

Small-Diameter Hardwood Utilization with Emphasis on Higher Value

Products

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Abstract

A significant portion of our hardwood forests are eligible for timber removal treatments that will yield small-diameter timber. Between 1995 and 1999, roundwood receipts by manufacturers of composite panels, primarily the oriented strandboard (OSB) industry, increased more than for any other primary wood processing sector in the southern United States. OSB manufacturing trends are important because OSB utilizes both softwoods and lower density hardwoods in diameters ranging from 24 inches down to 4 inches. The financial incentive for conducting timber stand improvement and uneven-aged management should increase if smaller diameter logs can be profitably processed into hardwood lumber for use in higher value products such as kitchen cabinets, mouldings, and furniture. But, because smaller diameter trees often are younger trees with a relatively large juvenile wood zone, lumber cut from these trees usually is of lower grade and value. The current study looks at the volume recoveries and lumber-grade distributions for both the green and dried lumber from black cherry, red oak, and sugar maple. In the initial test on cherry, problems associated with drying lumber produced from small-diameter logs were evident as only half of the boards in the two highest quality (grade) classifications before drying remained high-quality boards after drying.

The Hardwood Resource: Today and Tomorrow

In the hardwood forests of the eastern United States, the small diameter problem is not a problem of fire risk associated with biomass buildup as it is in the coniferous forests in the Rocky Mountain and West Coast regions. Rather, it is a problem of markets – markets are needed to promote sound forest management so that healthy and productive forests become more abundant in this region. Careful removal of small-diameter timber can improve the structure, vitality, quality, appearance, and disease resistance of the residual stand without degrading other ecosystem functions.

The positive effects of thinning and timber stand improvement on the quality of the eastern hardwood resource become evident when one contrasts tree-grade distributions measured on USDA Forest Service research plots with those measured in comparable forest inventory plots. For example, of the white oak trees 12 inches and larger sampled in Kentucky-wide inventory plots in 1998, only 40 percent of the trees were grades 1 and 2. By contrast, more than 72 percent of the white oaks on Forest Service research plots in Kentucky were grades 1 and 2. Similarly, for cherry trees 12 inches and larger sampled in West Virginia-wide inventory plots in 1999, only 41 percent were tree grades 1 and 2 while 80 percent of the trees located on Forest Service research plots were grades 1 and 2.¹

A significant portion of our hardwood forests are eligible for timber-removal treatments that will yield small-diameter timber. It is estimated that 10 percent of the hardwood acreage in five southeastern states is in need of thinning and timber stand improvement. This acreage could be a significant source of small-diameter hardwood roundwood (Bumgardner et al. 2001). An additional 34 percent of the hardwood acreage in these states may yield small-diameter timber as a secondary product from stand harvesting, regeneration, and salvage operations (Bumgardner et al. 2001).

Current Small-Diameter Hardwood Markets

Sawlogs and pulpwood were the two principal markets for hardwood and softwood roundwood in the South in 1999. Each of these sectors accounted for nearly 43 percent of the 13-state region's total roundwood manufacturing inputs (Bentley 2003). Thirty-six percent of the pulpwood roundwood consumed in 1999 was hardwood roundwood but only 27 percent of the sawlog roundwood consumed was hardwood. Overall, hardwoods accounted for 29 percent of industrial roundwood production in the South.

A comparison of industrial roundwood production statistics in the South from 1995 to 1999 revealed the following production results: 1) hardwood sawlogs increased 5 percent (on a volume basis); 2) hardwood pulpwood decreased by 11 percent; 3) hardwood veneer logs increased by 10 percent; and 4) hardwood roundwood for use in composite panels increased by 38 percent (Bentley 2003). Roundwood receipts by manufacturers of composite panels, primarily the oriented strandboard (OSB) industry, increased more than for any other primary wood processing sector during this period (Bentley 2003). Three new panel manufacturing facilities went into production between 1995 and 1999 and two additional plants are being constructed in Oklahoma and Arkansas. In 1999,

¹ These results are from a not yet completed study in which the quality of timber located on multiple study sites is being reevaluated and compared to inventory data compiled by the Forest Service's Forest Inventory and Analysis surveys. The results will be published in a final report to the National Hardwood Lumber Association which funded this study. The authors of this report are J. Baumgras, G. Miller, and C. Gottschalk of the Northeastern Research Station.

nearly 10 percent of consumption of industrial hardwood roundwood in the United States was used in OSB production (Bumgardner et al. 2001).

OSB manufacturing trends are important because OSB utilizes both softwoods and lower density hardwoods in diameters ranging from 24 inches down to 4 inches. In fact, maximum size limitations are more critical than are those for minimum size. Lower grade stems also are efficiently utilized in OSB manufacturing except that log sweep, crook, forking, and limbs are limited. Yellow-poplar, hard and soft maple, basswood, beech, sweetgum, birch, aspen, white pine, and southern yellow pine stems are commonly used in OSB production.

Local demand for OSB roundwood should provide considerable financial incentive for the forest landowner to extract smaller diameter material from his or her forests compared to that provided by local demand for pulpwood. We estimated that the average delivered hardwood pulpwood price in the South in 1993 was nearly \$14 per ton. This compares to an average delivered price of nearly \$22 per ton for OSB hardwood pulpwood.

The incentive for conducting stand improvement thinnings and sound uneven-aged management would be even greater if smaller diameter logs could be profitably processed into hardwood lumber for use in higher value products such as kitchen cabinets, mouldings, and furniture. The average delivered price for hardwood sawlogs is at least 25 percent higher than that for hardwood roundwood for OSB. However, because smaller diameter trees often are younger trees with a relatively large juvenile wood zone, lumber cut from them usually is of lower grade and value. Thus, it would not be profitable to manufacture lumber from smaller diameter logs so long as standard practices and equipment are used. The expected lumber volume and value from a grade 3 red oak trees having 10, 13, and 20-inch d.b.h. respectively, are 31 board feet (bf) and \$18, 67 bf and \$39, and 339 bf and \$208! Because log size has such a dramatic impact on the volume and value of lumber recovered in sawing, the typical hardwood sawmill stipulates that the small end log diameter must be at least 12 inches. This number differs slightly depending on log species, mill equipment, log quality, and current market conditions.

Studies in Small-Diameter Hardwood Utilization

In an early study of lumber grade yields from small-diameter logs (8 to 11 inches diameter at the small end of the log), 20 red oak logs removed in thinnings produced 30 percent grade 1 Common and Better lumber (higher grade) with a 25 percent overrun based on the International 1/4-inch log scale (Emanuel 1983). Twenty small-diameter hard maple logs produced 19 percent grade 1 Common and Better lumber with a 12 percent overrun. Twenty small-diameter yellow-poplar logs produced only 15 percent grade 1 Common and Better lumber with a 20 percent overrun (Emanuel 1983).

In a more recent study of small-diameter log yield, 134 small-diameter logs of several species and a range of sizes produced 28 percent overrun (International 1/4-inch scale) and a lumber recovery factor of 7.2 (Hamner et al. 2002). The average overrun for the three species studied by Emanuel (1983) was 19 percent. It is the lumber-grade distributions that are of particular concern. The lumber-grade distributions for larger diameter grade 3 logs typically are 30 to 40 percent grade 1 Common and Better (Hanks et al. 1980). Since higher grades of lumber command a considerably higher price than lower grades in most markets and for most species, the production of a high proportion of lower grade boards makes it difficult to process small-diameter logs profitably.

The two small-diameter log studies mentioned were concerned only with yields of green (i.e., not yet dried) lumber. As it loses moisture, lumber can develop a variety of severe defects. For example, wood splits, warpage, and holes frequently result from a combination of drying forces across different zones within a piece of wood. If a board is cut from a peripheral location on a larger log, the annual growth rings will have less curvature than those from a board cut from a peripheral location on a smaller diameter log. A board that has more growth-ring curvature will have a higher likelihood of warping, all other things being equal, than will the board that has less curvature. In Figure 1, the board represented by the right-most rectangle is less likely to warp than is the board represented by the rectangle that lies within the inner (shaded) region of the log. The inner region of the larger log has many wood properties in common with the peripheral region of a small-diameter log, so the potential product recovery from small-diameter logs/trees should be based on the volume and grade recovery of dry lumber.



Figure 1. Log end showing the wood zone where wood quality and strength properties are diminished due to cellular changes and proximity to the pith (the two rectangles represent board locations). A board whose grain has less curvature is less likely to warp than a board with greater grain curvature.

A New, More Comprehensive Study

Our current study looks at the volume recoveries and lumber-grade distributions for both the green and dried lumber from black cherry, northern red oak, and sugar maple. Because one of the greatest challenges associated with processing small-diameter logs is related to lumber degrade that results in value loss during drying, this study examines the effect of conventional and alternative lumber drying schedules on lumber yield and value.

The lumber-grade distributions for the cherry that we obtained from small-diameter logs and then dried using a conventional, T8B4 cherry drying schedule (for 1-inch-thick lumber) met our expectations based on a comparison with studies conducted during the 1970's (Hanks et al. 1980). Table 12 in Hanks et al. (1980) reveals that yields from sawing thirty-four, 8-inch diameter, and fifty-two 9-inch diameter grade 3 cherry logs were, respectively, 2.3 and 3.2 percent Selects grade lumber and 4.2 and 10.1 percent 1 Common grade lumber. In our initial control study with cherry we recovered 2.2 percent Selects grade and 4.5 percent grade 1 Common lumber. The average log diameter for our 37 study logs was 9 inches (range: 8 to 12 inches). Volume recovery was lower than expected with a 7 percent underrun compared to Hanks et al.'s overrun of 8.5 percent for 9-inch-diameter logs. The fact that 13 of the 37 logs in our sample were not of sufficient form and quality to make the lowest Forest Service sawlog grade, grade 3, is worth noting. For cherry, the Hanks et al. (1980) results are the only prior study results available for comparison. Although their lumber grade distributions were not based on direct measurements of dry lumber, adjustment factors were applied to grade recoveries for green lumber, so the percentages presented here are comparable.

The initial red oak and sugar maple lumber samples sawn from small-diameter logs were dried using standard schedules for those species (T4D2 and T8C3), and the quality of the dry lumber exceeds that for the cherry sample. Data collection for this study is such that we can test many numerous potential relationships between log characteristics, sawing and drying approaches, and value recovery for dry lumber. The log data sets include age, grade, small- and large-end diameters, length, position in tree, crook and sweep, and position in log from which each board was sawn. The data sets for green and dry lumber include grade, defect identification and marking, slope of grain, warpage measurement, and cutting sizes and locations.

Summary

Facing periodic log shortages that may become more severe in coming years due to continued forest fragmentation, many sawmill owners are beginning to consider small-diameter log processing. Small "sawlogs" that may be allocated to lumber mills often contain a relatively high proportion of juvenile wood that usually is of lower intrinsic wood quality. Optimizing the potential quality of lumber sawn from small-diameter trees and the upper bole sections of larger

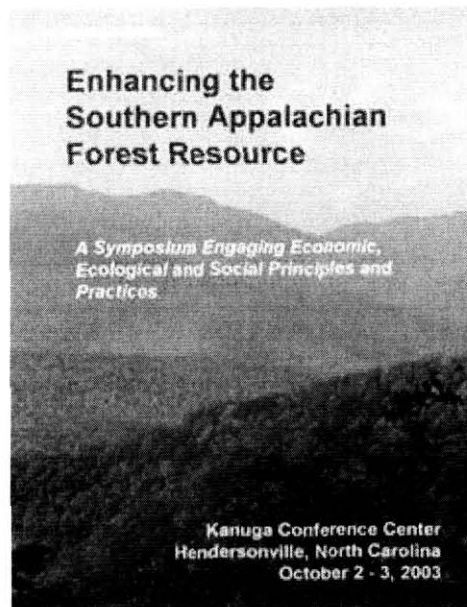
diameter trees has become an important concern. In studies of lumber recovery from small-diameter hardwood logs, the volume of green lumber recovered has been acceptable. The quality (grade) of the lumber recovered from small-diameter hardwood logs is the larger issue, particularly with respect to the grade yield of dry lumber. Initial study results indicate that the yield of grade 1 Common and Better (dry) lumber from small-diameter cherry logs is less than 10 percent. Alternate drying schedules designed to reduce warp and other drying defects should increase grade yields.

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