VARIATION IN WOOD DENSITY BY STAND ORIGIN AND LOG POSITION FOR LOBLOLLY PINE SAWTIMBER IN THE COASTAL PLAIN OF ARKANSAS

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Abstract—A study was undertaken to investigate and report scaling factor variation for loblolly pine sawtimber in the Coastal Plain of Arkansas. Scaling factors for butt logs averaged 65.6 pounds per cubic foot for trees in stands of naturally seeded origin and 65.0 pounds per cubic foot for plantation trees. These scaling factors were not significantly different by stand origin at $\alpha = 0.05$. Scaling factors for the upper logs of trees in stands of naturally seeded origin averaged 70.5 pounds per cubic foot and those for plantation-grown trees averaged 71.0 pounds per cubic foot. These scaling factors were likewise not significantly different by stand origin at $\alpha = 0.05$. A seasonal trend was noted; treelength log scaling factors were numerically larger during spring and fall than those during fall and winter. These results should assist weight scaling of loblolly pine sawlogs in southern Arkansas.

INTRODUCTION

The predominant method of buying and selling timber in Arkansas and the Southern United States is by weight. The Arkansas legislature recognized this in the 2003 legislative session by no longer requiring use of the Doyle log rule (a volume-based rule) as the only legal rule for sawlog timber transactions within the state. It is simply more efficient to determine log weight than log volume. This gain in efficiency does come at a cost; it is now more difficult for a landowner to receive a premium for higher-quality large logs as a high quality and low quality log of the same dimensions can have the same weight.

Many forest inventories are conducted in terms of the timber volume and not weight. The landowner or land manager must then convert from units of volume to units of weight in order to determine timber value. To aid in this process, individual tree weight equations have recently been developed for loblolly pine (*Pinus taeda* L.) in southern Arkansas and surrounding regions (Newbold and others 2001, Posey 2003).

Issues regarding the weight and thus scaling factor of merchandized logs are also important. Scaling factor, or the outside-bark weight of a log divided by the inside-bark volume, is of interest when weight scaling merchandized logs. Logs of the same dimensions can have different scaling factors based on specific gravity and moisture content. Specific gravity is known to vary by position in the bole (Ezell and Schilling 1980, Hamilton 1961, Taylor 1979) as well as geographic location (Koch 1972). Patterson and Wiant (1993) found that moisture content varies according to position in the bole, while Yerkes (1967) reported seasonal fluctuations in moisture content. Thus, knowledge of scaling factors by season of the year, log position in the bole, and perhaps stand origin will assist weight scaling for loblolly pine in southern Arkansas.

The specific objectives of this project were to (1) determine scaling factors for loblolly pine sawtimber trees in southern Arkansas and (2) quantify how the scaling factors in (1) are impacted by stand origin, season of the year, and position in the bole.

SITES

A total 16 stands were visited during 2002 in conjunction with this project, with four unique stands visited per season of the year. Five stands were plantations, and the remaining 11 stands were of naturally seeded origin. The stands were scattered across Ashley, Cleveland, Drew, and Lincoln counties in southeastern Arkansas. The stands visited averaged 16 inches in quadratic mean diameter (range of 11 to 32 inches), possessed on average 51 pine trees per acre (range of 5 to 130), and had an average basal area of 67 square feet per acre (range of 17 to 135).

PROCEDURES

The researchers visited each stand shortly before it was scheduled for harvest. At this initial visit, 20 loblolly pine sawtimber trees were selected as subject trees via systematic random sampling. Several measurements were taken on each subject tree, including d.b.h. (nearest 0.1 inch), total height (nearest foot), and the number of 17-foot plylogs it contained. Each tree was then marked with a unique combination of paint bands to be used for identification on the loading deck.

Each stand was revisited after harvest. The felled bole (4-inch top) of each tree was measured and weighed at the loading deck within 1 day of harvest. Trees were weighed in February, May, August, and November 2002, to represent the winter, spring, summer, and fall seasons, respectively.

The following measurements were made on each tree-length log prior to merchandizing by a logging crew: total length (nearest 0.1 foot), inside bark diameter (nearest 0.1 inch) at the large and small ends, diameter and bark thickness (nearest 0.1 inch, respectively) at 40 percent of total length, and age (years) as counted at the large end. The tree-length log was weighed using a load cell (Measurement Systems International, Challenger 2, Model 3360, 10,000 pound capacity, 2 pound precision) suspended from a loader. After the tree-length log was weighed, a logging crew merchandized the tree-length log into 1-, 1.5-, or 2-log plylogs. Each merchandized plylog bucked from the bole was subsequently measured and weighed using the same protocol outlined for the tree-length

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log. The weight of any treelength log that exceeded the scale's capacity was determined by weighing the residual topwood and adding its weight to the weight of the merchandized plylogs from said bole.

Inside bark cubic-foot volumes were determined via a modified Newton's formula (using diameter at 40 percent of length as opposed to the true midpoint diameter) for each merchandized log. Scaling factors were then determined by dividing the outside-bark log weights by their respective inside-bark log volumes. T-tests ($\alpha = 0.05$) were used to test for differences in scaling factor by stand origin.

RESULTS AND DISCUSSION

A wide range in tree sizes composed the dataset used herein. Tree d.b.h.s ranged from 10 to 32 inches, total tree heights ranged from 45 to 120 feet, tree-length weights ranged from 800 to 17,000 pounds, and tree ages ranged from 30 to 100 years. The most prevalent merchandized butt log length was 1.5 plylogs; therefore, only results from such trees and/or tree boles are reported herein.

Scaling factors of the 1.5 plylog butt logs averaged 65.6 pounds per cubic foot (with a standard deviation of 6.8 pounds per cubic foot) for trees in stands of naturally seeded origin and 65.0 pounds per cubic foot (with a standard deviation of 5.7 pounds per cubic foot) for trees in plantations. These scaling factors were not significantly different at $\alpha = 0.05$.

Scaling factors of upper logs from 1.5 plylog butt log trees averaged 70.5 pounds per cubic foot (with a standard deviation of 5.1 pounds per cubic foot) for trees in stands of naturally seeded origin and 71.0 pounds per cubic foot (with a standard deviation of 6.6 pounds per cubic foot) for trees in plantations. These scaling factors also were not significantly different at $\alpha = 0.05$.

The approximate 5 pounds per cubic foot increase in scaling factor, butt logs versus upper logs, is large enough to warrant attention when weight scaling loblolly pine sawlogs. A truckload containing a mixture of upper logs and butt logs will yield less volume than a truckload (of equal weight) composed primarily or exclusively of butt logs.

An interesting pattern emerged when tree-length scaling factor was averaged across all trees by season (table 1). Treelength scaling factors were numerically largest in spring and fall when compared to those of winter and summer. Statistical tests were not performed on these data inasmuch as the same stands were not visited in each season of the year. Thus, the authors cannot rule out stand to stand variation as a cause of the varying scaling factors shown in table 1. However, Doruska and Patterson (in press) noted a similar pattern in scaling factors of loblolly pine pulpwood trees in southern Arkansas when the same stands were visited seasonally. This trend suggests that truckloads of equal weight will contain more volume during winter and summer than during spring and fall.

Table 1—Seasonal pattern of tree length log scaling factor for loblolly pine sawtimber in southern Arkansas

Season	Winter	Spring	Summer	Fall
	- - - - *pounds per cubic foot* - - - -			
Scaling factor	63.7	66.2	64.4	66.9

The seasonal scaling factor pattern noted herein differs from that of the ponderosa pine (*Pinus ponderosa* Dougl.) work of Yerkes (1967), who reported moisture contents, and thus most likely scaling factors, were highest in February and March. The pattern of larger scaling factors with increasing height above ground is consistent with that found by Clark and Taras (1976) and Patterson and Wiant (1993).

SUMMARY AND CONCLUSIONS

Loblolly pine sawtimber trees were measured, harvested, and weighed in 2002 to determine their scaling factors and to examine possible differences in scaling factor by stand origin. The scaling factors of butt logs averaged about 65 pounds per cubic foot and were not significantly different by stand origin. Scaling factors of upper logs averaged about 70 pounds per cubic foot and also were not significantly different by stand origin.

A seasonal trend was noted in tree-length scaling factors. Tree-length scaling factors tended to be numerically larger in spring and fall than in winter and summer. This trend should be considered when using the scaling factors previously described. The results of this project should assist those scaling loblolly pine sawlogs by weight in southern Arkansas and surrounding regions.

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