Changes in Eastern US Sawmill Employment and Estimated Hardwood Lumber Production from 2001 to 2015

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Abstract

Sawmills are an important component of the hardwood industry, developing value-added products derived from the timber resources of the eastern United States. Employment in eastern sawmills has declined during the 21st century, reaching its lowest point in 2009 and 2010. Employment declines in the North and South Central regions of the United States were less than declines in the Northeast and Southeast regions, but East-wide employment was over 30 percent lower in 2010 than in 2001. The number of sawmills also has declined in the East, but since 2010, average employment in those mills has been increasing. Eastern hardwood lumber production followed sawmill employment for the four eastern subregions between 2001 and 2008; the last year estimates were available by state. Initial estimates of hardwood lumber production in 2009 based on production-to-employment ratios for the 2001 to 2008 period appeared higher than US Department of Agriculture estimates from timber product output data. A potential cause of this discrepancy was sawmills maintaining key employees during the Great Recession. After adjusting for these differences, eastern hardwood lumber production for 2009 was estimated to be 6.5 billion board feet (BBF), which was consistent with estimates of hardwood lumber consumption, net exports, and inventory adjustments. Eastern hardwood lumber production had increased to 9.2 BBF by 2015 but still was 28 percent less than the peak production year of 1999.

Hardwood lumber is a general term that embodies numerous sawn products, including boards, squares, cross ties, pallet cants, crane mats, board roads, and staves; it is a major value-added product derived from the forests of the eastern United States. The hardwood lumber industry also provides employment in rural areas of Appalachia, the Midwest, and the South, areas that have experienced declines in their forest products industries in recent years (Lin et al. 2011, Woodall et al. 2011, Brandeis and Hodges 2015). Therefore, understanding the level of hardwood lumber produced over time is critical in assessing the impact of markets on the eastern hardwood sawtimber resource and the contributions of this industry to local and national economies. However, as outlined below, data limitations have made it increasingly difficult to ascertain hardwood lumber production levels to meet these informational needs.

In 1999, eastern hardwood lumber production exceeded 12.7 billion board feet (BBF) (Fig. 1), the highest volume ever recorded (Steer 1948, Luppold and Bumgardner 2008). Between 1999 and 2005, hardwood lumber production declined by 1.25 BBF, which coincided with a 1.3-BBF decrease in domestic consumption during the same period (Luppold and Bumgardner 2016). Hardwood lumber production remained nearly constant in 2005 and 2006 before sharply declining between 2006 and 2009 (US Department of Commerce, Census Bureau [USDC] 2011). The USDC reported in *Current Industrial Reports, Lumber Production and Mill Stocks* that the decline was 5.9 BBF, or 55 percent (Fig. 1), with the greatest decline occurring between 2007 and 2008 (USDC 1995 to 2009).

A large portion of the decline in hardwood lumber production for 2008 was the result of omitting estimated production of nonsurveyed small mills whose production was reported under the notation ''Eastern hardwoods not specified by kind (n.s.k)'' in 1993 (USDC 1995 to 2009).
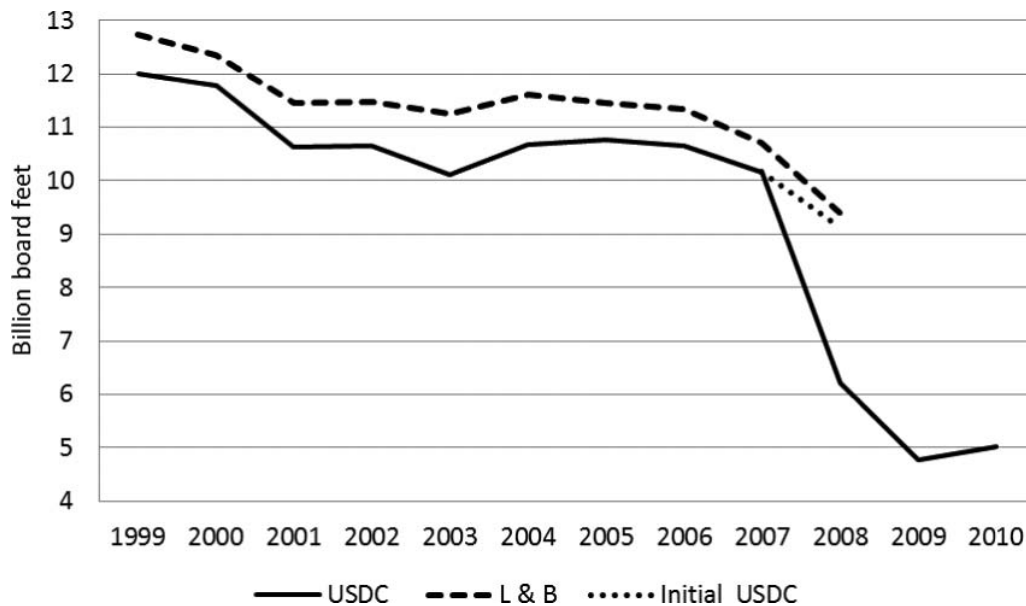
Figure 1.—Estimated eastern hardwood lumber production developed by the US Department of Commerce, Census Bureau (USDC) for 1999 to 2010, Luppold and Bumgardner for 1999 to 2008, and original USDC (initial USDC) for 2007 to 2008 (USDC 1995 to 2009, 2010, 2011; Luppold and Bumgardner 2008). Luppold and Bumgardner (2008) value estimated on the basis of the initial 2008 estimate by the USDC.

Between 2000 and 2007, the Eastern hardwood n.s.k. category accounted for 27.5 to 29.2 percent of eastern hardwood lumber production (USDC 1995 to 2009). Initial estimates for 2008 reported production of 2.9 BBF in the n.s.k category, which was 32 percent of total eastern hardwood lumber production that year (USDC 1995 to 2009). The initial estimate of 9.1 BBF for eastern lumber production for 2008, as reported in USDC (1995 to 2009), is shown in Figure 1 as ''Initial USDC.'' The revised estimate of 6.2 BBF for 2008 excluded the n.s.k. category, as reported in USDC (2010), so the initial estimate is shown in Figure 1 as a continuation of the series.

The USDC continued to develop estimates of hardwood lumber production that excluded production at smaller sawmills in 2009 and 2010 (Fig. 1). Related to this exclusion was discontinuation of state estimates for hardwood and softwood lumber production. After 2010, the USDC halted the publication of *Current Industrial Reports, Lumber Production and Mill Stocks*. An announcement in association with the discontinuation was that ''while few data users wanted to eliminate this existing data source, the availability of manufacturing data from the 'Annual Survey of Manufacturers' and the '5-year Economic Census,' help mitigate the loss of the CIR data products'' (USDC 2015). The *Annual Survey of Manufacturers* and the 5-year *Economic Census* provide values of all lumber produced on a national level and partial information of values lumber produced at state levels as limited by disclosure rules. However, estimation of hardwood lumber production with any degree of accuracy using these remaining USDC reports would be technically impossible.

In the past, estimates for hardwood lumber production at the state level for specific years have been developed from the US Department of Agriculture, Forest Service (USDA FS) timber product output (TPO) reports using saw log consumption (mill receipts) information (Luppold and Dempsey 1994). These reports have been developed every

2 years for most states in the southern United States since the mid-1990s but have been developed less frequently in the northern states. Lumber production data also is developed by the state of Texas.

Another source of data for the sawmill industry is *Quarterly State and County Employment and Wages* (US Department of Labor [USDL] 2016a), which includes total employment and number of establishments producing lumber for all major and most minor lumber-producing states beginning in 2001. However, USDL data do not separate hardwood, softwood, or mixed hardwood/softwood sawmills. As a result of the data limitations from individual sources, the only way to understand what is currently occurring in the eastern sawmilling industry is to examine and combine information from several sources into a compressive structure with an emphasis on changes in employment and hardwood lumber production.

The first objective of our study was to examine the eastern sawmilling industries for the regions defined in Table 1 with an emphasis on the hardwood sector of this industry. The second objective was to examine changes in sawmill employment, the number of establishments, and average employment per establishment for these regions. The final objective was to estimate eastern hardwood lumber production by integrating information developed by Luppold and Bumgardner (2008) and the USDC's *Current Industrial Reports, Lumber Production and Mill Stocks* data in conjunction with USDL employment data, USDA FS TPO estimates for several states, and data developed by the Texas Forest Service.

Methods

Both USDC and USDL classify sawmills under the North American Industry Classification System (NAICS) as NAICS 321113. Data on NAICS 321113 total employment and total number of establishments were collected for the period 2001 to 2015 for individual states using *State and*

Region[a]	States
Northeast	Connecticut, Delaware,[b] Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island,[b] Vermont, West Virginia
North Central	Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota,[b] Ohio, South Dakota, Wisconsin
Southeast	Florida, Georgia, North Carolina, South Carolina, Virginia
South Central	Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas

[a] These regions correspond to those used in the development of background timber volume information for periodic reports required by the Forest and Rangeland Renewable Resources Planning Act of 1974; 16 U.S.C. 1601 (note).

[b] Employment data were unavailable because of disclosure rules.

County Employment Data (USDL 2016a). When disclosure rules resulted in suppressed data for an individual year, those values were estimated by averaging values for proximate years. In some states, employment and establishment information had to be developed for the more general NAICS 3211(sawmills and treating) category because the existence of a small number (one to three) of wood-preserving operations caused information on employment to be suppressed for both sawmill and NAICS 321114 (wood-preserving) facilities.

Hardwood lumber production estimates for individual states from 2001 to 2008 were developed using procedures discussed in Luppold and Bumgardner (2008). The USDC data used for 2008 were from the initial estimates for that year since the revised data omitted estimates for small mills and production estimates by state (USDC 1995 to 2009). Estimates for eastern hardwood lumber production for each region listed in Table 1 were developed by summing estimated hardwood lumber production for the states in that region. Regional ratios of hardwood lumber production–to–employment (PE) for the period 2001 to 2008 were developed using

$$PE_{ij} = P_{ij}/E_{ij}$$

where P_{ij} is the hardwood lumber production in region i ($i = 1$ to 4) in year j ($j = 2001$ to 2008) and E_{ij} is the sawmill employment in region i in year j. The resulting PE ratios were relatively consistent within each region but tended to peak during the mid-2000s and experienced their low points in 2001 and 2008. An initial estimate of eastern hardwood lumber production was developed by first estimating an average ratio (APE) for each region

$$APE_i = \Sigma PE_{ij}/8$$

and summing the quotients of the APE ratios multiplied by employment in the years 2009 to 2015:

$$EP_k = \Sigma APE_i \times E_{ik}$$

where EP_k is the eastern hardwood lumber production in year k ($k = 2009$ to 2015) and E_{ik} is the sawmill employment in region i in year k.

Results

Eastern lumber production

In 2008, 9.4 BBF of hardwood lumber and 14.8 BBF of softwood lumber were produced in the eastern United States (Table 2). Since 2002, combined hardwood lumber production in the two northern regions has been similar to the combined hardwood production of the two southern regions (Luppold and Bumgardner 2008). By contrast, the two southern regions produced seven times more softwood lumber than the northern regions in 2008.

The type of softwood lumber produced in the southern regions is primarily yellow pine species (*Pinus* spp.), while softwood lumber production in the northern regions ranges from eastern white pine (*Pinus strobus* L.) in New Hampshire; white pine, red spruce (*Picea rubens* Sarg.), and balsam fir (*Abies balsamea* L.) in Maine; and red pine (*Pinus resinosa* Ait.) in Michigan. The northern regions contained higher quantities of sugar maple (*Acer saccharum* Marsh.) and red maple (*Acer rubrum* L.), and the southern regions contained higher quantities of sweetgum (*Liquidambar styraciflua* L.). Red and white oak species (*Quercus* spp.) and yellow-poplar (*Liriodendron tulipifera* L.) were found in all eastern regions.

Softwood lumber production is relatively concentrated in the South, with 55 percent of production occurring in five states: Georgia, Arkansas, Mississippi, Alabama, and North Carolina (Table 2). The five states with the greatest hardwood lumber production—Pennsylvania, Tennessee, Kentucky, North Carolina, and Virginia—account for 41 percent of nation's softwood lumber production. The wide distribution of the hardwood lumber industry over the eastern states is perhaps best characterized by the North Central region, which accounted for nearly 25 percent of eastern hardwood lumber production, but its largest contributor, Missouri, accounted for only 5.9 percent of total eastern production. The importance of the southern states to overall hardwood lumber production is demonstrated by the fact that four of the leading five hardwood-producing states listed above are in the South.

Regional changes in sawmill employment and number of establishments

In 2001, more than 81,000 persons were employed directly by the sawmilling industry at 3,770 establishments in the eastern United States (Tables 3 and 4). The region with the greatest number of employees was the South Central. In the early and mid-2000s, 75 percent of the lumber produced in this region was softwood. The Southeast region had the second-greatest number of sawmill employees in 2001, and the softwood proportion of total lumber production approached or exceeded 80 percent during the 2002 to 2006 housing boom (USDC 1995 to 2009). The Northeast region contained 21 percent of sawmill employees in the eastern United States in 2001. While this region contains high volumes of hardwood sawtimber, nearly a third of lumber production in this region was softwood. The North Central region had the fewest number of employees but the highest proportion of hardwood lumber produced.

The Northeast, South Central, and Southeast regions initially had a marked decline in employment during the early 2000s, but employment increased in conjunction with home construction in the mid-2000s (Fig. 2). The North Central region had the smallest decrease in employment in

Table 2.—Top states for hardwood and softwood lumber production in the eastern United States and the respective proportion of production in 2008.[a]

Region	Hardwood		Softwood	
	Volume (MMBF)	Top states (percentage of East)	Volume (MMBF)	Top states (percentage of East)
Northeast	2,384	Pennsylvania (10.3)	1,163	Maine (4.9)
		West Virginia (5.5)		New Hampshire (1.0)
		New York (4.6)		—
North Central	2,298	Missouri (5.9)	695	Michigan (3.0)
		Indiana (4.1)		—
		Michigan (3.7)		—
Southeast	1,737	Virginia (7.5)	5,560	Georgia (13.0)
		North Carolina (6.3)		North Carolina (9.5)
		Georgia (3.8)		South Carolina (6.1)
South Central	2,982	Tennessee (9.4)	7,386	Arkansas (10.9)
		Kentucky (7.8)		Mississippi (10.8)
		Mississippi (4.4)		Alabama (10.6)

[a] Using procedures developed by Luppold and Bumgardner (2008) for hardwoods and the US Department of Commerce, Census Bureau (1995 to 2009) for softwoods. — = All other states in the region represented less than 1 percent of production.

the early 2000s. East-wide, the number of sawmill employees declined by more than 30 percent between 2001 and 2009 (Table 3; Fig. 2), the Southeast region having the smallest decline (25%).

Sawmill employment continued to decline in the southern regions until 2010 as the result of reduced home construction but increased after 2009 for the hardwood-dominated northern regions (Fig. 2). The increase in northern production appears to be a function of the 20 percent increase in hardwood lumber exports during this period since domestic hardwood lumber consumption did not change (Luppold and Bumgardner 2016). Employment in all regions increased after 2010, but the North Central had the largest increase.

The South Central region had the greatest number of sawmill establishments in 2001 (Table 4), and 43 percent of these firms were in the predominantly hardwood-producing states of Tennessee and Kentucky. The two northern regions had a similar number of sawmills in 2001, and the Southeast region had the fewest establishments. In contrast to East-wide sawmill employment, which has fluctuated since 2001, the number of sawmill establishments steadily declined between 2001 and 2014 but increased slightly in 2015 (USDL 2016a). Between 2001 and 2015, the Northeast region had the largest decline (35%) and the North Central region the smallest (24%) in the number of sawmills (Fig. 3). However, the decline in sawmill establishments in the predominantly hardwood region cannot be attributed solely to declining production because such decline has been occurring since the mid-1970s as sawmill size has increased (Luppold 1996, Luppold and Bumgardner 2009).

There are considerable differences in the number of employees per establishment (Table 5) among regions. Average employment per sawmill in the softwood-dominated southern regions approached 30 in 2001, while employment per establishment was considerably less in the two northern regions. As the number of sawmills declined in all regions between 2001 and 2006, average employment increased, indicating that smaller operations were going out of business during this period. Average sawmill employment declined to their lowest levels this century as a result of the Great Recession but by 2015 rebounded to near or above 2006 levels.

Estimated hardwood lumber production, 2009 to 2015

Using regional average PE ratios for the 2001 to 2008 period and regional employment for later years, hardwood lumber production was estimated for 2009 to 2015 (Estimate 1 in Fig. 4). This procedure provided an estimate of eastern US hardwood production of 8.1 BBF for 2009. While this estimate represents a level of hardwood lumber production last occurring during the recession of 1981 (Luppold and Bumgardner 2008), it was considerably higher than what was expected given that domestic hardwood lumber consumption plus net exports was estimated to be 7.4 BBF in 2009 (Luppold and Bumgardner 2016), reported hardwood inventories at sawmills had declined by 200 million board feet (MMBF) between 2008 and 2009 (USDC 2010, 2011), western hardwood lumber production was estimated at 240 MMBF (USDC 2011), and an unknown

Table 3.—Sawmill employment for the Northeast, Southeast, North Central, and South Central regions in 2001, 2006, 2009, and 2015.[a]

Year	Northeast	Southeast	North Central	South Central
2001	16,796	20,493	12,531	31,525
2006	15,018	19,799	12,599	29,854
2009	10,555	15,386	9,066	21,317
2015	11,973	17,154	10,802	22,839

[a] According to the US Department of Labor 2016a.

Table 4.—Number of sawmill establishments for the Northeast, Southeast, North Central, and South Central regions in 2001, 2006, 2009, and 2015.[a]

Year	Northeast	Southeast	North Central	South Central
2001	994	720	980	1,076
2006	804	626	898	994
2009	729	584	851	910
2015	645	502	746	768

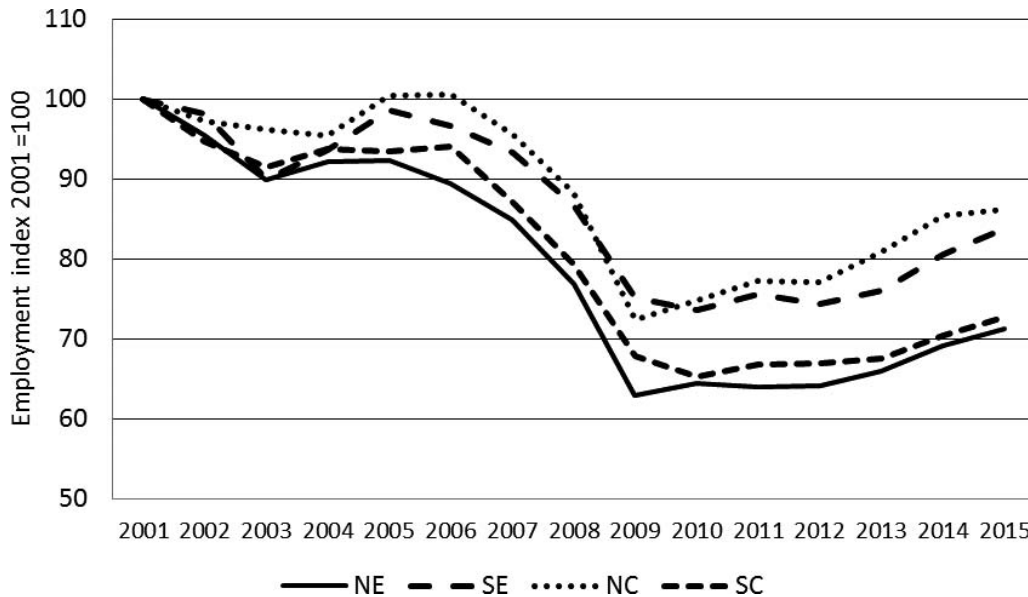[a] According to the US Department of Labor 2016a.

Figure 2.—Index of sawmill employment for the Northeast (NE), Southeast (SE), North Central (NC), and South Central (SC) regions, 2001 to 2015 (US Department of Labor 2016a).
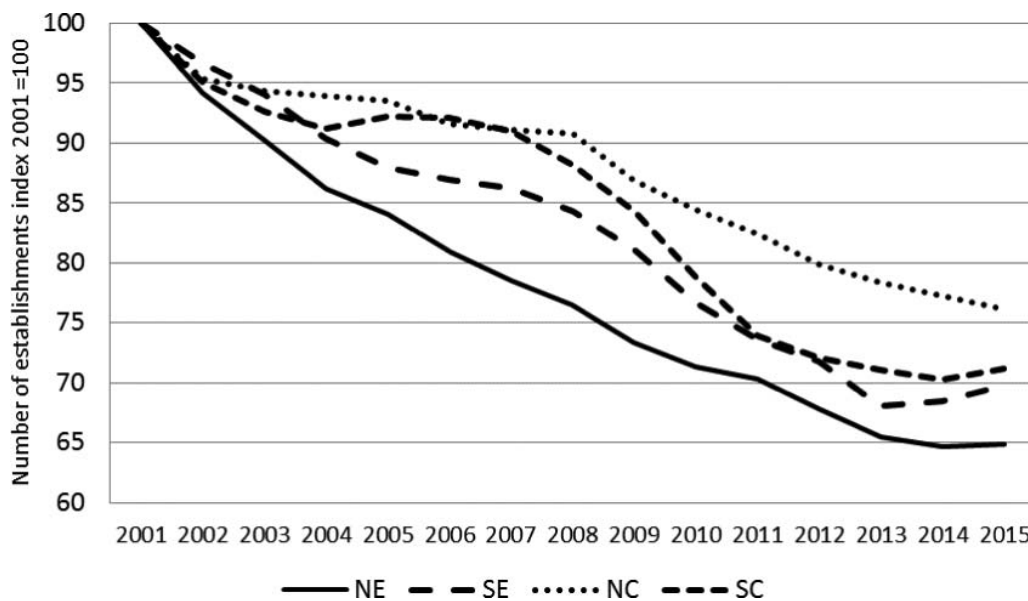

Figure 3.—Index of number of sawmills for the Northeast (NE), Southeast (SE), North Central (NC), and South Central (SC) regions, 2001 to 2015 (US Department of Labor 2016a).

Table 5.—Average number of employees for the Northeast, Southeast, North Central, and South Central regions in 2001, 2006, 2009, and 2015.[a]

Year	Northeast	Southeast	North Central	South Central
2001	16.9	28.5	12.8	29.2
2006	18.7	31.6	14.0	30.0
2009	14.5	26.3	10.7	23.4
2015	18.6	34.2	14.5	29.7

[a] According to the US Department of Labor 2016a.

volume of lumber inventories were being liquidated because secondary hardwood processors were going out of business. When combined, this information for hardwood lumber consumption, net exports, and inventory adjustments indicates that domestic production was at or below 6.9 BBF in 2009.

The problem with estimating hardwood lumber production during the Great Recession is that the PE ratios used were developed under fairly normal market conditions compared with 2009. The 2009 recession was unique in the magnitude of the decline in domestic consumption (Luppold and Bumgardner 2016) and hardwood lumber price (Fig. 5).
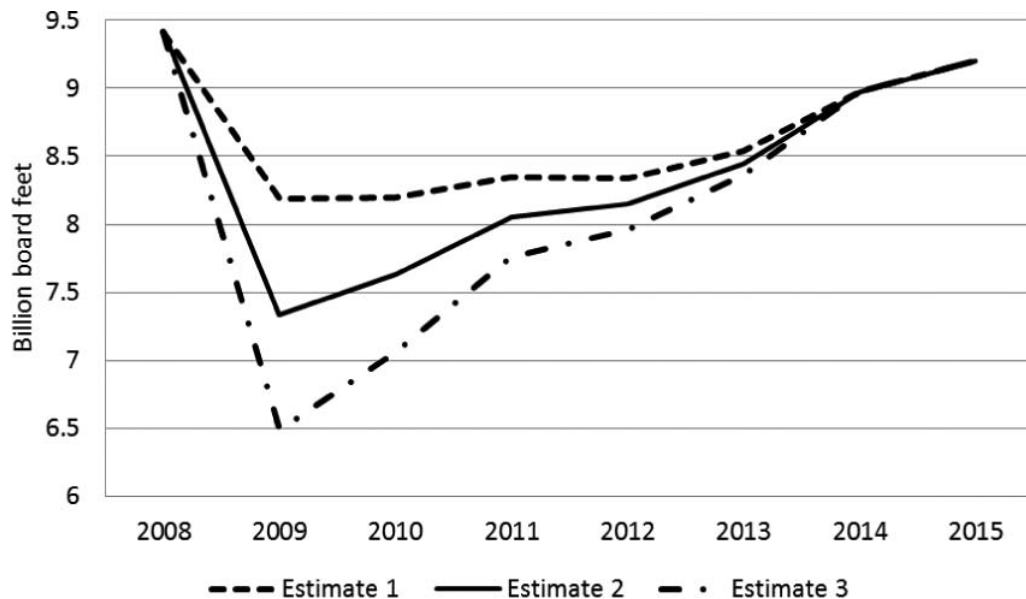
Figure 4.—Estimated eastern hardwood lumber production from 2008 to 2015 under assumptions of Estimates 1, 2, and 3.

And while eastern employment declined (Fig. 2), the decline could have potentially been greater but for the desire of the remaining mills to retain essential personnel, such as sawyers, saw filers, dry kiln operators, and other key individuals, in expectation of improved future market conditions. As indicated in Figure 5, the hardwood market is cyclical, and pronounced cycles of hardwood lumber production and price have been occurring since the early 1970s (Luppold et al. 1998).

To examine the potential overestimation of hardwood lumber production in 2009, estimates developed with the PE ratios were compared with estimates of hardwood lumber production using TPO and Texas data for the South Central and Southeast regions. As indicated in Table 6, regional estimates using TPO and Texas data were 21 percent less than estimates using the PE ratios for the two combined southern regions in 2009. This difference declined to 7 percent for 2011 (the last available year). Using this information, two additional estimates were developed. Estimate 2 assumes only a 21 percent and a 7 percent difference for 2009 and 2011, respectively, and no difference after 2014 for the southern regions only. Estimate 3 assumes that the two northern regions collectively had similar overestimates of hardwood lumber production, as did the two southern regions.

The estimate of 6.9 BBF developed using consumption, inventory change, net exports, and estimated western production falls between Estimate 2 and Estimate 3. While
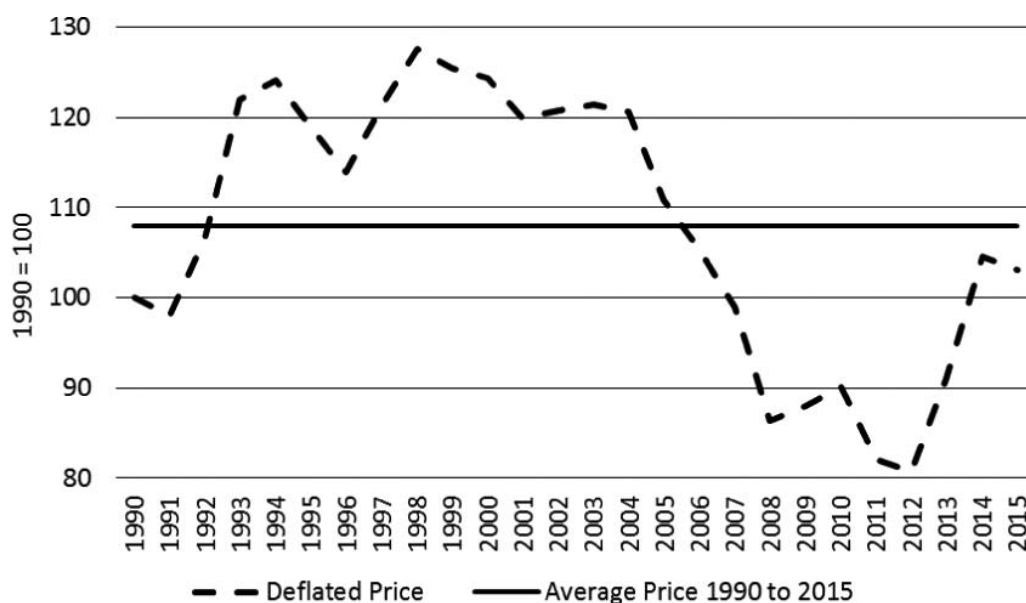

Figure 5.—Inflation-adjusted hardwood lumber price index, 1990 to 2015, 1990 = 100 (US Department of Labor 2016b). Hardwood lumber price index (WPU0812) adjusted by producer price index for all commodities (WPU 00000000).

Table 6.—Comparison of Estimate 1 with timber product output (TPO) estimates for 2009 and 2011 for the Southeast region, South Central region, and total South.[a]

	Southern TPO (MMBF)	Estimate 1 (MMBF)	% difference
Southeast, 2009	1,260	1,569	−19.7
Southeast, 2011	1,419	1,578	−10.1
South Central, 2009	2,067	2,629	−21.4
South Central, 2011	2,476	2,611	−5.2
South, 2009	3,327	4,198	−20.7
South, 2011	3,895	4,189	−7.0

[a] Data sources: Bentley and Schnabel (2007), Bentley et al. (2008), Howell and Johnson (2009), Mathison and Schnabel (2009), Schiller et al. (2009), VanderSchaaf (2009), Bentley and Johnson (2011), Brandeis et al. (2011), Johnson et al. (2011), Bentley (2015), Edgar et al. (2015).

there is no hard estimate of volume of hardwood lumber available for consumption due to inventory liquidation by secondary processors and other parts of the hardwood lumber distribution systems such as concentration yards, the actual level of production in 2009 was best approximated by Estimate 3, or 6.5 BBF. While the 6.5-BBF estimate is 35 percent higher than the USDC estimate of 4.8 BBF in 2009, it would still be the lowest level of hardwood lumber production since 1961, when volume of eastern sawtimber volume was a third of current levels (Luppold and Miller 2014). This would make eastern hardwood lumber production in 2009 nearly half the level occurring in the peak production year of 1999.

In 2015, Estimate 1 for eastern hardwood lumber production was 9.2 BBF, and western production most likely exceeded 300 MMBF, indicating estimated national production at or exceeding 9.5 BBF. Using procedures presented in Luppold and Bumgardner (2016), domestic hardwood lumber consumption plus net export was 9.1 BBF, or 400 MMBF, lower than production. Using the available estimates of total US lumber production (east and west) and assuming that lumber inventories have not increased substantially, system-wide estimated hardwood lumber production exceeds estimated consumption. An alternative way of examining this is to estimate apparent demand, which is production minus exports, plus imports, and net changes in inventory. Apparent consumption normally exceeded estimated consumption (Luppold and Bumgardner 2016) if for any reason other than it is nearly impossible to capture all aspects of hardwood lumber use.

Summary and Conclusion

Eastern sawmill employment fluctuated between 2001 and 2005, declined between 2006 and 2010, but has been slowly trending upward since then. Employment in the North Central and South Central regions experienced smaller declines than the Northeast and Southeast regions, but by 2015, none of the eastern regions had regained 2006 employment levels. The number of eastern sawmills has declined in all eastern regions for most of the 21st century. Initially, this decline was associated with the overall decline in the production of hardwood and softwood lumber, which also resulted in a decrease in average employment in these establishments. Since 2014, the number of sawmills has stabilized, while the average employment per sawmill has increased.

Eastern hardwood lumber production followed eastern sawmill employment on regional and subregional levels between 2001 and preliminary estimates for 2008. After 2008, state estimates of hardwood lumber production were no longer reported, and East-wide estimates did not account for the smaller mills that were not surveyed. In 2011, all estimates of lumber production were discontinued as the *Current Industrial Reports, Lumber Production and Mill Stocks* series was halted, the last data year release being 2010.

The discontinuation of USDC estimates occurred during a period when hardwood lumber production was declining to levels last occurring in the early 1960s. In an effort to determine how much hardwood lumber production had declined during the Great Recession and the level of hardwood lumber production since then, estimates were developed using the average PE ratio based on 2001 to 2008 production and employment data for the four eastern regions. When compared with TPO data for the two southern regions, estimates using the PE ratios were higher for 2009, but these two series began to converge by 2011. The most likely cause of the overestimation was the maintaining of key personnel at sawmills with the expectation that the decline in hardwood lumber production was similar to cycles that had been occurring since the early 1970s.

When adjusting the initial estimates of hardwood lumber for the decline noted in the southern TPO data, the low estimate for eastern hardwood lumber production in 2009 was 6.5 BBF. This estimate is consistent with estimates of domestic hardwood consumption, net export, and the apparent liquidation of lumber inventories throughout the hardwood market production and distribution system. This level of production last occurred in the early 1960s, when hardwood sawtimber volumes were a third of the level today. Hardwood lumber production has recovered since the 2009 low point but is still well below mid-2000 levels. However, this level of production still exceeds the 4.8-BBF level published by the USDC (2011), which excluded production at smaller sawmills.

The estimates of hardwood lumber production presented in this study are based on incomplete information. Additional efforts must be made by researchers, state forest products utilization specialists, foresters, forest inventory analysts, and others to develop accurate future estimates of hardwood lumber production. It would be ideal to have estimates of individual species groups, but even estimates of total lumber production would be useful to the federal, state, and private sectors in their planning efforts.

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