Utilization of the Eastern Hardwood Resource by the Hardwood Sawmilling Industry

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ABSTRACT: *The eastern hardwood resource contains numerous species that differ in grain, color, texture, and workability. Because the value of hardwoods is derived from appearance, these variations in physical attributes can cause the price for identical grades of hardwood lumber to vary by as much as 600% between species. As a result, there is incentive for primary processors to harvest certain species more intensively than others, which could affect long-term forest composition. This article introduces the concept of relative utilization to augment the infrequently published annualized growth-to-drain ratio and examines the relative utilization of* 13 *eastern hardwood species on a national and regional basis. An analysis of relative utilization coefficients developed from primary and secondary data showed that black cherry, red oak, hard maple, and yellow-poplar were relatively overutilized, while the gums, hickory, and beech were underutilized. Relative utilization has varied by species over time due to changes in furniture styling and the ability of industry to substitute species. Shade-tolerant species such as hard and soft maple are regenerating faster than shade-tolerant species, resulting in increased long-term supply even if current sawtimber volumes are relatively overutilized. North.* 1. *Appl. For.* 18(2):37-41.
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The eastern hardwood resource is composed of numerous species, each with a unique set of physical attributes with respect to grain, color, texture, and workability. Because the value of hardwoods is derived from appearance, these variations in physical attributes can cause the price for identical grades of lumber to vary by as much as 600% between species. For example, in June 1999, prices for the highest grade of hardwood lumber (first and seconds) ranged from $355/mbf for southern elm to more than $2000/mbf for Appalachian black cherry. However, the relative use and value of a particular hardwood species also varies over time. In January 1968, the price of grade No.1 Common 4/4 Appalachian yellow-poplar lumber was 33% higher than that of No. 1 Common red oak lumber (Lemsky 1968); by January1993, the price of grade No.1 Common red oak was 136% higher than that of yellow-poplar (Jones 1993).

The market's valuation and subsequent utilization of a species in combination with natural disturbance (e.g., climate, fire, animal populations) affect forest composition. Perhaps the most revealing statement on the impact of species selection is found in a report on the 1949 West Virginia forest inventory: 'The red oak type alone takes up nearly one-third of the forested area. This type occupies nearly every kind of site from cool, moist bottomland to dry southern slopes. Many of the red oak stands are red only because the more desirable species such as white oak, yellow-poplar, and basswood have been removed" (Wray 1952). However, 40 yr after Wray' s report, walnut and cherry were the only domestic species that were valued higher than red oak.

Economic theory would suggest that the higher the value of products emanating from a resource, the greater the rate of resource extraction. Yet it is difficult to measure the impact of market forces because the hardwood resource has grown rapidly over the last 50 yr. This growth resulted from regeneration after heavy cutting in the early 1900s in combination with the continual transition of agricultural land to forestland that began in the 19th century. However, there has been a continual change in the composition of this forest over the last 70 yr in part due to removal and management practices related to a specific species and quality of timber (Luppold and Baumgras 1999). Therefore, it is important to determine if current market forces are affecting future forest composition through the overutilization or underutilization of particular species relative to their physical inventory.

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Forest researchers have traditionally used the annualized growth to drain ratio to evaluate species use. This ratio is informative because it can be developed for virtually every commercial species. However, this ratio is published infrequently, is inconsistent across regions, and can understate current drain activity (Luppold and McWilliams, in review). Given the rapidly changing market for hardwood lumber, researchers need an indicator of utilization levels that can be calculated more frequently than the growth/drain ratio.

We present here an alternative for assessing species utilization by examining relative lumber production versus relative sawtimber inventory (relative utilization). Relative utilization is the ratio of the proportional lumber production by species to the proportion of sawtimber inventory for that species. This coefficient is similar to location quotients used to analyze concentration of industries within a region (Isserman 1977)

The relative rate of utilization indicates how the market, through harvesting, is changing forest composition relative to the natural state (i.e., nonharvest disturbances only). If a species has a low rate of relative utilization, then the proportion of that species in the forest is increasing relative to its natural rate of growth or decline. If relative utilization for a particular species is high, the proportion of that species in the forest is declining relative to the natural state in the short run (and possibly the long run). In a rapidly growing forest, both the/growth/drain ratio and relative utilization ratio can be considerably higher than one. In a mature or slow-growing forest, a high utilization ratio would coincide with a growth/ drain ratio lower than one.

The concept of relative utilization augments, but is not a substitute for, the growth/drain ratio. The advantage of examining relative utilization is that it can be estimated annually using data from the Bureau of the Census (U.S. Department of Commerce, Bureau of the Census, MA24T, 1998). The disadvantage is that relative utilization does not consider the rate of regeneration for specific species.

This article presents relative utilization rates for 13 hardwood species using both Census data and data collected by the Weekly Hardwood Review (WHR). Proportional estimates of sawtimber inventory were developed from Powell et al. (1993). Relative utilization on a national basis was developed using Census and WHR data. This analysis is followed by a regional analysis of relative utilization based on WHR data.

Data Considerations

Annual estimates of hardwood lumber production published by the U.S. Bureau of the Census (U.S. Department of Commerce, Bureau of the Census, MA24T, 1998) provides information on the production of a particular species, an aggregate of minor species (other eastern hardwoods), mixed hardwoods, and hardwoods not specified by kind (nsk). The mixed-hardwood category includes ungraded hardwoods for ties, timbers, blocking, cants, and pallet stock. Mills that maintain production records for a particular species usually tally and grade lumber using National Hardwood Lumber Association rules. These "grade mills" tend to be relatively large, though a small number of these mills produced less than 1 million bf annually. Mills that report lumber in the mixed-hardwood and nsk categories tend to be small mills that produce ungraded lumber or large mills that specialize in industrial products.

According to the Bureau of the Census, of the 10.7 billion bf of the hardwood lumber produced in 1997,4.7 billion bf (44%) were categorized as mixed hardwoods or nsk (U.S. Department of Commerce, Bureau of the Census, MA24T, 1998). The remaining 6 billion bf were stipulated by species or as other eastern hardwoods. Although this estimate of production seems to be low (Hansen and West 1998), it is assumed that the estimates of species proportions correspond to the proportions of hardwood species produced by grade mills.

In 1998, the WHR surveyed by mail 600 sawmilling firms that subscribe to the Weekly Hardwood Review. Most of the sawmilling firms that subscribe to the WHR and/or the Hardwood Market Report are eastern grade mills. Of the firms surveyed, 130 (22%) returned usable questionnaires. These respondents operate 217 mills that produced nearly 2 billion bf of hardwood lumber in 1997. These firms also exported nearly 250 million bf of lumber in 1997. All respondents provided detailed production data for 20 commonly produced species or species groups. The respondents operated mills producing 1 million to 50 million bf per year with a mean annual production of 8.8 million bf. More than 75% of these firms produce more than 5 million bf of hardwood lumber annually.

Luppold (1995) estimated that in 1992, hardwood sawmills that produced more than 5 million bf accounted for 53% of total production and represented 14% of all hardwood sawmillers. However, mill capacity has increased since the early 1990s. For instance, the average capacity of West Virginia sawmills that produced more than 5 million bf annually increased from 10.2 million in 1992 to 11.2 million in 1997 or 10% (WV Department of Commerce, Labor, and Environmental Resources, 1992, WV Bureau of Commerce, Division of Forestry 1997).

Development of Relative Utilization Coefficients

The relative utilization of a particular species is defined as:

$$ULi = PPi / PIi; \quad (1)$$

where

ULi = Utilization level of species *i*

PPi = Proportion of production in species *i*

PI i = Proportion of the inventory in species *i*

For this study, five utilization levels (UL) were developed that ranged from highly overutilized to highly underutilized. Species are considered highly overutilized when they are being produced at twice the proportion that exists in the resource (UL of 2) and highly underutilized when lumber production is half of the proportional sawtimber inventory (UL of 0.5, the reciprocal of 2). Because

Table 1. Utilization levels based on range of relative utilization.

Utilization level	Range of relative utilization coefficients
Highly overutilized	Greater than 2.01
Overutilized	1.26-2.00
Fully utilized	0.80-1.25
Underutilized	0.50-0.79
Highly underutilized	Less than 0.49

estimates of hardwood lumber production may not be precise, it was decided to set the range of the central category (fully utilized) to plus or minus 25%. This gives a range of 1.25 to 0.8 (the reciprocal of 1.25) for that level. The total range is less than 0.51 for highly underutilized to greater than 2.01 for highly overutilized (Table 1).

Analysis of National Relative Utilization

Census estimates and WHR survey results for hardwood lumber production are presented in Table 2 along with proportional estimates of hardwood lumber production (U.S. Department of Commerce, Bureau of the Census, MA24T, 1998) and sawtimber inventory (Powell et al. 1993). A comparison of these data indicates that the proportional level of lumber production is similar for most species. However, there are major differences in the proportional estimates for the gums, walnut, and cottonwood estimated between the two databases.

Relative utilization coefficient and utilization levels calculated using WHR and Census data for 13 species are presented in Table 3. The two databases showed the same utilization levels for 7 species (ash, beech, gums, hickory, red oak, white oak, and yellow-poplar), while 4 species (birch, cherry, hard maple, and soft maple) have utilization levels relatively close to one another. The species with divergent results were cottonwood/aspen and walnut.

Studies of timber product output in the Lake States region have shown that large quantities of aspen sawtimber are being consumed (Hackett and Whipple 1997, Hackett and Pilon 1997). Although there are mills in this region that specialize in this species, much of the aspen is consumed by manufacturers of oriented strand board. In the Southern region, large volumes of cottonwood are processed by a small number of large mills located near the Mississippi River. None of these mills participated in the WHR survey.

Black walnut is produced primarily in the central region with a small number of producers specializing in the production of this species. A review of the firms that completed the WHR survey revealed that many of the larger producers participated in the survey. It should be noted that demand for walnut has declined in recent years in part because secondary processors are concerned about supplies. Thus, cottonwood/aspen producers are underrepresented in the WHR survey, while walnut producers appear to be over represented.

Species that were overutilized in both data sets include cherry, red oak, and yellow-poplar. Although the current market prices for these species are high, the relative overutilization of yellow-poplar in both data sets was unexpected. Although hard maple was overutilized in Census data, the relative utilization coefficients for this species were close to the range limit for fully utilized.

Ash, birch, and white oak were fully utilized while soft maple was fully utilized in the WHR database but underutilized in the Census data. However, the relative utilization coefficient was close to the minimum value (0.80) for fully utilized. Beech, the gums, and hickory were highly underutilized in both data bases. At the time of the WHR survey, lumber of these species traded at a relatively low price. Since 1997, the price of hickory has increased by 30 to 50% depending on grade (Barrett 1997, Barrett 1999).

Analysis of Regional Relative Utilization Coefficients

The hardwood regions listed in Table 4 correspond to those regions developed by Luppold and Dempsey (1994). However, the Appalachian region also includes Kentucky and Tennessee due to relatively few responses from these states. The regional utilization levels reported in Table 5

Table 2. Comparison of species production for 1997 Census estimates and WHR survey data.

Species	Production volume		Proportion of species		Proportional sawtimber inventory
	WHR data	Census data	WHR data	Census data	
	(mmbf)		(%)		
Ash	90.0	193.0	4.75	3.44	3.87
Beech	18.2	69.0	0.96	1.23	3.15
Birch	27.5	70.0	1.45	1.25	1.13
Cherry	80.7	195.0	4.26	3.48	1.94
Cottonwood/aspen	17.2	216.0	0.91	3.85	4.39
Hickory	24.8	95.0	1.31	1.69	5.55
Hard maple	137.2	437.0	7.24	7.79	5.76
Soft maple	109.4	256.0	5.78	4.56	7.07
Red oak	744.8	1,983.0	39.32	35.35	23.19
White oak	282.0	929.0	14.89	16.56	16.53
Yellow-poplar	253.6	946.0	13.39	16.87	8.86
Gums	21.9	195.0	1.15	3.48	9.28
Walnut	23.7	25.0	1.25	0.45	0.53
Other species	63.3		3.34		8.76

Table 3. Comparison of utilization rates based on WHR and Census data.

Species	Utilization rates		Utilization level	
	WHR data	Census data	WHR data	Census data
Ash	1.22	0.84	Fully utilized	Fully utilized
Beech	0.30	0.37	Highly underutilized	Highly underutilized
Birch	1.28	1.05	Overutilized	Fully utilized
Cherry	2.19	1.71	Highly overutilized	Overutilized
Cottonwood/aspen	0.21	0.82	Highly underutilized	Fully utilized
Gums	0.12	0.35	Highly underutilized	Highly underutilized
Hickory	0.23	0.30	Highly underutilized	Highly underutilized
Hard maple	1.26	1.27	Overutilized	Overutilized
Soft maple	0.81	0.61	Fully utilized	Underutilized
Red oak	1.69	1.45	Overutilized	Overutilized
White oak	0.90	0.95	Fully utilized	Fully utilized
Yellow-poplar	1.51	1.81	Overutilized	Overutilized
Walnut	2.36	0.81	Highly overutilized	Fully utilized

differ from the national data in Table 3. Since individual species are not processed in significant quantities in all regions, the designation for insufficient data (na) was used in Table 5.

In aggregate, cherry was highly overutilized (Table 3) but ranged from highly overutilized in New England, Appalachian, and Central regions to overutilized in Penn/York and Lake State regions (Table 5). Red oak was highly overutilized in New England and overutilized in the other five regions. Hard maple and birch ranged from fully utilized in the New England and Penn/York regions to highly overutilized in the Lake States. Yellow-poplar was overutilized in three regions, but fully utilized in the Appalachian region where it is in the greatest abundance. Although hard maple was overutilized in many regions, the growth/drain ratios for this species may remain greater than one because current harvesting practices have caused a rapid regeneration of shade-tolerant species.

Beech was highly underutilized in all regions other than the Lake States, where it was underutilized. The other species that were highly underutilized in the WHR data (cottonwood! aspen, gums, and hickory) also were highly underutilized in the regional analysis. White oak was highly underutilized in New England, underutilized in the Central region, but fully utilized in the other four regions. The relatively low price and demand for white oak in recent years may be the primary reason why this species appears slightly underutilized while red oak was overutilized. Ash was overutilized in three regions but fully utilized in three others.

As with the coefficients developed from Census data, species with higher lumber prices were more likely to be overutilized while species with lower lumber prices tended to be underutilized. The major exception was yellow-poplar. Logs of this species are easy to saw, and the diameter of yellow-poplar sawtimber tends to be larger than that of others species.

Conclusions

This analysis of relative hardwood lumber production and inventory volumes indicates that different species are utilized at different rates and that market forces such as current lumber price seems to influence relative utilization level. Black cherry, red oak, hard maple, and yellowpoplar are favored by the market on both a national and regional level. The relatively high utilization level of yellow-poplar cannot be explained by the price of this species but may result from factors such as ease of sawing, relative log size, and proportion of more valuable sap wood. Black walnut is the only high-value species that appears to be fully utilized nationally.

Lower value species such as hickory, beech, and gum have lower utilization levels while cottonwood/aspen appear to be fully utilized nationally. Since the beginning of 1997, both the demand for and price of hickory lumber have increased by 42 to 60% depending on grade, possibly increasing the utilization rate of this species (Barrett 1997, 1999). Unlike red oak, white oak is being produced at or below its relative inventory levels. Historically, white oak has been priced near or higher than red oak. However, mid-grade prices for red oak began to diverge from those of white oak in 1981. By the beginning of 1998, the price of No.1 Common red oak was 30% higher than that of white oak.

Although there are some difficulties associated with projecting future forest composition using relative utilization coefficients, they do represent an additional tool that is useful in understanding the dynamics of forest growth drain relationships. Still, additional research that examines these coefficients over time is needed to determine how long-term relative utilization rates relate to long-term changes in forest composition.

Table 4. Definitions of regions and the number of firms and mills surveyed in each region.

Region New	States included	No. firms	No. mills
England	CT, ME, MA, NH, RI, VT	13	18
Penn/York	PA,NY	29	34
Appalachian	KY, NC, TN, VA, WV	25	44
Central Lake	IA, IL, IN, KS, MO, OH	20	31
States	MI, MN, WI	20	27
Southern	AL, AR, GA, FL, LA, MS, SC	21	37

Table 5. Relative utilization of hardwood species by grade mill for six eastern hardwood regions

Species	New England	Penn/York	Appalachian	Central	Lake States	Southern
Ash	Overutilized	Fully utilized	Overutilized	Fully utilized	Fully utilized	Overutilized
Beech	Highly underutilized	Highly underutilized	Highly underutilized	Highly underutilized	Underutilized	Highly underutilized
Birch	Fully utilized	Fully utilized	na*	na	Highly overutilized	na
Cherry	Highly overutilized	Overutilized	Highly overutilized	Highly overutilized	Overutilized	na
Cottonwood/aspen	Highly underutilized	Highly underutilized	na	Highly underutilized	Highly underutilized	Highly underutilized
Gums	na	na	Highly underutilized	na	na	Highly underutilized
Hickory	Highly underutilized	Highly underutilized	Highly underutilized	Highly underutilized	na	Highly underutilized
Hard maple	Fully utilized	Fully utilized	Overutilized	Overutilized	Highly overutilized	na
Soft maple	Highly underutilized	Underutilized	Overutilized	Fully utilized	Fully utilized	Highly underutilized
Red oak	Highly overutilized	Overutilized	Overutilized	Overutilized	Overutilized	Overutilized
White oak	Highly underutilized	Fully utilized	Fully utilized	Underutilized	Fully utilized	Fully utilized
Yellow poplar	na	Overutilized	Fully utilized	Overutilized	na	Overutilized
Walnut	na	na	na	Highly overutilized	na	na

*na = insufficient data for estimating regional utilization coefficient.

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