PRELIMINARY GUIDELINES FOR

PRESCRIBED BURNING OF LODGEPOLE PINE SLASH

by

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INTRODUCTION

The clearcut logging method entirely removes merchantable
and unmerchantable trees and adds heavy volumes of slash to the site.
Timber resource managers are left with a problem as this slash in-
creases fire hazard and compounds regeneration efforts.

Prescribed burning is a feasible method of reducing fire
hazard and improving site conditions for regeneration (Chrosciewicz,
1959; Beaufait, 1962; Kiil, 1966; Jarvis and Tucker, 1968; Brender
and Copper, 1968). However, before fire can be safely and effectively
used, burning guidelines are necessary (Dixon, 1965; Beaufait, 1966).

As a contribution towards this end, a study was undertaken
to evaluate rate of spread and fuel consumption in lodgepole pine slash
in terms of past and present weather. Ten one-acre blocks were experi-
mentally burned over a range of weather conditions in the summer of 1969
and the study will continue through the summer of 1970.

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DESCRIPTION OF AREA

Physiography and Soils

The studies were conducted at the Kananaskis Experimental Station, located 50 miles west of Calgary, in an area typical of the Subalpine Forest Region (Rowe, 1959). The burning site, described by Duffy and England (1967) as a well-drained sandy loam alluvium, lies on an old level terrace adjacent to the Kananaskis River. The river valley is about 4500 ft and has a SW-NE orientation.

The burning unit is bounded by the Kananaskis River to the west, by a fairly large creek to the north and east, and by a wide gravel outwash to the south. The area is visible from the Alberta Forest Service lookout on Pigeon Mountain. Figure 1 shows the experimental unit with a moderate hazard fire in progress.

Stand Before Logging

Before logging, the stand was predominantly even-aged lodgepole pine with a scattering of white spruce. The forest floor consisted of moss-covered duff about 3 inches deep. Salin spp, Rosa spp, and Cornus spp composed the understory. Stand characteristics before logging are listed in Table 1.

TABLE 1.   Stand characteristics before logging

Characteristics	Lodgepole pine	White spruce
Average DBH (inches)	8.5	11.3
Average height (feet)	61	68
Average age (years)	90	75
No. of stems per acre	325	100
Basal area (sq.ft/acre)	186	

METHODS

Plot Layout

Twenty-five acres were clearcut during the winter of 1968 in a combined sawlog and post operation. Twenty-foot firelines were bulldozed to mineral soil (Fig. 2), subdividing the area into 16 one-acre plots ($2\frac{1}{2}$ x 4 chains). The long axes of the blocks were oriented to the prevailing valley wind as a headfire effect was desired.

Fuel Inventory

The line intersect method (Van Wagner, 1968) was used to inventory slash weight before and after burning. Unmerchantable stems with diameters greater than 4 inches were tallied by six 120-ft lines radiating at 60° intervals from the center of the plot. Weight of the smaller fuel was tallied by twenty-four 3-foot transects per block, and by the following size classes: 0" to .5", .6" to 2.0", and 2.1" to 4.0".

Duff depth and ovendry weight were determined from 8-sq-ft samples taken randomly from each block. Ninety-six spikes, each measuring 6 inches, were placed flush with the top of the duff layer and used as height standards to measure depth of burn in each block.

Weather and Fuel Moisture

Wind, temperature, relative humidity, and precipitation were continuously measured throughout the summer at a standard weather station located on the burning site. Buildup and Spread Indices (Anon., 1966) and the new Canadian Fire Weather Index (Anon., 1969) were plotted daily and served as guidelines for the fire classes,i.e.,low, moderate, high,and

Fig. 1.   View of the burning site from the Alberta
          Forest Service lookout tower, with a moderate
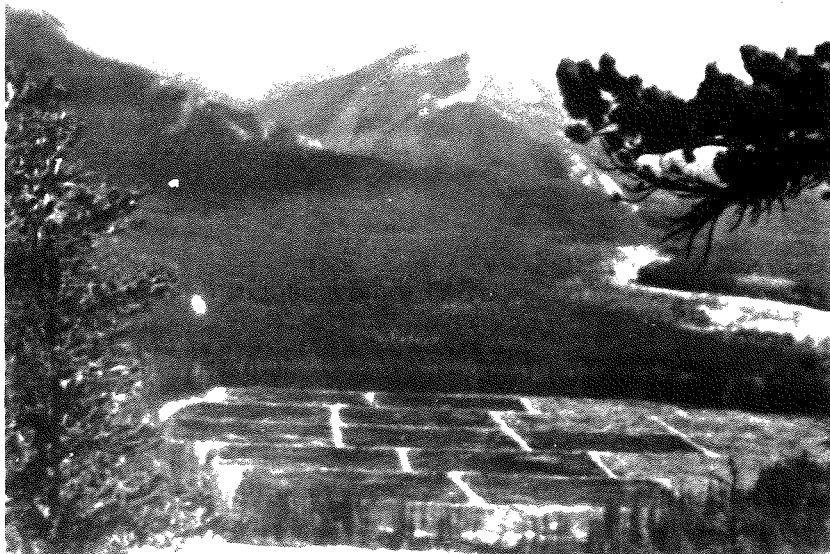   hazard fire in progress.

Fig. 2.   Layout of 1-acre plots delineated by
          20-ft fire lines.

extreme. A range of 0 to 60 on the Buildup Index, divided into four

equal classes, was the main criterion for planning burning periods.

A large drought range was desired for the 1969 studies.

Immediately before each burn, samples for moisture content

determinations were collected for all fuel categories. The samples

were dried in a forced-air oven at 105°C until a constant weight was

recorded.

In addition, $\frac{1}{2}$-inch fuel-moisture sticks were weighed hourly

during burning periods.

Fire Behavior

All blocks were ignited along the lee and windward edge, which

created backing and headfires respectively (Figs. 3 and 4). Rate of

spread was measured by both visual mapping and thermocouple networks.

Fire progress was continuously filmed by an 8-mm movie camera.

Fire Intensity

Fire intensity was calculated from the formula I = Hwr (Davis,

1959) where

$$I \ = \ \text{fire intensity in Btu/sec/ft of fire front}$$
$$H \ = \ \text{heat yield in Btu/pound of fuel}$$
$$w \ = \ \text{weight of available fuel in pounds/sq ft}$$
$$r \ = \ \text{rate of spread in feet/sec}$$

Net heat-yields used to calculate average fire intensity for

each hazard class represent total heat-yields less losses for separation

and vaporization of bound water, incomplete combustion, and radiation.

Fig. 3.   Ignition of a
moderate hazard block
by a pressurized
flame thrower.

Fig. 4.   Headfire, minutes
after ignition.

Fig. 5.   Pre-fire view –
moderate hazard
block.

Fig. 6.   Post-fire view showing
48% reduction of fine
fuels.

Actual values used for low, moderate, high, and extreme classes were 7000, 7100, 7200, and 7300 Btu per pound of fuel.

Suppression

Protection efforts were flexible, as they were organized according to the prevailing fire hazard. Patrol crews from the Alberta Forest Service, Bow River District, assisted Federal forestry personnel during the high risk fires.

Spotting into the surrounding stand was kept to a minimum by the application of 1500 gallons of phos-chek 259 long-term chemical retardant along the perimeter of the 25-acre unit. A pre-mixed batch of retardant was also available as standby if a going fire was to be aborted.

RESULTS

Danger indices and wind speeds for each burn are listed in Table 2. Actual drought range for all experimental fires was 5 to 64, from the Buildup Index.

Fuel consumption in all categories increased with hazard class (Fig. 7). As expected, slash consumption was inversely related to diameter class. Figures 5 and 6 illustrate the effect of a moderate hazard fire on the fine fuels.

Duff reduction showed the greatest increase per class, which reflects the important effect of accumulated drying days on depth of burn. The relationship of depth of burn and Buildup Index is demonstrated in Figure 8.

TABLE 2. Fire hazard by date and burn number

Date	Fire	Buildup[1] Index	Spread[1] Index	Wind Speed (mph)	Danger[1] Rating
July 8	1	5	5	5	Low
July 8	2	5	5	6	Low
July 14	3	19	6	5	Moderate
July 15	4	22	4	2	Moderate
July 22	5	40	10	6	High
July 22	6	40	10	4	High
Aug 1	7	57	18	6	Very[2] High
Aug 1	8	57	18	9	Very[2] High
Aug 7	9	42	11	7	High
Aug 14	10	64	12	4	Very[2] High

[1] Buildup and Spread Index Tables for use at Alberta Forest Service Weather Stations.

[2] For purposes of slash burning, this class was rated as extreme.

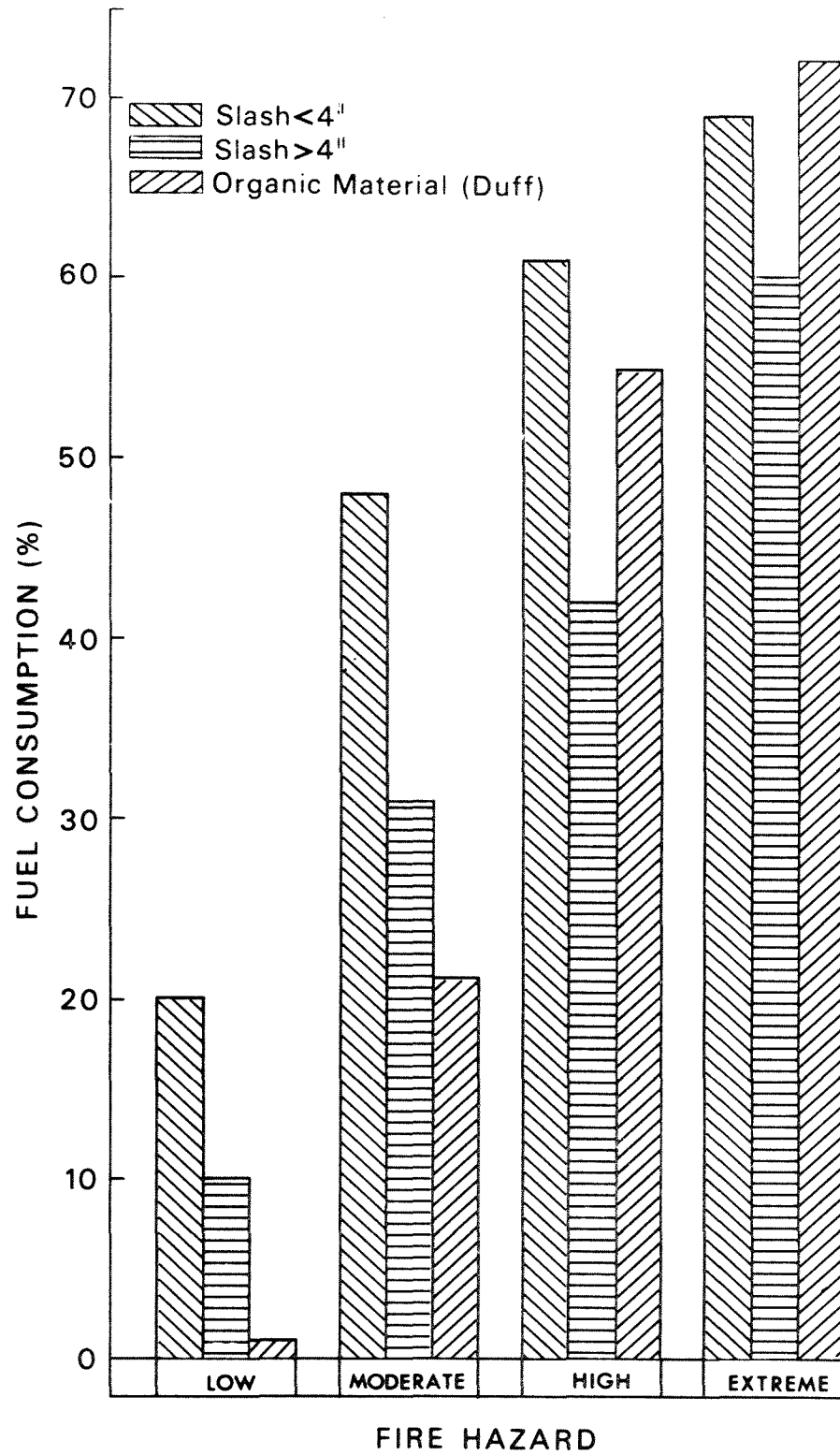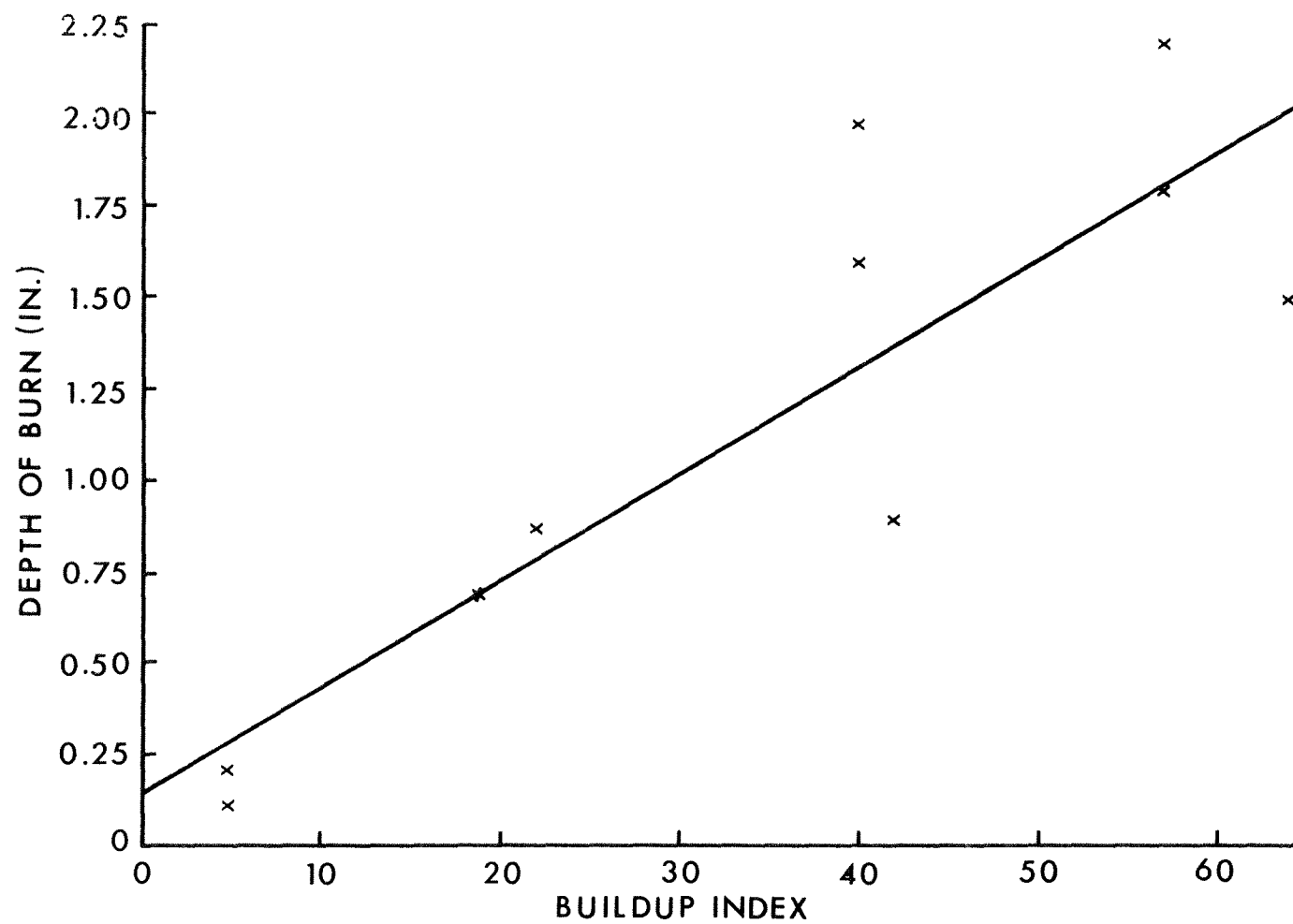Figure 7. Fuel consumption by fire hazard class.

Figure 8. Average depth of burn per block as a function of Buildup Index.

Rate of spread increased exponentially with danger class rating (Fig. 9). Both low and moderate fires exhibit low risk while high and extreme fires are associated with a great increase in risk . In this report, rate-of-spread figures from visual mapping were used.

Fire intensity exhibits a similar exponential curve (Fig.10).

DISCUSSION AND CONCLUSIONS

Firebrand spotting was anticipated and sufficient suppression forces were strategically placed during each fire. Spotting downwind into previously burned area occurred during high and extreme fires. Intense smoke concentration prevented suppression efforts in the downwind blocks until sometime after the burning period and this allowed smoldering to establish itself and spread. Although this created no immediate escape problem, it did add considerably to the mop-up effort.

The analysis indicates a strong relationship between fire accomplishment, i.e., depth of burn and slash consumption, and the relative danger classes defined by the Buildup and Spread Index tables. Fire accomplishment in the low and moderate hazard classes was accompanied with rate-of-spread averages of 8.5 ft/min and 11.0 ft/min. The increase of fire accomplishment in the two upper hazard classes, however, was gained at increased risk, i.e., rate-of-spread averages of 28.0 ft/min and 52.5 ft/min.

For operational burning then, low and moderate hazard fires will effectively reduce slash hazard at a minimum risk. High and extreme class fires, although effectively reducing slash volumes for ease of planting
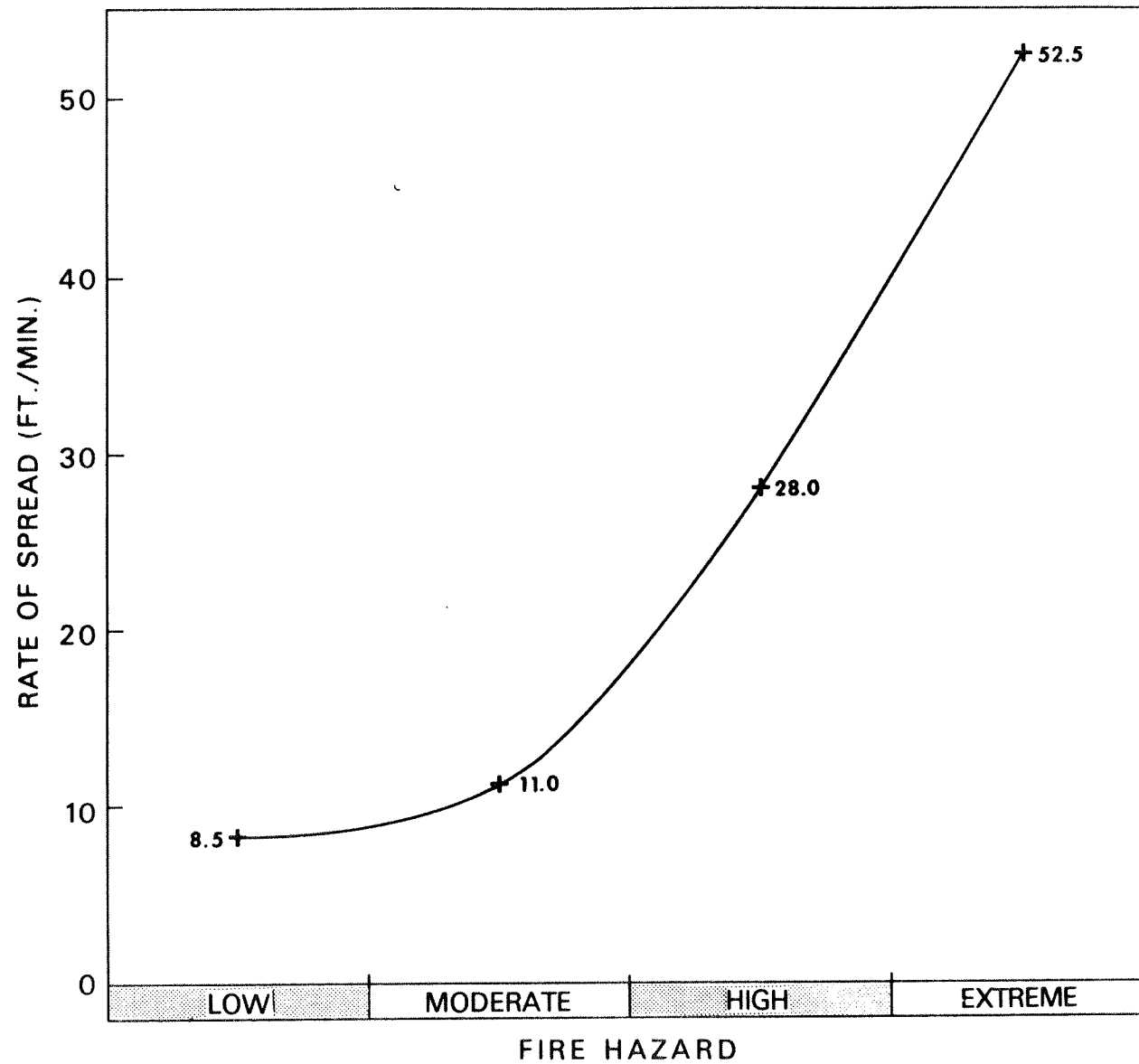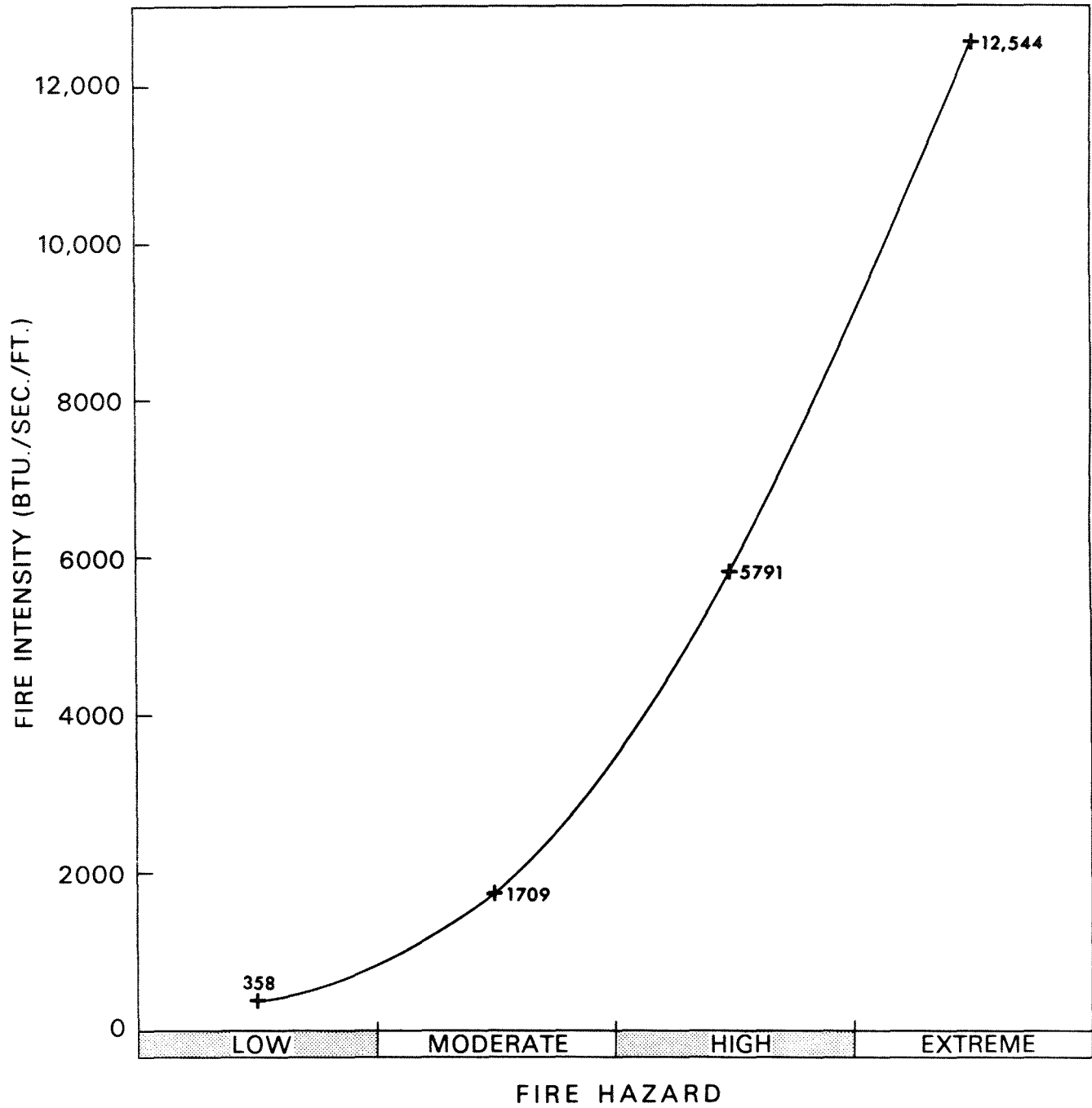
Figure 9. Rate of spread by fire hazard class.

Figure 10. Fire intensity by fire hazard class.

and removing significant portions of organic material, are associated with a much lower safety margin.

Results presented here were obtained from fires in needle-retaining lodgepole pine slash over a selected wind range. They will, hopefully, serve as preliminary burning guidelines to aid the resource manager in timing a controlled-fire program for specific results with a knowledge of the associated risk.

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