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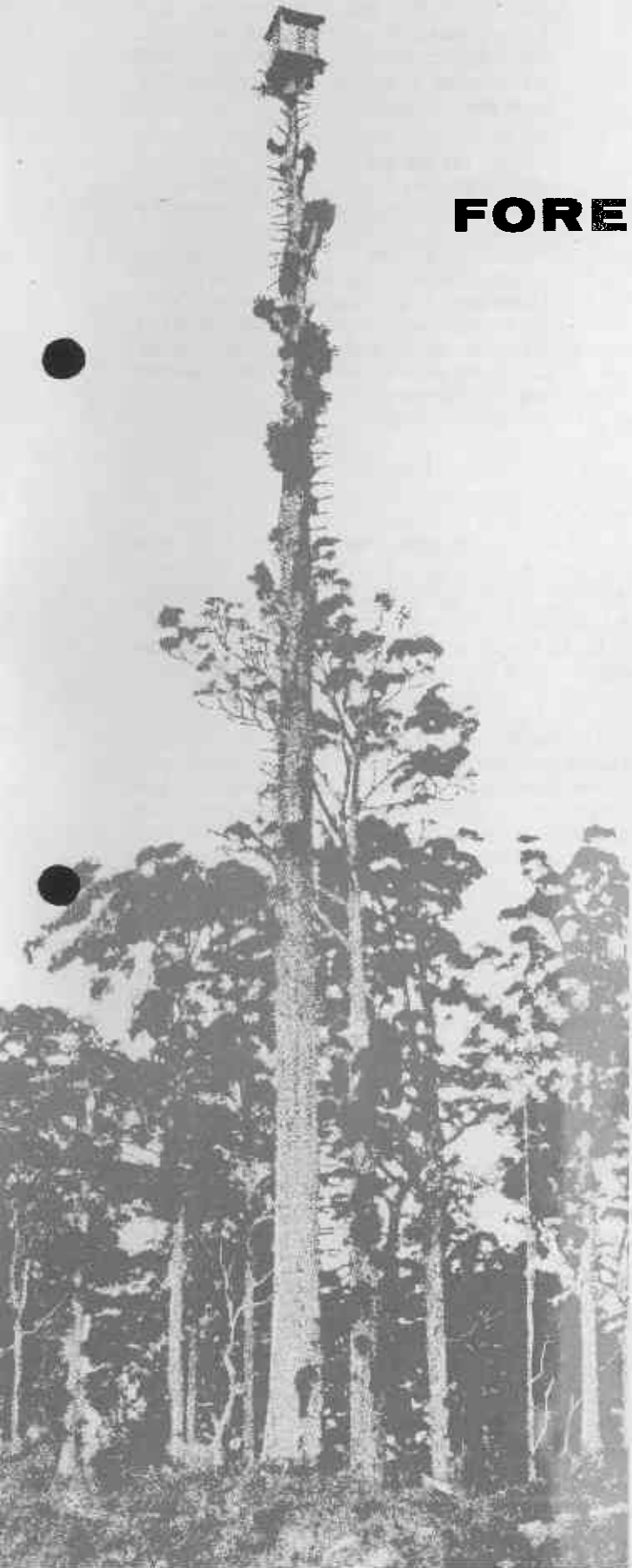

ASSESSING MARITIME PINE FUEL QUANTITY

by

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SUMMARY

A procedure for mapping litter fuels in maritime pine plantations has been developed to aid planning for prescribed burning. The method measures litter depth and assesses the fuel quantity resulting from thinning by measuring the base of the lopped tree crowns. Maps produced from the data are a reliable basis for decisions on lighting sequence and technique.

INTRODUCTION

Whenever fuel reduction by prescribed burning is necessary for fire control, a system which records fuel quantity and distribution is warranted. Such a system must combine reasonable accuracy with practicability and should reduce both the cost of prescribed burning operations and the incidence of fire damage.

A characteristic of pine fuels is their uneven depth over short distances both within and between compartments of the same age and species. This investigation, aimed at providing a better understanding of fuel distribution and build-up, was carried out for maritime pine (*Pinus pinaster* Ait.) plantations on the south-west coast of Western Australia.

METHOD

Broad Aims

Fuel types included both unthinned stands and thinned stands containing lopped crowns left behind after logging. Three methods of sampling were developed:

(i) Gauging the depth of the litter bed to determine weight of litter.

(ii) Girthing of lopped crowns to determine the weight of needles and twigs on thinning residues.

(iii) Line sampling to determine total fuel on the ground.

Detailed procedure

(i) To establish the relationship between litter depth and litter weight, ten 30.5m lines were randomly located and sampled, within an 11ha compartment of a 14 year-old maritime pine plantation. The compartment had been pruned but not thinned. Fuel weight and depth measurements were taken at 3.0m intervals along the lines with a depth gauge.

At each sampling point four depths were measured at the corners of a 0.3m x 0.3m quadrat which formed the litter sample unit. Litter samples were oven dried at 105°C and their weights converted to equivalent oven dry weight (o.d.w.) in tonnes per hectare.

(ii) The calculation for sampling slash, or thinning residue, was based on a relationship between the o.d.w. of needles and twigs per unit length of branch, and the total branch length for one crown. Total branch length was related to the butt girth of the crown, so that by measuring a number of butt girths the weight of needles and twigs in the lopped crown, could be evaluated.

To obtain fuel weights per unit of branch length, a number of tree crowns were sampled by taking one branch from each of the three or four branch nodes in the thinned crowns. The branch length was measured and all needles and the twigs less than 12.7mm diameter were collected, oven dried and weighed. Sampling was extended until the sampling error was reduced to less than 5 per cent.

(iii) Sometimes it is of interest to know the total fuel on the ground e.g. for the removal of clear-cutting residue by burning. The sampling technique used for this purpose was the line intercept method (van Wagner, 1968). Twenty lines, each 30.5m long, were randomly oriented throughout an area of 8ha. Diameters of all branches and stems crossing the lines were measured with calipers at the point of intercept. Only crown-wood intercepts greater than 12.7mm diameter were considered.

RESULTS

Litter Depthing

The four depth measurements obtained for each litter sample quadrat in unthinned stands were averaged and related by regression analysis to litter oven dry weight.

Litter weight in tonnes/ha (Y) and the depth in millimetres (X) were related by the equation:

$$Y = 4.176 + 0.307\,X$$

The coefficient of determination for the regression was 0.89 and the variance ratio was highly significant. In the thinned 16 year old compartment, 92 fuel samples were collected from litter beds ranging from 13mm to 76mm in depth. Only one depth measurement from the middle of each quadrat was taken. Data, on analysis, gave the regession:

$$Y = 5.008 + 0.207\,X$$

The coefficient of determination was 0.60 and the variance ratio was again highly significant. The single depth measurement for each quadrat proved to be adequate.

Slash sampling of fine fuel

Measurements from twenty-five lopped crowns were used to determine a relationship between the needle weight and crown branch length and between twig weight and crown branch length. There were 193g of needles and 45g of twigs under 12.7mm diameter for every metre of crown branch length. A study of one hundred lopped crowns revealed a linear regression of total branch length in metres (Y) on the butt girth of the crown in millimetres (X):

$$Y = 0.217X - 24.254$$

The regression gave a coefficient of determination of 0.77 and the variance ratio was very highly significant. These relationships were used to directly relate butt girth to needle and twig weight.

Line Sampling

The sum of the squares of all diameters measured in each line was incorporated in the formula:

$$W = (0.013S \sum d^2)/L$$

Where W = weight of wood in tonnes per hectare
S = specific gravity of wood
d = diameter of branches and stems in millimetres
L = length of sample line in metres.

FIELD TESTING

Litter Depthing

Depth measuring was tested over an 11ha compartment using a 20m x 40m grid to provide a sampling intensity of ten depth measurements per hectare. The average litter depth recorded was 56 ± 3mm which gave an average fuel quantity of 22.5 tonnes/ha and a 95 percent confidence limit of 20.9 to 24.4 t/ha.

These results were considered satisfactory in showing that a practical level of depth sampling can give an accurate indication of average fuel quantity over a large area.

To test the precision of the method with different surveyors, further tests were made using a 30m grid which gave a sampling intensity of about twelve samples per hectare. Two surveyors evaluated an area of about 8ha at this spacing, beginning 3m along and 3m inward from the compartment corner. The area was sampled twice by each surveyor, once beginning from the southeast corner and once beginning from the northwest corner. The results, given in Table 1, suggest large areas can be depth sampled with reasonable consistency between operators.

TABLE 1

Depth measurements recorded inside a compartment by two surveyors

Surveyor	Starting Point	Number of Measurements	Fuel Depth mm	Standard Error (%)
1	S.E.	107	43.9	3.9
2	S.E.	103	46.0	4.2
1	N.W.	118	45.5	4.0
2	N.W.	101	53.3	3.8

A heavier build-up of fuels along the edges of compartments was observed. In a small study, litter fuels within 3m of the compartment edges were found to be more than double the weight of those measured inside the compartment (Table 2). This edge zone is an important fuel component and, as such, requires attention separate from the remainder of the compartment area.

TABLE 2

Depth measurements on a compartment edge by two surveyors

Surveyor	Starting Point	Number of Measurements	Fuel Depth mm	Standard Error (%)
1	N.W.	22	98.0	8.7
2	S.E.	22	119.1	6.2

Line Sampling

Use of the line intercept method to assess the quantity of wood on the ground was tested in a 14 year old stand following first thinning. It provided an average value of 13.1 ± 0.8 t/ha for a compartment of 10ha. An average specific gravity for the wood of 0.47 was determined from mid-crown stem sections.

DISCUSSION

Fuel Mapping

Depth sampling lends itself readily to fuel mapping for both plantations and compartments. Average fuel quantity values for each compartment can be recorded on a fire plan. Depth measurements on a grid will provide a compartment fuel isoline plan for study prior to prescribed burning operations.

For mapping, the sampling intensity considered most suitable is twelve depth measurements per hectare (30m x 30m grid). If average litter depth is required, only ten samples per hectare will suffice. Usually it is adequate to locate the sample points by pacing.

Depth measurements can be recorded on grid paper. Joining sites of similar fuel depth or quantity yields an isoline map. If understorey vegetation is present, this can be recorded simultaneously in terms of type, height and abundance.

Of necessity, fuel isolines must be reproduceable with a reasonable degree of accuracy, irrespective of the surveyor or orientation of sample lines. Judging from large scale field tests, this is quite feasible. (Figure 1).

FIGURE 1

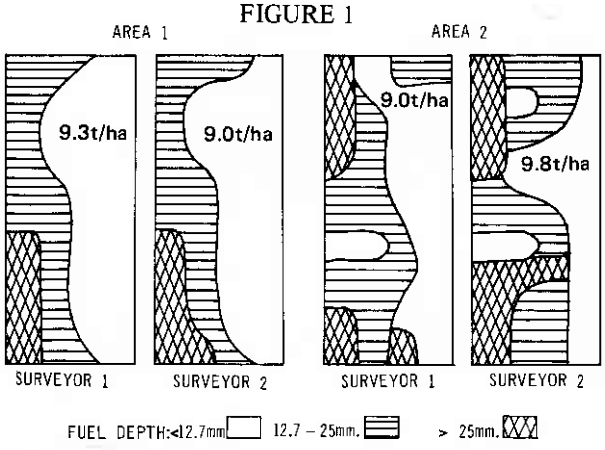

FIGURE 1: *Fuel contour maps of two areas, each surveyed independently by two operators.*

Sampling Errors

Errors in sampling will occur if depths are taken close to old hardwood stumps, coppice growth, graded tracks, drains or bushes. These errors are reduced by sampling no closer than 2.0m to any such obstacles.

If depth sampling in the thinned stand is not carried out shortly after thinning has taken place, care must be taken to avoid bias in sampling from the accumulation of dead needles released by thinned tops. Whenever depth is sampled, heaps of thinned crowns should be avoided.

CONCLUSION

By using the systems outlined above an objective system of sampling and mapping of litter fuels of maritime pine stands was developed and tested. The method proved rapid, simple and reliable.

LITERATURE CITED

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