ESTIMATION OF KARRI UNDERSTOREY FUEL WEIGHTS FROM SELECTED STRUCTURAL PARAMETERS

by

R.J. Sneeuwjagt

INTRODUCTION

Fire behaviour in Karri understorey scrub can alter rapidly from low intensity flames burning in litter, to flaring of foliage, to conflagrations consuming whole scrub.

The present Karri forest fire danger tables (Harris, 1968), which is an extrapolation of the successful Jarrah fire danger tables, contain subjectively selected fuel loadings chosen to account for the scrub fuel differences.

However, these corrections, which are incorporated in the drought index, do not take into consideration differences in scrub type, density, height and disposition. Consequently, these adjustments have not met with a great deal of success.

It was with the aim of remedying this situation that a detailed study of Karri scrub fuel was initiated in 1961 prior to an intensive experimental fire behaviour study, (Ward, 1970).

The scrub study was designed to develop a simple, rapid sampling technique for evaluating fuel characteristics of high dense scrub, so that relationships between the structural parameters and fuel weights could be used to obtain scrub fuel loadings for more reliable predictions of Karri fire danger.

EXPERIMENTAL METHOD

The Study Area

The experimental area located at Strickland Road, twenty miles west of Manjimup, consists of a cover of mature and over mature Karri and Marri. The scrub understorey is representative of a major portion of the southern Karri forests. The major understorey species include Netic (Bossiaea aquifolium Benth), Hazel (Trymalium spathulatum Labill), and various Acacia species such as A. pulchella and A. strigosa. The area was divided into 180 three-chain square plots, which were sufficiently large to contain an experimental fire.

Assessment Method

The major considerations in choosing a suitable sampling method for measuring scrub composition and structure are the procedure be objective, reproducible, efficient and adaptable to tall and dense vegetation.

The line transect and random quadrat sampling techniques were judged unsuitable in the tall and dense vegetation.

The method chosen was based on a system of point sampling developed by Levy and Madden (1933). In this point sampling method the observer records the number of contacts at separate height intervals made by the plant species on a long vertically placed rod. The rod used was ¼ inch in thickness, and thirteen feet in length marked at one foot intervals.

Errors introduced by observer interpretation and by the finite rod diameter are only slight, so long as the diameter is kept small and all observations are made objectively (Goodall 1952).

The two major expressions derived by the Levy point sampling method which are of value to the present study are:

(i) Total Cover Density (T.C.D.)

$$\text{T.C.D.} = \frac{\text{total number of hits recorded on vegetation}}{\text{number of rods with at least one contact}}$$

(ii) Percentage cover contribution (P.C.C.)

$$\text{P.C.C.} = \frac{\text{total number of contacts recorded on the species}}{\text{total number of hits on all species.}}$$

T.C.D. is an expression of overall scrub structural density, and P.C.C. is an expression of the contribution of a particular species to the total population.

Because of the large number of plots to be assessed it was necessary to sample at minimum acceptable intensity. A sampling trial of four plots with up to 100 systematically chosen sites in each, indicated that 30 to 40 sites per plot gave reliable estimates of plot cover density and cover contribution by the main species. On the basis of these results the remaining plots were assessed using 36 sites per plot (40 per acre).

Each of the 180 plots was divided by three equally spaced lines. Six sites were spaced per line and sampling was conducted one yard either side of the 18 sites to give a total of 36 observations. Depending on topography of the area, the time taken for two men to assess each plot varied from 30 to 60 minutes.

Once, each of the percentage cover contribution values were determined it was possible to classify each plot in terms of major scrub species contribution.

A graphical method using an equilateral triangle was used to seperate the plots into distinct scrub types. In this convenient method of plotting, the triangle apices represented 100 per cent contribution by Hazel, Netic and 'other species'. Figure I shows that plots lying, say, on base line BC contain only Hazel and Netic, but no 'other species'. Similarly, those lying on line DF contain equal percentage of Hazel.

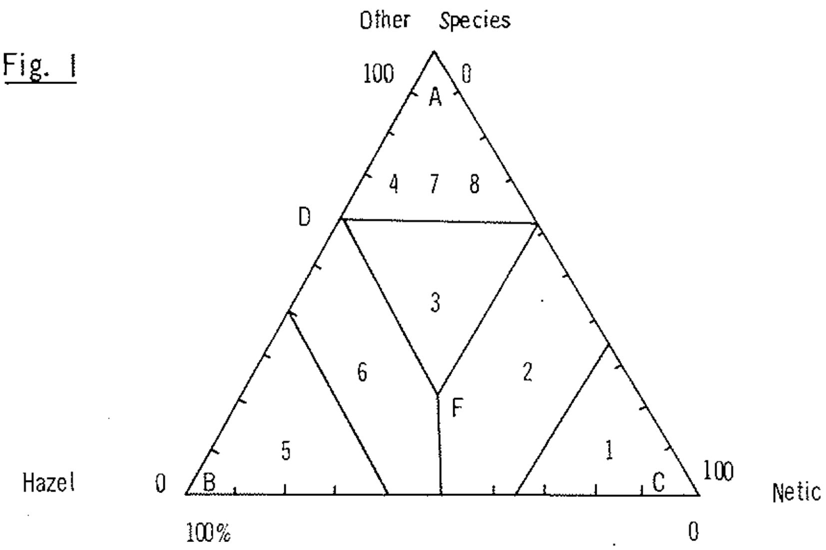
Eight distinct scrub classes were located within the triangle.

These are:–

(1) Netic only ($>$ 55%)
(2) Netic dominant ($>$ 40%) plus Other Species (O.S.)
(3) Mixture of Netic, Hazel and O.S.
(4) A. pulchella dominate ± Netic and O.S.

(5) Hazel only (> 60%)
(6) Hazel Dominant(> 40%) + Netic, O.S.
(7) Swamp type (A. divergens, swordgrass mainly)
(8) A. strigosa dominant + Netic.

Fig. 1



Scrub Weight Assessment

In order to determine what the expressions of cover density and height meant in terms of scrub weight, a weight sampling was conducted on each of the scrub types. Sampling was limited to those plots exhibiting extremes in both height and cover density within each of the scrub types. Six plots were sampled within each scrub type, each of which belonged to one of the following six categories.

A.	Tallest plots	(i) Densest	(ii) Least dense
B.	Intermediate height plots.	(i) Densest	(ii) Least dense
C.	Shortest plots	(i) Densest	(ii) Least dense

Sampling within each plot was conducted on a systematic basis, using every fourth of the original 36 points as the new weight sampling site. The sampling number of nine per plot was derived at from tests conducted on four trial plots in three scrub types.

The sampling method involved the weighing of all live and dead scrub material within a vertical cylinder of 1.66 feet radius, and described by a sliding wire arm attached to a twelve foot vertical pole. The radius of assessment was calculated to give simple conversion to tons per acre.

All material within two foot height intervals was removed by cutting, and seperated into live and dead. These were further broken up into four diameter classes of less than 1/8 inch (flash), 1/8 to 1/2 inch, 1/2 to 1 inch, and greater than 1 inch. Moisture samples were collected of all scrub components for each height interval. These were oven dried at 105°C and the calculated moisture contents used to express the data in terms of equivalent oven dry weight.

RESULTS

Scrub Weight Relationships

A preliminary examination of live scrub weight data indicated the existence of constant relationships between scrub component and total live weights for all scrub classes.

Weights of material less than 1/8 inch were plotted against total live weight and two linear regressions were evident (Fig. II).

The Netic and Acacious species dominant plots could be combined into one close regression. The Hazel dominant types separated out in a regression above the first. Those plots containing a mixture of these species, fell in between the two regressions.

The weights of material of 1/8 to 1/2 inch diameter and greater than 1/8 inch also separated out into two distinct linear regressions (Figs III & IV). Similar treatment on the dead material data, however, failed to show relationships existing between the total dead weight and the weights of the various size components. It was noticed that the weights of dead material do not vary much between samples of a scrub type, so that it was possible to use mean values for all plots within a scrub type irrespective of scrub height and density.

Scrub Weight and Scrub Height-density Relationships

The possible presence of relationships between live material weights and the derived quantitative expressions of scrub height and density were investigated. It was shown that both height and density parameters were directly related to scrub weight, although individually these parameters do not give sufficiently accurate estimates of scrub weight.

By combining cover density and height as a product a much better relationship was obtained. It was found possible to combine the Netic and Acacia species dominant types in a single linear regression (Fig. V). The Hazel dominant types formed a slightly concave regression above the first. (See Fig. VI).

The presence of these relationships make possible the determination of total live weight values of scrub types of known average top height and cover density. Thus, a direct estimation of scrub weight may be obtained by using the simple "Levy" point sampling technique to determine top height and cover density.

Scrub Weight Profile Histograms

It is of interest to both fire managers and research workers to learn how the weights of the various scrub components are distributed throughout the understorey profile.

From the scrub weight field data, the weights of the three live scrub components within 2 foot height intervals were plotted against the top height x cover density value of each sample plot within scrub types. A line of best fit for each size class gave three consistent and logical trends for each height interval.

These graphs were combined into a series of weight profile histograms for each scrub group, with each histogram spanning 20 units of the height-density product range.

Figure VII shows an example of two ranges of product values (80-100 and 100-120) for theNetic dominant scrub group.

DISCUSSION AND CONCLUSIONS

The present study successfully identified relationships existing between live scrub fuel weight, and the product of the structural parameters of scrub cover density and top height for all scrub fuels encountered.

The weights of live scrub structural components were demonstrated to be directly related to total live weight.

Thus, the values of average cover density and top height, determined by the point sampling method, are the only parameters required in order to estimate the weights of the total live material and the scrub components.

The weights of the dead scrub material did not vary greatly with change in scrub height and density, so that it was possible to adopt mean weight values for the entire range of parameters within each scrub type.

It is planned to investigate further the various weight-parameter relationships of several other common Karri understorey scrub types, and to expand the present data into both older and younger age groups.

At the completion of this work, it will then be possible to estimate scrub fuel weights of all common Karri scrub types within a proposed control burn area, by employing the simple point sampling technique and making use of the pertinent relationships obtained.

REFERENCES

1. Goodall, D.W. (1952). – Some considerations in the use of point quadrats for the analysis of vegetation. Aust. J. Sci. Res. 58: 1-41.

2. Harris, A.C. (1968). – Forest Fire Danger Tables. W.A. For. Dept.

3. Hopkins, E.R. (1969). – Personal Communication on scrub assessment techniques.

4. Levy, E.B. and Madden, E.A. (1933). – The point method of pasture analysis. N.Z.J. Agr. 46: 267-279.

5. Peet, G.B. (1965). – A Fire Danger Rating and Controlled Burning Guide for the Northern Jarrah (Euc. marginata S.M.) Forest of W.A. W.A. For.Dept. Bull. No. 74: 37 pp.

6. Sneeuwjagt, R.J. – Karri Scrub Fuel Study. W.A. Forests Dept. Prog. Report 1970.

7. Ward, D.W. (1970). – Factors influencing Fire Rate of Spread in Karri Litter. Prog. Report Working Plan 40/65. Forests Dept. of W.A.

Fig. II

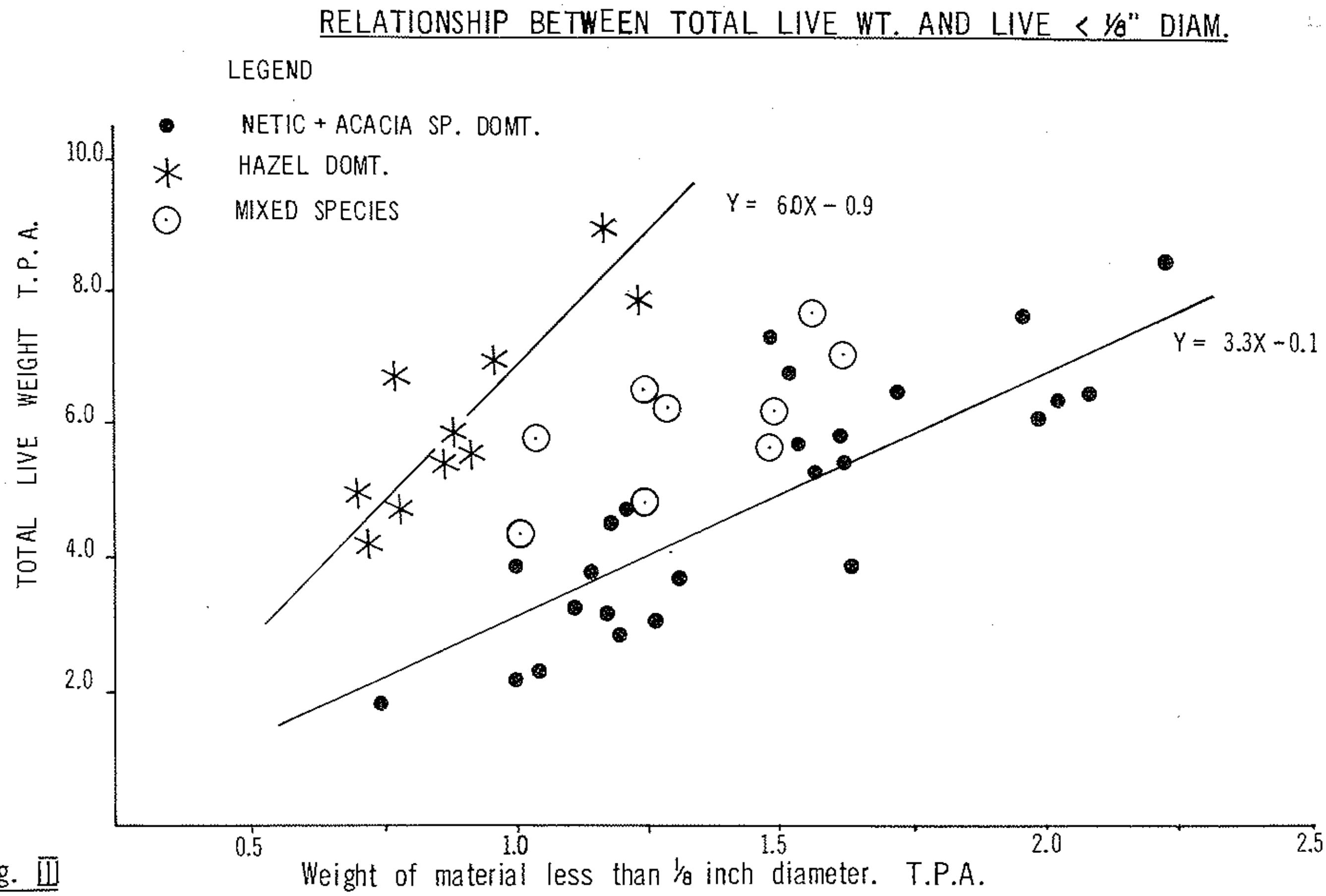


Fig. III

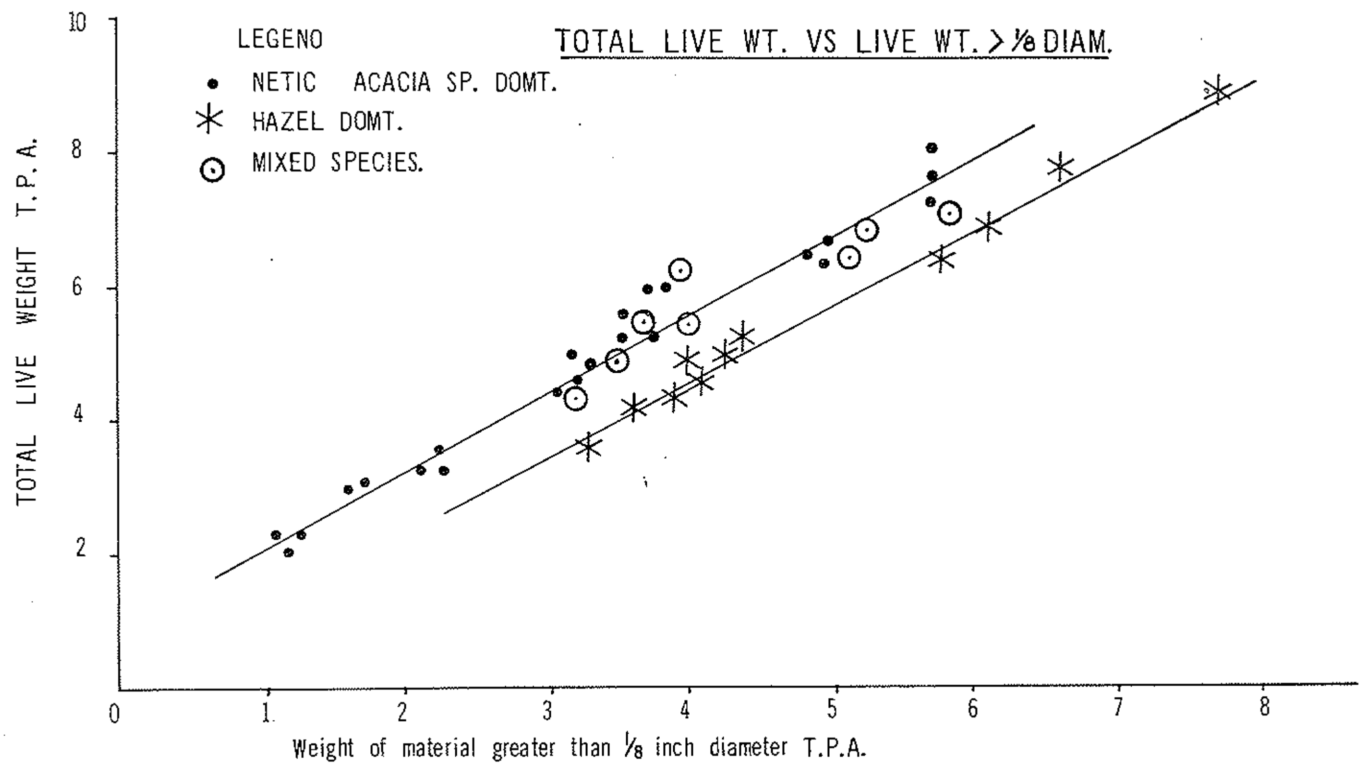


Fig. IV

RELATIONSHIPS BETWEEN TOTAL LIVE WT. AND WEIGHTS OF VARIOUS LIVE FUEL SIZE COMPONENTS.

Netic domt. and Acacia sp. domt. only.

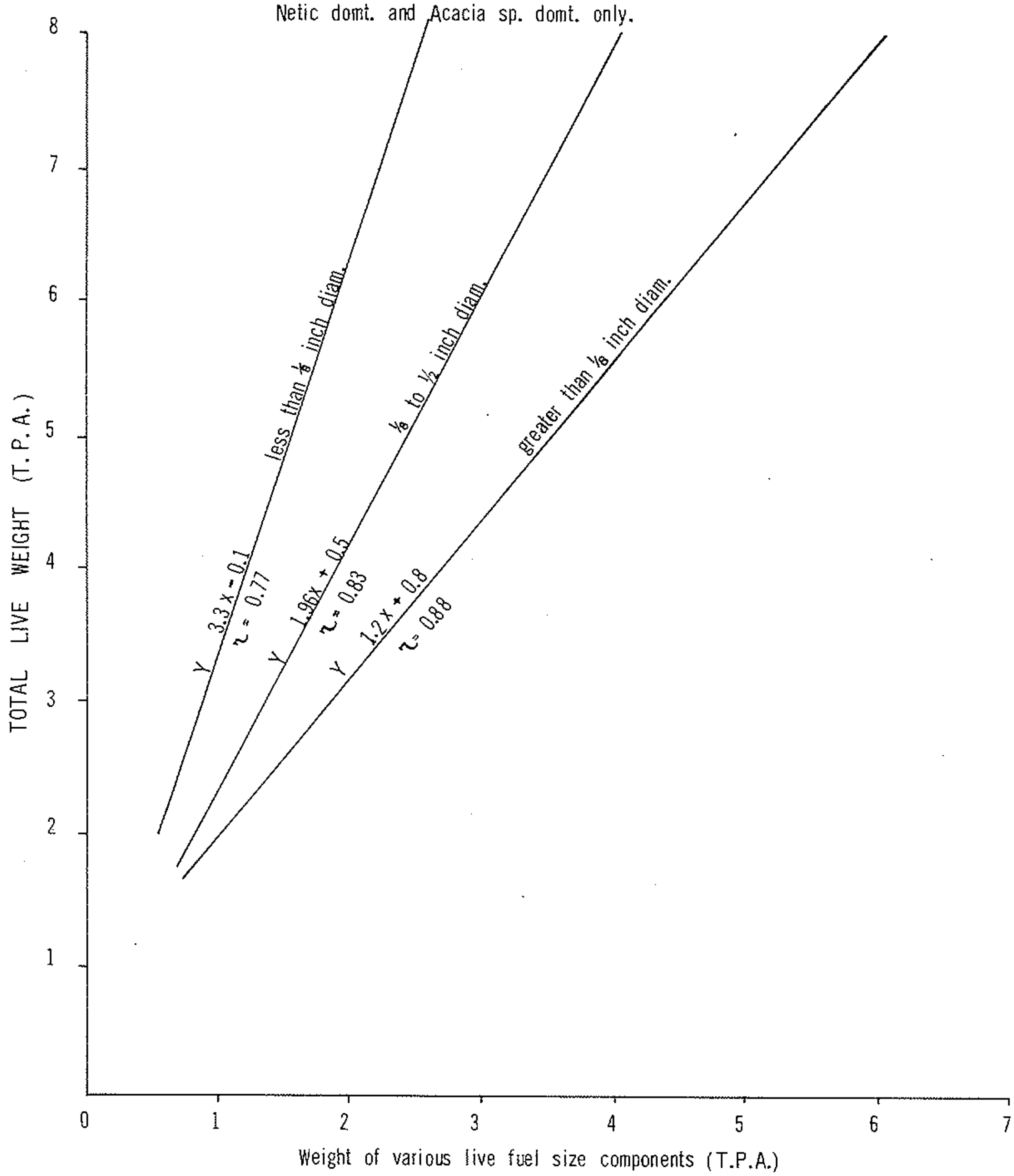


Fig. V

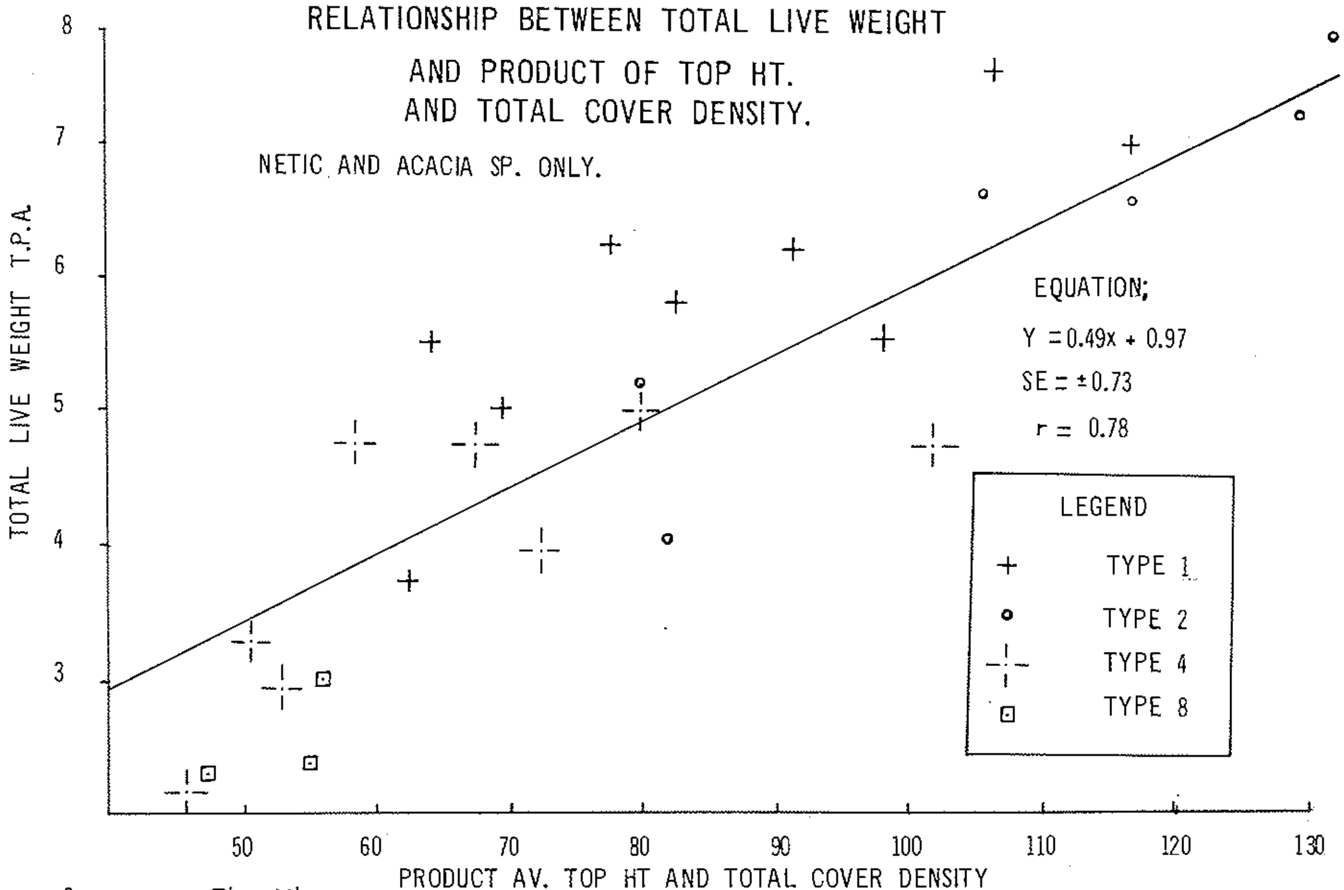

RELATIONSHIP BETWEEN TOTAL LIVE WEIGHT
AND PRODUCT OF TOP HT.
AND TOTAL COVER DENSITY.
NETIC AND ACACIA SP. ONLY.
EQUATION;
Y = 0.49x + 0.97
SE = ±0.73
r = 0.78
LEGEND
TYPE 1
TYPE 2
TYPE 4
TYPE 8
TOTAL LIVE WEIGHT T.P.A.
PRODUCT AV. TOP HT AND TOTAL COVER DENSITY
3
4
5
6
7
8
50
60
70
80
90
100
110
120
130

Fig. VI

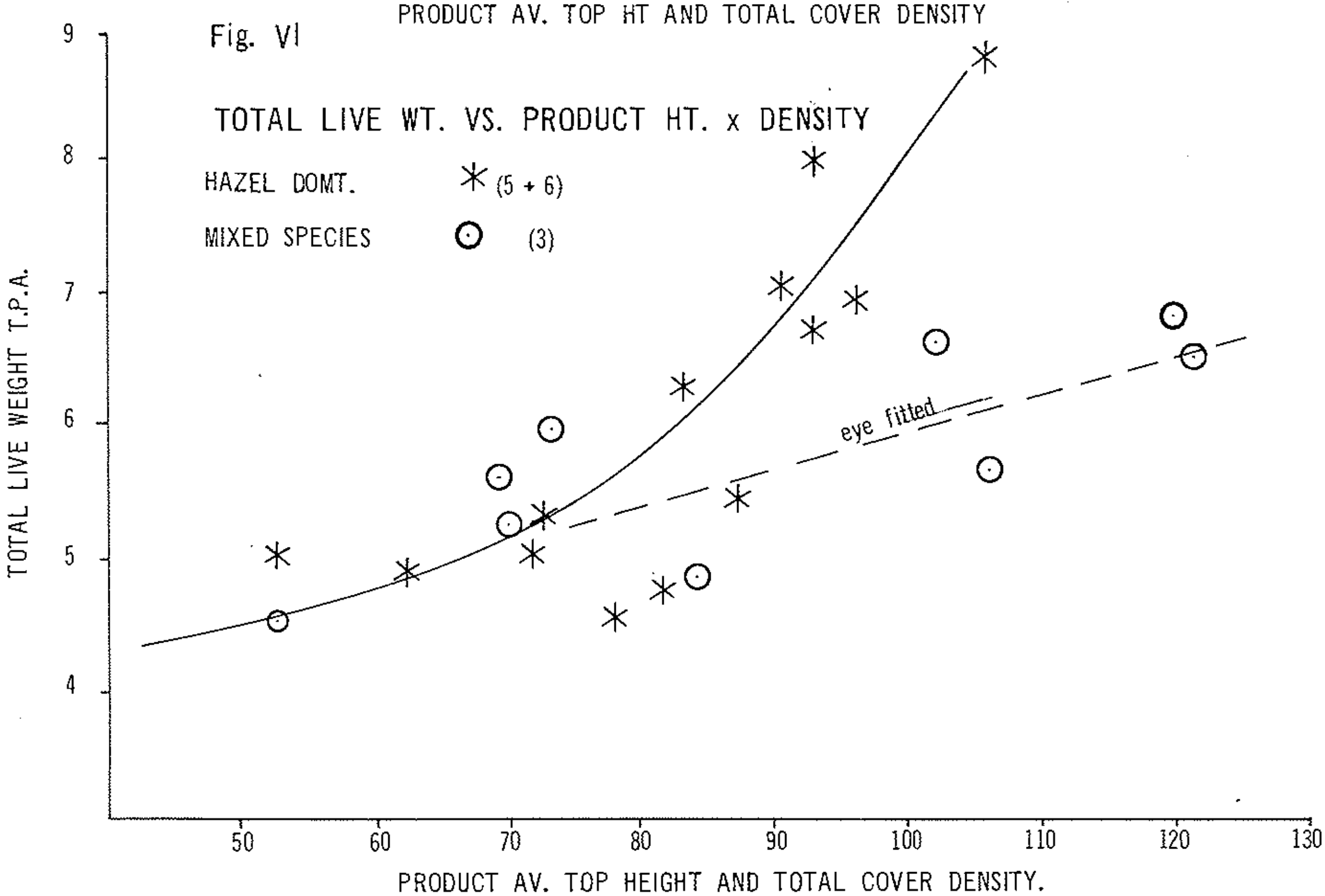

TOTAL LIVE WT. VS. PRODUCT HT. x DENSITY
HAZEL DOMT. (5 + 6)
MIXED SPECIES (3)
eye fitted
TOTAL LIVE WEIGHT T.P.A.
PRODUCT AV. TOP HEIGHT AND TOTAL COVER DENSITY.
4
5
6
7
8
9
50
60
70
80
90
100
110
120
130

Fig. VII LIVE SCRUB WEIGHT PROFILE HISTOGRAMS

TWO EXAMPLES WITHIN ONE MAJOR SCRUB TYPE.

BOSSIAE AQUIFOLIUM DOMT.