GREEN WEIGHT, TAPER, AND VOLUME EQUATIONS FOR LOBLOLLY PINE IN OKLAHOMA, USA

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Extended abstract—Equations to estimate merchantable green weight, merchantable volume and taper for tree boles based on diameter at breast height (diameter at 4.5 feet, dbh), total tree height, and a specified merchantable diameter or height limit are indispensable to forest inventory. These equations have been developed for loblolly pine (*Pinus taeda* L.) over most of the area where it is grown. Some equations have been developed for specific growing regions within the South, while others are based on data representing most of the South.

There is currently one set of equations available for Oklahoma (Clark and others 1991); however, it is not adequate for some forest management needs because only data from natural stands are included, weight estimation is not included in the original document, and the system is complex. Additionally, because Oklahoma loblolly pine is primarily grown outside the natural range, range-wide prediction systems are likely biased for predictions limited to this smaller growing region. These facts indicate that Oklahoma forest managers will benefit from a loblolly pine stem content and taper prediction system fitted to data from Oklahoma.

To assess this need and, if necessary, ameliorate it, we collected data from 158 trees located in industrial plantations in the Ouachita Mountains of southeastern Oklahoma, USA. This area is near the northwest extreme but outside of the natural range of loblolly pine. The sample trees came from 22 stands across a range of site indices, ages, and tree sizes. Taper data were collected inside and outside bark at 0.5, 1, 2.5, 4.5, and intervals of 4 (feet) thereafter. Tree bole green weight with bark was determined in the field by weighing bolts corresponding to the lengths between taper measurements.

We compared Oklahoma loblolly pine to southwide populations using paired t-tests of the differences between true values and values predicted from southwide equations for green weight and taper. After analyzing the data, we found statistically and practically significant differences (5-10 percent over prediction for mature log green weight). We then used the merchantable-to-total stem content ratio method to estimate merchantable tree content; taper was estimated using compatible equations derived from the merchantable tree content equations. Ratios and total content were fit as a single equation to cumulative tree content profiles consisting of the green weights or volumes of bolts summed from the stump to the points along the stem where taper measurements were taken.

We selected the nonlinear version of the logarithmic total tree content equation (Schumacher and Hall 1933), the exponential merchantable diameter ratio equation (Parresol and others 1987, Van Deusen and others 1981), a new merchantable height ratio equation (Zhao and Kane 2017), as well as a new taper equation (Lynch and others 2017) derived from the merchantable height ratio equation. We compared these equations to several other well-known models using AIC, BIC, the root of the mean square error, mean bias, the pseudo R^2, parameter standard error size, and normality assessments. We utilized a power of the mean variance structure to model variance for a weighted nonlinear ordinary least squares estimation that could account for non-constant error variance in our data. We used this procedure to develop prediction equations for loblolly pine merchantable outside bark green weight as well as merchantable inside and outside bark volume. We used parameters from the merchantable height based volume equation in the taper equations to predict inside and outside bark taper. This work produced equations that have good predictive ability for trees across a wide range of conditions present in the Ouachita Mountains of southeastern Oklahoma and that are simple to use.

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ACKNOWLEDGMENTS

We are grateful for the participation of Rayonier Inc., the Oklahoma State University Kiamichi Research Station, Virginia Tech, and the University of Georgia in accomplishing and supporting this project.

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