2ND DRAFT

A MONITORING METHOD FOR PRESCRIBED BURNING

1. INTRODUCTION

The individual plants and animals which together form wildlife populations are in a state of continuous change. These changes can be broadly divided into two types. Firstly there are those that represent life cycle changes, that is those related to reproduction, growth, senescence, death and decay; and secondly those changes which are related to physical damage, for example by fire, disease and predation. The cumulative effect of change at the individual level may lead to changes at the population and community levels. In extreme cases, change may lead to the extinction of populations and communities.

For those managing wildlife populations it is important to be able to detect, understand and predict changes at the population and community levels. It is only on this basis that managers can adjust their strategies to correct, or attempt to correct, undesirable trends in wildlife populations.

It is readily apparent that not only must "natural" changes be monitored, but also those that result from management action. This is particularly so in the case of prescribed burning, which results in sudden and marked changes within habitats. It is the aim of this working paper to describe one method of monitoring the effects of prescribed burning on vegetation and fuel loads.

2. CHOICE OF METHOD

Fire affects a wide range of environmental characteristics - for example floristics, faunal assemblage, fuel loading, and soil structure are but a few of those which are likely to be altered by prescribed burning. While an ideal method for monitoring prescribed burning would include measures of all the characters that might be affected by fire, this would be an immense task and beyond the resources of management staff. Therefore it is important that the characters selected for monitoring provide valuable information from a minimum input of effort.

Three habitat characters - namely vegetation structure, floristics and fuel loads - were chosen to assess the effects of prescribed burns. These characters were selected because they a) are all influenced by fire frequency and fire intensity; b) together provide a measure of fire induced changes in vegetation; and c) are all indices of faunal habitat. Furthermore, to measure other fire related habitat characters - such as numbers of animal species and soil structure - requires the input of greater management resources than are currently available.

Taking into consideration both the resources available for monitoring and the characteristics chosen for measurement, it was considered that the monitoring method should have the following qualities.

1. Quantifiable Results: while subjective methods of assessing changes through time may be less demanding of resources, they do not provide sufficient "hard" information upon which to assess the effects of prescribed burns.

2. Repeatable Procedures: if meaningful measurements are to be made through time, then the method must be repeatable. That is, the method must be precisely described so that different people, at different times, can produce comparable results.

3. Minimal sampling effort: assessment of vegetation structure, floristics, and fuel load often requires

large sample sizes, particularly if random sampling techniques are used. Given that management resources are limited, it was decided that the method used should be based on a permanently fixed transect. In this manner it was hoped to be able to produce comparable results through time with a minimum of sampling effort.

4. Practicality: for the method to be useful, it must be practical for field staff to use, particularly with respect to constraints on resources.

Apart from the above qualities, it was also decided that the monitoring method should be based as far as possible on techniques currently available, particularly where these techniques are likely to remain in use for the forseeable future. For this reason it was decided to base the monitoring method described here on the methods of classifying vegetation structure devised by Muir (1977), and of measuring fuel loads described by Sneeuwjagt (1973).

The following specific characteristics, then, were selected for measurement:

1. vertical vegetation structure, including both the dead and living components of the vegetation.

2. the floristics of the vertical vegetation structure.

3. site floristics, as assessed by a line transect method.

4. litter depth.

5. trash density.

6. fuel load, calculated from 1., 4., and 5. above.

3. METHODS

All measurements were based on a 49 metre transect upon which 50 fixed points were established at one metre intervals. To test the method a transect was established on the Boyagin Nature Reserve, and results cited below are taken from this work.

3-1 Fixing the Line

The site and direction of the transect line were subjectively selected so that the line represented a specific vegetation type which contained sufficient fule to carry a fire under prescribed burning conditions.

A three metre steel rod marked at one metre intervals was used to place the 50 fixed points, spaced one metre apart, along the transect line. A steel rod proved to be a more effective instrument than a tape measure for maintaining a straight line and for accurately spacing fixed points. Each fixed point was marked with a 15 cm nail driven through a 5 cm x 5 cm metal sheet. The metal sheets were marked from 1 to 50.

3-2 Vegetation Stucture/Floristics

The vertical, vegetation structure was assessed by counting the vegetation contact points against a steel rod (length 3 metres; diameter 9.5 mm) inserted vertically into the vegetation at each of the fixed points. A contact point was defined as any part of a plant which touched the steel rod. Each contact point was scored for height interval (0-0.5; 0.5-1m; 1-1.5m; 1.5-2m; or 2-2.5m); whether or not the part of the plant was dead or living; and for species (Table 1). Contact points for a dead plant were scored if the roots of the plant were fixed in the soil. Dead plants with roots free of the soil were defined as a

TABLE 1 : VERTICAL VEGETATION STRUCTURE AND FLORISTICS

Transect 1, 120610, Data Recorded Wallace and Graham 29/4/83. Only part of data collected shown.

POINT NO.	CONTACT POINTS / HEIGHT CLASSES 0-0.5m	0.5-1m	1-1.5m	1.5-2m	2-2.5m
1	0	0	0	0	0
2	0	0	1A	0	0
3	0	0	0	0	0
4	1Dd	0	0	0	0
5	0	0	0	0	0
6	1A, 2C	1Ad, 1A	0	0	0
7	1C	0	0	0	0
8	0	0	0	0	0
9	2Ed	0	1A	1A	0
10	0	0	0	0	0
11	3C	1Ad	2Ad	0	0
12	2Xd	0	0	0	0

SYMBOLS USED

0, 1, 2 etc = number of contact points
A = Melaleuca ? subtrigona
C = Dryandra nivea
D = ? Restio sp.
E = Dryandra armata
X = Fabaceous plant
d = contact point ~~part of~~ against a dead plant, or dead part of ~~plant~~ living plant.

part of the trash (see 3-5 below).

To ensure that the steel rod used was inserted vertically into the vegetation, two levels fixed at right angles were held against the rod while measurements were made (Figure 1.).

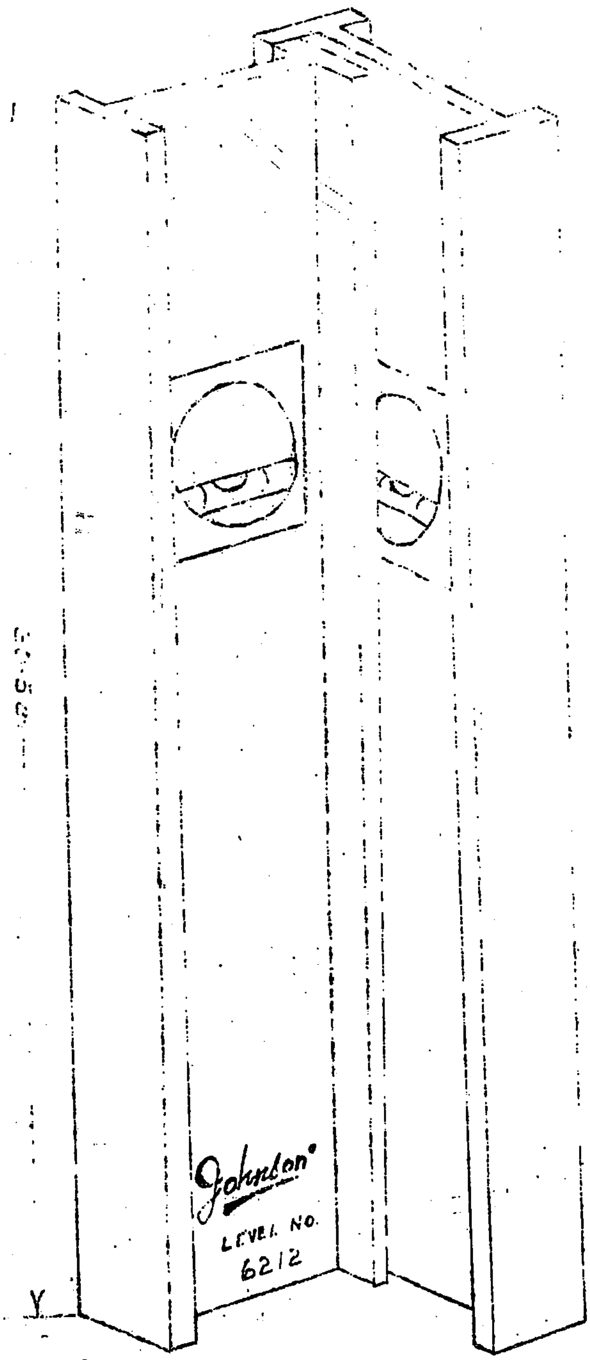
By recording the species involved for each contact point an estimate of the relative contribution by each species to the vertical structure was obtained (Table 2).

3-3- <u>Floristics</u>

To provide an estimate of the floristics along the transect, a piece of string was stretched along the ground between each fixed point. For each one metre section of transect a record was made of plant species which either touched the string, or which obviously crossed above the string. Species were recorded for presence only in each section (Table 3). While it would have been preferable to score the number of each species in each one metre segment of the transect, this was deemed to be too time consuming for the extra information obtained. Instead, the percentage of transect segments within which each species occurred was calculated (Table 4) to provide an estimate of the floristic composition along the transect line.

3-4 <u>Litter Depth</u>

For the purposes of the present work litter was defined as the fallen leaves, bark and very fine twigs (less than 1mm in diameter) which form an obvious layer on the ground surface. Litter depth was measured at a distance of one metre ~~perpendicular~~ to the transect line from each fixed point. The sample point was fixed by using a one metre rod (Figure 2).



Not really necessary

FIGURE 1

Levels ~~fixed at right angles~~ (fixed at right angles) used ~~for~~ against steel rod to ensure accurate measurement of contact points.

TABLE 2: ANALYSIS OF CONTACT POINTS ON A SPECIES BASIS

Transect 1, T20610, 0–0·5 metre height class only

Data collected 29/4/83

SPECIES	CONTACT POINTS Dead	CONTACT POINTS Living	TOTAL	%
Dryandra nivea	32	13	45	60·8
Dryandra armata	5	4	9	12·1
? Restio sp.	4	3	7	9·4
Daviesia rhombifolia	2	2	4	5·4
Fabaceous	4	0	4	5·4
Bossiaea eriocarpa	0	2	2	2·7
Melaleuca ? subtrigona	0	1	1	1·4
? Leucopogon sp	0	1	1	1·4
sedge	1	0	1	1·4
	48	26	74	100

TABLE 3: SPECIES RECORDED IN ONE METRE SEGMENTS OF TRANSECT.

Transect 1, T20610, part (3 out of 49 segments) data shown only. Data collected 29/4/83

Fixed Points between which species recorded	Species recorded
1 – 2	A, H, L, P, Q, R
2 – 3	A, L, B, H, P, D
3 – 4	A, D, P, B

Symbols Used

A = Melaleuca ? subtrigona

H = Hakea trifurcata

TABLE 4 : % OCCURRENCE OF PARTICULAR SPECIES IN ONE METRE SEGMENTS. Transect 1, ↑20610, 38 species recorded, data for most common 4 shown. Data collected 29/4/83

Species	Total number of 1m segments	Number of segments in which scored	% Occurrence
Meloleuca ?subtrigona	49	32	65%
?Restio sp.	49	23	47%
Dryandra nivea	49	17	35%
herbaceous sp.	49	12	24.5%

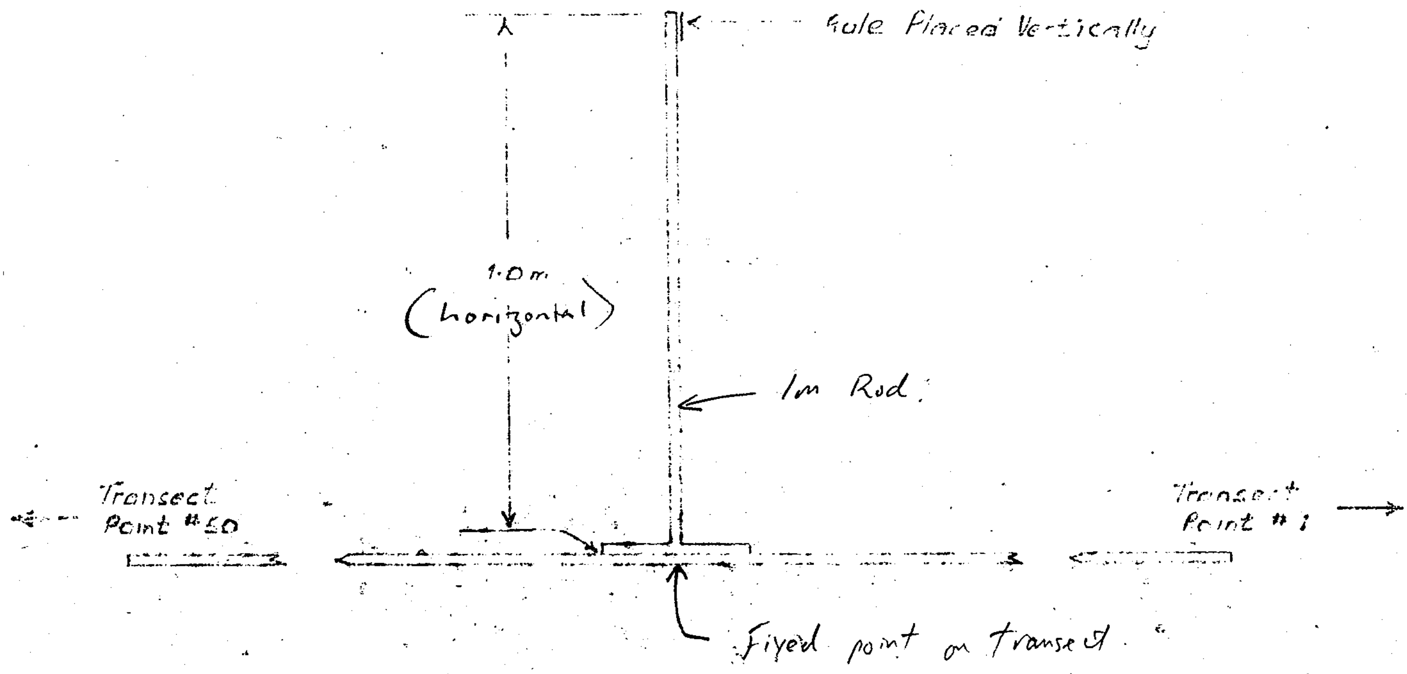


Fig 2.
Method of ~~50~~ establishing litter/trash sampling point PLAN VIEW.

For all measurements a ruler was placed flush with the end of this rod, and on that side of the rod lying closest to fixed point one. Litter depths were recorded in millimetres, and these measurements provided an estimate of the contribution to the fuel load made by litter (see Section 4-5).

3-5 Trash

Trash was defined as dead plant material which was:

1. not part of the litter;

2. not fixed to a living plant;

3. not a dead plant with roots fixed in the ground.

Two measurements of trash were made. These were firstly the maximum trash height touching the ruler as inserted for litter sampling; and secondly the maximum trash height within 30 cm of the ruler inserted as for litter sampling. Two sampling methods were used in order to assess the most practical method of measuring trash density. In particular, it was thought that the former method might provide insufficient data upon which to estimate trash density and volume.

Figures obtained from the above measurements were then used to provide an estimate of trash fuel loads (Section 4-5).

3-7 Photography

Photographs were taken from both ends of the transect looking towards the centre of the transect; and photographs were also taken from the centre of the transect looking towards both ends. These photographs were repeated following the burn being carried out.

Photographs, which are quite interesting, will be included in final draft.

3-7 Work Effort on Transect

The amount of work required to lay out the transect and take measurements is given below. Hours given are single man hours.

1.	to set out 50 fixed points.............	2 hours
2.	to assess contact points...............	4 hours
3.	to assess fuel and litter..............	2 hours
4.	to assess transect floristics..........	4 hours
	TOTAL	12 hours

The above times do not include time spent on plant identification, photography, assessing results etc.

3-8 Description of the Prescribed Burn

The following measurements were made of fire weather at the beginning of the prescribed burn. The instruments used are show in brackets.

1. Temperature at the beginning of the burn (aspirating hygrometer).

2. Relative humidity at the beginning of the burn (aspirating hygrometer).

3. Surface moisture content at the beginning of the burn (Marconi moisture meter). Samples were taken from surface leaf litter 20 metres or more inside the edge of the block to be burnt.

4. wind speed and direction (cup anemometer set 1.5 m above the ground on a firebreak).

On the basis of the above the rate of forward spread was calculated from Forestry Department tables prepared for the jarrah forest. The maximum termperature recorded at the Pingelly Post Office on the day of the burn was also obtained.

Within one month of the burn being carried out, field sampling of vertical vegetation structure/floristics, litter depths and trash heights were re-assessed for those sections of the transect which were burnt in the prescribed burn. A precise measurement was also made of the portions burnt within each one metre segment of the transect line.

4. RESULTS & DISCUSSION

4-1 Vegetation Structure and Floristics

The vegetation structure of the total transect line is shown in Figure 3a, and the preburn and postburn data for fixed points 1 to 28 inclusive are shown in Figures 3c and 3b respectively. The structure shown in Figure 3a was quite apparent from visual inspection of the transect line.

When postburn data ~~was~~ were collected, some of the unburnt fixed points were measured again to provide an estimate of the consistency of the monitoring technique. It was found that while the pattern of readings had not changed, there were minor quantitative differences between the two sets of data. Given that the readings were taken 6 weeks apart, it is possible that these differences reflect actual changes within the vegetation structure rather than differences in the techniques used on the two occasions. However the act of inserting a steel rod disturbs the structure of the vegetation, and particular care is required to ensure that no plant is displaced from its normal position. It is therefore unlikely that replicate samples of the same transect would produce quantitatively identical sets of data.

If the method described in this paper were to be used in the future, it would be most useful to carry out replicate sampling of a transect to more accurately assess the consistency of the technique described here.

A comparison of the preburn and postburn data for that section of the transect burnt during the prescribed burn (Figures 3b,c) shows that the fire significantly changed ($\chi^2 = 23.88$, 3df, $p < 0.001$) the vegetation structure.

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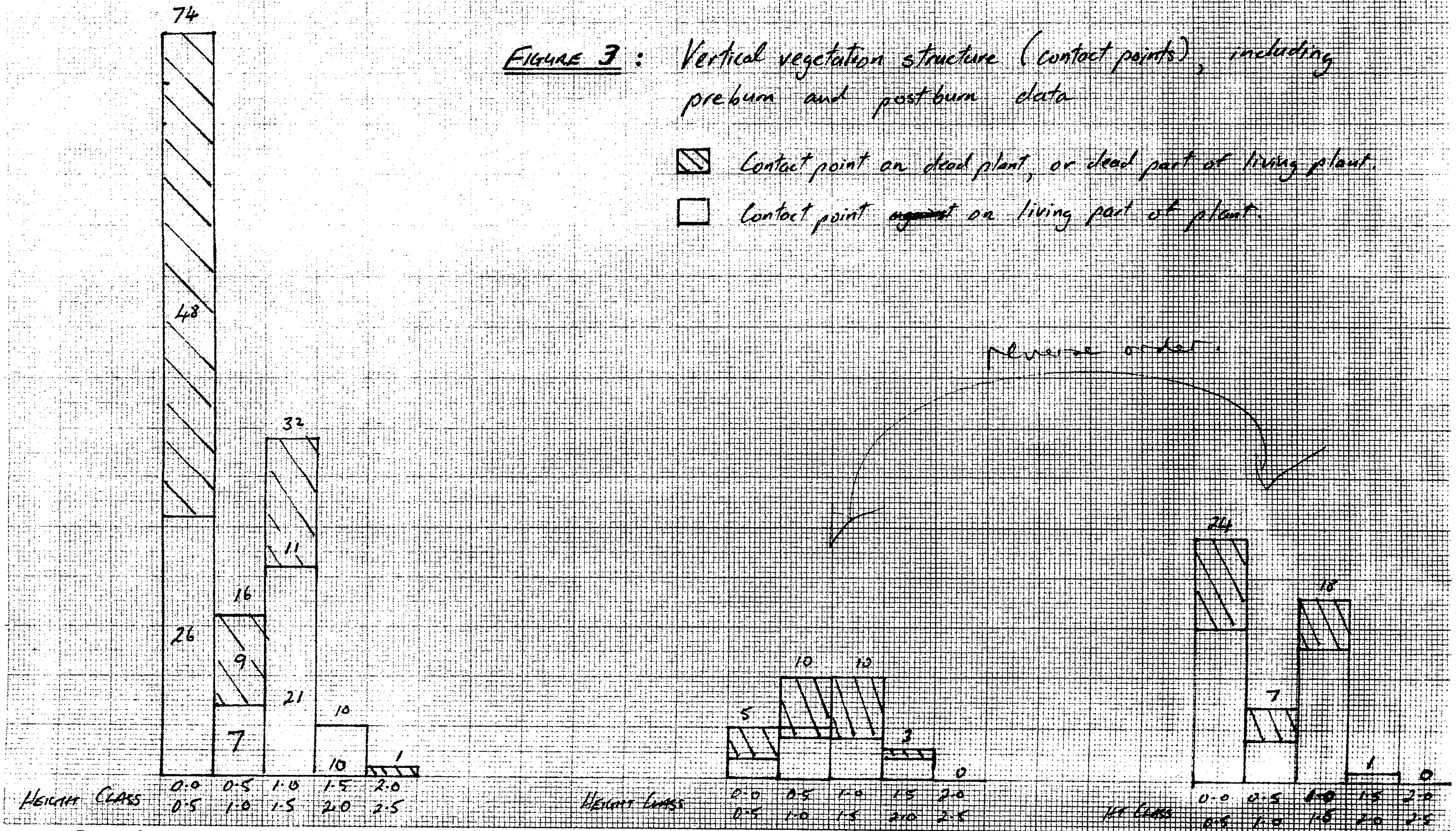
FIGURE 3: Vertical vegetation structure (contact points), including preburn and postburn data



3a Preburn, sample points 1–50 incl.

3b. Postburn, sample points 1–28 incl.

3c Preburn, sample points 1–28 incl.

TABLE 5 : Species composition of vertical vegetation structure expressed as % of total contact points, pre & post burn data for fixed points 1-28 incl.

	% Contribution to Vertical Structure	
	Pre burn	Post burn
Melaleuca sp.	32% (16)^	57% (16)
Dryandra armata *	18% (9)	0
Dryandra nivea *	12% (6)	11% (3)
Hakea trifurcata	10% (5)	25% (7)
Daviesia rhombifolia *	6% (3)	0
Petrophile heterophylla	6% (3)	0
Acacia "pulchella"	6% (3)	0
Bossiaea eriocarpa *	4% (2)	7% (2)
Fabaceous (dead bush) *	4% (2)	0
?Restio sp. *	2% (1)	0

^ Number of contact points recorded

* species recorded only in 0–0.5m height class.

Overall the number of contact points was greatly decreased (50 to 28) by the fire, however within two height classes the number of contact points was increased. With respect to one of these height classes (1.5-2.0m), the number of contact points recorded both before and after the burn was low, therefore it is doubtful whether the figures are significantly different. In the case of the 0.5-1 m height class, the increase may have resulted from fire induced, structural changes in the vegetation.

That the prescribed burn predominantly affected the 0-0.5 m height class is shown both by the relatively large reduction in contact points (Figures 3b,c) and the shift in vegetation floristics towards those species above 0.5m (Table 5).

In summary it may be said that the monitoring method used demonstrated that quantitative changes occurred in the vegetation structure and floristic composition, as a result of the prescribed burn. Sufficient data has been collected to provide a basis for assessing the rate at which the vegetation recovers after fire, particularly with respect to the 0-0.5 m height class. ~~in particular~~. However the low number of records for particular species will make statistical comparisons difficult other than at the level of gross vegetation structure.

4-2 Line Floristics

A sample of the results obtained from the line floristics technique is shown in Tables 3 and 4. Post-fire sampling has not yet been carried out.

No problems were encountered with the line floristics technique in the field, and the increased number of species recorded in comparison with the structural/floristics method (35 as opposed to 15 species) demonstrates the need for the more precise measure.

The patchiness of species occurrence along the transect line is shown by the fact that 10 out of the 35 species present were only recorded once in 49 metres of line.

4-3 Litter

Field work demonstrated that there are difficulties with the litter sampling technique. These are:

a) in heavy, ~~low~~ shrub fuels it is difficult to accurately establish the sampling point;

b) the litter is disturbed by sampling;

and c) the definition of the base and top of the litter layer is somewhat subjective.

For these reasons the data on litter is best considered together rather than as individual points. Again, it would be useful to carry out replicate sampling to assess whether or not consistent data can be obtained.

Grouped data for litter recorded pre-and postburn are shown in Tables 6a and 6b. These figures show that average litter depth along the transect was reduced by 42%. This corresponds to a reduction in fuel load from about 1 to 0.7 tonne/ha (Sneeuwjagt 1973, jarrah graph on Figure 1).

4-4 Trash

Sneeuwjagt (1973) has pointed out that trash is a difficult fuel to assess because of the large variation in the size and density of its individual components, and in his paper he gives a method for only approximating the contribution of trash to fuel loads.

Of the two sampling methods tested during the work at Boyagin, that which involved a point sample rather than an area sample (see section 3-5 above) was the most useful method. This is because a) it provides an estimate of the horizontal density of trash; and b) it provides a less biased estimate of the average top height of trash.

Neither of the methods used was particularly satisfactory as they do not provide an estimate of the vertical distribution of trash. If the transect method is to be used again; it would be useful to measure trash contacts at each fixed point in a manner similar to that used for assessing the vertical vegetation structure.

The effect of burning of trash is shown by the decrease in average trash height (Table 5a), and by the decrease in the number of sampling points at which trash occurred (Table 5b)

4-5 Fuel Loads

The following assessment of fuel load along the transect is derived from the Boyagin data using the tables of Sneeuwjagt. These tables were not designed for use in vegetation types such as those found at Boyagin, and therefore the fuel load figures derived from these tables should be treated with caution.

Litter (jarrah graph, Figure 1 in Sneeuwjagt)	1 tonne/ha
Scrub Weight (Dense-medium type 6, scrub flammability 10-20)	15-30 tonnes/ha
Trash	< 3 tonnes/ha
Total Fuel	18-34 tonnes/ha

4-6 Description of the Prescribed Burn

For the prescribed burn at Boyagin, readings of fuel and weather conditions were only taken prior to ~~the start of~~ lighting up. It would be desirable for the four measurements listed in section 3-8 to be repeated during ~~the burn~~ and ~~at the end of~~ the burn to provide an estimate of weather conditions extant throughout the burn.

The uncorrected rate-of-spread index on the day of the Boyagin prescribed burn was 18 m/hr (Sneeuwjagt & Peet 1979). The difficulty of using tables written for the jarrah forest under wheatbelt conditions is demonstrated by the fact that while in jarrah forest litter levels are at about 4.5 tonnes/ha (10% canopy cover) after about 6 years (Beggs 1973); after more than 10 years at the Boyagin transect site litter levels had only reached 1 t/ha. Such a figure for litter levels is not shown in Forest Tables.

The corrected rate of spread at Boyagin, based on litter levels alone, is about 13 m/hr. However if the 0-0.5m height class of vegetation is included as part of the litter then the corrected rate of spread is about 27 metres/hr on the transect line.

It is obvious that, wherever possible, it is important that detailed notes on prescribed burning conditions, including an estimate of actual rate of spread, are kept for prescribed burns to provide the beginnings of an information base for predicting the behaviour of fires during prescribed burns.

CONCLUSIONS AND RECOMMENDATIONS

Despite the deficiencies in the monitoring system described above, the method does provide a relatively objective method for monitoring vegetation structure, floristics and fuel loads. Unless a better technique is evolved, I recommend that the monitoring method is used for selected prescribed burns in the future. I also recommend that the Boyagin transect be re-monitored in April 1984, 1986 and 1988. After 1988, the usefulness of continuing the monitoring at Boyagin should be re-assessed. I also recommend that replicate sampling of a single transect be carried out to assess the consistency of the techniques described.

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TABLE 6 ~~FIGURE #~~ : Comparison of Pre burn and post burn samples with respect to litter and trash levels. Data from fixed points 1–28 incl.

	Average Depth of Litter (mm)	Average Trash Height method 1*	method 2*
PRE BURN	16.5	4.25	8.77
POST BURN	9.5	0.18	5.99
% REDUCTION	42%	96%	32%

FIGURE 6a : Comparison of average litter and trash heights between Pre burn and post burn samples

	% sample sites with litter	% sample sites with trash Method 1*	Method 2
PRE BURN	93	32	68
POST BURN	79	11	64

Figure 6b : Percentage of sample sites carrying litter or trash, pre and post burn.

* Method 1 : trash height at sampling point

‡ Method 2 : maximum trash height within 30cm radius of sampling point.