C I N T R A F O R

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117

Positioning and Market Analysis of the US Decking Materials Market: A Perceptual Mapping Approach

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Executive Summary

Overview

The demand for decking materials is driven by several factors, including the macroeconomic environment, demographics, construction expenditures, and the repair and remodel sector. In addition, competition within the decking market has recently been significantly altered by regulatory constraints on the forest products industry that have restricted harvest levels, by increasing imports of softwood lumber and by expanding competition from non-wood substitute materials. These last two factors are likely to have the greatest impact on the specification and use of decking materials in the mid to long term as the markets adjust to the changing regulatory environment and changing consumer perceptions and preferences. CINTRAFOR has been collecting market information on the material usage trend in the U.S. deck building industry since 1995. This report will present an analysis of the material usage trends and practices in the decking materials market. Further this report will provide a comprehensive product positioning and marketing analysis of the major decking materials in the US.

An interactive web-based survey was used to collect the data and information presented in the report. Sufficient care was given to ensure that the respondents of the survey had significant deck building experience, hence, only those deck builders who had built more that 5 decks over the past two years were allowed to take the survey. A total of 372 qualified respondents completed the survey, representing 44 states and providing representation across all regions of the US. The number of residential decks built by the respondents in 2008 ranged from 1 to 250, with more than 60% of the respondents building between 3 to 8 decks. A substantial number of respondents (12% of the respondents) indicated that they built more than 20 decks in 2008.

US Decking Market

With the decline in US housing starts in 2007 and 2008 the focus of the deck building industry has shifted away from new decks for new houses. This study shows that the primary revenue generator for the US decking industry in 2008 was repair and remodel (approximately 44%) closely followed by building new decks on existing houses (approximately 42%). Under the present scenario, constructing new decks in new homes only marginally contributes (approximately 14%) to the overall revenue of the US decking industry. This trend is more or less consistent across all the regions of the country with the repair and remodeling projects and deck construction in existing houses strongly dominating the industry's revenue generation. This result confirms that when homeowners live in their houses longer they tend to invest in remodeling their houses; remodeling existing decks or installing new decks has traditionally been important aspects of renovating and remodeling houses. Moreover, such a trend also indicates that the deck building industry is at least partially insulated from the housing downturn.

The survey results reveal that the size of the decks built in the US have not changed significantly since a previous survey conducted by CINTRAFOR in 2003, averaging 438 square feet. However, the average unit construction cost of decks built in the US has increased substantially from $13.50 per square feet in 2003 to $18.62 in 2008. Regional differences in the unit construction cost were also observed in the study. The average unit construction costs of decks built in the Northeastern and Western regions were approximately $20 per square feet, whereas, the average unit construction costs of decks built in the Southern region of the country were approximately $16 per square feet. Finally, the average cost of decks built in the Western region (approximately $9,533) was significantly higher than the national average ($7,319).

Decking Material Usage Trends

The market for residential decking materials in North America has become increasingly competitive over the past decade. Past studies have indicated that wood plastic composite decking (WPC) and plastic

lumber (PVC) are increasingly replacing treated softwood lumber and naturally durable timber species (i.e., redwood, western red cedar and tropical hardwoods) in deck building applications. Our 2009 survey results indicate that this trend of gradual market displacement of naturally durable timber species and treated softwood lumber decking materials has continued. Over 66% of the respondents surveyed indicated that they have increased their usage of WPC and 37% of the respondents increased their usage of PVC between 2006 and 2008, with less than 10% reporting that they had decreased their use of WPC and PVC. In contrast, a high percentage of respondents indicated that they have decreased their usage of pressure treated lumber (31%), western red cedar (36%) and redwood (35%) while less than 20% reported increasing their use of these materials.

The deck market can be segmented into the three main end-use applications; deck substructure, deck surface, and rails/accessories (benches, stairs, planters, etc). It is important to note that only 59% of the total demand for decking materials (based on value) is derived from the construction of the primary substructure and deck surface. The remaining demand can be attributed to deck rails and accessories, suggesting that overall demand for a specific decking material may be influenced to a substantial degree by the availability of rails and accessory products manufactured from the same material. Growth in both of these market segments is expected to be strong. While pressure treated lumber (PTL) remains the dominant material used in substructure applications, with a market share over 80%, PTL only has a 30% share of the national deck surface market. WPC is now the market leader in deck surface applications across all regions of the US, with the exception of the South where almost 40% of deck surfaces were still built using PTL. In contrast, only about 10% of the deck surfaces built in the western US used PTL and WPC has emerged as the market leader with a 34% market share. The western US is also the region with the greatest use of naturally durable wood decking, perhaps reflecting the greater availability of these products. Plastic decking made its greatest inroad in the northeast where almost 18% of deck builders reported using this product.

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Review of the Literature on the US Decking Market

Introduction

The demand for decking materials is driven by several factors, including the macroeconomic environment, construction expenditures, residential housing starts, and repair and remodel expenditures. In addition, competition within the decking and fencing markets has been significantly altered by regulatory constraints on the forest products industry and competition from substitute materials. These last two factors are likely to have the greatest impact on the specification and use of decking materials in the mid to long term as the markets adjust to the changing regulatory environment and changing consumer preferences. This report explores the influence of these factors on the demand for decking materials in the residential, non-residential, public and non-building segments of the construction industry.

Construction Industry Expenditures

Construction expenditures are the primary driver of demand for decking materials, Figure 1. Construction of new residential and non-residential buildings, as well as additions, replacements and repairs to existing structures, directly generates demand for decking materials. Finally, expenditures on public facilities such as public marina, port, park and private dock structures also influence the demand for decking materials.

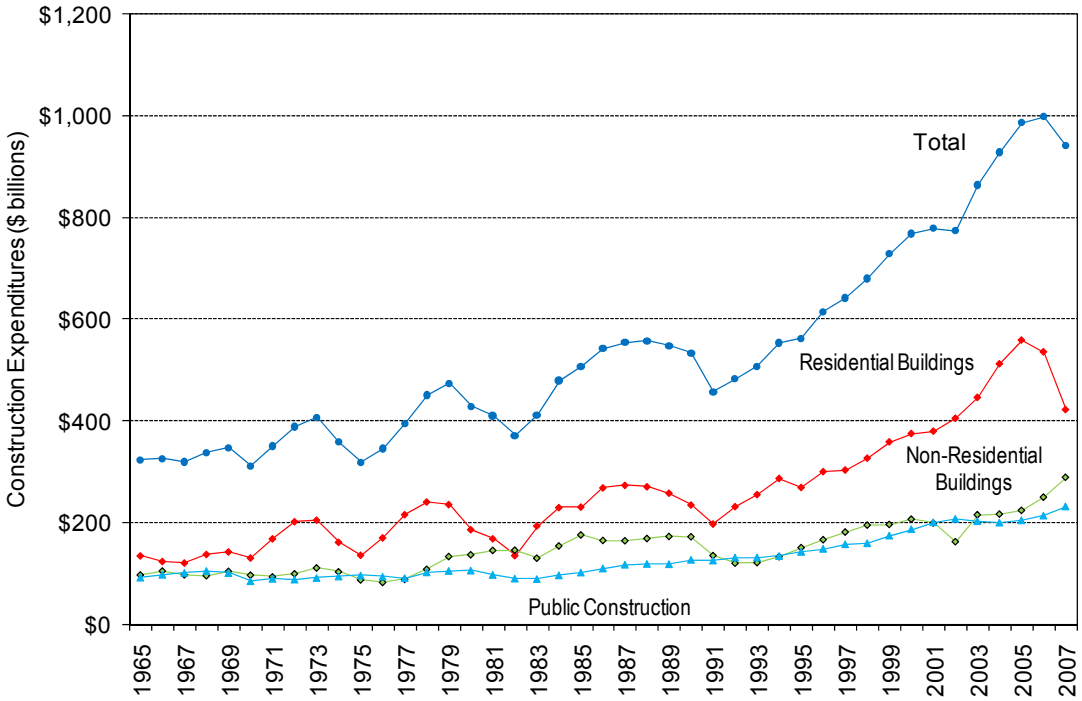


Figure 1. Real construction expenditures, by type, in 2000 dollars, 1965-2007.

Source: US Census Bureau, Construction Statistics, 2008 (http://www.census.gov/const/C30/c30_hist.html)

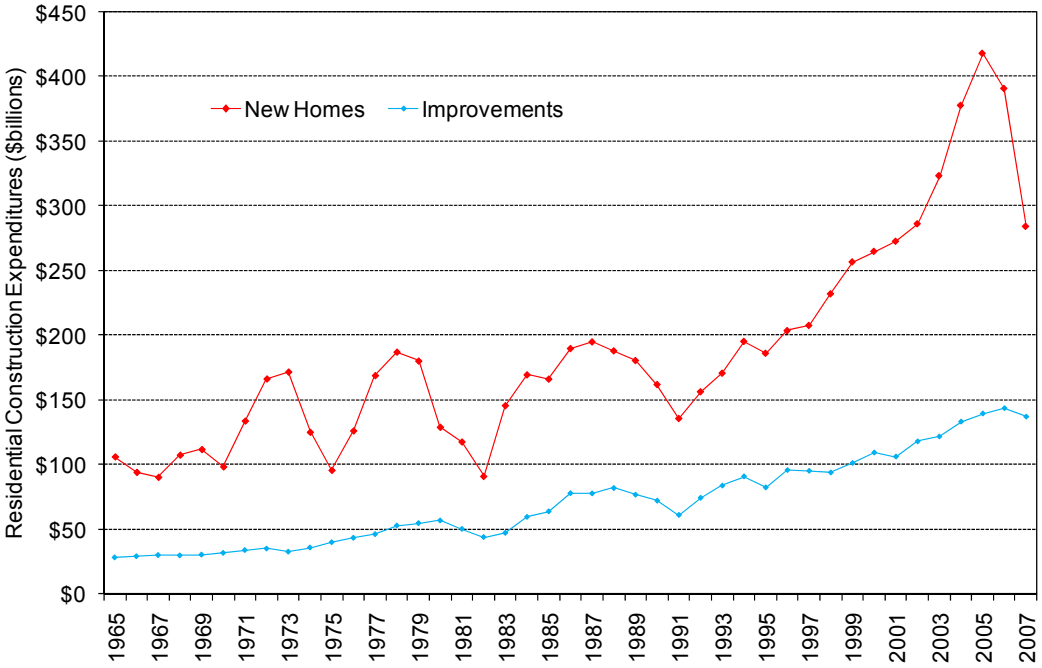


Figure 2. Real construction expenditures on new homes and residential improvements, 1965-2007.
Source: US Census Bureau, Construction Statistics, 2008 (http://www.census.gov/const/C30/c30_hist.html)

Real expenditures in the construction sector increased substantially over the period 1996-2006, despite modest declines in 2001 and 2002, Figure 1. This trend was driven by a decade of strong growth in the residential construction sector which was unaffected by the short recession in 2001 or the slow economic growth in 2002 and the first half of 2003. Total construction expenditures more than doubled from $457 billion in 1991 to $997 billion in 2006. Residential construction expenditures led the way over this period jumping from $231 billion in 1991 to $558 billion in 2005, Figure 2. However, this explosive growth ended in 2005-2006 as the property bubble burst and mortgage credit dried up. Between 2005 and 2007, total construction expenditures dropped by 5.7% while private residential construction expenditures dropped by 24.4% with a steeper decline occurring in 2008 (although the final 2008 data was unavailable for this report). Expenditures for residential improvements were less affected by the housing crisis, although they also suffered a modest decline in 2007 (with a further decline forecast in 2008).

Residential Construction Sector

The number of new housing starts is one of the most important indicators of demand for decking materials. A recent market research report estimated that in 2002 over 62% of the total demand for decking materials was generated within the residential construction sector, including both new construction and repair and replacement activities by homeowners (Freedonia 2002).

Housing Stock and Existing Home Sales

It was estimated in the National 2001 American Housing Survey that the housing stock in 2001 was 128.4 million compared to 86 million units in 1980. The change is housing stock has varied substantially over the various period of the Housing Survey. For example, the average annual increase in the housing stock over the period 1980-1983 was 2.5 million units. Annual changes in the housing stock for subsequent periods were 2.3 million units (1984-1987), 0.63 million units (1987-1990), 0.67 million units (1990-1993), 1.45 million units (1993-1997), 1.68 million units (1997-2001). However, none of these previous periods compares with the huge annual increase of 7.93 million units that occurred between 2002 and 2006.

While analysts often closely track the number of new homes built in the US as a proxy for the demand for building materials, they tend to pay less attention to the number of existing home sales. However, existing home sales exert a much stronger influence on the demand for decking materials than does the construction of new residential homes. For example, in 2002 it is estimated that 86.3% of the demand for decking materials and was attributed to repair and remodel activities by homeowners (Freedonia 2002).

This is due to several factors which work together to influence the demand for decking materials. First, the number of existing homes sold annually exceeds the number of new homes built by a factor of approximately 5-6, Figure 3. Second, home owners preparing to sell their homes often invest in improvements, including new decks, that can increase the sale price of the house or improve the sales prospect. Finally, buyers of existing homes often invest significant amounts of money in improvements during their first few years in the house. Real estate sales statistics indicate that existing home sales have increased at a much faster rate than have new home construction. During the period 1991-2005, the number of existing homes sold annually increased from 3.2 million to 7.1 million units while new home sales increased from 509,000 to 1,283,000 homes, although existing home sales fell to 4.9 million in 2008 and new homes sales fell to 483,000 (its lowest level since 1982).

New Home Construction

The residential construction sector continued to defy the economic trends through 2005 until the housing crisis caused housing starts to plummet between 2006 and 2008, Figure 4. The continued strong performance of the residential construction sector gave strong support to the idea that residential housing starts are much more sensitive to mortgage rates than they are to other general measures of economic performance. With mortgage rates hovering at historic lows, home builders continued to ignore the anemic performance of the economy and housing starts in 2002 and 2003 exceeded 1.8 million units. In addition, the size of the average house continued to increase, rising from approximately 1,500 square feet in 1980 to almost 2,259 square feet in 2006 before dropping to 2,153 square feet in 2008.

New home construction is another, albeit somewhat less important, driver of demand for decking materials for two reasons. First, the number of new housing starts is significantly lower than the number of existing homes sales. Second, the number of new homes that are sold with an attached deck has been declining overall while the number of new homes that are sold with a patio has been increasing. In general, it can be assumed that whereas most decks are built using wooden building materials, the vast majority of patios are built with concrete or cement. Census statistics indicate that while the number of new homes built with decks declined from 37% in 1992 to 29% in 2002, the number of new homes built with a patio increased from 37% in 1992 to 44% in 2002. Overall, the percentage of new homes built with either a deck or patio (or both) remained relatively stable over the past decade at approximately 74%.

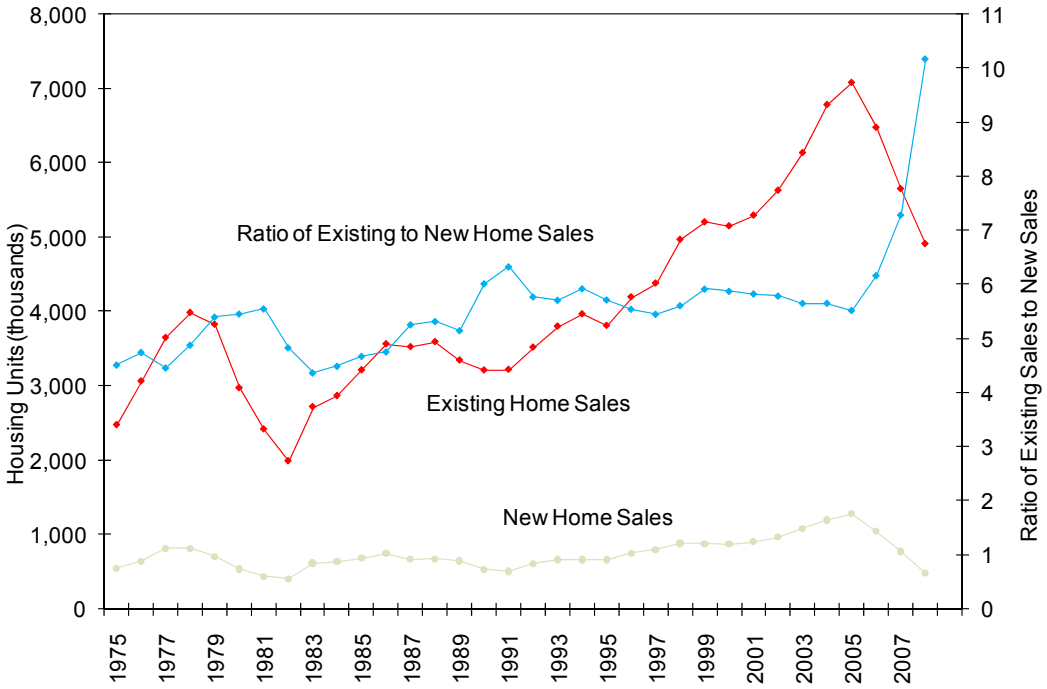


Figure 3. Comparison of new home and existing home sales, 1975-2008.

Source: US Census Bureau, Construction Statistics, 2008. (http://www.census.gov/const/startsan.pdf) and National Association of Realtors 2008

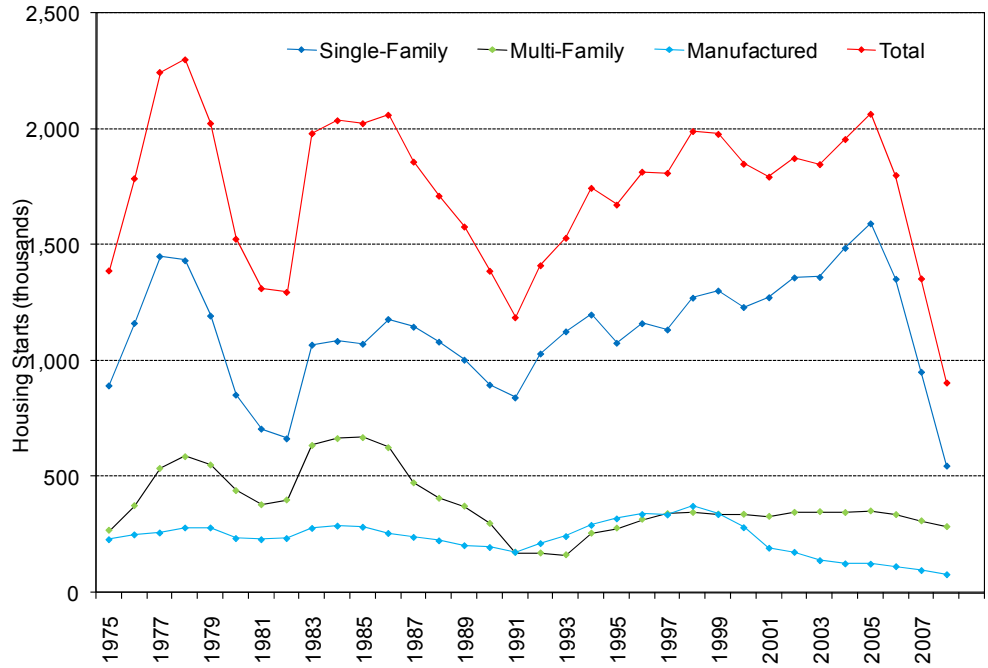


Figure 4. Housing starts by type, 1975-2008.

Source: US Census Bureau, Construction Statistics, 2008 (http://www.census.gov/const/startsan.pdf)

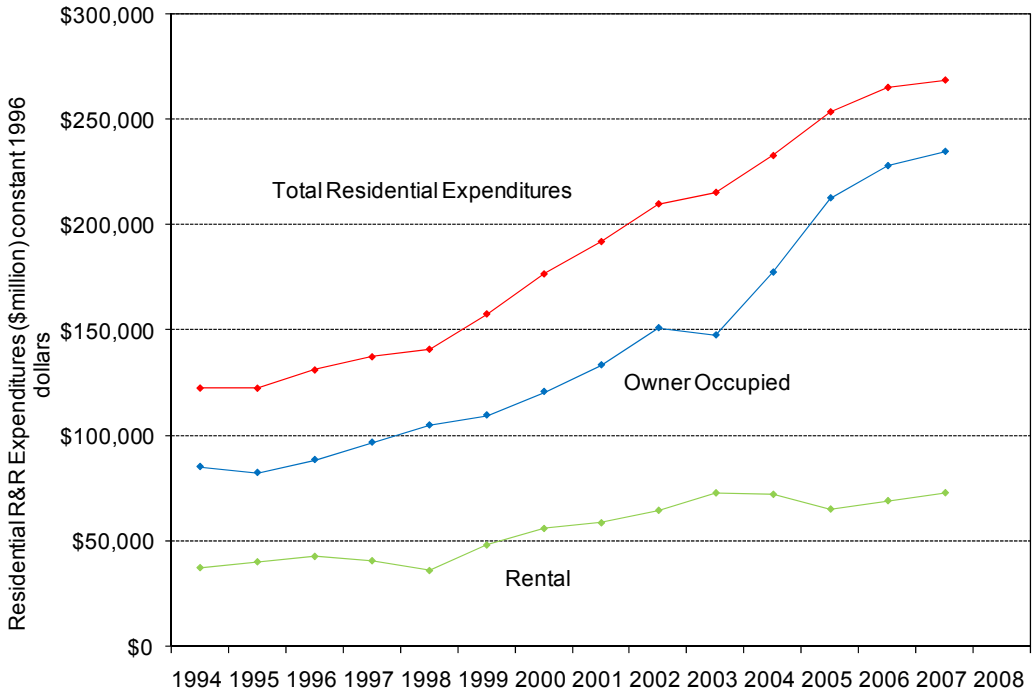


Figure 5. Total repair and replacement expenditures within the residential housing sector.
Source: www.census.gov/const/C50/histtab2.pdf

Repair and Replacement Expenditures

As noted previously, the single most important driver of demand for decking materials is repair and replacement projects by homeowners, Figures 5 and 6. This category includes the following types of construction projects: repair (improvement) of an existing deck, replacement of an existing deck, expansion of an existing deck, and the addition of a new deck to an existing home. Construction census statistics indicate that total improvement expenditures on residential structures increased from $122.8 billion in 1994 to $226.4 billion in 2007, an 84.4% increase, Table 1. The largest portion of residential improvement expenditures, approximately 77%, occur in owner occupied properties as opposed to rental properties, and this disparity has grown substantially since 2003, Figure 5.

Expenditures for decks represent a relatively small percentage of total residential improvement expenditures. Total expenditures on these types of projects in 2007 was $10.5 billion, or just 4.7% of total improvement expenditures, although this ratio was up substantially from the 3.1% recorded in 1994, Table1. In 2007, improvement expenditures totaled $5.0 billion for decks and $5.5 billion for patios and terraces. Over 77% of these expenditures were attributed to construction activities on owner occupied properties. Total improvement expenditures on these projects increased by over 98% between 1994 and 2007, a clear indication that homeowners have substantially increased their spending on outdoor living areas.

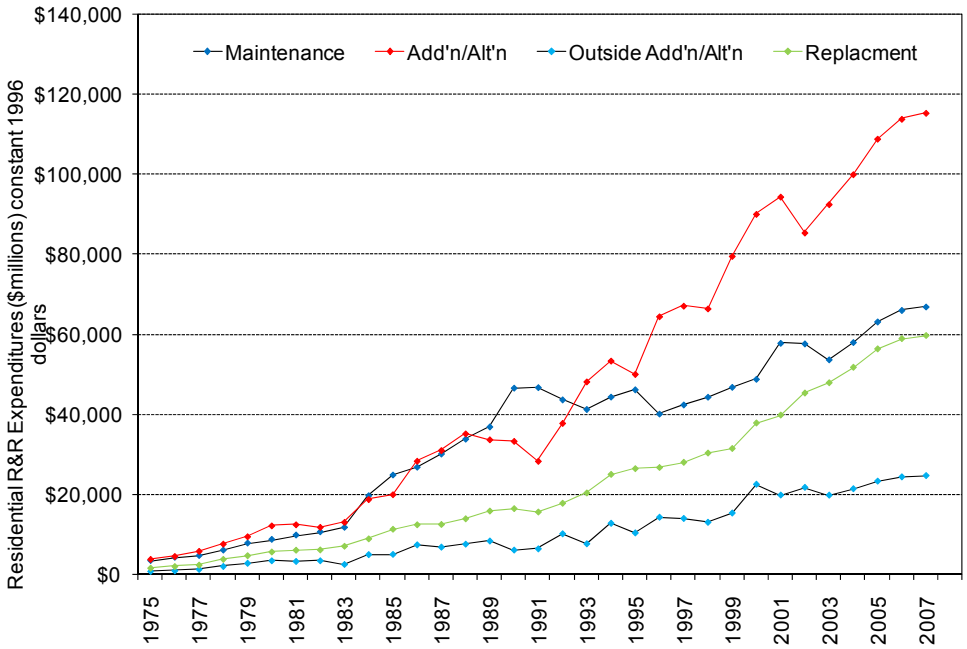


Figure 6. Expenditures for residential improvements and repairs, 1975-2007.

Source: www.census.gov/const/C50/histtab2.pdf

Table 1. Residential repair and renovation expenditures in 1996 dollars ($millions).

	1994	1995	1996	1997	2001	2002	2003	2004	2005	2006	2007
Total	137,584	141,180	157,905	176,839	192,158	173,324	176,899	198,556	215,030	228,207	226,359
Decks	3,899	2,232	4,525	3,586	2,150	3,689	4,193	2,345	3,408	3,503	5,041
Patios	1,398	725	877	1,857	1,821	1,090	3,083	3,685	6,417	5,219	5,475
% Owner-Occupied	70.3%	74.3%	69.5%	68.4%	69.5%	70.1%	67.8%	72.2%	77.3%	77.9%	77.0%

Source: http://www.census.gov/const/C50/table_s1_o.pdf

US Softwood Lumber Supply

Softwood Lumber Production

US softwood lumber production has been historically correlated to housing starts to a surprisingly high degree, Figure 7. However, in the mid to late 1980s two factors came into play that reduced the linkage between housing starts and softwood lumber production. The first of these factors had to do with the rapid expansion of the repair and remodel market in the US. The second factor was supply-related and was caused by the timber harvest reductions in the US west that resulted from federal and state regulatory decisions to protect endangered species habitat (e.g., spotted owls) in old-growth forests.

The impact of the first factor was to reduce the impact of the economic cycle on softwood lumber demand. Historically, softwood lumber production plunged when housing starts declined during slowdowns in the US economy. However, the emergence of the repair and remodel market, and particularly the rapid expansion of the large home centers that cater to this market segment, reduced this dependence and helped to buffer the softwood lumber industry from the declines in housing starts, Figure 8. In addition, this new market segment helped to push the demand curve for softwood lumber outward faster than the US sawmill industry could expand, leading to increased imports. As a result, softwood lumber consumption hit records levels throughout the late 1990s and up until 2005, totaling 64.3 billion board feet in 2005. At the same time, softwood lumber production expanded to 40.5 billion board feet while softwood lumber imports reached a record 24.7 billion board feet. However, the housing crisis saw softwood lumber production dropped by 23.7% to 30.9 bbf in 2008, while consumption dropped by 30.9% to 44.3 bbf and imports dropped by 41.1% to 14.5 bbf (their lowest level since 1992).

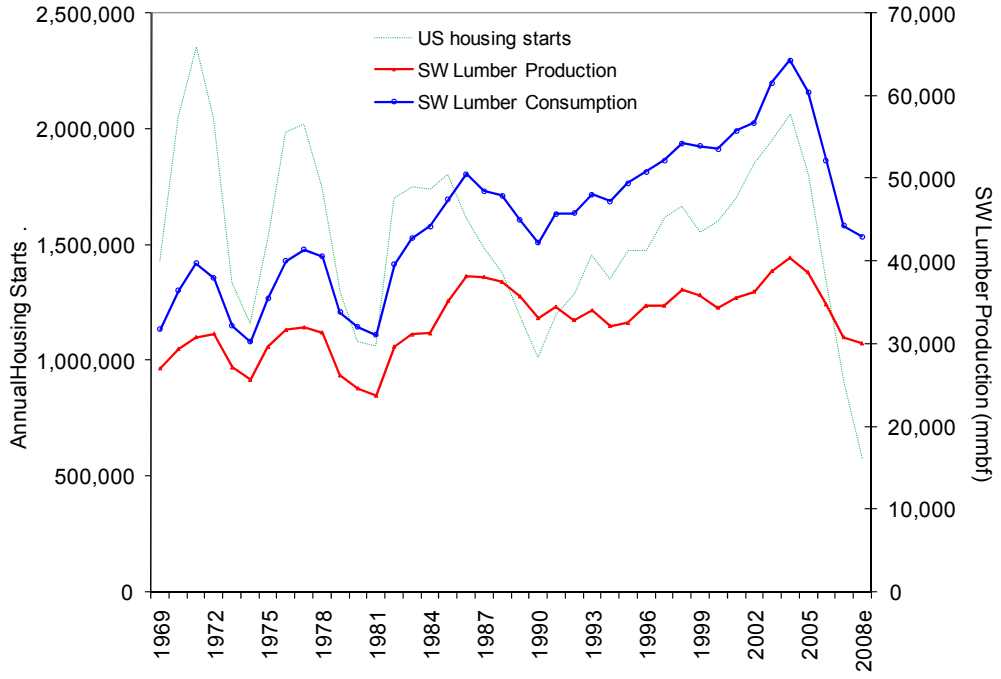


Figure 7. Trends in housing starts, softwood lumber consumption and production, 1970-2008.
Source: WWPA Annual Yearbook, various years

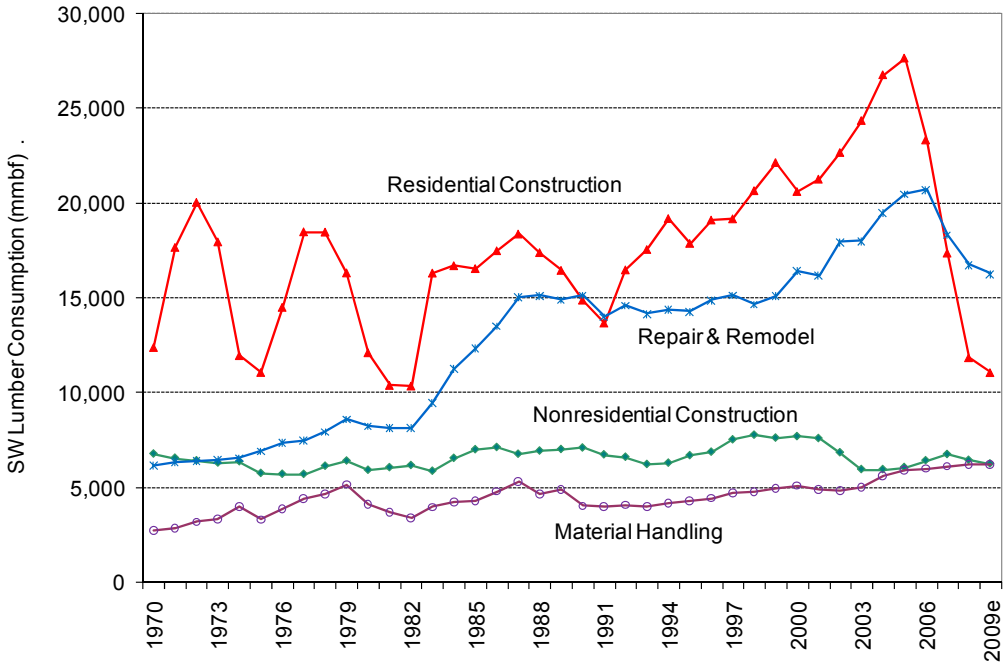


Figure 8. Softwood lumber consumption, by end-use market, 1970-2009e.

Source: WWPA Annual Yearbook, various years

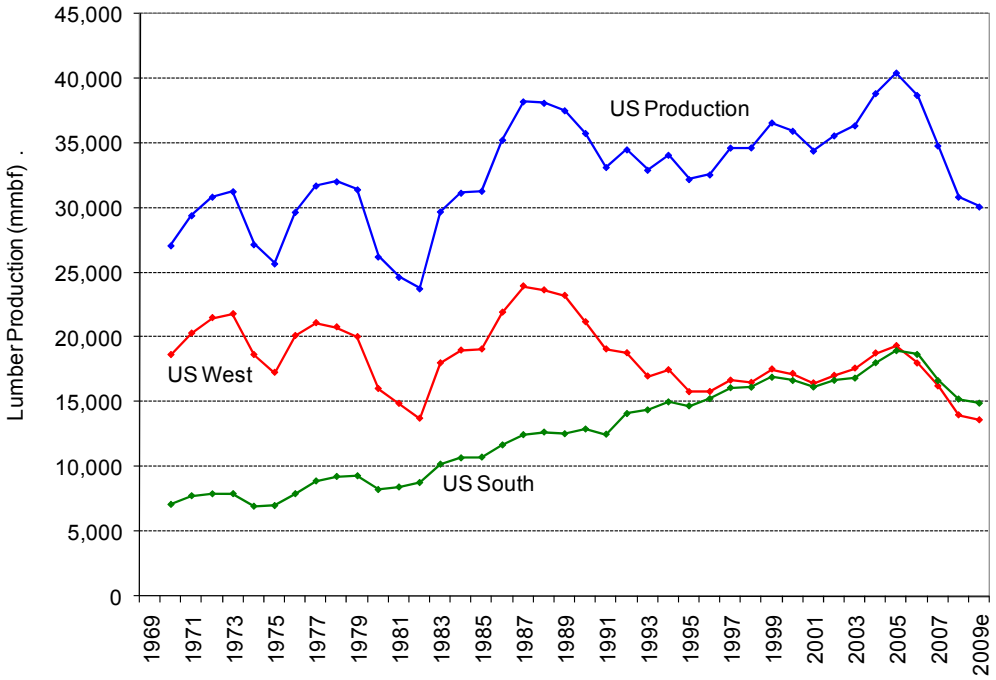


Figure 9. US softwood lumber production, by region, 1970-2009e.

Source: WWPA Annual Yearbook, various years

The second factor that impacted the US softwood lumber industry was the decision in early 1990 to list the spotted owl as an endangered species and prohibit virtually all timber sales in federal and state old-growth forests in Washington and Oregon. While this decision had a devastating impact on the western sawmill industry, it provided an opportunity for sawmills in the US south to expand their production to take advantage of the increasing demand for softwood lumber in the US, Figure 9. The net result of this policy decision was that the western share of US softwood lumber production plummeted from 61.8% in 1989 to just 44% in 1994. However, shutdowns of older, less efficient western mills and investments in newer small diameter sawmilling technology have increased the efficiency of western sawmills and allowed them to increase their lumber production and increase their share of US softwood lumber production to 46.6% by 2002, which they have maintained through 2008. Despite this, US sawmills have been unable to increase their production capacity at the same rate as consumption has increased, resulting in increasing imports of softwood lumber throughout the 1991-2002 period.

The three largest producers of softwood lumber in the US west are Oregon, California and Washington. While timber harvest restrictions in state and federal forests caused softwood lumber production to decline in all three states during the first half of the 1990s, by the mid-90s both Washington and Oregon had begun to expand their production of softwood lumber. In contrast, softwood lumber production in California continued to decline through 2002 before picking up from 2003-2005. Overall, softwood lumber production in Oregon, Washington, and California has been increasing since the mid-1990s, although it is still well below the volumes produced in the late 1980s. However, softwood lumber production in all three states began declining in 2006 as a result of the housing crisis. Between 2005 and 2007, softwood lumber production dropped by 14.1% in California, by 16.9% in Oregon and by 16.9% in Washington.

The primary softwood species used to build decks include redwood, western red cedar and southern yellow pine (preservative treated). Redwood lumber production is limited to the state of California and has been declining since 1988, dropping to just 434 million board feet in 2007. Similarly, western red cedar lumber is primarily produced in the coastal region of Washington, although small volumes are produced in western Oregon and western Washington. The production of western red cedar lumber, while variable, has remained relatively constant in the 600-700 million board foot range since the early 1980s, although it dropped to just 505 million board feet in 2007. In contrast, the production of southern yellow pine lumber has continued to increase since the early 1970s, reaching a volume of almost 19 billion board feet in 2005 before declining to just under 17 billion board feet in 2007. It is important to note that only a portion of this production is treated for use in decking applications.

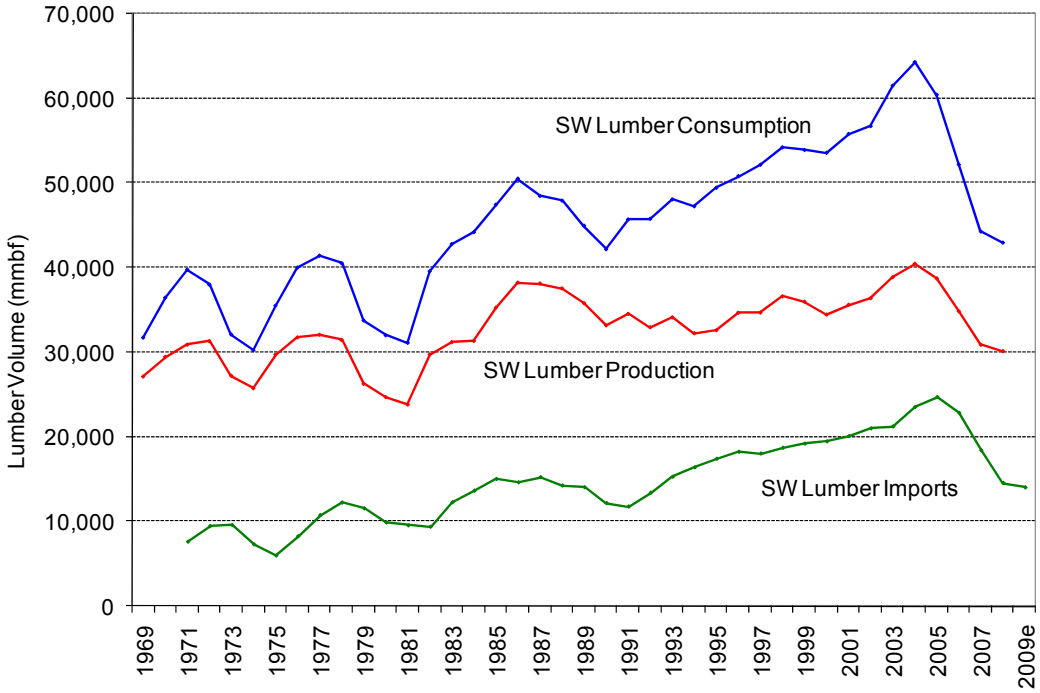


Figure 10. US consumption, production and imports of softwood lumber, 1970-2009e.
Source: WWPA Annual Yearbook, various years

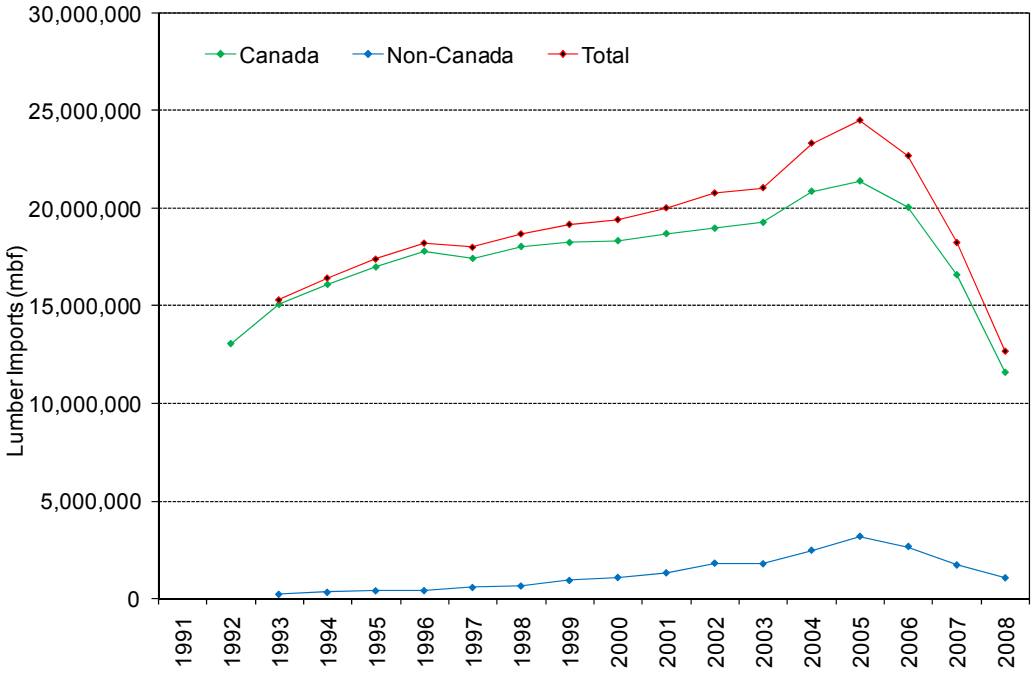


Figure 11. US imports of softwood lumber from Canada and other suppliers, 1991-2008.
Source: WWPA Annual Yearbook, various years

US Softwood Lumber Imports

As noted earlier, while US softwood lumber consumption jumped from 42.2 billion board feet in 1992 to 64.3 billion board feet in 2005 (a 52.4% increase), the ratio of US softwood lumber production to consumption actually declined from 78.5% in 1992 to 64.0% in 2006, although it subsequently increased to 69.7% in 2008, Figure 10. The growing gap between consumption and production was filled by increased softwood lumber imports, the vast majority of which originated from Canada, Figure 11 and 12. As imports of softwood lumber have increased in response to growing demand in the US, these imports have had the net effect of moderating softwood lumber prices in the US.

The strong demand for softwood lumber in the US attracted the attention of a number of non-traditional suppliers around the world. With weak demand for softwood lumber in many countries, some of these suppliers began to export softwood lumber into the US, Figure 13. Between 1999 and 2005, imports of softwood lumber from non-Canadian suppliers increased from 925 million board feet to 3.2 billion board feet, a 246% increase. The crash of the housing market has undermined softwood lumber prices and as a result, imports of softwood lumber from non-Canadian sources dropped to just 1 billion board feet. Interestingly, while the bulk of softwood lumber imports into the US was non-structural boards (primarily from NZ and Chile), the increased demand for structural lumber led many European sawmills to acquire grade stamp approval from US softwood lumber grading agencies. This trend resulted in the number of European sawmills qualified to manufacture structural lumber for the US market increasing from 17 to 68 between 1999 and 2006.

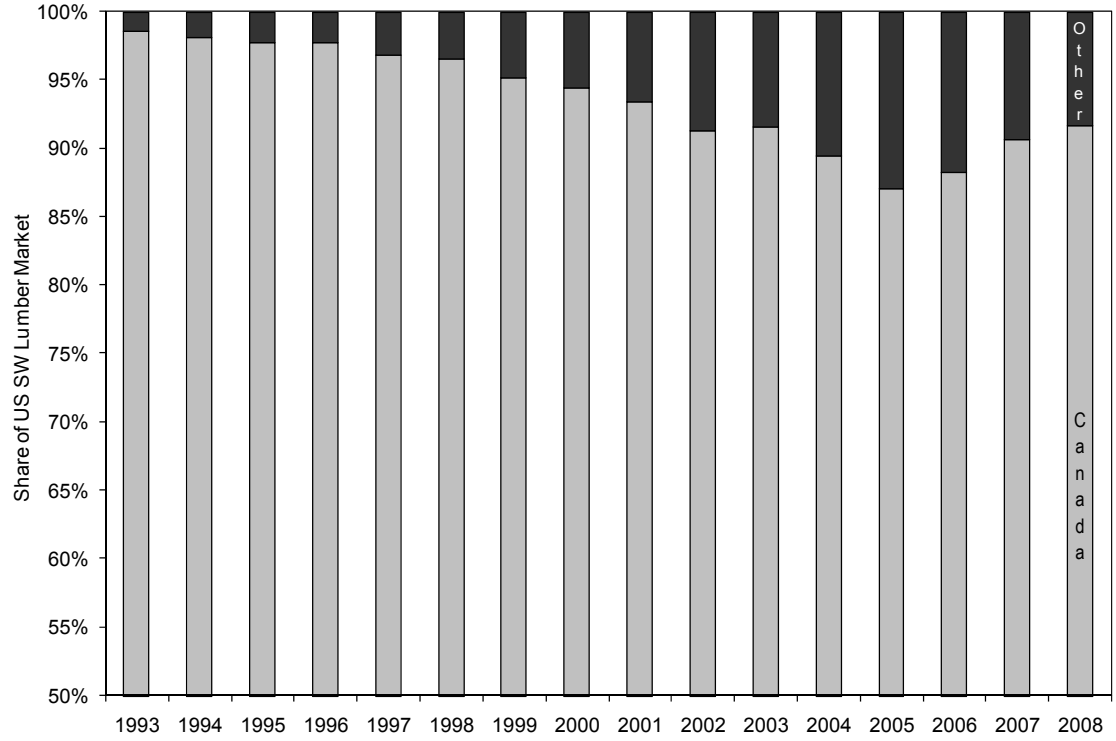


Figure 12. Supplier shares of the US market for imported softwood lumber, 1993-2008.

Source: US International Trade Commission Databank (http://dataweb.usitc.gov/scripts/user_set.asp)

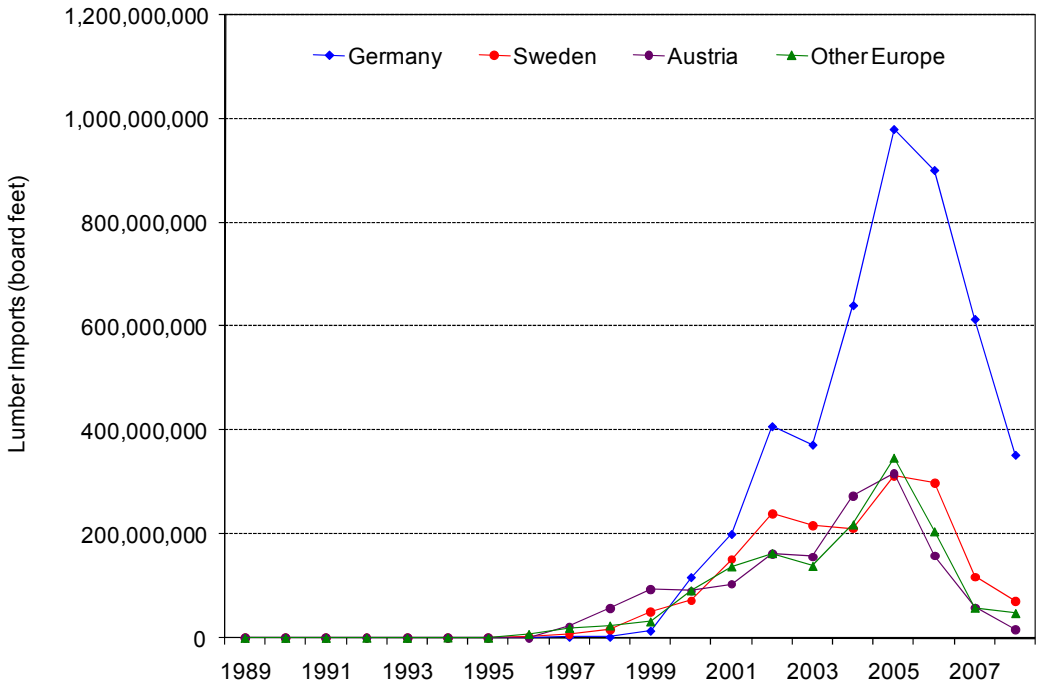


Figure 13. US imports of softwood lumber from non-Canadian sources, 1989-2007.
Source: US International Trade Commission Databank (http://dataweb.usitc.gov/scripts/user_set.asp)

US Imports of Wooden Decking Lumber

US trade statistics indicate that over 90% of the deck products imported into the US originate from Canada. The major product is western red cedar lumber although some redwood lumber is also imported. The international codes for these products under the international Harmonized Trade System are: western red cedar lumber (4407.10.0068 and 4407.10.0069) and redwood lumber (4407.10.0082 and 4407.10.0083). It should be noted that the trade statistics do not break down these imports based on their end-use markets.

Canadian exports of western red cedar lumber to the US declined dramatically during the period 1995-1998 although they recovered strongly between 1998 and 2000. They declined slightly in both 2001 and 2002, recording a volume of just over 1.4 million cubic meters (or 610.4 million board feet). The volume of WRC lumber imported annually over the period 1989-2008 has been roughly equivalent to the volume of WRC lumber produced domestically in the US, Figure 14. In contrast, imports of redwood lumber are relatively minor, totaling just 7,901 cubic meters (or 3.4 million board feet). It is interesting to note that the majority of redwood lumber imports come from Mexico and New Zealand. Another source of competition in the decking market derives from imported tropical hardwood lumber. Unfortunately, the US import statistics do not identify most of these species and it is impossible to determine the volume of species such as ipe or jarrah that are imported into the US.

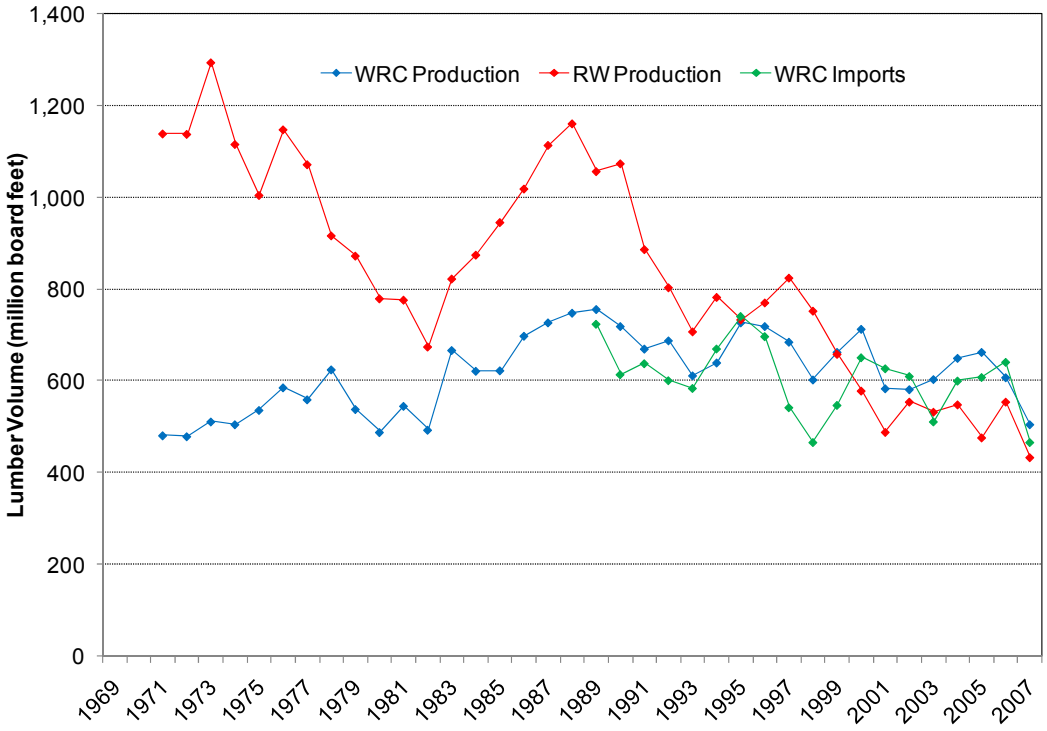


Figure 14. US imports and production of western red cedar and redwood lumber, 1969-2007.
Source: US International Trade Commission Databank (http://dataweb.usitc.gov/scripts/user_set.asp)

US Decking Market

Decking Market Characteristics

Few research studies have been published concerning the residential decking market despite its considerable size. After a thorough search through a large number of databases, less than two dozen articles and reports were found that address, either specifically or tangentially, the residential decking market. Therefore, due to the modest amount of information currently available, this section on residential decking products will draw together all the information that is contained within these sources.

General Market Information

Research results reported by Shook and Eastin (2001) indicated that approximately 6.5 million decks are constructed in the US on an annual basis at an installed cost of between $1.9 to $3 billion. R.E. Taylor & Associates (2002) estimate the current retail value of the residential decking market at about $2.5 billion in 2002, while another source places the retail value at $4 billion (Anonymous 2003). Shook and Eastin also report that the market size for the deck market expanded at an annual rate of more than 8% during the decade of the 1990s. Growth of the market is expected to continue at an annual rate of 7.5% over the next four to five years (Anonymous 2003). General characteristics of decks in 1999, as reported by Shook and Eastin include the following:

- Nearly 60% of new spec homes and 68% of new custom homes were built with a deck.
- The average size of a deck on new spec and new custom homes averaged 252 square feet and 407 square feet, respectively.
- The total cost of a deck on new spec and new custom homes average $2,997 and $4,923, respectively.

Figure 15 illustrates the growth of deck material demand based on board foot consumption from 1990 to 2000 as estimated by the Freedonia Group (2002). The growth of the deck market has been rather steady over the past decade, with the exception of one major downturn in the market occurring in 1991 when the residential construction industry suffered a slump. The Freedonia Group (2007) also estimates that the volume of demand for deck materials will increase by 2.2% annually to reach 3.6 billion lineal feet ($5.6 billion) in 2011. Note that most of the growth in volume demand is expected to be in wood plastic composite deck materials rather than solid wood; the volume demand for wood plastic composites is forecast to increase by more than 15% annually through 2011.

The Freedonia Group (2002) estimated that about 63.3% of deck materials, by volume, are consumed in the residential market and that this market has the strongest prospects for growth due to increased activity in deck repair and replacement. The nonresidential market consumes approximately 9.2% of deck materials by volume, while 27.5% of deck materials are consumed in non-building construction (e.g., boardwalks, piers/docks, walkways, outdoor furniture).

Approximately 80% of all deck sales in 2000 were installed by a professional contractor (Freedonia Group 2002), with the deck contractor choosing the type of deck material. The Freedonia Group study forecasted that deck material installation and material choices would shift from professional contractors as a result of strong growth in the DIY market.

The residential decking industry can be characterized by the following: extremely aggressive price competition; modest product differentiation; economies of scale; introduction of decking systems (including coordinated decking lumber, railing systems, stair systems, fascia boards and low voltage lighting systems), and well-developed marketing and distribution systems (D.G. Bell & Associates 1986; Smith and Sinclair 1990). The characteristics of manufacturers of residential decking materials are varied, and most firms are small to medium sized. However, several large firms supply a significant proportion of residential decking materials in markets located in certain regions of the US.

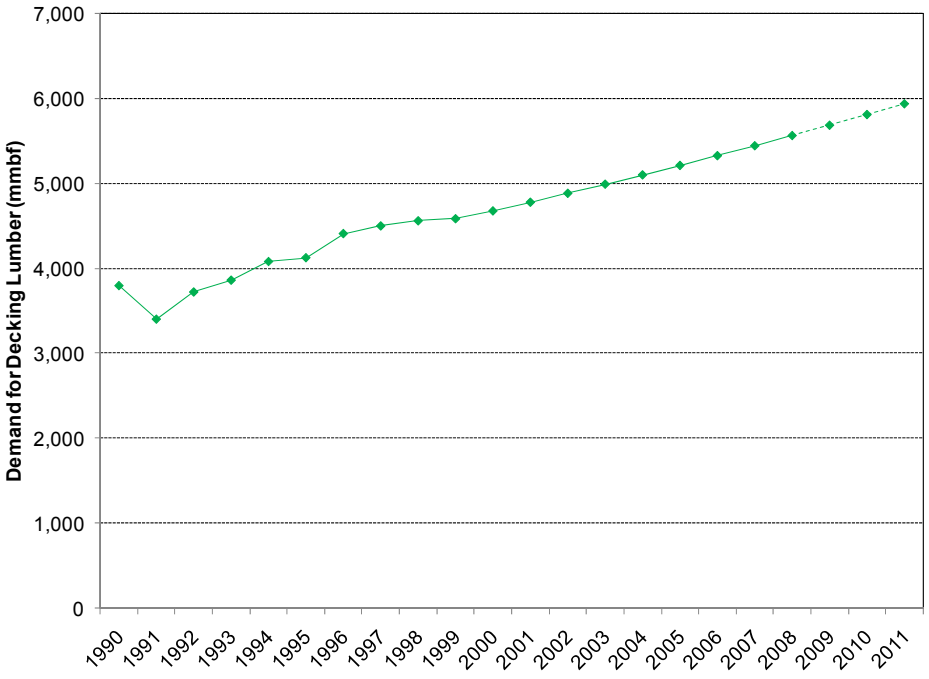


Figure 15. US deck material demand on a board foot basis, 1990-2011e.
Source: The Freedonia Group, 2002; 2007.

Major Decking Products

Several dozen materials are currently utilized in residential deck construction. It should be noted that many of these materials are only used in relatively small, regional markets. Five materials, however, are used to a much greater extent in deck construction than any others. These materials include naturally decay-resistant solid wood (primarily western red cedar, or redwood), treated wood (e.g., primarily southern yellow pine although some Douglas-fir, spruce and fir are used), wood-polymer composite lumber, plastic lumber and THW.

The competitive relationships between the various materials used in the residential decking market are based on several factors. The relative difference in material, installation, and maintenance costs between the differing products is the primary basis for market differentiation and product positioning. In addition, product quality factors, such as longevity, durability, and maintenance requirements, also constitute a basis for product differentiation. Product aesthetics and availability of the material have become increasingly important factors for producers of residential decking materials on which to base competition. This has been especially true in the remodeling and renovation market, where a growing number of homeowners build their own decks.

Market Share of Decking Products

The most recent reports on the decking market include a report by the Freedonia Group (2007) and two CINTRAFOR Working Papers (2001, 2005). It is important to note the differences between the Freedonia market report and the two CINTRAFOR reports. The primary difference between the two sets of reports is that the CINTRAFOR reports are based on surveys of builders and contractors regarding their use of different materials for building decks on non-residential structures. In contrast, the Freedonia data is based on an extensive review of company annual reports and interviews with expert industry informants regarding past, present and future trends in material usage in the deck building industry. As such, the Freedonia report may have some bias based on the views of the informant used. The important distinction to keep in mind is that the CINTRAFOR results are based on a survey of new home builders and deck builders while the Freedonia data is based on a limited number of interviews with industry insiders and reviews of company reports.

The data presented in Table 2 estimates that the demand for decking products will increase from 4.7 billion board feet (bbf) in 2000 to 5.6 bbf in 2010, a 19.3% increase over the ten year period. This market expansion will not be distributed evenly across the three major types of deck materials, with WPC materials expected to increase by 491% and plastic materials by 152%. The demand for wood decking material is projected to decline by 8.5%. Further, the demand for redwood is expected to decline by over 15% between 2000-2010, although the decline in the demand for redwood lumber is attributed to supply constraints rather than declining demand. These demand outlooks are driven by two fundamental end-user attributes: durability (long-deck life) and low maintenance. Very little consideration was paid to price and price sensitivity of home builders, deck builders or home owners. As a result, these demand estimates are more heavily weighted towards the higher priced substitute materials than the actual market situation might otherwise justify, particularly between 2005-2010.

Table 2 also provides demand estimates for the major decking market segments. The primary construction application for decking is repair and remodel (approximately 86%) followed by new home construction (approximately 14%). While the demand for decking products is expected to experience strong growth between 2000 and 2010, the sheer size of the repair and remodel market makes it a much more attractive market segment. In addition, new home builders are a much more price sensitive set of buyers compared to home owners and deck builders given the nature of the project expenditures. In addition, decks on new homes tend to be smaller than repair and replacement deck projects.

Residential construction is the primary market for decking materials, followed by non-building projects (docks, marinas, park structures, etc.) and non-residential construction, Table 3. Perhaps more importantly, the demand for decking materials in the residential market is expected to grow by 24.3% between 2000 and 2010 while demand is expected to grow by just 6.9% in the non-building market. Again, specifiers in the non-building segment are much more price sensitive given the nature of the bidding process in these types of projects.

Almost 80% of the decking material is installed by professionals as opposed to homeowners. While demand is expected to grow substantially in both segments, the highest growth is projected to occur within the DIY segment (27.7%) rather than the pro segment (15.9%). Given the profit constraints facing most pro installers, this segment of the market tends to be more price sensitive than the DIY segment.

Finally, the deck market can be segmented into deck platforms versus rails and accessories (benches, stairs, planters, etc), Table 3. It is important to note that only 59% of the total demand for decking materials is derived from the construction of deck platforms. The remaining demand can be attributed to deck rails and accessories, suggesting that overall demand for a specific product may be influenced to a substantial degree by the availability of rails and accessory products manufactured from the same material. Growth in both of these market segments is expected to be strong.

Table 2. Summary characteristics of total US decking demand (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Total Demand	4,115	4,677	5,075	5,580	19.3%
Total Value ($millions)	$2,885	$3,369	$4,540	$6,390	89.7%
Wood	3,976 (96.6%)	4,366 (93.4%)	4,470 (88.1%)	3,995 (71.6%)	*-8.5%*
Pressure-Treated	*3,244 (81.6%)*	*3,619 (82.9%)*	*3,717 (83.2%)*	*3,225 (80.7%)*	*-10.9%*
Redwood	*378 (9.5%)*	*349 (8.0%)*	*320 (7.2%)*	*294 (7.4%)*	*-15.6%*
W. Red Cedar	*274 (6.9%)*	*306 (7.0%)*	*331 (7.4%)*	*360 (9.0%)*	*17.6%*
Other	*80 (2.0%)*	*92 (2.1%)*	*102 (2.3%)*	*116 (2.9%)*	26.1%
WPC	95 (2.3%)	236 (5.1%)	488 (9.6%)	1,396 (25.0%)	491.5%
Plastic & Other	44 (1.1%)	75 (1.6%)	117 (2.3%)	189 (3.4%)	152%
Construction Application					
New	563 (13.7%)	644 (13.8%)	688 (13.6%)	758 (13.6%)	17.7%
Repair and Remodel	3,552 (86.3%)	4,033 (86.2%)	4,387 (86.4%)	4,822 (86.4%)	19.6%
Construction Type					
Residential	2,465 (59.9%)	2,900 (62.0%)	3,220 (63.4%)	3,605 (64.6%)	24.3%
Non-Residential	367 (8.9%)	444 (9.5%)	485 (9.6%)	550 (9.9%)	23.9%
Non-Building	1,283 (31.2%)	1,333 (28.5%)	1,370 (27.0%)	1,425 (25.5%)	6.9%
Installer Type					
Pro	3,406 (82.8%)	3,820 (81.7%)	4,100 (80.8%)	4,426 (79.3%)	15.9%
Homeowner (DIY)	709 (17.2%)	857 (18.3%)	975 (19.2%)	1,094 (20.7%)	27.7%
End-Use Application					
Deck Boards	2,469 (60.0%)	2,781 (59.5%)	2,994 (59%)	3,262 (58.5%)	17.3%
Rails & Accessories	1,646 (40.0%)	1,896 (40.5%)	2,081 (41%)	2,318 (41.5%)	22.3%

Source: Freedonia 2002

Table 3. Summary of US deck demand, by region (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Total Decking	**4,115**	**4,677**	**5,075**	**5,580**	**19.3%**
Northeast	1,061 (25.8%)	1,180 (25.2%)	1,250 (24.6%)	1,330 (23.8%)	12.7%
Midwest	1,010 (24.5%)	1,127 (24.1%)	1,225 (24.1%)	1,320 (23.7%)	17.1%
South	1,321 (32.1%)	1,537 (32.9%)	1,685 (33.2%)	1,910 (34.2%)	24.3%
West	723 (17.6%)	833 (17.8%)	915 (18.0%)	1,020 (18.3%)	22.4%

Source: Freedonia 2002

Demand for deck materials is summarized by geographic region in Table 3. The projections indicate that the largest demand region is the US south while the US west is the smallest demand region. Interestingly, the largest growth in demand for decking materials is expected to come from these two regions, with substantially higher rates of projected growth than in the northeast or midwest regions.

Results of the 2004 CINTRAFOR Survey of Deck Builders

A summary of some of the results of the 2004 CINTRAFOR survey of deck builders material use are presented in Tables 4-9. The deck building industry is dominated by small to medium-sized firms with over 63% of survey respondents indicating that their sales revenue was less than $1 million in 2003, although a little over 11% of deck builders generated sales revenue in excess of $5 million. The average deck builder constructed 93 decks with an average deck size of 456 square feet, Table 4. Since the average construction cost for a new deck was $6,161, the average construction cost for a deck in the US on a square foot basis) was $13.51 per square foot, although this increased to $15.63 per square foot on the west coast. Approximately 45% of the construction cost was attributed to the deck surface while another third was for the substructure and 21% was for accessories. Just over 40% of deck builder projects were new (first time) decks built on existing homes while almost a third were replacement decks built on existing homes and 25% were new decks built on new homes. It is important to note that approximately 46% of home builders rely on deck builders to build decks on new homes.

The survey data clearly shows substantial differences in deck characteristics based on geographic location, Table 5. For example, deck builders in the eastern US built more than twice as many decks per year as companies in the interior west and three times as many as companies on the west coast. In addition, the average deck size was significantly higher in the west, although the average construction cost in the interior west was substantially lower than in either the eastern US or the west coast. As a result, there was significant variation in the unit construction cost for decks in each region. Unit construction costs in the eastern US were $14.81 per square foot versus $8.18 in the interior west and $15.63 on the west coast. Finally, deck builders on the west coast primarily target new deck construction on both new and existing home with relatively little focus on deck repair/replacement. In contrast, deck builders in the east and interior west have a much more balanced mix of deck building projects.

The survey data suggests that deck builders use a broad mix of decking products, much broader than home builders use, Table 6. Deck builders registered their largest increases in material use for WPC, plastic lumber and tropical hardwoods. Interestingly, while 20% of deck builders reported increasing their use of treated lumber, almost twice as many (6.2%) indicated that their use had declined. The data suggests that many deck builders are reducing their use of WRC, RW and treated lumber in favor of WPC, tropical hardwoods and plastic lumber. The deck materials with the largest positive usage values included: WPC-77%, tropical hardwoods-15.7% and plastic lumber-20.2%.

Table 4. Deck builder demographic information.

Average size of decks built	456 ft^2
Average number of decks built	93
Average total construction cost of decks built	$6,161
Average construction cost of deck structure	34.2% ($2,108)
Average construction cost of deck surface	45.1% ($2,776)
Average construction cost of deck accessories	21.2% ($1,306)
Average % of new decks built on existing home	42.2%
Average % of new decks built on new home	25.2%
Average % of repair/replacement decks built	31.9%
Average number of years firm has been in business	17.8 years

Table 5. Deck builder demographics by region.

	East Coast	Interior West	West Coast
Ave. deck size	395 ft^2	553 ft^2	513 ft^2
Ave. number of decks built	126	65	42
Ave. construction cost	$5,851	$4,524	$8,019
Ave. construction cost/sq. ft.	$14.81	$8.18	$15.63
Deck structure	34.2% ($2,001)	35.0% ($1,583)	31.7% ($2,542)
Deck surface	43.9% ($2,569)	47.4% ($2,144)	46.6% ($3,737)
Deck accessories	21.9% ($1,281)	17.6% ($796)	21.7% ($ 1,740)
Decks on existing home	41.6%	43.7%	42.4%
Decks built on new home	27.9%	27.0%	45.7%
Repair/replacement decks	30.5%	25.5%	11.9%

Sample sizes (East=64-81; West excl. coasts=16-28; West Coast=24-39)

Table 6. Deck builders changing material use over the past two years.

	Increased	Remained the Same	Decreased	Never Used
Western Red Cedar (WRC)	11.8	27.0	35.5	25.7
Redwood (RW)	5.6	16.8	30.1	47.6
Treated Lumber	20.1	37.6	36.2	6.0
Untreated Lumber	4.2	19.4	11.8	64.6
Wood-Plastic Composite (WPC)	79.6	7.2	2.6	10.5
Tropical Hardwood (THW)	24.5	21.1	8.8	45.6
Plastic	27.1	11.1	6.9	54.9

Material Use in Decking End-Use Applications

The survey data shows that treated lumber is the dominant material used in deck substructures with an overall market share of 81.2%, Table 7. Treated lumber and WPC each represent about a third of the deck surface market while WRC and RW together comprise another 22%. Treated lumber has a 34% share of the accessories market while WRC and RW represent another 30% followed by WPC with 22% of the overall market. Material use by deck builders for deck substructures was dominated by treated lumber with a market share of over 90%. Material use in deck surface applications was dominated by wood-plastic composite products followed by treated lumber and western red cedar. Finally, approximately 30% of deck accessories were built using wood-plastic composites and treated lumber while an additional 18% were built from western red cedar.

The research results highlighted that fact that deck builders almost exclusively use treated lumber for deck substructures, whereas home builders are more likely to use naturally durable wood species as well as WPC lumber in this application. This is interesting given the fact that few WPC products are manufactured in cross-sectional sizes that would be appropriate for support beams or primary posts. This would suggest that home builders are most likely using WPC lumber as joists and perhaps intermediate support posts. Interestingly, deck builders, who we could assume are more knowledgeable of deck construction details and material specification, use virtually no WPC lumber in deck substructures. From this we can conclude that either home builders are ahead of the curve in terms of trying WPC as a structural material in deck substructures or else they are mistakenly specifying WPC for an application where its use is not intended. In either case, this finding merits additional investigation into how home builders are using WPC in structural applications.

The summary data suggests that there are three groups of material attributes, Table 8. The most important attributes, those with an importance rating higher than 6, included long life, material quality, beauty and availability. The second group of attributes (those with an importance rating between 5.5 and 6.0) included natural decay resistance, ease of maintenance and price stability. It is interesting to note that while price stability was rated moderately high, the actual price of a decking material was rated as being relatively unimportant, receiving the third lowest importance rating.

Respondents were also asked to indicate the degree to which each decking material possessed a specific material attribute using a Likert-like scale where a rating of 1 meant that the material did not possess the attribute at all and a rating of 7 meant that the material possessed the attribute to a high degree. The average ratings across all survey respondents are summarized in Table 9. The material attributes presented to survey respondents included five of the highest rated attributes in terms of their influence on the material specification process: long life, beauty, ease of maintenance, availability and natural decay resistance. Two of the material attributes, strength and low cost, were also included in this question.

In terms of long life, WPC lumber received the highest rating by far. Other highly rated materials included THW lumber, plastic lumber, treated lumber and RW. In terms of beauty, the highest rated product was RW lumber with a rating of 6.02. Other highly rated materials included THW and western red cedar (WRC). Surprisingly, WPC lumber received a relatively high rating of 5.33, not that much lower than the scores recorded for WRC, RW and THW and much higher than both treated lumber and plastic lumber.

Table 7. Material use in different end-use applications in deck building in 2003.

Deck Builders	Substructure	Surface	Accessories
Western Red Cedar	0.7	10.8	17.5
Redwood	0.0	5.3	6.6
Treated Lumber	91.2	28.3	27.8
Untreated Lumber	6.0	1.5	1.8
Wood-Plastic Composite	0.6	39.6	29.5
Tropical Hardwood	0.7	5.8	4.4
Plastic	0.0	4.2	4.8
Other	0.8	3.5	5.6

Table 8. Average importance ratings for material attributes, by builder type.

Material Attribute	Deck Builders
Long Life	6.35
Beautiful & Aesthetically Pleasing	6.29
Consistent Material Quality	6.17
Availability	5.76
Naturally Decay Resistant	5.71
Ease of Maintenance	5.68
Resistance to Splintering	5.63
Price Stability	5.34
High Workability/Ease of Use	5.30
High Strength Properties	5.08
Little Product Waste	4.80
Low Heat Retention in Service	4.50
Low Material Cost	4.49

Both WPC and plastic lumber were widely perceived as being the easiest materials to maintain. Further behind were the naturally durable species followed by pressure treated lumber (PT) and untreated lumber. The naturally durable timber species were the lowest rated material in terms of availability, and this lack of availability was often cited by respondent s as a major factor in their low use rates. Respondents indicated that the lowest cost materials were perceived to be treated and untreated lumber. In contrast, redwood was perceived to be the most expensive material followed by THW and WPC. However, there was little difference in the relative ratings for these four materials, suggesting that cost does not pose a major disadvantage for any of the naturally durable materials. Finally, the materials perceived to have the highest level of natural durability were WPC and plastic lumber. The naturally durable wood materials, while highly rated, were rated substantially lower both of the non-wood materials.

Table 9. Average ratings for each decking material with respect to the degree to which each material possesses each specific material attribute.

Long Life	**WRC**	**RW**	**PT**	**UT**	**WPC**	**THW**	**Plastic**
Non User	5.20	5.49	5.56	2.24	6.18	5.56	5.53
User	4.94	5.04	5.26	2.75	6.27	5.55	5.45
Total	5.17	5.44	5.53	2.30	6.19	5.55	5.52
Beauty							
Non User	5.86	6.11	4.09	2.94	5.45	5.89	4.48
User	5.77	5.97	3.68	3.61	4.34	5.82	3.48
Total	5.85	6.10	4.05	3.01	5.33	5.88	4.34
Ease of Maintenance							
Non User	4.50	4.72	4.63	2.36	6.28	4.89	5.69
User	4.50	4.70	4.10	2.48	5.89	4.96	5.86
Total	4.50	4.72	4.58	2.37	6.24	4.90	5.72
Availability							
Non User	5.30	4.92	6.59	6.30	6.39	4.74	5.37
User	5.34	4.16	6.28	5.73	6.20	4.44	4.88
Total	5.30	4.84	6.56	6.24	6.37	4.70	5.30
High Strength							
Non User	5.05	5.18	6.01	4.86	4.97	5.97	4.44
User	4.61	4.88	5.62	5.08	4.00	5.67	3.76
Total	5.00	5.15	5.97	4.88	4.87	5.93	4.35
Low Cost							
Non User	4.12	3.75	5.36	5.08	3.98	3.57	3.92
User	4.13	3.18	5.00	5.00	3.62	3.39	3.95
Total	4.12	3.69	5.32	5.07	3.94	3.55	3.93
Natural Decay Resistance							
Non User	5.19	5.44	5.66	1.86	6.45	5.63	6.36
User	4.97	5.24	5.22	2.52	6.17	5.42	6.18
Total	5.17	5.42	5.62	1.93	6.42	5.60	6.34

This question refers to builder's relative perceptions of specific deck materials. Respondents were asked to indicate the degree to which each material possesses each attribute using a Likert-like scale where a rating of 1 means the material does not possess the specific attribute at all and a rating of 7 means that the material possesses the attribute to a high degree.

Demand for Wood Decking Materials

US demand for wood decking materials is summarized in Table 10. The projected demand data indicates that even as the volume of wood decking materials is projected to decline by 8.5% over the period 2000-2010, the value of wood decking material demanded will increase by 38.5%. An analysis of the historic price data for western red cedar decking and treated SYP decking suggests that while this type of price increase might be expected for western red cedar and redwood, the ten year average price increase for SYP (with an 80% market share) has averaged a lower 13.3% overall. In fact, the declining demand

projections, if correct, would tend to support smaller overall price increases for decking products in general. However, we would expect that the prices for premium wood decking species (such as redwood and western red cedar), would tend to increase at a faster than average rate.

Areas of potential growth in wood decking demand will be in residential construction projects (1.3% growth), DIY projects (8.1% growth), and in decking rails and accessories (1.4% growth), Table 10. The worst market outlooks are in non-building applications (30.6% decline), professionally installed decks (14.1% decline), and deck boards (15.5% decline).

Table 10. Summary characteristics of US wood decking demand (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Total Wood Volume	3,976	4,366	4,470	3,995	-8.5%
Wood Value ($million)	$2,705	$2,975	$3,715	$4,150	38.5%
Construction Application					
New	552 (13.9%)	616 (14.1%)	632 (14.1%)	604 (15.1%)	-1.9%
Repair and Remodel	3,424 (86.1%)	3,750 (85.9%)	3,838 (85.9%)	3,391 (84.9%)	-9.6%
Construction Type					
Residential	2,412 (60.7%)	2,764 (63.3%)	2,934 (65.6%)	2,800 (70.1%)	1.3%
Non-Residential	348 8.8%)	401 (9.2%)	408 (9.1%)	362 (9.1%)	-9.7%
Non-Building	1,216 (30.6%)	1,201 (27.5%)	1,128 (25.2%)	833 (20.9)	-30.6%
Installer Type					
Pro	3,277 (82.4%)	3,537 (81.0%)	3,560 (79.6%)	3,039 (76.1%)	-14.1%
Homeowner (DIY)	699 (17.6%)	829 (19.0%)	910 (20.4%)	896 (23.9%)	8.1%
End-Use Application					
Deck Boards	2,372 (59.7%)	2,563 (58.7%)	2,574 (57.6%)	2,166 (54.2%)	-15.5%
Rails & Accessories	1,604 (40.3%)	1,803 (41.3%)	1,896 (42.4%)	1,829 (45.8%)	1.4%

Source: Freedonia 2002

Table 11. Summary characteristics of US wood-plastic composite decking demand (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Total WPC Volume	95	236	488	1,396	491.5%
WPC Value ($millions)	$92	$236	$550	$1,750	641.5%
Construction Application					
New	5 (5.3%)	17 (7.2%)	36 (7.4%)	122 (8.7%)	617.6%
Repair and Remodel	90 (94.7%)	219 (92.8%)	452 (92.6%)	1,274 (91.3%)	481.7%
Construction Type					
Residential	50 (52.6%)	126 (53.4%)	261 (53.5%)	749 (53.7%)	494.4%
Non-Residential	9 (9.5%)	26 (11.0%)	53 (10.9%)	150 (10.7%)	476.9%
Non-Building	36 (37.9%)	84 (35.6%)	174 (35.7%)	497 (35.6%)	491.7%
Installer Type					
Pro	86 (90.5%)	211 (89.4%)	431 (88.3%)	1,216 (87.1%)	476.3%
Homeowner (DIY)	9 (9.5%)	25 (10.6%)	57 (11.7%)	180 (12.9%)	620.0%
End-Use Application					
Deck Boards	72 (75.8%)	177 (75.0%)	357 (73.2%)	995 (71.3%)	462.1%
Rails & Accessories	23 (24.2%)	59 (25.0%)	131 (26.8%)	401 (28.7%)	579.7%

Source: Freedonia 2002

Demand for Wood-Plastic Composite Decking Materials

In contrast to the wood market demand projections presented above, demand for WPC decking materials is expected to grow by 491.5% between 2000 and 2010 while the value of WPC decking materials demanded is expected to grow by an even larger 641.5%, Table 11. Huge increases in demand are projected across every segment of the industry. However, these projections assume a correspondingly large increase in production capacity, which to date has occurred. In fact, the entire WPC industry has exploded with established manufacturers developing multiple brands to exploit demand at various price points and new players entering the market regularly. The appearance of new manufacturers in this market segment is hardly surprising given the low barriers to entry that exist in this sector. Finally, two new trends in the WPC market include the development of hidden fastener systems and integrated railing and accessories systems that are coordinated with existing decking board lines. Hidden fastener systems provide a much cleaner look to a deck surface and avoid the problem of exposed screw heads and mushrooming around fasteners that occur when traditional screws and nails are used. The recent development of integrated fascia board and railing and stair systems reflect the desire on the part of consumers to have deck stairs and railing systems that match with their deck surface, providing a more finished look to a deck.

Demand for Plastic Decking Materials

The demand for plastic decking materials is presented in Table 12. While demand for plastic decking materials is expected to grow substantially, a range of product limitations and end-user concerns will restrict its overall share of the decking material market. The factors include high heat retention, high linear expansion, unnatural appearance (non-wood), high purchase price, higher installation costs and color fading. Despite these restrictions, plastic decking materials will experience their strongest growth in

demand in those applications that require high durability and long product lifetimes (to justify the higher product prices) but where aesthetics may be a secondary concern. The two most significant markets that meet these requirements are the non-residential and non-building market segments. The high growth estimates provided for the residential market appear to be overly optimistic and would most likely require a substantial drop in product prices along with an improvement in product appearance and performance. Significantly, plastic decking manufacturers have also introduced hidden fastener systems and have developed railing and stair systems that are coordinated with their decking brands. They have also begun to offer "color fast" guarantees that warranty their products against color fade.

Table 12. Summary characteristics of US plastic decking demand (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Total Plastic Volume	44	75	117	189	152.0%
Plastic Value ($millions)	$88	$158	$275	$490	210.1%
Material Type					
Vinyl	22 (50.0%)	39 (52.0%)	63 (53.8%)	106 (56.1%)	171.8%
Polyethylene	15 (34.1%)	25 (33.3%)	40 (34.2%)	64 (33.9%)	156.0%
Other Materials	7 (15.9%)	11 (14.7%)	14 (12.0%)	19 (10.0%)	72.7%
Construction Application					
New	6 (13.6%)	11 (14.7%)	20 (17.1%)	32 (16.9%)	190.9%
Repair and Remodel	38 (86.4%)	64 (85.3%)	97 (82.9%)	157 (83.1%)	145.3%
Construction Type					
Residential	3 (6.8%)	10 (13.3%)	25 (21.4%)	56 (29.6%)	460.0%
Non-Residential	10 (22.7%)	17 (22.7%)	24 (20.5%)	38 (20.1%)	123.5%
Non-Building	31 (70.5%)	48 (64.0%)	68 (58.1%)	95 (50.3%)	97.9%
Installer Type					
Pro	43 (97.7%)	72 (96.0%)	109 (93.2%)	171 (90.5%)	137.5%
Homeowner (DIY)	1 (2.3%)	3 (4.0%)	8 (6.8%)	18 (9.5%)	500.0%
End-Use Application					
Deck Boards	25 (56.8%)	41 (54.7%)	63 (53.8%)	101 (53.4%)	146.3%
Rails & Accessories	19 (43.2%)	34 (45.3%)	54 (46.2%)	88 (46.6%)	158.8%

Source: Freedonia 2002

Finally, the demand projections for the three major project applications (residential, non-residential and non-building) are summarized in Table 13. This data suggests that, as discussed earlier, wood decking materials will experience modest growth only in the residential sector. Wood will continue to be the dominant decking materials used in this segment although it will see its market share decline from 95.3% in 2000 to 77.7% in 2010.

Table 13. Summary decking market characteristics (mmbf)

	1995	2000	2005	2010	% Change 2000-2010
Residential Decking					
Residential Volume	2,465	2,900	3,220	3,605	24.3%
Residential Value ($millions)	$1,696	$2,033	$2,790	$4,000	96.8%
Wood	2,412 (97.8%)	2,764 (95.3%)	2,934 (91.1%)	2,800 (77.7%)	1.3%
WPC	50 (2.0%)	126 (4.3%)	261 (8.1%)	749 (20.8%)	494.4%
Plastic	3 (0.1%)	10 (0.3%)	25 (0.8%)	56 (1.6%)	460.0%
New	307 (12.5%)	377 (13.0%)	397 (12.3%)	442 (12.3%)	17.2%
Repair and Remodel	2,158 (87.5%)	2,523 (87.0%)	2,823 (87.7%)	3,163 (87.7%)	25.4%
Non-Residential Decking					
Non-Residential Volume	367	444	485	550	23.9%
Non-Residential Value ($millions)	$265	$334	$455	$660	97.6%
Wood	348 (94.8%)	401 (90.3%)	408 (84.1%)	362 (65.8%)	-9.7%
WPC	9 (2.5%)	26 (5.9%)	53 (10.9%)	150 (27.3%)	476.9%
Plastic	10 (2.7%)	17 (3.8%)	24 (4.9%)	38 (6.9%)	123.5%
New	54 (14.7%)	67 (15.1%)	72 (14.8%)	80 (14.5%)	19.4%
Repair and Remodel	313 (85.3%)	377 (84.9%)	413 (85.2%)	470 (85.5%)	24.7%
Non-Building Decking					
Non-Building Volume	1,283	1,333	1,370	1,425	6.9%
Non-Building Value ($millions)	$924	$1,002	$1,295	$1,730	72.7%
Wood	1,216 (94.8%)	1,201 (90.1%)	1,128 (82.3%)	833 (58.5%)	-30.6%
WPC	36 (2.8%)	84 (6.3%)	174 (12.7%)	497 (34.9%)	492.7%
Plastic	31 (2.4%)	48 (3.6%)	68 (5.0%)	95 (6.7%)	97.9%
New	202 (15.7%)	200 (15.0%)	219 (16.0%)	236 (16.6%)	18.0%
Repair and Remodel	1,081 (84.3%)	1,133 (85.0%)	1,151 (84.0%)	1,189 (83.4%)	4.9%

Source: Freedonia 2002

Decking Lumber Price Trends

The prices for two of the primary wood decking materials are tracked in Figure 16. The price data illustrates several interesting characteristics of the wood decking market. First, decking prices are cyclical and seasonal, increasing during the late spring to early autumn when the weather becomes warmer and drier throughout the US. As noted earlier, this is also the season when new residential construction picks up and demand for wood decking materials increases substantially, both in new construction and the R&R sector. Second, the price data clearly shows that while western red cedar

decking prices increased by approximately 62% between 1998-2008, prices for SYP preservative treated decking actually declined by approximately 17% over the same period.

Finally, Figures 16 and 17 suggest that the price data can be broken into two time periods. Time Period 1 occurs prior to the imposition of the Canada-US Softwood Lumber Agreement (SLA) while Time Period 2 shows the price trends after the imposition of the SLA. It should be noted that the volume of WRC lumber imported from Canada annually is approximately equivalent to the volume of WRC lumber produced domestically. The SLA resulted in a decline in Canadian western red cedar imports into the US, and contributed to a steep increase in WRC decking prices in the short-term. These price increases occurred as the percentage of houses built with a deck declined from 34% (1996) to 29% (2002). The combination of reduced supply and reduced demand initially caused a sharp decline in both WRC and SYP prices between March and October of 1998. However, tight supplies of WRC and over-production of SYP in the US south eventually contributed to an increasing price disparity between the two products over the period 1999-2002, Figure 17. The disparity in prices between these two products dropped significantly between 2003 and 2005, although the price disparity jumped to a record level by late 2007. There has been some moderation in WRC prices during 2008 and early 2009, although the price disparity between WRC and SYP still remains extremely high.

The consistent price discrepancy between WRC and SYP suggests that the market intrinsically places a higher value on WRC lumber in outdoor applications. However, it is also true that the artificial supply constraints caused by import restrictions on WRC decking products and harvest restriction in the US west have exacerbated the price discrepancy between WRC and SYP decking.

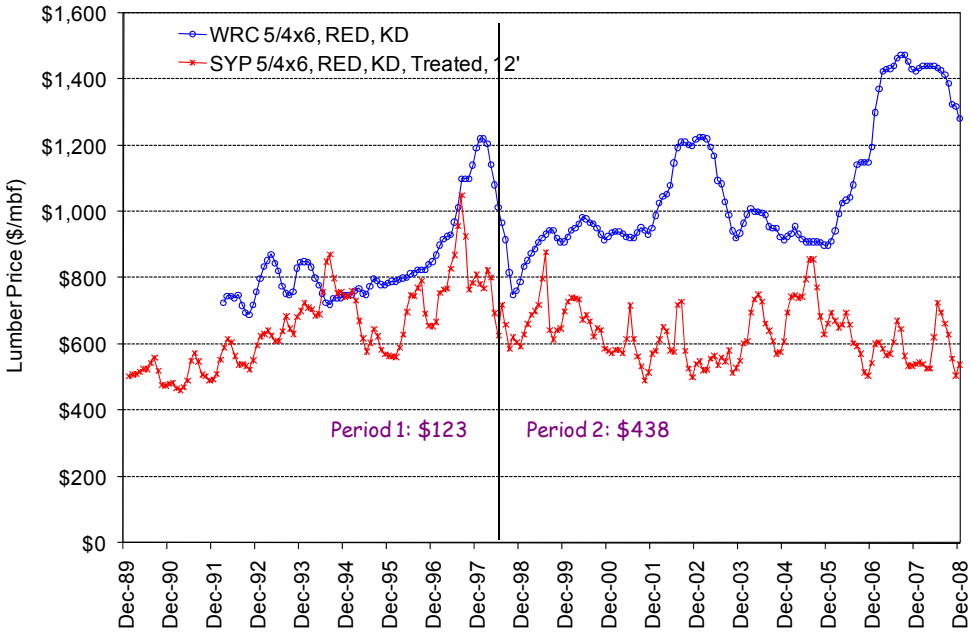


Figure 16. Prices for western red cedar and yellow pine decking products, 1989 - 2008.
Source: Random Lengths, various editions.

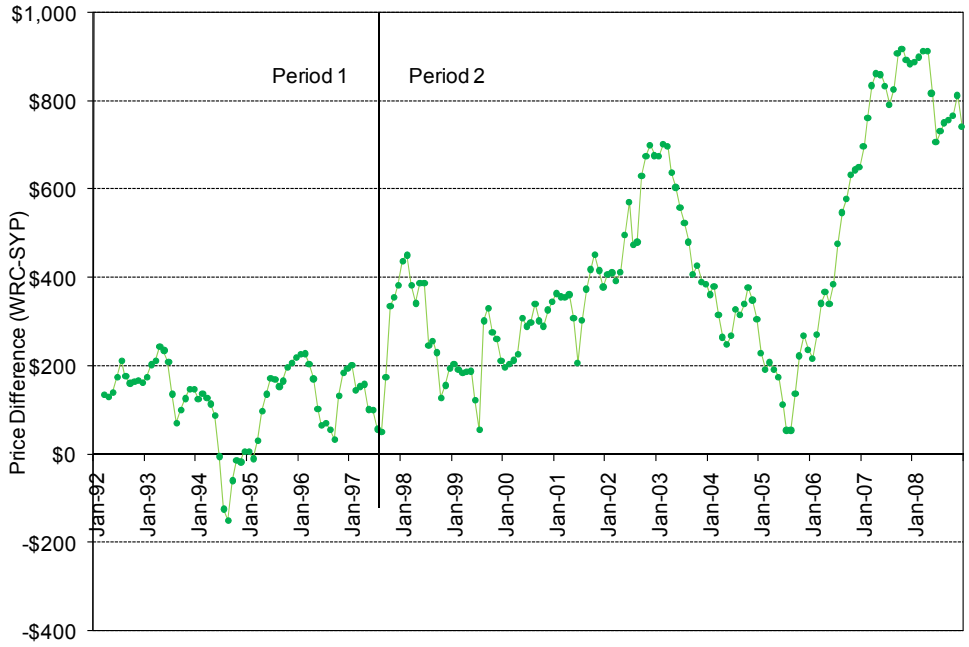


Figure 17. Price differential between western red cedar and yellow pine decking lumber, 1992 – 2008.
Source: Random Lengths, various editions.

Factors Influencing Preferences for Residential Decking Products

The literature pertaining to residential decking material was thoroughly examined in order to inventory the factors that were thought to influence the residential decking planning and purchase process. Factors were categorized into three distinct groups of decision makers: the wholesaler/retailer, the builder/contractor/designer, and the homeowner/do-it-yourself decision makers.

Within each of the three categories of decision makers, the factors were further broken down into four general domains, the first being designated as the *product qualities* domain. The items listed in this first domain tend to be factors that a producer of decking would have little control over in terms of product design. The second set of factors was designated as the *economic* domain. These items tend to be factors related to price and costs (e.g., maintenance costs, installation costs). The third set of factors was designated as the *manufacturer services* domain. In this domain, items tended to deal with factors that the manufacturer had considerable amount of control to change the existing consumer perception of the factor (e.g., product availability, promotional material provided by manufacturer). The final set of factors was designated as the *consumer perception* domain. Items listed in this domain tend to be factors that are strongly held beliefs of consumers with regard to the decking material itself. The factors in this last domain are frequently cited as being consumer perceptions that are strongly held and difficult to change.

Research by Shook and Eastin (2001) found that residential contractors were most concerned with the long life, durability, and aesthetics of deck materials for new home with a deck. Material strength properties, material waste, and material cost were found to be relatively unimportant for contractors. Consumer perceptions that builders, contractors, and designers felt influenced their perceptions of residential decking materials were mostly concerned with product safety issues; most notably with treated lumber. These consumer perception factors included disposal of waste material, handling safety, safety for outdoor applications, and risk to children.

Survey Methodology

A web-based survey was implemented to obtain a comprehensive understanding of the US decking materials market. The target population for the survey was deck builders, remodelers and homebuilders with significant deck building experience at a professional level. The survey was restricted to respondents with significant deck building experience, hence, only the respondents who have built more than 5 decks in last two years were allowed to take the survey. The sample frame used for the survey was the 25,000 subscribers of Hanley Wood's Professional Deckbuilder magazine. Proper attention was given to the fact that only a single respondent from each organization was invited to take the survey and multiple entries from the same organization were removed. The resultant list consisted of approximately 20,000 entries, from which 5,000 randomly selected e-mail addresses were included in the final sample frame.

An initial email explaining the objectives of the survey, eligibility criteria and the incentives associated was emailed to this selected sample frame. The email message clearly explained that the survey was co-sponsored by the Professional Deckbuilder magazine and CINTRAFOR and encouraged their participation. The email also contained an embedded link leading them to the web-based survey. To encourage participation, each email recipient was offered a $10 gift certificate, a summary of the survey results and a chance to win one of three $200 gift certificates from a national DIY store following the completion of the survey. A week following the initial email invitation to take the survey, non-respondents were sent an email reminder encouraging them to take the survey. The survey was closed 10 days following the reminder email. The three winners of the random drawing were mailed their prizes ($200 Home Depot Gift card) and their names were published on the CINTRAFOR website.

Survey Development and Design:

A web-based survey instrument was used to conduct the survey. The key advantages of using panel based internet surveys are cited as being their greater speed and lower cost (Dillman 2000; Duffy et. al. 2005). Another key advantage of using a web-based survey is that the time lag associated with data collection for empirical research in the field of social sciences and economics is drastically reduced relative to traditional survey methods and errors associated with data entry of survey data are eliminated (Schonlau et. al. 2006). All the methods of communication used for administering surveys have their own advantages and disadvantages (Churchill et. al. 2005). The primary criticism against web-based surveys is related to the sampling frame and population representation; however, these criticisms can be applied to all other survey methodologies as well. This weakness is known as non-coverage error which results from a non-comprehensive sampling frame that excludes some segment(s) of the target population (Churchill 2005). The subscription list of Professional Deck Builder magazine used as the sample frame for this research consists of deck builders, residential homebuilders, remodelers and residential contractors located in all 50 states and includes firms of all sizes. Moreover, since most deck building, homebuilding and remodeling firms in the US now have access to e-mail, the issue of non-coverage error in this research is believed to be minimal.

Industry experts on CINTRAFOR's advisory board, as well as homebuilders, remodelers and architects, were contacted for input on the preliminary draft of the questionnaire and the questionnaire was enhanced and edited based on their feedback. Following Dillman's (1978) recommendation, the resultant enhanced 'structured survey questionnaire' was pre-tested to ensure the comprehensiveness, clarity and ease of use of the survey instrument. The pretest group consisted of a mix of individuals with varied knowledge of the US residential decking industry. The revised survey was then pre-tested with a small sub-sample of the target population and CINTRAFOR's advisory panel using the web-based survey instrument. Minor modifications were made to further improve the clarity and comprehensiveness of the survey. Finally, prior to emailing the survey, the web-based survey instrument was tested and debugged using an automated computer response generation process and all possible options were tested for viability.

Sample Size:

Sample size calculations are based on the primary variable of interest in the study and the nature of the variable (Cochran 1977; Bartlett et. al. 2001). The primary variable in this study was respondent awareness of decking materials, a variable which is categorical in nature. In order to estimate a sample size for a given population size, with a specified confidence interval, the following formula can be applied (Krejcie and Morgan 1970).

$$n = \frac{\chi^2 NP(1-P)}{d^2(N-1) + \chi^2 P(1-P)} \qquad \text{…..(1)}$$

Where, n = required sample size; N = the target population size; P = the estimated value for the proportion of a sample who are aware of the decking materials; d = acceptable margin of error for the estimated value of P; χ^2 = table value of chi square for one degree of freedom relative to the desired level of confidence, (1-d)

The sample size calculation was based on several implicit assumptions. First, given the large population size of the number of homebuilders and deck builders in the US, we can use the large sample size approximation of equation 1. Second, due to multiple decking materials of interest, the proportion of material awareness varies between products and a conservative value of 0.5 (50%) was used for P in order to provide the largest sample size for the specified margin of error (Cochran 1977). The marketing literature recommends a 5% acceptable margin of error for categorical data (Krejcie et. al. 1970). Using equation 1 and the assumptions noted above, the minimum sample size for this study was calculated to be 376.

Results and Discussion

The completed survey responses were automatically stored as MS Excel and SPSS data file formats based on a previously designated coding scheme. Summary frequencies were run to ensure that all survey data was coded and recorded correctly. A statistical analysis of the survey data was then performed. The results of this analysis are presented in this section of the report. While the results of the statistical analyses are presented in the tables and figures that follow, the emphasis of the discussion is targeted towards identifying the information that has the greatest strategic importance with regards to potential for new product positioning and identifying market opportunities within the US decking market. The preliminary discussion of the survey results includes a summary of the demographic information derived from the survey, followed by a summary of the general survey results. The results obtained from each question on the survey will be presented in a logical sequence to facilitate the discussion – not necessarily in the same order that the questions were asked in the survey.

Survey and Data

Two email blasts were sent out to the selected sample frame, with the first blast being sent on the 9th of March, 2009 at 12:00 pm eastern time. A total of 156 qualified respondents took the survey on the day the initial email was sent and a total of 230 qualified responses were obtained between the 9th and 15th of March. The reminder email was sent to non-respondents on the 16th of March and the survey was closed on the 30th of March. The response from the second wave peaked on the day the email was sent and 142 completed surveys were received following the second mailing. In total, we received 372 completed surveys. Here it should be emphasized that only deck builders who had built more than 5 decks in the last two years were allowed to complete the survey, a requirement that effectively eliminated an additional 90 respondents from completing the survey. Figure 18 depicts the dates and frequencies of survey responses.

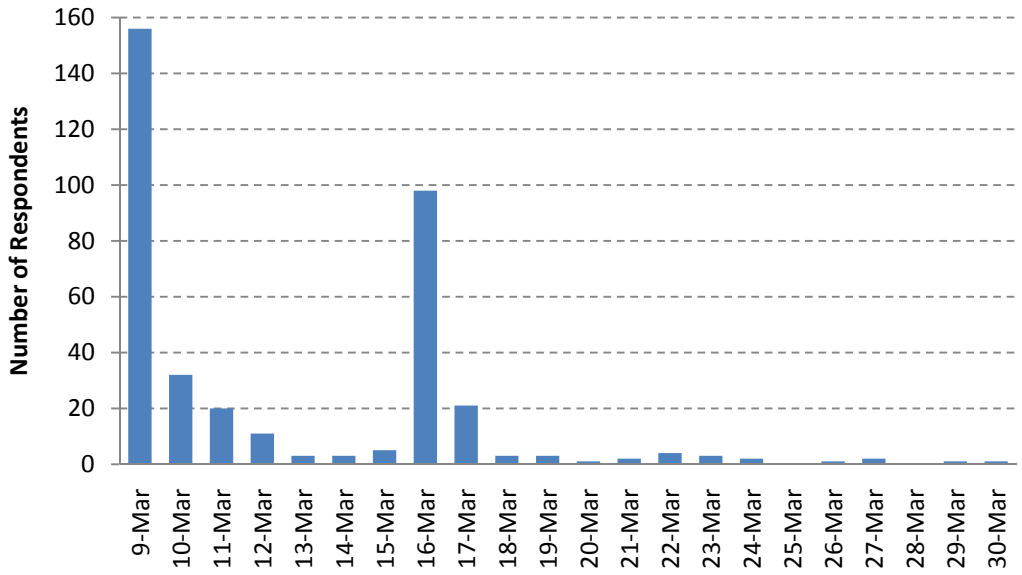


Figure 18. The timeline for survey responses.

Though no time limit was imposed on the web based survey, it was designed in such a way that the survey could be completed within a 10-15 minute time period. Moreover, the survey was designed such that the respondents were allowed to complete the survey in multiple sittings. Based on the completion

time data estimated by calculating the difference between the start time and the end time of each survey it was evident that a number of respondents took the option of taking the survey in multiple sittings which increased the mean duration of taking the survey to 21 minutes (Figure 19). However, about 45 percent of the respondents finished the survey in less than15 minutes.

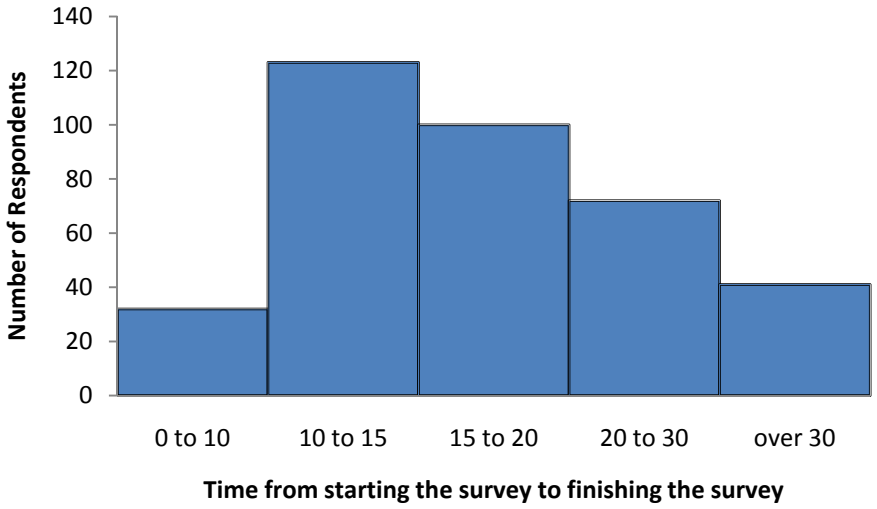


Figure 19. Distribution of time taken to complete the survey.

Survey Demographics

To ensure that the respondents had relevant deck building experience, only those deck builders who built more that 5 decks over the past two years were allowed to take the survey. A total of 372 qualified respondents completed the survey, with respondents being located in 44 states within the four regions of the US. The regional distribution used in this paper is based on the following US census regions: the Northeast, Midwest, South and West, Table 14. The results show that 32% of the survey respondents were located in the South, the largest of the four census regions in terms of number of households. Approximately 25% of the survey respondents were located in each of the Northeast and Midwest regions and 18% of the respondents were located in the West. Hence, the survey provides a comprehensive representation of all the regions in the US; making possible both inter and intra-regional analysis of deck builders' material usage behavior and decking material perceptions.

Survey respondents were asked about their geographic focus in terms of working in urban, small town or rural locations. For this study, an urban (or suburban) population center is defined as a city or group of contiguous communities with a population greater than 50,000 while a small town is defined as a city or town that is generally isolated from a major urban area with a population less than 50,000 and a rural area is defined as having a low density of population that is scattered over a wide area. Based on these definitions, over 57% of the respondents indicated that they focus on urban locations while 15% of the respondents cater to a rural population, Table 15. It can also be observed from Table 15 that the survey includes significant regional representation of respondents catering to all the three population centers. However, the percentage representation of the respondents from each of these three population centers differs significantly by region. The results of a Pearson's chi-square square test (χ^2 value = 25.5, df=6) indicates significant differences (at significance value = 0.00) in the proportion of regional representation

Table 14. Regional distribution of respondents.

Northeast		Midwest		South		West	
Connecticut	11	Iowa	6	Alabama	2	Arizona	3
Massachusetts	12	Illinois	14	Arkansas	3	California	28
Maine	7	Indiana	2	Delaware	1	Colorado	6
New Hampshire	3	Kansas	6	Florida	18	Hawaii	2
New Jersey	17	Michigan	9	Georgia	10	Idaho	4
New York	23	Minnesota	12	Kentucky	6	Montana	1
Pennsylvania	14	Missouri	10	Maryland	13	New Mexico	2
Rhode Island	5	N. Dakota	1	N. Carolina	18	Oregon	8
Vermont	4	Nebraska	4	Oklahoma	2	Utah	1
Total Northeast	**96 (25.8%)**	Ohio	12	S. Carolina	9	Washington	12
		Wisconsin	14	Tennessee	6	**Total West**	**67 (18%)**
		Total Midwest	**90 (24.2%)**	Texas	6		
				Virginia	23		
				W. Virginia	2		
				Total South	**119 (32%)**		

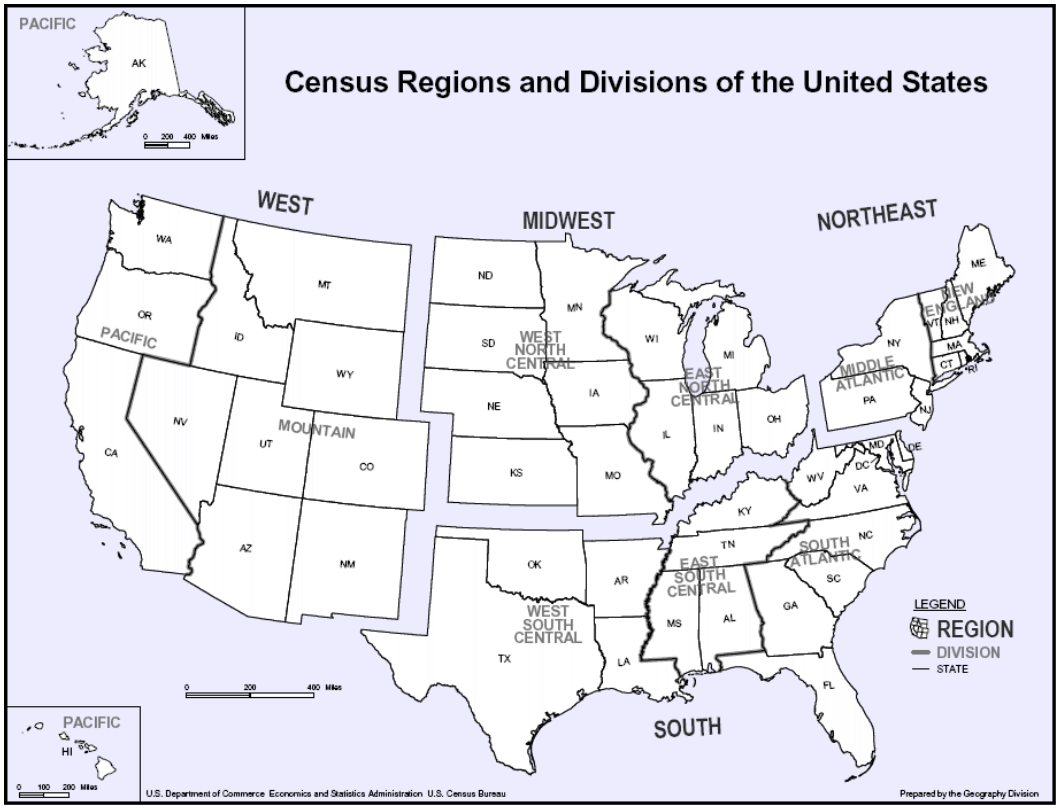


Figure 20. Census regions used for the study

of respondents catering to various population centers. (*Table 15 is color coded and throughout this paper we will use a similar color coded explanation while analyzing the contingency tables. Box 1 contains an explanation for interpreting the color coded tables.)*

Within the sample population, a significantly higher proportion of urban-focused businesses are located in the Southern and Western regions of the country, whereas a significantly higher proportion of respondents from the Northeast indicated that they work in small towns. Additionally, a higher proportion of respondents from the Midwest and West regions indicated that they cater to a rural population relative to the national average. These results are likely a result of differences in the regional distribution of population, patterns of housing starts and the preference for decks in each region.

Table 15. Population centers where the respondents undertake most of their business

	Northeast (n=95)	Midwest (n=90)	South (n=117)	West (n=66)	Overall US (n=372)
Urban/Suburban	**42.7%**	54.4%	**68.1%**	**64.2%**	57.5%
Small Town	**40.6%**	25.6%	25.2%	**14.9%**	27.4%
Rural	16.7%	**20.0%**	**6.7%**	**20.9%**	15.1%

In this section of the report the contingency tables will be represented and interpreted using similar visual clues. The following general rules are used for creating the tables:

1. Color coding will be used only when a significant ($p < 0.05$) Pearson's Chi-Square value for the contingency tables is observed.
2. If the Pearson's Chi-Square results produce statistically significant results, given the degrees of freedom, it indicates that there is some significant difference between the cells within the table. Hence, the cells that have significantly higher or lower values are color coded. The cells with observed values similar to the expected values are not colored.

Box 1. Interpretation guide for the contingency tables presented in this section of the report

In the US residential construction industry, decks are generally built by (i) deck builders who specialize in building decks on new or existing homes or (ii) homebuilders or residential contractors who are involved in building spec decks or custom decks on existing or new homes, or (iii) remodelers whose business includes (but is not specifically focused on) remodeling existing decks or building new decks on existing homes. A small proportion of the residential decks built in the US are undertaken by deck designers, architects or outdoor construction specialists – who may be involved in deck building in various capacities. Among the survey respondents, 58% identified themselves as homebuilders or residential contractors involved in building decks, 24% identified themselves as remodelers and 12% identified themselves as deck builders. The other category consisting of architects, outdoor living specialist and specialty constructors represented almost 4% of the sample surveyed (Table 16).

Table 16. Respondents' primary nature of business.

Primary nature of business	Number of Respondents	Percentage of Respondents
Deck Builder	46	12.4%
Deck Designer	7	1.9%
Home Builder/Contractor	216	58.1%
Residential Remodeler	89	23.9%
Other	14	3.8%

Previous research by CINTRAFOR has found that the vast majority of firms in the deck building and residential construction industries are small to medium-sized firms, a finding confirmed by this research, Table 17. Over 93% of deck builders surveyed have annual sales of $2 million or less. Small firms, defined as having annual revenue below $1 million represented the vast majority (82.4%) of the respondents in the survey. This survey result is also in confirmation with previous deck builder surveys conducted by CINTRAFOR, although a higher proportion of the homebuilders in this sample were in the middle to higher income group, as compared to deck builders and remodelers.

Table 17. Approximate sales revenue reported by the survey respondents in 2008.

Annual Sales revenue	Number of Respondents	Percentage of Respondents
0 - $100,000	70	19.5%
$100,001 - $250,000	75	20.9%
$250,001 - $500,000	78	21.7%
$500,001 - $1,000,000	73	20.3%
$1,000,001 - $2,000,000	38	10.6%
$2,000,001 - $3,000,000	11	3.1%
$3,000,001 - $5,000,000	7	1.9%
Over $5,000,000	7	1.9%

Note: Given the sensitive nature of the information, a response to this question was made optional in the web-based survey and 13 respondents declined to respond. Only the valid percentages, pertaining to the respondents of this question are reported.

On average, the number of decks built by the respondents in 2008 was 12, Table 18. However, the number of decks built by survey respondents in 2008 varied widely; ranging between 1 and 250. More than 61% of the respondents indicated building between 3 to 8 decks in 2008 and less than 12% of the respondents indicated building more than 20 decks in 2008. The average size of the decks built by survey respondents ranged between 100 square feet and 5,000 square feet. However, the main range of deck size varied between 200 square feet and 500 square feet, with 63% of the respondents falling in this range. The overall national average of the size of the decks built in 2008 was 438 square feet. The average cost of the decks built in the US in 2008 was calculated to be $7,319 or $18.62 per square foot, which is marginally higher than the results found in the 2004 CINTRAFOR decking study. More than 44% of deck building revenue in 2008 came from repair and remodeling projects with an additional 42% being generated from building new decks on existing houses. Only 14% of total deck building revenue came from building new decks on new housing, a trend which can be attributed to the housing crisis.

Table 18. Information on decks built and project type in 2008, by region.

		Northeast (n=95)	Midwest (n=90)	South (n=117)	West (n=66)	Overall US (n=372)
Basic information on decks	Average deck size (sq. ft.)	463	405	414	486	438
	Average number of decks built	9	11	15	14	12
	Average cost per deck	$8,093	$6,630	$6,026	$9,533	$7,319
	Average cost per sq. foot	$19.99	$18.92	$16.27	$20.55	$18.62
Percentage of decks built by project type	Decks on existing homes	46.3%	43.1%	39.8%	38.8%	42.5%
	Decks on new homes	11.8%	18.3%	16.6%	10.0%	13.9%
	Repair/replacement decks	41.8%	38.6%	43.5%	51.2%	43.6%

The survey data reveals some differences in deck characteristics based on geographic location, although the average size of the decks built in the different regions of the country was not significantly different from the national average of 438 square feet, Table 18. The average number of decks built by the respondents from the Northeast was 9 decks, whereas the average number of decks built by the respondents from the South was 15 decks. The average unit construction costs of decks built in the Northeastern and Western regions of the country was approximately $20 per square foot, whereas, the average unit construction cost of the decks built in the Southern region of the country was estimated at $16 per square foot. The average cost of decks built in the Western region of the country was significantly higher than the national average. From Table 18 it may be observed that in the West more than half (51.2%) of the deck building revenue came from repair and remodeling projects, with only 10% of all deck building revenue coming from building new decks on new homes. Compared to other regions of the country, the deck builders in the Midwest earned a higher (18.3%) proportion of their overall deck building revenue from building new decks on new homes. However, across all regions of the country, repair and remodeling projects and building new decks on existing houses strongly dominated deck builder's revenue streams.

Table 19. Information on decks built and project type in 2008, by business type.

		Deck Builders (n=46)	Deck Designers (n=7)	Homebuilders/ Contractors (n=216)	Deck Repair/ Remodelers (n=89)	Others (n=14)	Overall US (n=372)
Basic information on decks	Average deck size (sq. ft.)	380	458	470	389	423	438
	Average number of decks built	28	10	10	9	11	12
	Average cost per deck	$8,988	$11,500	$7,237	$6,598	$5,114	$7,319
	Average cost per sq. foot	$23.35	$24.48	$17.53	$18.74	$15.74	$18.62
Percentage of decks built by project type	Decks on existing homes	41.9%	25.0%	44.6%	40.4%	35.0%	42.5%
	Decks on new homes	13.4%	35.0%	18.1%	3.5%	15.0%	13.9%
	Repair/replacement decks	44.7%	40.0%	37.3%	56.1%	50.0%	43.6%

Significant differences can be observed in the characterisitcs of the decks built based on the survey respondents' primary type of business, Table 19. For example, deckbuilders built almost 3 times as many decks as homebuilders, contractors or remodelers. The unit construction cost of the decks built also significantly varied among the respondents with different primary nature of business. The deck builders and deck designers indicated that the average construction cost of their decks was approximately $24 per square foot, whereas the decks built by the homebuilders, contractors and remodelers ranged between $18 and $19 per square foot. Moreover, the average cost of the decks built by deck designers was almost twice ($11,500) the cost of the decks built by remodelers ($6,598) and respondents categorized in the other category ($5,114). Significant differecences were also observed in the sources of revenue of the respondents based on their primary type of business. It can be observed that 35% of the revenue generated by deck designers came from building new decks on new homes, which was significanly higher that the other groups. While it was expected that deck repair and remodeling projects would be the primary source of revenue for the deck remodelers (56.1%), it is interesting to note that deck repair and remodeling projects were also a major source of income for the other groups as well, including deck builders (44.7%), deck designers (40%) and homebuilders/contractors (37.3%).

Table 20. Information on decks built and project type in 2008, by population center focus of business.

		Rural (n=46)	Small Town (n=7)	Urban (n=14)	Overall US (n=372)
Basic information on decks built	Average deck size (in sq. ft.)	428	476	422	438
	Average number of decks built	8	9	15	12
	Average cost per deck	$7,452	$7,038	$7,418	$7,319
	Average deck cost per sq. foot	$20.83	$16.54	$19.04	$18.62
Percentage of decks built by project type	Decks on existing home	44.5%	38.9%	43.6%	42.5%
	Decks built on new home	15.3%	13.8%	13.6%	13.9%
	Repair/replacement decks	40.2%	47.3%	42.8%	43.6%

The respondents were also grouped by the population centers they primarily cater to and the basic information on the decks built by each of these groups are summarized in Table 20. The average size of decks built by the respondents catering to small towns tends to be larger (476 square feet) than their counterparts catering to rural or urban populations. Respondents catering to urban populations built more decks (15 decks) in the year 2008 as compared to the respondents catering to rural or small town population (8 and 9 decks, respectively). The average unit construction cost of the decks built by the respondents based on their primary population center orientation was not significantly different. Moreover, the revenue generated from the different decking project types was also similar among the groups catering to urban, rural or small town populations.

Material Use Changes

The market for residential decking materials in North America has become increasingly competitive over the past decade. Moreover, the regulatory constraints on timber harvests from public forests and competition from substitute materials have significantly altered the competitive environment within the deck building industry. Past studies have shown that wood plastic composites (WPC) and plastic lumber (PVC) are increasingly replacing treated softwood lumber and naturally durable species (i.e., redwood, western red cedar and tropical hardwoods) in deck building applications (with the exception of decking use in substructure applications). The survey results indicate that this trend of gradual market displacement of naturally durable species and treated softwood lumber continues. From Figure 21 it can

be observed that over 66% of the respondents indicated that they have increased their usage of WPC while 37% increased their usage of PVC between 2006 and 2008. Equally important, of greater concern to the forest products industry, is the fact that during the same time period a high percentage reported decreasing their usage of pressure treated lumber (31%), western red cedar (36%) and redwood (35%). It may also be noted that in 2008 only 5% of the respondents indicated that they have never used wood plastic composite as a decking material, which shows the effective dissemination of the product in the US decking market in last 10 years.

To help highlight the changing trends in material use, a simple rating scale called the Material Trend Scale (MTS) was developed. In the MTS, the percentage of decreased use for a product is subtracted from the percentage of increased use for that same product, resulting in a positive or negative MTS value. A large positive value would correspond to strong increases in the use of a decking material (suggesting that builders are happy with a product and increasing their use of that product) whereas a negative value would correspond to decreased use of a decking material (suggesting that builders are not happy with the product and are reducing their use of that product). For example, the MTS value of WPC decking was the highest of all the materials considered with a value of 59.7% (67%-7.3%). Of course, it is important to also take into consideration the percentage of respondents who indicated that their use of the material has remained unchanged as well as the percentage of respondents who indicated that they have never used the material. For the total sample, only three materials displayed positive values: WPC (MTS value = 59.7%), plastic lumber (MTS value = 29.3%) and tropical hardwood (MTS value = 0.8%), although it is useful to note that almost 47% of the respondents have never used tropical hardwoods and 30% of the respondents indicated never using plastic lumber as a decking material. Based on the MTS values, deck builders have sharply reduced their use of redwood decking (MTS value = -33%) closely followed by western red cedar (MTS value = -30%) and pressure treated lumber (MTS value = -14%).

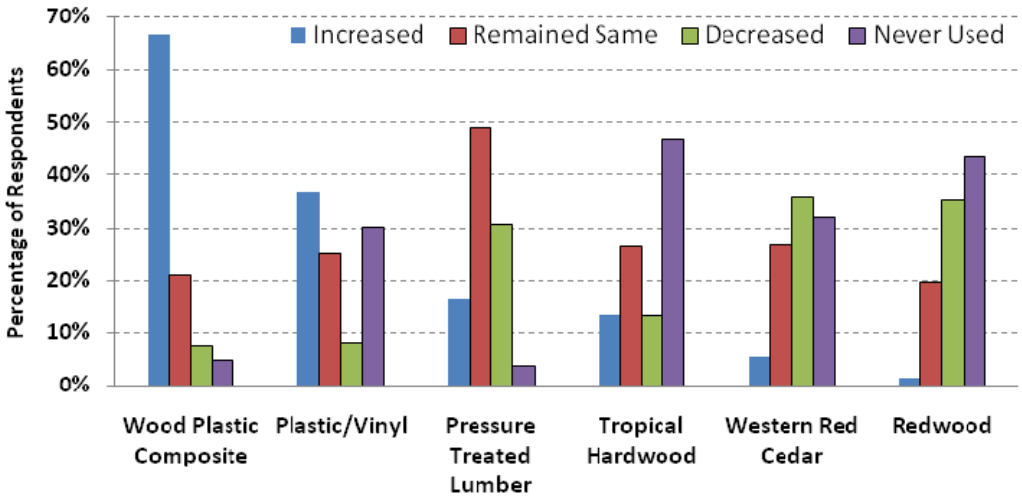


Figure 21. Changes in decking material usage between 2006 and 2008.

Table 21. Change in Material Usage between 2006 and 2008, by region of operation.

		Northeast	Midwest	South	West	Pearson χ^2 Tests
Western Red Cedar	Increased	1.0%	11.1%	5.0%	4.5%	**Sig. = 0.03** (χ^2 value=18.74, df=9)
	Remained Same	25.0%	32.2%	26.1%	26.9%	
	Decreased	43.8%	26.7%	30.3%	43.3%	
	Never Used	30.2%	30.0%	38.7%	25.4%	
Redwood	Increased	1.0%	1.1%	0.0%	6.0%	**Sig. = 0.00** (χ^2 value=27.89, df=9)
	Remained Same	13.5%	22.2%	20.2%	25.4%	
	Decreased	32.3%	30.0%	32.8%	47.8%	
	Never Used	53.1%	46.7%	47.1%	20.9%	
Pressure Treated Lumber	Increased	11.5%	17.8%	21.0%	14.9%	**Sig. = 0.00** (χ^2 value=33.04, df=9)
	Remained Same	35.4%	55.6%	51.3%	53.7%	
	Decreased	49.0%	25.6%	26.1%	20.9%	
	Never Used	4.2%	1.1%	1.7%	10.4%	
Wood Plastic Composite	Increased	72.9%	66.7%	60.5%	70.1%	**Sig. = 0.70** (χ^2 value=6.43, df=9)
	Remained Same	17.7%	20.0%	25.2%	17.9%	
	Decreased	5.2%	8.9%	9.2%	4.5%	
	Never Used	4.2%	4.4%	5.0%	7.5%	
Tropical Hardwood	Increased	20.8%	11.1%	8.4%	16.4%	**Sig. = 0.02** (χ^2 value=20.17, df=9)
	Remained Same	26.0%	20.0%	28.6%	31.3%	
	Decreased	13.5%	6.7%	17.6%	11.9%	
	Never Used	39.6%	62.2%	45.4%	40.3%	
Plastic/Vinyl	Increased	50.0%	35.6%	32.8%	26.9%	**Sig. = 0.01** (χ^2 value=20.73, df=9)
	Remained Same	24.0%	28.9%	26.1%	19.4%	
	Decreased	5.2%	7.8%	10.9%	6.0%	
	Never Used	20.8%	27.8%	30.3%	47.8%	

The survey results indicate significant regional differences in the material usage change patterns for five of the six decking materials included in the survey, Table 21. The only decking material with consistant material usage change trends for all regions of the country was WPC, with the majority of the respondents from each region indicating that they have increased their usage of WPC. A significantly higher proportion of respondents in the Midwest indicated that their usage of WRC had increased between 2006 and 2008, whereas a signficantly lower proportion of respondents in the Northeast region reported that their consumption of WRC had increased. As a result of the limited availability of RW decking beyond the western region of the US, almost half of the respondents in the Northeast, Midwest and Southern regions indicated that they have never used RW, whereas only a fifth of the respondents in the Western region indicated that they had never used RW. It should also be noted that relative to other regions of the country, a significantly higher proportion (49%) of respondents in the Northeast have decreased their usage of pressure treated lumber in the past two years while a significantly higher proportion of these same respondents reported that they have increased their usage of PVC decking. The reported increase in usage of PVC decking was significantly lower in the western region of the country. Finally, THW decking seemed to be least popular (or least available) among the respondents in the Midwestern region, with more than 62% of the respondents from this region reporting that they have never used THW decking material.

Table 22. Change in material use between 2006 and 2008, by population center focus of business.

		Rural	Small Town	Urban	Pearson χ^2 Tests
Western Red Cedar	Increased	7.1%	3.9%	5.6%	**Sig. = 0.70** (χ^2 value=3.86, df=6)
	Remained Same	28.6%	30.4%	25.7%	
	Decreased	26.8%	33.3%	38.3%	
	Never Used	37.5%	32.4%	30.4%	
Redwood	Increased	5.4%	0.0%	1.4%	**Sig. = 0.02** (χ^2 value=15.09, df=6)
	Remained Same	21.4%	19.6%	19.6%	
	Decreased	41.1%	25.5%	37.4%	
	Never Used	32.1%	54.9%	41.6%	
Pressure Treated Lumber	Increased	23.2%	12.7%	16.8%	**Sig. = 0.54** (χ^2 value=5.04, df=6)
	Remained Same	46.4%	52.9%	47.2%	
	Decreased	25.0%	32.4%	31.8%	
	Never Used	5.4%	2.0%	4.2%	
Wood Plastic Composite	Increased	62.5%	68.6%	67.3%	**Sig. = 0.78** (χ^2 value=3.24, df=6)
	Remained Same	26.8%	18.6%	20.1%	
	Decreased	3.6%	7.8%	7.9%	
	Never Used	7.1%	4.9%	4.7%	
Tropical Hardwood	Increased	17.9%	9.8%	14.5%	**Sig. = 0.19** (χ^2 value=8.71, df=6)
	Remained Same	14.3%	25.5%	29.9%	
	Decreased	10.7%	14.7%	12.6%	
	Never Used	57.1%	50.0%	43.0%	
Plastic/Vinyl	Increased	28.6%	43.1%	36.0%	**Sig. = 0.52** (χ^2 value=5.21, df=6)
	Remained Same	30.4%	21.6%	25.2%	
	Decreased	7.1%	9.8%	7.0%	
	Never Used	33.9%	25.5%	31.8%	

The study also analyzed the differences in the material usage change trends among the respondents catering to populations living in urban, rural or small towns, Table 22. The only significant result obtained from this analysis was that a higher than average proportion of respondents working in small towns have never used Redwood. No other significant differences in material usage change trends were identified, suggesting that the decking material usage changes between 2006 and 2008 have been relatively similar within rural areas, urban areas and small towns. This similarity in the material usage change trends provides an indication of homogeneity of demand and preferences for decking materials across the different population centers defined in this research.

Table 23. Change in Material Usage between 2006 and 2008, by business type.

		Deck Builder	Homebuilder/ Contractor	Remodeler	Pearson χ^2 Tests
Western Red Cedar	Increased	0.0%	6.0%	6.7%	**Sig. = 0.36** (χ^2 value=6.57, df=6)
	Remained Same	30.4%	25.0%	30.3%	
	Decreased	30.4%	38.4%	29.2%	
	Never Used	39.1%	30.6%	33.7%	
Redwood	Increased	0.0%	2.3%	1.1%	**Sig. = 0.40** (χ^2 value=6.21, df=6)
	Remained Same	13.0%	20.8%	19.1%	
	Decreased	28.3%	36.1%	37.1%	
	Never Used	58.7%	40.7%	42.7%	
Pressure Treated Lumber	Increased	15.2%	17.6%	15.7%	**Sig. = 0.41** (χ^2 value=6.1, df=6)
	Remained Same	47.8%	45.4%	56.2%	
	Decreased	37.0%	33.3%	23.6%	
	Never Used	0.0%	3.7%	4.5%	
Wood Plastic Composite	Increased	65.2%	67.1%	67.4%	**Sig. = 0.08** (χ^2 value=11.03, df=6)
	Remained Same	23.9%	21.3%	19.1%	
	Decreased	8.7%	4.6%	12.4%	
	Never Used	2.2%	6.9%	1.1%	
Tropical Hardwood	Increased	8.7%	14.8%	14.6%	**Sig. = 0.27** (χ^2 value=7.52, df=6)
	Remained Same	39.1%	25.5%	20.2%	
	Decreased	6.5%	14.4%	14.6%	
	Never Used	45.7%	45.4%	50.6%	
Plastic/Vinyl	Increased	34.8%	36.6%	36.0%	**Sig. = 0.45** (χ^2 value=5.76, df=6)
	Remained Same	34.8%	25.0%	23.6%	
	Decreased	8.7%	6.5%	12.4%	
	Never Used	21.7%	31.9%	28.1%	

Identified by their primary nature of business, the three largest groups represented in our sample are deck builders, home builders and deck remodelers, Table 23. In this case five out of the six decking materials included in the survey showed no significant differences in use change between these groups. The only significant difference identified was in the usage of WPC, where a significantly higher proportion of deck remodelers indicated that their usage of the product had decreased over the past two years. In contrast, fewer homebuilders and contractors indicated that their usage of WPC had decreased. Similarities in the material usage changes trends indicated by the respondents in each of the different businesses suggests that the competition in the US decking market has led to increasing homogeneity in the types of decking materials used within each industry segment.

Decking material attribute importance ratings

The importance ratings reported by deck builders and home builders for different material attributes is useful in understanding the relationship between material attributes and their influence on the material specification process for decking materials. Figure 22 shows the relative importance ratings for the various decking material attributes. To obtain the importance ratings, the survey respondents were asked to rate the importance of the various decking material attributes with respect to their decision-making process, using a scale of 1 – 7, where 1 is not important, 4 is neutral and 7 is extremely important.

Consistent material quality and beauty of the decking material were rated as the most important of the decking material attributes, followed by longevity, natural decay resistance, resistance to splintering and minimal surface checking. Low heat retention in service, reduced environmental impact and low material

cost were rated as the least important decking material attributes. The red vertical line in the figure represents the overall mean (5.83) for the importance ratings. The attributes which have importance rating scores greater than the mean may be considered as attributes with above average importance. The red section of the bars indicates ratings above the average level. Consistent material quality, beauty and longevity of the decking material emerged as the three most important attributes influencing the selection of decking materials. In contrast, survey respondents indicated that they consider low material cost, reduced environmental impact and low heat retention in service as the least important attributes when they are specifying decking materials.

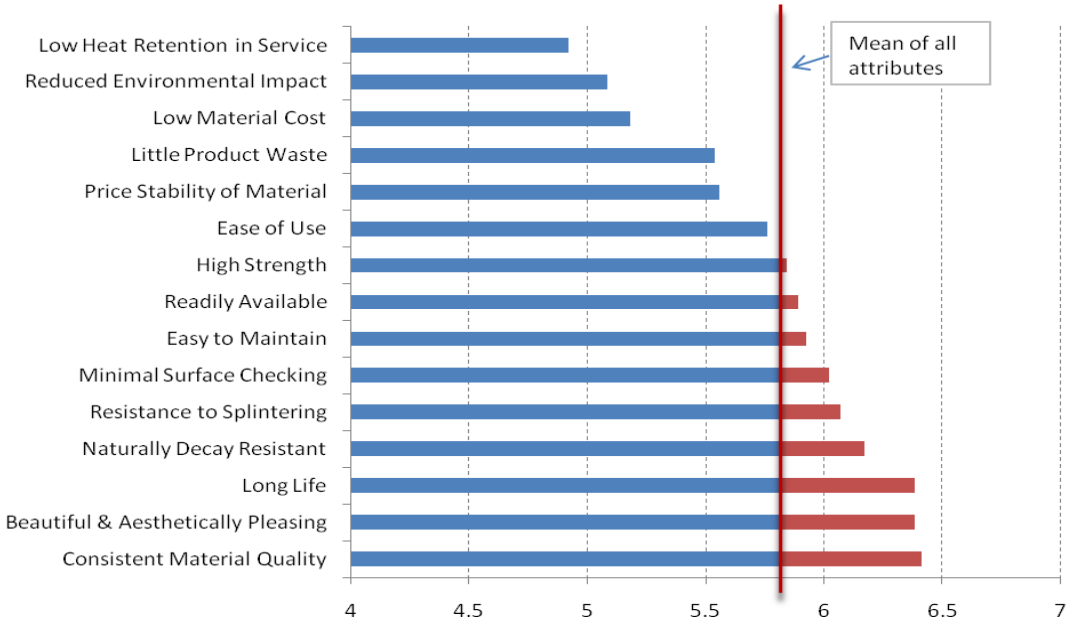


Figure 22. Decking Materials Attribute Importance Ratings

The summary data as presented in Figure 22 suggests that the material attributes may be segmented into three groups. The most important attributes, those with an importance rating higher than 6.3, included consistent material quality, beauty and long life. This top three attribute list is identical to the results obtained from the 2004 decking material study by CINTRAFOR. The second group of attributes, those with an above average importance rating (rating from 5.83 to 6.3), included natural decay resistance, resistance to splintering, minimal surface checking, ease of maintenance, ready availability and high strength. The last group of attributes, those with below average importance ratings, included ease of use, low environmental impact, little product waste, low material cost, price stability and low heat retention.

Environmental Perception

The survey respondents were asked to rank the top three environmental attributes of decking materials in terms of their effectiveness in protecting the environment. Among the survey respondents, usage of recycled materials was ranked the most important environmental attribute, followed by wood sourced from sustainably managed forests. Decking materials made with no preservatives or chemicals and certified/eco-labeled decking materials were ranked third and fourth (Figure 23). It is interesting to note that though wood sourced from sustainably managed forests was ranked higher in the list, certified wood was further down in the list though certified wood essentially indicates that the wood is sourced from sustainably managed forests. This may be either due to low awareness regarding certified wood, low confidence in the certification process, or an unwillingness to pay a high price premium for a labeled product.

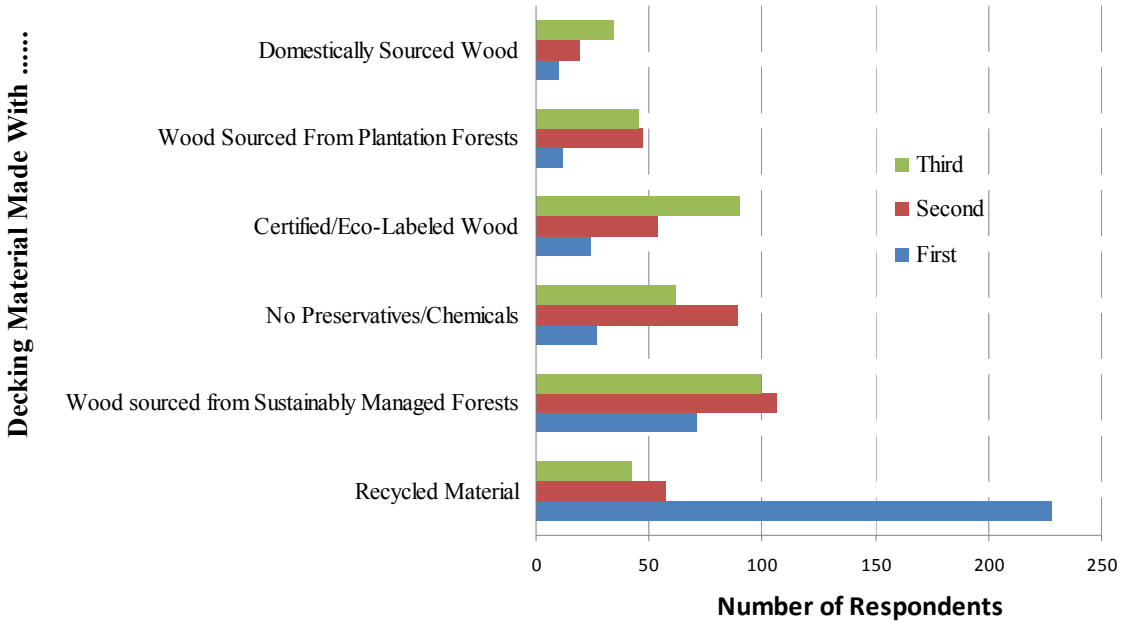


Figure 23. Ranking of environmental attributes of the decking materials

Here it may be noted that 'wood sourced from sustainably managed forests' and 'eco-labeled/certified wood' have been included as two separate categories, although it might be argued that these are essentially the same thing and that they should be considered together as a single category. However, these two categories were kept separate for two reasons. First, previous CINTRAFOR studies have found that there is a low level of awareness among deck builders regarding the existence of certified wood. Secondly, previous studies by CINTRAFOR and by other researchers (see Vlosky 1988) have indicated that there is a high degree of distrust or lack of understanding, or both, regarding the certification/eco-labeling process. Since we wanted neither of these factors to influence the results of this study, the two attributes were coded separately. In the following section of this report we use a cluster analysis to identify the latent traits among the respondents based on these attribute rankings.

The differences in the regional perception of the environmental attributes of the decking materials are presented in Table 24. A χ^2 analysis was conducted to identify any statistical differences among the respondents from different regions of the country. The analysis returned a χ^2 value of 12.9 with 15 degrees of freedom which was not significant at the .05 level of significance. Hence, it can be stated that the respondents from all regions of the country uniformly ranked usage of recycled materials as the most important environmental aspect of decking materials followed by wood sourced from sustainably managed forests.

Table 24. Attributes ranked as most important environmental feature, by region

	Northeast	Midwest	South	West
Recycled Material	64%	63%	59%	60%
No Preservatives/Chemicals	7%	10%	8%	3%
Wood sourced from Sustainably Managed Forests	20%	16%	21%	19%
Wood Sourced From Plantation Forests	2%	4%	3%	4%
Domestically Sourced Wood	0%	2%	5%	3%
Certified/Eco-Labeled Wood	7%	4%	5%	10%

Cluster Analysis – environmental orientation of the respondents

A cluster analysis was used to identify common traits among survey respondents and help to classify the respondents into clusters in terms of their common perceptions of the importance of various environmental attributes of decking materials. The following cluster analysis is based on the environmental attribute rankings presented in Figure 22.

Objectives for conducting the cluster analysis

The primary objective of conducting this cluster analysis was to identify the common cognitive characteristics within the respondents in terms of their appreciation of various environmental attributes of the decking materials. The secondary objective of the cluster analysis was to estimate the relative size of the industry segments in terms of their perception of the environmental aspects of the various decking materials. This section also explores the role of the environmental attributes in influencing the respondents' usage of decking materials.

Methodology and Results

A Hierarchical Cluster analysis was used to identify the segments within the survey population. Cluster analysis is used to identify common traits among the respondents by measuring the proximity between them based on some distance measure. In this case the distance measures were developed based on the respondents' ranking of the various environmental attributes. Ward's Sum of Squares was used with a Camberra metric index as the distance measure. In the hierarchical cluster analysis, individuals are grouped into smaller clusters based on their distance scores and smaller clusters are joined together into larger clusters interactively. An analysis of the dendrogram obtained from the analysis combined along with a subsequent analysis of the mean '*niche width*' confirmed that a three group solution was the most efficient for this dataset.

An analysis of the differences between the three clusters is summarized in Table 25. A chi-square test was conducted on all six variables for each of the three clusters. The chi-square results indicated that the ratings of the environmental attributes for all three clusters were significantly different. Previous marketing research suggests that the material attribute rated as being the most important plays a significant role in material selection decision; hence, in developing a nomenclature for each of the clusters, the material attribute listed first for each cluster is accorded the highest importance. The environmental attribute ranked second for each of the clusters was also considered to be important in identifying the cognitive characteristics of the respondents in that cluster.

Table 25. Classification of the clusters

Importance Level	Environmental Attributes	Pro-recycle (Cluster-1)	Pro-wood (Cluster-2)	Mixed-opinion (Cluster-3)
		N=208	N=87	N=77
FIRST	Recycled Material	**90%**	0%	**53%**
	No Preservatives/Chemicals	3%	17%	8%
	Wood sourced from Sustainably Managed Forests	7%	**38%**	**30%**
	Wood Sourced From Plantation Forests	0%	6%	9%
	Domestically Sourced Wood	0%	11%	0%
	Certified/Eco-Labeled Wood	0%	**28%**	0%
SECOND	Recycled Material	0%	**66%**	0%
	No Preservatives/Chemicals	**36%**	13%	5%
	Wood sourced from Sustainably Managed Forests	**41%**	15%	10%
	Wood Sourced From Plantation Forests	15%	6%	13%
	Domestically Sourced Wood	6%	1%	6%
	Certified/Eco-Labeled Wood	2%	0%	**65%**
THIRD	Recycled Material	0%	11%	42%
	No Preservatives/Chemicals	15%	16%	22%
	Wood sourced from Sustainably Managed Forests	25%	26%	30%
	Wood Sourced From Plantation Forests	14%	13%	5%
	Domestically Sourced Wood	11%	13%	1%
	Certified/Eco-Labeled Wood	35%	21%	0%

From Table 25 it can be observed that 90% of the individuals grouped in the first cluster (first column) indicated that the presence of recycled materials in a decking material was the most important environmental attribute. Only 7% of the respondents in this cluster considered that wood sourced from sustainably managed forest was the most important environmental attribute and not a single individual in this group considered eco-labeled wood to be the most important indicator of an environmentally friendly decking material. Moreover, 36% of the individuals in the first cluster thought that the lack of preservatives in a decking material was the second important characteristic of the decking materials which is highest proportion recorded for this attribute across all of the clusters. While 41% of the respondents in the first cluster indicated that wood sourced from sustainably managed forests was the second most important environmental attribute of decking materials, the overwhelming support for recycled materials within the first cluster strongly supports the conclusion that this cluster consists of individuals who are pro recycling. Based on this analysis, this group was designated as the PRO-RECYCLE cluster. A total of 56% of the respondents (208 respondents) were included in the pro-recycle cluster.

The analysis showed that none of the respondents in the second cluster rated the usage of recycled material as the most important environmental attribute (Table 25). In contrast, 38% of the respondents rated wood sourced from sustainably managed forests as being the most important environmental attribute while 28% of the respondents rated certified wood as being the most important environmental attribute. Considering all of the wood based environmental attributes showed that 83% of the respondents included in this category rated one of the wood attributes as being the most important attribute. Hence, we named this cluster the PRO-WOOD cluster. A total of 23% of respondents (87 respondents) were included in the pro-wood cluster.

In the third cluster 53% of the respondents rated the usage of recycled materials as the most important environmental attribute and 30% of the respondents rated wood sourced from sustainably managed forests as the most important attribute. Moreover, 65% of the respondents in this cluster indicated that they consider certified wood as being the second most important environmental attribute. This group has traits of both of the first two clusters, with the only difference being the high proportion of individuals ranking certified wood as their second choice of environmental attribute. Hence, we name this group MIXED-OPINION cluster. A total of 21% of respondents (77 respondents) were included in the mixed opinion cluster.

Further analysis of characteristics of the Clusters

A further analysis was also undertaken to identify the differences in the demographic factors among the clusters and only one of the demographic variables was significantly different between the clusters. A higher proportion of urban respondents were included in the pro-recycle category as compared to small town respondents. None of the other demographic variable groups shows any significant differences, indicating that respondents from all the regions of the country, across all firm sizes and business types are proportionately represented in each of these three clusters.

Environmental rating of decking materials:

To better understand how the material attribute rankings affect the environmental impact ratings of the individual decking materials, we conducted an F-test of the ratings presented in Table 26. With the singular exception of pressure treated lumber, each of the decking materials was rated as being significantly different by the respondents in each cluster. The most striking difference in the clusters 1 and 2 is evident in Tables 25 and 26. The pro-recycle cluster rated the positive environmental aspect of WPC and Plastic as being much higher than the pro-wood cluster. In contrast, the pro-wood cluster rated the environmental attributes of western red cedar and tropical hardwoods as significantly higher than the pro-recycle cluster. Hence, from this study it can be conclusively stated that the message highlighting the usage of recycled materials in WPC and Plastic decking products has successfully resonated in the decking market and that this has provided these decking materials with a positive environmental image for a significant proportion of deck builders. On the other hand, a second segment of the decking industry that places a high value on sustainable forest management identified WRC and tropical hardwood as being the most environmentally friendly decking materials. Moreover, of all the clusters, the pro-wood cluster had the lowest importance rating regarding the environmental impact of using recycled materials in WPC and plastic decking products.

Table 26. Differences in environmental impact ratings among the groups

Environmental Impact Rating of	Pro-recycle (Cluster-1)	Pro-wood (Cluster-2)	Mixed-opinion (Cluster-3)
Western Red Cedar*	3.96	**4.63**	4.36
Pressure Treated Lumber	3.62	3.72	3.64
Wood Plastic Composite*	**5.11**	4.45	4.55
Tropical Hardwood*	3.48	**4.18**	3.71
Plastic/Vinyl*	**4.60**	3.94	4.08

* - between cluster ratings significantly different at 95% confidence level

It may also be noted that more than 56% of the respondents surveyed in this study were included in the pro-recycle cluster while just 23% of the respondents were assigned to the pro-wood cluster. This hints at the success of the WPC and plastic decking industry in communicating their message regarding the positive environmental impact of using recycled materials in their decking materials. These results

emphasize the need for the US forest products industry to develop and communicate their message regarding the environmental benefits of using wood decking materials derived from sustainably managed forests.

Surface Material Usage:
Reduced environmental impact was rated as one of the least important attributes in influencing the purchase decision among the list of attributes provided to the respondents. Hence, the decision to specify a single decking material is likely to be influenced by other more important attributes. However, the F-statistic for the percentage material usage by the respondents in each of these clusters indicated that the pro-recycle group used a significantly higher proportion of WPC whereas the pro-wood group used a significantly lower proportion of WPC for deck surfaces (Table 27). Moreover, the pro-wood group was found to use a significantly higher proportion of tropical hardwood relative to the other groups. While this analysis suggests that a conclusive causal relation between the environmental attributes and material usage cannot be drawn, it can be stated that the perception of the environmental attributes of decking materials and the subsequent specification of decking materials used in deck surfaces are closely related. Hence, these results show the increased importance of the environmental attributes on the subsequent specification of decking products within the US decking industry.

Table 27. Differences in decking surface material usage among the groups

Decking Material	Pro-recycle (Cluster-1)	Pro-wood (Cluster-2)	Mixed-opinion (Cluster-3)
Western Red Cedar	9.4	11.0	13.6
Redwood	6.2	7.0	8.1
Pressure Treated Lumber	29.1	29.9	32.4
Wood Plastic Composite	**33.1**	25.2	29.1
Tropical Hardwood	7.3	**10.2**	4.4
Plastic/Vinyl	13.9	12.7	11.7

Familiarity with Certified Wood

Survey respondents were also asked questions regarding their level of familiarity with certified wood. More than 50% of the respondents indicated that they were aware of certified wood but had never used it, Figure 24. Only 20% of the respondents said that they are not aware of certified wood, which is significantly lower than the number the CINTRAFOR study showed in the 2004 decking material study. Moreover, 28% of the respondents indicated that they had used certified wood in the past which is approximately 10% higher than the 2004 study results. The results show not only an increased awareness of certified wood among deck builders, but also increased usage of certified wood since 2004.

Figure 24. Respondent familiarity with certified wood.

From Table 28 it may be noted that 12% of the respondents who have used certified wood indicated eco-labeling as the most important environmental feature of decking materials, whereas, only 1% of the respondents who are not aware of certified wood indicated this eco-labeling as the first option. It may also be noted that 20% of the respondents who are not aware of certified wood indicated that wood sourced from sustainably managed forests is the most important environmental attribute of decking materials. Though eco-labeling is supposed to indicate that the wood has been sourced from sustainably managed forests, 19% of the aware non-users of certified wood and 17% of the users of certified wood indicated 'wood sourced from sustainably managed forests' as the most important environmental attribute of the decking materials as opposed to eco-labeling. This indicates that there is not only a lack awareness of certified wood among the respondents but also a lack of reliance on the certification process which prompted more respondents to choose wood from sustainably managed forests over certified wood, Table 28.

Table 28. Attributes ranked as most important environmental feature, by familiarity with certified wood

Environmental Attributes	Familiarity with Certified Wood		
	Not aware of certified wood	Aware of certified wood but never used it	Have used certified wood
Recycled Material	61%	63%	58%
No Preservatives/Chemicals	11%	6%	8%
Wood sourced from Sustainably Managed Forests	20%	19%	17%
Wood Sourced From Plantation Forests	3%	4%	3%
Domestically Sourced Wood	4%	3%	2%
Certified/Eco-Labeled Wood	1%	6%	12%

Reasons for using certified wood

The study also explored the perceptions of survey respondents about the various advantages of using certified wood. Based on preliminary interviews with homebuilders and deck builders, four advantages for using certified wood were identified in the survey. The respondents were asked to indicate if they agreed, disagreed or were unsure regarding each of the following four statements:

i. Homeowners are willing to pay a higher price for decks built with certified wood.
ii. Using certified wood positions my company as an environmentally friendly builder.
iii. Using certified wood increases the green building rating of the house.
iv. Using certified wood increases my company's green builder rating.

From the results presented in Figure 25, it can be observed that only 16% of the respondents indicated that they believe that homeowners are willing to pay a higher price for decks built with certified wood, while more than 40% of the respondents indicated that they believe homeowners are not willing to pay a premium for certified wood. The fact that more than 80% of the respondents indicated that they are either unsure or do not believe that the homeowners are willing to pay a premium for certified wood suggests that respondents believe that their customers lack awareness or appreciation of certified wood and are unlikely to pay a premium for it.

A majority of the respondents indicated that they agreed with the remaining three statements. Almost 70% of the respondents indicated that usage of certified wood in decks would increase the green rating of the house, while 60% of the respondents believed that using certified wood would enhance their company's reputation as an environmentally friendly builder and 60% felt that it would increase their company's green builder rating. It is important to note that less than 5% of the respondents disagreed with these three statements. Hence, respondents are aware of the green market benefits resulting from the usage of certified wood.

These results provide evidence that the green building movement in the US has created significant awareness among builders with respect to the environmental benefits of using certified wood. Given that the national residential green building programs and rating systems were formally introduced in the US in 2008, the rate at which they have created awareness among builders is impressive. Though certified wood currently plays a minor role overall green certification programs, it has helped increase the awareness of eco-labeled wood among homebuilders, deck builders and remodelers.

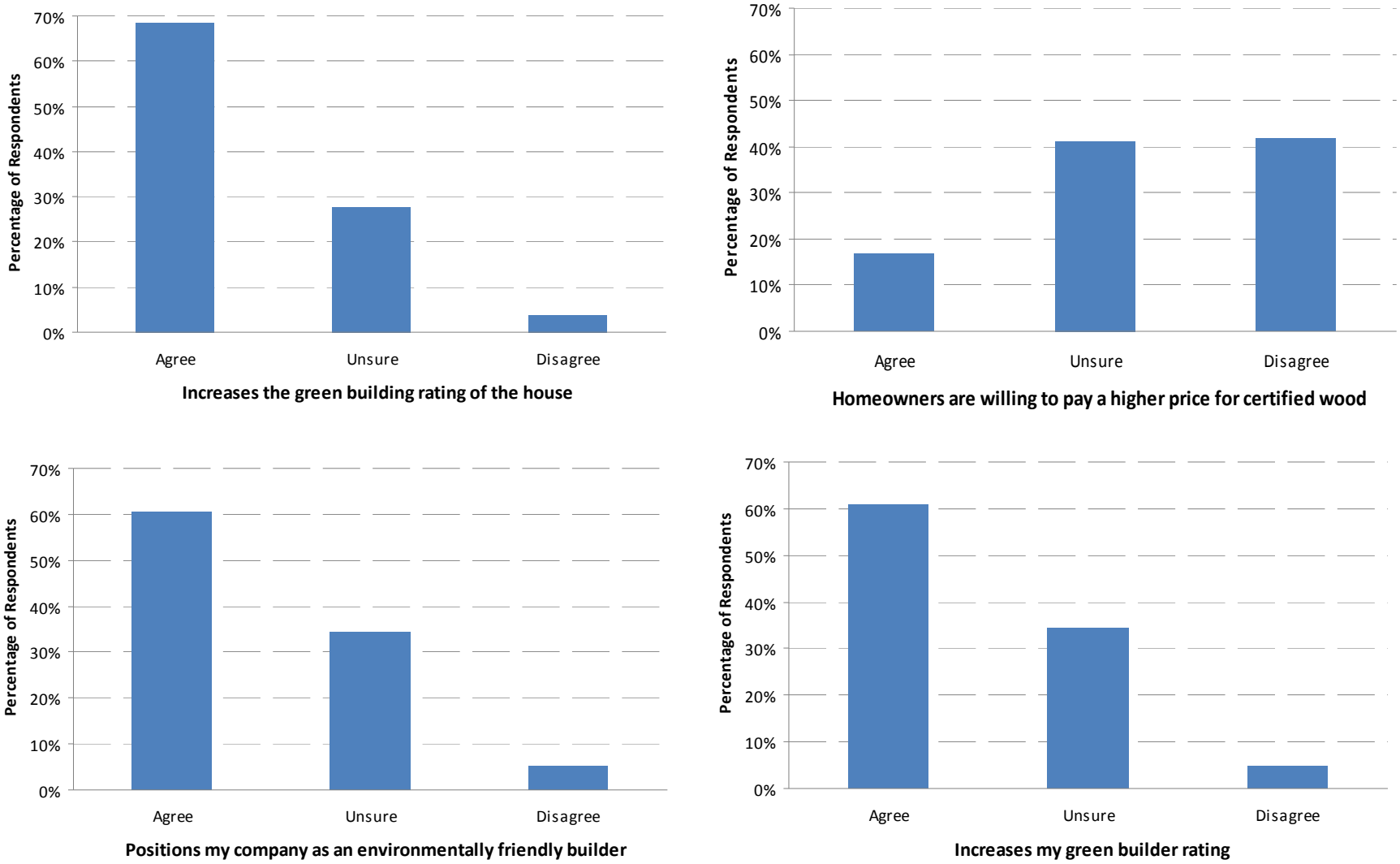


Figure 25. Respondents' perception on various stated advantages of using certified wood.

Role of familiarity with certified wood in the respondents' perception

Respondents' perception of the various advantages of using certified wood may be highly influenced by the respondents' level of familiarity with the product. In Table 29, a contingency table analysis was undertaken to analyze the influence of the respondents' familiarity with certified wood on their perception of the various advantages of using certified wood for decking applications. The analysis shows that each of the four statements produced significant results indicating that the respondents' familiarity with certified wood does influence their perception of the advantages of using certified wood. Significantly higher proportions (30%) of respondents who have used certified wood in the past believe that homeowners would be willing to pay a premium for decks built from certified wood. In contrast, only 14% of the respondents who are aware of certified wood but have never used it and just 7% of those who have not heard of certified wood believe that homeowners are willing to pay a premium for decks built from certified wood. Moreover, 86% of the respondents who reported being aware of certified wood but who had never used it were either unsure or disagreed with the statement that homeowners are willing to pay a premium for decks built from certified wood. This high level of uncertainty or disagreement regarding homeowners' willingness to pay a premium for certified wood, likely influences these respondents willingness to use certified wood. It should also be noted that independent of their level of familiarity with certified wood, approximately 40% of the respondents do not believe that homeowners are willing to pay a premium for using certified wood. Hence, it is evident that this attitude contributes to the lack of demand for certified wood by builders.

This study has also shown that a significantly higher proportion of the respondents who have used certified wood agreed to all the four statements. Similarly, it is not surprising that a higher proportion of respondents who indicated that they are not aware of certified wood stated that they are unsure of the benefits of using certified wood. Among the users of certified wood, approximately 80% of the respondents indicated that using environmentally certified wood increases the green building rating of the house and also positions them as an environmentally friendly builder. Whereas, only 57% of the respondents who were aware of certified wood but had never used it perceived that using certified wood would position them as an environmentally friendly builder. The significant difference in opinion regarding the benefits of using certified wood, suggests that builders who have used certified wood are significantly more likely to perceive that using certified wood helps to position their company as being environmentally friendly. This finding is noteworthy and can be used by industry managers and policy makers to enhance the appeal of the product.

Table 29. Respondents' perception on various stated advantages of using certified wood, given their familiarity with certified wood

Statements	Respondents' Opinion	Deck builders' familiarity with certified wood			Pearson χ^2 Tests
		Unaware of certified wood	Aware of certified wood but never used it	Have used certified wood	
Homeowners are willing to pay a higher price for certified wood	Agree	7%	14%	30%	**Sig. = 0.00** (χ^2 value=20.6, df=4)
	Unsure	50%	43%	31%	
	Disagree	43%	43%	39%	
Positions my company as an environmentally friendly builder	Agree	43%	57%	79%	**Sig. = 0.00** (χ^2 value=28.2, df=4)
	Unsure	53%	37%	16%	
	Disagree	4%	5%	6%	
Increases the green building rating of the house	Agree	55%	67%	81%	**Sig. = 0.00** (χ^2 value=18.8, df=4)
	Unsure	42%	30%	14%	
	Disagree	3%	3%	6%	
Increases my green builder rating	Agree	49%	60%	71%	**Sig. = 0.00** (χ^2 value=15.9, df=4)
	Unsure	49%	36%	21%	
	Disagree	3%	4%	8%	

Perceptions of Relative Material Attributes

Respondents were also asked to indicate the degree to which they perceived that the different decking materials possessed each of a variety of material attributes using a Likert-like scale, where a rating of 1 indicated that they perceived that the material did not possess the attribute at all and a rating of 7 meant that they perceived that the material possessed the attribute to a high degree. In interpreting the results presented in Table 30, we compare the mean score that each of the decking materials received for each attribute (e.g., the mean score for WRC on the long life attribute was 4.76) and compare them to the scores received by the other decking materials as well as to the mean score calculated for each attribute (e.g., the mean score for the long life attribute was 4.57). In Table 30, the orange shaded boxes indicate the product that received the highest rating for each specific attribute. The numbers in bold red font indicate the highest rated feature of each product. Among all the products included in the survey, wood plastic composite was rated as the decking material with the longest service life, the easiest material to maintain, with the least amount of surface checking and the most environmentally friendly decking material. Longevity and ease of maintenance were rated as the best features of plastic lumber. Low material cost was rated as the best feature of pressure treated lumber, which was also considered to be the lowest priced product in the market. Pressure treated lumber was also rated as the product which is easiest to use and is the most readily available in the market. Tropical hardwood was considered to be the most beautiful looking product among the alternatives but at the same is it considered to be the most expensive decking material. The highest rated attributes for western red cedar were its aesthetic appeal (beauty) and ease of use. Based on a consideration of all the attributes taken together (and excluding all other factors that might influence material selection), WPC decking received the highest overall rating followed by plastic lumber.

Table 30. Average attribute ratings of the decking products.

Material Attribute	Decking Material				
	WRC	PT	WPC	THW	PVC
Long Life	4.76	5.03	**6.21**	5.27	**5.73**
Beauty	**5.80**	3.52	5.38	**6.01**	4.49
Availability	4.44	**6.52**	6.04	3.86	5.39
Low Cost	3.55	5.43	3.84	2.98	3.93
Ease of Use	5.74	5.77	5.35	4.23	4.81
Minimal Environmental Impact	4.19	3.66	4.83	3.68	4.34
Ease of Maintenance	3.83	3.88	5.78	4.25	**5.73**
Minimal Surface Checking	4.21	3.56	5.71	4.72	5.60
Average Product Scores	**4.57**	**4.67**	**5.39**	**4.38**	**5.00**

Perceptual Maps

A multiple discriminant analysis was undertaken using 6 decking products (5 actual products and an ideal product category) based on respondents' rankings of the 8 product attributes identified in Table 30. The resultant product positioning scores and ideal point scores were standardized across respondents and products as recommended by Green and Rao (1972). By convention, the first two discriminant functions were used to create a two-dimensional perceptual map. More than 72% of the variation in the dataset was captured by these two dimensions; with over 40% of the variation in the data being explained by the first discriminant function and another 32% of the variation was explained by the second function.

In the perceptual map presented in Figure 28, the perceptual space is defined by the attributes. The perceptual map ties together three elements of the map (the attribute vectors, the product position centroids and individual ideal preference points), through the two discriminant functions which are represented as the x and y axes. Some of the information that can be observed from the perceptual map includes: the relationship between the attributes, the relative importance of the attributes, the positioning of the products, the role of the attributes in differentiating the products, and the ideal points of the individual respondents. Each product is perceived differently by the individual respondents and the product centroids displayed on the map represent the average of their responses, which are represented by yellow circles in the perceptual maps.

Representation of the market demand density

In this study, demand density is defined in cognitive terms whereas the perceptual space is defined by the material. In the absence of prior information regarding the demand distribution along these attributes, a nonparametric regression approach has been adopted to model demand. For this study, the Nadarya-Watson Kernel smoother with a 0.5 smoothing parameter (also known as the bandwidth) was used. The results of the regression function have been depicted in the two dimensional perceptual maps by using shades of grey to translate the regression results into a two dimensional contour map. The product positioning and attribute vectors were then superimposed on the two-dimensional contour map. The darker shades of grey indicate a higher demand density. Hence, the perceptual map represents a comprehensive analysis of product positioning information for the U.S. decking market along with a non-parametric distribution of the market demand density.

<u>Detailed explanation on market demand density</u>

In marketing, the term 'demand density' generally represents the spatial pattern of demand over a geographically explicit area of market demand. In this study, demand density is defined in cognitive terms where the perceptual space is defined by the material attributes. The perceptual map presented in Figure 26 represents the ideal points for each of the individual respondents within the perceptual space. It can be

seen that the top-right quadrant of the map has a higher density of individual ideal points (represented by the dark grey shading) relative to the other quadrants, indicating that more respondents indicated that they favored a decking material possessing the attributes located in the top-right quadrant of the perceptual map. However, using dots to represent the demand density can be misleading since multiple overlapping dots would appear as a single point within the two-dimensional (bird's eye) view of the map. In this case using histograms has been accepted as an established method of graphical tabulation, although it requires that the survey data be binned into categories or groups. In cases without a natural break or separation in the data, the binning of the data is done based on the development of logical or analytical groups of categories.

In the spatial representation of the demand density, histograms having equal bin sizes are suitable since each category would represent an equal space on the perceptual space. The identification of the number of bins in most regular histogram algorithms is determined by minimizing the number of bins with no responses included in them, with the exception of the taut string method which tries to minimize the number of peaks (Davies *et al.*, 2007). Given the perceptual space and the sample size used in this analysis, it is highly likely that a number of regions on the map will have no ideal points, leading to a number of bins with zero responses. Hence, a visually iterative exercise was used to optimize the number of bins based on the dual objectives of minimizing the number of local peaks and maximizing the robustness of the obtained peaks. The ultimate objective was to find a pattern in the data distribution that remained stable over a series of binning solutions. Given the sample size and the described objectives, a 29 bin per axis solution for developing the two dimensional histograms was found to be optimal (Figure 26).

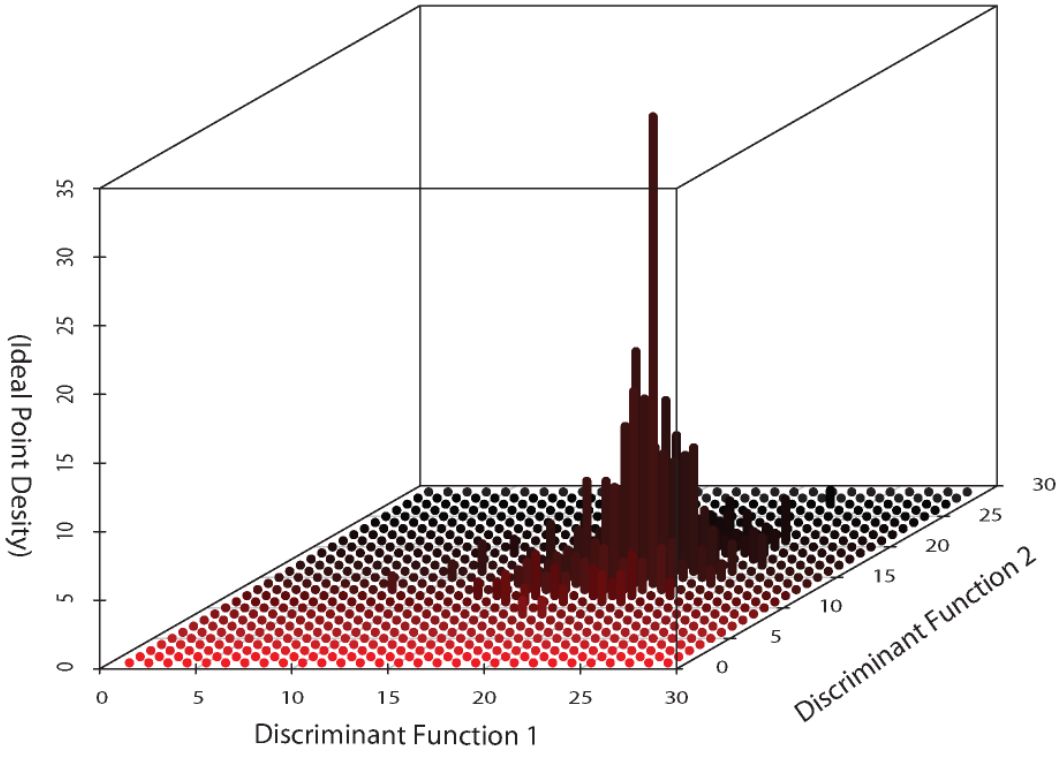


Figure 26. Frequency distribution of the builder ideal points over the perceptual space.

The distribution of the ideal points within the perceptual space may be represented by using a parametric regression method, where we make assumptions about the decking market and estimate the distribution accordingly, using a probability density function. There are a number of advantages to using the parametric approach, including ease of interpretation and estimation. However, in cases with little prior information, and in the absence of established theories, there is a danger of selecting a suboptimal or incorrect parametric form, leading to a misinterpretation of the market or information loss. In contrast, a non-parametric approach makes fewer a priori assumptions and dictates the structure of the regression model based on the data (Scott *et al.* 1978; Wand and Jones 1995). Kernel estimates (Parzen 1962; Rosenblatt 1956), also called Kernel smoothers, are among the most commonly used non-parametric density estimation techniques. For this study we used a popular form of Kernel regression known as the Nadarya-Watson smoother with 0.5 as the smoothing parameter (also known as the bandwidth). The results of the two-dimensional non-parametric regression are presented in Figure 27. This figure depicts the smoothed representation of the histogram presented in Figure 26, where the higher elevations represent a higher density of respondent ideal points.

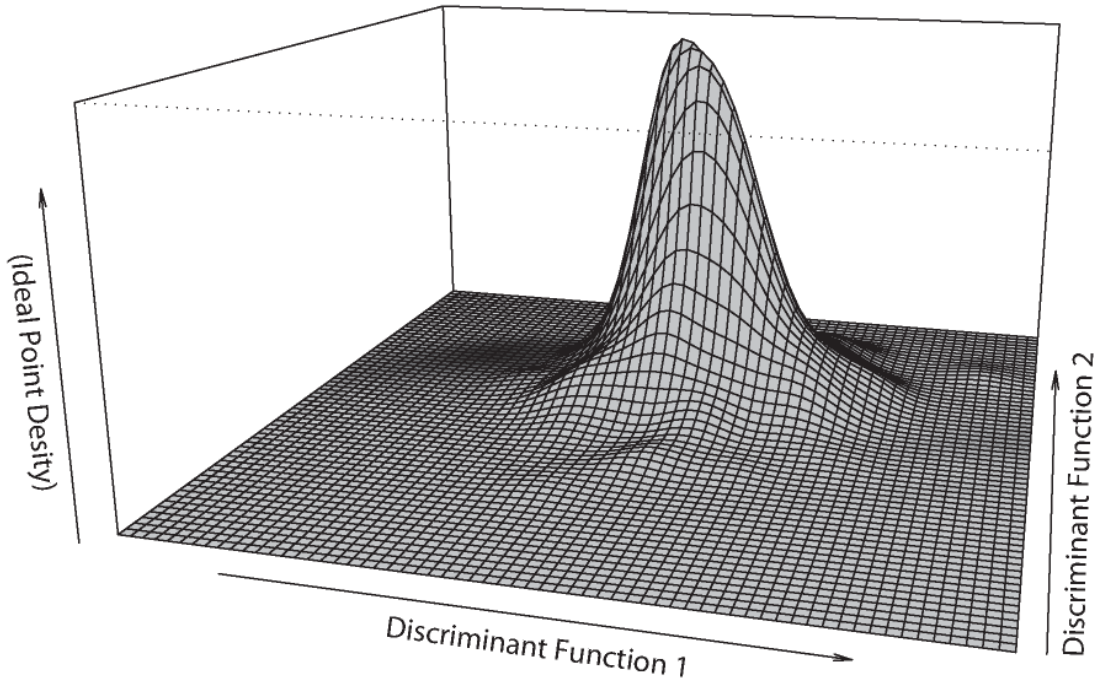


Figure 27. Ideal point density distribution on the perceptual space.

The interpretation of consumer preferences using an ideal point model is similar to that of spatial models where preference is measured by an inverse function of the distance between the point representing the product and the consumer's ideal point (Carroll, 1972; DeSarbo, DeSoete, and Eliashberg, 1987; DeSarbo *et al.*, 1990; DeSarbo and Rao, 1986; De Soete, Carroll and DeSarbo, 1986; Elrod, 1988; Kamakura and Srivastava, 1986; Zinnes and MacKay, 1992). Hence, the cognitive space on the perceptual map with a higher density of ideal points would indicate a higher demand density. In order to facilitate the simultaneous presentation of the product positioning information along with the demand density distribution on the same two dimensional map, the demand density distribution presented in Figure 27 was translated into a two dimensional contour map. In addition, the product positioning centroids and the attribute vectors were superimposed on the two-dimensional contour map (Figure 28). This final perceptual map represents the complete product positioning information for the U.S. decking market along with a non-parametric distribution of the market demand density.

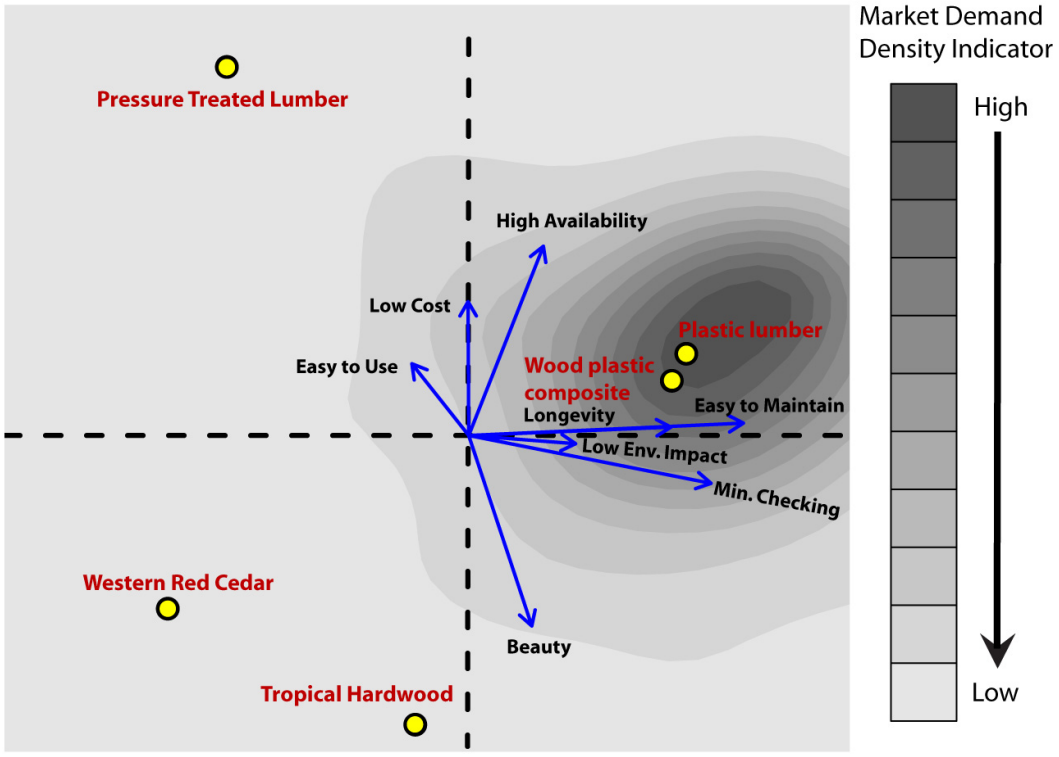


Figure 28. Perceptual Map of US Decking Market with Demand Distribution in General – Based on 8 Attributes

Reading the Perceptual Map

Attribute vectors: The decking material attributes are represented as vectors on the perceptual maps. These attribute vectors are the most important aspect of the perceptual map since the perceptual space is defined by these attribute vectors via the two axes (discriminant functions). There are two important aspects of the attribute vectors to consider; the length of the vectors and the angles between the vectors and the axes (or the direction of the vectors). A longer vector for an attribute indicates the greater discriminating power of that attribute in differentiating between the products. In Figure 28, it can be observed that the 'easy to maintain' attribute vector is longer than the 'longevity' attribute vector, though they trace the same direction, indicating that 'ease of maintenance' is more effective in discriminating between the decking products than is 'longevity'. Further, the relationship between the attributes and that between an axis and an attribute can be inferred from the angle between the vectors. The relationship between two attributes can be inferred by referring to the smaller angle between the vectors. An acute angle between two attributes implies that the attributes are perceived to be positively correlated to each other. If the attributes are orthogonal then the attributes are independent of each other. Finally, an obtuse angle between two attributes indicates an inverse relationship, the larger the angle (nearing 180 degrees), the stronger this inverse relationship. For example, 'longevity' and 'easy to maintain', are perfectly correlated with each other, indicating that survey respondents perceived that these two attributes are similar (i.e., an easy to maintain decking material has greater longevity and vice-versa). The vectors 'availability' and 'minimal checking' are almost orthogonal to each other implying that these attributes are perceived to be unrelated to each other. Finally, the decking attribute vectors for 'beauty' and 'low cost' are at an obtuse angle to each other, implying that these attributes are considered to be trade-offs (i.e., a lower cost material will be less beautiful than a higher cost material and vice-versa).

Product Positioning: Interpreting the relative positioning of the products in the perceptual map should be done with reference to the length and direction of the attribute vectors. A convenient way of interpreting the positioning of the products, using the direction of the attribute vectors, can be done with reference to the quadrants in which the products are positioned. For example, the quadrant diametrically opposite to the beauty vector is the top-left quadrant. Any product positioned in this quadrant (i.e. pressure treated lumber) would be perceived as having a lower aesthetic value than a product located in the same quadrant as the beauty vector. Using the information of the attribute vector lengths is also important in interpreting the positioning of the products. The attribute 'low environmental impact' has a very short length, indicating that this attribute plays a very small role in differentiating between the products, whereas, the attribute 'beauty' has a longer length, indicating the greater power of this attribute in differentiating between the decking materials, Figure 28. For example, within the US decking materials market, deck builders perceive that all of the decking materials generally have a similar environmental impact, whereas the availability, beauty and ease of maintenance attributes of the materials are perceived to vary substantially. Both of the naturally durable species considered in this study (tropical hardwood and western red cedar), are located in the same quadrant, indicating that these decking materials are perceived to have similar characteristics and that they compete within the same market niche.

Analyzing the US decking market using the perceptual map

A more detailed explanation on how to read the perceptual maps is presented in Appendix C. Consistent with the previous perceptual maps developed from the 2004 CINTRAFOR decking material study, the 2008 study also indicates that some of the decking material attributes are perceived to be tradeoffs. For example 'low cost' and 'beauty' are negatively correlated to each other. Such tradeoffs between product price and other product attributes may either result from imperfect market information or a two way influence. Referring to US decking materials, reducing the 'price' of a product adversely impacts the 'aesthetic appeal' of the product. It may further be noted that the attribute 'availability' is positively correlated with the 'low cost' attribute (an acute angle between the vectors) and negatively correlated with the beauty attribute (an obtuse angle between the vectors). Past research has shown that a product's scarcity may enhance customers' expectations of quality and value (Lynn 1992a), although the association between scarcity and quality is highly market specific. In the case of the decking market, all of the naturally durable wood decking materials were perceived to be both scarce and high priced. The low availability and high price of the naturally durable decking materials can support in developing an image of exclusivity for these products, making them attractive to customers in the high quality niche market.

The darker shading in Figure 28 indicates a greater demand density, with the darkest region representing the highest demand density. The positioning of wood-plastic composite lumber and plastic lumber are located closest to the area of the highest demand density. WPCs and PVC decking materials are perceived to have favorable performance in terms of the product attributes 'longevity', 'ease of maintenance', 'minimal surface checking' and 'low environmental impact'. The only attribute not positively associated with WPC and PVC decking materials is 'beauty'. However, WPC is better positioned in terms of 'beauty' than is PVC. The relatively advantageous positioning of both WPC and PVC decking materials has been instrumental in the rapid increase in market share of these decking materials over the past decade.

Pressure treated lumber, which is perceived to be a low cost material, easy to use and highly available in the market, is located further away from the high demand density zone. This is largely a reflection of the fact that it is perceived to be difficult to maintain, has lower longevity and has unfavorable surface checking characteristics. Moreover, it is perceived to be less environmentally friendly than both WPC and PVC decking materials. Finally, the naturally durable species included in the study (THW and WRC) were considered to be the most aesthetically appealing decking materials but they were also considered to

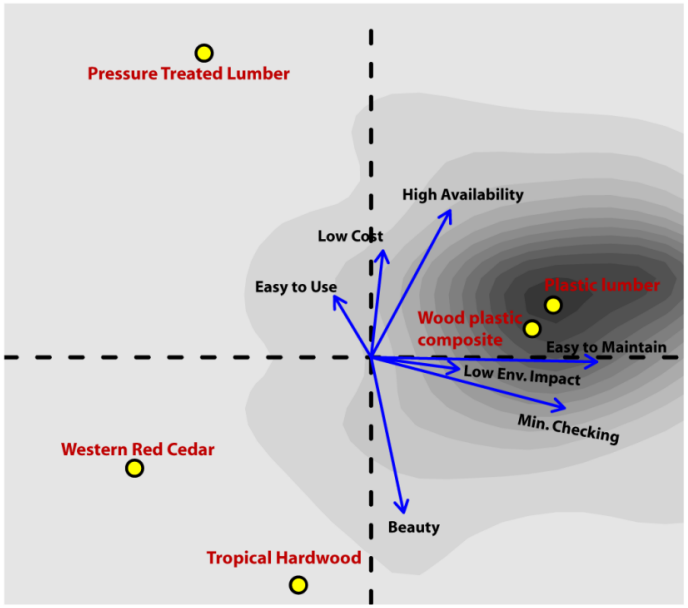
be high priced, difficult to maintain, having lower longevity, and unfavorable surface checking characteristics relative to WPC and PVC decking materials.

End-use specific perceptual maps

The survey also looked at respondents perceptions of decking materials in two specific end-use applications: 1) deck surface and 2) deck railings. In order to simplify the survey, the materials attribute 'longevity' was not included in this set of questions. This decision was supported by the fact that the material attributes 'longevity' and 'ease of maintenance' were found to be perfectly correlated Figure 28. Hence, a minimal amount of variation was lost by removing the material attribute 'longevity' from the survey. In addition, the material attribute 'longevity' had a lower discriminating power than did the material attribute 'ease of maintenance' (the length of the 'longevity' vector was substantially shorter than the 'ease of maintenance' vector). As a result, in the following end-use specific perceptual maps, there are only 7 material attribute vectors. Figure 29 represents the overall decking market perceptual map with 7 vectors (i.e., Figure 29 is another version of Figure 28 but without the longevity attribute included). Comparing the perceptual maps in Figures 28 and 29 it can be observed that the relationship between the attributes and the positioning of the products remained unchanged, although it should be noted that the map itself rotated a couple of degrees clockwise (which is of no significance in a relative sense).

Figure 30 represents the perceptual map of the demand density distribution for decking materials used in a deck surface application and Figure 31 represents the demand density distribution for decking materials used in a deck railing application. The only major decking end use application not included in the questionnaire was the decking substructure. This was done to shorten the survey but also because building codes restrict the use of WPC and PVC decking materials in the deck substructure. In Figures 30 and 31 the demand density for both deck railing and deck surface shifted downward in the direction of the beauty attribute (in other words, removing the substructure application from consideration results in a greater emphasis on beauty). When asked to consider decking surface or railing end-uses exclusively, the respondents' preference for beauty and aesthetic appeal increased and they indicated they would be more likely to pay a higher price for a product used in these applications. These end-use application specific maps clearly indicate the favorable positioning of THW over WRC.

When asked about the decking materials in general, the respondents appeared to balance their demand for all three end-use applications, deck surface, deck railings and deck sub-structure. Hence, the demand density is relatively closer to pressure treated lumber in Figure 28. However, when we specified the end-use applications to be deck surface or deck railing, the demand density shifted downward and away from PTL. This trend supports the loss of market share experienced by PTL in the deck surface and deck railing applications, and given the preferences revealed by the respondents in this research, this trend will likely continue.



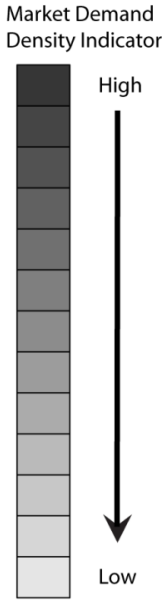
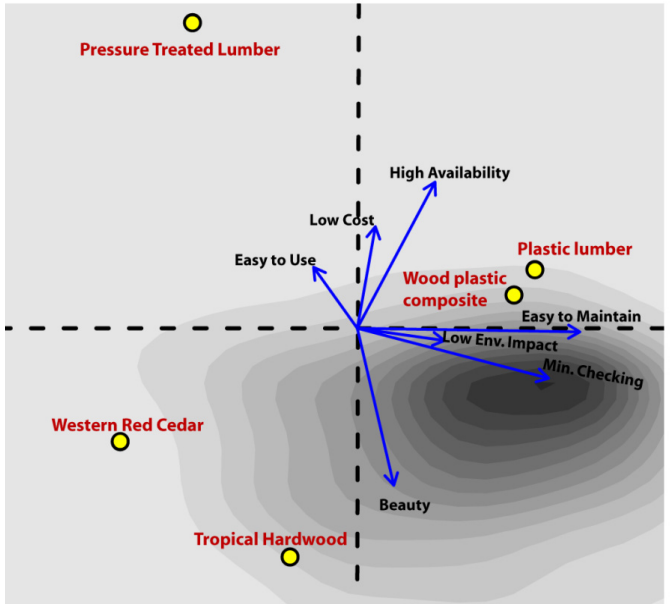
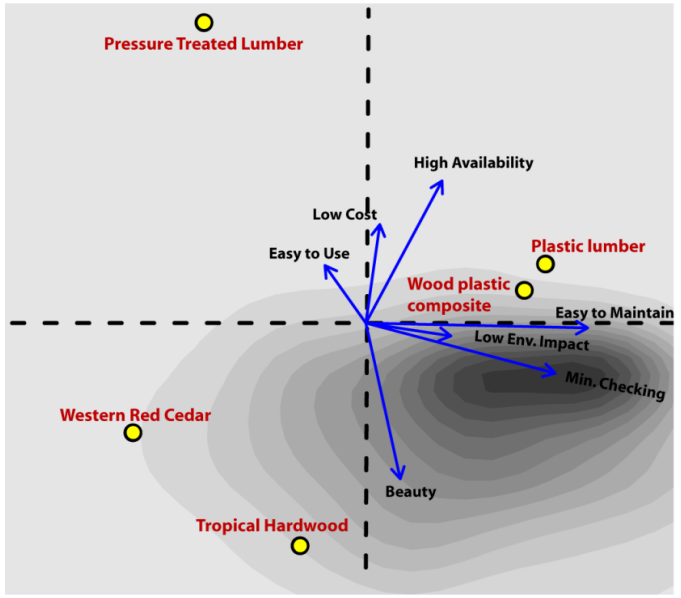


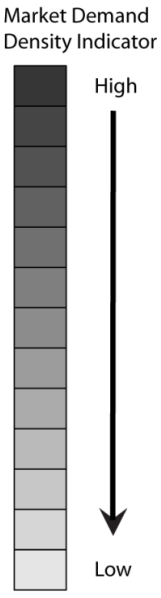
Figure 29. Perceptual Map of US Decking Market with Demand Distribution in General – Based on 7 Attributes
(Top Left)

Figure 30. Perceptual Map of US Decking Market with Demand Distribution for Surface Material– Based on 7 Attributes
(Bottom Left)

Figure 31. Perceptual Map of US Decking Market with Demand Distribution for Railing Material– Based on 7 Attributes
(Bottom Right)







Conclusions

Among all the decking materials considered, WPC seems to be favored most by deck builders, home builders, contractors and remodelers. Over 65% of the deck builders, home builders and remodelers reported that they increased their usage of WPC between 2006 and 2008. The results also show that deck builders, home builders and remodelers reported an increase in their usage of plastic decking materials. Pressure treated lumber has been losing market share, primarily in the surface decking and accessory end-use applications. The relative homogeneity in the material usage trends among the deck builders, homebuilders, contractors and remodelers indicates that these different groups use similar decking materials even though building decks may or may not be their primary area of business. Moreover, the material usage trends among the respondents working in rural, urban or small towns are also relatively similar.

The regional usage trends indicate that the rapid increase in the usage of WPC has been occurring in all regions of the country. The increase in the usage of plastic decking materials is more prevalent in the northeastern region of the country and the decrease in the usage of pressure treated lumber is most prevelant in the northwest. The study results indicate that the western regions of the US have been the slowest in adopting the use of plastic decking materials.

In assessing the importance of the various material attributes in influencing the use of decking materials, consistent material quality, longevity and beauty were rated as being the most important product attributes. The major difference between homebuilders and deck builders was the relative importance ratings for low price. Low price was found to be of least importance to deck builders, whereas homebuilders rated low material price as being much more important. The material attributes that are least important in terms of influencing the use of decking materials were low environmental impact, little product waste, low material cost and price stability.

This study provides a clear indication that innovative engineered decking materials (such as WPC and plastic decking) are steadily gaining acceptance with home builders and deck builders and that they are gaining market share primarily at the expense of naturally durable species (e.g. WRC and RW) and pressure treated lumber. While the naturally durable species still retain a unique niche market, particularly in the decking surface and accessory segments of the market, it is clear that the manufacturers of these products must do a better job of communicating their competitive advantage in terms of natural decay resistance, beauty, and availability within regional markets. This will be particularly important as the baby boomers continue to emphasize low maintenance products that combine long life and beauty for their decking and outdoor lifestyle projects.

Finally, environmentally friendly building practices are rapidly gaining acceptance among deck builders and home builders. The US residential construction industry in general, and the deck building industry in particular, have begun to realize the importance of developing a green image. From this study it was evident that the usage of recycled materials was perceived by respondents in all regions of the US to be the most important environmental attribute of decking materials. Though most of the plastic and WPC decking materials use significant amount of virgin plastic and a high volume of resin, WPC and plastic lumber are still perceived to be more environmentally friendly that wood. Wood is a renewable resource and despite the fact that wood sourced from sustainably managed forests has a much smaller carbon footprint than synthetic decking materials, wood is considered to be less environmentally friendly by deck builders. This is a clear indication that if the forest products industry can not communicate the green aspects of wooden building materials, the industry will continue losing market share to synthetic decking materials. Performing a life cycle analysis of synthetic decking materials, similar to the CORRIM LCA performed for softwood lumber, would be useful in objectively comparing the environmental performance of the various decking materials.

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Appendix A

Email Messages Sent to Deck Builders in the Sample Frame

Initial Email Message

Dear Deck Builder,

The Center for International Trade of Forest Products (CINTRAFOR) at the University of Washington, in cooperation with Professional Deck Builder and the North American Deck and Railing Association is conducting a survey to learn how different types of decking materials are used by deck builders such as yourself. A summary of the final survey results will be sent to all survey participants and the survey results will also be published in a future edition of Professional Deck Builder magazine. The survey will only take about 10 minutes of your time and we would greatly appreciate your help in making this survey a success. The information obtained from this survey will help us understand the types of materials used to build decks and the factors that influence the selection of decking materials.

Each deck builder who completes the survey will be mailed a $10 gift card. In addition, your name will be entered in a drawing to win one of three $200 Home Depot Gift cards that will be awarded at the completion of the survey at the end of March. If you would like to complete the survey, please click on the following secured link below which will take you to the Deck Builder survey.

http://hw-media.com/portal/wts/cemc4CbeqSaquwoqix6CmkkjyE7b

** Please note that only one response per deck builder will be accepted. **

We at Professional Deck Builder and the University of Washington's College of Forest Resources thank you for taking the time to complete the survey. Your kind assistance is greatly appreciated.

Best Regards,

Dr. Ivan Eastin
Director and Professor
Center for International Trade in Forest Products (CINTRAFOR) College of Forest Resources, Box 352100 University of Washington Seattle, WA 98195-2100
Tel: 206-543-1918
mailto:eastin@u.washington.edu

Email reminder to take the survey

Dear Deck Builder,

This is a reminder that you have not yet completed the deck builder survey being conducted by the University of Washington, Professional Deck Builder magazine and the North American Deck and Railing Association. The purpose of the survey is to learn how different types of decking products are used by deck builders and the factors that influence their selection of decking materials. A summary of the final survey results will be sent to all survey participants and the survey results will also be published in a future edition of Professional Deck Builder magazine. The survey will only take about 10 minutes of your time and we would greatly appreciate your help in making this survey a success.

We know that you are busy and as a token of our appreciation, we will mail each survey respondent a $10 gift card upon completion of the survey. In addition, your name will be entered in a drawing to receive one of three $200 Home Depot Gift cards that will be awarded at the completion of the survey at the end of March. If you would like to participate in this survey, please click on the secured link below which will take you to the Deck Builder survey.

http://hw-media.com/portal/wts/cemc4Cbe6Daqu0E6iyEgmkrNnk3c

** Please note that only one response per deck builder will be accepted. **

We at Professional Deck Builder and the University of Washington's College of Forest Resources appreciate you taking the time to complete the survey.

Thank you for helping to make this survey a success.

Ivan Eastin

Director and Professor
Center for International Trade in Forest Products (CINTRAFOR) College of Forest Resources,
Box 352100 University of Washington Seattle, WA 98195-2100
Tel: 206-543-1918

Appendix B

Summary of Attribute Ratings, by Region

Table B1. Decking Materials Attribute Importance Ratings, by region

Census Region	Northeast	Midwest	South	West	**Significance** (F-statistic)
Long Life	6.5	6.5	6.1	6.5	**0.00** (4.80)
Beautiful & Aesthetically Pleasing	6.6	6.4	6.2	6.5	**0.01** (4.01)
Naturally Decay Resistant	6.3	6.3	5.9	6.3	**0.01** (3.62)
High Strength	5.9	5.9	5.8	5.8	0.61 (0.62)
Low Heat Retention in Service	4.9	4.9	5.2	4.5	**0.04** (2.81)
Readily Available	5.9	5.8	6.1	5.7	0.08 (2.31)
Low Material Cost	5.1	5.2	5.3	5.0	0.55 (0.71)
Minimal Surface Checking	6.1	5.8	6.0	6.1	0.17 (1.70)
Ease of Use	5.9	5.8	5.8	5.6	0.63 (0.58)
Price Stability of Material	5.6	5.6	5.5	5.4	0.64 (0.57)
Consistent Material Quality	6.5	6.3	6.4	6.4	0.51 (0.77)
Easy to Maintain	5.9	6.0	5.9	5.9	0.90 (0.19)
Little Product Waste	5.4	5.5	5.6	5.6	0.56 (0.68)
Resistance to Splintering	6.2	6.0	6.0	6.1	0.65 (0.55)
Reduced Environmental Impact	5.3	5.1	4.9	5.2	0.28 (1.29)
Reduced Material Waste	5.4	5.4	5.5	5.4	0.98 (0.07)

An analysis of decking material attribute importance ratings by region revealed that some significant differences exist in the way the respondents from different regions of the country rated the attributes.

Appendix C

Review of the Literature on Perceptual Maps

The importance of product differentiation and favorable product positioning in successfully marketing products in a competitive market environment has been stressed in the marketing literature (Green and Srinivasan 1978; Pressemier 1982; Wind 1980). One approach for positioning a product in the market is by differentiating it from its competitors based on superior product performance along one or more important product attribute (Dickson and Ginterm 1987). Successfully positioning a product involves marketing the product so that it is distinctly and favorably positioned for its target customers relative to competing products (Kohli and Leuthesserm 1993). This requires a simultaneous understanding of the competitive products in the market as well as consumers' preferences. Perceptual maps are popular visual tools used by managers and market researchers to communicate the complex relationships between competing products and the criteria used by buyers in making purchase decisions (Wittenschlaeger and Fiedler 1997). The perceptual mapping technique employed in this study presents the competitive product positioning, the discriminating role of the various product attributes and the market demand density using a highly interpretable and innovative visualization technique.

Overview on Perceptual Maps

Perceptual mapping falls within the genre of graphical representation known as biplots where the variables and the observations are represented together in a way that elucidates their joint relationship. A biplot is usually represented as a two dimensional display (Gabriel 1971; Gower and Hand 1996); however, the prefix 'bi' in biplot refers to the two kinds of objects presented in the graphs and not the dimensions (Jacoby 1998). What makes some perceptual maps distinctly different from biplots is the presence of a third object in the mapping space; the ideal points (or ideal zone or ideal vector). The ideal point model assumes that each consumer's preference for any particular product depends on that product's perceived distance from the consumer's ideal point (Johnson 1998).

The perceptual aspect of product positioning and differentiation is well established in the marketing literature. Any particular brand or product is valued by the perception it carries in the consumer's mind (Ries and Trout 1981) and the perceptual differences in product attributes are instrumental in creating 'brand images' (Dickson and Ginter 1987). The general assumption used in developing and interpreting perceptual map is that a certain number (relatively small) of common perceptual dimensions exist that effectively differentiate between the products available in the market (De-Sarbo and Rao 1986; DeSarbo and Hoffman 1986, 1987). Hence, all competing products have a specific location in this perceptual space, and the level and nature of differentiation between the products may be observed by their distance and direction of separation (Chaturvedi and Carroll 1998).

Analytical Techniques for Developing Perceptual Maps

The primary purpose of perceptual mapping is the investigation of the various cognitive dimensions that consumers use to differentiate between competing products in a product category. The data used to develop the maps are determined by the theorization of the various aspects of the market, the desired outcome and the multivariate technique used for creating the maps. The nature of the data also depends on specific managerial objectives such as product positioning, demand estimation, optimal new-product design, and pricing strategy. The selection of specific mapping models may also be influenced by the ease of managerial interpretation of the dimensions of the map, and the use of diverse cross-validating models.

The two major forms of data used for perceptual mapping are 'similarity scaling data' and 'attribute ratings data'. Multi-dimensional scaling (MDS) and conjoint analysis require similarity scaling data, whereas discriminant analysis and factor analysis require attribute rating data. Though similarity scaling

data collection is difficult and expensive, some researchers suggest that similarity measures are more accurate measures of consumer perceptions than are direct attribute ratings. However, Hauser and Koppelman (1979) showed that the attribute ratings based methodologies in general, and factor analysis in particular, have superior predictive ability, managerial interpretability and ease of use compared to similarity based scaling approaches. Moreover, Summers and MacKay (1976) noted the lack of reliability and validity of direct similarity judgments as measures of individual perceptions.

The comparison of multivariate methods using attribute rating based methods for perceptual mapping is also not uncommon. The choice of any particular multivariate technique depends on the questionnaire design and the nature of data available for analysis. Multiple discriminant analysis (MDA) has been deemed appropriate when the objective is to examine relationships among sampling units naturally partitioned into groups (Kenkel et. al. 2002) and is recommended for perceptual mapping over factor analysis (Wittenschlaeger and Fiedler 1997; Kohli and Leuthesser 1993). The use of canonical analyses and combinations of cluster and multiple discriminant analyses has gained popularity in examining the multivariate predictor-criterion relationships between adopter characteristics and usage behavior (Schaninger et. al. 1980).

Preference Information and Consumer Choice

The inclusion of consumer preferences in cognitive market maps makes perceptual maps distinctly different from biplots. Such joint-space maps with information on consumer preferences and the product characteristics that appeal to consumers have become an important visual tool in product design and positioning decisions (Green 1975; Johnson 1971). A number of variations have been proposed for the inclusion of preference data within the perceptual space. It has been debated whether consumer preference should be represented as a vector, where 'more' (or 'less') of a combination of attributes is always better, or an ideal point where consumers prefer a certain combination of attributes (Johnson 1998). The individual level deterministic ideal point model proposed by Combs (1950) assumed that each individual in the market has an ideal point, whereas, the 'point of view approach' proposed by Tucker and Messick (1963) assumed that an individual's preference can be represented by an 'ideal vector' within the perceptual space. Later, however, Carroll and Chang (1970) showed that vector models can be considered to be special case of ideal point models. With the availability of extensive information on panel consumer and household scanner data, linking preference heterogeneity to consumer variables and market segmentation has become increasingly popular among marketing managers (Srinivasan and Winer 1994). Various theoretical approaches have been proposed for identifying consumer choice using preference data. Popular consumer choice modeling approaches include stochastic choice models (Lehmann 1972) and random utility models (Elrod and Keane 1992).

Most perceptual mapping models with ideal point/s define choice to be discrete and assume that the consumer purchases the single product that yields the highest utility. However, some researchers argue that consumers might not have a single well defined ideal point (Lee et. al. 2002) and consumer choices may be affected by situational preferences resulting from differences in uses and occasions (Belk 1979; Laurent 1978) or by the variety seeking and experimental nature of consumers (Bass et. al. 1972; McAlister and Pessemier 1982). Multiple product purchases and product purchase as a scalar variable (i.e. quantity of product purchased) can also be introduced in this framework using specific assumptions of consumer behavior and subsequently incorporating those in the utility functions (Srinivasan and Winer 1994).

Identification of the Scaling Method

The identification of the scaling method for measuring product perception plays an important role in designing the research methodology for the study. Specifically, the survey design and the selection of multivariate technique used for developing the perceptual maps is incidental upon the scaling

methodology adopted. The multivariate analytic techniques proposed for developing perceptual maps using similarity scaling are conjoint analysis (Green and Wind 1973) or any variation of multi-dimensional scaling (Torgerson 1958; Carroll and Chang 1970; Kruskal et. al. 1977). The commonly used multivariate methods used for developing perceptual maps using attribute rating scales are discriminant analysis (Pessemier 1977) and factor analysis (Hauser and Urban 1977).

The number of similarity ratings to be included in the survey increases quadratically with the number of products considered in the study and the number of attributes on which the respondents make the product selection decision. Given the number of decking materials available in the US residential decking market, and the number of important material attributes on which the builders make their decisions, the similarity ratings based approach was not deemed practical for this project in terms of required respondent time and the desired response rate. The attribute ratings based approach was not only considered to be a more feasible approach for the study, but it is also known to have superior predictive ability, managerial interpretability (Hauser and Koppelman 1979) and has been gaining popularity for perceptual mapping applications (Wittenschlaeger and Fiedler 1997). Accordingly, for this study we will adopt an attribute rating based scaling approach.

Identification of the Multivariate Analytical Method

On the issue of identifying the best multivariate modeling technique for developing perceptual maps, using attribute ratings, the market research literature seems to be divided. Hauser and Koppelman (1979) found results in favor of factor analysis in terms of superior predictive ability and ease of interpretability, whereas Huber and Holbrook (1979) stated that discriminant analysis is more likely to yield objective dimensions while factor analysis is more likely to yield affective dimensions. Canonical discriminant analysis (CDA), also known as multiple discriminant analysis (MDA) has been termed appropriate when the objective is to examine relationships among sampling units naturally partitioned into groups (i.e. products) (Kenkel et. al. 2002) and is recommended for perceptual mapping over correspondence analysis and factor analysis (Wittenschlaeger and Fiedler 1997; Kohli and Leuthesser 1993). Moreover, the use of canonical analyses and combinations of cluster and MDA has gained popularity in examining the multivariate predictor-criterion relationships between adopter characteristics and usage behavior (Schaninger et. al. 1980). MDA also facilitates a predictive and formal hypothesis testing modeling approach (Legendre and Legendre 1998).

In this study each respondent was asked to rate the importance of the product attributes of those products that they had used. Hence each product was rated on their attributes by multiple respondents and for canonically analyzing the data each product may be considered a distinct group. The objective of the discriminant analysis is to determine whether these groups are statistically different from one another based on the measured attributes. In this study the data had an underlying structure related to a specific sampling or experimental design (e.g. attribute ratings across products); hence, MDA was identified as the appropriate multivariate method.

Representing Consumer Preference on the Map

Both individual and aggregate level ideal point models have been proposed in the psychology and marketing literature. Some researchers have assumed consumer preferences to be homogenous (Lehmann 1972; Fraser and Bradford 1983 and 1984), whereas, others have estimated consumer preferences individually (Lebart et. al. 1984; Hoffman and Franke 1986; Levine 1979; DeSarbo and Keramidas 1986; DeSarbo and Hoffman 1986). Aggregate ideal point models using aggregate sales data represent the cumulative market preference and assume that consumer preferences are homogenous in nature. Models using panel data may incorporate consumer heterogeneity in the models, with the (not unreasonable) assumption that consumer preferences are stationary over time (Elrod 1988).

In the case of survey based research, the preference data collection regime depends on the methodology adopted for developing the perceptual maps and theorization of individual preferences. The uni-dimensional unfolding method (Combs 1950) later extended to a multidimensional space (Bennett and Hays 1960), assumes deterministic behavior where the consumer chooses the product closest to his/her ideal point. Later it was proposed that the actual purchase behavior of a consumer (Hausman and Wise 1978; Kamakura and Srivastava 1986) or actual sales data (Elrod 1988) may be used as an indicator of consumer preference. However, the usage of actual purchase data assumes that all the products considered in the study were available to the consumers at the point of purchase and that they were aware of the product attributes (both in an absolute and relative sense). Accordingly, the decision taken by the consumer is informed, rational and not constrained by availability. Such assumptions are not valid for the decking materials market; hence an alternate approach was adopted for the study. In this study ideal points for the consumers are identified using their attribute importance ratings.

A product can be perceived as a mix of attributes (both tangible and intangible), price and brand or quality associations (Kotler and Armstrong 1993). A simplifying theory is that the greater the presence of positive product attributes, the higher the product quality perception among consumers and the greater their satisfaction with the product. This theory is backed by a number of studies (Jacoby et. al. 1971; Rao 1971; Rao & Monroe 1988; Szybillo *&* Jacoby 1974) and leads to an ideal vector model (Johnson 1998). However, in real life situations both manufacturers and customers encounter physical or perceptual tradeoffs between attributes, which explains the simultaneous and successful coexistence of multiple products in the market. These product trade-offs are based on the relative importance ratings of the various product attributes, which indicates that consumers are willing to trade-off less important product attributes for more important ones to attain a higher level of overall satisfaction. Hence, the attribute importance ratings were used as indicators of the ideal attribute mix in the products. The attribute importance rating of the respondents is incorporated in MDA as a hypothetical product rating along with the actual product rating. This approach is essentially comparable to the alternatives suggested by Lehman (1972), where respondents may be asked to ascertain the distance of each product from a hypothetical ideal product.

Appendix D

Factsheet of the Survey Results that was Sent to the Respondents

CINTRAFOR

FACT SHEET

CINTRAFOR Decking Material Survey Results, 2009

The Center for International Trade in Forest Products (CINTRAFOR) at the University of Washington conducts period market research to understand and interpret the trends in material usage in the U.S. residential construction industry. CINTRAFOR has been collecting market information on the material usage trend in the U.S. deck building industry since 1995. This fact sheet presents a brief overview of the data collected through a web-based survey of professional deck builders and companies involved in building residential decks. To ensure that the respondents had relevant deck building experience, only those deck builders who built more that 5 decks over the past two years were allowed to take the survey. A total of 372 qualified respondents completed the survey, representing 43 states and providing representation across all regions of the US. The number of residential decks built by the respondents in 2008 ranged from 1 to 250, with more than 60% of the respondents building between 3 to 8 decks. A substantial number of deck builders (12% of the respondents) indicated that they built more than 20 decks in 2008.

The market for residential decking products in North America has become increasingly competitive over the past decade. Moreover, regulatory constraints on timber harvests from public forests and competition from substitute materials have significantly altered the competitive environment within the deck building industry. Past studies have indicated that wood plastic composite decking (WPC) and plastic lumber (PVC) are increasingly replacing treated softwood lumber and naturally durable species (i.e., redwood, western red cedar and tropical hardwoods) in deck building applications. The 2009 study results indicate that this trend of gradual market displacement of naturally durable species and treated softwood lumber decking materials has continued. From Figure 1 it can be observed that over 66% of the respondents indicated that they have increased their usage of WPC and 37% of the respondents increased their usage of PVC as between 2006 to 2008, with less than 10% reporting that they had decreased their use of WPC and PVC. In contrast, a high percentage of respondents indicated that they have decreased their usage of pressure treated lumber (31%), western red cedar (36%) and redwood (35%) while less than 20% reported increasing their use of these materials.

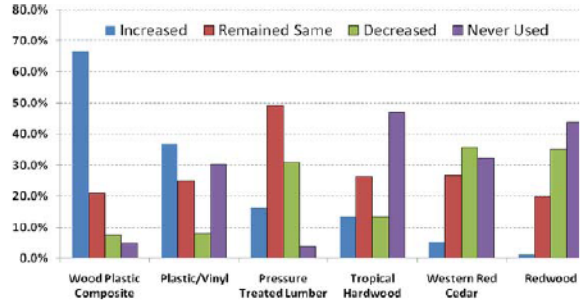

Figure 1: Changes in decking material usage between 2006 and 2008.

Table 1 presents the demographics of the deck builders surveyed, divided by census regions. The survey results reveal that the median cost of decks built in the West is significantly higher than the rest of the country, whereas, the median per unit cost of decks built in the Northeast is relatively higher than in the other regions of the country. The median size of decks built in the western US (400 square feet) was substantially

Table 1. Deck builder demographics and material usage, by region.

		Northeast (n=95)	Midwest (n=90)	South (n=117)	West (n=66)	Overall US (n=372)
Basic information on decks built	Median deck size (in sq. ft.)	350	300	320	400	350
	Median number of decks built	6	6	8	6	6
	Median cost per deck	$7,500	$5,600	$5,000	$9,000	$6,500
	Median deck cost per sq. foot	$21.43	$15.50	$15.31	$18.57	$18.00
Percentage of decks built by project type	Decks on existing home	46.3%	43.1%	39.8%	38.8%	42.5%
	Decks built on new home	11.8%	18.3%	16.6%	10.0%	13.9%
	Repair/replacement decks	41.8%	38.6%	43.5%	51.2%	43.6%
Decking material usage for deck surface	Western Red Cedar	9.8%	16.0%	6.0%	12.7%	10.6%
	Redwood	3.2%	5.5%	3.8%	19.4%	6.8%
	Pressure Treated Lumber	28.4%	30.8%	41.7%	10.3%	30.0%
	Wood Plastic Composite	30.3%	31.1%	27.6%	34.2%	30.4%
	Tropical Hardwood	10.1%	4.4%	6.1%	10.1%	7.4%
	Plastic/Vinyl	17.5%	11.2%	13.7%	8.4%	13.1%

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larger than the in the other regions of the US. The survey respondents indicated that over 42% of their revenue came from building new decks on existing homes while an additional 44% came from repairing and replacing existing decks. This result suggests that deck builders should be insulated from the new housing downturn to some extent. Moreover, when homeowners are living in their houses longer they tend to invest in remodeling their houses; remodeling existing decks or installing new decks has traditionally been important aspects of renovating and remodeling houses.

While pressure treated lumber (PTL) remains the dominant material used in substructure applications with a market share over 80%, PTL only has a 30% share of the national deck surface market, Table 1. WPC is now the market leader in deck surface applications across all regions of the US, with the exception of the South where almost 40% of deck surfaces were built using PTL. In contrast, only about 10% of the deck surfaces built in the western US used PTL and WPC has emerged as the market leader with a 34% market share. The western US is also the region with the greatest use of naturally durable wood decking, perhaps reflecting the greater availability of these products. Plastic decking made its greatest inroad in the northeast where almost 18% of deck builders reported using this product.

Decking material attribute importance ratings

The importance ratings reported by survey respondents for the different material attributes is useful in understanding the relationship between material attributes and their influence on deck builders choice of decking materials, Figure 2. Survey respondents were asked to rate the importance of decking material attributes in their material selection process using a scale of 1 – 7, where a score of 1 means that the attribute is not important, 4 is neutral and 7 means the attribute is extremely important. Consistent material quality and longevity of the decking materials were rated as the most important of all decking material attributes, followed by beauty, natural decay resistance, resistance to splintering and minimal surface checking. Low heat retention, reduced environmental impact and low material cost were rated as the least important decking material attributes. The vertical line in the figure represents the average importance rating for all of the attributes (5.83). The attributes which have importance rating scores greater than the average rating may be considered as having the greatest influence on the material specification process, as indicated by the red segment of each bar. Consistent material quality, beauty and long life emerged as the three most important attributes of decking materials. Other influential material attributes included natural decay resistance, resistance to splintering, minimal surface checking, ease of maintenance and availability.

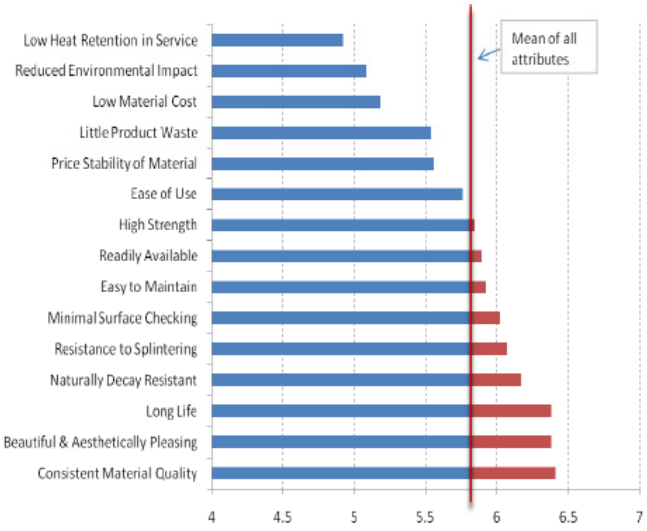

Figure 2: Attribute importance rating reported by survey respondents.

Conclusions

WPC continues to gain favor among deck builders in decking surface applications, with almost two-thirds of the respondents reporting that their use of WPC's had increased between 2006 and 2008. The results also reveal a significant increase in the usage of PVC decking material. Among the naturally durable species, tropical hardwood maintained its market share while the domestically available naturally durable species (WRC and RW) experienced a reduction in usage in general, although they still have significant market shares in the midwestern and western US. The results of the survey indicate that innovative decking materials (such as WPC and PVC decking lumber) are steadily gaining acceptance in the US deck building industry at the expense of WRC and RW lumber. The decking material attribute ratings reveal that both WPC and plastic lumber are perceived to be superior to solid wood decking (including PTL) in terms of durability and ease of maintenance. Despite its declining market share (particularly in deck surface applications), pressure treated lumber continues to have a significant presence in the southern US, which can be attributed to its high availability, low cost and ease of usage.

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