A CONTROLLED BURNING GUIDE FOR MARITIME PINE PLANTATIONS

by

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INTRODUCTION

This fire behaviour guide is for planning controlled burning in plantations of Maritime pine (P. pinaster). It is a preliminary effort, has not been presented as a Departmental report, and therefore has no official sanction.

Our purpose in publishing it here is to invite you, the users, to suggest such modifications or changes you think are necessary for field operations. These can be incorporated before putting it forward for approval and general testing.

We intend making a few changes in the figures, e.g. moisture contents in Tables I, II and III will be re-calculated before next winter. It is unnecessary to deal with the details of these figures unless you observe a glaring mistake. More value to us will be gained by concentrating on presentation, ease of understanding and use.

We used five tables where information flows from one to the next culminating in an expression of fire intensity. The principles of this flow are similar to the Jarrah tables, but the way moisture content and fire intensity are calculated varies somewhat.

We would like to know if the flow from one table to the next is easy to follow. If not, where do the hitches lie?

Are the fuel and weather factors used in the tables readily understood? Is information in Tables IV and V sufficient to stop or start a burn? Do you think an extension to cover lighting technique should be added? Is the explanation adequate, and if not where are the confusing parts?

An alternative presentation you may prefer is the slide rule type such as McArthur used for his forest fire danger tables.

BACKGROUND INFORMATION

The controlled burning guide (attached) deals with winter conditions and refers best to unthinned stands.

Separate papers have been written by McCormick in this issue, showing methods of assessing fuel tonnages and allowing for edge effects in drying.

It is assumed fuels have been mapped and sufficient winter rain has fallen to thoroughly wet the duff and ground-wood. (Between 3 and 5 inches in the past 4 to 6 weeks seems necessary).

Since the prerequisites are a wet duff and wood, these fuels play no further part in this calculation of fire behaviour. The guide refers to fires burning in the top ½ to 1½ inches of a litter bed. The quantity of fuel and its moisture content are worked out first, then wind is added

for rate of forward spread and, finally, rate of spread combines with available fuel to predict fire intensity.

WEATHER

Certain weather information is necessary for these tables.

(a)   Forecast of minimum relative humidity and wind strength to-day.

(b)   Measurements of wind strength at 4 feet above the ground within the compartment (roughly one-fifth of velocity at 30 feet in the open).

(c)   A record of rainfall read at 8 or 9 a.m. each morning, also number of dry days since rain. A drying day is one when no rain fell (ignore the temperature control used for jarrah). Combine rain which fell on successive days.

(d)   A chart of overnight relative humidity. Moisture uptake in litter depends on time of exposure as well as on increases in humidity. An easy way of integrating the two was to count the rectangles on a hygrograph chart. The instrument used here was a Casella thermohygrograph fitted with a 7-day chart. One rectangle represents a count of 1, also 2 per cent humidity for 2 hours (refer Fig. 1). The chart should be marked at the 70 per cent humidity line. Each morning count the rectangles between the trace and 70 per cent line. This is the overnight relative humidity count for Table II. If charts vary in calibration adjustment is easily calculated on the basis of what one rectangle represents.

(e)   List the weather information and table calculations in the sequence shown in Table VI. This will minimize errors and keep the day to day calculations in order.

DISCUSSION

This method of estimating moisture content should be a closer approximation to natural conditions than the jarrah tables.

After rain, no account is taken of daily fluctuations until the 3 p.m. moisture content reaches 36 to 40 per cent. Thereafter, the fuel is inflammable and day and night changes become important.

The rate of moisture change depends on initial moisture content as well as the drying force. This was the reason for using 3 p.m. percentages, to work out overnight gains, and 9 a.m. for daily drops.

Some testing was done with the spread phase (Table IV).

For 100 fires predicted rates from Table 4 were compared with actuals. For 70 fires actual spreads were slower than predicted, indicating the tables tend to overestimate. The error was not large, for 93 fires actual rates were within 0.6 feet per minute of predicted rates. Fifty fires were within 0.2 feet per minute. This is ample accuracy for the field since fairly tight safety limits were imposed in both Tables IV and V.

In Table V, fires exceeding 20 B.T.U. per second per foot were considered risky for controlled burning. These limits were set from growth plots all of which were burnt quite mildly. It may be possible to slacken the controls once results of more intense fires last winter are known, and some measure of the risk point is fixed. On the other hand, it is unnecessary to burn at intensities of more than 20 B.T.U. to fill the objectives of controlled burning.

The guide assumes normal tree sizes are maintained in planning. Burning under trees less than 6" diameter, with a 1/3 to ½" thickness of bark, and pruned, is considered risky. Scorch to tree crowns should be negligible.

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CONTENTS AND EXPLANATION

Table I. Uses amount of last rain and number of dry days since rain to predict when an initial 3 p.m. moisture content of 36 to 40 per cent is reached, and thereafter tons per acre of needle fuel available for burning. When 3 p.m. M.C. reaches 36 to 40 per cent move to Table II.

N.B. Field check fuel availability before lighting, i.e.
  ½" of dry surface needles = 3 tons per acre.
  1" of dry surface needles = 5 tons per acre.
  1½" of dry surface needles = 7 tons per acre. .

Note "too damp" and "unsafe" dry limits. At 36 to 40 per cent litter will ignite but burning will not sustain.

Table II. Predicts Moisture Content of surface needles at 9 a.m. to-day from their M.C. at 3 p.m. yesterday, and overnight count of relative humidity. (A count of 1 represents an increase of 2 per cent (above 70) for 2 hours. Note "too damp" limit.

Table III. Predicts M.C. at 3 p.m. to-day from to-day's 9 a.m. M.C. (Table II) and minimum relative humidity. Note "too damp" and "too dry" limits.

Table IV. Predicts rate of Forward Spread of Headfire from 3 p.m. M.C. (Table III) and wind velocity at 4 feet in the compartment. Note safe limits.

Table V. Combines R.O.F.S. (Table IV) with available fuel (Table I) to predict fire intensity for the burn in B.T.U./sec./ft. Note boundaries of safety.

Table VI. Provides an example of the weather record necessary to work the table. A forecast of minimum relative humidity to-day and wind strength is needed as well. The table shows the sequence of "feeding in" and "extracting" information and finally whether conditions are safe or otherwise.

Table I. Effects of Past Rain showing time to reach a M.C. of 36 to 40 per cent and Increasing Fuel availability thereafter.

Number of Days Since Rain	Amount of Rain (points)				
	10	30	50	100	150+
1	3				
2	5	3			
3	7	5	3		
4		7	5	3	
5			7	5	3
6				7	5
7					7

36 to 40 per cent.

Table II.   Moisture Content at 9 a.m. (%)

3 p.m. M.C. (yesterday)	Overnight Count of Relative Humidity								
	10	20	30	40	50	60	70	80	90
6 to 10	12	14	16	18	19	21	23	24	26
11 to 15	13	16	18	20	23	25	27	30	32
16 to 20	14	17	20	23	26	29	32	35	
21 to 25	15	19	23	26	30	34	38		
26 to 30	16	20	25	29	33	38		Too	Damp
31 to 35	17	22	27	32	37				
36 to 40	18	23	30	36					

Start point from Table I.

Table III.   Moisture Content at 3 p.m. (%)

9 a.m. M.C. (Table II)	To-day's Minimum Relative Humidity							
	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70	71 to 80	81 to 90
6 to 10	3	5	7	8	9	10	15	19
11 to 15	4	7	9	12	14	17	20	23
16 to 20	5	8	11	14	17	21	24	28
21 to 25	6	10	13	17	21	24	28	32
26 to 30	7	12	15	20	24	28	32	37
31 to 35	8	13	17	22	27	32	38	40
36 to 40	9	15	19	25	30	36	40+	40+

Too Dry   Too Damp

Table IV.   Rate of Forward Spread of Headfire (ft./min.)

3 p.m. M.C. To-day	Wind Velocity at 4 feet in m.p.h.									Flame Ht. and R.O.S.	
	0 to 0.5	0.6 to 1.0	1.1 to 1.5	1.6 to 2.0	2.1 to 2.5	2.6 to 3.0	3.1 to 3.5	3.6 to 4.0		R.O.S.	F.H. feet
11 to 15	0.8	1.0	1.4	1.7	2.0	2.3	2.6	2.9		0.5	1.0
16 to 20	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.6		1.0	1.5
21 to 25	0.5	0.7	1.0	1.2	1.5	1.7	1.9	2.2		1.5	2.0
26 to 30	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8		2.0	2.5
31 to 35	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.3			

Patchy   Risky

Table V.   Acceptable Fire Intensity

R.O.F.S. ft./min.	Av. Fuel Tons/acre		
	3	5	7
0.5	Safe		
1.0			
1.5		Risky	
2.0			
2.5		Unsafe	

Table VI.   Example of Weather Record

1	2	3	4	5	6	7	8	9	10	11		
Date	Rain to 9 a.m. (points)	Number of dry days	Fuel Average (T.1.)	Count of RH	M.C. at 9 a.m. (T.2.)	Min. RH To-day	M.C. at 3 p.m. (T.3.)	Wind Vel. at 4 feet	ROFS ft/min (T.4.)	Fire In-tensity Class (T.5.)	Column refers to	Table No.
1	170	1	Too Damp								2	1
2		2	,,								3	1
3		3	,,								5	2
4		4	3	30	30	40	15	0.8	1.0	Safe	7	3
5		5	5	40	20	28	8			Too Dry	9	4
6		6	7	90	26	80	32	1.7	0.7	Safe	10 & 4	5
7		7	Too Dry									
8	10	1	5	20	23	44	17	2.3	1.7	Risky		

Fig. I

COUNT OF OVERNIGHT

RELATIVE HUMIDITY

Number of rectangles exceeding 70% = 39

One rectangle = 2% RH x 2 hours.