0.04	535 812	27

[a] Because Class A fires have a maximum size of 0.1 ha, the expected value is calculated on a cost per fire basis rather than a cost per hectare basis as in all other size classes.

Conclusions

Debris fires are common in the northern region of the province and include debris created by the forest industry, the oil and gas industry, and private landowners clearing land. Lightning is a common ignition agent in the region, affecting debris piles left on the landscape. Although the number of debris fires have declined, the risk still exists for fires to involve debris, which can lead to problematic fire control and high costs of control and extinguishment.

Recommendations and implementation

The following are recommendations from the FERIC reports on the eastern slopes, east-central, and west-central regions of Alberta (Baxter 2002b, 2004a, b) that are also applicable to the northern region.

- Remove all coniferous debris by burning piles or by mechanical means (Baxter 2002b, 2004a, b).
- Manage aspen debris (refer to the recommendations in Baxter [2004a]). Aspen debris may be spread or small piles/windrows can be constructed and left on site. Piles should be placed at least 6 m apart and a minimum of 20 m from a block edge. Maximum size should be 2 m high × 3 m wide × 10 m long. There should be no debris piles within 10 km of a value at risk.
- Place wildlife piles a minimum of 20 m from a block edge. Wildlife piles should be a maximum of 2 m high × 3 m wide × 10 m long (Baxter 2002b, 2004a, b).
- Investigate techniques to reduce the potential of piles being hit by lightning or limiting the extent of damage resulting from a strike (Baxter 2004b).
- Develop standards for scanning operations and equipment. Investigate technologies to monitor sites where debris piles have been burned and are believed to be extinguished (Baxter 2004b).

- Complete a simple fire plan before winter debris burning commences (Baxter 2002b).

The following recommendations are based on the findings in the *Results and discussion* section of this report:

- Burn coniferous debris piles or mechanically treat them as per Alberta's Timber Harvest Planning and Operating Ground Rules.
- Investigate end-of-season FWI values in addition to snow-on-ground data to develop a risk chart for debris burning.
- Investigate harvest techniques and costs for a higher utilization of harvested wood. This would decrease the amount of debris left on site.
- When burning, attempt to locate the burn on the road system within the cutblock.
- Develop a debris burning checklist for use by industry and private landowners.
- Develop a questionnaire to supplement the standard fire report form if harvesting debris is involved in a fire. FERIC could collect and collate the results, and post summaries on its website.
- Develop a simple burn plan for use by the oil and gas industry.
- Develop a soils map for use by industry to assist in block layout design and pile locations.
- Meet with members of the oil and gas industry to discuss potential solutions to the problems caused by their grassing practices.
- Investigate the use of soil moisture monitoring to provide current information on moisture conditions.

References

Alexander, M.E. 1982. Fire behaviour in aspen slash fuels as related to the Canadian Fire Weather Index. Canadian Journal of Forest Research 12:1028–1029.

Baxter, G. 2002a. Analysis of the occurrence and cause of fires in slash fuels in Alberta for the period 1961–2000. FERIC, Vancouver B.C. Internal Report IR-2002-06-13. 20 pp.

Baxter, G. 2002b. Management of harvesting debris along the eastern slopes of Alberta's Rocky Mountains. FERIC, Vancouver, B.C. Advantage Vol. 3 No. 42. 12 pp.

Baxter, G. 2003. Issues arising from observed fire behaviour in aspen cutblocks during the House River Fire in Alberta in May–June 2002: a case study. FERIC, Vancouver, B.C. Internal Report IR-2003-05-06. 12 pp.

Baxter, G. 2004a. Management of harvesting debris in east-central Alberta. FERIC, Vancouver, B.C. Advantage Vol. 5 No. 4. 12 pp.

Baxter, G. 2004b. Management of harvesting debris in west-central Alberta. FERIC, Vancouver, B.C. Advantage Vol. 5 No. 20. 12 pp.

Forestry Canada Fire Danger Group. 1992. Development and structure of the Canadian Forest Fire Behavior Prediction system. Forestry Canada, Ottawa, Ont. Information Report ST-X-3. 63 pp.

Newendorp, P.D. 1975. Decision analysis for petroleum exploration. Petroleum Publishing Company, Tulsa, Okla. 668 pp.

Schneider, R. 2001. The oil and gas industry in Alberta: practices, regulations, and environmental impact. Alberta Centre for Boreal Studies, Edmonton, Alta. 23 pp.

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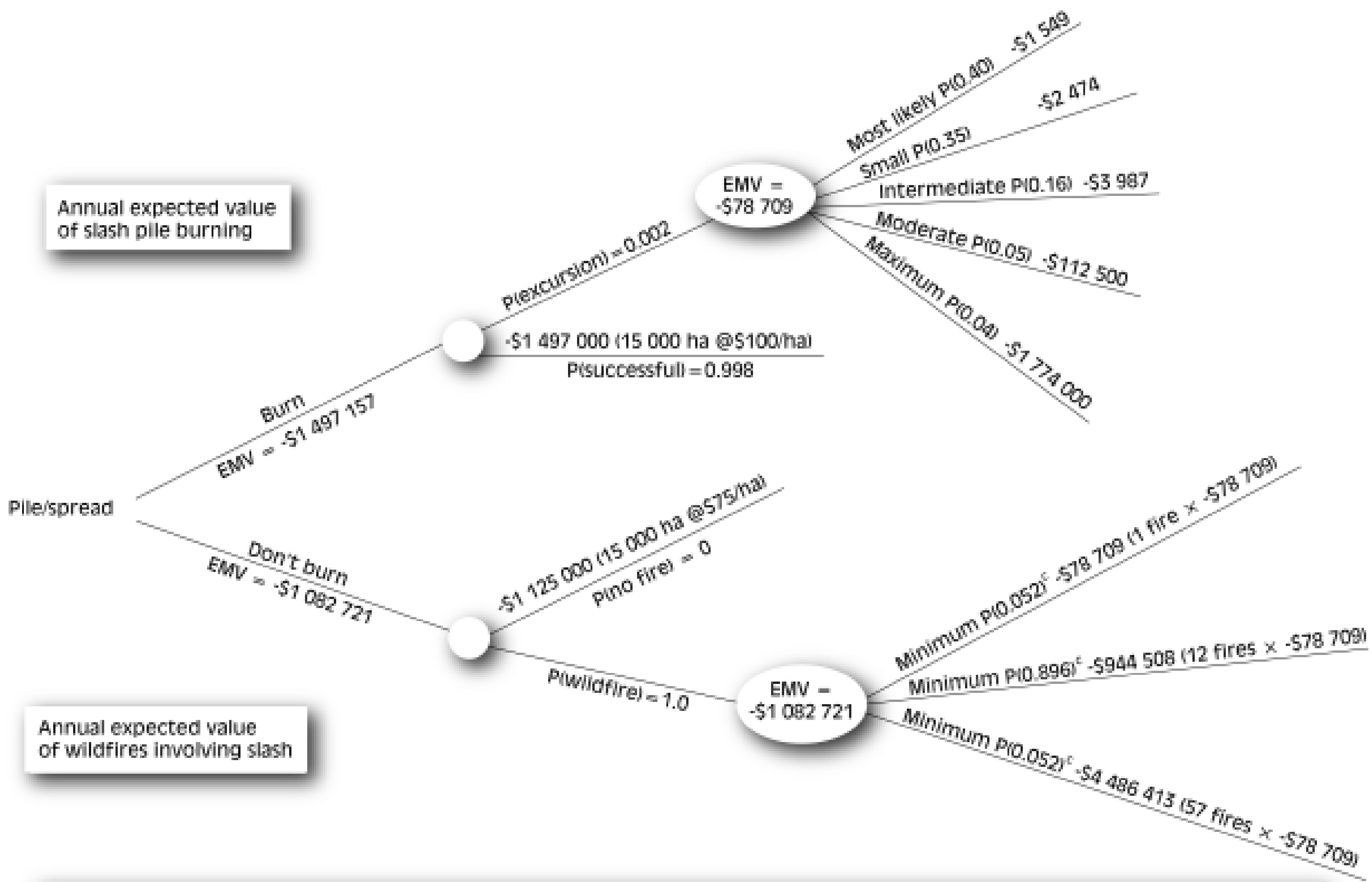
Appendix I

Decision tree analysis [a,b]



Most likely	0.01 ha	$1549/fire
Small	1 ha	$1614/ha
Intermediate	3 ha	$469/ha
Moderate	100 ha	$265/ha
Maximum	2000 ha	$27/ha

[a] Probabilities do not equal 1 in this Appendix due to rounding.

[b] Timber lost due to fire is valued using current Alberta Lands and Forest Service values which are $860/ha. Regeneration loss is assumed to be $860/ha.

[c] Probabilities calculated using annual fire frequency data for 1982–2000 for the northern region, where 231 fires occurred over 19 years and and where all 19 of those years experienced fire.