ESTIMATING BROWSE FROM TWIG AND STEM MEASUREMENTS

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Highlight

In upland forests of east Texas, total twig length was closely correlated with yield of deer browse plants, but the best predictor of yields was a combination of twig numbers and length.

In the study reported here, wildlife browse species were examined to find how closely main-stem diameter, number of twigs per plant, and total twig length were associated with forage weight and to learn which combination of factors was best for predicting weight. The factors selected appear to be closely associated with weight, their dimensions are fairly constant from midsummer until growth resumes the following spring, and they can be precisely measured without bias.

Previously, studies by Schultz (1956), Kinsinger and Strickler (1961), and Shafer (1963) showed that twig weights are correlated with various plant factors.

Procedure

The eight species studied were American beautyberry *(Callicarpa* *americana* L.), flowering dogwood (*Cornus florida* L.), fringetree (*Chionanthus virginicus* L.), sassafras (*Sassafras albidum* (Nutt.) Nees), rusty blackhaw (*Viburnum rufidulum* Raf.), yellow jessamine (*Gelsemium sempervirens* (L.) Ait.), and two greenbriers (*Smilax rotundifolia* L. and *S. bona-nox* L.). Fifty plants of each species were measured in October 1962 for main-stem diameter at groundline, number of live twigs per plant, total length of twigs, and total weight of twigs with and without leaves.

Shoot weights (twigs with leaves) represented browse forage available to deer in summer, and twigs (without leaves) the forage available in winter. Length and diameter measurements were in centimeters; weight was in grams of oven-dry browse. All measurements were restricted to growth of the current year.

The plants were collected from a sandy upland shortleaf-loblolly pine-hardwood site on the Kurth Experimental Forest, 7 miles south of Nacogdoches, Texas. Sampling was limited to well-established plants less than 7 feet tall.

Regression analysis included the dependent variables of total shoot weight (Y_1) and total twig weight (Y_2), and five independent variables: main-stem diameter squared (X_1), number of twigs per plant (X_2), number of twigs squared (X_3), total twig length (X_4), and total twig length squared (X_5). Variables X_3 and X_5 were included as tests of curvilinearity. Equations for all possible combinations of the five independent variables were solved for each Y variable (Grosenbaugh, 1958).

Results and Discussion

Usually, though not always, combinations of factors were superior (0.05 level of significance) to single factors for predicting browse yields. Of the combinations, that of total twig length with twig numbers was generally best.

Transformation of twig number and twig length by squaring did not significantly improve estimates, an indication that the relations were linear. Covariance analyses showed that the slopes of the regression lines were different for each species, thus precluding the use of a common equation for all species. Table 1 lists the regressions that gave the best estimates for individual species. The two- and three-variable regressions are significantly better than formulas having fewer variables.

Yellow jessamine, a vine, showed the highest correlations (r = 0.968) between total shoot weight (twigs plus leaves) and the measured independent factors. The combination of total twig length and twig numbers accounted for 93.7 percent (r^2) of the variation in shoot weights. This is rather surprising since the greenbriers, also vines, showed very poor correlations (and hence are omitted from table 2).

The highest correlation between total twig weight and other plant measurements (r = 0.978) was exhibited by sassafras. Total twig length and twig numbers accounted for 95.6 percent of the variation in total twig weight.

Table 1. Equations for estimating current-season shoot weight (Y_1) and current-season twig weight (Y_2) of some common southern browse plants.

Species	Equation	Proportion of total variation explained	Standard error $s_{y.x}$	Mean $\bar{y}$
		Percent		
American beautyberry	$Y_1 = -23.9 + 8.0L - 42.7N$	0.87	311.3	1,254.0
	$Y_2 = -54.5 + 4.4L - 35.7N$	.89	132.1	501.4
Rusty blackhaw	$Y_1 = +63.7 + 4.0L + .3D^2$	.87	278.3	968.4
	$Y_2 = -26.0 + 2.3L$	.80	154.3	319.2
Flowering dogwood	$Y_1 = -251.3 + .9D^2 + 22.0N$	.81	595.6	1,657.8
	$Y_2 = -85.5 + 1.8L + .2D^2 - 5.8N$	.92	108.0	478.5
Fringetree	$Y_1 = +166.7 + 15.7L$	.74	975.2	2,235.0
	$Y_2 = -103.1 + 5.2L$	.80	276.3	585.1
Sassafras	$Y_1 = -195.4 + 2.4L + .2D^2 + 23.5N$	.83	225.8	494.2
	$Y_2 = -41.3 + 2.8L - 6.0N$	.96	43.0	208.2
Yellow jessamine	$Y_1 = -80.3 + 1.3L + 11.6N$	.93	95.3	305.3
	$Y_2 = -39.6 + .7L + .3N$	.94	39.5	108.0

L = Total current-season twig length; N = Total number of twigs; D^2 = Main-stem diameter squared.

Table 2. Simple correlation coefficients between browse weights and stem diameter, number of twigs, and twig length.[1]

Species and plant parts	Stem diameter squared	Number of twigs	Total twig length
American beautyberry			
Shoot	0.694	0.556*	0.908
Twig	.672	NS	.875
Rusty blackhaw			
Shoot	.858	.826	.920
Twig	.788	NS	.895
Flowering dogwood			
Shoot	.838	.824	.849
Twig	.857	NS	.908
Fringetree			
Shoot	.829	.688*	.860
Twig	.788	NS	.893
Sassafras			
Shoot	.776	.878	.877
Twig	.720	.829	.972
Yellow jessamine			
Shoot	[2]	.792	.934
Twig	[2]	.637*	.967

[1] All coefficients are significant at the 0.01 level unless marked; * is significant at 0.05 level; and NS is not significant at 0.05 level.
[2] Main-stem diameter not measured on vines.

Although multiple variables gave significantly better predictions for most species, single variables may be of some value in practical sampling.

For most species, total twig length was the single variable most closely correlated with both shoot and twig weight (table 2). If measurements are taken from twigs within reach of deer and after the current season's growth is completed, it may be a useful estimator of forage availability.

Although not generally so good as total twig length, stem diameter squared also was closely related to weight. Unless sampling is confined to plants less than about 7 feet tall, however, much of the growth it represents may be out of reach of the browsing animals.

Twig counts showed the poorest correlation with weight. Usually they were more closely related to shoot weights than to twig weights. They thus are of some value for estimating browse when leaves are present, but have only limited usefulness for predicting winter forage. Shafer (1963), in Pennsylvania, increased their utility by combining them with average twig weights.

The equations in this article can be considered applicable only to the present data, as they may vary with site and year. The study shows, nevertheless, that relationships exist. Additional experience may permit development of standard equations, but even if the regressions must be computed anew each year this method of estimating forage offers substantial advantages. It is more objective than visual estimating, is less time-consuming and expensive than clipping and weighing samples, and permits repeated measurements on the same plant.

LITERATURE CITED

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Erratum. In table 1, the second equation for flowering dogwood should read: $Y_2 = -85.5 + 1.8L + .2D^2 + 5.8N$.