29

Landnote

Department of Conservation & Land Management

2/88

ASPECTS OF FIRE BEHAVIOUR AND FIRE SUPPRESSION IN A PINUS PINASTER PLANTATION

By N. Burrows, B. Ward and A. Robinson

INTRODUCTION

As part of the Kirup District's fire training programme, a small plot of *Pinus pinaster* was set alight to test the District's Red Action despatch and Large Fire Organisation procedures. This exercise also provided a rare opportunity to study aspects of *P. pinaster* fire behaviour under warm, dry conditions.

This note reports on fire behaviour observed during the exercise and makes comparisons with that predicted by the Department's "Forest Fire Behaviour Tables for Western Australia" (Red Book). The effectiveness of various foam lays on reducing fire intensity is also discussed.

The Study Area

The exercise was conducted at Mullalyup in a 7 ha area of 17 year old *P. pinaster*. The plot was heavily stocked (about 2 000 stems/ha) with unpruned trees of very poor form. Having outlived its usefulness, as a growth plot, it was scheduled for clearing and re-planting with native tree species.

METHODS

The area was divided into a number of plots, each about 1.3 ha, by a bulldozed firebreak. Three types of fuel were identified in the area, these being i) needlebed, ii) dead needles suspended in the branches of standing trees and iii) live needles in tree crowns. Each fuel type was sampled to determine its weight (tonnes/ha) before and after burning and fuel moisture content was monitored throughout the day of the exercise. The mock Red action commenced with the lighting of one of the small subplots at 1000 hrs on December 10th, 1986.

Throughout the day, several other plots were lit to test suppression techniques such as the effectiveness of foam and retardent lays on slowing headfire spread.

Comparisons were made of the observed rate of spread of fire and with the rate of spread predicted by the Red Book. Red Book predictions were compared on the basis of both forecast parameters (weather and fuel moisture) and measured parameters.

RESULTS

Table 1. Predicted and observed fire rates of spread for *P. pinaster* plots.

Plot No.	Ground fire rates of spread (m/h)			Observed crown fire rates of spread (m/h)
	Predicted using predicted fuel and weather parameters	Predicted using measured fuel and weather parameters	Observed	
1	154	137	180	280- 350
2	165	155	200	900-1440
3	165	155	158	400- 800

Table 2. Weather conditions measured during the burning of the *P. pinaster* plots.

Time (hrs)	Temp (°C)	R.H. (%)	Tower wind speed (km/hr)	Under canopy wind speed (km/hr)	Wind speed ratio tower: under canopy
1030	21	37	20	3.2	6
1130	23	35	20	3.8	5
1230	23	33	22	3.4	6
1330	25	31	22	3.7	6
1430	25	30	24	2.9	8

Table 3. Estimates of fuel quantities before and after burning *P. pinaster* plots.

Sub plot No.	Mean fuel quantities before burning (t/ha)			Total quantity burnt (t/ha)	
	Needlebed	Aerated dead needles	Live crown needles	Crown fire	Ground fire
1	10.1	1.1	6.7	17.9	12.0
2	10.7	2.8	8.5	20.6	12.1
3	10.6	1.7	7.2	19.0	11.8

Table 4. Predicted (Red Book) and measured fuel moisture content in *P. pinaster* plots.

Time (hrs)	Fuel Moisture (%)				
	Measured			Predicted	
	Surface	Profile	Aerial	Surface	Profile
1045	10.1	10.9	11.1	13	19
1235	12.1	12.6	12.5	12	20
1440	10.5	14.2	11.4	10	21

DISCUSSION

Observed rates of fire spread varied considerably during each burn. Fires pulsated from severe crown fires to slow burning backfires. Hence, within any one plot, spread rates varied from about 40 m/h to in excess of 1 000 m/h during short bursts of crown fire activity (Table 1). However, the average rates of spread, calculated by dividing plot length by the total time taken for the fire to burn through the plot, varied from 158-200 m/h. This compares favourably with the average rates of spread predicted using the Red Book (see Table 1).

The observed pulsating fire behaviour can best be explained by the continual inter-play between the ambient windfield and the fire induced convection column. When a large area of dry and heavy fuels is burning (that is, the flames are deep) then the energy in the convection column is greater than that in the windfield, so the flames are erect. This causes torching and the development of crown fires. As the ground fuels in the deep flaming zone burn out, the convection column collapses and the flames lean over the unburnt fuels and spread as a ground fire.

While the predicted values for fire rate of spread were close to the average spread rate throughout the plot, the extremes of fire behaviour observed were far in excess of that predicted. It seemed that fuel, weather and stand conditions during this exercise were just below the threshold for sustaining crown fires. Perhaps crown fires would have been sustained if wind speeds were slightly higher. However, when crowning did occur, then fire spread rates were 2-5 times that of ground fires.

In keeping with observations made elsewhere, there was no observed long distance spotting from these fires. Spots were thrown 50-100 m at most. Pine needles burn away completely and cool more rapidly than eucalypt leaves and bark so have less potential for long distance spotting.

The foam lays were completely ineffective under the conditions of this trial. Fuel loads were too great and the energy output of the fires was more than sufficient to evaporate the foam, and ignite the fuels with no effect on fire behaviour.

CONCLUSIONS

The potential exists for severe and erratic crown fire development in well stocked pine plantations carrying heavy ground fuels. The Forest Fire Behaviour Tables (Red Book) performed well in predicting ground fire spread, but were not able to forecast crown fire behaviour or spotting potential. Both phenomena can lead to extreme fire behaviour.

The surest and safest way of preventing and controlling crown fires in pine plantations is to manage fuels before the event of a wildfire. This involves reducing ground fuels and pruning and thinning to reduce the risk of crown fires. Ground fuels (needlebed) re-accumulate very rapidly in pine plantations so to be effective in minimising the impact of wildfires, fuel reduced buffers need to be burnt at least every 3 years.

REFERENCE

SNEEUWJAGT, R.J. and PEET, G.B. (1985) - Forest Fire Behaviour Tables for Western Australia. Department of Conservation and Land Management, Western Australia.

ACKNOWLEDGEMENTS

We thank CALM personnel at Kirup District and Linda Simmonds for typing.

0666 0788 500