EFFECT OF ROTATION AGE AND PHYSIOGRAPHIC REGION ON WEIGHT PER CUBIC FOOT OF PLANTED LOBLOLLY PINE

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Abstract—Most harvested southern pine is sold by weight. We discuss how the weight of wood and bark per cubic foot of wood (the weight scaling factor) for plantation-grown loblolly pine (Pinus taeda L.) varies with tree age across the coastal and inland regions of the Southern United States. To determine the weight scaling factor for plantation trees in the Atlantic Coastal Plain, Gulf Coastal Plain, upper Coastal Plain, Piedmont, and Hilly Coastal Plain, we destructively sampled > 1,200 loblolly trees 5 to 17 inches in diameter at breast height and 10 to 45 years old. We cut cross-sectional disks at 4- to 8-foot intervals up the stem and determined the green weight of wood and bark per cubic foot. We weighted disk values by basal area to obtain a stem-weighted scaling factor. Our results show that the weight scaling factor averaged 2 percent higher for loblolly pine planted in the coastal region than loblolly planted in the inland region. In both regions, the weight scaling factor decreased significantly with tree age. This variation shows that the factors should be adjusted to account for differences in tree age at the time of harvest.

INTRODUCTION

Southern pine saw logs and pulpwood are purchased on a weight basis at wood-processing plants. A truckload of harvested trees is weighed, and the weight of wood and bark is converted to cords, board feet, or cubic feet of wood using weight scaling factors. Early reports show that weight scaling has been used in the southern pine pulp market since the late 1920s. Strickland (1955) reported that Gaylord Container Corporation began purchasing all their pulpwood on a weight basis in 1928. Schumacher (1946) developed southern pine weight factors to convert the green weight of wood and bark to cords. He found that the volume-weight ratio for pulpwood varied significantly from one area to another, and a single conversion factor was inappropriate. During the late 1950s and early 1960s, weight scaling to convert the green weight of wood and bark to cords became common practice at most pine pulp mills in the South. In the mid 1960s, weight scaling became the accepted standard for buying and selling southern pine saw logs and veneer logs.

Page and Bois (1961) and Taras (1956) reported that southern pine weight factors differ between species and among locations. Lang (1962) found that weight factors varied between natural second-growth and old-growth southern pine. Examination of the variability of weight factors has continued. Patterson and others (2004) determined the green weight of wood and bark per cubic foot of wood (the weight scaling factor) for loblolly pine (Pinus taeda L.) plywood logs in southeast Arkansas. They found the weight scaling factor averaged 61.9 pounds for butt logs and 68.8 pounds for upper logs.

Because weight factors do vary by species, geographic location, and log position, wood processing plants continue to revise weight scaling factors. The common procedure is to weigh truckloads of logs, spread them in the yard, measure the diameter inside bark of each log, and then calculate the wood volume. The net weight of the logs (with bark) is then divided by the volume of wood in the load. For this study, we determined the weight scaling factor by cutting disks from along the stem of sampled trees. We discuss how weight scaling factors for planted loblolly pine vary with tree age and by geographic region.

PROCEDURE

The U.S. Department of Agriculture Forest Service's Southern Research Station at the Forestry Sciences Laboratory in Athens, GA, has sampled plantations across the South to determine the effects of silvicultural practices and environmental factors on the physical and mechanical properties of loblolly pine. We conducted our studies in cooperation with the Wood Quality Consortium, Pine Management Research Cooperative, and Consortium for Accelerated Pine Production Systems at the University of Georgia, the Auburn University Herbicide Cooperative, and the Growth and Yield Cooperative at Virginia Polytechnic Institute and State University. For the purpose of our analysis, we used the physical property data collected in those cooperative studies. Most sampled trees are within areas subjected to conventional management practices. Although some trees were within areas receiving total weed control, none included in our analysis received fertilization treatments.

We sampled loblolly pine plantations ranging from 10 to 45 years old on 323 locations across the South (fig. 1). One to 48 trees were felled and destructively sampled in each stand for a total sample of 1,220 trees. Cross-sectional disks 1 to 1.5 inches thick were collected at 4- to 8-foot intervals along the stem of each tree to a 4-inch diameter outside bark top to determine the green weight of wood and bark per cubic foot of wood. We calculated the disk weight scaling factor or green weight based on disk weight with bark and disk green volume without bark. Green volume without bark was determined by water displacement. We calculated stem scaling factors by weighting disk values in proportion to the disk's cross-sectional area.

We separated loblolly pine plantations sampled into two regions: coastal and inland (fig. 1). Trees sampled in the Atlantic and Gulf Coastal Plains were identified as from the coastal region; trees sampled in the upper Coastal Plain, Piedmont, and Hilly Coastal Plain as from the inland region.

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Citation for proceedings: Connor, Kristina F., ed. 2006. Proceedings of the 13th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–92. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 640 p.

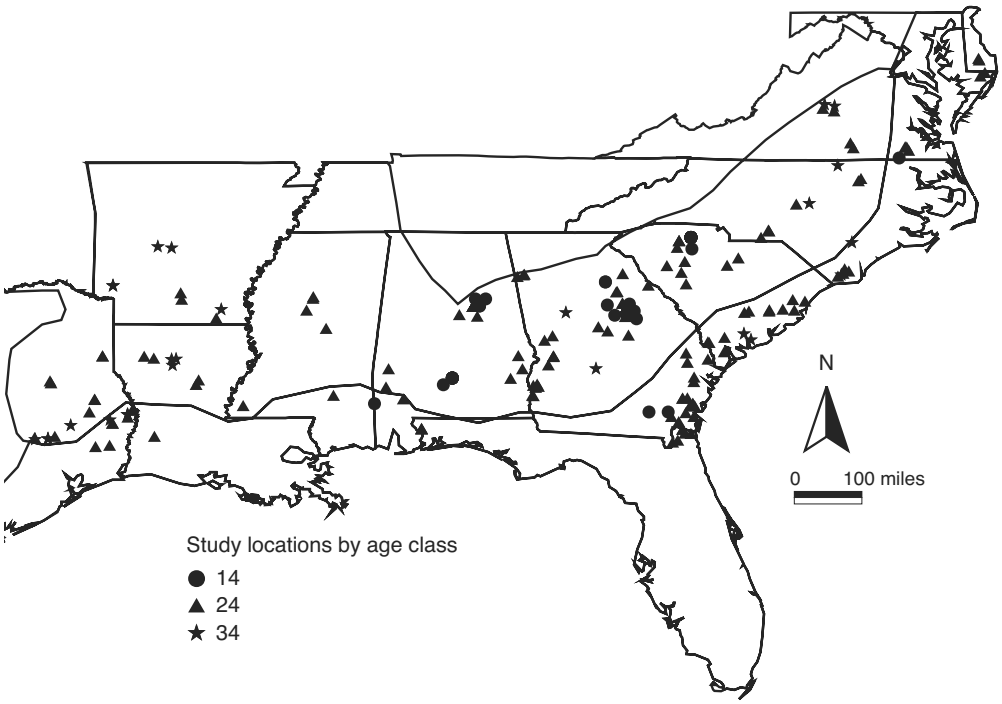

Figure 1—Location of loblolly pine plantations in the coastal and inland regions sampled for weight scaling factors by age class.

Trees sampled in each region were separated into 3 age classes: 14, 24 and 34years. The 14-year age class (trees 10 to 18 years old) represented the first thinning, the 24-year age class (19 to 27 years old) represented the second thinning, and the 34-year age class (> 27 years old) represented the final harvest. The average and range of tree age, diameter, and total height in each region are shown in table 1 by age class. Confidence intervals at the 95 percent level were calculated for each region and age class mean weight scaling factor to determine which means were significantly different.

RESULTS

The number of trees sampled in each region and age class varied, but the mean and range of tree ages and diameters sampled in each class were similar (table 1). The average diameter at breast height (d.b.h.) of sampled trees in the coastal region in the 14-, 24-, and 34-year classes was 7.2, 9.1, and 11.2 inches d.b.h., respectively, compared to 7.1, 8.6, and 10.9 inches for the inland trees. On average, the 24- and 34-year-old coastal trees were taller than the inland trees.

The weight of wood and bark per cubic foot of wood, across all age classes, averaged 68.12 pounds per cubic foot in the coastal region, or 2 percent higher than in the inland region, which averaged 66.61 pounds per cubic foot (table 2). The 95 percent confidence limits about the regional means show no significant difference in weight scaling factor between coastal and inland trees when averaged across age classes.

The weight scaling factor varied significantly among tree age classes within the two regions (table 3). In both it decreased significantly with increasing tree age. For the 14-year coastal trees, it was significantly higher than for the 24-year coastal trees, and for the 24-year coastal trees it was significantly higher than for the 34-year coastal trees. The coastal region's

Table 1—Average tree characteristics for plantation loblolly pine trees sampled

Region	Age class	Trees sampled	Average	Range	
				Min.	Max.
	years	*no.*			
			Tree age (*years*)		
Coastal	14	98	14	12	18
	24	179	23	19	27
	34	68	37	29	45
Inland	14	273	14	10	18
	24	317	22	19	27
	34	285	35	28	43
			Tree d.b.h. (*inches*)		
Coastal	14	98	7.2	5.3	9.9
	24	179	9.1	5.7	14.4
	34	68	11.2	5.8	16.9
Inland	14	273	7.1	5.0	11.1
	24	317	8.6	5.0	14.2
	34	285	10.9	5.8	18.0
			Total height (*feet*)		
Coastal	14	98	46	36	68
	24	179	66	41	84
	34	68	80	50	108
Inland	14	273	47	24	69
	24	317	59	36	89
	34	285	74	29	91

Table 2—Average, standard error, and 95 percent confidence limits for weight of wood and bark per cubic feet of wood for coastal and inland region plantation loblolly pine averaged across age classes

Region	Stands sampled	Trees sampled	Average	Standard error of mean	95 percent confidence limit	
					Lower	Upper
	- - - - *number* - - - -			*lbs/ft*^{3}		
Coastal	70	345	68.12	0.61	66.91	69.33
Inland	253	875	66.61	0.37	65.89	67.32

Table 3—Average, standard error, and 95 percent confidence limits for weight of wood and bark per cubic feet of wood for inland and coastal plantation loblolly pine by tree age class

Region	Age class	Stands sampled	Trees sampled	Average	Standard error of mean	95 percent confidence limit	
						Lower	Upper
	years	- - - - *number* - - - -			*lbs/ft*^{3}		
Coastal	14	4	98	70.87	0.52	69.21	72.52
	24	59	179	67.69	0.26	67.16	68.22
	34	7	68	65.28	0.66	63.67	66.89
Inland	14	114	273	69.20	0.96	66.30	70.10
	24	121	317	67.03	0.27	66.50	67.56
	34	18	285	64.60	0.55	63.44	65.77

14-year trees averaged 70.87 pounds per cubic foot, or 4.7 percent more than the 24-year coastal trees, which averaged 67.79 pounds per cubic foot, and 8.6 percent more than the 34-year trees, which averaged 65.28 pounds per cubic foot.

In the inland region, the weight scaling factor for 14-year trees averaged 68.2 pounds per cubic foot and was not significantly different from the 24-year trees, which averaged 67.03 pounds per cubic foot (table 3). However, for a 34-year inland tree the weight scaling factor was significantly less than for a 24- or 14-year tree (averaging 64.6 pounds per cubic foot). The weight of wood and bark per cubic foot of wood decreased with tree age for two reasons: First, d.b.h. increases with tree age, so the proportion of weight in bark decreases, e.g., in the inland region the proportion of stem weight in bark averaged 12.8 percent for the 14-year class, 11.3 for the 24-year class, and 9.8 for the 34-year class. The proportion of stem weight in bark affects the weight scaling factor, because only bark weight is considered, not bark volume. Second, the weight scaling factor decreases with tree age because stem moisture content decreases with increasing tree age, e.g., the average moisture content in the inland trees decreased from 124 percent in 14-year trees to 114 percent in 24-year trees and to 104 percent in 34-year trees.

Using the correct weight scaling factor is important to both buyer and seller. For example, if the coastal weight scaling factor for 24-year-old trees (67.79 pounds per cubic foot) is used to buy 14-year first-thinning trees, which weigh 70.87 pounds per cubic foot, then the buyer is getting 4.6 percent less wood volume. If a seller sells 24-year second-thinning trees, which weigh 67.79 pounds per cubic foot, but the buyer is using the factor for 34-year-old trees, or 65.28 pounds per cubic foot, the seller is losing the value of 3.8 percent of the volume sold. Thus, it is important that the seller and buyer of southern pine negotiate and agree on the proper weight scaling factor for each stand of timber sold.

CONCLUSION

The weight scaling factors for plantation loblolly pine, i.e., the weight of wood and bark per cubic foot of wood, when averaged across age classes, are 2 percent higher in the coastal region than in the inland region. The factors decreased significantly with tree age in both regions. On average, the weight scaling factor for 24-year-old trees was 2 percent lower than for 14-year-old trees, and the weight scaling factor for 34-year-old trees was 4.6 percent lower than for 24-year-old trees. Thus it is important that both the seller and buyer of plantation loblolly pine timber understand how weight scaling factors vary with geographic location and tree age.

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