Extra

SOUTHERN FOREST EXPERIMENT STATION

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ESTIMATING FOLIAGE ON LOBLOLLY PINE

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SOUTHERN FOREST EXPERIMENT STATION

The weight of foliage on loblolly pine trees in a 25-year-old north Mississippi plantation was found to be closely related to tree diameters, while fascicle length and weight were independent of tree size. Thus foliage parameters such as needle numbers, volumes, or surface areas, often needed for hydrologic and other purposes, may be approximated from relatively inexpensive stand measurements. Since the study area included a considerable range in site quality, the relationships should be rather widely applicable in similar fully stocked stands.

METHODS

Fascicles were stripped from 28 trees in the 25-acre plantation during April 1963, after winter leaf fall was complete, and before new needles had developed. They were air-dried for 2 months and then weighed. Ovendry weights were determined from subsamples dried at 105° C. for 24 hours.

Sample trees ranged from 5.4 to 10.9 inches in diameter and averaged 8.08 inches—very close to the stand average. Total heights ranged from 37 to 66 feet; lengths of live crowns, from 15 to 30 feet; and areas of crowns projected vertically, from 50 to 373 square feet. Basal area as measured on 10 one-tenth-acre plots was 131.2 ± 20.6 square feet per acre at the 5-percent probability level. Site index ranged from 69 to 97 over the area sampled.

Relationship of Foliage Weight to Tree Characteristics

Equations were developed to relate foliage weight per tree to every possible combination of the seven independent tree variables:

X_1 = Diameter at breast height (d.b.h.)

X_2 = Projected crown area

X_3 = Length of live crown

X_4 = Total height

X_5 = Basal area

X_6 = Basal area × projected crown area

X_7 = Projected crown area × length of live crown

Table 1 is a summary of selected equations.

Single-variable equations utilizing diameter and basal area accounted for more variation

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Table 1.—*Summary of selected equations for predicting foliage weight (Y) in kilograms*

Variables		Equations	Percent of variation accounted for
D.b.h., X_1	(1)	$Y = 1.46342X_1 - 7.16756$	78.7
Basal area, X_5	(2)	$Y = 16.10160X_5 - 1.26096$	78.8
Projected crown area, X_2	(3)	$Y = 0.02688X_2 + 0.74603$	74.7
Length of live crown, X_3	(4)	$Y = 0.34565X_3 - 3.31464$	24.1
Total height, X_4	(5)	$Y = 0.20612X_4 - 6.71368$	32.4
Basal area $\times$ projected crown area, X_6	(6)	$Y = 0.03898X_6 + 2.24574$	76.6
Projected crown area $\times$ length of living crown, X_7	(7)	$Y = 0.00091X_7 + 1.47624$	68.7
X_1, X_2	(8)	$Y = 0.89876X_1 + 0.01298X_2 - 4.49355$	84.4
X_2, X_5	(9)	$Y = 0.01273X_2 + 9.92227X_5 - 0.84208$	83.9
X_1, X_2, X_3, X_4, X_5, X_6, and X_7	(10)	$Y = 0.76181X_1 + 0.02715X_2 - 0.07712X_3 - 0.02310X_4 + 5.36089X_5 - 0.01947X_6 - 0.00012X_7 - 2.73002$	86.1
Log d.b.h., X_8	(11)	$\text{Log } Y = 2.67156X_8 - 1.79586$	81.0

than the other one-variable equations. Projected crown area made a small but statistically significant contribution when included after diameter or basal area in the better two-variable equations. Adding a third variable to either of these equations did not provide significant improvement.

The minor refinement associated with the inclusion of crown area after diameter or basal area, together with the difficulty of measuring this variable, encouraged the acceptance of a single-variable equation relating foliage weight to some function of diameter. A logarithmic transformation suggested by previous investigations,[2,3] seems to describe the relationship adequately. The equation finally accepted (No. 11 in table 1) is graphed in figure 1. The weight of foliage on a tree at the geometric mean diameter (7.95 inches) was 4.074 kilograms or 8.98 pounds. The gray band around the regression in figure 1 indicates the confidence limits for mean foliage weight with a one-in-three chance of error. Within the wide band are the probable limits of error for predicting the weight of foliage on a single tree at the same odds.

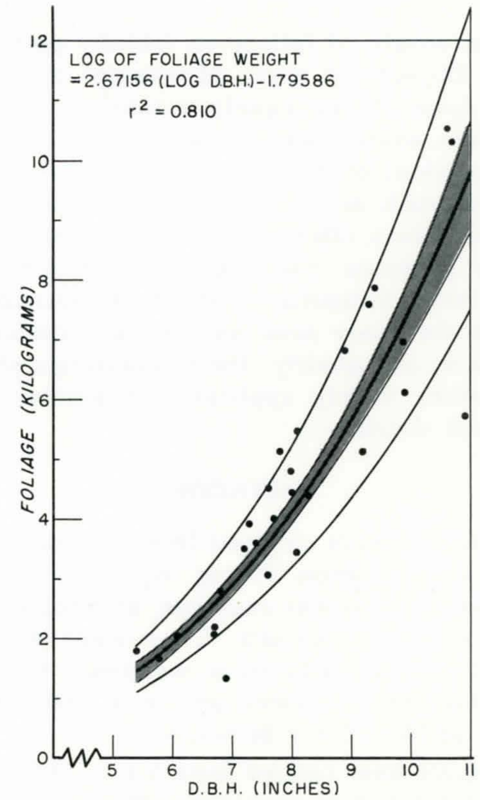

Figure 1.—*Regression of ovendry foliage weight on tree diameter with 67-percent confidence bands for mean foliage weight of population (gray band) and of individual observations (wide band).*

[2] Kittredge, Joseph. **Forest influences.** 394 pp., illus. New York: McGraw-Hill. 1948.

[3] Cable, Dwight R. **Estimating surface area of ponderosa pine in central Arizona.** Forest Sci. 4: 45-49, illus. 1958.

ESTIMATE OF FASCICLES

The average length of fascicles and their ovendry weight were independent of tree diameter. Correlation coefficients squared (r^2) were 0.003 and 0.018, respectively. Because of this independence, the fascicle is best described by the mean length and weight of all fascicles sampled. The average length was 5.88 ± 0.06 inches (95-percent level); the average ovendry weight was 0.11709 ± 0.00423 gram (95-percent level).

Dividing estimated foliage weights by average weight per fascicle provides estimates of numbers of fascicles, which can be multiplied by three to obtain needle numbers. With a good model of needle geometry, needle length and number can be used to estimate total foliage volume and surface. Since these calculations involve errors of estimate in addition to the variance about the regression (fig. 1), estimates for single trees would be subject to appreciable errors. For many purposes, however, estimates on an area basis are useful, and could be computed with considerably more precision by applying these relationships to stand tables.