An examination of eastern U.S. hardwood roundwood markets

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Abstract

There are multiple markets for hardwood roundwood due to variations in the value of this material within and among hardwood stands. These variations are a function of differences in species mix and bole quality. Furthermore, individual trees can be processed or merchandised into numerous products with each product going to a different market. Because the merchandising process has an underlying profit motive, the characteristics of hardwood roundwood markets in a given area influence what sites will be harvested and what trees will be removed. Through this selection process markets can influence future composition and structure. In this paper, the industries that use hardwood roundwood and the attributes of the material used are characterized and the methods by which roundwood is distributed are described. There are three broad categories of hardwood roundwood markets: aesthetic, industrial, and fiber. Hardwood roundwood used to manufacture products for aesthetic application accounts for a relatively small portion of total roundwood harvested, but the value of these products has a disproportional influence on what sites will be harvested. Because of the skewed value of hardwood material, the potential value of a given stand may be determined by relatively few trees within the stand. Still, there are areas within the eastern hardwood region where a large portion of the resource is lower value or lower quality timber. In these areas, fiber-based industries may be an important factor influencing harvesting.

Roundwood products traditionally have been classified in generic groupings such as pulpwood, sawlogs, and veneer logs (USDA 1958, 1965, 1982) and assumed as intermediate steps in the production process. While such terminology and assumptions are convenient for accounting purposes and applicable to most softwood-consuming industries, they imply an oversimplification of hardwood markets. Hardwood trees generally grow in mixed-species stands; numerous types of hardwood roundwood can result from a single logging job and can be sold in numerous markets. Understanding these markets is key to evaluating their impact on forest ecosystems because their characteristics determine what sites will be harvested and what trees will be removed. Through the harvesting process, roundwood markets can influence forest composition and structure by removing specific stems and influencing regeneration (Luppold and Baumgras 2000).

The number of hardwood roundwood markets and their complexity increase as the value of the products traded increases. Lower value hardwood roundwood can be separated by density or other general characteristics. Higher value hardwood roundwood is merchandised by species, diameter, number of clear faces, end use (e.g., veneer or sawlog), or other characteristics (Sawlog Bull. 2002). As the relative value of hardwood roundwood products of differing quality has become more divergent (Luppold and Baumgras 1995) and differences between domestic and international markets more pronounced (Luppold 1994), there has been added incentive to separate product and increase the amount of hardwood roundwood merchandising.

Understanding the market demands and values for hardwood roundwood is critical to understanding the impact of markets on the forest resource. The eastern hardwood forest has been heavily influenced by past harvesting activity (MacCleery 1992, Carvell 1986). While current harvesting levels are not as intense as in the past, the selectiveness of current harvesting activity is having a more subtle impact on future resource composition and structure. The combi-

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nation of stand characteristics that includes species, diameter and quality, available markets, and price is what motivates timber buyers to select certain timber stands and ignore others. This combination of biological and market attributes also influences overall harvest intensity in a region, that is, what will be removed and what is left standing (residual stand attributes). As a result, projections of future removals can be spurious when markets are not fully identified and data concerning their influences are poorly understood.

In this paper, the hardwood roundwood supply, characteristics of roundwood consumption by major hardwood industries, and variations in the price of roundwood and related stumpage are examined. Also included are examples of how local variations in timber resources and changing markets can influence hardwood roundwood demand. It is hoped that the information presented will benefit individuals attempting to understand hardwood markets or predict future hardwood resource use on a regional or subregional basis.

Hardwood stumpage and roundwood supply

Most hardwood timber is privately held as more than 70 percent is controlled by nonindustrial private owners (Smith et al. 2001). This ownership pattern may allow hardwood stumpage and roundwood supplies to be more market driven than supplies of softwood that are influenced to a greater extent by the decisions of integrated corporations and government owners of timber (both U.S. and Canadian). The slow growth of hardwood also means that the physical supply of timber is fixed in the short run and that the economic supply (the schedule of what is available at what price) is highly inelastic. The distribution of species, timber quality, and aesthetically important growth characteristics (ring count, color, consistency of ring count, roundness of bole, etc.) varies within and among regions.

Hardwood roundwood can be obtained from both the growing-stock or nongrowing-stock portion of the timber resource. Growing-stock refers to trees of commercial species, which are of good form, and at least 5 inches in diameter at breast height (DBH). Trees considered sawtimber size are softwoods at least 9 inches in DBH or hardwoods at least 11 inches in DBH. Nongrowing-stock comprises saplings; cull trees; the cull section of trees, tops, limbs, and roots. Trees can be classified as cull due to poor form, presence of rot, or short bole length. Quality hardwood roundwood can be obtained from trees not considered growing stock because the butt log is too short and some nongrowing-stock sections such as crotch and burl can be processed into valuable lumber and veneer. The portion of growing-stock to nongrowing-stock material in an average timber stand varies considerably by region (Luppold and McWilliams 2000)

Roundwood production entails harvesting stumpage and bucking (cutting the stem into logs) or whole-tree harvesting and processing.[1] Purchasers of stumpage can be primary processors, independent loggers, or timber speculators. Primary processors who purchase stumpage usually stipulate the merchandising efforts. However, the objectives of the primary processor may include resale of veneer or other logs. When stumpage is purchased by loggers or speculators, merchandising decisions are based on the purchaser's view of the entire market (all primary processors within the region) but still are constrained by the prices that these processors are willing to pay. If primary processors do not distinguish between a grade 1 northern red oak and a grade 1 black oak log, the price for these logs will be similar and separation uneconomical. However, merchandising will occur when hardwood roundwood purchasers pay significantly different prices for different species, grades, diameters, ring counts, etc.

Table 1. — Hardwood roundwood production by product category and proportion of roundwood production attributable to sawtimber, pole timber, and nongrowing-stock portions of the hardwood resource in 1996.[a]

	Sawlogs	Veneer logs	Pulpwood	Composites
Total volume consumed (million ft.^{3})	1,902.0	145.9	2,189.4	242.6
Proportion sawtimber (%)	87.2	94.7	49.0	53.2
Proportion pole timber (%)	3.4	0.3	37.5	38.4
Proportion nongrowing-stock (%)	9.4	5.0	13.5	8.4

[a] Estimates based on timber product output studies and inventory removal estimated during or prior to calendar year 1996.

Characteristics of hardwood roundwood demand

For the purpose of this study, hardwood roundwood markets are divided into three broad categories: aesthetic (or appearance), industrial, and fiber or composites (fiber). Aesthetic hardwood roundwood includes logs and bolts used principally to produce lumber, veneer, or other products whose physical appearance is the major marketing attribute. Industrial products include logs or bolts that are transformed primarily into pallet stock, crossties, or other timber products whose physical qualities and/or relative low price are the primary marketing attributes. Fiber hardwood roundwood refers to trees or tree sections that are pulped, flaked, or otherwise broken down and reconstituted as paper, panels, or board products.

Hardwood roundwood removals by major product and roundwood category are shown in **Table 1** (USDA 2002). This information was developed from timber product output studies conducted in 1996 or earlier and may not totally reflect current consumption. Greater use of satellite pulp chipping operations and development of new technology in engineered wood product manufacturing may have increased the proportion of nongrowing stock used. Further, while timber product output studies place hardwood roundwood into broad end-use categories, the industry views hardwood roundwood in terms of quality, value, and specific end uses. **Table 2** is an attempt to classify these operations by category of hardwood roundwood product consumed, type of wood material consumed, value range of the roundwood used, and potential for using the nongrowing-stock portion of the hardwood resource.

[1] This includes whole-tree chipping. Although chips are not roundwood, they are a direct substitute for roundwood in paper production.

Table 2. — Primary hardwood industries, principal products manufactured, value range of roundwood purchased, and potential volume of roundwood requirements that could be supplied by nongrowing-stock trees.

Industry	Category of roundwood product consumed	Timber product category listed in Table 1	Quality category of wood commonly consumed	Value range of roundwood primarily consumed	Potential use of nongrowing stock resource
Face veneer mills (slicer)	Aesthetic	Veneer logs	Veneer logs	High to very high	Slight
Face veneer mills (rotary)	Aesthetic	Veneer logs	Veneer or sawlogs	Medium to high	Slight
Large sawmill (grade mill)	Aesthetic or industrial	Sawlogs	Sawlogs	Medium to high	Low
Large sawmill (industrial)	Industrial or aesthetic	Sawlogs	Sawlogs and bolts	Low to medium	Medium
Medium sawmill	Aesthetic or industrial	Sawlogs	Sawlogs and bolts	Low to high	Low to medium
Plywood mill	Aesthetic or industrial	Veneer logs	Sawlogs and bolts	Low to medium	Low to medium
Pulp mill	Fiber	Pulpwood	Cull logs, bolts, tree-length logs, chips, and mill residue	Very low to low	Medium to high
Engineered products mills	Fiber	Composites	Cull logs, bolts, tree-length logs, and roundwood residue	Very low to low	Low to high

Hardwood face veneer

Face veneer refers to material that is sliced or peeled from logs to be used in appearance applications such as paneling, furniture, or flooring. The actual thickness of hardwood veneer ranges from 1/100 of an inch to more than 1/8-inch depending on the production process (HPVA 2002). On a volume basis, the face veneer industry is relatively small with domestic and international buyers consuming approximately 750 million board feet (MMBF) of logs annually.[2] This small volume masks the economic impact that this market can have in an area containing high-quality timber.

In general, sliced face veneer uses the highest quality and valued logs of fashionable species (**Table 2**) while peeled face veneer manufacturers use lower quality logs or logs of less valuable species. While most veneer is manufactured from butt logs of a high-quality bole, high-value veneer also can be produced from noncommercial species, short logs, and cull sections. Because of their value, veneer logs are exported in relatively high volume to production. European-based companies also control a significant portion of the domestic sliced veneer production, and a large portion of domestically produced sliced veneer is exported to Europe. The combination of veneer logs and sliced veneer exported means that changes in the value of the dollar can influence high-grade timber demand (Luppold 1994).

[2] Forest Service estimate of veneer log production for both face and plywood logs. Nearly 600 MMBF of this production was associated with species normally used for appearance applications. Exports of veneer logs are assumed to account for an additional 150 MMBF.

Hardwood lumber

Hardwood sawmills range in capacity from less than 100,000 MBF to more than 50 MMBF per year (Luppold 1995, Luppold et al. 2000). These mills produced approximately 1.9 billion ft.^{3} in 1996 (**Table 1**). Most large mills (yearly production > 5 MMBF) are termed "grade mills" because they produce lumber for appearance applications using National Hardwood Lumber Association grades or other rules. Grade mills generally consume relatively higher quality sawlogs of species that are currently in fashion. Also, there are a number of large (industrial) mills that are designed to use lower grade log or logs of lower valued species to produce crossties, pallet parts, or flooring lumber. Industrial mills can use logs from trees that are not considered growing-stock due to short butt-log length.

Medium-sized mills (2 to 4.9 MMBF/year) can consume a wide variety of logs depending on local conditions and mill size. In some regions, these mills produce large amounts of low-grade and upgraded hardwood lumber. Because of the relatively large number of medium-size mills producing industrial products, there is a greater likelihood that these mills will consume nongrowing-stock portions of the timber resource. Small sawmills (fewer than 100,000 MBF to 2 MMBF/year) tend to be circle mills or portable band mills. Literally thousands of small mills operate in the eastern hardwood region, but the volume of roundwood consumed by these mills is relatively small.

Hardwood plywood

Manufacturers of hardwood plywood use peeled logs to produce interior stock for standard-size panels, flooring, containers/container materials, and specialty products. Such producers are not numerous but individual plywood plants can be large and consume large quantities of logs of a specific species. Hardwood plywood is generally manufactured from lower density species such as yellow-poplar and sweetgum, though specialty manufacturers may use other species such as maple and oak. Plywood manufacturers often finish plywood panels or flooring blanks with face veneer manufactured at another facility that is owned by the company or that is purchased from face-veneer processors. Plywood producers can use short logs or 4-foot bolts and thus use portions of the nongrowing-stock resource.

Hardwood pulp

Hardwood pulp has traditionally been used to manufacture sheet paper or packaging materials that may require the compression strength of hardwood fibers. In the 1960s, consumption of hardwood roundwood for eastern U.S. pulp production was dwarfed by roundwood used in the production of hardwood lumber. However, over the last 30 years consumption of hardwood pulpwood has increased, exceeding 2.2 billion ft.^{3} by the late 1990s (**Table 1**).

Although nearly all species of hardwood can be pulped, denser hardwood species usually are preferred. An emerging procurement process for hardwood pulpwood is whole-tree satellite chip yards that can be located a considerable distance from the actual mill. These satellite mills allow conversion of crooked nongrowing-stock material that would have been difficult to transport

long distances, and in some cases allow for whole-tree conversion (including limbs and tops). The greatest volume of hardwood pulpwood is consumed in the southern United States, where pulp consumption exceeds hardwood sawlog consumption by 50 percent (Luppold et al. 2002). The U.S. Northeast remains the only area in which hardwood sawlog consumption exceeds consumption of hardwood pulpwood.

Engineered wood products

Engineered wood products (EWP) are materials manufactured by press gluing thin sections of wood that have been formed by flaking or veneering. They are made from low-density hardwoods (yellow-poplar, aspen, etc.) and southern pine. Estimated consumption of hardwood roundwood by this industry was 445 million ft.^{3} in 1998 (Luppold et al. 2002) and likely has increased since then. Although oriented strandboard (OSB) is by far the most common EWP, this group of products also includes laminated veneer lumber, oriented strand lumber, and parallel strand lumber. While some EWP mills use lathes for primary breakdown and require sawlog-size material, many others can use lower quality stems from both growing-stock and nongrowing-stock trees. The newer OSB mills can use crooked roundwood and even limbs, making them similar in fiber conversion to whole-tree pulp-chipping units.

Relative valuation of hardwood roundwood and stumpage

As the discussion of primary processors suggests, hardwood roundwood markets are numerous due to different combinations of species and products. Likewise, there can be a considerable range in the prices of hardwood products due to variations in quality and in fashion trends. By contrast, there are fewer commercial softwood species and fewer markets for softwood products. One way to demonstrate differences between hardwood and softwood products and prices is the Maine stumpage report (Maine For. Ser. 2002) as it provides detailed information for a state with diverse timber-consuming industries (**Table 3**).

A comparison of softwood and hardwood stumpage prices as defined by the resulting primary products is presented in **Table 3**. The overall range in hardwood stumpage price is considerably wider than that for softwood prices, and hardwood sawlogs and veneer products have a considerable price range depending on species. In Maine, prices of softwood pulpwood stumpage prices range upward to $50 per thousand board feet (MBF) while softwood sawlog stumpage range from $51 to $150 per MBF. Hardwood pulpwood prices are in a narrow range, but hardwood sawlog prices range from less than $50/ MBF for aspen to more than $200/MBF for red oak. Veneer log prices range from less than $100/MBF for aspen to more than $500/MBF for sugar maple. The price of hardwood boltwood (short logs that are merchandised primarily in New England markets) ranges from less than $50/MBF for mixed hardwood to nearly $150/MBF for red oak, sugar maple, and white birch.

Table 3. — Value of hardwood and softwood roundwood products in Maine by value range, state average for 2001.

Value range[a]	Softwood products	Hardwood products
($/MBF)		
Less than 20	Red and white pine pulpwood	Aspen and mixed hardwood pulpwood
21 to 50	Hemlock, mixed softwood, and spruce/fir pulpwood; cedar boltwood	Aspen sawlogs
51 to 100	Hemlock, cedar, and red pine sawlogs	Beech and red maple sawlogs; aspen, red maple, ash, and yellow birch boltwood; aspen veneer logs
101 to 150	Spruce/fir and white pine sawlogs	White birch, ash, and yellow birch sawlogs; sugar maple, white birch, and red oak boltwood; red maple veneer logs
151 to 200		White oak and sugar maple sawlogs
201 to 300		Red oak sawlogs; ash veneer logs
301 to 400		Yellow and white birch veneer logs
401 to 550		White oak, red oak, and sugar maple veneer logs

[a] Developed from Maine Forest Service (2002); International 1/4-inch log scale, assuming two cords of pulpwood roughly equivalent to 1,000 board feet (MBF).

The range in hardwood sawlog and veneer log prices in **Table 3** relates not so much to the inherent quality of these logs but to their use as described in the previous section. Aspen sawlogs and veneer logs are used primarily by EWP industries. Aspen lumber is the lowest valued northern species (Hardwood Mar. Rep. 2002). In Maine, most red maple veneer logs are consumed by industries that peel rather than slice (plywood and rotary cut face veneer). By contrast, red oak sawlogs tend to be processed into lumber and red oak veneer logs are sliced or rotary cut for face veneer.

While the range of hardwood prices for Maine appears wide, it is relatively truncated because of the relative quality of Maine's hardwood resource. By contrast, the average price of hardwood roundwood in Pennsylvania ranges from approximately $10/MBF ($5 per ton) for pulpwood to more than $1,700/MBF (International 1/4-inch scale) for black cherry sawlogs and $3,000/MBF for cherry veneer logs in northwestern Pennsylvania (Penn. State Univ. 2002). This range demonstrates that the greatest variability in hardwood roundwood product prices is within the sawlog and veneer log portion of the market, and reflects the relative value of different species and the impact of growth characteristics (ring count, color, consistency of ring count, roundness of bole, etc.). Still, growth characteristics are difficult to define because evaluation criteria differ for different species and different growth characteristics occur conjointly. Growth characteristics often are associated with a region such as Indiana white oak or Allegheny black cherry.

Another aspect of hardwood product prices is that there seems to be no long-term interrelationship between the price of different hardwood species or species groups. For the most part, the price of higher value hardwood products does not seem to be cointegrated over time (Luppold and Prestemon 2001). The lack of cointegration suggests no structured pattern of species substitution.

Examples of localized changes in hardwood roundwood demand

It is sometimes assumed that changes in the production of primary hardwood products are uniform across the eastern

U.S. hardwood regions. However, we assert that the hardwood resource and demand for this resource varies by location. We support this contention by examining changes in regional and subregional hardwood lumber production from 1965 to 2000 and demonstrate how growth in the markets for lower value hardwood roundwood has also varied by region.

In developing new estimates of eastern U.S. hardwood production (Luppold and Dempsey 1989), it was found that hardwood lumber production had not changed uniformly among regions between 1965 and 1986. While production increased by 25 and 35 percent in the northeastern and north-central regions, respectively, production decreased in the south-central region and remained constant in the southeast. Luppold and Dempsey attributed these changes in production to changes in international and domestic demand and emphasis on pine production in the south, though a contributing factor to these changes could be the greater increase in sawtimber volumes in the north versus the south during this period (Smith et al. 2001).

A second study by Luppold and Dempsey (1994) examined nine hardwood regions identified in terms of states proximate to one another with similar species composition. In this study, the Central States (Ohio, Indiana, Illinois, Missouri, and Iowa), the Lake States, and a region that included Kentucky and Tennessee had the largest increase in production of lumber while regions to the south and east of these states had smaller or negative increases in production. Again, these findings were linked to changes in the domestic flooring and cabinet industry and to international demand for white oak, both of which affected price and production in the Central States and Kentucky/Tennessee.

An example of how prices for specific groups of species can influence hardwood roundwood demand in a specific state is sawlog production in Maine (Fig. 1). The 21-percent decline in hardwood production in Maine[3] from 1979 to 1989 (versus the 32% increase in national production during the same period) and the subsequent rebound in lumber production apparently hinge on the markets for red oak versus hard maple and other northern hardwoods abundant in this state. The 1980s were the age of red oak as oak dominated furniture fashions (Frye 1996) and the price of No. 1 Common oak was second only to that of black walnut and black cherry. Maple prices declined through much of this period and were about 60 percent of the value of red oak by the end of 1987 (Luppold and Prestemon 2001). By the end of 2000, the price of No. 1 Common color select hard maple was nearly 50 percent higher than that for similar grades of red oak. This helped boost Maine's sawlog production by 77 percent from 1987 to 2000.

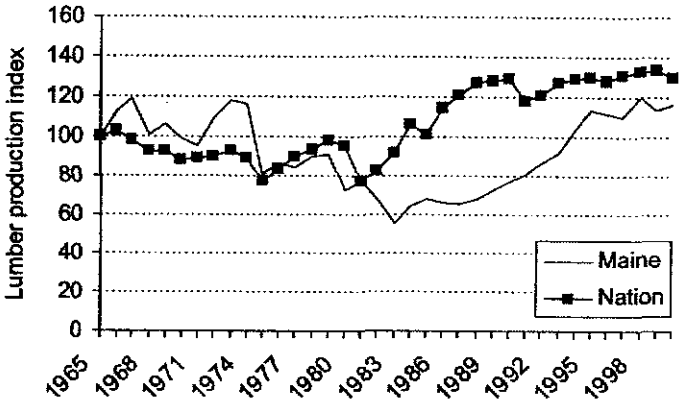

Figure 1. — Hardwood lumber production in Maine and the United States, 1965 to 2000 (indexed, 1965 = 100). Developed from Maine Forest Service Wood Processor Reports (various years) and by combining estimates from Luppold and Dempsey (1989, 1994) with the U.S. Department of Commerce (2002).

The data from Maine also point out how a structural shift in production technology can influence demand for a specific hardwood roundwood product. Aspen has been a relatively low-value hardwood species that generally has been consumed as pulpwood. In the 1980s, OSB plants were built in Maine resulting in a 20-fold increase in aspen sawlog (as opposed to pulpwood) production from the late 1970s to the late 1980s (P. Lammert, Maine Forest Service, pers. comm.).

Summary and conclusions

Although roundwood can be considered as an intermediate step between harvesting and primary processing, hardwood roundwood can be traded actively in relatively complex markets. As the relative value of different hardwood roundwood products has become more divergent, there has been added incentive to separate product by quality, species, diameter, grade, color, or other characteristics. Understanding these attributes and their importance to different markets is important because the proximity to specific hardwood roundwood markets determines how a stand is harvested and regenerates.

The three broad categories of hardwood roundwood markets – aesthetic, industrial, and fiber – can include materials that emanate from the growing-stock or nongrowing-stock portion of forests. Pulpmills and hardwood sawmills consume the greatest volume of hardwood roundwood, but veneer mills, plywood mills, and EWP plants can be important consumers in a specific subregion. However, most consumers of hardwood roundwood (other than pulpmills) are difficult to define in finite groups.

The diversity of hardwood roundwood demands is partly the result of the biological supply. The composition and structure of hardwood forests varies among and within regions, and most of this forestland is privately held and unmanaged. Stumpage can be purchased by primary processors, independent loggers, and, in some cases, timber speculators. The method of harvest may be influenced by the type of purchaser.

There are numerous hardwood roundwood markets due to different combinations of species and products, and a considerable range in the price of hardwood products. The ranges in the price of hardwood roundwood products are greatest within the sawlog and veneer log portion of the market due to the relative value of different species and the

[3] Hardwood lumber production was estimated by subtracting the aspen component for what was used primarily to manufacture OSB from total sawtimber production.

impact of growth characteristics (ring count, color, consistency of ring count, roundness of bole, etc.) on different markets. Another aspect of hardwood product prices is that there seems to be no long-term interrelationship between the price of different hardwood species or species groups.

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