Fire Management Branch
Department of Conservation & Environment

A STUDY OF THE DISTRIBUTION OF AERIALLY APPLIED FIRE RETARDANT IN SOFTWOOD PLANTATIONS

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Ackowledgements: This study would not have been completed without the contribution of Bryan Rees, Technical Assistant, and the co-operation of the staff and employees of the Heywood Forest District.

FOREWORD

Although aerially applied retardant has not yet been used operationally on plantation fires in Victoria, the results contained in this report indicate that firebombing is likely to be a useful suppression technique in at least some stand types.

Until further research is carried out, there will remain some uncertainties with respect to retardant use in plantations. However, there is no reason to exclude firebombing from the options available for fire suppression.

Further research is planned to examine:

1 The distribution of aerially applied retardant beneath stands older than those examined in this study.

2 The effectiveness of particular retardant concentrations at ground level in suppressing fire.

3 Techniques to improve retardant penetration through canopy.

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SUMMARY

The distribution of aerially applied fire retardant was studied in unthinned stands of *Pinus radiata*, aged 8, 12 and 15 years, and a thinned stand aged 15 years.

The aircraft used was a de Havilland Beaver, capable of loading 885 litres of retardant.

Assuming an effective ground level retardant concentration to be greater than 0.25 l/sq. m, adequate penetration was obtained in the 8 and 12 year old stands, and the 15 year old thinned stand.

INTRODUCTION

The aerial application of long term fire retardants, to assist in the control of wildfire, is an established suppression technique in Victorian eucalypt forests. The technique has not yet been used for fire control in softwood plantations.

The usefulness of the technique depends on fire intensity, and the amount and distribution of retardant retained on the fuel.

The objective of this study was to examine the effect of various *Pinus radiata* stand types on retardant distribution.

STUDY AREA

The study was conducted in the Kentbruck plantation in south-west Victoria.

A number of stand types were recognised, based on age, site quality and thinning history. Four stand types were chosen for this initial study. The stand characteristics of each plot are shown in Table 1.

TABLE 1 - STAND CHARACTERISTICS

Plot No	Planting Year	Mean DBHOB (cm)	Stand Height (m)	Stem No /ha	Thinning History
1	1962	22.5	21.3	708	Thinned
2	1962	20.8	27.7	1 307	Unthinned
3	1965	19.9	18.5	1 144	Unthinned
4	1969	14.3	13.6	1 571	Unthinned

METHOD

1 Aircraft

The aircraft used was a de Havilland Beaver, operated by Western Aerial Crop Spreading and Spraying, Derrinallum. This aircraft had previously been proved suitable for firebombing.

2 Drop Specifications

The ground speed of the aircraft was nominated to be 80 knots for each drop.

Drop height was nominated as twice tree height above ground level. Stand conditions did not allow a ground measurement of aircraft height at the time of load release.

The slurry dropped was water, thickened with sodium carboxymethyl cellulose (CMC) to a viscosity of 30 Marsh Funnel seconds. Each aircraft load was 885 litres.

3 Sampling Design

The sampling design was selected with the objective of defining retardant distribution on the ground and within the canopy.

To ensure the full extent of each drop was included within the sample area, each plot covered an area approximately 37 metres wide and 146 metres long. The long axis of each plot, and therefore the subsequent flight direction, was parallel to the row direction.

Plot corners were marked with hydrogen balloons.

(a) Sampling at ground level

Position 1 - Central to the grid formed by the stand

2 - The centre of the row perpendicular to the flight direction

3 - The base of the tree

4 - The centre of the row parallel to the flight direction.

The basic design used sampling position 1 located in every second row and column formed by the spacing of the stand itself.

A sub-sample of the other three positions was taken in each of the thinned stands.

Figure 1 is a diagrammatic representation of the ground level sampling design.

(b) Sampling within tree crowns

The sampling positions within tree crowns are illustrated in Figure 2.

The number of levels sampled within each crown depended on the height to which it was possible to climb each tree.

It was originally intended to sample 21 trees on each plot in this manner. The complexity of the task often caused fewer trees to be sampled.

(c) Drop on open ground

One drop was conducted on open ground using a grid spacing 3.0 m wide and 6.1 m long.

FIGURE 1 : SAMPLING DESIGN AT GROUND LEVEL

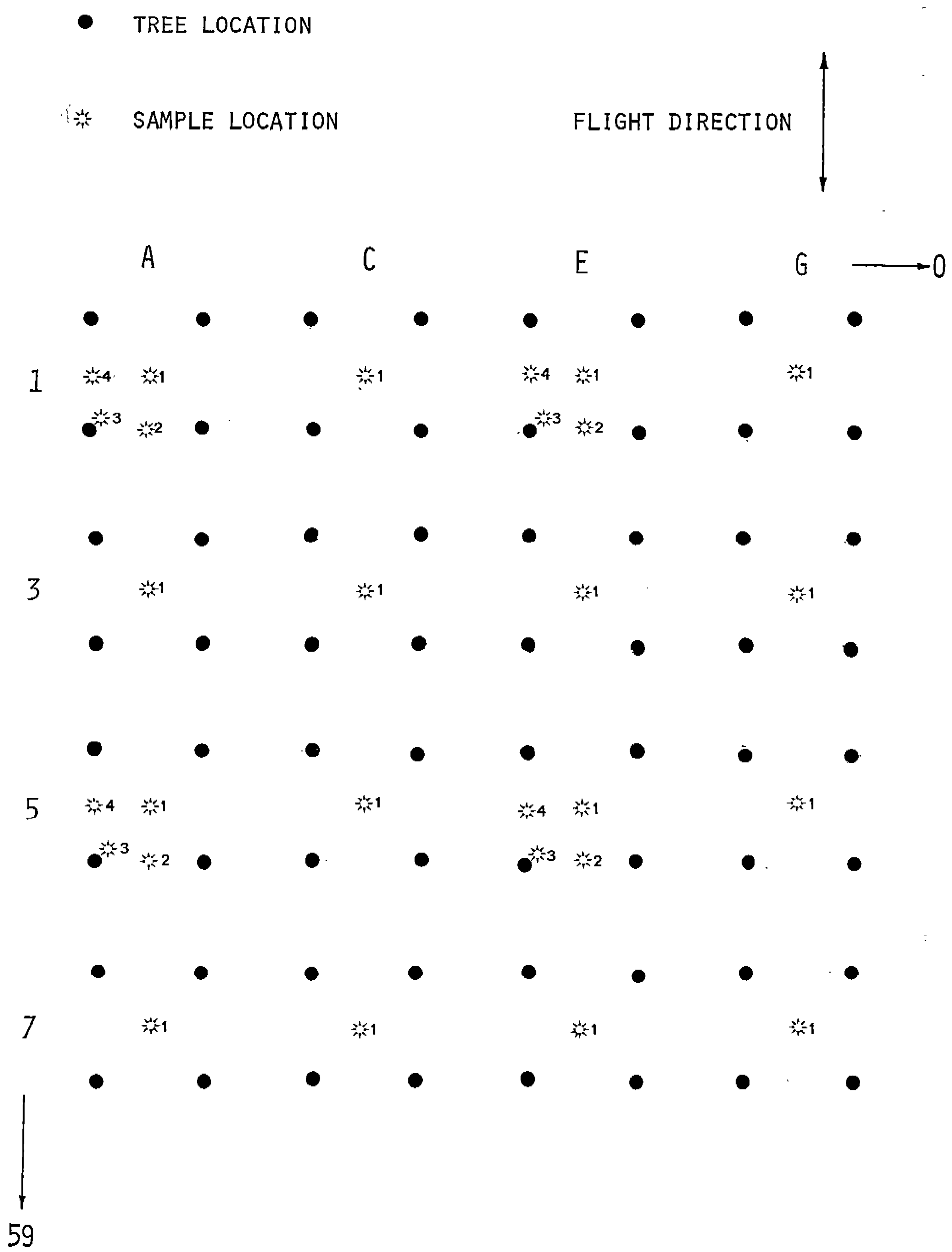
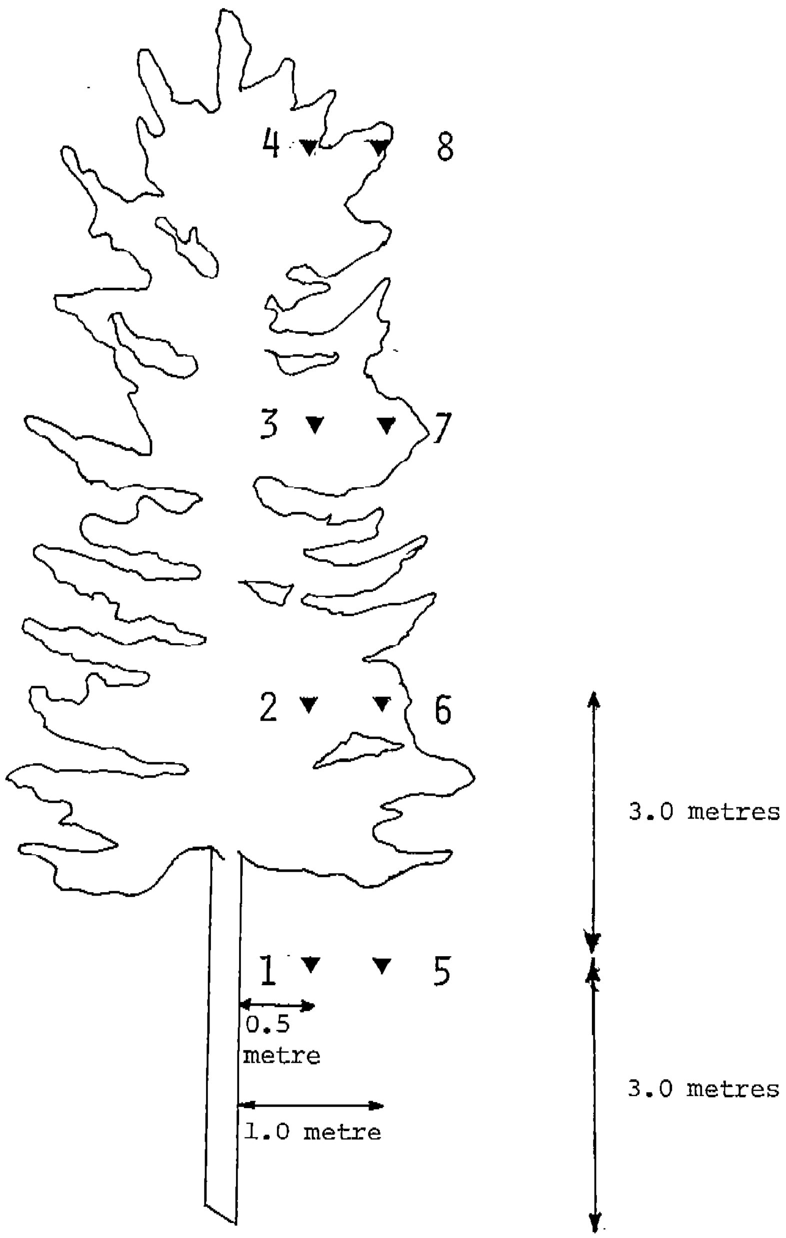


FIGURE 2 : SAMPLING DESIGN IN TREE CROWNS



4 Data Analysis

Plastic cups 17.7 cm and 11.8 cm in diameter were used to sample volumes on the ground and within tree crowns respectively.

For both cup sizes, an average cup weight was used in the calculation of volume collected at each sample point. Sampling showed that the minor variations existing in cup weight would not significantly affect volume calculation.

The ground area affected by each drop was calculated using an estimate of mean tree spacing at the time of planting, together with the number of points at which slurry was collected in sampling position 1. The mean volumes calculated for each ground level sampling position were then used to estimate the total volume of slurry reaching ground level, as a percentage of the volume dropped.

Drop patterns were drawn on the basis of volumes collected at sampling position 1.

RESULTS

1 Distribution in the Open

Figure 3 shows the drop pattern obtained on open ground.

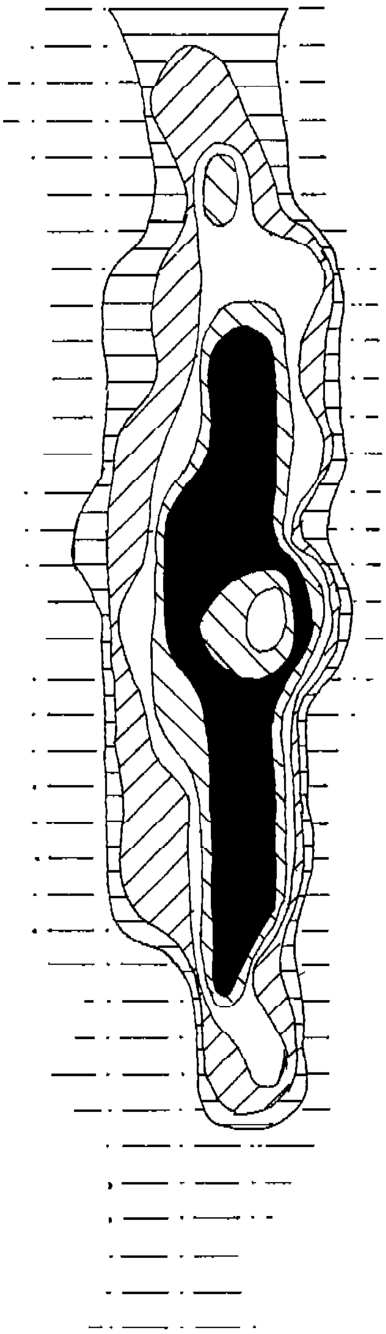
Of the total volume dropped, 84% was recovered on the sampling grid, i.e. 16% was lost due to evaporation and drift.

2 Distribution at Ground Level under Canopy

Figures 4 - 7 show the drop patterns obtained under canopy.

Assuming an effective concentration is >0.25 l/sq m, Table 3 shows the approximate effective lengths of control line possible in each stand type.

FIGURE 3 : DISTRIBUTION IN THE OPEN



FLIGHT DIRECTION

SCALE : 1 CM = 5 M

VOLUME CLASSES (L/SQ M)

L.T.	0.125
0.125 - 0.249	
0.250 - 0.499	
0.500 - 0.749	
0.750 - 0.999	
G.E.	1.000

FIGURE 4 : PLOT NO 1 THINNED 1962 PLANTING

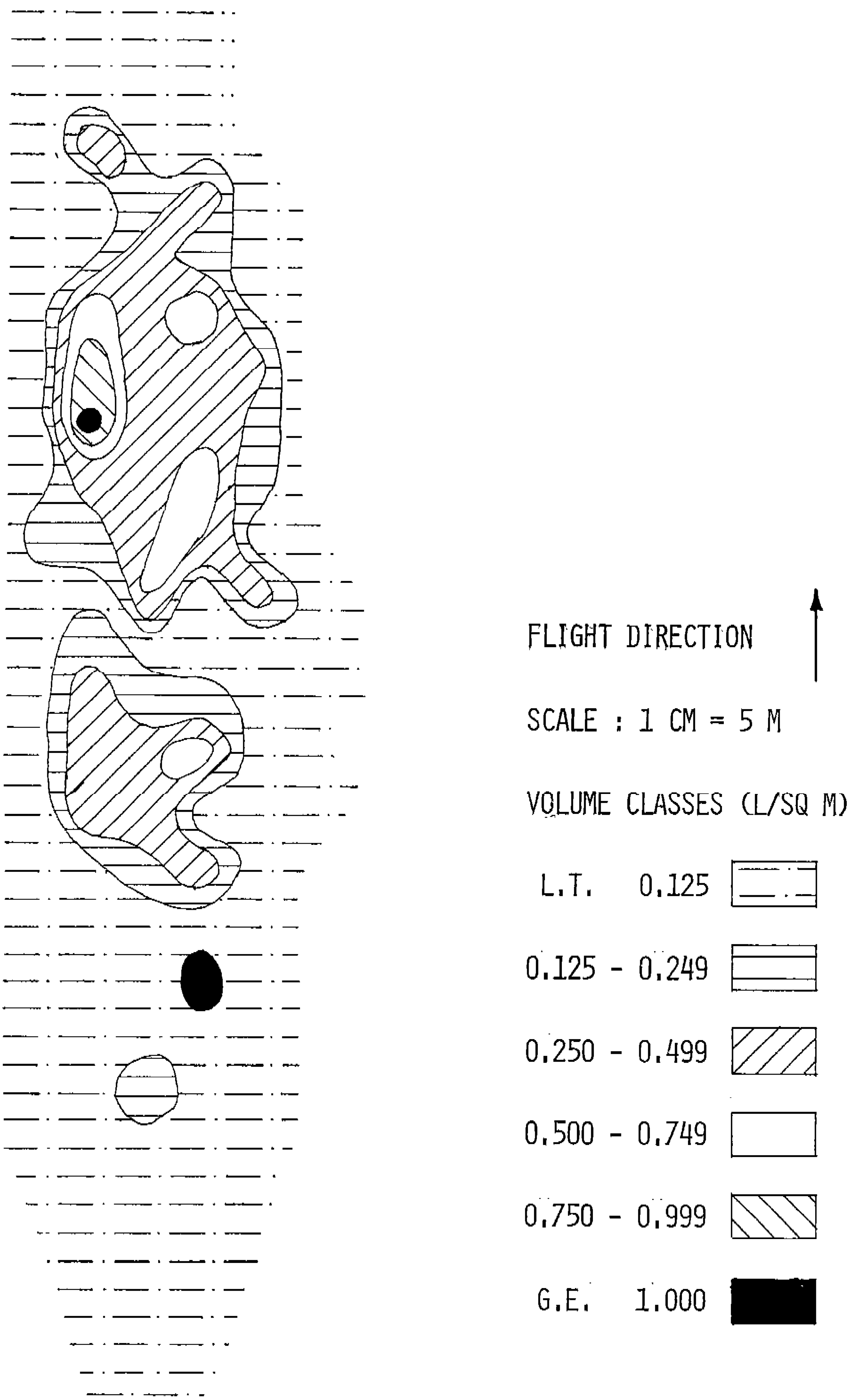


FIGURE 5 : PLOT NO 2 UNTHINNED 1962 PLANTING

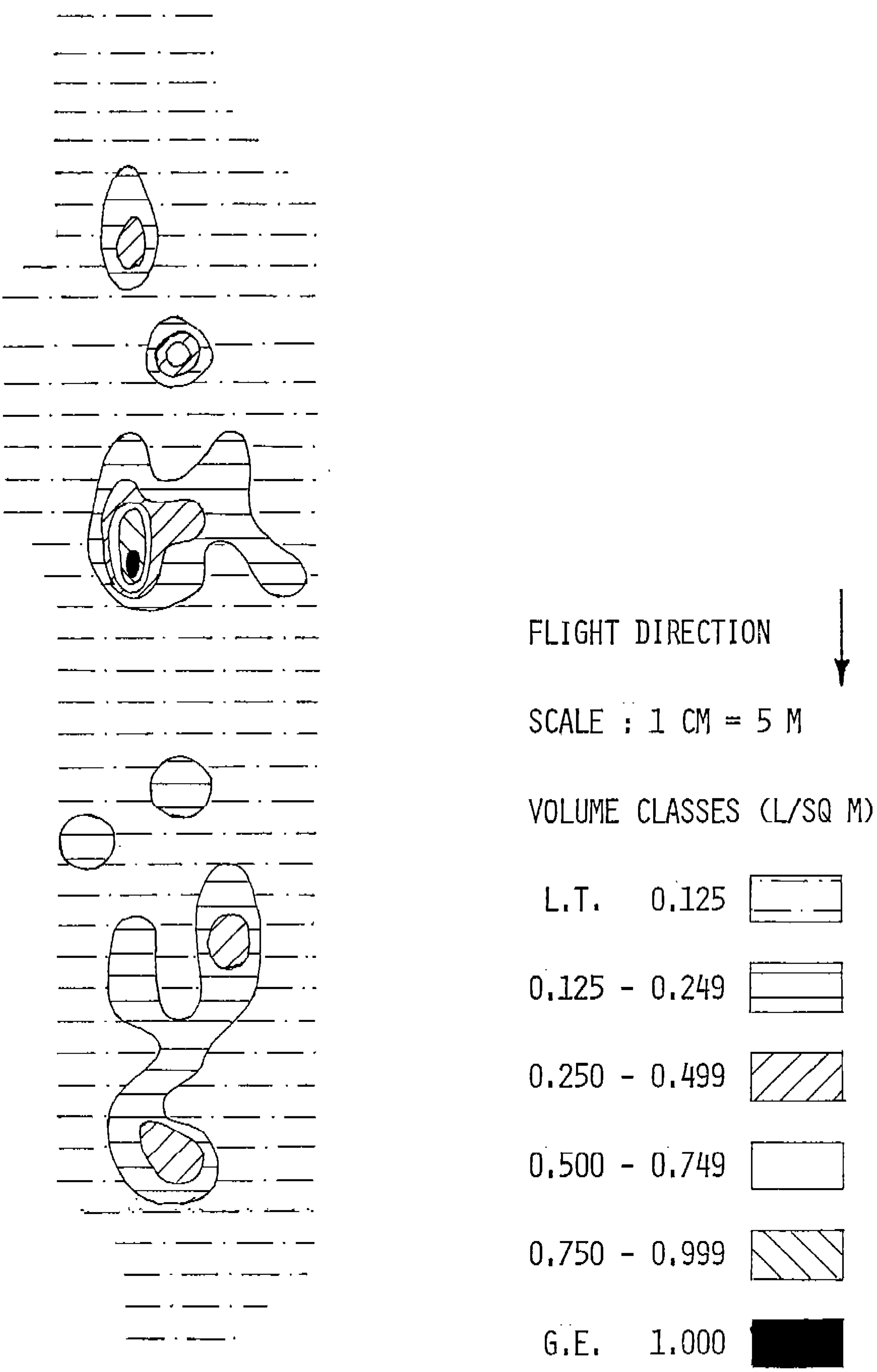


FIGURE 6 : PLOT NO 3 UNTHINNED 1965 PLANTING

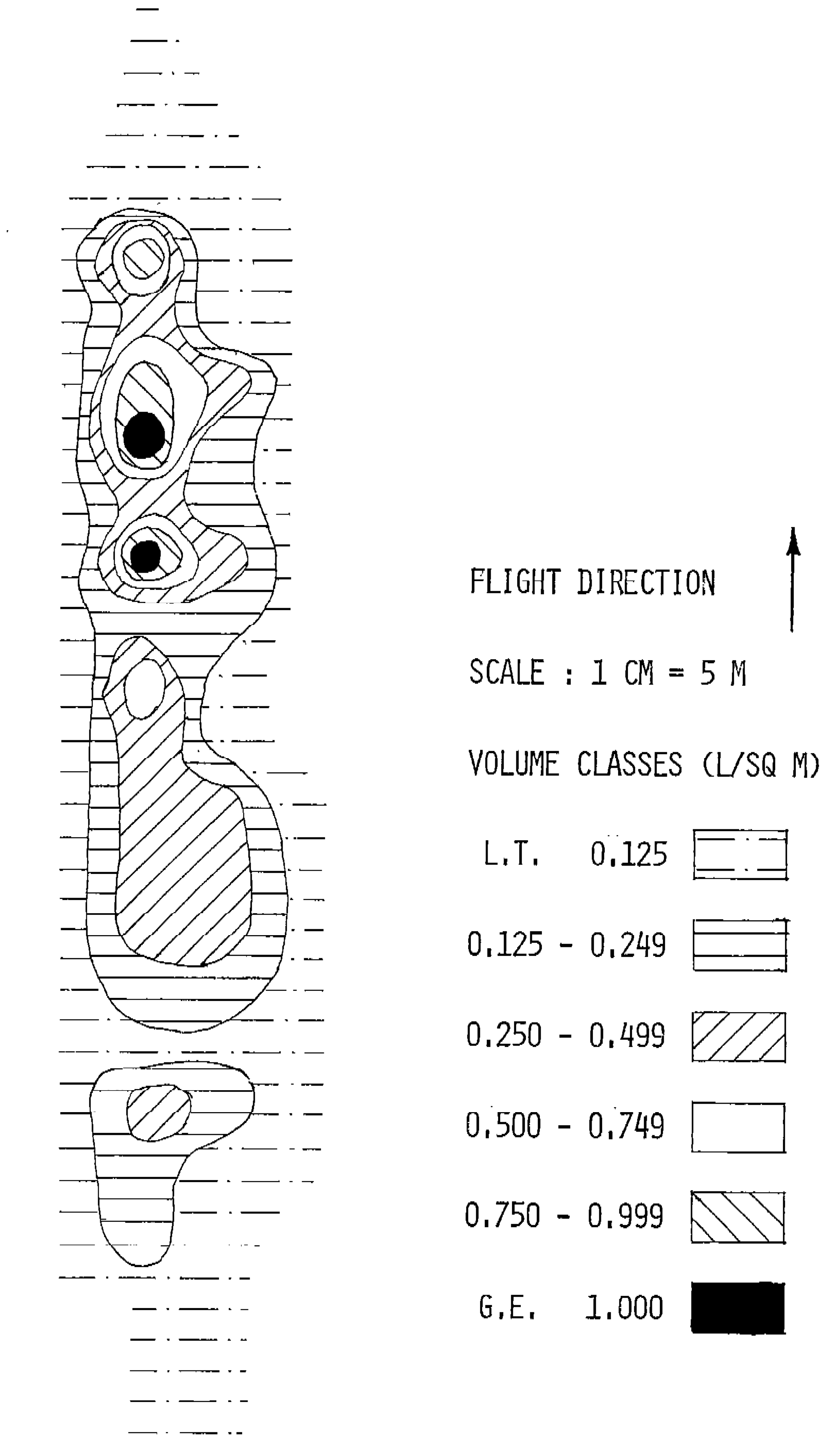


FIGURE 7 : PLOT NO 4 UNTHINNED 1969 PLANTING

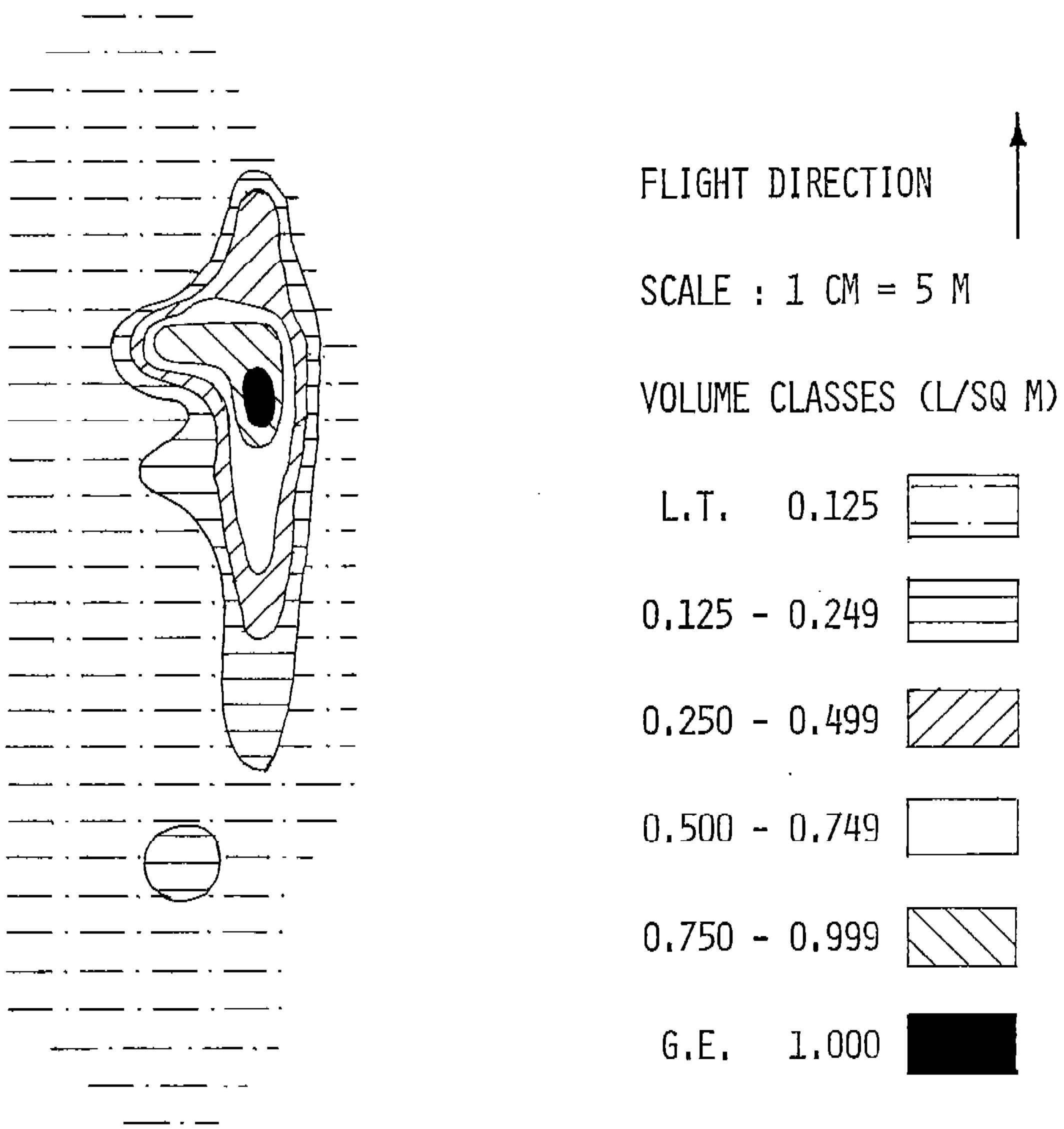


TABLE 2 - EFFECTIVE LENGTH OF CONTROL LINE (M)

Plot No	Length
1	60*
2	None effective
3	60*
4	30

*These distances include small sections in the centre of each drop with a concentration <0.25 l/sq m

Table 3 gives the percentage of volume reaching ground level, and the percentage of volume remaining in tree crowns, assuming 84% of the volume reached the upper canopy level.

TABLE 3 - DISTRIBUTION OF SLURRY

Plot No	Percentage Collected	
	Ground	Canopy
1	52	32
2	11	73
3	35	49
4	14	70

The distribution of volume between the four sampling positions recognised in unthinned stands is shown in Table 4. The distribution is given as a percentage of the mean volume collected in sampling position one.

TABLE 4 - DISTRIBUTION AT GROUND LEVEL - UNTHINNED PLOTS

Plot No	Sampling position			
	1	2	3	4
2	100	58.8	15.1	56.8
3	100	130.9	21.1	30.4
4	100	86.6	6.4	26.4

3 Distribution Within the Canopy

Results for plot one and three only are presented. Insufficient data were collected on the remaining plots to warrant consideration.

Table 5 gives the mean volume collected at each position in the canopy (see Figure 2) as a percentage of the mean volume assumed to reach the upper canopy level.

TABLE 5 - WITHIN CANOPY DISTRIBUTION

Plot No	Position	% Collected	Position	% Collected
1	8	93	4	28
	7	40	3	25
	6	49	2	13
	5	54	1	16
3	8	NA	4	NA
	7	22	3	NA
	6	6	2	5
	5	12	1	4

DISCUSSION

There is presently no data available to define the relationship between fire intensity, plantation fuel properties and effective retardant concentrations.

The only basis on which the effectiveness of the ground patterns, shown in Figures 4 - 7, may be assessed, is by comparison with information available for eucalypt fuels. A value for eucalypt fuels is given in "Air Operations for Forest Fire Control" - Forests Commission,Victoria. It is stated that a retardant concentration between 0.25 and 0.75 l/sq m will stop the spread of a fire burning in fuels weighing 17 t/ha with an intensity of 520 kW/m.

On this basis the distributions shown in Figures 4, 6 and 7 are likely to provide a significant barrier to the spread of wildfire. It should however be remembered that the drop patterns shown are based on the volume of slurry collected in the most readily penetrated sections of the stand. Table 4 shows the significant alterations to volume that will occur within each distribution due to the effect of individual tree crowns.

Distribution changes will occur with drops made at an angle to the row direction. However, it is difficult to visualize any significant alteration to the length of control line constructed in each case.

Data presented in Table 3 show significant volumes were retained within the canopy for each drop. The data in Table 5 indicate most of the volume is retained in the upper canopy levels, with little penetration occurring either to the lower canopy levels, or sideways into individual crowns.

It appears that the delivery mechanism of the aircraft used could be causing a reduction in volume towards the centre of the distribution (see Figure 3). This reduction may be reflected in the breaks in effective concentration evident in the distributions shown in Figures 4 and 6.

CONCLUSION

Of the four stand types examined, effective ground level concentrations were obtained in the 8 and 12 year old unthinned stands, and the 15 year old thinned stand. Although the volumes retained in tree crowns were high, sufficient gaps existed within these stands to allow effective penetration.

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ACKNOWLEDGMENTS

This study would not have been completed without the contribution of Bryan Rees, Technical Assistant, and the co-operation of the staff and employees of the Heywood Forest District.