Fire Management Branch
Department of Conservation & Environment

A LOW INTENSITY PRESCRIBED BURNING OPERATION IN A THINNED RADIATA PINE PLANTATION

RESEARCH REPORT NO. 6
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INTRODUCTION

Billing (1979) has produced guidelines for the use of low intensity fire to reduce fine fuel quantities after first thinning in pruned radiata pine *(Pinus radiata)* plantation.

A fuel reduction burning operation in the Kentbruck Plantation during October 1979 provided an opportunity to study fire behaviour on an operational scale and to evaluate the guidelines. The influence of lighting technique, site factors, fuel properties and weather on the observed fire behaviour are presented in this report together with a review of the existing guidelines.

STUDY AREA

Compartment 010/01 (Figure 1) is Site Quality III radiata pine and has an area of 22.4 ha. At the time of burning trees in this compartment were 16 years old with a mean diameter (dbhob) of 22.8 cm and a stand height of 22 m. An area of 0.3 ha remained unpruned and was excluded from burning. Lower crown height in pruned areas varied from 4 to 7.5 m above ground level. Slopes within the compartment are less than 7° and access is good.

First thinning took place in two periods. During the first period, in June 1978 an area of 8.8 ha was thinned and in December 1978 and January 1979 the remaining area was thinned (see Figure 1). Thinning removed every fifth row with the remaining trees being thinned to give a final stocking of approximately 700 trees per hectare.

FIGURE 1 - STUDY AREA

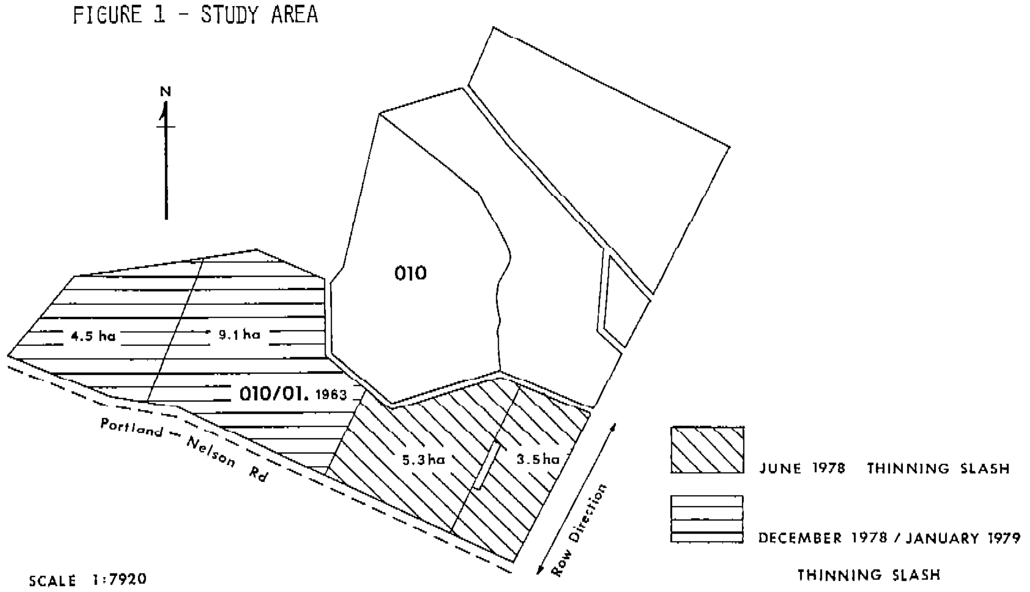


FIGURE 2 - PERCENTAGE OF FUEL BURNT

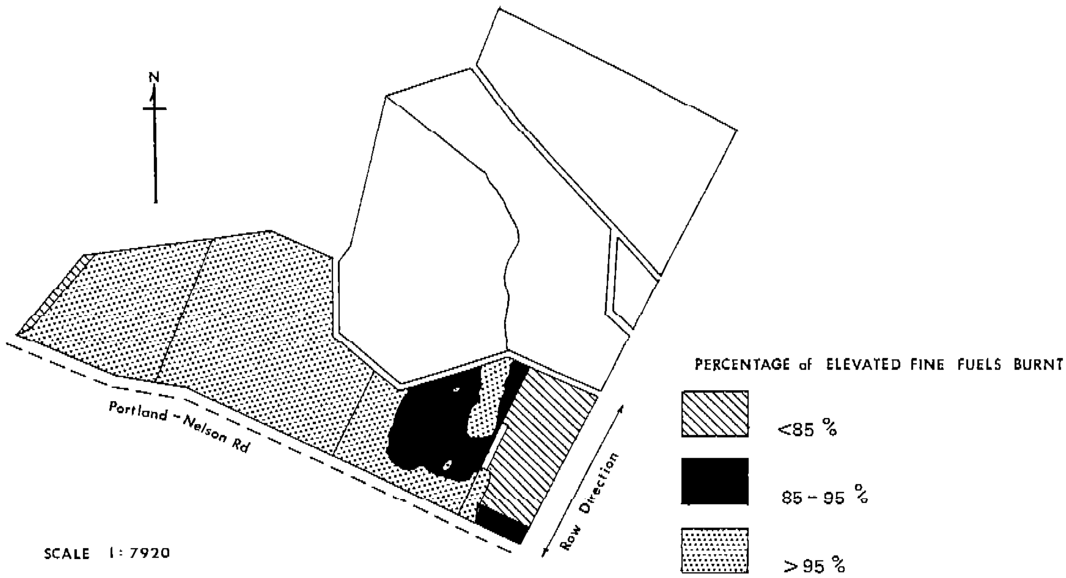
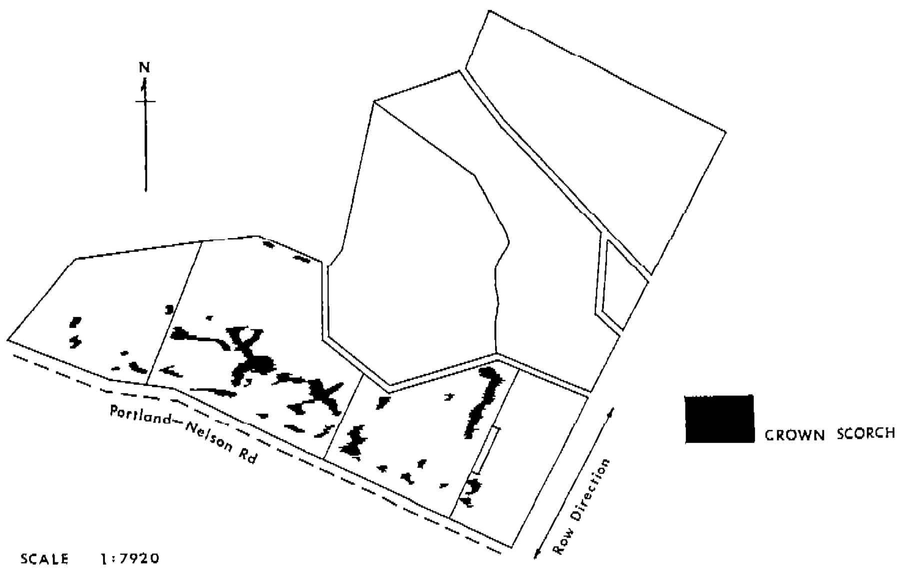


FIGURE 3 - AREAS OF SCORCH



FUEL DESCRIPTION

Fuels were classified into two types based on the age and distribution of thinning slash. The June 1978 slash was 19 months old at the time of burning and the December 1978/January 1979 slash was 10 months old. The older slash had weathered more and contained less elevated fine fuel.

In the June 1978 area, contractors kept slash clear of outrows, and soil disturbance and wheel ruts in the outrows separated the fuel into bays 10-12 m wide. This type of outrow forms an adequate internal fuel break for low intensity fire.

In contrast, contractors thinning the December 1978/January 1979 area placed most of the slash in or close to outrows and as a result the fuels in this area were much more continuous.

DESCRIPTION OF OPERATION

The area was burnt on October 19, 1979. At 1030 hours, the moisture content of elevated fine fuels within Compartment 010/01 was 22.4%. (All moisture contents in this report are expressed as a percentage of oven dry weight). Weather conditions within the stand were mild, with a temperature of 16^{o}C and a relative humidity of 72%. Wind speed at 1.8 m was 2 km/hr from the west.

The Drought Index (Byram and Keetch, 1968) at Heywood was 10 and consistent with this, the moisture contents of the duff layer and coarse fuels at Kentbruck were greater than 40%.

A test fire lit in the June 1978 slash had a rate of forward spread of 15-20 m/hr and a flame height of 0.5-0.8 m at the head. This fire behaviour was considered satisfactory and general lighting commenced at 1040 hours along the eastern edge of the June 1978 area.

1040-1100 hours

Bays of slash fuels in the June 1978 fuel type were lit on the downwind edge using spot fires and short lines of fire. Fires lit in drier fuel near the edge of the stand were observed to spread satisfactorily at 10 m/hr with 0.2 m high flames. However, within the stand, the moisture content of the fine fuel was approximately 22% and fires failed to spread effectively against a 4 km/hr breeze. The lighting pattern was therefore changed to a line of fire within each bay of fuel, allowing the fire to spread several metres with the wind as well as back into the wind. Head fires spread at 18 m/hr with flame heights up to 1 m while backfires spread at 10 m/hr with 0.2 m high flames. At the edge of the stand, fires in drier fuels spread at up to 35 m/hr with 1.8 m high flames.

The wind speed gradually increased to 5 Km/hr at 1100 hours.

1100-1130 hours

As the wind speed increased, back fires failed to spread and significant areas of fuel were not being burnt. The lighting pattern was therefore changed to spots and short lines of fire allowed to spread with the wind across each bay of fuel.

At 1130 hrs the wind was steady at 6 km/hr and the fires were spreading at up to 35 m/hr with 1.6 m high flames. Flank fires were spreading at 20 m/hr with flames 0.4 m high.

Outrows in the June 1978 fuel type helped to regulate the area alight by dividing the fuel into convenient work units. These bays of fuel were burnt out relatively quickly by head fires and flank fires compared to the burn out time associated with back fires.

1130-1230 hours

During this period the wind speed within the stand fluctuated between 6-8 km/hr. Fire behaviour was generally similar to the previous period although on some slopes, the rate of spread increased to 60 m/hr and flame heights of 2 m were observed.

At 1230 hours burning in the 8.8 hectare June 1978 fuel type was completed.

1300-1415 hours

Without the advantage of outrows forming internal fuel breaks, the lighting pattern was altered to burn the fuel in strips from a safe downwind edge. Lighting commenced on the north and north-east edges of the December 1978/January 1979 fuel type using spots and short lines of fire about 25-30 m apart.

By 1315 this lighting pattern was proving to be suitable in most areas as head fires spread at 40 m/hr with flame heights up to 2 m, and the flank and back fires were also spreading satisfactorily. However, on more exposed sites with slopes near seven degrees, fire spread more rapidly and at 1330 hours spread rates of 80 m/hr were recorded.

As the area alight increased, so did the convective activity over the fire. Increased local wind speeds associated with stronger convection caused the spread rate to increase to approximately 100 m/hr for about ten minutes. Flame heights during this period were close to 3 m in the zones where flame fronts converged.

By 1400 hours the convective activity had moderated considerably with the spread rate decreasing to 45 m/hr.

The area was burnt out at 1415 hours.

RESULTS AND DISCUSSION

Weather and fire behaviour data collected during the operation are shown in Appendix 1.

1 Operational Success

The success of an operation of this type must be assessed not only in terms of the reduction in fuel quantity achieved, but also the extent of any damage sustained by the stand.

This operation significantly reduced the quantity of elevated needle fuel in thinning slash as well as needle fuel on the ground (see Figure 2) and has therefore considerably reduced the additional fire hazard created by the thinning operation. The quantity of fine fuel removed by burning was estimated at 10–12 t/ha.

Immediately following the fire there was no evidence of stem damage. The high moisture contents of both the heavy fuels and the duff layer meant that fires failed to ignite these fuels and this would have been an important factor in minimizing stem damage. However, there were some areas where scorch did occur (Figure 3) due to a combination of higher than average fire intensities and the lower green levels present on poorer sites within the compartment. The effect of crown scorch on tree growth is unknown at this stage, and a study has been established to determine if there is a significant effect.

2 Adequacy of Established Burning Guidelines

The guidelines previously specified for burning first thinning slash in radiata pine plantations (Billing, 1979) are shown in Table 1.

TABLE 1 - BURNING GUIDELINES

DI	Moisture Content (%) O.D.wt) Duff	Elevated Fuel	Wind (Km/hr)	Temp (^{o}C)	RH (%)
<70	>40	17-21	<5	<20	>50

In addition, Billing recommended using a back firing technique, in conjunction with the parameters shown in Table 1, to achieve a satisfactory result.

The moisture content of elevated fine fuels was within the specified range of 17-21% and both the coarse fuels and duff layer had moisture contents greater than 40%. There is no evidence from this operation to suggest that the present fuel moisture limits should be altered.

The general wind speed under canopy was less than 8 km/hr during the burning period although convective activity caused the wind speed near the fire to exceed this value later in the burn. Winds up to 8 km/hr were found to be associated with satisfactory fire behaviour in most areas although on poorer sites crown scorch did occur. However, despite the fact that over most of the area scorch was not significant, it is considered that the upper limit of 5 km/hr, within the stand, should be retained in the guidelines.

The guidelines recommended the lighting pattern should be based on a line of fire allowed to backburn across an area. Generally, this approach is now considered most suitable if the area to be burnt consists of strips less than 30 m wide and the fine fuel moisture content is close to the drier end of the range. However, the burn out time associated with back fires is quite long and a large area may be alight during an operation. This disadvantage is offset to some extent since back fires eliminate junction zone effects and have a greater safety margin if burning conditions deteriorate.

Although not recommended in the guidelines, a lighting pattern based on spot fire development or a line of head fire is more suitable at higher fine fuel moisture contents, particularly where broad scale burning is involved. Under these fuel conditions back fires may not spread as effectively as head fires or flank fires. Since burn out time is reduced and the area alight can be kept to a minimum, the use of head and flank fires is more efficient. To minimise crown scorch, lighting patterns which reduce the area burnt by junction zones should be selected. A wide spacing of spot fires or a line of head fire under calmer conditions may be applicable.

In the June 1978 thinning slash, the outrows acted as internal fuel breaks and did not permit the fire to develop momentum. In contrast, the fuels were continuous in the December 1978/January 1979 thinning slash, allowing fires to spread unchecked. From this experience it seems desirable to have some form of internal fuel break, to divide the area into manageable sections, and to give more control over fire behaviour. Where broad scale burning is planned, internal fuel breaks which divide the area into convenient sections are strongly recommended.

3 Cost

The 22 ha burn was completed in less than four hours. Three men from the crew of five were used to light the area. The total cost was approximately $150, or $7/ha.

CONCLUSION

Low intensity fire in Compartment 010/01 has achieved a satisfactory reduction of fire hazard by burning almost all fine fuels in first thinning slash and on the ground above the duff layer.

The operation confirmed the guidelines in Fire Research Branch Report No 4 generally provide a sound basis on which to develop burning operations in first thinning slash, although some adjustments to the lighting pattern used may be required depending on the conditions.

ACKNOWLEDGEMENTS

The assistance and co-operation of the staff and employees of the Heywood Forest District is acknowledged.

REFERENCES

Byram G M & J J Keetch (1968)	A drought index for forest fire control. U.S. For. Serv. Res Pap. SE-38
Billing P R (1979)	Using fire to reduce fuel accumulations after first thinning in radiata pine plantations. For. Comm. Vic - Fire Research Report No. 4. Unpublished.

APPENDIX 1

FIRE BEHAVIOUR AND WEATHER 19/10/79

Time	Temp (°C)	RH (%)	Wind Vel Km/hr	Wind Dir^n	Moisture Content Elev.Fine Fuel (%)	Headfire Max R.O.S. (m/hr)	Headfire Flame Ht (m)	Flankfire Max R.O.S. (m/hr)	Flankfire Flame Ht (m)	Backfire Max R.O.S. (m/hr)	Backfire Flame Ht (m)	Area Burnt (%)	Max Scorch Ht (m)	Max Intensity (KW/n)
1030	16	72	2	W	22.4									
1045	17	72	3-4	W	-	18	1.0	12	0.2	10	0.2	<85	<4	90
1100	17.5	72	5	W	21.1	20	1.3	12	0.2	10	0.2	85-95	<4	100
"	17.5	72	8	W	21.1	35	1.8	12	0.2	10	0.2	<85	5-6	180
1115	17.5	68	5-6	W	-	30	1.5	15	0.3	12	0.3	↑	<4	155
1130	17.5	68	6	W	-	35	1.6	20	0.4	15	0.3	85-95	<4	180
1145	17	68	6-8	W	19.9	40	1.6	20	0.4	12	0.3	↓	4-5	210
1200	17	68	6-8	W	-	36	1.6	20	0.4	15	0.3	↑	4-5	190
"	17	68	8	W		60	2.0	25	0.5	12	0.3		7-8	310
1215	16.5	68	6	W		40	1.8	20	0.4	12	0.3		5-6	210
1230	16.5	68	6-8	W	19.2	42	1.8	18	0.3	12	0.3		5-7	220
1300	17	68	6	W	-	36	1.8	20	0.4	12	0.3		5-7	190
1315	17	62	6	W		40	1.8	20	0.4	10	0.3		6-8	210
1330	17	68	6	W	18.5	45	2.1	25	0.5	12	0.3	>95	7-9	240
"	17	68	9	W		80	2.5	25	0.5	12	0.3		10-12	420
1345	17	68	6-8	W		60	2.0	25	0.5	15	0.3		8-10	310
"	17	68	12	W		100	2.8	25	0.5	15	0.3		15-18	520
1400	16	72	5	W	19.5	45	1.8	20	0.4	12	0.3	↓	6-7	240
1415	16	72	5	W										