

AN ASSESSMENT OF FIRE HAZARD ON SEISMIC LINES
IN ALBERTA

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INTRODUCTION

In Alberta, the total length of seismic lines (Fig. 1) resulting from geophysical exploration exceeds 140,000 miles and is increasing at a yearly rate of about 10,000 miles. Forest managers charged with the responsibility of protecting the forest against fire are concerned about possible fire hazard created by seismic lines. The construction of these lines generally entails the levelling (Fig. 2) by bulldozer of all vegetation along a right-of-way 20 to 25 ft wide. The felled timber is usually cleared from the center part of the line, which creates a strip of land 15 to 20 ft wide free of woody material. Most of this work is done in the winter, depending on the terrain and forest cover. The cost of dozing and debris treatment varies with local operating conditions, the average being near \$300.00/mile or \$85.00/acre.

This report assesses the effectiveness of partial debris-disposal methods in terms of fire hazard and makes recommendations relating to the reduction of fire hazard on seismic lines. The report is based on field inspection of seismic lines before, during, and after wildfires, discussions

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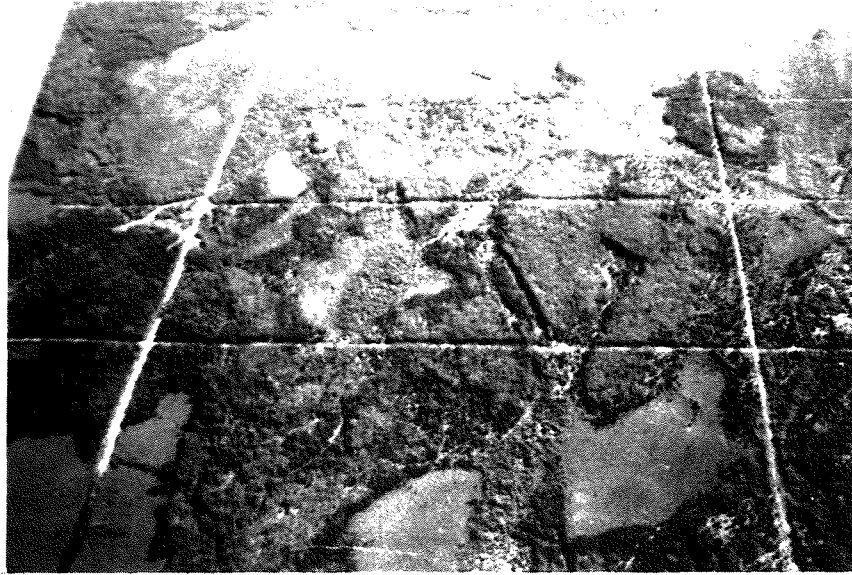


Figure 1. Aerial view of seismic lines in Footner Lake Forest.



Figure 2. A typical example of fuel consumption along windrow adjacent to standing trees.

with members of the Alberta Forest Service and oil industry, and the writer's knowledge about fire behavior in forest debris.

FACTORS ASSESSED

Evaluating fire hazard from accumulated forest debris entails three considerations: (1) probability of fire occurrence in the region (2) effect on rate of fire spread and (3) effect on suppression. The fire hazard on seismic lines varies considerably with adjacent forest cover, the type, amount, and condition of debris, fuel moisture, type and condition of vegetation, and prevailing weather. These are complexly interrelated and a quantification of the effect of each on ignition probability, rate of spread, and difficulty of control is beyond the scope of this report. Nevertheless, some assessment of each factor is essential in the evaluation of the total fire hazard.

Adjacent Forest Cover

The type of forest vegetation determines, to a large extent, the rate of fire spread and difficulty of control. Generally, pine and black spruce stands are more susceptible to extensive fire damage than hardwood and mixedwood stands but all forest types may be burned during extreme hazard conditions. For this discussion, the following major forest types are considered important:

- 1) Lodgepole and jackpine-moss, cladonia or needle and grass forest-floor.
- 2) Black spruce-moss or cladonia forest-floor.

- 3) Aspen-leaves and herbaceous vegetation on forest-floor.
- 4) White spruce and mixedwood - generally moss, needles, and herbaceous vegetation on forest-floor.

Dense pine stands provide a near-ideal crown-fuel continuity for spread of crown fires whereas black spruce trees, with their long crowns, facilitate the rapid development of crown fires. Aspen stands represent a very low hazard during the growing season but may sustain relatively fast-spreading fires during the spring. White spruce and mixedwood stands support damaging crown fires only after extended periods of drought.

Forest Debris on Seismic Lines

The type and amount of debris left on seismic lines are determined by the forest stand (Table 1), the quantity of debris increasing with stand volume. The probability of fires starting or the rate of fire spread, however, is not always a direct reflection of fuel quantity. The effort required for mop-up is primarily a function of depth or quantity of forest-floor fuels and the distribution of moisture therein.

TABLE 1. Fuel weight in hypothetical forest stands in Alberta by size classes

	Standing timber		Forest floor (L, F, & H layers)
	Material <4" dia.	Material >4" dia.	
All weights in oven-dry tons per acre			
Pine	15-20	60	20
Black spruce	10	20	more than 50
Aspen	less than 15	50	25
White spruce	20	more than 100	40
Mixedwood	15	75	30

Data summarized in Table 1 are general approximations but the quantities are considered to be representative and indicate also the relative differences between stands. In addition to weight, there are important differences in fuel size, vertical and horizontal arrangement of various stand components, and the type and composition of forest-floor fuels between stands.

Aspen stands do not represent a serious fire problem although surface fires are common in the spring. Decay of aspen slash is relatively rapid and crowning practically nil, so that the height of the windrow is not important. Mature pine and spruce stands produce considerable debris and some partial disposal is usually desirable, particularly from the point of view of accessibility and appearance of the line. Black spruce debris is highly flammable but it is usually broken and flattened in the process of line construction and the height of windrows seldom exceeds 3 ft.

Decay of Fuels

In many regions of Alberta, disintegration of forest debris is extremely slow and a significant reduction in fuel loading is likely to take at least 5 to 10 years. Decay is generally faster in partially or fully shaded areas and in situations where the fuels are in direct contact with a moist, but not saturated, ground surface. On seismic lines, conditions for decay are such that any redistribution of debris into windrows or flat on the ground is unlikely to result in a significant reduction of fuel available for burning for several years after the treatment has been applied. There are, however, important differences in decay rates between

regions, and partial debris-disposal regulations and priorities should recognize and make allowances for such variations. The rate of moisture loss from slash is greatest near the centers of seismic lines that are most frequently exposed to the full desiccating effects of the atmosphere. Windrows along the sides of seismic lines are exposed to less severe drying conditions during part of the day but even here the moisture content of the fuels is significantly lower than in the adjacent stands. Fuel moisture under the adjacent forest canopy remains high enough to retard rapid fire spread except after extended periods of drought.

Fine fuels such as needles and twigs become highly flammable within two months after felling. Heavy fuels such as tree stems require several fire seasons to reach equilibrium moisture content levels and, having reached this condition, are not likely to re-saturate. The rate of moisture loss by evaporation is greater on seismic lines than in the adjacent stand, but total evapotranspirational losses in the stand may exceed those from seismic lines, particularly following extended periods of drought.

Vegetation

A dense cover of herbaceous vegetation usually invades the seismic line soon after clearing. While it is growing and green, it provides shade for the lower part of the debris and acts as an effective barrier against the spread of low-intensity surface fires during the growing season. In the spring and fall, however, the cured herbaceous vegetation will increase ignition probability and rate of fire spread.

The density and height of lesser vegetation vary considerably between and within cover types but tend to be extremely lush on fresh sites.

Appearance of Seismic Lines

Heavy accumulations of forest debris and "leaners" on and adjacent to seismic lines are unsightly and detract from the overall aesthetic value of the forest area. It is conceivable that such unsightly debris will act as a deterrent against public travel on seismic lines, thereby reducing the risk of man-caused fires. In northern areas especially, seismic lines are often partly or completely flooded during the fire season and public travel is minimal.

FIRE BEHAVIOR IN SEISMIC LINES

Fire Occurrence

There appears to have been no significant increase in fire starts attributable solely to the presence of debris on seismic lines. Certainly, an increase in man-caused fires is possible, and indeed probable, if seismic lines are used for easy access into previously inaccessible areas. Nevertheless, any changes in fire incidence on seismic lines are likely to be the same whether the debris is untreated or partially treated. There appears to be no likelihood for a significant change in the frequency of lightning-caused fires attributable to the presence of seismic lines.



Figure 3. Fire had crossed the seismic line and continued unabated for several thousand feet. Note the exposed mineral soil in middle of seismic line.



Figure 4. A seismic line had no effect on crown-fire spread. Note the 10-foot strip of mineral soil in the centre of the line.

Rate of Fire Spread

The effect of debris on rate of fire spread varies with the type of fire (ground, surface, crown) and existing burning conditions (low, moderate, high, extreme), fuel, wind, etc. A low-intensity surface fire may spread through the cured vegetation and exposed debris (Fig. 2) but it will not crown in the adjacent timber. During extreme burning conditions, on the other hand, the fire will likely crown regardless of the type and condition of the fuel on the line. Crown fires approaching a seismic line are not appreciably affected by the type and arrangement of the debris on the line (Fig. 3). Windrows along the edge of a seismic line facilitate fires of long duration and these may provide the impetus for intense fires during extreme burning conditions. Generally, when burning conditions are in the low to high range, partial disposal of slash may be beneficial provided it breaks up fuel continuity. Regardless of the type and condition of debris, the seismic line that is 20 to 25 ft wide is too narrow to have an important effect on rate of spread when crown fires prevail (Fig. 4).

DISCUSSION AND CONCLUSIONS

Any meaningful evaluation of fire hazard on seismic lines and any reduction in this hazard owing to partial disposal of debris involves consideration of forest type, fire risk, fire history, economics, access, watershed values, and aesthetics. For example, seismic lines provide convenient access for fire-fighters and fire-fighting equipment. Many seismic lines provide a near-ideal base for burnout and backfiring operations. In

Figure 5, backfiring was reportedly applied from the right-hand side of the seismic line and effectively stopped the advance of the wildfire.

The slash fire hazard on and along the borders of seismic lines approximates that on clearcuts resulting from logging operations. The main differences relate to the width of the seismic line and the piling of debris along the length of the line adjacent to the standing timber. In some instances, the organic mantle is also removed and pushed next to the stand (Fig. 4). The net effect of this treatment is difficult to assess but the windrowing of debris along the border of standing timber undoubtedly increases the fuel loading and, therefore, the intensity of the fire in that location. Fires will burn in these fuel concentrations for long periods and could conceivably facilitate crowning when conditions are suitable for crown fires.

In terms of reduced fire hazard, the apparent benefits from lopping and scattering can be questioned, particularly during critical burning conditions. While lopping and scattering brings a greater proportion of the fuels near the ground surface where decay-causing organisms may be more active, this treatment does not reduce fire risk or the propagation of fire along the seismic line. The construction of fireguards 20 to 30 ft wide across a seismic line will break the continuity of fuel along windrows and may prove to be a more effective treatment than lopping and scattering. In addition, adjacent windrow sections should be constructed on opposite sides of seismic lines. The greatest difference in hazard between treated and untreated slash is probably during low burning conditions when the likelihood of fire spread is, likewise, very low.

However, past history behavior in areas containing seismic lines does not appear different from that in areas without seismic lines. Over 90% of fire damage is caused by a few conflagrations and these are unlikely to be greatly affected by the presence of treated or untreated debris along a seismic line. This by itself does not prove that slash treatment is not required or that the situation will not change in the future; rather, it implies that existing partial-disposal methods have apparently not resulted in any important reduction in fire losses in areas where seismic lines are found.

I believe the greatest value in some kind of fuel treatment on seismic lines is in the improvement of the appearance of the area. In inaccessible areas such as those in northern Alberta, the appearance of the seismic line is not as important as in more accessible southern parts of the province. Seeding of the seismic lines with grass and burning of the slash within 5 chains of a main access road will likely be sufficient to reduce the risk of man-caused fires on seismic lines and to make the line aesthetically acceptable to the travelling public. For burning, the debris should be piled in the center of the line (Fig. 6).

It is in the highly productive forest regions that considerable cleanup needs to be done to reduce fuel flammability and to improve the appearance of seismic lines, particularly those adjacent to main access roads. Salvage operations might be one way to aid in reducing fuel volumes. Another stipulation might be that windrows and all other woody material lie within 5 ft of the ground surface. Every effort should

be made to eliminate leaners through effective bulldozing techniques. Decay is generally more rapid under the shade of the adjacent crowns and whole trees should be pushed into the stand.

RECOMMENDATION

Problems related to establishing the degree of slash treatment on seismic lines and of enforcing, on relatively short notice, treatment regulations, are difficult to solve. Forest, fuel, and decay conditions vary greatly between regions and the individual(s) charged with these duties differ in their interpretation of what constitutes satisfactory debris disposal. Owing to these difficulties, the best interests of all agencies involved would be served if the Alberta Forest Service levied a fee and utilized that for debris disposal or other operations deemed necessary.



Figure 5. An example of how a seismic line can be used effectively for backfiring.

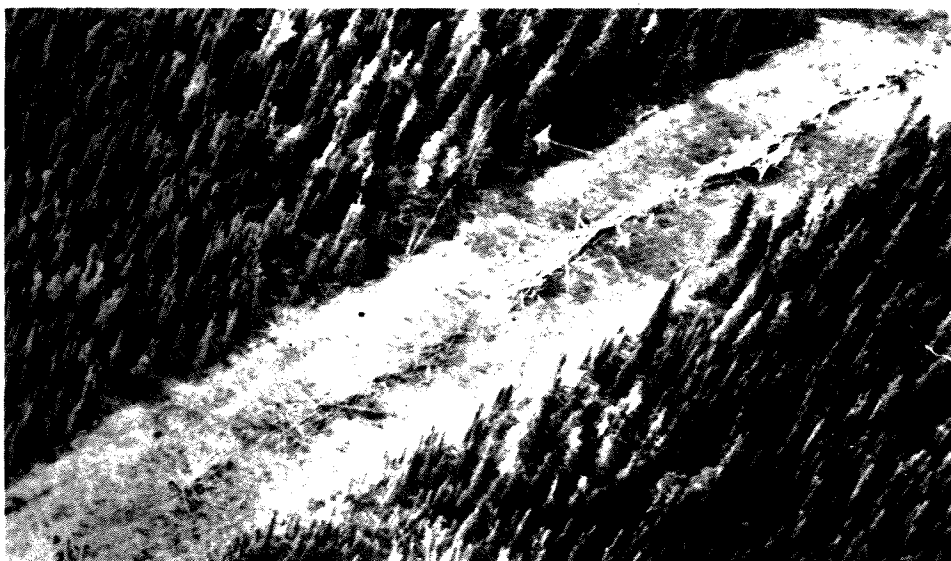


Figure 6. Recommended location of windrows to be burned.