LONGITUDINAL VARIATION IN WOOD SPECIFIC GRAVITY OF PLANTED LOBLOLLY PINE IN THE SOUTHERN UNITED STATES

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Loblolly pine (*Pinus taeda* L.) is the most important plantation species grown in the southern United States, having more than half of the standing pine volume. Wood from loblolly pine is a principal source of raw material for the pulp and paper industry and is desirable for the production of lumber and composite wood products. The quality of wood produced from a loblolly pine tree is defined by its physical and mechanical properties. Of these, specific gravity (SG) is an important measure of wood quality (Panshin and de Zeeuw 1980), and varies both with tree height (Megraw 1985; Zobel and vanBuijtenen 1989) and with geographic locations (Clark and Daniels 2002; Jordan et al. 2008). The objectives of the present study were to model the regional and within tree variation in disk SG of loblolly pine.

The Wood Quality Consortium at the University of Georgia and the United States Department of Agriculture (USDA) Forest Service Southern Research Station sampled planted loblolly pine trees across its natural range to study the vertical variation in wood SG. Trees were sampled from 135 stands from six physiographic regions across the southeastern US. Regions sampled included: 1- southern Atlantic Coastal Plain, 2- northern Atlantic Coastal Plain, 3- Upper Coastal Plain, 4- Piedmont, 5- Gulf Coastal Plain and 6- Hilly Coastal region. A minimum of 12 plantations from each of the six physiographic regions were sampled. The stands selected for sampling included 20- to 25-year-old loblolly pine plantations planted at 1250 or more trees per hectare and with 625 trees per hectare or more after thinning. Only stands that were conventionally managed with no fertilization (except phosphorus at planting on phosphorus deficient sites) and no competition control were sampled. Three trees from each stand were felled and cross sectional disks of 3.8 cm thickness were collected from 0.15, 1.37 m and then 1.52 m intervals along the stem up to a diameter of 50 mm outside bark. Disk SG based on green volume and oven-dry weight was measured for each disk collected at different heights.

A semiparametric model, a flexible statistical approach to explain nonlinear trends, was proposed to explain the within tree (with tree height) and regional variation in disk SG. Based on the fitted model, disk SG follows a decreasing trend with relative height (Figure 1). Significant differences were observed among regions (p-value <0.0001). The mean trend in disk SG of trees from the southern Atlantic and Gulf Coastal Plain was observed to be higher than other physiographical regions (Upper Coastal, Hilly Coastal, northern Atlantic Coastal Plain and Piedmont). The lowest disk SG was observed for trees from the northern Atlantic Coastal Plain.

Our study suggests that the stem of loblolly pine can be divided into three zones based on the longitudinal variation of disk SG. Based on the first derivative of fitted semiparametric model for all regions, mean SG decreased rapidly from the base of the tree to a relative height ~0.1; SG then decreased at a decreasing rate between relative heights of ~0.1 - ~0.3; for relative heights >~0.3 SG decreases at constant rate. These findings agree with the three segmented classification of the stems of loblolly pine proposed by Burdon et al. (2004).

The mean trend of disk SG was highest for the southern Atlantic and Gulf Coastal Plain. The overall mean SG observed for these two regions was 0.46, which was higher than the mean disk SG observed for the other regions (0.42) (Table 1). The high SG of trees from southern Atlantic and Gulf Coastal Plain might be attributed to two major reasons: (1) reduced length of core wood formation and proportion of core wood formed in these two regions compared to other inland regions (Clark and Daniels 2002; Jordan et al. 2008); (2) high latewood percent in the rings of trees growing in these regions (~40 %) compared to other regions (~35 %). The proportion of latewood formed is highly correlated with summer precipitation, mean annual temperature and number of growing days. The trees growing in the southern Atlantic

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and Gulf Coastal Plains, on average, receive more summer precipitation, have a higher mean annual temperature and more growing days than the other regions (Clark and Daniels 2002).

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Table 1—Mean stand attributes collected from six regions, standard deviation in parenthesis

Region	Age	DBH (cm)	Total Ht (m)	Disk SG
southern Atlantic	22.73 (1.82)	24.07 (4.58)	20.86 (2.50)	0.45 (0.06)
northern Atlantic	22.46 (1.61)	24.56 (3.74)	18.89 (2.48)	0.41 (0.05)
Upper Coastal	23.00 (1.46)	24.07 (4.87)	19.39 (3.08)	0.43 (0.05)
Piedmont	23.08 (2.01)	23.90 (4.54)	18.19 (2.11)	0.42 (0.05)
Gulf Coastal	23.22 (3.26)	21.16 (3.79)	19.54 (2.58)	0.46 (0.05)
Hilly Coastal	23.86 (3.58)	23.39 (4.12)	19.59 (2.75)	0.43 (0.05)

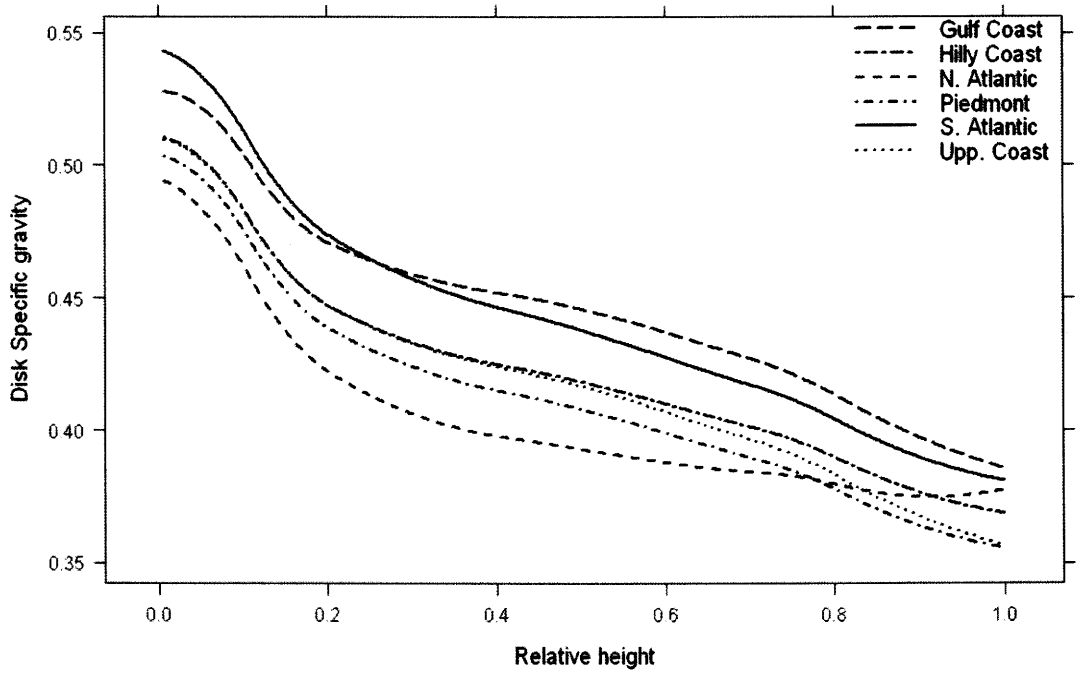

Figure 1—Predicted disk SG for six regions from fitted semiparametric model.