ASSESSMENT OF FIRE DAMAGE IN KARRI POLES

by

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INTRODUCTION

The Manjimup fire research section conducted over 100 experimental fires in a 40-year old stand of karri poles from October 1970 to March 1971. The fires ranged from light, patchy burns of 50 B.T.U./sec./ft. to intense, all scrub-consuming conflagrations of up to 800 B.T.U./sec./ft.

The range in fire behaviour within a uniform stand presents an ideal opportunity to assess the effect of fire on both crown and bole damage.

This study sets out to determine the extent of damage incurred by the stand with the aim of setting limits of fire behaviour in these forests.

METHOD

Location

The study area located at Four Mile Road consists of a mostly pure karri pole stand averaging 80 feet in height, and ranging from 60 feet to 120 feet. The area had been divided into plots ranging in area from $\frac{3}{4}$ acre to 8 acres and which contained at least one experimental fire each.

Fire Intensity

A pilot study indicated that approximately 40 chains of assessment would be required to obtain an acceptable level of accuracy in estimating crown and bole damage.

An attempt was first made to carry out the assessment through three levels of fire intensity. These levels were defined as hot, mild, and cool. The level for "cool" was between 0 and 150 B.T.U., for "mild" between 200 and 300 B.T.U., and "hot" from 350 to 800 B.T.U. The intensities were determined from Byram's formula: $I = h.w.r.$, where I = intensity, h = heat of combustion (6), w = weight of fuel consumed (T.P.A.), r = headfire rate of spread (feet per minute).

Twenty four permanent assessment lines, 5 chains long and 1 chain wide were pegged through plots falling into one of the above intensity levels. Lines were located so as to include the densest grouping of pole and sapling size trees present within each experimental-burning plot. From inspection of the burning plots chosen, it was obvious that in some cases the calculated fire intensities did not reflect the extent of fire damage observed. For example, a plot defined as "mild" had sustained far more scorch than another defined as "hot".

It was decided to obtain another estimate of fire intensity by the use of an alternative formula which employed simply headfire flame length.

The formula is

$$I = 5.62\ h^{2.17}$$

where h = headfire flame length (feet)

The fact that the above formula requires an estimate of only one easily determined variable makes it an improvement over the first formula of, I = h.w.r. which employs two hard-to-measure variables. A field check revealed that the new fire intensity estimates correlated with fire damage to a greater degree than the first estimates. It was decided to use the flame-length derived fire intensity values.

The modification of fire intensity values meant a reclassification of intensity levels. The level for "cool" became 0 to 100 B.T.U., for "mild" between 110 and 300 B.T.U., and for "hot" between 310 and 800 B.T.U.

The new distribution of assessment lines are -

Intensity	No. of Chains
Cool	45
Mild	30
Hot	45

Damage Assessment

Trees within the line plots were placed in one of four damage categories of fire killed, epicormic crown, bole epicormics and normal crown.

Within each damage category stems below 12" D.B.H.O.B. were separated into the following diameter classes - 0 - 3.0", 3.1" - 6.0", 6.1" - 9.0", 9.1" - 12.0". The stems above 12" D.B.H.O.B. were separated into the G.B.H.O.B. classes of 36" - 60", 60" - 80", greater than 80".

The trees were noted for their dominance or suppression within each size class.

Any sign of butt damage was noted, however it was realized that this damage would be best detected about 12 months after burning when the trees had shed their bark.

It is planned to conduct the damage assessment annually so that such damage as butt scarring and drysiding may be detected as well as the scorch damage.

RESULTS

The results of assessments in the four fire damage classes are given in Table 1. There were a total of 2,647 trees observed in the 120 chains (12 acres) of line assessed. 762 of these were dominants and potential crop trees.

(i) Fire Killed

As the table shows, fire deaths occurred in 55 per cent of the trees with diameters less than 9.0 inch, and no deaths occurred in the larger trees. Of the fire killed trees only 0.7 per cent belonged to the dominant crown category, and the rest belonged to the suppressed category. The percentage of deaths occurring in the three classes up to 9 inch d.b.h.o.b. was plotted against the calculated fire intensity. See figure 1. The curves show that death begins to occur in the 0 - 3.0 inch class at the low intensity of 10 B.T.U. per second per foot, and that these increase very rapidly to 90 per cent at 50 B.T.U.'s and 100 per cent at 80 B.T.U.'s.

In the 3.1 - 6.0 inch d.b.h.o.b. class, deaths first occur at about 50 B.T.U.'s, and increase up to 60 per cent at 200 B.T.U.'s, and 70 per cent at 800 B.T.U.'s. In both size classes the fire killed trees were nearly all suppressed.

In the 6.1 to 9.0 inch d.b.h.o.b. class, deaths first occur at 100 B.T.U.'s, and increase gradually up to 35 per cent at 780 B.T.U.'s.

No deaths occurred in the larger size classes.

(ii) Bole and Crown Epicormics

Of the live trees counted, 23 per cent contained bole epicormics and 3 per cent contained crown epicormics. Bole epicormics were found mainly in the less than 12 inch d.b.h.o.b. classes, called small poles, whereas crown epicormics showed up mostly in the large poles (greater than 12 inch d.b.h.o.b.) treated with high intensity fires.

(iii) Normal, Replaced Crowns

Most of the trees with normal crowns belong to the large pole classes. In fact, 78.7 per cent of large poles had normal crown, compared with 17.0 per cent in small poles. Of the latter 34 per cent were dominant, whereas 92 per cent were dominant in the larger pole classes.

In order to illustrate the relationship between fire intensity and tree damage, the calculated fire intensity was plotted against the percentage ratio of the number of trees showing any damage, including death, over the total number of trees within each size class. This analysis was not done on the large pole sizes as there were insufficient tree numbers present in these classes. (See figure 2)

DISCUSSION

The damage assessment results indicate that stems up to 6 inch d.b.h.o.b. suffer heavy losses at even low levels of fire intensity. Of the survivors very few have escaped without severe crown or bole damage, so that the use of fire in this class must be approached with great caution. If this size class should contain the potential crop trees, then it is inadvisable to burn under them unless intensities can be maintained below 20 B.T.U.'s (or headfire flame length of 1.5 feet). However in most cases (e.g. Four Mile Road) this size class represents the suppressed and dying individuals and is of no commercial value. Mild burning may be a useful tool in the thinning of these redundant trees.

The 6.1 to 9.0 inch d.b.h.o.b. class suffered fewer losses but survivors sustained a high degree of epicormic development even at low fire intensity levels.

There were no deaths recorded in trees with d.b.h.o.b. greater than 9 inches, even at the highest levels recorded (780 B.T.U.). There was a considerable development of crown epicormics at the high intensity levels in the larger trees. It may be concluded that whereas this treatment killed the small trees, it was the cause of crown damage in the larger dominant trees.

The results indicate that the maximum safe level for prescribed burning under pole size trees is 80 B.T.U.'s. This is achieved with a headfire flame length of 3.0 feet. Above this the extent of damage increased markedly.

CONCLUSION

The fire damage assessment revealed the close relationship between the extent of damage, including deaths, occurring to karri poles and fire intensity. These relationships make it possible to calculate desirable burning limits on fire behaviour under stands of pole size karri trees.

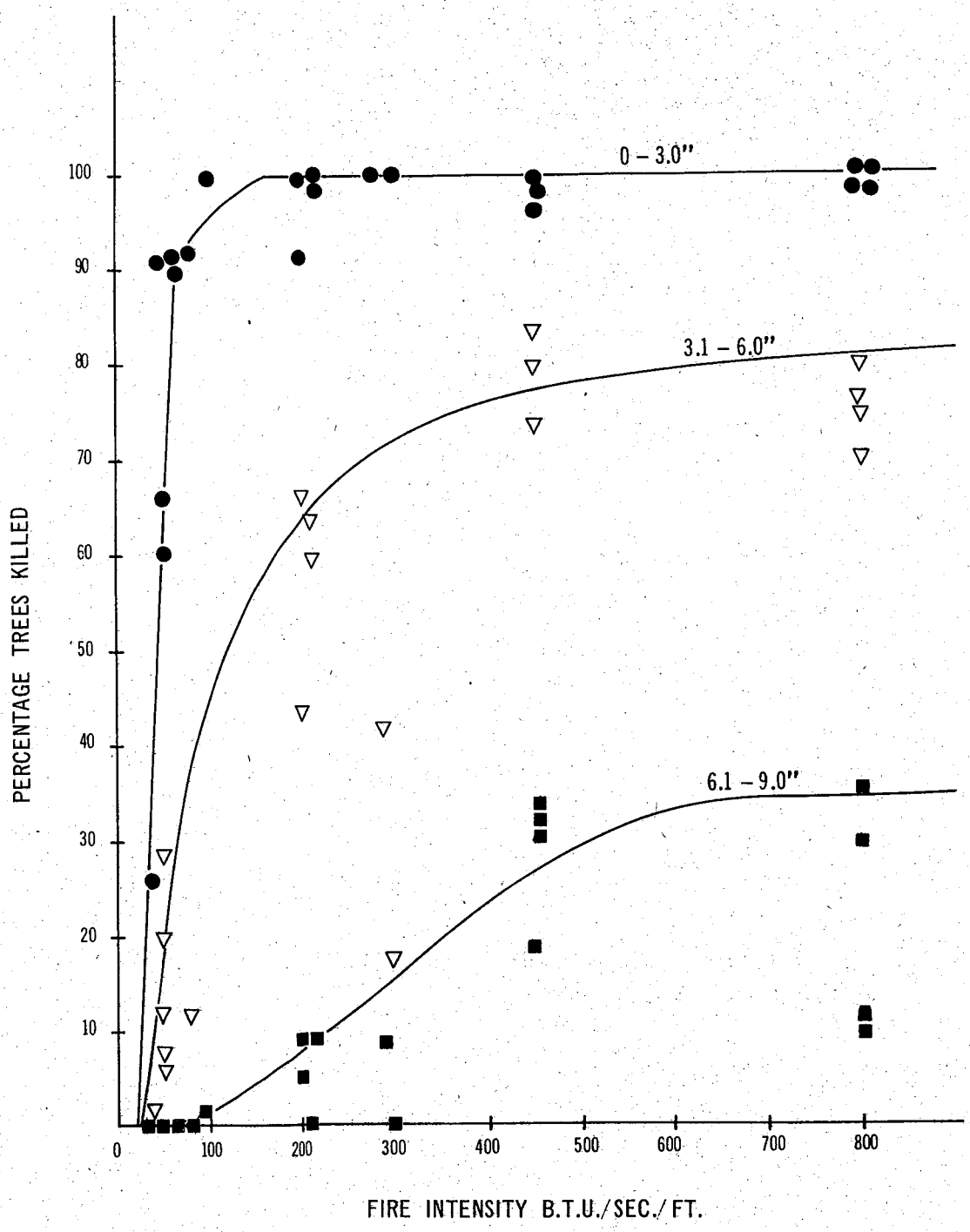
The assessment is the first of a series to be conducted annually on the stand.

TABLE 1. RESULTS OF FIRE DAMAGE ASSESSMENT - FOUR MILE ROAD

Size Classes	Fire Intensity Classes	% Dominants	% Suppressed	% Fire Killed	% Crown Epicormics	% Bole Epicormics	% Total Damage (Incl. Deaths)	% Normal Crown	No. of Trees
0-3.0" dbhob	Cool	2	98	90.0	.01	8.5	99.0	0.6	456
	Mild	0	100	99.0	0	1.0	100	0	83
	Hot	0	100	99.0	0	1.0	100	0	289
	Mean	1	99	96.0	0	3.5			828
3.1-6.0" dbhob	Cool	28	72	10.0	5.5	56.0	81.0	19.0	224
	Mild	1	99	48.0	0.8	44.0	92.0	8.0	122
	Hot	8	92	71.0	0	27.5	98.0	2.0	269
	Mean	12	88	46.0	2.1	42.5	90.5	9.5	615
6.1-9.0" dbhob	Cool	31	69	0	9.0	32.0	41.0	59.0	116
	Mild	4	96	7.0	1.7	56.0	65.0	35.0	116
	Hot	12	88	26.0	0.5	51.0	78.0	22.0	193
	Mean	17	83	11.0	3.5	46.5	61.0	39.0	425
9.1-12.0" dbhob	Cool	60	40	0	1.0	4.0	5.0	90	57
	Mild	47	53	0	16.0	20.0	36.0	64	55
	Hot	42	58	3.5	1.0	37.0	42.0	58.0	113
	Mean	50	50	1.5	6.0	20.0	27.5	72.5	225
36-60" gbhob	Cool			0	13.5	12.0	25.5	74.5	75
	Mild			0	12.0	12.0	24.0	76.0	141
	Hot			0	10.5	13.0	23.5	77.0	143
	Mean	100	0	0	12.0	12.0	24.0	76.0	359
61-80" gbhob	Cool			0	12.5	6.0	18.5	81.5	48
	Mild			0	21.5	8.0	29.5	70.5	51
	Hot			0	19.5	12.0	31.5	68.5	41
	Mean	100	0	0	18.0	9.0	27.0	73.0	140
80"+ gbhob	Cool			0	6.0	0	6.0	94.0	16
	Mild			0	11.0	0	11.0	89.0	9
	Hot			0	16.0	6.0	22.0	78.0	30
	Mean	100	0	0	11.0	2.0	13.0	87.0	55

RELATIONSHIPS BETWEEN THE PERCENTAGE OF TREES KILLED (0–9.0" d.b.h.o.b.) AND CALCULATED FIRE INTENSITY.

Figure 1.



RELATIONSHIPS BETWEEN THE PERCENTAGE OF TREES DAMAGED (INCLUDING DEATHS) FOR KARRI POLES FROM 0–12.0" d.b.h.o.b. AND FIRE INTENSITY.

Figure 2.