BRANCH AND FOLIAGE BIOMASS RELATIONS FOR SHORTLEAF PINE IN SOUTHEAST OKLAHOMA

Charles O. Sabatia, Thomas B. Lynch, and Rodney E. Will[1]

EXTENDED ABSTRACT

Data from 36 shortleaf pine trees, sampled from thinning study plots in even-aged naturally regenerated shortleaf pine forests in Southeast Oklahoma, were used to fit tree branch and foliage biomass equations. In 1989 sample plots were thinned to 50 percent stocking or 70 percent stocking, with the remainder as unthinned controls; basal areas ranged from about 16 m^2/ha to 44 m^2/ha. Three hundred seventy branches sampled on the basis of one branch per whorl, and the terminal branch, on the 36 trees, were used to fit regression equations to predict branch wood and branch foliage biomass. The best equations are shown in Table 1, with parameters fitted by weighted nonlinear regression using SAS PROC NLIN (SAS Institute). The variables in these equations were selected from the log-transformed form of the model

$$w = b_0 d^{b1} R^{b2} S^{b3}$$

using stepwise selection procedure of SAS PROC REG (SAS Institute). In this model, w is the branch or branch foliage dry weight in grams; d is the diameter at the base of the branch in centimeters; R is the relative branch height, in meters, obtained as (H – h) where h is height to the branch and H is the total height of the tree; S is the ratio (H/D) where D is the DBH of the tree in centimeters, and H is the total height of the tree, in meters; b_0, b_1, b_2, and b_3 are parameters. The model is that proposed by Ek (1979) for estimating branch weight and branch foliage weight in biomass studies.

Tree level estimates of branch and foliage biomass, obtained by summing up individual estimates obtained using the equations in Table 1, were regressed on tree dendrometric variables to obtain tree level branch and foliage biomass equations. Using stepwise selection procedure of SAS PROC REG (SAS Institute), to select variables from the log-transformed form of tree biomass models of the form $w = b_0 X_1^{b1} X_2^{b2} \ldots X_n^{bn}$, DBH alone was found to be the best predictor of tree foliage biomass. Stand density was found to have an effect on the b_1 parameter. DBH and crown width were found to be the best predictors for tree branch biomass; stand density appeared not to have an effect on the parameters. DBH and crown width together were also observed to be good predictors of foliage biomass. The tree level biomass equation forms are shown in Table 2.

In the equation forms in Table 2, w is the tree level biomass in kilograms, D the DBH in centimeters, CW the crown width in meters, and X1 a dummy variable—1 if the tree is from an unthinned stand and 0 otherwise. The parameters b_0, b_1, and b_2 are fitted by weighted nonlinear regression using SAS PROC NLIN (SAS Institute).

The model:

$$w = \xi dob^{\beta} C_h^{\tau} [2(1-e^{-\gamma l}) - \gamma l(\gamma l+2)e^{-\gamma l}],$$

developed by Zhang et al. (2004) for predicting tree foliage biomass, was found to provide the best fit to the foliage biomass data, with a Fit Index of 0.940. The model was slightly modified by replacing *dob* (diameter at crown base) with D (DBH):

$$w = \xi D^{(\beta+\delta X1)} C_h^{\tau} [2(1-e^{-\gamma l}) - \gamma l(\gamma l+2)e^{-\gamma l}]$$

The model was fitted to the pine data by weighted nonlinear regression using SAS PROC NLIN (SAS Institute). In the modified form, w, D, and X1 are as in Table 2 above; C_h is the height of the crown while *l* is the length of the crown, both of them in meters; ξ, β,δ,τ, and γ are parameters; e is the base of the natural logarithm. These models will be used to predict individual tree biomass components on the thinning study plots to obtain per-unit area biomass values.

ACKNOWLEDGMENT

The invaluable assistance of R. Heinemann, R. Holeman, D. Wilson, G. Campbell and K. Anderson of OSU Kiamichi Forest Research Station in the data collection for this project is acknowledged.

[1]Graduate Research Assistant (COS), Department of Natural Resource Ecology and Management, Oklahoma State University, 008C Agricultural Hall, Stillwater, OK 74078; Professor (TBL), Department of Natural Resource Ecology and Management, Oklahoma State University, 008C Agricultural Hall, Stillwater, OK 74078; and Associate Professor (REW), Department of Natural Resource Ecology and Management, Oklahoma State University, 008C Agricultural Hall, Stillwater, OK 74078. TBL is the corresponding author: to contact call (405) 744-5447 or email at tom.lynch@okstate.edu

Table 1.—Equations for predicting branch and branch foliage biomass in shortleaf pine.

Stand Type	Branch		Foliage	
	Equation form	Fit Index	Equation form	Fit Index
Thinned to 50 percent stocking	$w = b_0 d^{b1}$	0.8876	$w = b_{01} d^{b11} R^{b21}$	0.6354
Thinned to 70 percent stocking	$w = b_0 d^{b1} S^{b3}$	0.9687	$w = b_{02} d^{b12} R^{b22}$	0.6220
Unthinned	$w = b_0 d^{b1}$	0.9670	$w = b_{03} d^{b13} S^{b3}$	0.3746

Table 2.—Equations for predicting tree level branch and foliage biomass in shortleaf pine.

Tree part	Equation	Fit Index
Branch	$w = e^{b01} D^{b11} CW^{b21}$	0.956
Foliage	$w = e^{b02} D^{b12} CW^{b22}$	0.894
Foliage	$w = e^{b03} D^{(b13+b22X1)}$	0.919

LITERATURE CITED

Ek, A.R. 1979. A model for estimating branch weight and branch leaf weight in biomass studies. Forest Science. 25(2): 303-306.

Zhang, Y.; Borders, B.; Will, R.E.; De Los Santos Posadas, H. 2004. A model for foliage and branch biomass prediction for intensively managed fast growing loblolly pine. Forest Science. 50(1): 65-80.