Low-grade hardwood lumber production, markets, and issues

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Abstract

Due to a recent downturn in the economy and changes in traditional hardwood markets, U.S. hardwood manufacturers are facing significant difficulties. In particular, markets for low-grade lumber have been diminishing, while increased levels of this material are being produced at hardwood sawmills in the United States. A nationwide survey of hardwood lumber manufacturers was conducted to define the term "low-grade," identify current markets for low-grade hardwood lumber, identify methods currently used and those being considered to develop markets for this material, and determine important factors in the decision to enter a new market for low-grade lumber. The study found that the definition of low-grade is not consistent among U.S. hardwood sawmills and most sawmills sell the majority of their low-grade lumber to a single market. In addition, market profitability and market stability are important factors in considering a new market for low-grade lumber. This information is important in benchmarking industry characteristics regarding low-grade lumber and understanding the issues and needs of hardwood manufacturers.

Annual hardwood lumber production in the United States has been estimated at greater than 13 billion board feet (BBF) and contributes over $730 million to the U.S. economy through employee wages and salaries (Hansen and West 1998, USBC 1999). However, due to recent changes in markets for hardwood lumber and secondary wood products manufactured from hardwood lumber, it is believed that U.S. production has decreased in recent years. A slowdown in the U.S. economy, beginning in the fourth quarter of 2000, affected hardwood manufacturers' ability to profitably saw lumber from logs, which has led to production reductions and mill shutdowns across the United States (Anonymous 2001a, 2001b). These economic concerns coupled with the recent trend in the U.S. furniture industry toward closing production facilities and outsourcing component production to Asian countries have placed considerable pressure on the nation's hardwood sawmills.

Another challenge facing the hardwood industry is a changing raw material base. Paun and Jackson (2000) suggest that there is an "overabundance" of low-value, small-diameter timber in forests in the western United States for which new markets need to be developed. There is evidence that the same trend is developing in hardwood forests in the eastern United States. While a weakened economy has affected sales and profitability among hardwood manufacturers, the industry has also experienced a trend toward lower quality logs, and as a result, an increase in low-grade lumber production (Cumbo 2002). The pains of a weakened economy are felt particularly strongly among mills generating large volumes of low-grade lumber, a product for which profit margins are low and markets are few. Moreover, this material must be sold to ensure overall mill profits.

The pallet industry, traditionally the largest domestic market for sawn hardwoods and the primary market for low-grade hardwood lumber and cants, has experienced an increase in pallet recovery, repair, and reuse. According to Bejune (2001), wood recovery in the pallet industry increased nearly 1.8 BBF from 1995 to 1999, an increase of approximately 80 percent. These increases have resulted in reduced demand of sawn hardwood material among pallet

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manufacturers. Corr (2000) suggested that demand for low-grade lumber in the pallet market could be expected to soften with further increases in pallet recovery, repair, and reuse. Recovered pallets are typically sold at reduced prices compared to new wood pallets (Corr 2000). In addition, the pallet market is increasingly being targeted by substitute materials such as plastic, metals, and wood-based composite products such as plywood and oriented strandboard (Bejune 2001).

The upholstered furniture frame industry has traditionally been recognized as a market for low-grade hardwood lumber as well. However, this industry has recently experienced a change from hardwood lumber to plywood as the primary raw material. Plywood use in furniture frames increased from 31 million ft.^{2} in 1992 to 538 million ft.^{2} in 1999, on a 3/8-inch basis (Cumbo et al. 2001). Reasons for the switch were largely based on economics. Engineered wood products offer a more consistent and uniform material resulting in cost savings throughout the production process (Cumbo et al. 2001).

Railroad crossties represent another traditional market for low-grade hardwoods. Most higher density hardwood species are acceptable for use in railroad ties. Hardwood sawmills produce tie cants, which are then treated with decay-resistant chemicals prior to installation. The most common railroad tie size is 7 by 9 inches (Phelps and McCurdy 1993). Tie cants are sawn from the center portion of the log where defects are most highly concentrated. Therefore, by producing these larger cants for use in railroad ties, the sawmill saves the production costs associated with producing low-value, low-grade lumber.

Wood flooring manufacturers use a lower grade mix of lumber compared to many secondary wood products industries, generally lumber graded No. 1 Common and below (Cumbo 1999). This industry may represent the bright spot among current low-grade hardwood markets. The flooring industry has experienced significant growth in recent years. Wood flooring saw double-digit sales growth in the late 1990s and hardwood lumber consumption increased by 120 percent in the last decade (Hansen and West 1998). However, this industry sector's sales trends follow closely the new housing and repair and remodeling industries, which are strongly affected by the overall economy.

The challenges just outlined emphasize the need to develop, maintain, and diversify markets for low-grade hardwood lumber. To do this, however, information is needed regarding low-grade lumber production, the capabilities of hardwood manufacturers, and current markets for low-grade lumber.

Objectives

Three objectives were established for this study: 1) determine the meaning of low-grade lumber as defined by hardwood manufacturers; 2) identify current markets for low-grade lumber and identify actions currently used or being considered to maintain and develop markets for this material; and 3) identify important factors in considering entry into a new market for low-grade hardwood lumber.

Methodology

Sample development

The population of interest included hardwood sawmills in the United States. A total of 700 companies were surveyed for this study. The sample frame consisted of 390 National Hardwood Lumber Association (NHLA) member hardwood sawmills and 310 non-NHLA member hardwood sawmills. To maximize response rate, the sample frame was assembled using randomly selected respondents and non-respondents from a previous survey of hardwood manufacturers in the United States by the Center for Forest Products Marketing and Management (Bowe 2001). The 285 NHLA member sawmills that responded to the previous study were selected. Another 310 non-NHLA member sawmills that responded to the previous study were selected. Finally, 105 NHLA member sawmills that did not respond to the previous study were randomly selected bringing the total number of companies in the sample frame to 700.

Data collection

Data were collected via a nationwide mail survey. A questionnaire was designed to gather information relative to the study objectives. Questions examined the meaning of "low-grade" according to hardwood manufacturers, markets for low-grade hardwood lumber, value-added activities for low-grade lumber, and important factors in the decision to enter a new market for low-grade lumber.

Members of the faculty at Virginia Tech, scientists from the USDA Forest Service, and members of the hardwood lumber manufacturing industry assisted in questionnaire development and pre-testing. The questionnaire was pre-tested with 10 hardwood manufacturers prior to mailing. Questionnaires were mailed to companies in the sample frame in June 2001. Survey mailings were patterned after the Total Design Method and included an initial mailing followed by a reminder postcard (Salant and Dillman 1994). To achieve the highest response rate possible, this pattern was repeated following the initial mailing.

Survey response

There were 253 usable responses received. Another 131 companies were removed from the sample frame due to companies no longer performing operations relevant to the study or bad addresses, reducing the sample frame to 569 hardwood sawmills. The final adjusted response rate was calculated at 44.5 percent.

Data analysis

Definitions of low-grade lumber were examined using a multiple-choice question format. Various other questions used the multiple-choice format as well. A scaled question, based on a 7-point Likert-type scale, was used to rate the importance of various market factors in deciding to enter new markets for low-grade lumber. This question consisted of an array of factors to which the respondent was asked to rate the importance of each (1 = least important; 4 = moderate importance; 7 = most important). Comparisons were made between industry segments on the scaled question using analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA). Industry comparisons included single facility versus multiple facility companies, comparisons based on lumber grade use (No. 2 Common and below, 3A and below, 3B, and other), and comparisons of company size based on lumber production volume in board feet (BF) (very small, small, medium, large, and very large). In addition, comparisons were made between responding and non-responding

Table 1. — Proportion of respondents producing different lumber grades; multiple categories were selected by respondents.

Grade	No. of respondents	Mean
		(%)
Cants	176	23.5
Other	51	22.3
1C	212	21.7
2C	209	18.6
FAS	188	16.5
Selects	139	10.7
3A	173	9.8
3B	145	9.1

companies using the Mann and Whitney non-parametric test.

Questions regarding company demographics were included to develop a respondent profile and make inferences about the population of interest. Frequency tables and summary statistics were used to analyze demographic data. A 5 percent trimmed mean technique was used in estimating mean per-mill lumber production. The trimmed mean technique was used to reduce the effects of statistical outliers. The range of reported lumber production estimates was greater than 51 million board feet (MMBF). Cross-tabulations were used to compare answers to different questions to identify relationships between respondents' perceptions regarding specific topics. For example, the level of priority placed on finding/developing markets for low-grade lumber was compared to changes in low-grade lumber production over the past 5 years.

Non-response bias

Potential for non-response bias exists when response rates are less than 100 percent. To be sure that significant differences did not exist between survey respondents and non-respondents and that the sample frame was truly representative of the population of interest, a Mann and Whitney non-parametric test was used to test for differences between respondents and non-respondents at a 95 percent confidence level. The Mann and Whitney test was conducted based on evidence of non-normal distribution of data among non-respondents. A total of 45 companies that did not respond to the survey were contacted by phone and asked a series of questions. Questions for which mean values could be calculated were selected for the comparisons. These questions included: 1) the percentage of 2000 total capital expenditure devoted to maintaining and/or developing low-grade lumber markets; 2) importance ratings of four of the eight factors in considering entry into a new market for low-grade lumber; and 3) estimation of total 2000 single facility lumber production.

Test results revealed no significant differences between respondents and non-respondents on five of the six variables tested. However, a significant difference was detected between the two groups on the *market stability* factor. This variable received a higher rating (5.59) among respondents than non-respondents (4.89). This finding indicates that our sample may not be representative of the population of interest (hardwood sawmills) regarding the importance of market stability in the decision to enter a new market for low-grade hardwood lumber. Other "market entry" factors tested included: *market profitability*, *compatibility with operations*, and *competition*.

Results

Respondent demographics

Greater than 65 percent of respondents indicated that their sawmill was a single operation, i.e., not part of a multiple facility company; nearly 35 percent indicated that their operation was part of a multiple facility company. The average sawmill responding to this survey produced approximately 8.0 MMBF of hardwood lumber in 2000. Using a trimmed mean technique to reduce the effect of statistical outliers resulted in a 5 percent trimmed mean of approximately 7.2 MMBF. The median value was calculated at 6 MMBF. The trimmed mean technique eliminated 5 percent of the data on the extreme ends of the distribution, thereby reducing the effect of excessively high and low lumber production estimates on the mean. A 5 percent trimmed mean was calculated for direct comparison with a previous study by the Center for Forest Products Marketing and Management, which estimated annual hardwood lumber production at 6.7 MMBF in 1998 using a 5 percent trimmed mean technique (Bowe 2001). The decrease in production between 1998 and 2000 is most likely the result of the downturn in the U.S. economy, which began in the fourth quarter of 2000. Responses ranged from a low of 8,000 BF to a high of 52 MMBF of hardwood lumber produced in 2000.

Respondents were asked to indicate the volume of lumber of each grade produced at their mill, as a percentage of total hardwood lumber production. Lumber grade categories included: *FAS, Selects, No.1 Common, No.2 Common, No.3A, No.3B, Cants,* and *other.* Survey results revealed that *Cant* production was most common followed by other, No.1 Common, No.2 Common, FAS, Selects, No. 3A, and No. 3B (**Table 1**). Included in the *other* category were: dimension products, railroad ties, pallet grade lumber, blocking and dunnage, frame grade lumber, and specialty products such as fence boards, and trailer decking. A category for FAS-1F was neither included as an option in the question nor was this grade category cited in the *other* category; therefore, it is assumed that respondents included the FAS-1F grade in the *Selects* category, which is not uncommon in the hardwood industry.

To determine the definition of "low-grade" lumber from the hardwood manufacturer's perspective, respondents were asked to indicate what grades of lumber were considered low-grade in their operations. Approximately 37 percent indicated that lumber graded No. 2 Common and below was considered low-grade, while a similar percentage of respondents (roughly 34%) defined low-grade as 3A Common and below (**Fig. 1**). Roughly 21 percent indicated that lumber graded 3B Common was considered low-grade in their operation. Approximately 8 percent defined low-grade as something other than a single lumber grade or category of grades. The most common responses included in the other category were pallet and

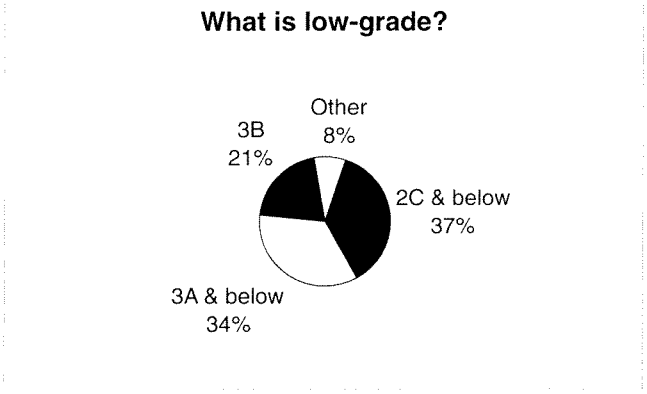

Figure 1. — Low-grade as defined by survey respondents.

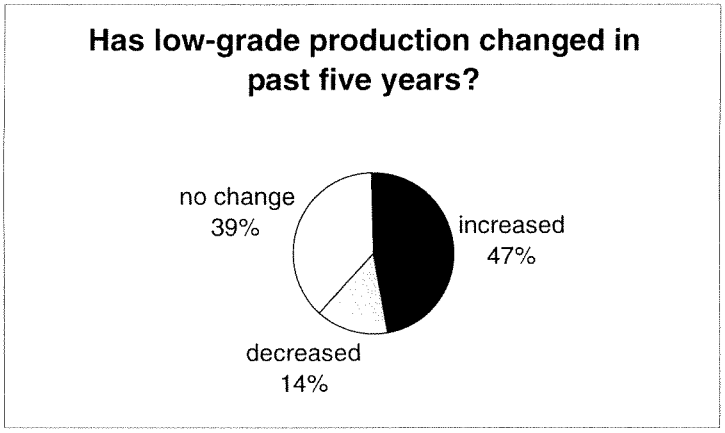

Figure 2. — Five-year change in low-grade production.

Table 2. — Proportion of responding firms involved in different low-grade markets; multiple categories were selected by respondents.

Low-grade market	Mean (%)
Pallets	54.9
Company-owned secondary facility	40.0
Other	33.3
Flooring	29.0
Furniture	21.8
Dimensions	20.6
Railroad ties	20.5
Cabinets	18.4
Upholstered frames	17.6
Millwork	14.2
Packaging/dunnage	12.6
Chipping operation	9.5

railroad tie material. In addition, several companies indicated that their definition of low-grade lumber was dependent upon species.

Respondents were asked to indicate whether they experienced an increase, decrease, or no change in low-grade lumber production in their mill over the past 5 years. Nearly one-half (46.6%) indicated that the level of low-grade lumber production had increased in the past 5 years (**Fig. 2**). Approximately 14 percent indicated that they had experienced a decrease in the level of low-grade lumber production, while approximately 39 percent indicated that low-grade lumber production had remained constant over the past 5 years. Respondents were also asked to estimate the percentage increase or decrease, respectively, noted in their mill in the past 5 years. The average increase in low-grade lumber production, among respondents indicating an increase, was 15.6 percent over the past 5 years. The average decrease, among respondents who experienced a decrease, was calculated at 17 percent.

Markets for low-grade lumber

In an effort to identify the major markets for low-grade lumber and determine the relative size of these markets, respondents were asked to indicate the amount of low-grade hardwood lumber sold to various markets, as a percentage of total low-grade lumber production. Low-grade markets included *pallets, packaging and dunnage, dimension products, railroad ties, upholstered furniture frames, flooring, cabinets, furniture, millwork, chipping operation, company-owned secondary processing facility,* and *other.* The pallet market was the most common market for low-grade lumber, while the chip market was the least common (**Table 2**). The *other* market category included *pallet parts, bushel crates, fence boards, industrial blocking, grading stakes, farm/shop lumber, coal mine timbers, custom sawn boards, construction markets,* and *firewood.*

Of particular interest was the frequency of respondents selling their total low-grade lumber production volume to a single market or to relatively few markets. Approximately 60 percent of respondents indicated that they sold greater than 50 percent of their low-grade lumber in a single market. Among those single markets were pallets, company-owned secondary manufacturing facility, dimension, railroad ties, and flooring.

Respondents were asked whether they had noticed changes in low-grade markets in the past 5 years, e.g., shrinking or expanding markets, price volatility, etc. Responses were nearly equally divided, 47.8 percent answered "no" to this question, while 52.2 percent answered, "yes". Of those respondents answering "yes," several specific changes were

Table 3. — Comparison of percentage of 2000 capital investments dedicated to markets for low-grade lumber versus level of priority on markets, number of respondents (n = 229).

Capital investment as % of 2000 total	Level of priority on low-grade markets			
	Low	Moderate	High	Total
0%	27	51	32	110
> 0% to 5%	4	32	17	53
6% to 15%	5	13	13	31
16% to 50%	0	7	12	19
51% to 90%	1	4	11	16
Total	37	107	85	229

Table 4. — Comparison of change in low-grade production versus level of priority on markets for low-grade, number of respondents (n = 248).

Change in low-grade production, past 5 years	Level of priority on low-grade markets			
	Low	Moderate	High	Total
Increased	16	49	50	115
Decreased	7	19	10	36
No change	16	51	30	97
Total	39	119	90	248

noted. Most often noted was a decrease in orders from furniture frame manufacturers and pallet manufacturers. Other comments indicated that low-grade lumber price volatility had increased, more low-grade lumber was being sold to the flooring and dimension industries, and the overall market for low-grade hardwood lumber had been diminishing recently. Respondents also indicated a need to develop several smaller markets for low-grade lumber as opposed to a single large market, e.g., the pallet market. Several smaller markets for low-grade lumber were cited in the "other" category.

To determine how hardwood manufacturers were responding to changes in low-grade lumber markets, respondents were asked to list actions they had taken to maintain or develop low-grade markets in the past 5 years. The most common responses dealt with enhanced communication with customers, personal sales calls to potential customers, improving product quality (sorting) and services, and offering custom products and services. Other comments included adding full-time marketing and sales positions, investing in equipment to add value to low-grade lumber, and diversifying markets.

Respondents were asked to indicate the level of priority that they placed on maintaining and/or developing markets for low-grade lumber. Three choices were provided: *high, moderate,* and *low.* The highest percentage of respondents (48%) indicated placing a moderate level of priority on markets for low-grade lumber. Respondents were also asked to estimate, as a percentage of total capital investments for 2000, the amount that was dedicated to maintaining and/or developing markets for low-grade lumber. Responses ranged from 0 to 90 percent of 2000 capital investments dedicated to maintaining and/or developing low-grade markets, with a mean estimated at approximately 10 percent. A majority of respondents (71%) dedicated 5 percent or less of their total 2000 capital investments to maintaining and/or developing markets for low-grade lumber, while approximately 7 percent invested greater than 50 percent.

Comparison of capital expenditure versus priority reveals that, in general, companies placing higher priority on low-grade lumber markets also dedicated more resources to this issue than companies placing a low priority on low-grade markets (**Table 3**). Only one company investing greater than 50 percent of 2000 capital expenditures viewed maintaining and/or developing low-grade markets as a low priority. In contrast, over 37 percent of those companies perceiving low-grade markets as a high priority invested 0 percent of 2000 capital expenditures. Nearly 73 percent of companies (27 of 37) perceiving low-grade markets as a low priority and greater than 47 percent (51 of 107) of the moderate priority respondents, respectively, dedicated 0 percent of their total capital expenditure budget for 2000 to markets for low-grade lumber. It is worth noting that roughly 48 percent of total respondents answering this question dedicated 0 percent of their capital expenditure budget to markets for low-grade lumber.

Similarly, a comparison of changes in levels of low-grade lumber production versus level of priority using cross-tabulation reveals that of those companies placing high priority on markets for low-grade lumber, most (56%) had experienced an increase in low-grade lumber production over the past 5 years (**Table 4**). However, as a percentage of all respondents indicating an increase in low-grade lumber production, the majority (56%) perceived maintaining and/or developing markets for low-grade lumber as a moderate or low priority. One might expect the level of priority placed on developing and/or maintaining markets for low-grade lumber to increase with an increase in low-grade production, due to the low profitability associated with sawing this material.

Respondents were asked to rate a list of eight factors in terms of their importance in considering a new market for low-grade lumber (1 = least important; 4 = average importance; 7 = most important). The factors included in the list were: *market profitability, market size, market stability, initial cost to enter market, compatibility with existing operations, competition, market potential,* and *other* (**Table 5**). Mean rating values for all factors were higher than 4, indicating that the factors were of at least moderate importance in the decision to enter a new market for low-grade lumber. *Market profitability* and *market stability* were the highest rated factors at 5.7 and 5.6 respectively, while *market size* (4.3) and *competition* (4.2) were the lowest rated factors. However, there was the possibility of non-response bias noted for *market stability.* In addition, a mean rating of 6.2 was calculated for the *other* factor; however, only nine respon-

Table 5. — Market entry factor importance ratings.

Deciding factor	No. of respondents	Factor rating		
		Mean	Minimum	Maximum
Market profitability	237	5.7	1	7
Market stability	236	5.6	1	7
Compatibility	236	5.4	1	7
Potential	235	5.2	1	7
Cost	232	4.6	1	7
Market size	233	4.3	1	7
Competition	234	4.2	1	7
Other	9	6.2	2	7

Table 6. — Current value-added activities for low-grade lumber performed by sawmills (n = 251).

Value-added activity	Performed
	(%)
Sorting	49.8
Dimension manufacturing	28.7
End coating	21.9
Surfacing	25.9
Edging	23.1
Kiln-drying	23.5
Custom grading	23.1
None	23.1
Other	4.0

Table 7. — Value-added activities currently considered for low-grade lumber (n = 251).

Value-added activity	Considered
	(%)
None	61.4
Dimension manufacturing	10.8
Sorting	6.8
Kiln-drying	5.6
Surfacing	4.8
Custom grading	3.2
Other	2.8
End coating	2.4
Edging	1.6

dents rated this factor. It was not surprising that a high rating was noted for the *other* category as respondents might be expected to highly rate a factor of their choosing. The majority of respondents selecting the *other* factor indicated *credit worthiness* and/or *terms and ease of payment* as important factors in deciding to enter a new market.

Finally, respondents were asked if there were specific species or groups of species for which they had particular difficulty finding feasible markets for low-grade lumber. Exactly one-half of respondents answered "yes" to this question. The four most common species cited were basswood, poplar, gum, and aspen. Other species cited, in descending order, were cottonwood, ash, soft maple, hickory, elm, "softer hardwoods," sycamore, beech, cherry, and willow. Less frequently mentioned were birch, "frame-grade hardwoods," "all species other than oak," hard maple, and buckeye.

Value-added activities

To identify methods by which hardwood manufacturers add value to their products, respondents were asked to indicate value-added activities currently performed at their mill regarding low-grade lumber. The following value-added activities were included: *custom sorting, dimension manufacturing, end coating, surfacing, edging, kiln-drying, custom grading, none,* and *other* (**Table 6**). Nearly one-half (49.8%) of all respondents indicated that they custom sorted low-grade lumber products for their customers, while roughly one-quarter of respondents performed at least one other value-added activity. However, nearly one-quarter of respondents performed no value-added activities. A small percentage (4%) checked the category labeled *other.* Among the value-added activities noted in the *other* category were: *air-drying, building pallets, flooring manufacturing, dipping,* and *precision-end-trimming.*

Similarly, respondents were asked to indicate which value-added activities they were considering for low-grade lumber. Identical value-added activities were used for both questions (**Table 7**). Most respondents (61%) were considering no additional methods of adding value to the low-grade hardwood lumber they produce. Approximately 11 percent were considering *dimension manufacturing* and roughly 7 percent were considering additional *custom sorting.* Conversely, less than 3 percent were considering *end coating*, while approximately 2 percent were considering *edging*. Roughly 3 percent of respondents indicated considering *other* methods of adding value to their low-grade lumber products. Air-drying, railroad tie manufacturing, pallet cant manufacturing, cut-to-size products, grading stakes, moulded products, and pre-cut pallet parts were cited.

Few market opportunities currently exist for kiln-dried low-grade hardwood lumber. Moreover, the inevitable degrade that occurs during the drying process and limited drying capacity at most sawmills causes many manufacturers to view kiln-drying lower grades of lumber as an unattractive alternative. Furthermore, it was hypothesized that sufficient drying capacity might not be available if a market for lower moisture content, low-grade hardwood lumber could be identified. To assess the level of drying capacity that exists at hardwood saw-

Table 8. — ANOVA, market factor mean importance rating comparison.

Market	Mean rating		
	Multiple[a]	Single[b]	Significance level
Market profitability	5.4	5.8	0.058
Market size	4.5	4.1	0.083
Market stability	5.4	5.7	0.242
Initial cost to enter market	4.3	4.8	0.048[c]
Compatibility with operations	5.3	5.4	0.699
Competition	4.2	4.2	0.909
Market potential	5.3	5.1	0.353

[a] $n = 81$.
[b] $n = 153$.
[c] Weak significance.

mills, respondents were asked to indicate if they kiln-dried low-grade lumber and if they had sufficient capacity in the form of yard, pre-dryer, and/or kiln capacity to dry low-grade lumber produced at their mill. The responses were overwhelmingly "no." Roughly three-quarters (74.8%) of respondents indicated that they did not kiln-dry low-grade lumber and approximately 63 percent indicated that they did not have the necessary drying capacity to dry the low-grade lumber that they produce.

Industry comparisons

In assessing markets for low-grade lumber it is important to understand differences among industry segments regarding important market attributes, e.g., market profitability. Important factors in deciding to enter a new market for low-grade lumber were previously discussed. To determine if differences existed between segments of the hardwood manufacturing industry, various segments were compared on these factors. The segments included single and multiple facility companies, company size based on production volume, definition of "low-grade," and respondents versus non-respondents. The factors included: *market profitability, market size, market stability, initial cost to enter market, compatibility with existing operations, competition, market potential,* and *other.* Factors were rated on a 1 to 7 scale (1 = least important; 4 = average importance; and 7 = most important).

Using ANOVA at a 95 percent confidence level to test for differences between single facility and multiple facility operations on the above factors, a significant difference was detected on the *cost to enter market* variable (**Table 8**). However, the significance level was weak, indicating that single facility operations may perceive the *cost to enter market* variable as more important than multiple facility operations in deciding to enter a new market for low-grade lumber. This finding may be expected as multiple facility companies might be expected to have more working capital compared to smaller single facility operations.

MANOVA was used to test for statistically significant differences on the market factors among respondents based on 2000 production volume, at a 95 percent confidence level. Production volume ranged from 8,000 BF to 52 MMBF of hardwood lumber produced in 2000. For comparison purposes, responses were categorized into very small, small, medium, large, and very large producers. Production of less than 2 MMBF in 2000 was considered to be very small, 2 to 5 MMBF was small, greater than 5 to 15 MMBF was medium, greater than 15 to 25 MMBF was large, and production greater than 25 MMBF was categorized as very large.

Interestingly, no significant differences were detected between groups on any of the eight market factors: *market profitability, market size, market stability, initial cost to enter market, compatibility with existing operations, competition, market potential,* and *other.* In other words, mill size (production volume) did not affect importance ratings of the eight market factors.

MANOVA was also used, at 95 percent confidence, to test for differences among respondents based on their definition of "low-grade." The test groups were No. 2 Common and below, 3A and below, 3B, and other. No significant differences were detected between groups for any of the eight market factors.

The sample frame was assembled using randomly selected respondents and non-respondents from a previous survey of hardwood manufacturers by the Center for Forest Products Marketing and Management (Bowe 2001). In this analysis, respondents were grouped according to their response or non-response to the previous study and compared on several factors. Comparisons were made between groups on percentage of 2000 capital investment in low-grade markets, 2000 hardwood lumber production, and the eight market factors listed previously. No significant differences were detected on capital investment and production volume between groups using ANOVA at a confidence level of 95 percent. However, significant differences were detected on all eight market factors, using ANOVA at 95 percent confidence.

After depicting the data graphically, it was determined that the data obtained from non-respondents appeared to be heavily skewed toward the low end of the distribution. Therefore, a Mann and Whitney non-parametric test of the means was used to test for significant differences. Using the Mann and Whitney test, no significant differences were detected between groups on the eight factors at 95 percent confidence. Since the assumption of normality was violated, the Mann and Whitney test would have a higher validity; however, the reader should use caution in making inferences regarding the eight market factors as significant differences were detected on all eight factors using ANOVA.

Open-ended responses

The final question on the questionnaire asked the respondent if there was anything else he/she wished to share concerning low-grade hardwood lumber. Fifty-five responses were received. No prevailing comment or idea was identified among responses; however, many indicated that they were generating either no profit or negative profit from sawing low-grade lumber. Several indicated that they had experienced a decrease in log diameter, they expected to see an increase in low-grade production in the future, and that low-grade lumber represented a "marketing mystery" to them. In addition, several respondents expressed concern regarding competition from other materials and

foreign producers, specifically China and Canada. Finally, several comments stressed the importance of strong relationships with customers and a focus on customer service attributes to be successful in the hardwood lumber business.

Summary and conclusions

Based on the study results, no prevailing definition for "low-grade" could be identified among hardwood manufacturers. No single grade was cited with sufficient frequency to determine a definition for low-grade hardwood lumber. Similar percentages of respondents defined low-grade as No. 2 Common and below and 3A Common and below, while a smaller percentage of respondents identified low-grade as 3B only.

The level of low-grade lumber production has increased among U.S. hardwood manufacturers in recent years; however, respondents placed relatively low priority on maintaining and/or developing markets for low-grade hardwood lumber. In addition, respondents invested relatively little in maintaining and/or developing markets for low-grade lumber. Finally, the majority of respondents were not considering any additional value-added activities regarding low-grade lumber at the time of this study. However, it should be noted that many responding companies were already involved in some value-added activity at the time of this study.

The majority of study respondents indicated selling most of their low-grade lumber to a single market. In light of the recent increases in recycling and recovery in the pallet industry and changes in the upholstered furniture frame industry, a lack of market diversity for low-grade lumber could be risky. Furthermore, study results revealed that *market stability* and *market profitability* were important factors in deciding to enter a new market for low-grade lumber. This may be the result of aforementioned recent changes in traditional low-grade markets. *Market size* and *competition* were of less importance, while *initial cost to enter the market* may be more important to single facility manufacturers compared to multiple facility manufacturers.

While several respondents indicated they were sawing low-grade lumber at zero or negative profit, a number of manufacturers were investigating value-added low-grade lumber markets other than traditional markets such as pallets and upholstered furniture frames. Smaller markets included grading stakes, fence boards, international flooring markets, construction markets, farm/shop lumber, manufactured pallet parts, custom sawn boards, and mine timbers. A trend toward smaller and more diversified markets for low-grade hardwood lumber may develop as a result of the changes in larger, more traditional markets for this material.

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