EFFECTS OF SPRING BURNING ON VEGETATION IN OLD PARTIALLY CUT SPRUCE-ASPEN STANDS IN EAST-CENTRAL ALBERTA

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INTRODUCTION

Competition from minor vegetation greatly affects the survival and growth of conifer reproduction in the Mixedwood Section of the Boreal Forest Region (Rowe, 1955, 1959). On moist and fertile sites of spruce-aspen (*Picea glauca* - *Populus tremuloides*), the main hindrance to successful regeneration appears to be severe competition from the dense growth of broad-leaved herbs. Lesser vegetation is particularly rank after opening of the canopy by logging. Seedling survival is threatened also by greater extremes of habitat conditions, competition from other plants, grazing by rodents, and smothering by leaf fall.

The project reported here determined if prescribed fire could be used safely and what effect it would have on the makeup of the post-fire vegetation in a partially cut spruce-aspen stand. Such information is essential in the assessment of the value of prescribed burning as a tool in hazard reduction and regeneration.

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The Alberta Forest Service conducted and assumed responsibility for burning and mop-up operations whereas a fire-research team from the Canadian Forestry Service documented fire behavior and fire effects. This report describes only those aspects of the co-operative burning trial for which the Canadian Forestry Service assumed responsibility.

The study area is located in the Lac La Biche Forest 130 miles north-east of Edmonton, Alberta.

MATERIALS AND PROCEDURES

The site selected for study had been logged for merchantable white spruce in the early 1950's, and retained a residual overstory of dacadent aspens and poplars (P. balsamifera) and scattered spruce trees (Fig. 1). The understory component of the residual stand consisted primarily of aspens, poplars, birches (Betula papyrifera), and alders (Alnus crispa (Ait.) Pursh.). Grasses, wild rose, raspberry, highbush cranberry, gooseberry, and fireweed were the important minor vegetation species. Two ten-acre blocks within the area were prepared and instrumented for the prescribed burning experiments.

Stand characteristics were determined on 2 1/5-acre permanent sample plots in each of the 2 burning blocks (Table 1). Measurements on each plot included those of diameter at breast height (dbh) in inches of all stems by one-inch diameter classes, height and crown width of three spruce and poplar dominants in feet, age of several dominants, an estimate of leaf development, and percentage surface coverage and average dominant height of selected species. A count of alder stems was made on a representative subplot 22 ft wide and 132 ft long in each plot.

Figure 1. Aerial view of partially cut spruce-aspen stands.

TABLE 1. Summary of site and stand characteristics for a partially cut spruce-aspen stand

Category	Hardwood	White spruce	All
Avg. diameter at breast height (inches)			
- overstory	14	14	14
- understory	2	N/A	2
No. of stems per acre			
- overstory	50	20	70
- understory	400	N/A	400
Basal area per acre (square feet)	75	23	98
Avg. dominant height (feet)	75	75	
Age of dominants (years)			85
Moisture regime (est.)			2-3
Aspect and slope			4% south-easterly
Depth of organic soil layer (inches)			4-5

Mean height and depth, and weight of pre- and post-burn minor vegetation and litter were determined from data taken from two 2 x 3-ft randomly located subplots within each plot. On each subplot, the minor vegetation was clipped at ground-surface level, the litter was removed down to the top of the underlying F layer. Mean depth and weight of the F and H layers were determined from 1-ft-square sub-subplots extracted in each subplot. All samples were taken to a field laboratory for oven-drying. Pre- and post-burn samplings were carried out on May 16 and

August 12, respectively. On the day of burning, leaves on deciduous vegetation were less than 20% developed.

Rate of fire spread, flame height, and depth of burn were measured and estimated at regular intervals during both burns. Depth of burn was determined by measuring the exposure of 20 6-in spikes placed at 5-ft intervals. Sampling for determining moisture content of selected fuels was carried out about 30 minutes before ignition.

Both blocks were burned between 1 and 6 PM on May 16, 1969. Surface winds throughout the afternoon averaged about 4 mph gusting to 10 mph. Air temperature ranged between 55 and 60°F and the relative humidity averaged about 25%. Weather data for computing Spread and Buildup Indexes were available from Heart Lake Tower about 1 mile from the burning blocks. On the day of the two burns, the Spread and Buildup Indexes were 15 and 31 respectively. No precipitation in excess of 0.03 in had fallen during the last 12 days before burning. A total of 0.51 in of rain and snow fell on May 4.

RESULTS

Fire Behavior

The continuous and well-aerated surface fuels facilitated fire spread and over 90% of the surface area in both blocks was burned over. Average rates of spread of headfires and backfires were 12 and 3 ft per minute respectively. Maximum headfire rate-of-spread exceeded 20 ft per minute but this was observed for short periods when wind gusts exceeded 8 mph. Depth and height of headfires and backfires were estimated to be

2 and 6 ft, and 0.5 and 1.5 ft, respectively. Crowning was observed in the lower parts of some white spruce trees but there was never any threat of extensive crowning. Fire intensities were calculated according to the following forumula (Davis, 1959):

Fire Intensity =	Heat of combustion x	Fuel consumed x	Rate of spread.
(Btu/sec/ft of fire front)	(Btu/lb)	(lbs/sq ft)	(ft/sec)

Heat yield of minor vegetation and hardwood litter was determined to be 6000 Btu/lb. Fuel consumption was calculated to be 0.12 lbs/sq ft and assumed to be similar for both headfires and backfires. Rates of spread of headfires and backfires were 0.2 and 0.05 ft/sec. The resulting headfire and backfire intensities were 168 and 42 Btu/sec/ft of fire front.

Fire Effects

With the exception of isolated wet depressions, the fires consumed all cured minor vegetation and 1.3 in, or about 75% of the leaf litter by depth (Table 2). Combustion of the underlying F layer was negligible and no attempt was made to measure fuel consumption in this layer. Bark on standing trees and parts of shrubs were scorched and partially consumed but this was not believed to have contributed greatly to fire intensity.

Generally, fire spread was predictable and burning under such fuel and weather conditions can be carried out safely and economically.

TABLE 2. Fuel depth, consumption, and moisture content by fuel type

	Minor vegetation	Leaf litter	F layer	Total (L & F)
Percentage surface coverage	75	90	-	-
Avg. depth (inches)	6	1.7	2.2	3.9
Weight per acre of fuel (oven-dry tons)	0.55	2.76	12.17	14.93
Weight per acre of fuel consumed (tons)	0.55	2.07	-	2.62
Moisture content (%)	11.1	10.5	450	-

Three months after burning, nearly all hardwood saplings less than 2 in. in diameter were classified as dead (Fig. 2). A greater proportion of the overstory hardwoods were living but these will probably die within a few years if the presence of firescars, heartrot, and lack of foliage are indicative of their condition. With the exception of a few badly-scarred crowns, spruce trees generally survived the fire better than aspens and poplars. A vigorous growth of alder, willow, and aspen suckers around fire-killed alder stems followed the burns (Fig. 3) but these will likely not reach preburn densities for several years. Of the 637 alder stems counted, 622 or 97.6% were completely defoliated. The mean dominant height of aspen, alder, and willow suckers was 1, 2, and 4 ft respectively. The greatest accumulation of leaves is likely to occur in a few years when perennating parts of aspens and shrubs reach pre-fire densities.

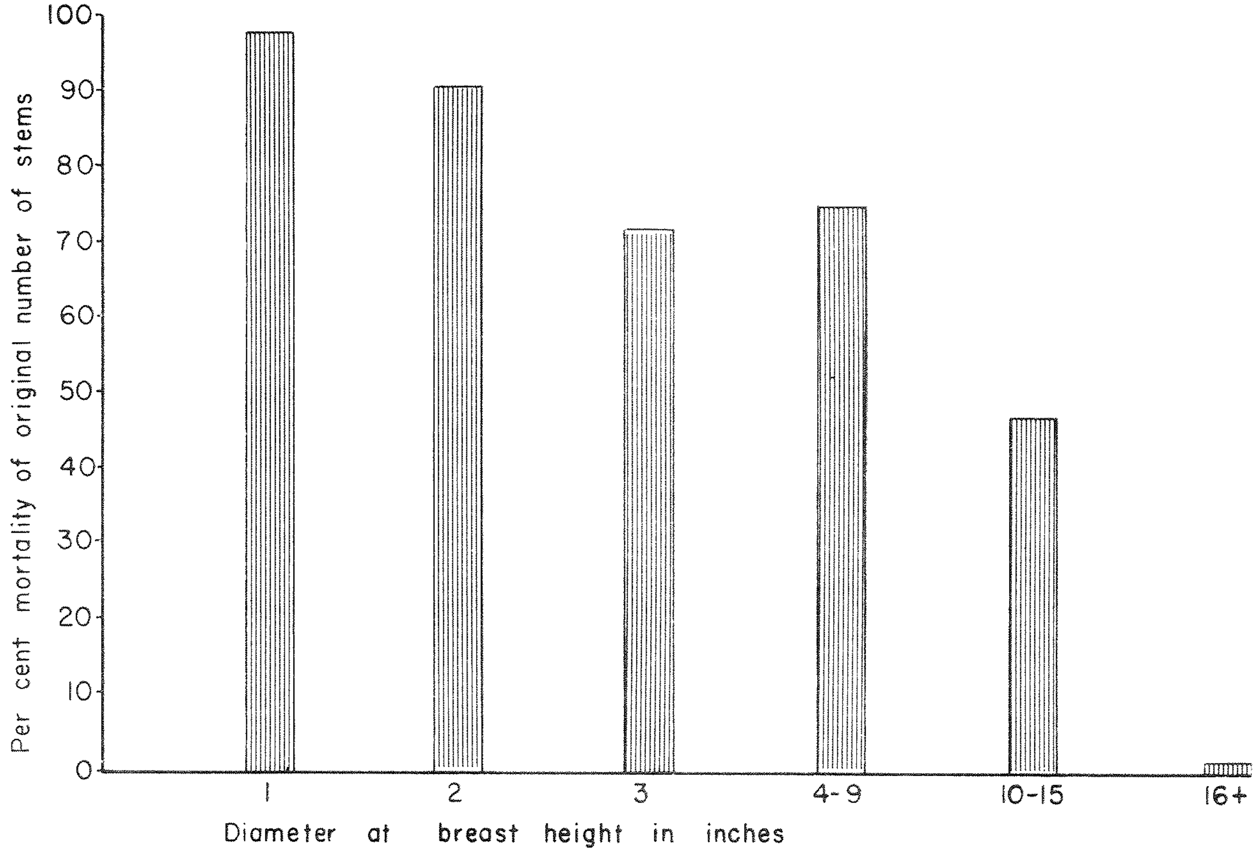

Figure 2. Tree mortality 3 months after burning.

Figure 3. Alder suckering and density of herbaceous vegetation 3 months after burning.

As expected, the light surface-fires stimulated a rank growth of herbaceous vegetation, including fire-weed and grasses. This vegetation was remarkably uniform throughout the burned area and averaged between 2 and 3 ft high (Figs. 4 & 5). Total weight of herbaceous vegetation three months after burning was 0.62 oven-dry tons per acre, of which grasses and fire-weed accounted for 0.33 and 0.05 tons.

DISCUSSION AND CONCLUSIONS

The burning trials in partially cut spruce-aspen stands defoliated and/or killed the dominant aspen and aspen saplings, stimulated the growth of herbaceous vegetation and suckers, and practically eliminated the woody shrubs. The almost complete survival of the residual spruce will hasten its future dominance on these sites. However, the excessive density of suckers and herbaceous vegetation create unfavorable seedbed conditions for establishment of spruce seedlings. The greatest damage to small spruce will result from the smothering effect of leaf accumulation from hardwoods and herbaceous vegetation, and from the lack of adequate light during the growing season. The greatest accumulation of leaves is likely to occur in a few years when perennating parts of aspens and shrubs reach pre-fire densities.

A more intensive burn resulting in a greater amount of duff removal would have reduced the hardwood suckering. That would have required a high fuel concentration and low moisture content; both factors were missing on these sites. Even when slash accumulations burn fiercely,

Figure 4. Close-up of herbaceous vegetation three months after burning.

Figure 5. General appearance of burned block three months after burning. Note charring of bark on standing trees.

damage to roots is slight owing to the high moisture content of the F and H horizons (Tucker and Jarvis, 1967).

Burning may be useful to induce suckering for a future aspen stand (Horton and Hopkins, 1965) and for improving the food supply for big-game animals. In either case, it should be applied shortly after logging when slash accumulations and lack of lush herbaceous vegetation would contribute to greater fire intensities. Because the duff in these stands is usually moist, late-summer burning after an extended period of drought is most likely to produce the desired fire effects.

The application of prescribed burning in old, partially cut spruce-aspen stands resulted in relatively low fire intensities and the operation can undoubtedly be conducted safely and economically both in spring and fall. Three months after burning, the area was covered with a dense growth of herbaceous vegetation and resulted in a shady, moist, and cool micro-environment on the nearly unburned F and H horizons. Nearly all smaller hardwood saplings were killed by the fire but the incoming alder, willow, and aspen suckers will probably reach pre-fire densities within a few years. Artificial and natural spruce seedlings will suffer from the smothering effect of leaf accumulations from hardwoods and herbaceous vegetation. Prescribed fire does not appear to be an effective tool for creating site conditions suitable for survival of conifer seedlings in old, partially cut spruce-aspen stands, but it shows promise for hazard reduction, vegetative manipulation, and improvement of wildlife habitat.

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