Wood Use Trends in the Pallet and Container Industry: 1992 - 1999

By

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Thesis submitted to the Faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science

in

Wood Science and Forest Products

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May 25th, 2001

Keywords: Pallets, Containers, Wood Use, Trends

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ABSTRACT

This study was undertaken to determine the use and quantities of new and recovered wood materials utilized by the United States pallet and container industry in 1999. Wood use trends were identified by comparing the results of this study with that of three previous studies (1992, 1993, and 1995) conducted by Virginia Tech and the United States Forest Service. Also, information was gathered on firm employment, plant operations, and production. A mail survey of 3,507 manufacturers of wood pallets and/or containers in the United States was used to obtain primary data.

It was found that the pallet and container industry consumed an estimated 6.54 billion board feet of solid wood in 1999, of which 4.41 billion was hardwood and 2.13 billion was softwood. It was further estimated that 3.7 billion board feet of the hardwood was purchased or processed as lumber and cants, and an additional 707 million board feet as hardwood parts. Approximately 51% of the hardwood consumed was a mixture of hardwood species. Oak accounted for 31% of the hardwood used by the industry. For softwood, an estimated 1.52 billion board feet was consumed in the form of lumber and cants, and another 610 million board feet as parts. Southern Pine (48% of the total softwood volume) and Spruce-Pine-Fir (25%) were the solid softwoods most commonly

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used by the pallet and container industry. Of the estimated 289 million square feet of wood panels that went into the production of pallets and containers, nearly 208 million square feet of it was softwood plywood, followed by oriented strand board (77 million square feet), and hardwood plywood (5 million square feet).

The pallet and container industry produced approximately 429 million new pallets in 1999. Approximately 80% of these pallets were stringer type and 12% were block type. The pallet industry was responsible for the recovery of 299 million pallets in 1999. Furthermore, it was estimated that the pallet industry returned to service nearly 218 million pallets through either repair or recycle.

Of the wood use trends identified, the most significant are the large increases in pallet recovery, repair, and recycling during the 1990s. The production of landscape mulch has become the leading use of ground or chipped pallets. A small increase was seen in new pallet production. Increases in new wood use were modest, and primarily limited to softwood parts and oriented strand board. The use of Southern Pine by the pallet and container industry continues to grow relative to other softwood species and in terms of total volume used.

ACKNOWLEDGEMENTS

I would like to thank the following people and agencies for their support during my graduate studies.

My sincere appreciations to Dr. Robert J. Bush, for providing me the opportunity to pursue my Masters degree at Virginia Tech. As my advisor, his support and guidance were instrumental to the success of my research.

My thanks to Mr. Philip A. Araman, Dr. Bruce Hansen, and Dr. Robert Smith, for the support and encouragement they provided as my committee members.

My thanks to the USDA Forest Service Northeastern Research Station and Southern Research Station for providing the needed funds for this research.

My thanks to Joanne Buckner, for making my time here at Virginia Tech a very special experience.

My thanks to my fellow graduate students: Delton Alderman, Scott Bowe, Daryl Corr, Dan Cumbo, Nathan Hosterman, David Olah, Chris Surak, and Roger Wehner. Their friendship, support, and help have made this a great two years.

Lastly, I would like to thank my family. This would not have been possible without their unwavering support.

PREFACE

This thesis is divided into four chapters. Chapter One characterizes the problem addressed in the study, provides justification, reviews recent literature, and describes the methods used in analysis. Chapter Two details the results of the study. In Chapter Three the results of previous studies are compared to those of this study so as to identify industry trends. Chapter Four includes a research summary, study conclusions, study limitations, and recommendations for further research.

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

INTRODUCTION

The wooden pallet and container industry is a vital consumer of wood materials in the United States. The industry provides a much-needed market for wood materials, especially lower grade hardwoods. In 1995, it was estimated that the industry utilized over 6.3 billion board feet of wood in the form of lumber, cants, and parts (Reddy et al. 1997). An estimated 4.53 billion board feet of this was hardwood, which was equivalent to 38% percent of the annual U.S. hardwood lumber production and an even greater percentage of the low-grade hardwood production. Softwood consumption was estimated at 1.79 billion board feet or 5.6% of U.S. softwood lumber production in 1995 (Bush and Araman 1998a). In addition, the industry used approximately 208 million square feet (3/8" thickness basis) of oriented strand board and softwood plywood (Reddy et al. 1997).

The pallet industry recovers a significant amount of its own wood materials, thus playing an important role in efforts to conserve natural resources and reduce the amount of waste being landfilled. In 1995, it was estimated that the pallet industry recovered 171 million pallets, containing 2.6 billion board feet of wood material (Bush et al. 1997). From these recovered pallets and their parts, approximately 139 million pallets were repaired or recycled and returned to service. Additional uses for recovered pallets included fuel, animal bedding, landscape mulch, and furnish for fiber-based products. Less than 1% of the pallets recovered were sent to landfills.

Due to the large quantities of new and recovered wood materials utilized by the pallet and container industry, minor shifts in its wood usage patterns affect many in the forest products industry. In a similar study conducted by Virginia Tech in 1995, the results showed

that the pallet and container industry's consumption of new wood materials was stagnant to declining (Reddy et al. 1997). It was believed that this downturn in new wood consumption was due to the growth in pallet repair and recycling (Bush and Araman 1997). Today, there are many other factors that are impacting the industry's use of wood materials in addition to pallet repair and recycling. This study provides the pallet and container industry and its wood material suppliers with current data regarding ongoing wood use trends. Companies can position themselves to exploit these developments by making the appropriate changes to their business strategies and any necessary capital investments.

PROBLEM STATEMENT AND JUSTIFICATION

The wood pallet and container industry plays a critical role in the forest products industry and the U.S. economy. The industry provides a large market for low-grade wood materials that, if it did not exist, would have a significant impact on the profitability of many sawmills. In addition, the Department of Labor estimates that the industry is directly responsible for the employment of more than 50,000 people nationally (Bell 2000). When taking into account the employment the industry supports indirectly through its large consumption of wood materials, this number would be considerably larger. Furthermore, pallets and containers facilitate the efficient shipment of goods from industry to consumer, thereby playing another important role in the economy.

There are a number of ongoing trends affecting the wood pallet and container industry. Third party management, increased repair and recycling, use of alternative materials, the price and availability of raw materials, and current logistics have all had some effect on the demand for wood pallets and containers. It is likely that these trends will continue to impact wood pallet and container production in the future.

Although there are some uncertainties regarding the future demand for wood pallets, some of their attributes will continue to make them important in the transportation of tomorrow's goods. For example, wood's cost advantage over other materials makes it an obvious choice where closed loop distribution systems cannot be established in which to track and recover pallets. Furthermore, wood pallets can be designed and modified more easily than their plastic counterparts, thus making them better suited for the custom pallet segment (Scheerer 1997).

A recent survey of the warehousing, distribution, and manufacturing industries, revealed a significant opportunity for the pallet industry (MMH 1999). A majority of the survey respondents stated that they intended to purchase a greater number of pallets over the next five years. It will be important for the wood pallet industry to take advantage of this projected upswing in sales.

If the wooden pallet and container industry is to remain competitive in the future, it will be important for its companies to understand the dynamics of the industry in which they operate. By staying up-to-date and informed about ongoing industry developments, the industry's decision makers can better assess the new challenges they face and implement the needed business strategies. However, the most recent study conducted to obtain information on the production and wood consumption of the pallet and container industry was in 1995 by Virginia Tech. Since that time, the industry has undergone a great deal of change. This study generated up-to-date information that would normally be impossible or impractical for a company to obtain for itself. Collection of such data enables certain wood use and production trends to be identified. This is possible by analyzing the results of this study in combination with three previous studies conducted by the Center for Forests Products Marketing and Management at Virginia Tech and the United States Forest Service. The information will not only benefit pallet and container producers, but also the sawmills that supply them with their wood materials. In addition, it will be beneficial to local, state, and federal governments and agencies in their effort to understand the importance of the pallet and container industry to the economy and the resources it requires to remain healthy.

RESEARCH OBJECTIVES

The primary goal of this study was to determine the use of new and recovered wood materials by the pallet and container industry for 1999. Because of the regional differences in wood material use, a national mail survey was necessary to gather data characteristic of the entire industry. By analyzing the responses, this study accomplished the following objectives:

- 1. Determined the types and volumes of new wood materials used by the U.S. pallet and container industry
- 2. Determined the volume of wood pallets recovered by firms in the pallet and container industry and the uses of recovered pallets
- 3. Identified trends in new wood use for pallets and containers and in wood recovery from these products

GLOSSARY

A variety of terms are used in conjunction with pallets and containers. To avoid

confusion, the terms used in this study and their intended definitions are listed below. The

American Society of Mechanical Engineers was the source of the following definitions

(ASME 1997).

block pallet: pallet with blocks between decks or beneath top deck.

corrugated board pallet: pallet constructed of corrugated paper, paperboard, or fiber board.

limited-use pallet: pallet designed for an average of up to nine trips, with an average of five handlings per trip in an average handling environment.

synonymous terms: single-trip pallet; one-trip pallet; one-way pallet; expendable pallet; shipping pallet; general service pallet.

multiple-use pallet: pallet designed for repeated uses for more than one unit load with an average minimum life-to-first repair of ten trips or more, with an average of five handlings per trip in an average handling environment.

synonymous terms: multiple-trip pallet; returnable pallet; reusable pallet; permanent pallet; general-purpose pallet; special service pallet; through-transit pallet.

panel-deck pallet: pallet whose deck or decks consist of such board materials as plywood, particleboard, flakeboard, strandboard, fiberboard, corrugated paper, plastic, and metal.

remanufactured pallet: pallet made entirely of recycled components or parts from damaged pallets.

synonymous terms: reassembled pallet

rental pallet: pallet owned by other than user and rented by user.

recycled pallet: pallet made reusable by repairing, sorting, or rebuilding pallet, using reclaimed components or parts from damaged pallets.

repaired pallet: pallet with damaged components replaced with new or used components.

skid: pallet without bottom deckboards or deck.

stringer pallet: double-deck pallet with stringer spacers between decks

Throughout the remainder of the text, unless otherwise noted, the term "pallet" will be used in reference to both pallets and skids. In addition, the term "container" will include the following products: containers, boxes, barrels, reels, and crates.

LITERATURE REVIEW

Product Description

Pallets

Pallets are portable platforms that facilitate the handling, stacking, and storage of goods. Using pallets to handle materials as unit loads allows for handling larger loads, reduced loading and unloading times, and streamlining the flow of materials (Auguston 1990). According to the National Wooden Pallet and Container Association there are an estimated 2 billion pallets in the U.S., nearly seven pallets for each person (Anonymous 1999a). These pallets are manufactured to many different dimensions. In a National Wooden Pallet and Container Association survey of U.S. pallet producers, 135 respondents reported producing 428 different pallet sizes (NWPCA 1996). The most common pallet size was 40" x 48" (30.2%), followed by the 42"x 42" (5.7%). Although pallets are constructed from a variety of materials including plastics, corrugated paperboard, and metal, approximately 91% of new pallet purchases are wood (MMH 1999). In 1995, new pallet production in the U.S. was estimated at 411 million and the number of used pallets recovered and returned to service by the pallet industry was estimated at 139 million (Bush et al. 1997, Reddy et al. 1997). Prices received for new pallets tend to be anywhere from \$6 to \$10 (MOEA 2001). Repaired and recycled pallets typically sell for between \$3.50 and \$5.00, depending on the extent of the repair (Brindley 2000). Figure 1 illustrates the general price movement of new and recycled pallets from 1995 to 1999 (Pallet Profile Weekly 1995-1999). The pallet industry is characterized as those firms that manufacture wood or wood and metal combination pallets and skids. They are categorized under the Standard Industrial Classification (SIC) code 2448. The products they produce can be any of the following:

- Pallets, wood or wood and metal combination
- Skids, wood or wood and metal combination
- Pallet containers, wood or wood and metal combination

Containers

In contrast to the wood pallet industry, the container industry is made up of a wide range of products that differ greatly in their dimensions, function, and material makeup.

Often the container industry is categorized by the SIC codes 2441 and 2449. Products

included in the SIC 2441 (nailed and lock corner wood boxes and shook) are:

- Ammunition boxes, wood
- Boxes, wood plain or fabric covered, nailed or lock corner
- Carrier trays, wood
- Chests for tools, wood
- Cigar boxes, wood or part wood
- Egg cases, wood
- Packing cases, wood: nailed or lock corner
- Shipping cases, wood: nailed or lock corner
- Shook, box

Some of the products included in SIC 2449 (wood containers, not elsewhere classified) are:

- Barrels, wood coopered
- Baskets, fruit and vegetable
- Berry cups, veneer and splint
- Till baskets, veneer and splint
- Tubs, wood: coopered
- Vats, wood
- Vegetable baskets, veneer and splint

Due to the broad range of products included in this grouping and their relatively small size when taken individually, there is very little published material concerning this particular segment. Therefore, it is difficult to give an accurate description of the industry's history as well as the number of factors that have an effect on it today. The one notable trend that has been identified by several different sources is the decline in wood consumption by the container industry over the years (McKeever and Hatfield 1984, Spelter and Phelps 1984, USDA 1989). Figure 2 illustrates the container industry's weakened demand for wood materials (Spelter and Phelps 1984).

New Wood Material Use

In 1995, the pallet and container industry's demand for new wood materials showed signs of weakening (Reddy et al. 1997). Studies conducted by Virginia Tech and the U.S. Forest Service showed a decline or a leveling off in the six wood materials tracked: hardwood lumber and cants, softwood lumber and cants, hardwood parts, softwood parts, oriented strand board, and softwood plywood. The industry consumed an estimated 6.32 billion board feet of new solid wood in 1995 (Reddy et al. 1997). This represents a decline from the 1993 and 1992 estimates (Bush et al. 1994a, Christoforo 1993).

Hardwood

In the United States, pallets and containers are predominately constructed of hardwood (Reddy et al. 1997). It was estimated that the industry utilized 4.53 billion board feet of solid hardwood material in the form of lumber, cants, and parts in 1995 (Reddy et al. 1997). This is a decrease from 1993 and 1992, which were estimated at 4.82 billion board feet and 4.74 billion board feet, respectively (Bush et al. 1994a, Christoforo 1993). Of the

hardwoods consumed in 1995, 56% was a mixture of hardwood species (Reddy et al. 1997). Oak was the single most utilized hardwood species at an estimated 27% of total hardwood consumption.

Softwood

The pallet and container industry consumed 1.79 billion board feet of softwood in 1995 (Reddy et al. 1997). This represents a decrease from the 1992 and 1993 estimates (Christoforo 1993, Bush et al. 1994a). For 1995, firms in the Western and Southern regions of the United States accounted for 70% of the total solid softwood consumption at 702 million board feet and 556 million board foot, respectively (Reddy et al. 1997).

Four species accounted for 93% of the solid softwood used in the production of pallets and containers in 1995 (Reddy et al.1997). Approximately 731 million board feet of Southern Pine was consumed, making it the largest softwood species or species group utilized by the industry. Spruce-Pine-Fir consumption was estimated at 552 million board feet, followed by Douglas-fir and the Hemlock-fir species group. Although species utilization varied by region, two trends stand out: 1) Southern firms consumed a majority of the Southern Pine (73%); and 2) Firms in the West and Mid-West consumed a majority of the Spruce-Pine-Fir (88%).

Industry Trends Affecting Wood Use

Third Party Management

Perhaps one of the most significant recent developments in the U.S. pallet and container industry is the acceptance of third party managers. These companies or associations manage their clients' pallet and container needs, often relieving them of such handling problems as sorting, cleaning, repair, and disposal. One type of third party management involves pallet users buying into a pool of pallets that is shared by many users. The pallet pool is then managed to maintain its quality. In another form of third party management, companies rent (also termed *lease*) pallets to users who then use them in a closed loop distribution system so as to facilitate recovery¹. Used pallets are exchanged for reconditioned pallets at one of the third party's depot centers.

When speaking of pallet rental companies, one must mention CHEP (Commonwealth Handling Equipment Pooling). Currently, CHEP operates in more than 36 countries, controlling more than 134 million pallets and 20 million containers (CHEP 2000). The company entered the U.S. market in 1994. Despite being relatively new to the U.S. market, CHEP has become a driving force behind the acceptance of rental pallets in this country. CHEP has more than 200 depots across the United States and a pallet pool estimated at more than 30 million for North America (Madl 2000, Brindley 1999c). The company has amassed an impressive customer list that includes such names as Nestle, Home Depot, Proctor & Gamble, Kraft, Campbell Soup and Wal-Mart (Bond 2000, Brindley 1999b, Forcinio 1998). Edward Brindley of *Pallet Enterprise* states, "*Now that Wal-Mart has endorsed rental pallets and is strongly encouraging its suppliers to ship on them, the door is opening to all kinds of products to be shipped in the United States on rental pallets. The new relationship between Wal-Mart and pallet rental could be the catalyst to help rental spread faster than most pallet people ever conceived*" (Brindley 1999b, p.23).

CHEP pallets differ from their competitors' in the quantity and species of wood material used. It is estimated that the typical GMA pallet is constructed of 15.8 board feet of

¹ Although a closed loop distribution system does imply pallet movement is restricted between specified locations, the degree in which the owner or user exerts such control does vary. CHEP pallets are used in a limited closed distribution system, in that the users do not have complete control over their movement.

hardwood material (Hansen et al. 1994). In contrast, 23 board feet are used in the construction of CHEP's 40"x 48" Mark 55 block pallet, which is Southern Yellow Pine (also termed Southern Pine) with the exception of two hardwood lead boards (Clark 2000). CHEP's Mark III is a 40" x 48" stringer pallet containing approximately 22 board feet and is constructed of Southern Yellow Pine with the exception of four hardwood lead boards. CHEP pallets received the highest overall pallet performance score for shipping dry goods downstream in a 1994 study of the grocery distribution industry, higher than both plastic and traditional solid wood pallets (Engle 1994).

Since rental pallets are repeatedly recovered and reused, growth in their use might reduce the overall number of pallets needed. The partnership between CHEP and Home Depot illustrates this point (Bond 2000). The typical Home Depot uses more than 30,000 pallets a year, of which 10,000 are discarded because of their low quality. In the agreement between the two companies, CHEP will create a pallet pool for Home Depot's vendors. Once the pallets are used they can be returned to one of CHEP's service centers for repair. It is estimated that Home Depot can avoid discarding close to 10 million pallets annually and close to 18 million by 2002 just by using and recovering CHEP pallets.

All indications point toward a growth in rental pallets. In a 1998 National Wooden Pallet and Container Association survey, 20% of respondents said they used or intend to use rented pallets (McCormick 1998). Just two years earlier only 7% answered the same. Various reasons are given for this change in position: potential cost savings, higher quality pallets, lower pallet inventory, reductions in pallet storage space, elimination of disposal problems, and a concern for the environment and natural resources (Mapleston 1998). In addition, CHEP and the Reusable Plastic Container Coalition (RPCC) continue to lobby for the elimination of state sales taxes on rental pallets based on the environmental benefits (LeBlanc 2000). The sales taxes on rental pallets in Florida and California were eliminated due to their efforts. The Reusable Plastic and Container Coalition is also lobbying the federal government for tax breaks, such as tax credits for those users of rental pallets and containers. These incentives are bound to have an effect on future pallet and container purchases and could become a major issue in coming years if they are further expanded.

Repair and Recycling

The 1990s marked unprecedented profitability and growth for pallet recycling firms. The National Wooden Pallet and Container Association reported that pallet recycling has become the most profitable segment of the industry (Bush et al. 1994b). Over the last decade, a series of surveys conducted by *Pallet Profile* estimated the average annual growth of recycling at close to 20% (Brindley 2000). Bush and Araman (1998b) identified the factors contributing to this rapid growth:

- 1. Increased awareness of the environment and activities that affect the environment have caused a previously unconcerned public to question the use of new wood for pallets;
- 2. Pallet producers, concerned with the availability and price of new lumber and cants, have found it economically advantageous to repair pallets and salvage material from used pallets;
- 3. Pallet users have turned to recycled pallets as a way of decreasing their product handling costs;
- 4. Pallet disposal costs can be significant and increasing attention is being paid to reducing or avoiding these costs through recovery and recycling;

- 5. Barriers to entry into pallet recycling are relatively low, resulting in an increase in the number of pallet recovery and recycling only firms (i.e., firms that do not manufacture new pallets) [In this particular case, low barriers could refer to low capital costs, no specialized or patented technology involved, little brand or customer loyalty, little benefit from economies of scale, and requires very little training.]; and
- 6. Public concerns over the capacity and cost of landfills have resulted in some facilities banning pallets.

Repaired and recycled pallets appear to be increasingly satisfying any new demand for wood pallets (Bush et al. 1997). In 1995, 171 million pallets were recovered by the pallet industry. This is up from 83 million for 1993 and 66 million for 1992 (Hansen et al. 1994, Christoforo 1993). Accordingly, the amount of wood recovered from these pallets has risen as well. These gains in recycling appear to have come at the expense of new wood use in pallet production (Bush and Araman 1997). In 1992, only 13% of the wood material used by the pallet industry was recovered wood material. This was shown to have risen to 15% in 1993 and 30% in 1995. As mentioned earlier, consumption of new hardwood and softwood lumber, cants, and parts had declined or leveled off over this same time period.

Recycled and repaired pallets should continue to be an important part of the pallet industry. A recent survey discovered that the growth in this segment declined from the 20% annual gains reported in the 1990s, but still remained impressive at 10% (Brindley 2000). Furthermore, a recent study conducted by Virginia Tech identified a partial solution to a problem many pallet repair and recycling firms have, that is, the lack of a stable supply of pallet cores (Corr 2000). Landfills were identified as having a significant number of recoverable pallets.

Alternative Materials

Although wood pallets currently dominate the market, pallets made from various other materials are finding and filling certain niches. Some of these alternative materials include plastics, corrugated paperboard, and metal. Pallets made from these materials have considerably different attributes than wood pallets. Some differences include cost, durability, strength, stiffness, and functionality. Table 1 compares the different attributes of pallets made of various materials (EIPS 2001).

Of all the materials used to manufacture pallets, plastic appears to be in the best position to make inroads on wood's hold on the market. Plastic pallets were once thought of being too weak structurally to justify their high cost. Where a traditional wood pallet cost less than \$10 dollars, plastic pallets can reach over \$100 (Madl 2000). Today, with advances in plastics and the formation of closed loop distribution systems, the use of plastic pallets has become much more cost effective. Some new plastic pallets resist burning, bending and breaking better than they did before (Murray 1999). As testament to the durability of plastic pallets, some respondents to a survey indicated plastic pallets would make at least 75 trips (distribution center to store and back) before needing repair, whereas a traditional wood pallet, on average, could only make an estimated five trips (Engle 1994). The additional cost of plastic pallets are thought to be recouped through decreased costs related to repair, fumigation (when used for exports), and sorting (Forcinio 2000).

In a study conducted by *Modern Materials Handling*, it was estimated that plastic pallets constituted 4% of the pallet purchases among buyers of material handling products (MMH 1999). In contrast, Plastic Custom Research Services (PCRS 2000) estimated that

just over 6 million plastic pallets were produced in 1999. Given that new wood pallet production has been estimated at over 400 million a year, plastic pallets would then represent less than 2% of the market (Reddy et al.1997, Anonymous 2000a).

Studies seem to point toward a growth in plastic pallets. Plastic Custom Research Services (PCRS 2000) estimated that the annual production of plastic pallets increased by approximately 3 million from 1994 to 1999, representing a 15.5% annual growth rate. Furthermore, the report estimated the growth of plastic pallets at 6.5% annually from 1999 to 2004. If this estimate holds true, plastic pallet production in 2004 will be approximately 8.25 million. In a 1994 Virginia Tech study of wholesalers and retailers, 22% of the respondents indicated that they used plastic pallets (Engle 1994). This number was projected to increase to 37.5% by 1997. In addition, all respondents indicated that they currently used wood pallets for at least some of their operations, but 6% indicated they intended to use plastic pallets exclusively by 1997. The recent adoption of plastic pallets could be due in part to the latest structural improvements and/or a change in users' perceptions of a pallet's value. In the same 1994 study, cost-per-use was rated the most important criterion for pallet purchases, which was a departure from the answer normally given in previous studies, initial purchase price. In a somewhat contradicting study conducted by Modern Material Handling, initial cost was found to be the most important factor in the purchase of new pallets (MMH 1999). This finding still signified a change in user attitude. The respondents choosing initial cost dropped from 85% in 1993 to 67% in 1999. In contrast, the number of respondents choosing cost-per-use increased from 22% to 35% over this same period of time.

As material handling becomes more automated, the exacting specifications to which plastic pallets can be manufactured might act as an incentive for some users to switch from wood to plastic. Inconsistent quality in wood pallets has caused problems for such automated systems and resulted in either system failure or product damage (Scheerer 1997). It should be noted that inexact dimensions and poor quality are not inherent characteristics of wood pallets. In a 1994 survey of grocery distribution personnel, many of the respondents attributed the poor quality of wood pallets to the lack of enforcement of quality standards (Scheerer 1997). In the same study, wood pallets from CHEP received a higher performance score than plastic pallets. This is evidence that wood pallets can be made to meet rigid specifications and the highest quality standards.

Although other materials are used in the production of pallets (e.g., corrugated paperboard and metal), their use is limited. It was estimated that pallets made from each of the above materials represented less than 1% of the market in 1999 (MMH 1999). Corrugated pallets are used in the low-end niche. Their low cost make them ideal for open-loop systems, where recovery is cost prohibitive (Bush and Araman 1998c). In addition, corrugated pallets pose very few disposal problems. Metal pallets, on the other hand, represent the very high-end of the pallet market. As a result of their high initial cost, they are often used as slave pallets that do not leave the owner's facilities (NCDENR 2000).

Economic & Transportation Factors

The economic expansion that the U.S. experienced in the 1990s has had an influence on those factors that directly affect the demand for pallets and containers, that is, the need to transport and store goods. This was a period of increased U.S. production, consumer demand, and disposable income, all of which had an effect on shipping levels. According to the U.S. Department of Commerce, the Gross Domestic Product grew 13% from 1993 to 1997, while per capita disposable income rose from \$20,490 to \$21,970 (Anonymous 1999b). The Department of Commerce also estimated that between 1993 and 1997, sales in the manufacturing, wholesale, and retail trade sectors grew at 15%, 19%, and 13%, respectively. Furthermore, the value of U.S. merchandise trade rose from \$496 billion to \$1.7 trillion from 1980 to 1997 (Anonymous 1999b).

According to the Bureau of Transportation Statistics, a branch of the U.S. Department of Transportation, the above factors contributed to an increase in commercial freight from 1993 to 1997 (Anonymous 1999b). During this time, freight shipments increased an estimated 14% in tons and 17% by value. In 1997, an estimated 14 billion tons of goods and raw materials, with a value of \$8 trillion, was shipped across the U.S. transportation system (Anonymous 1999b).

Raw Materials

Some pallet users consider a low initial price to be the most important factor in buying new pallets (MMH 1999). Therefore, the low price of wood compared to some alternative pallet and container materials could be considered an advantage. The downside of using wood materials is that they are often subject to price and supply fluctuations. As shown in Figure 1 and Figure 3, the price for new pallets rises and falls with the price of the raw material (Pallet Profile Weekly 1995 - 1999). Unpredictable supplies and price swings can negatively impact costs, product demand, and business operations.

A strong U.S. economy kept the demand and prices for many wood materials elevated for much of the late 1990s (Anderson 2001). As shown in Figure 3, hardwood cant and board prices rose from 1996 to 1998, before finally decreasing in 1999 (Pallet Profile Weekly 1995 - 1999). Softwood lumber and wood panels experienced a price spike and record production runs due to an increase in housing starts (Anderson 2001). In another development, The Engineered Wood Association (APA) estimated that North America's production of oriented strand board surpassed that of softwood plywood for the very first time in 1999 (Anonymous 2000b, Adair 2001). Such changes in the wood markets directly impact manufacturers of new pallets and containers, as a supply of reasonably priced lumber and/or parts is vital to the industry.

Trends in Logistics

Current logistic trends affect the demand for wood pallets. At a 1999 National Wooden Pallet and Container Association conference, Ralph Bartlett of Tompkins Associates, discussed many of these developments. Ed Brindley reiterated the main points of this presentation in the *Pallet Enterprise* (Brindley 1999a). Current logistic trends that could decrease the demand for pallets included:

- inventory reduction initiatives, such as Just-In-Time and Efficient Consumer Response;
- cross-docking;
- transportation consolidations and growth of the small package industry;
- increased use of floor loaded intermodal containers;
- plastic pallet research and development.

Some of the trends in logistics that could increase demand include:

- growth in consumer and producer goods;
- tendency towards more, smaller orders, proliferation of new products and variations of present ones;
- increased value-added and material, repair and other operations in warehouses;
- direct store deliveries that increase the number of smaller shipments;
- recognition and organization of reverse logistics;
- limited capabilities of plastic pallets.

Although wood pallets and containers have changed very little over the years, the industry remains very dynamic. The significant changes that appear to be taking place within the industry include increased recycling and a more prominent role for third party managers. Other developments include the adoption of pallets and containers made from alternative materials, current logistic trends, and shifts in wood supplies and prices. All the above will continue to impact the wood pallet and container industry, continually causing it and its use of wood materials to change.

METHODS

Sample Design

The population of interest for this study consists of those U.S. production facilities that manufactured, repaired, or recycled wood pallets, skids, containers, boxes, reels, barrels, or crates during 1999. These facilities are categorized under three Standard Industrial Classification (SIC) codes: 2441 (wood boxes and shook), 2448 (wood pallets), 2449 (wood containers not elsewhere classified). The more current North American Industry Classification System (NAICS) has combined all three SIC codes into 321920. These classification systems were used in defining the study's sample frame, that is, all firms that list one of the above codes as their primary, secondary, or tertiary business.

Instead of surveying a subset of the sample frame, a census of the pallet and container was conducted. This decision is based upon three factors that indicate a need for a large sample size, as identified by Alreck and Settle (1995):

- 1. There was likely to be a high level of variance among the units in the population to be sampled.
- 2. The sample was to be divided into relatively small sub-samples during analysis and interpretation.
- 3. Project costs and timing vary only slightly with increases in the sample size.

The companies that make up the pallet and container industry vary greatly in size, production, number of employees, and wood materials used. Therefore, it was expected there would be a considerable amount of variance in the responses. In addition, a sufficient number of responses were needed from each category in order to extrapolate and analyze the many sub-samples. The U.S.D.A. Forest Service Northeastern Research Station maintained a list of pallet and container manufacturers from various commercial, trade association, and government sources. This list was comprised of U.S. wood pallet and container companies (SIC 2448, 2441, 2449) taken from the American Business Disc (1999), National Wooden Pallet and Container Association (NWPCA 1999) membership register, and state directories. A mailing directory was created from all listed companies and duplicates were removed. The mailing directory was then cross-referenced with a company listing provided by PalEx Inc. and seven additional production facilities were added. It was critical that extra steps were taken to include all PalEx facilities in this study due to the company's high level of production and ongoing acquisitions within the industry. PalEx was the largest provider of new and recycled pallets in North America at the time of this study (Le Blanc 1999). The company had grown four-fold from 1997 to 1999 through acquisitions. Their holdings included 71 facilities in 23 states and seven Canadian provinces. After all of the above steps were completed, the sample frame consisted of 3,507 U.S. pallet and container firms.

Data Collection

A mail survey was used as the primary data collection vehicle because its attributes lend itself to this type of study. Mail surveys have the ability to reach a dispersed sample at a relatively low cost and allow time for respondents to search through records to locate the requested data (Dillman 1978, Fowler 1987). The survey instrument, a questionnaire, was constructed from the one used in Virginia Tech's previous tracking study regarding the same subject matter. A copy of the questionnaire and the accompanying cover letters can be found in Appendix A. It was important that the questions concerning wood consumption remain relatively unchanged so as to diminish the affect of instrumentation bias. This way, the results of the previous studies could be compared to those of this study.

The primary change made to the questionnaire was a greater use of conditional branching so as to reduce the amount of time and effort required of the respondent. The use of explicit branched questions allowed for respondents to skip those questions that were not applicable to their business. Due to this design, pages 2, 3, and 4 of the questionnaire were limited to one topic. Question 2 and page 5 sought information regarding the company's demographics and operations. These questions asked about the location of greatest production, number of employees, primary business, and plant operations. Page 2 inquired about the company's new wood use. On page 3, questions asked only about pallet production. Page 4 pertained only to the repair and recycling of pallets and could be skipped in its entirety if the responding firm did not engage in these operations. Question 16 on page 6 is a non-quantitative approach to gaining an understanding of the future wood use of the pallet and container industry. This question asked respondents to predict changes in their wood use over the next five years.

To ensure clarity and effectiveness, Virginia Tech faculty, United States Department of Agriculture scientists, and industry experts reviewed the questionnaire before it was administered. Changes were made as recommended.
Three mailings took place between late April and early August of 2000. In hopes of increasing the response rate, a follow-up postcard (Appendix A) was mailed between the first two mailings to those of the sample who had yet to respond. The purpose of the postcard was to remind the recipients of the importance of their participation and stimulate response. In an attempt to further increase the number of respondents, a partial third mailing was undertaken. Since there were a limited number of questionnaires remaining, only 1,500 of the remaining sample were sent a third questionnaire. The 1,500 were selected using the random number generator provided in Microsoft's Excel software application.

Of the 710 returned questionnaires that indicated they were involved in the production of pallets and/or containers, only 704 were included in the study's analysis. In contacting those companies that reported they were answering for more than one production facility, it was found that six companies had reported more than once. Duplication had occurred because questionnaires were sent to different mills within the same company. In each instance, the decision to remove one of the questionnaires was based on the information and recommendation of someone who oversaw all of the company's facilities. Two hundred and ninety eight respondents indicated they were not involved in the production of wooden pallets or containers. In addition, 503 questionnaires were returned as undeliverable due to an incorrect or out-of-date address. Given these numbers, the adjusted survey response rate was 26% based on the following equation:

Adjusted response rate =	<u>Number of usable responses received</u> Adjusted number of questionnaires mailed

Number of usable responses received	=	Responses from manufacturers of wood boxes, wood pallets, and/or wood containers who provided the answers to some or all of the questions on the questionnaire
Adjusted number of questionnaires mailed	=	All questionnaires mailed - (undeliverable questionnaires + questionnaires mailed to

containers).

companies not involved in the production of wood boxes, wood pallets, and/or wood

Companies that answered for more than one production facility were contacted in order to identify any duplication. It was found that those respondents answered for 36 production facilities that were included in the mailing list and an additional 34 that were not identified in our sample population. In each case, one individual oversaw the operations and material procurement for two or more plants. In addition, the 34 plants that were not identified in our sample population suggest that our attempt of a census of the pallet and container industry was unsuccessful. Due to the industry's large number of manufacturers, relatively low entry and exit barriers, and ongoing acquisitions, contacting all those involved in the manufacture of new and recycled pallets and containers was unlikely.

Data Analysis

Where

Returned questionnaires were sight edited for completeness and congruous answers. Companies were contacted by phone if further clarification was needed. Data was then entered into the statistical software SPSS® for further analysis. Due to the fact that no respondents indicated that a majority of their production was in the region *Other* (Hawaii or Alaska), it was excluded from further analysis.

Two methods were employed in data analysis. The first method determined wood use and production levels on a per employee basis. The second method was used to ascertain information regarding the composition of the material use and production, such as species use and pallet types. The sample ratios were projected onto the regional estimates to determine their quantities.

Material use and three pallet estimates were calculated on a per employee basis. For example, each firm's total hardwood parts consumption was divided by the firm's total number of employees to obtain a volume of hardwood parts per employee. The regional mean volume per employee was then calculated for hardwood parts for SIC 2448 (pallets, recycled pallets, pallet parts) and 2441/2449 (containers and others) and multiplied by their respective actual regional employment as provided by the Department of Labor (Bell 2000). Regional estimates were then calculated by summing the individual pallet and container industry estimates. The national estimate for hardwood parts consumption was obtained by summing the regional estimates. Wood panel use was calculated in the same manner, but without a thickness basis. Also, extrapolation was used in calculating the number of pallets recovered as well as new and recycled/repaired pallet production. Extrapolations were based on the pallet per employee measure. Further explanation of extrapolation calculations are provided in Appendix B.

Sample ratios were used to determine the composition of the extrapolated estimates, such as species use, pallet types, and use of recovered pallets. Projecting sample proportions

onto the regional extrapolated estimates provided the individual population estimates. Regional totals were again summed to obtain national estimates. For example, it was estimated that the Northeast firms recovered approximately 38 million pallets. Almost 13% of the sample was reported as limited-use pallets. Therefore, the estimated number of limited-use pallets recovered by Northeast firms was the product of multiplying the 38 million pallets by the 13% recorded in the sample. The same sample proportion used for calculating the number of pallets was then used in computing their volume. Calculations using sample ratios are further explained in Appendix B.

Non-response bias and its effect on the validity of a study's results is always a concern when conducting survey research; therefore, before any analysis occurred two tests were conducted to determine the influence of non-response bias on the data set.

One test involved comparing the answers given by respondents to those of nonrespondents. Firms that did not respond to the survey were randomly contacted to solicit answers regarding their employment and pallet production for the sole purpose of testing the data set for non-response bias. The questions were chosen based on their relevance to the production per employee measure, as this measure was the basis for some of the study's key estimates. From the obtained information, pallet (new and recycled) production per employee was calculated. Using the t-test for independent means, respondents and nonrespondents were compared within their primary business category. For example, primary producers of new pallets were only evaluated on new pallet production per employee, and not recycled pallets. As shown in Table 2, no significant differences were found between respondents and non-respondents.

In another non-response bias test developed by Armstrong and Overton (1977), answers given by early respondents are compared to late respondents. Any significant differences detected suggests that non-response bias exists in the data set. Using the t-test for independent means, the first thirty respondents were compared to the last 30 respondents on the same variables used in the previous test. No significant differences were detected. Given the results of these non-response tests, it was assumed that non-response bias was not a significant factor in this study. In other words, the samples were representative of their respective populations.

Objective 1

The first objective of this study was to determine the types and volumes of new wood materials used by the U.S. pallet and container industry. This information was elicited from respondents in questions 3 and 4 of the questionnaire. Question 3 asks for the quantities (board feet or square feet) of wood materials used in the production of pallets and/or containers in 1999. Accept for the addition of hardwood plywood, the question was identical to the one used in the 1995 questionnaire. Question 4 requests the wood species makeup of the wood materials given for question 3. Here again, the question remained unchanged from 1995's questionnaire.

Objective 2

The second objective of this study was to determine the number and volume of wood pallets recovered and their subsequent utilization. Questions 8 - 11 of the questionnaire were used to accomplish this objective. They inquired about the number and types of pallet cores a firm received or bought for the purpose of repair or recycling and what was done with those

pallets or pallet parts that were not utilized in the production of more pallets. With the exception of asking respondents to separate their landscape mulch production into colored and uncolored, the questions used for pallet repair and recycling were essentially unchanged from those used in the 1995 study. Here again, estimates were made using the extrapolation and sampling methods previously described.

Objective 3

The third objective of this study was to identify new wood use and recovery trends in the pallet and container industry. As mentioned previously, this was accomplished by comparing this study's results with those of studies completed by the Center for Products Marketing and Management at Virginia Tech and the U.S.D.A. Forest Service in 1992, 1993, and 1995. Data obtained from the above two objectives were used in the trend analysis. Movements in volumes, percentages, and numbers between studies were examined to identify different wood use trends within the industry.

Due to the request of the The Engineered Wood Association (APA), this study took a closer look at panel pallet and skid production than did any of the previous studies. The information sought was compatible with the objectives of this study; therefore, there was little difficulty incorporating it into the questionnaire. Question 7 was added to the questionnaire to determine what percentage of a firm's pallet and skid production was panel-decked and how many wood panels (oriented strand board, softwood plywood, hardwood plywood) were used in their production.

In achieving this study's objectives, secondary information regarding other aspects of the industry was obtained. A description of the industry's employment and plant operations

were generated from the respondents' data. Comparing the results of this study with previous studies, certain trends were identified. Research was conducted to discover the underlying factors that contributed to the study's findings. This involved secondary research on those factors that could have impacted the industry in a way that might have contributed to the trend.

BENEFITS OF RESEARCH

In accomplishing the outlined objectives, this study provides a detailed assessment of wood use trends of the pallet and container industry, which will benefit many within and outside of the industry.

The primary beneficiaries of this study are those firms that manufacture wood pallets and containers and their thousands of employees. Given the study's results, the industry's decision makers will have the needed information with which to make strategic business decisions regarding their operations. Due to the current challenges facing the industry, decisions involving production, capital investments, and suitable markets will need to be made in order to remain competitive in the future.

Firms that supply and service the pallet and container industry are also be affected by the industry's production and material use trends. These firms include sawmills, brokers/wholesalers, equipment/machinery manufacturers, and transportation companies. Here again, decisions regarding production, capital investments, and potential markets will be influenced by this study's results.

Government and federal agencies will use this study's findings to help understand the size and scope of the industry. The information will help government officials understand the impact the industry has on the national and regional economies. In addition, the study will define the demands of the industry to federal agencies such as the U.S.D.A. Forest Service. By analyzing wood use trends, policies and quotas regarding harvesting from federal lands can be crafted to meet the industry's future demand for wood materials as well as other considerations.





Note: Prices shown are a monthly composite of those given by the *Pallet Profile* for the Eastern/ Southern/ Northern/ Midwestern/ Hardwood Pallet Industry: 1995-1999. Prices are given for a new 5/8" deck & 1-3/8" stringer GMA pallet and R-1 recycled pallet delivered within region. Source: (Pallet Profile Weekly 1995 -1999)





Source: (Spelter and Phelps 1984)



Figure 3. Hardwood cant and lumber price index: 1995 – 1999 Note: Prices shown are a monthly composite of those given by the *Pallet Profile* for the Eastern/ Southern/ Northern/ Midwestern/ Hardwood Pallet Industry: 1995-1999. All prices are reported as delivered thousand board foot. Cants: 4×6 " & 3-1/2x6" (8'x16'). Boards: 1x4" & 1x6" (8' x 16'). Source: (Pallet Profile Weekly 1995 – 1999)

Table 1.	Comparison	of attributes	of pallets	made from	various	materials
	1					

Material	Strength	Stiffness	Durability	Functionality with Material Handling Equipment	Cost
Wood (one way)	+	+	-	-	Low
Wood (returnable)	+	+	+	+	Medium
Plywood	+	+	+	+	Medium to High
Plastic (HDPE)	+	-	+	-	Medium to High
Plastic (engineered)	+	+	+	+	Very High
Paper	-	-	-	-	Low to Medium
Metal	+	+	+	+	High to very High

Note 1: Good (+) and Poor (-)

Note 2: Due to the wide variability in pallet quality, capabilities, and characteristics due to different designs and manufacturing, this table should be used only as a general reference. Source: (EIPS 2001)

Table 2.	Statistical comparison of respondents and non-respondents based on employees per firm and
	the number of new or recycled pallets produced per employee

Primary Business	Variable	Number of Cases	Group	Mean	2-tail Significance
	employees	34	Non-respondents	27.3	960
New Pallet	per firm	425	Respondents	26.2	.000
Production	# of new pallets/skids	34	Non-respondents	13,363	704
	produced per employee	390	Respondents	12,849	.794
Desvelad	employees	30	Non-respondents	26.2	406
Pallet Production	per firm	174	Respondents	20.9	.490
	# of pallets/skids	30	Non-respondents	16,311	862
	recycled per employee	163	Respondents	16.743	.002

Significance was tested with the t-test for independent means.

CHAPTER 2: RESULTS

Respondent Profile

Seven hundred and four useable responses were returned from companies that produced, repaired, or recycled wood pallets or containers in 1999. In addition, respondents reported their primary business to be one of six types: new pallets and skids (61% of respondents), repaired/recycled pallets and skids (25%), containers (7%), pallet parts (2%), broker of pallets and skids (1%), and other (4%). Many of the respondents indicated they were providing information for more than one production facility. In total, this study captured information for 838 plants. Two production facilities that were reported in Alaska are not shown due to the fact that a majority of the company's production took place in the West. Therefore, all of this company's information was entered and analyzed as being located in the West. The regional distributions of the respondents and their production facilities are given in Figure 4.

Respondents reported having 21,043 employees, or nearly 41% of the industry's actual employment figure of 51,443, as estimated by the United States Department of Labor (Bell 2000). The greatest number of reported employees was in the South (9,242), followed by the Midwest (6,759), Northeast (2,995), and West (2,047). Table 3 provides the percentages of the actual employment captured in each region.

In reviewing this study's results, it is important to keep in mind the differences in the actual regional employment of the industry as reported by the Department of Labor, so as to understand why such disparities exist between the regional estimates. Probably the most important fact to remember is that nearly 41% of the industry is employed in the South and

another 32% is employed in the Midwest (Bell 2000). The actual employment for each region is provided in Table 3.

Using the t-test for independent means ($\alpha = .05$), it was found that the average number of employees per firm did not significantly differ between regions, but differences were detected when employment per production facility was tested (Table 4). A company's total employment was the sum of its full-time and part-time production and non-production employees. Employment per production facility was the company's total number of employees divided by the number of plants in which they indicated they were providing information. Firms in the Midwest and the Northeast had significantly fewer employees per production facility than those facilities in the West and South. Table 5 provides the mean regional employment breakdown for full-time and part-time production and non-production employment.

Comparisons were also made on the number of hours per day and number of days per year responding companies operated in 1999 (Table 6). Tukey's Honestly Significantly Different (HSD) test was used to determine if the differences between regions was significant at the .05 level. Respondents from the West and Midwest were statistically different in the number of days they operated in 1999. Pallet and container companies in the West operated a mean of 267 days in 1999, and firms in the Midwest operated 253 days. In addition, it was found that firms in the South operated significantly fewer hours per day than those in the Northeast and West.

New Wood Material Use

Figure 5 illustrates the frequency of wood material use for all 704 respondents. It provides some insight on how widely each new wood material is utilized by the pallet and container industry. Hardwood and softwood lumber and cants were the two most commonly used wood materials reported by respondents, at 61% and 37% respectively. It is important to note that many firms did not use any new wood materials, but instead relied solely upon recovered wood materials. Therefore, to get a better understanding of the users of new wood materials, only those firms that indicated they used any new wood material in 1999 were examined. Use of hardwood lumber and cants was reported by 75% of such respondents, making it the most widely utilized new wood material (Figure 6). Softwood plywood was the most frequently used wood panel.

Hardwood

This study determined that approximately 67% of all solid wood materials utilized in the production of pallets and containers in 1999 were hardwoods. The industry consumed an estimated 4.41 billion board feet of solid hardwood materials. Roughly 3.7 billion board feet of this was in the form of lumber and cants. The remaining 707 million board feet was hardwood parts (Table 7).

Firms in the South and Midwest utilized a majority of the solid hardwood material (Table 8). Southern firms consumed nearly half of the hardwood lumber and cants and Midwestern firms used another third. Conversely, it was estimated that the firms in the Midwest used about half of the hardwood parts, and Southern firms utilized close to a third.

Pallet and container companies in the West used the least amount of solid hardwood materials, consuming approximately 1% of the hardwood lumber and cants and 9% of the hardwood parts.

Approximately 51% of the hardwood used by the pallet and container industry in 1999 was either bought or processed as a mix of hardwood species (Figure 7). This was calculated to be nearly 2.26 billion board feet (Table 9). Oak (red and white) made-up nearly 31% of the hardwood used by the industry, at an estimated 1.35 billion board feet consumed. Other species used included yellow-poplar (11%) and alder (2%) at 478 million and 92 million board feet, respectively. A number of different hardwood species were listed as *Other* and accounted for another 234 million board feet.

Firms in the Midwest, Northeast, and South utilized hardwood species in similar proportions (Table 10). In each of these regions, mixed hardwoods were utilized the most often, followed by oak, yellow-poplar, other hardwoods, and alder. In contrast, alder represented 76% of the hardwood used in the West, followed by other hardwoods and mixed hardwoods. The obvious explanation for these utilization patterns is the location of the wood resource and the relationship it has on price, availability, and product familiarity. *Softwood*

Approximately one-third of the solid wood used by the pallet and container industry in 1999 was softwood. Softwood consumption was estimated at 2.13 billion board feet. Roughly 1.52 billion board feet of softwood was in the form of lumber and cants. Softwood parts accounted for approximately another 610 million board feet (Table 11).

It was estimated that pallet and container companies in the South and West were responsible for nearly three quarters of the industry's total softwood consumption (Table 12). Southern firms consumed approximately 792 million board feet of softwood material or 34% of the lumber and cants and 45% of the parts. Firms in the West used another 758 million board feet of softwood, or 35% of the softwood lumber and cants and 38% of the softwood parts. It was estimated that firms in the Midwest and the Northeast consumed 461 million and 120 million board feet of softwood material, respectively.

Nearly half of the softwood consumed by the pallet and container industry in 1999 was Southern Pine (Figure 8). It was estimated that the industry utilized approximately 1 billion board feet for the year (Table 13). Spruce-Pine-Fir was determined to be the next most utilized softwood species or species group (25%), at an estimated 539 million board feet consumed. Other species estimates included Hem-fir (11%), Douglas-fir (10%), and various other species (6%).

Softwood species use differed according to region (Table 14). It was estimated that firms in the South used 72% of the Southern Pine consumed by the industry in 1999, or approximately 740 million board feet. Southern Pine constituted almost 94% of the softwood material used in the South. The West consumed greater amounts of Spruce-Pine-Fir, Hemfir, and Douglas-fir than any other region. These three species groups accounted for 92% of the softwood consumption in the West at 298 million, 212 million, and 188 million board feet, respectively. In the Midwest, almost equal amounts of Southern Pine (46%) and Spruce-Pine-Fir (45%) were consumed. Close to 214 million board feet of Southern Pine was utilized in the region, compared to 205 million board feet of Spruce-Pine-Fir. Of the estimated 120 million board feet of softwood consumed by firms in the Northeast, nearly 48% of it was Southern Pine and another 25% of it was Spruce-Pine-Fir.

Wood Panels

This study estimated that 289 million square feet of wood panels were used in the production of pallets and containers in 1999 (Table 15). Softwood plywood accounted for approximately 208 million square feet of the total panel consumption, oriented strand board another 77 million, and hardwood plywood 5 million. It was further estimated that of the 289 million square feet of wood panels used by the pallet and container industry, approximately 86 million square feet went into the production of panel-deck pallets and skids. By subtracting this estimate from the total, wood panel use in container production was approximated at 203 million square feet. Table 15 provides the quantities of each panel type used by the individual pallet and container industries.

Due to the time required of the respondents to convert their wood panel use to 3/8" basis or to give the volume breakdown for each thickness, respondents were only asked to list each panel thickness used. The frequency of use was used to gain a general understanding of the most common thickness used for each panel type. The most frequently reported thickness used for oriented strand board was 7/16" (38%), followed by 3/4" (16%) (Figure 9). Thirty percent of the firms that used softwood plywood reported using it in 1/2" thickness. Other sizes commonly used were 3/4" and 5/8". Half inch was the most commonly reported thickness for hardwood plywood at 37%, followed by 3/4" (21%).

New Pallet/Skid Production

Through the extrapolation of the mean production per employee, it was estimated that the pallet and container industry produced approximately 429 million new pallets in 1999 (Table 16). This estimate somewhat differs from the estimate released by Dr. Cynthia West in an issue of *Pallet Talk* (Anonymous 2000a). She estimated pallet production at 454 million for 1999. The difference in the estimates can be attributed to the use of two different methodologies. West used Virginia Tech's 1995 estimate of 411 million pallets from which to make estimates using production hours (including overtime) and industry employment.

Pallet and container firms in the South produced almost 193 million new pallets, or almost 45% of the industry's total production (Table 15). The Midwest had the second greatest production at 139 million pallets, and was followed by the Northeast with 63 million. Pallet and container companies in the West produced an estimated 34 million new pallets, representing approximately 8% of the industry's total production.

In an effort to determine the differences between pallet and skid production, respondents were asked to give their production numbers for each. Extrapolation of the individual figures showed that new pallet production was considerably higher than new skid production (Table 17). In the Midwest, where skid production was the greatest, it was estimated that 20 million skids were produced. This was approximately 14% of the region's total production. Skids were shown to be a much smaller share of the total production in the other regions.

Roughly 80% of the pallets produced in 1999 were the stringer type, and 12% were the block type (Table 18). An estimated 182 million multiple-use stringer pallets were

produced in 1999, which made it the most manufactured pallet type. The next most produced pallet type was limited-use stringer, at nearly 161 million pallets produced. Limited-use and multiple-use block pallet production were estimated at 26 million and 25 million, respectively. Other pallet types and skids were calculated at 35 million.

Panel-deck pallet and skid production in 1999 was estimated at 6.7 million and .5 million, respectively (Table 19). These estimates were derived using the same extrapolation method (employee basis) used to calculate pallet production and material use. Given these numbers, panel-deck pallets and skids represent less than 2% of the industry's total pallet and skid production.

Table 15 provides the estimated quantities of wood panels used in the manufacture of panel-deck pallets and skids. Dividing the total square footage of panels used in pallet and skid production by the total number of panel deck pallets and skids produced results in an average of 12 square feet for each pallet and skid. Given that a 40"x 48" pallet with two panel decks would contain approximately 26.6 square feet in panels, the average square footage estimate was at first suspect. Since there is very little literature on panel use in pallet production, Mark Halverson from The Engineered Wood Association (APA) was contacted to request additional information (Halverson 2001). Based on his knowledge of wood panel usage, he estimated that more than 90% of panel pallets produced had one panel deck and one lumber deck. John Clark, the director of the Center for Unit Load Design at Virginia Tech, later concurred with Halverson's estimate (Clark 2001). If these observations of panel pallets are accurate within reason, it would explain the average square footage estimate made by this study.

Pallet Repair and Recycling

In 1999, the number of pallets recovered by the pallet and container industry for the purpose of repair or recycle was estimated through extrapolation to be approximately 303 million (Table 20). The pallet industry was responsible for the recovery of 299 million of these pallets. This study focused on the pallet repair and recycling efforts of the pallet industry, and as such, the following estimates regarding pallet repair and recycling are limited to only those 299 million pallets recovered by the pallet industry.

Pallet Recovery

Using sample ratios, it was determined that the 299 million pallets recovered by the pallet industry included 196 million multiple-use grocery pallets, 51 million other multipleuse pallets, 35 million limited-use, and 16 million skids and other types of pallets (Table 21). The fact that nearly 66% of the pallets received or purchased were multiple-use grocery pallets should come as no surprise. As mentioned in the literature review, the standard 48" x 40" grocery pallet is manufactured more than any other pallet dimension, and this standardization makes it the ideal pallet to repair and put back into service. It is believed that skids and other types of pallets include special purpose or custom pallets as well as skids.

It was estimated that pallet firms in the South recovered 156 million pallets, just over half the pallets recovered by the entire pallet industry (Table 22). Nearly 107 million of these pallets were multiple-use grocery pallets. Pallet companies in the Midwest recovered approximately 71 million pallets, followed by the Northeast (38 million), and the West (34 million). In each of these regions, multiple use-grocery pallets represented a majority of the pallets recovered.

Volume estimates for repaired and recycled pallets were calculated based on the number and type of pallets received. Virginia Tech's William H. Sardo Pallet and Container Laboratory estimated board footage for each pallet type: limited-use (10.1), multiple-use grocery (15.8), other multiple-use pallets (18.5), and other pallet types (15.1) (Hansen et al. 1994). These board footage estimates were used in all subsequent volume calculations regarding pallet repair and recycling.

The estimated 299 million pallets recovered by the pallet industry were calculated to be equivalent to 4.46 billion board feet of wood material (Table 21). Firms in the South and the Midwest were responsible for approximately 76% of the total volume recovered by the pallet industry (Table 23). The companies in these regions recovered 2.33 billion and 1.06 billion board feet, respectively. Pallet companies in the Northeast reclaimed an estimated 573 million board feet in recovered pallets and firms in the West were responsible for an additional 505 million board feet.

Utilization of Recovered Pallets

Using sample proportions, it was estimated that 69% of the pallets recovered in 1999 were repaired and then sold or reused (Table 24). This is equivalent to approximately 207 million recovered pallets used for this purpose. Of the 48 million recovered pallets that were un-nailed, 87% were used to repair or manufacture more pallets and 10% were ground or chipped. In addition, it was estimated that 25 million pallets were reused or sold without repair and another 16 million pallets were ground or chipped. Less than 1% of the total recovered pallets were sent to landfills or used for other purposes.

In all four regions, a majority of the recovered pallets were repaired and then reused or sold (Table 25). Southern pallet firms utilized nearly 115 million recovered pallets for this purpose, or nearly 55% of their total. Firms in the Midwest, Northeast, and West repaired and reused another 45 million, 25 million, and 24 million pallets, respectively. In each region the un-nailing of recovered pallets was the second largest use. Table 26 provides the regional breakdown of the number of pallets un-nailed and their subsequent use.

Approximately 92% of the wood material recovered by the pallet industry, or 4.1 billion board feet, went back into pallet production. This estimate was calculated by summing the pallet volumes that were repaired and then reused or sold (3098.7 MMBF), sold or reused without repair (380.7 MMBF), and un-nailed for use in the repair or manufacture of more pallets (624.1 MMBF). At an estimated total volume of 303 million board feet, the grinding or chipping of pallets or un-nailed pallet parts was another major use of recovered pallets. Regional volume estimates regarding recovered wood use are shown in Table 27 and Table 28.

Using extrapolation, it was estimated that the pallet industry returned close to 218 million pallets back to service in 1999 through either repair or recycling (Table 29). Table 30 gives the breakdown for each region's repaired or recycled pallet and skid production. Estimates regarding the repair or recycle (remanufactured using recovered parts) of pallets can be somewhat misleading since it is believed that at least some of the pallets were probably recovered and repaired or recycled more than once during the year, and thus counted multiple times. Therefore, it is better to think of these pallets returned to service as an indication of the industry's productivity in this particular segment.

It was estimated that Southern pallet firms returned 97 million pallets back to service through repair and recycling, almost 45% of the pallet industry's total production (Table 29). The remaining production was divided among the Midwest (30%), Northeast (13%), and West (12%).

Utilization of Ground or Chipped Pallets

Using sample proportions it was estimated that more than one-half of the pallets ground or chipped by the pallet industry went into the production of landscape mulch (Table 31). Nearly 7 million pallets were used to produce color mulch and another 4.4 million went into uncolored mulch. The volume estimates for these two uses were 100 million and 65 million board feet, respectively. Doug Breidle, sales manager of a company that manufactures pallet grinding machinery, attributes the popularity of colored landscape mulch to the profitability of the product and its ability to increase the sale of wood waste material (Breidle 2001). He states that colored mulch is currently in very high demand. In addition, he maintains that pallet recyclers are having a harder time disposing of their waste material, especially in landfills. In some cases pallet manufacturers have to offer colored mulch as a way to address their waste disposal problem.

Approximately 5 million ground or chipped pallets, with an estimated volume of 69 million board feet, were used as fuel. Ground or chipped pallets were used in smaller quantities for furnish in fiber-based products, animal bedding, and other various purposes. Regional estimates are given in Table 32.

Pallet firms in the Midwest and the South accounted for nearly 71% of the industry's total ground or chipped pallet volume (Table 33). Midwest firms ground or chipped roughly

109 million board feet, of which nearly 60 million board feet was used in the production of colored landscape mulch. This represents the single greatest use of ground or chipped pallets for all regions. The South used nearly 43% of its 107 million board feet of ground or chipped pallets for fuel. Furthermore, the South produced the greatest amount of uncolored landscape mulch, at close to 30 million board feet. The Northeast utilized approximately 40% of its ground or chipped pallet volume in the production of colored landscape mulch and another 25% for furnish in fiber-based products. Although firms in the Northeast produced only 19% of the industry's total volume of ground or chipped pallets, its firms were responsible for 54% of the furnish production for fiber based products. Western firms' use of ground or chipped pallets was divided among fuel (37%), furnish for fiber-based products (25%), and uncolored landscape (25%).

Predicted changes in wood material use

Finally, respondents were asked to predict changes in their wood use over the next 5 years. Given the choice of *more*, *less*, *same amount*, or *not applicable*, respondents chose the one response they felt would best describe their 5 year wood use for each of the listed wood materials: hardwood lumber/cants, softwood lumber/cants, oriented strand board, softwood plywood, pallet cores, and recovered/recycled parts. The question was then evaluated on only the *more*, *less*, *and same amount* responses. The *not applicable* response was included in the question to allow respondents who did not use a particular wood material an opportunity to answer. Since it was impossible to distinguish whether the respondents did not use a particular wood material requirements of their products, a *not applicable* response provided very little useful information.

Therefore, *not applicable* responses were excluded from analysis. It was also believed that respondents would have chosen the *more* response if they did not use a particular wood material at the time of the survey, but thought they would in the next five years.

As shown in Table 34, a majority of the respondents predicted their use of each wood material would either increase or remain the same over the next five years. The percentage of respondents that indicated they would use greater amounts of recovered/recycled parts and pallet cores was 73% and 64%, respectively. Approximately 55% of the respondents indicated they would use more hardwood lumber and cants over the next five years. The two materials chosen by the greatest number of respondents to be used less over the next five years were softwood lumber and cants and softwood plywood. In each of these cases, 9% of the respondents said they intended to use less.

From these responses, it appears that many involved in the pallet and container industry have a fairly positive outlook on the future. Those respondents that indicated future increases in wood material use undoubtedly believe that their production will increase as well. In addition, there does not appear to be any big shifts in material use, as would be indicted by a large decline in one material and a large increase in another substitutable wood material.



Figure 4. Regional distribution of respondents and their production facilities



Figure 5. Frequency of new wood material use as reported by all respondents



Figure 6. Frequency of new wood material use for respondents that reported using new wood material for 1999







Figure 8. Percentage breakdown of solid softwood species used by the pallet and container industry: 1999



Figure 9. Frequency of wood panel thickness use as reported by respondents: 1999

Table 3.	Actual regional and national employment of the pallet and container industry for 1999 as
	reported by the Department of Labor and the number and percentage captured by the study

Region	Department of Labor *	% of Total	Reported	% of Total	% Captured
West	7,812	15	2,047	10	26%
Midwest	16,354	32	6,759	32	41%
Northeast	6,361	12	2,995	14	47%
South	20,916	41	9,242	44	44%
Total	51,443	100	21,043	100	41%

*Source: (Bell 2000)

Table 4.	Mean regional and national 1999 employment of responding firms and their production
	facilities

Region	Mean Firm Employment	Mean Employment of Production Facilities (significantly differs from region #)
1) West	33.9	28.8 (2,3)
2) Midwest	27.1	18.2 (1,4)
3) Northeast	22.2	18.7 (1,4)
4) South	37.1	26.2 (2,3)
All Regions	30.4	22.1

Note: Significant differences were detected using Tukey's HSD test at the .05 level

Region	Full-Time Production	Part-Time Production	Full-Time Non-Production	Part-Time Non- Production
West	27.1	1.5	5.0	<1
Midwest	22.1	1.1	3.7	<1
Northeast	18.2	<1	3.1	<1
South	31.9	<1	4.4	<1
All Regions	25.3	<1	3.9	<1

 Table 5. Mean regional and national employment of responding firms for 1999 by employment type:

 full-time and part-time production and non-production

Table 6. Mean number of hours per day and number of days per year responding firms operated in 1999

Region	Days/Year (differs from region #)	Hours/Day (differs from region #)
1) West	267 (2)	10.2 (4)
2) Midwest	253 (1)	9.4
3) Northeast	256	9.6 (4)
4) South	255	8.8 (1,3)
All Regions	256	9.3

Note: Significant differences were detected using Tukey's HSD test at the .05 level

Table 7.	Estimated hardwood material consumption by
	the mellet and contain an induction 1000

Material	Volume (MMBF)	% of Total
Hardwood lumber/cants	3,704.2	16.0
Hardwood parts	707.2	84.0
Total	4,411.4	100

Table 8.	Regional	estimates	for hardwoo	od material u	se by the	pallet and	container	industry:	: 1999
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	Midwest		Northeast		South		West	
Material	Volume	% of	Volume	% of	Volume	% of	Volume	% of
	(MMBF)	total	(MMBF)	total	(MMBF)	total	(MMBF)	total
Hardwood lumber/cants	1,152.8	75.4	707.5	90.6	1,797.4	90.2	46.5	42.5
Hardwood parts	375.1	24.6	73.5	9.4	195.7	9.8	62.9	57.5
Total	1,527.9	100	781.0	100	1,993.1	100	109.4	100

Material	Volume (MMBF)	% of Total	
Oak	1,350.6	30.6	
Yellow-poplar	478.5	10.9	
Alder	92.1	2.1	
Mixed hardwoods	2,256.2	51.1	
Other hardwoods	234.0	5.3	
Total	4,411.4	100	

 Table 9. Estimated hardwood species consumption by the pallet and container industry: 1999

Table 10. Regional estimates for hardwood species use by the pallet and container industry: 1999

Hardward	Midwest		Northeast		South		West	
Species	Volume	% of	Volume	% of	Volume	% of	Volume	% of
openes	(MMBF)	total	(MMBF)	total	(MMBF)	total	(MMBF)	total
Oak (red and white)	444.9	29.1	210.4	26.9	694.1	34.8	1.2	1.1
Yellow-poplar	179.5	11.8	86.4	11.1	212.1	10.6	.5	.5
Alder	7.9	.5	0	0	.8	<.1	83.4	76.2
Mixed Hardwoods	737.2	48.3	433.6	55.5	1080.5	54.2	4.9	4.5
Other Hardwoods	158.5	10.4	50.5	6.5	5.6	.3	19.4	17.7
Total	1,527.9	100	781.0	100	1,993.1	100	109.4	100

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 11.	Estimated softwood material consumption by
	the pallet and container industry. 1000

Material	Volume (MMBF)	% of Total	
Softwood lumber/cants	1,520.3	71.4	
Softwood parts	609.6	28.6	
Total	2,129.9	100	

 Table 12. Regional estimates for softwood material use by the pallet and container industry: 1999

	Midwest		Northeast		South		West	
Softwood Material Use	Volume	% of	Volume	% of	Volume	% of	Volume	% of
	(MMBF)	total	(MMBF)	total	(MMBF)	total	(MMBF)	total
Softwood lumber/cants	357.3	77.6	114.0	95.4	520.8	65.8	528.2	69.7
Softwood parts	103.2	22.4	5.6	4.6	271.1	34.2	229.8	30.3
Total	460.5	100	119.5	100	791.8	100	758.0	100

Note: Row and column totals may not equal reported totals as a result of rounding.

the panet and container moustry. 1999							
Volume	% of						
(MMBF)	Total						
1,026.3	48.2						
213.8	10.0						
232.8	10.9						
539.5	25.3						
117.5	5.5						
2129.9	100						
	Volume (MMBF) 1,026.3 213.8 232.8 539.5 117.5 2129.9						

 Table 13. Estimated softwood species consumption by the pallet and container industry: 1999

 Table 14. Regional estimates for softwood species use by the pallet and container industry: 1999

	Midwest		Northe	ast	Sout	h	West	
Species	Volume (MMBF)	% of total						
Southern Pine	214.0	46.5	57.2	47.9	740.5	93.5	14.6	1.9
Douglas-fir	17.0	3.7	0	0	8.9	1.1	187.9	24.8
Hem-fir	3.0	.7	12.6	10.5	4.8	.6	212.4	28.0
Spruce-pine-fir	205.3	44.6	30.3	25.3	5.4	.7	298.5	39.4
Other softwoods	21.2	4.6	19.4	16.3	32.2	4.1	44.6	5.9
Total	460.5	100	119.5	100	791.8	100	758.0	100

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 15.	Estimated	wood pane	el use by th	e pallet and	l container	industry: 1999
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Wood Panel Type	Pallets (MMSF)	Containers (MMSF)	Total (MMSF)
Softwood plywood	64.1	187.6	207.8
Oriented strand board	20.2	56.6	76.7
Hardwood plywood	1.9	2.9	4.8
Total	86.2	203.1	289.3

Note: Panel volumes are reported without an assigned basis or thickness.

Table 16.	National and regiona	l estimates for new	pallet production	by the pallet and	container industry:
	1999				-

Region	Pallet Industry Number of Units (millions)	Container Industry Number of Units (millions)	Regional Totals	Percent of Total
Midwest	135.1	4.0	139.1	32.4
Northeast	61.2	1.8	63.0	14.7
South	184.5	8.2	192.7	45.0
West	23.3	10.6	33.9	7.9
Total	404.2	24.5	428.6	100

Note: Row and column totals may not equal reported totals as a result of rounding.

	Midwe	est	Northe	ast	Sout	h	Wes	t
Туре	Units	% of						
	(millions)	total	(millions)	total	(millions)	total	(millions)	total
New Pallets	118.9	85.9	59.1	92.3	180.0	93.7	32.4	96.4
New Skids	19.5	14.1	4.9	7.7	12.2	6.3	1.2	3.6
Total	138.4	100	64.1	100	192.2	100	33.7	100

Table 17.	Comparison of r	ew pallet and skie	l production	estimates by	y region:	1999
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Note: Row and column totals may not equal reported totals as a result of rounding. Totals may not equal those in Table 16 due to rounding.

Table 18. Estimated new pallet production by pallet type:1999

Pallet Type	Volume (MMBF)	% of Total
Limited-use block	25.6	6.0
Multiple-use block	24.5	5.7
Limited-use stringer	161.4	37.7
Multiple-use stringer	181.8	42.4
Other pallet types and skids	35.3	8.2
Total	428.6	100

Note: Estimates were obtained using sample ratios. Skid production in Table 17 exceeds the estimate of *Other pallet types and skids* in this table due to differing methods used to obtain the estimates.

Table 19. Estimated panel-deck pallet and skid
production by the pallet and container
industry: 1999

Panel Platform	Units (millions)	% of Total
Pallets	6.7	92.8
Skids	.5	7.2
Total	7.2	100

Table 20.	National and regional estimates of the number of pallets recovered by the pallet an	d container
	industry: 1999	

Region	Pallet Industry Number of Units (millions)	Container Industry Number of Units (millions)	Regional Totals	Percent of Total
Midwest	70.8	<.1	70.8	23.4
Northeast	38.1	.2	38.3	12.7
South	156.4	3.1	159.5	52.7
West	33.7	.2	33.9	11.2
Total	299.0	3.5	302.5	100

Pallet Type	Units (millions)	% of total	Volume (MMBF)	% of total
Limited-use	34.9	11.7	338.5	7.6
Multiple-use grocery	196.2	65.6	2,973.2	66.6
Other multiple-use	51.4	17.2	910.9	20.4
Skids & Other types	16.5	5.5	238.5	5.3
Total	299.0	100	4.46	100

 Table 21. Estimated number of pallets and volume recovered by the pallet industry by pallet type: 1999

 Table 22. Regional estimates for the number of pallets recovered by the pallet industry by pallet type:

 1999

	Midw	est	Northe	ast	Sout	h	Wes	st
Pallet Type	Units	% of						
	(millions)	total	(millions)	total	(millions)	total	(millions)	total
Limited-use	10.1	14.3	4.8	12.7	15.8	10.1	4.2	12.4
Multiple-use grocery	39.7	56.1	26.3	69.0	106.9	68.3	23.4	69.3
Other multiple-use	17.1	24.2	5.1	13.4	24.2	15.5	5.0	14.7
Skids & Other types	3.9	5.5	1.9	5.0	9.5	6.1	1.2	3.6
Total	70.8	100	38.1	100	156.4	100	33.7	100

Table 23.	Regional estimates of the volume of pallets recovered by the pallet industry by pallet type:
	1999

	Midwest		Northeast		South		West	
Pallet Type	Volume	% of	Volume	% of	Volume	% of	Volume	% of
	(MMBF)	total	(MMBF)	total	(MMBF)	total	(MMBF)	total
Limited-use	97.5	9.2	47.6	8.3	152.7	6.6	40.7	8.1
Multiple-use grocery	599.6	56.8	405.2	70.7	1,610.9	69.2	357.4	70.8
Other multiple-use	302.4	28.7	92.0	16.1	427.8	18.4	88.7	17.6
Skids & Other types	56.0	5.3	28.1	4.9	136.6	5.9	17.8	3.5
Total	1,055.4	100	573.0	100	2,328.0	100	504.7	100

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 24.	Estimated number and volume of recovered pallets utilized for
	various purposes by the pallet industry: 1999

Pallet Type	Units (millions)	% of total	Volume (MMBF)	% of total
Reused or sold w/o repair	25.0	8.4	380.7	8.5
Repaired & sold or reused	207.5 69.4		3,098.7	69.5
Un-nailed	48.4	16.2	713.8	16.0
Ground or chipped	15.7	5.2	231.2	5.2
Sent to landfills	1.5	.5	21.7	.5
Used for other purposes	1.0	.3	14.9	.3
Total	299.0	100	4,461.1	100

	Midwest		Northeast		South		West	
Type of Use	Units (millions)	% of total						
Reused or sold w/o repair	7.7	10.9	4.5	11.8	9.6	6.2	3.2	9.5
Repaired & sold or reused	44.6	63.1	24.6	64.4	114.7	73.4	23.6	69.9
Un-nailed	11.8	16.6	5.5	14.4	26.0	16.6	5.2	15.5
Ground or chipped	6.2	8.7	3.1	8.3	4.9	3.1	1.4	4.3
Sent to landfills	.3	.4	.3	.8	.6	.4	.3	.9
Used for other purposes	.2	.3	.2	.4	.6	.4	<.1	0
Total	70.8	100.0	38.1	100.0	156.4	100.0	33.7	100.0

 Table 25. Regional estimates of the number of recovered pallets utilized for various purposes by the pallet industry: 1999

 Table 26. Regional estimates of the number of un-nailed pallets utilized for various purposes by the pallet industry: 1999

	Midwest		Northeast		South		West	
Type of Use	Units (millions)	% of total						
Reused to build or repair								
pallets and skids	10.4	88.4	4.5	81.3	22.8	87.9	4.6	88.8
Ground or chipped	1.0	8.9	.9	16.4	2.5	9.5	.5	9.5
Other	.3	2.8	.1	2.3	.7	2.6	<.1	1.6
Total	11.8	100	5.5	100	26.0	100	5.2	100

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 27.	Regional estimates of the volume of ground or chipped pallets utilized for various purposes by
	the pallet industry: 1999

	Midwest		Northeast		South		West	
Type of Use	Volume	% of	Volume	% of	Volume	% of	Volume	% of
	(MMBF)	total	(MMBF)	total	(MMBF)	total	(MMBF)	total
Reused or sold w/o repair	117.0	11.1	68.4	11.9	145.5	6.2	49.9	9.9
Repaired & sold or reused	666.5	63.2	370.8	64.7	1,708.8	73.4	352.6	69.9
Un-nailed	171.0	16.2	82.1	14.3	383.8	16.5	77.0	15.2
Ground or chipped	93.4	8.9	45.1	7.9	71.8	3.1	20.8	4.1
Sent to landfills	4.0	.4	4.4	.8	8.9	.4	4.4	.9
Used for other purposes	3.5	.3	2.2	.4	9.2	.4	< .1	0
Total	1,055.4	100	573.0	100	2,328.0	100	504.7	100

Note: Row and column totals may not equal reported totals as a result of rounding.

	Midwest		Northeast		South		West	
Type of Use	Volume (MMBF)	% of total						
Reused to build or repair pallets and skids	150.7	88.2	66.4	80.9	338.5	88.2	68.5	89.0
Ground or chipped	15.7	9.2	13.8	16.8	35.2	9.2	7.2	9.4
Other	4.6	2.7	1.9	2.4	10.2	2.6	1.2	1.6
Total	171.0	100	82.1	100	383.8	100	77.0	100

 Table 28. Regional estimates of the volume of un-nailed pallets utilized for different purposes by the pallet industry: 1999

 Table 29. National and regional estimates of the number of pallets returned to service by the pallet and container industry through either repair or recycling: 1999

Region	Pallet Industry Number of Units (millions)	Container Industry Number of Units (millions)	Regional Totals	% of Total
Midwest	64.2	.1	64.4	28.8
Northeast	29.4	.2	29.6	13.3
South	97.3	5.0	102.3	45.8
West	26.8	.2	27.0	12.1
Total	217.8	5.5	223.3	100

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 30.	Regional comparison of the number of pallets and skids returned to service through either
	repair or recycling: 1999

	Midwest		Northeast		South		West	
Туре	Units	% of						
	(millions)	total	(millions)	total	(millions)	total	(millions)	total
Pallets	63.0	98.3	29.2	98.6	100.7	98.6	26.6	98.7
Skids	1.1	1.7	.4	1.4	1.4	1.4	.4	1.3
Total	64.1	100	29.6	100	102.1	100	27.0	100

Note: Row and column totals may not equal reported totals as a result of rounding. Totals may not equal those in Table 29 due to rounding.
Type of Use	Units (millions)	% of total	Volume (MMBF)	% of total	
Colored					
landscape mulch	6.8	33.1	100.1	33.0	
Uncolored					
landscape mulch	4.4	21.6	64.7	21.3	
Animal Bedding	1.6	7.7	23.2	7.7	
Fuel	4.7	23.0	69.0	22.8	
Fiber-based	1.8	8.5	26.9	8.9	
Other	1.3	6.1	19.0	6.3	
Total	20.6	100	303.0	100	

Table 31. Estimated number and volume of ground or chipped palletsthat were utilized by the pallet industry for various purposes:1999

Table 32.	Regional estimates of the number of ground or chipped pallets that were utilized by the pallet
	industry for various purposes: 1999

	Midwest		Northeast		South		West		
Type of Use	Units	Units % of Units		% of	Units	% of	Units	% of	
	(thousands)	total	(thousands)	total	(thousands)	total	(thousands)	total	
Colored									
landscape mulch	3,912	54.2	1,666	41.2	1,214	16.5	0	0	
Uncolored	4.040	10.0	660	40.4	0.000			00.0	
landscape mulch	1,218	16.9	662	16.4	2,089	28.4	461	23.9	
Animal Bedding	613	8.5	687	17.0	34	.5	252	13.0	
Fuel	829	11.5	24	.6	3,127	42.5	747	38.6	
Fiber-based	99	1.4	939	23.2	242	3.3	473	24.5	
Other	552	7.6	68	1.7	643	8.7	0	0	
Total	7,223	100	4,046	100	7,350	100	1,932	100	

Note: Row and column totals may not equal reported totals as a result of rounding.

Ľ	Midwest		North	neast	South		West	
Type of Use	Volume (MMBF)	% of total						
Colored landscape mulch	59.5	54.5	23.5	40.0	17.1	16.0	0	0
Uncolored landscape mulch	17.7	16.2	10.1	17.2	30.0	28.0	6.9	24.6
Animal bedding	9.9	9.0	9.2	15.7	.5	.5	3.7	13.1
Fuel	12.6	11.5	.4	.7	45.7	42.7	10.4	37.0
Fiber-based	1.5	1.4	14.5	24.7	3.7	3.5	7.1	25.4
Other	8.0	7.4	1.1	1.8	10.0	9.3	0	0
Total	109.1	100.0	58.8	100.0	107.0	100.0	28.1	100.0

 Table 33. Regional estimates of the volume of ground or chipped pallets that were utilized by the pallet industry for various purposes: 1999

Note: Row and column totals may not equal reported totals as a result of rounding.

Table 34. Predicted changes in respondents' material use over the next five years (1999-2004)

	Percent of Responses						
Material	More	Less	Same Amount				
Hardwood lumber/cants	55	6	39				
Softwood lumber/cants	52	9	39				
Oriented strand board	42	8	50				
Softwood plywood	39	9	52				
Pallet cores	64	7	29				
Recovered/recycled parts	73	4	23				

CHAPTER 3: TREND ANALYSIS

In order to identify certain wood use trends within the U.S. pallet and container industry, the results of this study were examined in combination with those of previous such studies conducted by Virginia Tech and the United States Forest Service. These earlier studies were carried out in 1992, 1993, and 1995. Since the studies used similar methods to obtain their estimates, comparisons can be made between their results.

Differences in each year's estimates were first examined. Closer attention was then paid to differences between this study and the study conducted in 1995. Whenever possible, statistical methods were employed to determine if there were significant differences between the two years. In instances where means could be compared and the assumptions for parametric tests were not violated, the t-test for independent means was used.

The results of the three previous Virginia Tech pallet and container studies are frequently mentioned throughout this chapter. To improve the readability of this chapter, each year's study will be cited only once as follows: 1992 (Christoforo 1993); 1993 [new pallet and wood use] (Hansen et al.1993 b); 1993 [pallet repair and recycling] (Hansen et al. 1993); 1995 [new pallet and wood use] (Reddy et al. 1997); and 1995 [pallet repair and recycling] (Bush et al. 1997).

Firm Employment and Operations

Nationally, the mean employment of pallet and container companies did not change considerably during the 1990s. The mean tended to be close to 30 employees for all four studies (Table 35). When comparing regional and national means for 1995 and 1999, there was mild evidence that the employment of Northeastern firms was statically different. The mean employment of Northeast firms rose from 16.7 in 1995 to 22.2 in 1999. An increase in

the respondents' employment could be as a result of increased production or a consolidation within the region that has resulted in a smaller number of firms with a larger capacity.

In the 1995 and 1999 survey, data were collected on the number of hours per day and the number of days per year each responding company operated. Using the t-test for independent means, it was shown that there were statistical differences in the number of days a year responding companies operated. From 1995 to 1999, the mean number of days Midwest firms operated decreased from 265 to 253. The national means decreased from 260 to 256 days due in part to the change in the Midwest (Table 36).

New Wood Material Use

The pallet and container industry's use of solid wood materials, that is, the consumption of hardwood and softwood lumber, cants, and parts, was estimated at 6.54 billion board feet for 1999. This represents a 3.6% increase over the 1995 estimate (Table 37). Despite this modest increase, the industry's use of new solid wood materials remains less than it did in the early 1990s. Of the four studies conducted by Virginia Tech to track wood material use by the pallet and container industry, the 1993 study showed the greatest level of consumption of new solid wood materials at 6.94 billion board feet. Figure 10 illustrates these various changes in solid wood use.

Softwood

Between 1995 and 1999, the industry's annual consumption of softwood parts increased from 254 million board feet to 610 million board feet (Table 37). This was a significant difference based upon the 95% confidence interval (Table 38) calculated for softwood parts as described in Appendix C. The small decrease in softwood lumber and

cants was determined to be insignificant based on its own 95% confidence interval (Table 38). The 1996 U.S. - Canadian Softwood Lumber Agreement might, in part, explain the increase in softwood parts. This agreement restricted Canadian softwood lumber exports to the U.S. through the use of quotas. With a quota in place, it was unlikely that the Canadian timber industry would have used the export of low-grade lumber toward their cap. The quota would primarily be applicable to the species group Spruce-Pine-Fir, which represented 25% of the softwood used by the pallet and container industry in 1999. Pallet parts were exempt from the quota when they were packaged in kits that contained enough material to manufacture a certain number of pallets (Brindley 1999c). Adding credibility to this theory is the slight decline in softwood lumber and cant use over this same time period.

In 1999, approximately 33% of new solid wood materials used by the pallet and container industry was softwood. This is up from the 31% reported in 1992 and 1993, and 28% for 1995. One of the factors that could have contributed to this shift to softwoods was the hardwood shortage of the mid-to-late 1990s (Brindley 1999c). Figure 3 illustrates the increases in hardwood cant and board prices that could have caused some pallet producers to substitute softwoods for hardwoods (Pallet Profile Weekly 1995-1999). The emergence of CHEP and its softwood pallet might also have played a small role in this shift (Brindley 1999c).

The use of Southern Pine (also called Southern Yellow Pine) and its percentage of the total softwood consumption have steadily increased since the 1993 study (Table 39). Southern Pine consumption increased from 724 million board feet and 34% of the softwood consumed in 1993 to just over 1 billion board feet and 48% of the softwood used in 1999.

Here again, this change can be attributed to the emergence of CHEP and the hardwood shortage in the mid-to-late 1990s (Brindley 1999c). Southern Yellow Pine attributes make it a good species to use in the construction of pallets and containers. Edward Brindley (1999c p. 17) of the *Pallet Enterprise* explains, "*The supply of SYP* [Southern Yellow Pine] *is as dependable as lumber supplies can be in today's rocky environmental waters. SYP has a high strength to weight ratio, and its uniform dry weight is a plus. SYP dries well which makes it desirable from both a weight and contamination points of view." Douglas-fir continues to be utilized less and less by the industry. Its use declined from 620 million board feet in 1992 to 214 million board feet in 1999.*

Hardwood

Another notable trend is the declining use of hardwood lumber and cants, albeit a gradual decline (Table 37). The estimated 4% decline in hardwood lumber and cant consumption and the 7% increase in hardwood parts consumption between 1995 and 1999 were both considered insignificant by the calculated 95% confidence interval estimate (Table 38) described in Appendix C.

The pallet and container industry continues to purchase and utilize mixed hardwoods more than any other species or species group (Table 40). For 1995 and 1999, mixed hardwoods represented approximately 56% and 51% of the total hardwood consumption, respectively. Another notable trend is the decline in alder use. In 1993 the industry consumed an estimated 393 million board feet of alder, which was equivalent to 8% of the total hardwood use. It was estimated that 92 million board feet of alder was consumed in 1999, representing 2% of the hardwood utilized by the industry. It could be that alder is of higher value in other markets; therefore, less is being sold as low-grade pallet stock. David Sweitzer, from the Western Hardwood Association, credits an aggressive domestic and international alder marketing campaign for gradually increasing the price of alder over the last 25 to 35 years and resulting in it becoming the third most exported hardwood species (Kaiser 1998).

Wood Panels

Softwood plywood continues to be the most utilized wood panel product by the panel and container industry despite its estimated 5% decline in use from 1995 to 1999 (Table 41). In comparison, oriented strand board use rose from 30 million square feet to 77 million over the same period of time, representing a 157% increase. As shown in Figure 11, oriented strand board appears to gaining a greater percentage of the industry's wood panel use. However, using the statistical test in Appendix C, changes seen in both softwood plywood and oriented strand board use between 1995 and 1999 were deemed insignificant using their calculated 95% confidence interval (Table 38).

New Pallet Production

Virginia Tech first tracked new pallet production in the 1995 study. In that study it was estimated that the pallet and container industry produced 411 million new pallets for the year. The estimated 429 million new pallets produced in 1999 represents a 4% increase over the 1995 estimate. Using the statistical method provided in Appendix C to calculate the 95% confidence interval (Table 38), it was shown that this change in pallet production was not significant.

Pallet Repair and Recycling

Pallet Recovery

From 1995 to 1999, it was estimated that the number of pallets recovered by the pallet industry increased from 171 million to 299 million (Table 42). Using the method outlined in Appendix C, it was determined that the change in the number of pallets recovered from 1995 to 1999 was significant according to the 95% confidence interval estimate (Table 38). Much of this increase can be attributed to developments discussed earlier, such as increased profitability, environmental concerns, reduction in users' costs, and low barriers to entry (Bush and Araman 1997).

Recovered wood material utilized by the pallet industry increased as a percentage of the total from 1995 to 1999 (Figure 12). For example, it was estimated that the total volume of wood (new and used) consumed by the pallet industry increased approximately 26% from 1995 to 1999, or just over 2 billion board feet. Approximately 190 million board feet of this increase was in new wood materials and 1.82 billion board feet was from recovered wood materials. These changes represent increases of 3.4% and 80%, respectively. This suggests that recovered wood materials are primarily satisfying any new demand for wood materials created by the pallet industry.

Multiple-use grocery pallets were consistently the most recovered pallet type (Table 42). The number of multiple-use grocery pallets recovered had increased from 40 million (61% of the total recovered) in 1992 to 196 million (66%) in 1999. Accordingly, the volume of wood recovered from multiple-use grocery pallets increased from 637 million board feet in 1992 to 2.97 billion board feet in 1999 (Table 43). The number of limited-use pallets

recovered decreased as a percentage of the total over this same time period. In 1993 they represented nearly 18% of the pallets recovered and in 1999 only 12%.

Utilization of Recovered Pallets

Of all the pallet industry's uses for recovered pallets, the largest increases were seen in the number of pallets that were repaired and then reused or sold. Recovered pallets used for this purpose increased from approximately 41 million pallets in 1992 to 207 million in 1999 (Table 44). Over this time, the number of recovered pallets repaired and then were reused or sold increased from 62% to 69% percent of the total. The wood volume associated with these pallets increased from 636 million board feet to just over 3 billion board feet (Table 45).

As shown in Table 44, increases were also seen in most every other use of recovered pallets. The estimated number of pallets that were un-nailed increased from 9 million in 1992 to 48 million in 1999. Much of this increase went into the production of other pallets (Table 46). Over the same eight years, the total volume of ground or chipped wood material produced from pallets and or pallet parts increased from 92 million to 303 million board feet (Table 45,Table 47). Data regarding the landfilling of recovered pallets were only collected in 1995 and 1999. It was estimated that 1.5 million recovered pallets were sent to the landfill in both of these years. In 1995 this represented .9% of the total recovered pallets and in 1999 it was .5%.

From 1995 to 1999, there was an estimated 56% increase in the number of pallets repaired or remanufactured with used pallet parts. Much of this increase appears to have come at the expense of new pallet production (Figure 13). The 143 million estimated pallets

returned to service by the pallet and container industry in 1995 represented approximately 26% of the pallet and container industry's total pallet production. In 1999 the estimated number of pallets returned to service by the pallet and container industry had grown to 223 million and 34% of the total pallet production. Using the statistical method provided in Appendix C, the calculated 95% confidence interval (Table 38) indicated that this increase in production between the two years was significant. Although it is impossible to say how many times the pallets were repaired or remanufactured and put back into service for each year, these findings clearly show that repaired pallets and pallets made from used parts are capturing most of the growth in pallet production.

Utilization of Ground or Chipped Pallets

The greatest change in the use of ground or chipped pallets between 1995 and 1999 was the increase in landscape mulch production. The number of recovered pallets that were ground or chipped for this purpose increased from 3.4 million to 11.2 million, respectively (Table 48). In addition, the volume used for this purpose rose from approximately 19% to 54% as a percentage of the total volume of ground or chipped pallets (Table 49). Part of this was offset by a decline in wood material used for fuel and other various uses. In 1995, approximately 43% of the ground or chipped volume went into fuel, whereas 23% of the volume was used for this purpose in 1999.

The shift in ground or chipped pallet material use might be related to the current value of landscape mulch. It was found in a 1998 Virginia Tech study that pallets that were recovered from landfills and subsequently ground or chipped sold for an average of \$8.50 a ton as fuel as compared to \$22.30 as animal bedding, mulch, or compost (Corr 2000).

Although the location of the recovery differs in this study, one would expect that this price difference between the products to still exist.



Figure 10. Solid wood use trends of the pallet and container industry: 1992, 1993, 1995, and 1999



Figure 11. Wood panel use trends of the pallet and container industry: 1992, 1993, 1995, and 1999

Note: Data for hardwood plywood not collected for 1993 and 1995. Panel volumes are reported without an assigned basis or thickness





Note: Recovered wood was the sum of the estimated volumes for pallets reused or sold without repair, pallets repaired and sold or reused, and un-nailed palled parts that were reused to build or repair pallet parts.



Figure 13. Comparison of new pallet production and pallets returned to service through repair or recycling by the pallet and container industry: 1995 and 1999

Region	Меа	1995 – 1999 2 Tail			
-	1992	1993	1995	1999	Significance
Midwest	29.7	29.0	26.0	27.1	.806
Northeast	19.4	18.9	16.7	22.2	.071
South	31.8	37.1	39.9	37.1	.716
West	30.6	34.1	34.0	33.9	.990
U.S.	28.7	30.8	29.9	30.4	.894

Table 35. Mean number of employees per responding firm: 1992, 1993, 1995, and 1999

Note: The T-test for independent means (.05 alpha level) was used to detect differences between 1995 and 1999.

Table 36. Mean number of hours per day and number of days per year responding companies operated in 1995 and 1999

Bogion	Days/	Days/Year		Hours	2 tail	
Region	1995	1999	Significance	1995	1999	Significance
Midwest	265	253	.000	9.8	9.4	.237
Northeast	256	256	.908	9.3	9.6	.522
South	258	255	.347	8.9	8.8	.622
West	257	267	.158	9.7	10.2	.350
U.S.	260	256	.021	9.4	9.3	.568

Note: The T-test for independent means (.05 alpha level) was used to detect differences between 1995 and 1999.

Table 37.	Estimated volume of new solid wood use by the pallet and container industry: 1992, 1993,
	1995, and 1999

Wood Material	1992 (MMBF)	Percent Change (+/-)	1993 (MMBF)	Percent Change (+/-)	1995 (MMBF)	Percent Change (+/-)	1999 (MMBF)
Hardwood lumber/cants	3,957	-2.7	3,852	+<.1	3,867	-4.2	3,704
Hardwood parts	785	+2.4	972	-32.0	661	+7.0	707
Softwood lumber/cants	1,623	-7.3	1,504	+1.9	1,533	-<.1	1,520
Softwood parts	529	+16.3	615	-58.7	254	+140.2	610
Total	6,894	+<.1	6,943	-9.0	6,315	+3.6	6,541

Wood Product	Average Standard Error	Lower Confidence Interval	Upper Confidence Interval		
Hardwood lumber use	282,136,796	-715,777,840	390,198,402		
Softwood lumber use	213,427,820	-430,746,166	405,890,886		
Hardwood parts use	156,638,033	-261,185,760	352,835,328		
Softwood parts use	13,854,4651	84,526,160	627,621,190		
Oriented strand board use	33,337,656	-23,750,939	106,932,673		
Softwood plywood use	83,347,797	-209,583,036	117,140,326		
Number of new pallets produced	30,064,298	-41,235,443	76,616,605		
Number of repaired pallets by pallet and container industry	23,975,203	32,930,419	126,913,215		
Number of pallets recovered by pallet and container industry	50,295,575	28,249,040	225,407,696		

 Table 38. Calculated 95% confidence intervals used in testing for significant differences between 1995 and 1999 extrapolated totals

Note: Statistics used to calculate confidence intervals are outlined in Appendix C. If zero falls within the confidence interval then there is no significant difference between the totals for the two years.

Table 39.	Estimated volume of solid softwood species use by the pallet and container industry: 1992,
	1993, 1995, and 1999

Softwood Species	ММВБ				Percentage of softwood species used			
	1992	1993	1995	1999	1992	1993	1995	1999
Southern pine	853	724	731	1,026	39.7	34.2	40.9	48.2
Douglas-fir	620	512	199	214	28.8	24.2	11.2	10.0
Hemlock-fir	N/A*	N/A*	178	233	-	-	10.0	10.9
Spruce-Pine-Fir	N/A*	N/A*	552	539	-	-	30.9	25.3
Other softwoods	679	883	126	117	31.6	41.7	7.1	5.5
Total	2,152	2,119	1,786	2,130	100	100	100	100

Note: Column and row totals may not equal reported totals as a result of rounding.

* Data not collected

Hardwood Species		MMBF				Percentage of hardwood species used			
	1992	1993	1995	1999	1992	1993	1995	1999	
Oak	1,879	1,511	1,221	1350	39.6	31.3	27.0	30.6	
Yellow-poplar	601	574	379	478	12.7	11.9	8.4	10.9	
Basswood / Aspen									
Cottonwood	204	267	N/A*	N/A*	4.3	5.5	-	-	
Alder	361	393	165	92	7.6	8.2	3.7	2.1	
Mixed Hardwoods	1,584	1,998	2,547	2,256	33.4	41.4	56.2	51.1	
Other Hardwoods	114	81	216	234	2.4	1.7	4.8	5.3	
Total	4,742	4,824	4,528	4,411	100	100	100	100	

Table 40. Estimated volume of solid hardwood species use by the pallet and container industry: 1992, 1993, 1995, and 1999

Note: Column and row totals may not equal reported totals as a result of rounding.

* Data not collected

$1 a \mu c + 1$, Estimated word panel use by the panel and contained model ($1, 1774, 1775, 1775, a \mu 1777$	Table 41.	Estimated wood	panel use by the	pallet and container	industry: 1992	, 1993, 1995, and 1999
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Wood Panel Material	1992 (MMSF)	Percent Change (+/-)	1993 (MMSF)	Percent Change (+/-)	1995 (MMSF)	Percent Change (+/-)	1999 (MMSF)
Oriented strand board	20	-10.0	18	+66.7	30	+156.7	77
Softwood plywood	169	+5.3	178	+22.5	218	-4.6	208
Hardwood plywood	16	-	N/A*	-	N/A*	-	5

* Data not collected

Table 42. Estimated number and proportion of pallets recovered by the pallet industry for each pallet type: 1992, 1993, 1995, and 1999

Type of Pallot Received	Nur	Proportion of pallets recovered by type (%)						
Type of Fallet Received	1992	1993	1995	1999	1992	1993	1995	1999
Single-use/limited-use	9.4	14.9	29.7	34.9	14.3	17.9	17.4	11.7
Multiple-use grocery	40.3	52.2	107.3	196.2	61.3	62.7	62.7	65.6
Other multiple-use	15.2	13.1	26.8	51.4	23.2	15.7	15.6	17.2
Other pallet type/skids	.8	3.1	7.3	16.5	1.2	3.8	4.3	5.5
Total	65.8	83.3	100	100	100	100		

Note: Column and row totals may not equal reported totals as a result of rounding.

Table 43. Estimated wood volume and proportion of pallets recovered by the pallet industry for each pallet type: 1992, 1993, 1995, and 1999

Type of Pallot Possived	Estimate	Proportion of volume recovered by type (%)						
Type of Fallet Received	1992	1993	1995	1999	1992	1993	1995	1999
Single-use/limited-use	95.3	146.5	301.4	338.5	9.3	11.9	11.6	7.6
Multiple-use grocery	637.2	804.4	1697.7	2973.2	62.1	65.1	65.2	66.6
Other multiple-use	281.9	237.7	496.1	910.9	27.5	19.2	19.0	20.4
Other pallet type/skids	12.3	47.0	109.9	238.5	1.2	3.8	4.2	5.3
Total	1,026.7	1,235.7	2,605.1	4,461.1	100	100	100	100

Note: Column and row totals may not equal reported totals as a result of rounding.

Type of Use	Nur	Proportion of total number of pallets recovered (%)						
	1992	1993	1995	1999	1992	1993	1995	1999
Reused without repair	9.8	11.1	16.8	25.0	14.9	13.3	9.8	8.4
Repaired & reused	41.0	50.9	107.8	207.5	62.3	61.2	63.0	69.4
Un-nailed	9.2	12.8	30.4	48.4	14.0	15.4	17.8	16.2
Ground/chipped	5.0	6.7	13.1	15.7	7.6	8.0	7.7	5.2
Sent to landfills	N/A	N/A	1.5	1.5	N/A	N/A	.9	.5
Other	.8	1.7	1.4	1.0	1.3	2.0	.8	.3
Total	65.8	83.3	171.1	299.0	100	100	100	100

Table 44. Estimated number and proportion of recovered pallets used for various purposes: 1992,1993, 1995, and 1999

Note: Column and row totals may not equal reported totals as a result of rounding

 Table 45. Estimated volume of recovered pallets used for various purposes: 1992, 1993, 1995, 1999

Type of Use	1992 (MMBF)	Percent Change (-/+)	1993 (MMBF)	Percent Change (-/+)	1995 (MMBF)	Percent Change (-/+)	1999 (MMBF)
Reused without repair	157.0	+ 9.9	172.6	+ 48.3	255.9	+ 48.8	380.7
Repaired & reused	636.3	+ 17.4	747.3	+ 121.6	1,656.2	+ 87.1	3,098.7
Un-nailed	143.6	+ 32.3	190.0	+ 137.9	452.0	+ 57.9	713.8
Ground/chipped	76.8	+30.6	100.3	+ 93.7	194.3	+ 19.0	231.2
Sent to landfills	N/A	N/A	N/A	N/A	24.0	- 9.6	21.7
Other	13.0	+ 96.2	25.5	- 10.6	22.8	- 34.6	14.9
Total	1,026.7	+ 20.2	1,235.7	+110.8	2,605.1	+ 71.2	4,461.1

Note: Column and row totals may not equal reported totals as a result of rounding.

Table 46.	Estimated number and proportion of un-nailed pallets used for various purposes: 1	1992,
	1993, 1995, and 1999	

Type of Use	Nur	Proportion of total number of un-nailed pallets (%)						
	1992	1993	1995	1999	1992	1993	1995	1999
Reused to build pallets	7.6	10.3	24.7	42.3	82.4	80.1	81.2	87.4
Ground or chipped	.9	1.7	4.1	4.9	10.2	13.1	13.4	10.1
Other	.7	.9	1.6	1.2	7.4	6.8	5.4	2.5
Total	9.2	12.8	30.4	48.4	100	100	100	100

Note: Column and row totals may not equal reported totals as a result of rounding

Table 47. Estimated volume of un-nailed	pallets used for various pur	rposes: 1992, 1993, 1995, and 1999
---	------------------------------	------------------------------------

Type of Use	1992 (MMBF)	Percent Change (-/+)	1993 (MMBF)	Percent Change (-/+)	1995 (MMBF)	Percent Change (-/+)	1999 (MMBF)
Reused to build pallets	118.5	+ 28.1	151.8	+ 141.4	366.4	+ 70.3	624.1
Ground or chipped	14.7	+ 70.1	25.0	+ 142.0	60.4	+ 18.9	71.8
Other	10.4	+ 26.9	13.2	+ 90.2	25.1	- 28.7	17.9
Total	143.6	+ 32.3	190.0	+ 137.9	452.0	+ 57.9	713.8

Note: Column and row totals may not equal reported totals as a result of rounding

Type of Use	1992 (million)	Percent Change (-/+)	1993 (million)	Percent Change (-/+)	1995 (million)	Percent Change (-/+)	1999 (million)
Landscape							
mulch	.8	112.5	1.7	100.0	3.4	229.4	*11.2
Animal bedding	.4	250.0	1.4	-14.3	1.2	33.3	1.6
Fuel	3.0	10.0	3.3	127.3	7.5	-37.3	4.7
Fiber products	N/A	-	1.8	-55.6	.8	125.0	1.8
Other	1.8	-	<.1	-	4.3	-69.8	1.3
Total	5.9	42.4	8.4	104.2	17.2	19.8	20.6

Table 48. Estimated number of ground or chipped pallets used for various purposes: 1992, 1993, 1995,and 1999

Note: Column and row totals may not equal reported totals as a result of rounding

* Combined uncolored and colored landscape mulch estimates

 Table 49. Estimated volume and proportion of ground or chipped pallets used for various purposes:

 1992, 1993, 1995, and 1999

Type of Use	Volume of ground or chipped pallets (MMBF)				Proportion of pallets by type use pallets (%)			
	1992	1993	1995	1999	1992	1993	1995	1999
Landscape mulch	11.3	23.1	47.6	*164.8	12.3	18.5	18.7	54.3
Animal bedding	5.3	21.5	18.8	23.2	5.8	17.1	7.4	7.7
Fuel	48.5	52.1	110.1	69.0	53.1	41.6	43.2	22.8
Fiber products	N/A	27.5	11.3	26.9	N/A	22.0	4.4	8.9
Other	26.4	1.10	67.0	19.0	28.8	.9	26.3	6.3
Total	91.5	125.3	254.7	303.0	100	100	100	100

Note: Column and row totals may not equal reported totals as a result of rounding.

* Combination of uncolored and colored landscape mulch estimates

CHAPTER 4: STUDY OVERVIEW

Research Summary

This study was the latest of four (1992, 1993, 1995, and 1999) conducted by Virginia Tech and the U.S. Forest Service to understand new and recovered wood use in the U.S. pallet and container industry. Each study employed the same methods in calculating industry estimates, thereby making the results consistent and comparisons between them more reliable. Industry trends were identified by examining changes between the studies.

To gather the needed data to make industry estimates, a census was attempted of all production facilities in the U.S. that manufactured, repaired, or recycled any wood pallets, skids, containers, boxes, reels, barrels, or crates in 1999; hence, companies with the Standard Industry Classification codes (SIC) 2441, 2448, and 2449 or the North American Industry Classification System code 321920. These companies were compiled using commercial, state, company, and trade association directories. A total of 3,507 companies were identified. The companies were contacted and solicited for information using a mail questionnaire. Seven hundred and four useable questionnaires were returned in which estimates were made.

It was estimated that the industry utilized 6.54 billion board feet of new lumber, cants, and parts in 1999. Although this represents a 3.6% increase over 1995's estimate, the industry consumption of new wood materials remains below the estimates for 1992 and 1993 (Christoforo 1993, Bush et al. 1994a, Reddy et al. 1997). Regionally, firms in the South and the Midwest were responsible for a majority of the new solid wood used in 1999. The South consumed an estimated 2.78 billion board feet and the Midwest roughly another 2 billion board feet. Nearly two-thirds of the new solid wood used in the production of pallets and containers in 1999 was hardwoods. Of the estimated 4.41 billion board feet of hardwood material utilized by the industry, roughly 3.7 billion board feet of it was in lumber and cants and another 707 million board feet was in parts. Firms in the South and the Midwest were responsible for nearly 80% of this consumption. Approximately 51% of the hardwood used was reported as being a mixture of hardwood species. Oak (red and white) was the next most used hardwood species or species group. Since 1993, when hardwood use was estimated 4.82 billion board feet, its use has shown a gradual decline (Bush et al. 1994).

From 1995 to 1999, the industry's annual softwood consumption increased from 1.79 billion board feet to 2.13 billion board feet (Reddy et al. 1995). As a result of this increase in softwood use and the slight decline in hardwood use, softwoods represented 33% of the new solid wood material used by the pallet and container industry in 1999. This was a greater percentage than in any of the previous studies. Of the 2.13 billion board feet of softwood consumed in 1999, 1.52 billion board feet was in lumber and cants and 610 million board feet was in parts. Firms in the South and West utilized approximately 73% of the softwood materials consumed by the industry. Southern Pine and Spruce-Pine-Fir were the softwood used and Spruce-Pine-Fir another 25%.

The pallet and container industry used an estimated 289 million square feet (no thickness basis) of wood panels in 1999. Roughly 208 million square feet of this consumption was softwood plywood, representing a 5% decrease from 1995's estimate (Reddy et al. 1997). In comparison, oriented strand board use increased from approximately

30 million square feet in 1995 to 77 million square feet in 1999. Hardwood plywood use was calculated at 5 million square feet for 1999.

It was estimated that the number of pallets made from new wood materials increased from 411 million in 1995 to 429 million in 1999 (Reddy et al. 1997). Regionally, firms in the South and Midwest were responsible for approximately 77% of all new pallet production in 1999. The South produced an estimated 193 million pallets and the Midwest another 139 million. It was also estimated that companies in the Northeast and West produced 63 million and 34 million pallets, respectively.

Nearly 80% of new pallet production in 1999 was stringer style. Multiple-use stringer pallet production was estimated at 182 million and limited-use stringer at 161 million. The number of block pallets produced was estimated at 12% of the total pallet production.

For 1999, panel-deck pallet and skid production was estimated at 6.7 million and .5 million, respectively. This represents less than 2% of new pallet and skid production. It was calculated that approximately 64 million square feet of softwood plywood, 20 million square feet of oriented strand board, and 2 million square feet of hardwood plywood went into their construction (no thickness basis). It was further estimated that the container industry utilized 203 million square feet of wood panels in 1999.

The tracking studies show that the pallet industry continues to increase its wood recovery. In 1992, it was estimated that nearly 66 million pallets were recovered by the pallet industry for the purpose of repair or recycling, which was equivalent to just over 1 billion board feet of wood material recovered (Christoforo 1993). In comparison, an

estimated 299 million pallets were recovered by the pallet industry in 1999. The volume of wood contained in these pallets was estimated at 4.46 billion board feet. Regionally, pallet firms in the South and the Midwest were responsible for nearly 76% of the pallets recovered by the pallet industry. The South reclaimed approximately 156 million used pallets and the Midwest another 71 million.

Multiple-use grocery pallets were the pallet type received or purchased the most for the purpose of repair or recycling. It was estimated that 196 million multiple-use grocery pallets were recovered by the pallet industry, or approximately 66% of the total. From 1995 to 1999, the percentage of limited-use pallets recovered decreased from 11.6% to 7.6% of the total (Bush et al. 1997).

Approximately 69% of the pallets recovered in 1999 were repaired and then reused or sold. The number of recovered pallets used for this purpose has risen from 41 million in 1992 to nearly 207 million in 1999 (Christoforo 1993). The 207 million pallets were calculated to contain approximately 3.1 billion board feet in wood material. Approximately 16 million pallets were ground or chipped. Only an estimated 1.5 million pallets were sent to the landfill. This is equivalent to one half of one percent of all recovered pallets.

An estimated 48 million recovered pallets were un-nailed for various purposes. Approximately 87% of the volume was reused to build more pallets. The volume used for this purpose increased from 1995's estimate of 366 million board feet to 624 million board feet in 1999 (Bush et al.1997). Increases were also seen in the grinding or chipping of unnailed pallet parts. Nearly 303 million board feet of recovered pallets and pallet parts were ground or chipped by the pallet industry in 1999. The greatest use for ground or chipped pallet material was landscape mulch. The volume of ground or chipped pallets or pallet parts used for this purpose increased from an estimated 48 million board feet in 1995 to 165 million board feet in 1999 (Bush et al. 1997). Approximately 100 million board feet of it was colored and the other 65 million was left uncolored or natural. Another 69 million board feet of ground or chipped pallet material was used as fuel. This represents a steep decline from 1995's estimate of 110 million board feet (Bush et al. 1997).

Conclusions

The results of this study show that the pallet and container industry's demand for wood materials continues to be strong. In each of the four tracking studies conducted by Virginia Tech and the U.S.D.A. Forest Service in the 1990s, total consumption of solid wood materials (new and used) increased. When excluding hardwood plywood use, which was only estimated for 1992 and 1999, the studies showed an increasing demand for wood panels. What has changed over the course of the 1990s was the composition or mixture of wood materials the industry utilized.

In this study, softwood use was estimated to be a larger percentage of the industry's total wood use than in any of the three previous studies. From 1995 to 1999, total softwood use increased an estimated 343 million board feet while hardwood use declined 117 million board feet (Reddy et al. 1997). The increase in softwood use might be the result of the hardwood supply shortage of the mid-to-late 1990s, and to a lesser degree, CHEP's softwood pallets (Brindley 1999b).

It is hard to predict future softwood use since there are so many unknowns involved. It would appear that the growth in rental pallets would increase the demand for softwoods (Brindley 1999b). However, manufacturers of pallets and containers might be reluctant to switch to softwood materials as long as there is a stable supply of hardwoods. Further complicating the matter is the 1996 U.S. - Canadian Softwood Lumber Agreement. At this time, the trade agreement between the two countries has ended, and no decision has been made as to what if any agreement should take its place. The U.S. timber industry is asking the U.S. government to implement duties on Canadian lumber imports and Canada is calling

for an end to the trade agreement in favor of free trade (Vaughn 2001). If either one of these proposals are implemented it would have a considerable impact on the supply and cost of Spruce-Pine-Fir in the United States.

Oriented strand board has taken hold in the pallet and container industry. The 1999 estimate of 77 million square feet consumed represents a large increase over 1995's estimate (Reddy et al. 1997). At the same time, softwood plywood showed a slight decline in use. Although the price advantage that oriented strand board has over softwood plywood might have something to do with this shift in material use, it would not have occurred unless the end user thought oriented strand board could perform satisfactorily in pallets and containers. Manufacturers of oriented strand board should further examine this market for opportunities.

Most of the growth in pallet production was due to the substantial increases in pallet repair and recycling. It was estimated that new pallet production increased a little over 4% between 1995 and 1999 (Reddy et al. 1997). In comparison, the number of pallets recovered and put back into service by the pallet and container industry increased 56% over the same time period. Some of the reasons given for the increase in repaired and recycled pallet production includes: lower costs, conservation of natural resources, and a solution to current disposal problems (Bush and Araman 1998b). These issues should continue well into the future, and as such, future increases in pallet repair and recycling might only be limited by the availability of pallet cores.

Recovered wood materials are becoming a larger portion of the pallet industry's wood consumption. The amount of recovered wood used in pallet production increased from 2.28 billion board feet in 1995 to 4.1 billion in 1999, raising the proportion of recovered wood use

as a percentage of the total (new and used) from 29% to 42% (Bush et al. 1997). Meanwhile, the pallet and container industry's consumption of new solid wood materials has been modest. Even with the estimated 3.6% increase from 1995 to 1999, the industry's consumption of new solid wood materials remains below the estimates for 1992 and 1993 (Christoforo 1993, Reddy et al. 1997). Despite the many reasons given for the large increase in wood recovery, it is questionable whether such gains can continue to be realized if the use of new wood materials does not increase as well. As competition increases for a limited supply of recoverable wood materials, it is likely profits will decline and growth will be hampered.

The use of ground or chipped pallet material has also changed over the 1990s. The estimates for 1999 showed big increases in the production of landscape mulch. This is likely the result of its present higher value, especially compared to fuel (Corr 2000). Regions differed greatly in the production of both colored and uncolored landscape mulch. This information can be important in finding new markets for this material.

Study Limitations

This study only investigated the wood use trends of the pallet (SIC 2448) and the container (SIC 2441 & 2449) industry, and as a consequence, not all production and recycling activity involving pallets and containers in the United States was included in the estimates. For example, many users of pallets and containers repair them using new and recovered wood materials in-house. In addition, a significant amount of pallets are recycled through grinding and chipping at many U.S. landfills (Corr 2000). These type of production and recycling activities were not captured by this study.

Due to the fragmented nature of the industry and response rates normally associated with mail surveys (< 100%), contacting and receiving data from each manufacturer of pallets and containers in the United States was unachievable. Therefore, different methods had to be employed to obtain industry estimates. Since different regions and segments of the industry differ in their production and material use, it was important to calculate the estimates for each separately. Such estimates are generally considered more accurate the greater estimates are aggregated. In general, industry estimates are more reliable than regional or category estimates.

In those cases where a mean was taken over all regions and industry segments of the sample (i.e., employment, hours per year, days per year) and frequency of material use, it is important to remember that the company makeup of the sample might not be reflective of the industry. For example, the sample proportion of new pallet manufacturers to those that repair pallets might be greater than in the actual industry. For this reason, these figures should be looked at and used with caution.

Recommendations for Future Research

The stakeholders in this study would benefit from additional research on those identified wood use trends. Although this study tried to provide some insight into the possible reasons contributing to the shift in material use or production, further market research is needed to correctly identify the different factors. Only by understanding the basis for each identified trend, can one implement the needed business strategy.

This study revealed large increases in pallet recovery and recycling. Possible reasons given for this growth were increased environmental awareness, pallets being restricted from landfills, and lower costs (initial price of pallet, waste disposal, and in cases where the users repair and recycle, handling costs) (Bush and Araman 1998b). In addition, pallet repair and recycling has been called the most profitable segment of the industry (Bush et al. 1994b). To fully understand this segment of the pallet industry and its opportunities, it is important to know which of these factors are primarily responsible for the increases seen in the different regions.

Although the sizeable increase in oriented strand board use signifies its acceptance by the industry, its use might be limited to some applications. Users of oriented strand board pallets and containers might be reluctant to use them in pallets and containers intended for multiple uses. By pinpointing those applications in which oriented strand board is used, the product can be better marketed to the industry.

Finally, further research is needed to determine the different factors behind the increased production of landscape mulch. A member of the industry suggested two reasons for this trend: profitability and a viable way to dispose of wood waste (Breidle 2001). In

terms of potential opportunities in this area, these reasons suggest two different things. Therefore, identifying those factors that were responsible for the growth in each region is critical.

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APPENDIX A: Survey Instrument




If your company **did not** use any **new** wood materials in 1999, please check here \Box and skip to page 3.

3. How much of the following <u>new</u> materials did your company use in 1999 for the production or repair of pallets and containers? (If your company purchased logs or bolts, please record the board footage used in pallets and containers in the lumber or parts category.)

Material	Units	Volume Used in 1999	Thickness <i>Example:</i> 3%
Hardwood lumber and cants	Board feet		
Softwood lumber and cants	Board feet _		
Hardwood parts	Board feet		
Softwood parts	Board feet		
Oriented Strand Board (OSB)	Square feet		
Softwood plywood	Square feet		
Hardwood plywood	Square feet		

¹ Hardwoods include oak, ash, poplar, basswood, aspen, alder, etc.

Softwoods include southern pine, Douglas-fir, spruces, pines, firs, etc.

4. What species of <u>new</u> wood (in the form of lumber, cants, and parts) did your company use in the production or repair of pallets and containers during 1999? (*Please indicate the percentage of total volume for each species.*)

0/2	Alder
%	Mixed hardwoods (no species separation)
%	Other hardwoods, please specify:
%	Southern pine
%	Douglas-fir
%	Hem-fir
%	Spruce-pine-fir
%	Other softwoods, please specify:
100%	

5. How many of the	following did your company i	produce in 199	90?	
(Please write "0")	if your company did not produc	e the product.)		
	Pallets		Skids	
	<u>New</u> pallets		<u>New</u> skids	
	Repaired/recycled pallets	<u>na na na na</u>	Repaired/recycled	skids
5. Did your company (<i>Please check the a</i>	y manufacture new <u>solid-wood</u> ppropriate box and follow the d	d pallets or sk arrows to the n	ds in 1999? ext question.)	
□ Yes	What percentage of yo	ur solid-wood p	allets and skids were each of	the following?
	% Limi	ted-use Block pa	llets (also called single-use pal	lets)
	% Mult	iple-use Block p	allets	
	% Limi	ted-use Stringer	pallets	
	% Mult	iple-use Stringer	pallets	
	% Othe	r pallet types and	l skids	
□ No ——	Please continue with th	ne next question	1 • skids? (By papel-deck palle	ets and skids
 No In 1999, did your we mean pallets an Yes 	Please continue with th company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your compa	he next question deck pallets on wood or orient our <u>new</u> pallet a ny did not produ	n • skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.)	ets and skids nel-deck?
 No In 1999, did your we mean pallets an Yes → 	Please continue with th company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your compa Pallets:	ne next question deck pallets on wood or orient our <u>new</u> pallet a ny did not produ %	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ice the product.) Skids:	ets and skids nel-deck? %
 No In 1999, did your we mean pallets an Yes → 	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your compand Pallets:	ne next question deck pallets on wood or orient our <u>new</u> pallet a ny did not produ	 skids? (By panel-deck palle ed strand board.) nd/or skid production was pan ce the product.) Skids: 	ets and skids nel-deck? %
 No	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your company Pallets: In 1999, how much of the follo production of panel-deck palle	he next question deck pallets on wood or orient bur <u>new</u> pallet a ny did not produ % wing <u>new</u> mate ts and /or skids	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.) Skids: rials did your company use for ?	ets and skids nel-deck? %
 No In 1999, did your we mean pallets an Yes → 	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your company Pallets: In 1999, how much of the follo production of panel-deck palle Material	ne next question deck pallets on wood or orient bur <u>new</u> pallet a ny did not produ % % wing <u>new</u> mate ts and /or skids Units	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.) Skids: rials did your company use for ? Volume used in 1999	ets and skids nel-deck? % r the Thickness
 No — 7. In 1999, did your we mean pallets an Yes → 	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of you (Please write "0" if your compand Pallets: In 1999, how much of the follo production of panel-deck palle Material Oriented Strand Board (OSB)	he next question deck pallets on wood or orient our new pallet a ny did not produ % wing new mater its and /or skids Units Sq. feet	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.) Skids: rials did your company use for ? Volume used in 1999	ets and skids nel-deck? % r the Thickness
 No	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of your (Please write "0" if your compand Pallets: Pallets: In 1999, how much of the follo production of panel-deck palle Material Oriented Strand Board (OSB) Softwood plywood	he next question deck pallets on wood or orient bur new pallet a ny did not produ % wing new mater ts and /or skids Units Sq. feet Sq. feet	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.) Skids: rials did your company use for ? Volume used in 1999	ets and skids nel-deck? % r the Thickness
 No	Please continue with the company produce <u>new</u> panel- d skids with decks made of ply In 1999, what percentage of your (Please write "0" if your compand Pallets: Pallets: In 1999, how much of the follo production of panel-deck palle <u>Material</u> Oriented Strand Board (OSB) Softwood plywood Hardwood plywood	he next question deck pallets on wood or orient our new pallet a ny did not produ % wing new mater ts and /or skids Units Sq. feet Sq. feet Sq. feet	skids? (By panel-deck palle ed strand board.) nd/or skid production was par ce the product.) Skids: rials did your company use for ? Volume used in 1999	ets and skids nel-deck? % The Thickness

This page asks about repaired/re 1999, please check here and	cycled pallets and skids. If you did not repair/recycle pallets or skids in continue on from the top of page 5.
8. How many pallet and skid cor repair/recycle in 1999?	res (used pallets/skids) did your company purchase or receive for
	I otal number purchased of received
9. What types of pallet and skid (Please indicate the percentage	cores (used pallets/skids) did your company receive in 1999? e in each category.)
% Liı	mited-use pallets (also called single-use pallets)
% Mı	ultiple-use <u>grocery</u> pallets
% Ot	her multiple-use pallets
% Sk	ids and other types of pallets
100%	
% Repaired and	then sold or reused How did your company utilize the un-nailed part
// Un-nailed -////////////////////////////////////	% Reused to build or repair pallets/ski % Ground or chipped
% Un-nailed - % Ground or ch % Sent to landf	hipped% Reused to build or repair pallets/ski % Ground or chipped % Other
% Un-nailed - % Ground or cl % Sent to landf % Other	nipped% Reused to build or repair pallets/ski % Ground or chipped% Other 100%
% Un-nailed - % Ground or cl % Sent to landf % Other 100%	hipped% Reused to build or repair pallets/ski % Ground or chipped% Other 100%
% Un-nailed - % Ground or ch % Sent to landf % Other 100% 11. Did your company grind or c	hipped % Reused to build or repair pallets/ski % Ground or chipped % Other 100% hip pallets, skids, or parts in 1999?
% Un-nailed - % Ground or cl % Sent to landf % Other	hipped
% Un-nailed - % Ground or cl % Sent to landf % Other	hipped
% Un-nailed - % Ground or cl % Sent to landf % Other	hipped % Reused to build or repair pallets/ski % Ground or chipped % Other
% Un-nailed - % Ground or cl % Sent to landf % Other	hipped
% Un-nailed - % Ground or cl % Sent to landf % Other	% Reused to build or repair pallets/ski % Ground or chipped % Other
% Un-nailed - % Ground or cl % Sent to landf % Other	% Reused to build or repair pallets/ski % Ground or chipped % Other % Colored landscape mulch % Fuel % Fuel % Furnish for fiber-based products
% Un-nailed - % Ground or el % Sent to landf % Other	hipped

Finally, we would like to ask you about your company. This information will be used only for statistical purposes and in combination with answers from other companies. Your company's name will not be released.		
2. On an averag operations du employees.)	e day, how many people were employed ring 1999? (Please include full-time and p	in your company's pallet and container part-time production and non-production
	<u>Full-time</u>	<u>Part-time</u>
Nu	mber of production employees	Number of production employees
Nu	mber of <u>non-production</u> employees	Number of <u>non-production</u> employees
3. Which produ (Please check	et category accounted for the greatest po conly one category.)	ercentage of your company's sales (\$) in 1999?
	New pallets and skids produced by your	company
Pallets and skids repaired/recycled by your company		
	Containers (including barrels, crates, boxes, reels, etc.) produced by your company	
	Pallet parts produced by your company	
Brokered or wholesaled pallets, skids, or containers		
	Other (please specify)	
4. During 1999,	how many days did your company's pa Davs	let/container facilities operate?
5. On average, 1 1999?	ow many hours per day did your comp	any's pallet/container facilities operate during
	Average l	iours per day

Г

16. In the next 5 years, do you see your company using more, less, or about the same amount of the following wood materials? (For wood materials that you do not use, please check "not applicable.")

Material	Use			
Hardwood lumber	more 🗌	🗌 less	same amount	not applicable
Softwood lumber	more []	🗌 less	same amount	not applicable
Oriented Strand Board (OSB)	more 🗌	🗌 less	🔲 same amount	not applicable
Softwood plywood	more	🗌 less	same amount	not applicable
Pallet cores	more 🗌	less	same amount	not applicable
Recovered/recycled parts	more	less	same amount	not applicable

Comments: (*Please use the space below if you would like to comment on the pallet and container industry or this study.*)

Thank you for your help! Please fold along the dotted lines shown on the next page, tape (please do not staple), and return the questionnaire by mail. Postage is prepaid.

6

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			UNITED STA
		$ \frac{1}{2} = \frac{1}{2} \frac{\partial (\partial u \partial u)}{\partial u} + \frac{1}{2} \frac{\partial (\partial u \partial u)}{$	
	BUSINESS REPLY MAIL		
	POSTAGE WILL BE PAID BY ADDRESSEE		
	VIRGINIA TECH THOMAS M. BROOKS FOREST PRODUCTS CENTER ATTN: JEFFERY BEJUNE		
	PO BOX 850 BLACKSBURG VA 24063-9985		
and the second second			
F	n	har Bafara mailin	a please
Please return make sure tha	the questionnaire after folding in haif and taping the ends toge t the return address is visible. No additional postage is need	ded.	y, piease

Tech	CENTER FOR FOREST PRODUCTS MARKETING AND MANAGEMENT
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY	Department of Wood Science and Forest Products 1650 Ramble Rd., mail code 0503 Blacksburg, Virginia 24061 Phone (540) 231-5876. Fax: (540) 231-8868 http://www.woodscience.vt.edu jbejune@vt.edu
April 26, 2000	
Dear ,	
The pallet and container industry is important of people and plays a critical role in the transp industry and your company remain healthy.	to the U.S. economy. It employs a significant number ortation of goods. Therefore, it is important that the
Virginia Tech supports this goal by identifying materials. This information enables suppliers how your company compares to other pallet an	g trends and changes in the industry's use of wood to better serve your needs and helps you determine nd container firms.
I am writing to ask for your help. Please con Your response will be kept confidential and y the study results. Questionnaires are number additional mailings after your response is rec	nplete and return the enclosed questionnaire, your name and company will <u>not</u> be mentioned in red only so that we can avoid sending you eived.
In order for the results of this study to correct that each questionnaire is completed and return production, your participation is important.	tly represent trends in the industry, it is important rned. Regardless of your company's size or
If you have questions or would like a free cop phone at (540) 231-5876 or by fax at (540) 23	py of the study results, please contact me by 31-8868.
Thank you for your cooperation.	
Sincerely,	
Jeffery J. Bejune Graduate Research Assistant	

Tech	CENTER FOR FOREST PRODUCTS MARKETING AND MANAGEMENT
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY	Department of Wood Science and Forest Products 1650 Ramble Rd., mail code 0503 Blacksburg, Virginia 24061 Phone: (540) 231-5876 Fax: (540) 231-8868 http://www.woodscience.vt.edu jbejune@vt.edu
June 13, 2000	
Dear	
Please help! A little over a month ago I mailed the <i>Study of New and Recovered Wood Use by th</i> I have not received your response. The accurac provide depends on the participation of people I questionnaire so that I can finish my thesis and p	you a questionnaire asking for your help with the Pallet and Container Industry. As of today, y and quality of information this study will ike you. Also, I need your help completing the graduate.
The results of the study will be made available t free copy of the study results, simply attach you	o you free of charge. In order to receive your ir business card to the completed questionnaire.
The information generated from this study will breading their operations. Ultimately, this will healthier industry.	help mill managers make informed decisions I lead to better profits for you and an overall
Your response will be kept confidential and you the study results. Questions are numbered only mailings after your response is received.	r name and company will not be mentioned in so that we can avoid sending you additional
Another questionnaire is enclosed in case the or minutes to help me by completing and returning	iginal has been misplaced. Please take a few the questionnaire. Postage is prepaid.
If you have any questions, please phone me at (540) 231-5876 or fax: (540) 231-8868.
Thank you for your help.	
Sincerely,	
Juffer Bejun	
Jeffery J. Bejune Graduate Research Assistant	
A Land-Grant University - The	Commonwealth Is Our Campus

Tech	CENTER FOR FOREST PRODUCTS MARKETING AND MANAGEMENT
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY	Jeffery Bejune Department of Wood Science and Forest Products 1650 Ramble Rd., mail code 0503 Blacksburg, Virginia 24061 Phone: (540) 231-5876 Fax: (540) 231-8868
August 9th, 2000	
Dear .	
I need your help!	
Recently, I sent you a questionnaire titled Study and Container Industry. As of today, I have no	of New and Recovered Wood Use by the Pallet t received your completed questionnaire.
Your contribution is important. The information current material use trends in the industry and e Since a limited number of companies were inclu- success of the study and the fulfillment of my d	n generated from this research will help identify nable your suppliers to better serve your needs. Ided in this study, your response is essential. The egree requirements rely on your participation.
The results of the study will be made available t free copy, simply circle "yes" on the front cover	to you free of charge. In order to receive your
Your response will be kept confidential and you the study results. The questionnaires are numbe additional mailings after your response is receiv	Ir name and company will not be mentioned in ered only so that we can avoid sending you red.
Please take a few minutes to complete the enclo	sed copy of the questionnaire.
Thanks for your help.	
If you have any questions or comments, please 540-231-8868 (Fax), or jbejune@vt.edu (Email).	feel free to contact me at 540-231-5876 (Phone),
Sincerely,	
Jeh Beg	
Jeffery Bejune Graduate Research Assistant	
A Land-Grant University - Th	e Commonwealth Is Our Campus

Dear Sir / Madam,

I need your Help! Recently, I mailed you a copy of a questionnaire titled "Study of New and Recovered Wood Use by the Pallet and Container Industry." I am contacting you now to ask for your help by completing and returning the questionnaire. If you have already returned it, please accept my sincere appreciation. If you have not completed the questionnaire, please take a few minutes to do so.

The information generated from this study will enable suppliers to better serve the industry's needs and will help you determine where your company stands in terms of industry trends.

Your participation is critical for the success of the study. The information that you provide will be kept **strictly confidential**. The number on the questionnaire is used only to remove your name from future mailings. If you have any questions, please contact me at 540-231-5876 or 540-231-8868 (facsimile). Thank you in advance for your help.

Sincerely. Jeffery Bejune

Graduate Research Assistant

APPENDIX B: Key Calculations

1999 Study

<u>Region</u>

Question used in analysis: 2

Data from each firm were entered and analyzed in the region in which the respondent reported the firm's greatest number of production facilities. In cases where there was the same number of plants in two different regions, the firms were contacted to determine the region with the greatest production.

Frequency of Wood Use

Question used in analysis: 3

Frequency was run on the question that asked respondents for the quantities of wood materials they used in their pallet and container production for 1999. Wood materials were included in the frequency count if the company reported any amount of material used.

1995 Study

Region

Data from each firm were entered and analyzed in the region in which the respondent reported the firm's greatest amount of production.

Frequency of Wood Use

Frequency was run on a separate question that asked respondents to check those wood materials they used in their pallet and container production for 1995.

Mean Employment

Question used in analysis: 12

Analysis 1: Mean employment per firm

- 1. Sum of all reported employees (full time and part time production and non-production)
- 2. Mean taken for each and all regions.

Analysis 2: Mean employment by type

Mean taken for each employee category (full-time, part-time, production, and non-production) for each and all regions.

Analysis 3: Mean employment per facility

- 1. Total employment reported / number of production facilities reported
- 2. Mean taken for each and all regions.

Mean Employment

Analysis 1: Mean employment per company

Respondents reported employment without differentiating between full-time and parttime production and non-production employees. Mean was taken for each region, and all regions.

Volume of Wood Material

Questions used in analysis: 3,12,13

Step 1: Calculate volume per employee for each firm:

Annual consumption of each wood material Total employment of firm

<u>Step 2</u>: Calculate mean volume per employee for 6 business types: (new pallets & skids, pallets & skids recycled/repaired, containers, pallet parts, brokered pallets & containers, other). This is done for each region and each wood material.

Step 3: Calculate the wood material volume calculated by SIC codes for each region:

- 2448
- 2441 + 2449 (combined)

Example: SIC 2448 =((A1*A2)+(B1*B2)+(C1*C2))/(A2+B2+C2)

= Average board foot used per employee in in the SIC code 2448 for one region

- A1 mean volume per employee for new pallet/skid firms
- A2 number of such firms reporting consumption
- B1 mean volume per employee for firms that recycle pallets/skid
- B2 number of such firms reporting consumption
- C1 mean volume per employee for firms that primarily produce pallet parts
- C2 number of such firms reporting consumption

<u>Step 4</u>: Calculate the wood material use for each region:

- 1. For SIC 2448 and 2441&2449: Mean material use per employee x Actual employment for region and SIC
- 2. 2448 estimate + 2441&2449 estimate = region estimate

Step 5: Calculate national estimate:

Sum regional estimates

New Pallet Production

Questions used in analysis: 5, 12

Step 1: For each firm, calculate new pallets per employee:

(new pallets + new skids) / total employment

Step 2: Calculate new pallet production for each region:

- 1. Calculate mean number of new pallets produced for 2448, 2441 & 2449 for each region
- 2. For SIC 2448 and 2441&2449: Mean number of pallets produced per employee for each region and SIC x Actual employment for region and SIC
- 3. 2448 estimate + 2441&2449 estimate = regional estimate

Step 4: Calculate national estimate:

Sum regional estimates

Number of pallets returned to service by the pallet industry through repair and recycling

Questions used in analysis: 5,12

Calculations were identical to new pallet production, except for step 1:

(recycled pallets + recycled skids) / total employment

Number of used pallets received or purchased by the pallet industry

Questions used in analysis: 8, 12

Calculations were identical to new pallet production, except for step 1:

(recovered pallets + recovered skids) / total employment

Species Estimates

Questions used in analysis: 3, 4

Step 1: For each firm, calculate each species use:

- 1. Total solid wood used = hardwood lumber/cants + softwood lumber/cants + hardwood parts + softwood parts
- 2. Total solid wood used x species proportion (%) = volume of species used

Step 2: Calculate sample proportion for each region and SIC code:

<u>Sum of the species utilized by SIC and region</u> = sample proportion (%) Sample volume of hardwood or softwood used by the SIC in that region

Step 3: Calculate regional estimates:

- 1. Sample proportion (%) for region and SIC x Estimated total hardwood or softwood consumption by SIC and region
- 2. Sum the estimates for each SIC 2448 and 2441 & 2449 = regional estimate for species use

Step 4: Calculate national estimate

Sum regional estimates

New pallet production by pallet type

Question used in analysis: 5, 6

Calculations are identical to Species Estimates

The following analysis only involved SIC 2448 (new pallets/skids, recycled pallets/skids, pallet parts)

Number of Pallets Received by Type

Questions used in analysis: 8, 9

<u>Step 1</u>: For each firm, calculate the number of each pallet type received:

Percentage of each pallet type received x number of pallets received

<u>Step 2</u>: Calculate sample proportion for each pallet type for each region:

Number of each pallet type / total number of pallets received = sample proportion (%)

Step 3: Calculate regional estimates:

Total number of pallets received in region x sample proportion (%)

Step 4: Calculate national estimate:

Sum of regional estimates

Volume Recovered from Various Pallet Types

Questions used in analysis: 8, 9

Step 1: For each firm, calculate volume of wood recovered by each pallet type:

Average board footage contained in each pallet type was calculated by the William H Sardo, Jr. Pallet and Container Laboratory at Virginia Tech

Pallet type	Average Board Feet
single-use pallet	10.1
multiple-use pallet	15.8
other multiple-use	18.5
other types of pallets & skids	15.1

A firm's estimated number of pallets recovered by type x average board footage in each pallet type

Step 2: Calculate regional sample proportions by pallet type:

Total volume for each pallet type / total volume of all pallets recovered by sample = sample proportion (%)

Step 3: Calculate regional estimates:

Sample proportion (%) for pallet type x estimated total volume of used pallets recovered in each region

Step 4: Calculate national estimate:

Sum of regional estimates

Number of Used Pallets Utilized for Various Purposes

Questions used in analysis: 8,10

<u>Step 1:</u> For each firm, calculate the number of used pallets utilized for each purpose:

Percent of pallets reported for each purpose x total number of used pallets recovered

Step 2: Calculate regional sample proportions:

Sum of pallets used for a particular purpose in region / sum of recovered pallets in region = sample proportion (%)

Step 3: Calculate regional estimates:

Sample proportion (%) x estimated total number of pallets recovered by region

Step 4: Calculate national estimate:

Sum regional estimates

Number of un-nailed pallets used for various purposes

Questions used in analysis: 8,10

Calculations are identical to those of Number of Pallets Utilized for Different Purposes

Number of ground or chipped pallets used for various purposes

Question used in analysis: 8,11

Calculations are identical to those of Number of Pallets Utilized for Different Purposes

Volume of Used Pallets Utilized for Various Purposes

Questions used in analysis: 8,10

Step 1: For each firm, calculate the volume of used pallets utilized for various purposes:

Sum (A*10.1board feet, B*15.8 board feet, C*18.5 board feet, D*15.1 board feet) x calculated number of pallets used for each purpose

А	% single use pallets
В	% multiple group pallets
С	% other multiple group pallets
D	% other pallet types

Step 2: Calculate regional sample proportions (%):

- 1. Sum the volumes for each purpose
- 2. Total volume used for each purpose / total volume for the region = sample proportion%

Step 3: Calculate regional estimates:

Sample proportion (%) x total volume of pallets received in the region

Step 4: Calculate national estimate:

Sum regional estimates

Volume of un-nailed pallets for various purposes

Question used in analysis: 8,10

Calculations are identical to Volume of Pallets Utilized for Various Purposes

Volume of ground or chipped pallets used for various purposes

Question used in analysis: 8,11

Calculations are identical to Volume of Pallets Utilized for Various Purposes

APPENDIX C: Statistical Methods

Since the extrapolated estimates were dependent on production per employee and the actual regional employment, any differences between years could be the result of a change in either one of these two variables or sampling error. Therefore, to detect significant differences between years, estimates for 1995 and 1999 were compared by calculating a 95% confidence interval for the difference of the extrapolated totals. The Statistical Consulting Center at Virginia Tech provided the following method in which to calculate such a confidence interval.

- 1. Calculate the standard deviation (σ) of the material/production per employee variable for 1995 and 1999.
- 2. Calculate the total standard error of total employment for each year.

$$S = \frac{\sigma}{\sqrt{\# respondents}} \quad X \quad \# of \ employees$$

3. Calculate the average standard error

 $SE = \sqrt{S^2_{99} + S^2_{95}}$ $S^2 = Sample \ variance$

4. Calculate confidence interval

$$(T_{99} - T_{95}) \pm Z, \ _{I-\infty/2} SE$$

T = Extrapolated total being tested

<u>The decision rule for the test was</u>: If zero falls within the confidence interval then there is no significant difference between the totals for the two years.

There were some limitations in using this test to make comparisons between years. Originally, comparisons were made without regards to region or Standard Industrial Classification (SIC). Due to the large differences in production and material use between regions and those companies in different SIC codes, it resulted in a large standard error causing the confidence intervals to show no significant differences in the extrapolated estimates. Whereas extrapolated estimates were based on the region and the primary business of the respondent, the statistical comparisons could not be made beyond the SIC level. This was due to the fact that employment breakdown for SIC 2448 was unknown. Therefore, the industry estimates for the two years were compared based only on region and SIC. As described above, this was accomplished by subtracting the 1995 total from the 1999 total and calculating the confidence interval using the average standard error for production /material use per employee in each region and SIC. Since there are large differences in wood use and pallet production between those companies that produce new pallets and those that repair or remanufacture them, it is believed that by calculating the standard error for the entire SIC 2448 that it introduced a considerable amount of variance. Nevertheless, some significant differences were detected between years.