Status and Potential of Michigan Natural Resources: Lumber, Furniture, Composition Panels and Other Solidwood Products
Michigan State University Agricultural Experiment Station and Cooperative Extension Service
Special Report
Jim Stevens, Forestry
Issued January 1995
24 pages

SPECIAL REPORT

Michigan Agricultural
Experiment Station,
Michigan State University

Status and Potential of Michigan Natural Resources

Lumber, Furniture, Composition Panels and Other Solidwood Products

January 1995 ■ Special Report 72

Reports on the Status and Potential of Michigan Natural Resources

This special report is one of a series (listed below) prepared for a project of the Michigan Agricultural Experiment Station (MAES) called the "Status and Potential of Michigan Natural Resources" (SAPMINR).

The project was designed to take an inventory of the current status of Michigan natural resources, identify emerging trends, and appraise future opportunities. The purpose was to assist MAES in establishing priorities and planning programs.

Both overview and focused topic assessments have been made. The overview reports provide background information on the political, economic, and social environments influencing Michigan natural resources. The focus reports examine specific resources, including timberland resources, fisheries and wildlife resources, parks and recreational resources, and land and water resources.

The SAPMINR project began in early 1993. At that time, interdisciplinary teams of MSU faculty members, graduate students, federal and state government officials, and others collaborated to develop preliminary reports. In March 1994, a SAPMINR conference took place during MSU's Agriculture and Natural Resources Week. The objective of the conference was to provide a public forum for discussion of the preliminary reports. Based on interaction with conference participants, the authors prepared the final drafts of the special reports (SR).

This report should not be considered final. Efforts to analyze the past and forecast the future are ongoing. Even so, this report is a base for dialogue on both the status and potential of Michigan natural resources.

To receive any of the reports listed below, contact: MSU Bulletin Office, Room 103 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039.

Status and Potential of Michigan Natural Resources List of Reports

Overview Reports

SR 67 --SAPMINR Highlights

SR 68 --Michigan Natural Resources Policy

SR 69 --Demographic, Social and Economic Trends

SR 70 --Integrated Natural Resource Systems

Focus Reports

SR 71 --Timber and Timberland Resources

SR 72 --Lumber, Furniture, Composition Panels and Other Solidwood Products

SR 73 --Pulp, Paper, Allied Products and Wood Energy

SR 74 --Fisheries

SR 75 --Wildlife

SR 76 --Tourism

SR 77 --Boating and Underwater Recreation

SR 78 --Camping, Trails and Dispersed Recreation

SR 79 --Water Resources

SR 80 --Land Resources

SR 81 --Nonrenewable Resources

SR 82 --Natural Resources and Communities

Acknowledgements

The author thanks Dr. Larry Pedersen from the Michigan Department of Natural Resources in Lansing, Russell Kidd of MSU Extension in Roscommon and Dr. Otto Suchsland from the Department of Forestry at MSU for contributing to various sections of the report.

I would also like to thank Robin Bertsch from the Michigan Department of Natural Resources Forest Management Division in Lansing, and Drs. Carl Ramm, Henry Huber, and Karen Potter-Witter from the Department of Forestry at MSU for their review of the draft and helpful comments.

Lumber, Furniture, Composition Panels and Other Solidwood Products

Lead Author: Jim Stevens, Department of Forestry, MSU

Introduction

The forests of Michigan provide many benefits to the state's citizens: wildlife habitat, recreation opportunities, clean water, erosion protection and a source of fuel for energy, as well as the raw materials for the wood-based products that consumers demand. This report deals only with forest products such as lumber, furniture and panels. It should be emphasized that these products, as important as they are to the economy, represent only a part of the value of our forests.

Michigan's Forest Products Industries

Michigan's forest products industries include the full range of production from stump to final product. This report will examine the solidwood industries, which include primary products and some consumer products, as well as composition panels—i.e., plywood and reconstituted board such as oriented strand board and medium density fiberboard (definitions of technical terms can be found in the glossary). Logging and the pulp and paper industry, both important contributors to the Michigan economy are excluded from this report. Further information on these industries can be found in SAPMINR Special Reports 71 and 73.

Primary production of forest products refers to the conversion of logs, pulp bolts or chips to something of value to society, such as fuel or intermediate products requiring further manufacture. Because logs have a relatively low value to weight (and value to volume) ratio, primary production is typically concentrated close to the woods. Michigan's timber resource increases from south to north in the Lower Peninsula and from east to west in the Upper Peninsula (Figure 1), with timberland being 21, 63, 77 and 84 percent of the area of the southern Lower Peninsula (Figure 2), northern Lower Peninsula, eastern Upper Peninsula and western Upper Peninsula, respectively.

Logging, the conversion of standing trees into round timber products, has long been an important component of the Michigan economy. In the late 19th century, Michigan was the country's largest lumber producer, with a volume of 5.5 billion board feet of lumber produced in 1889, the peak year. In contrast, the sawlog production level in 1990 was about 625 million board feet. The species composition has also changed since the boom of the last century. White pine and red pine were the primary species of that era, though large volumes of maple, oak and other hardwoods were also harvested. As the resource declined, the forests went through a long period characterized by little or no forest management. Natural succession plus a period of increased planting beginning in the 1930s produced the present mature forests. Today, hardwoods are the dominant commercial species in the state (Figure 3). This report will concentrate on three (primarily hardwood) inputs into the production process—veneer logs, sawlogs and pulpwood bolts; two intermediate products—veneer sheets and lumber; and four more processed products—panels, pallets, dimension products, and furniture.

Importance of the Industry

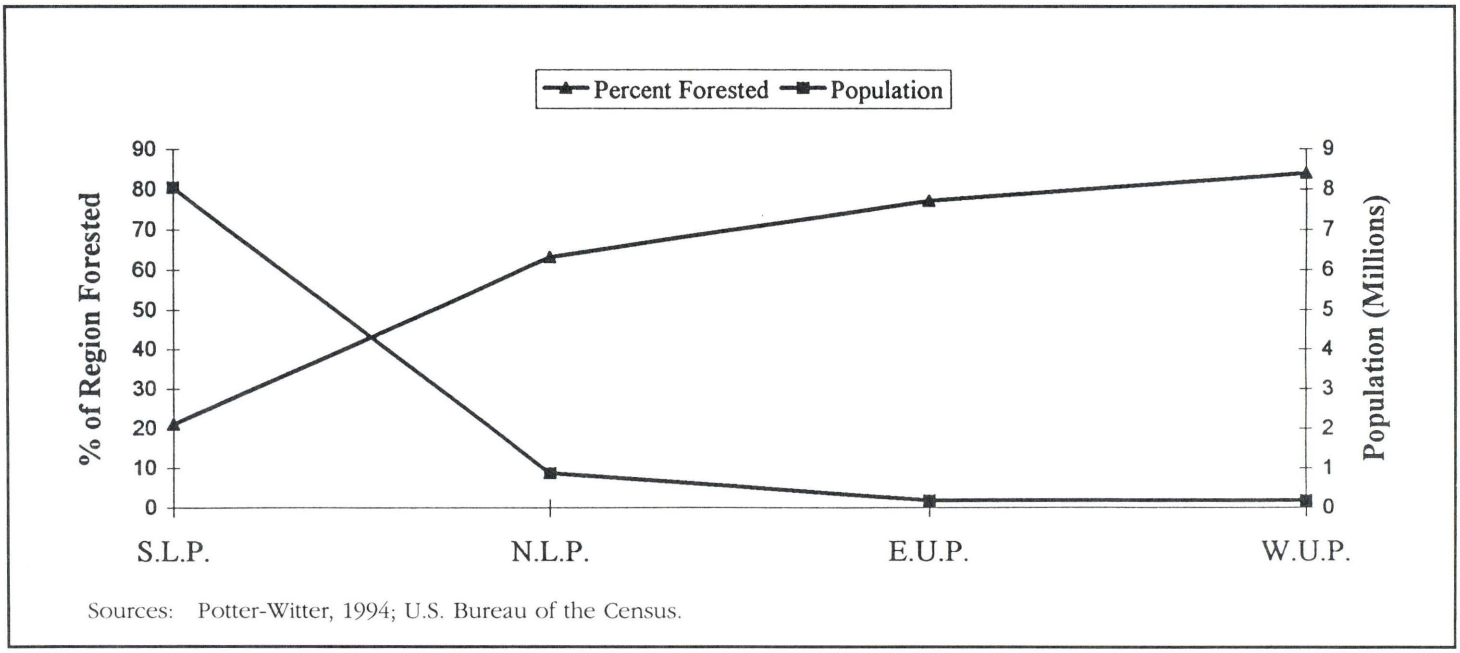
Timber, the raw material of forest products industries, is concentrated in the rural areas of the state (Figure 1). Many of the production facilities, however, are located in the more highly industrialized regions (Figure 2). Sawmills are the exception—they are scattered throughout the state, with the heaviest concentration in the Upper Peninsula and the northern Lower Peninsula (Figure 4). Pallets and containers, on the other hand, are concentrated near the industrial areas of Detroit and Grand Rapids (Figure 5). Dimension, millwork and furniture show a more even distribution, with some concentration near these cities (Figures 6 and 7). The relative importance of wood products industries is greatest in the Upper Peninsula (Figure 8). Taken together, lumber and wood products (SIC 24) and paper and allied products (SIC 26) account for about half of the manufacturing employment in the region (see Appendix for descriptions of SIC categories). The 1987 total market value of agricultural products sold from the Upper Peninsula was $52.7 million (Census of Agriculture), while in the same year the payroll alone of wood products industries (SIC 24 only) was $57.8 million (Census of Manufactures). Statewide, the solidwood industries (SIC 24, excluding logging and including wooden furniture from SIC 25) are as important in value of shipments as any of the state's processed food industries (Figure 9). When the value of shipments from paper mills (SIC 2621) in the state is considered, the significance of the forest industry's contribution to the state's economy becomes even more apparent.

It is also important to note the contribution of the industry beyond direct employment. Chappelle et al. (1986) estimated that for every job directly accounted for by forest products industries, 1.31 additional jobs are created. Total employment associated with Michigan's forest products industry may be estimated by multiplying the reported 1993 Michigan Employment Security Commission employment total of 53,702 and the average employment multiplier of 2.31. Thus, more than 124,000 jobs are associated with Michigan's forest products industry. Applying an estimated total value-added

multiplier of 2.0 (Chappelle and Pedersen, 1991) to the summary information for forest products industry value-added (Table 1) gives an estimate of more than $5.5 billion in total value-added impacts from Michigan's forest product industries in 1991.

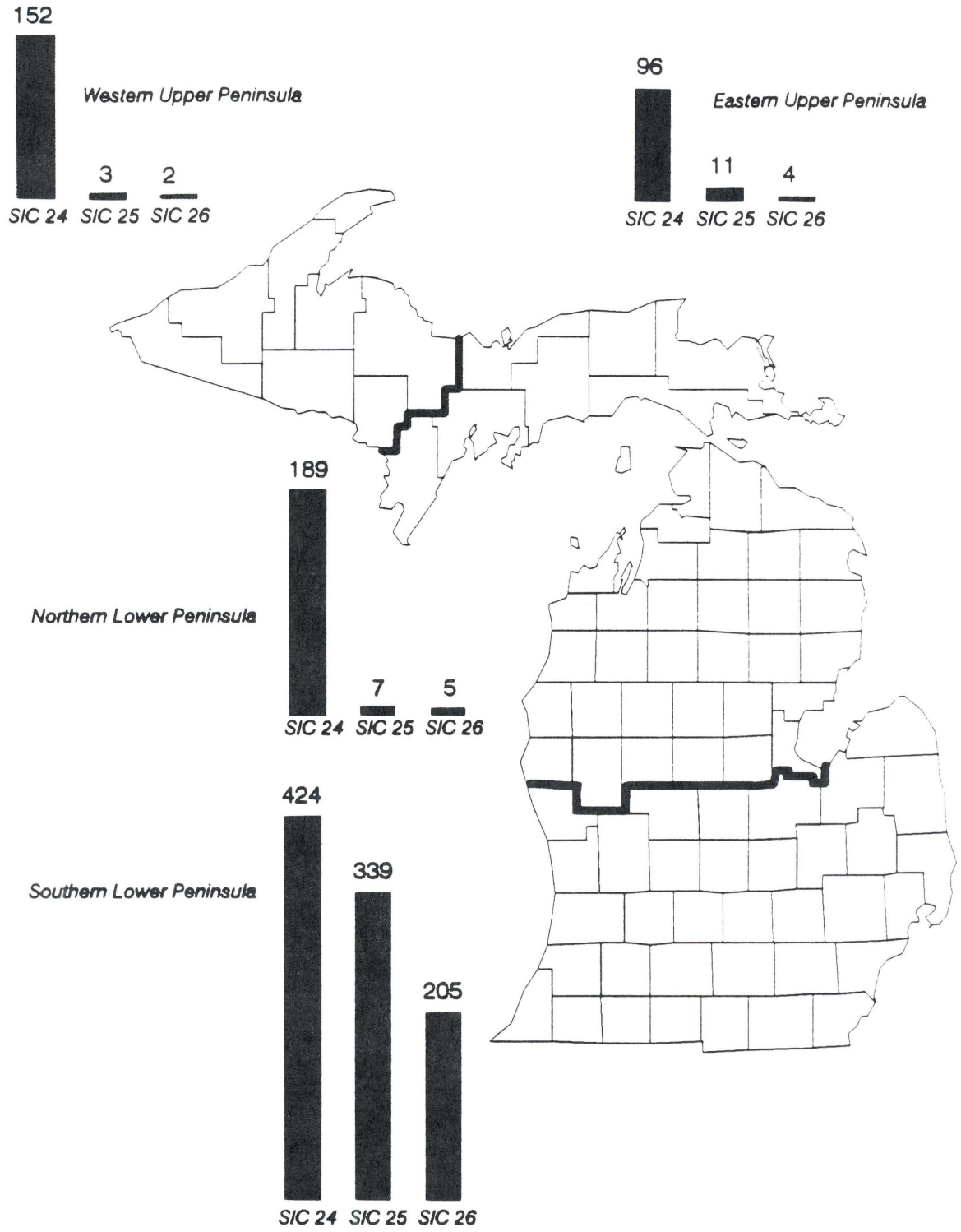
The forest products industry as a whole is a significant contributor to the state economy (Figure 10). Forest-based industries—wood products (SIC 24), wood furniture (from SIC 25), and paper and allied products (SIC 26)—not only contribute a greater percentage of state employment than food manufacturing firms (SIC 20), but have a more positive employment trend over the past decade.

Various types of producers operate at different scales (Table 2). Sawmills, which are the most evenly distributed wood products industry across the state, tend to be small operations—80 percent having fewer than 16 employees. The wood products industries concentrated in southern Michigan, particularly furniture and dimension plants, have a wider range of sizes. For example, 16 percent of the hardwood dimension mills and 44 percent of veneer plants have more than 50 employees.



Sources: Potter-Witter, 1994; U.S. Bureau of the Census.

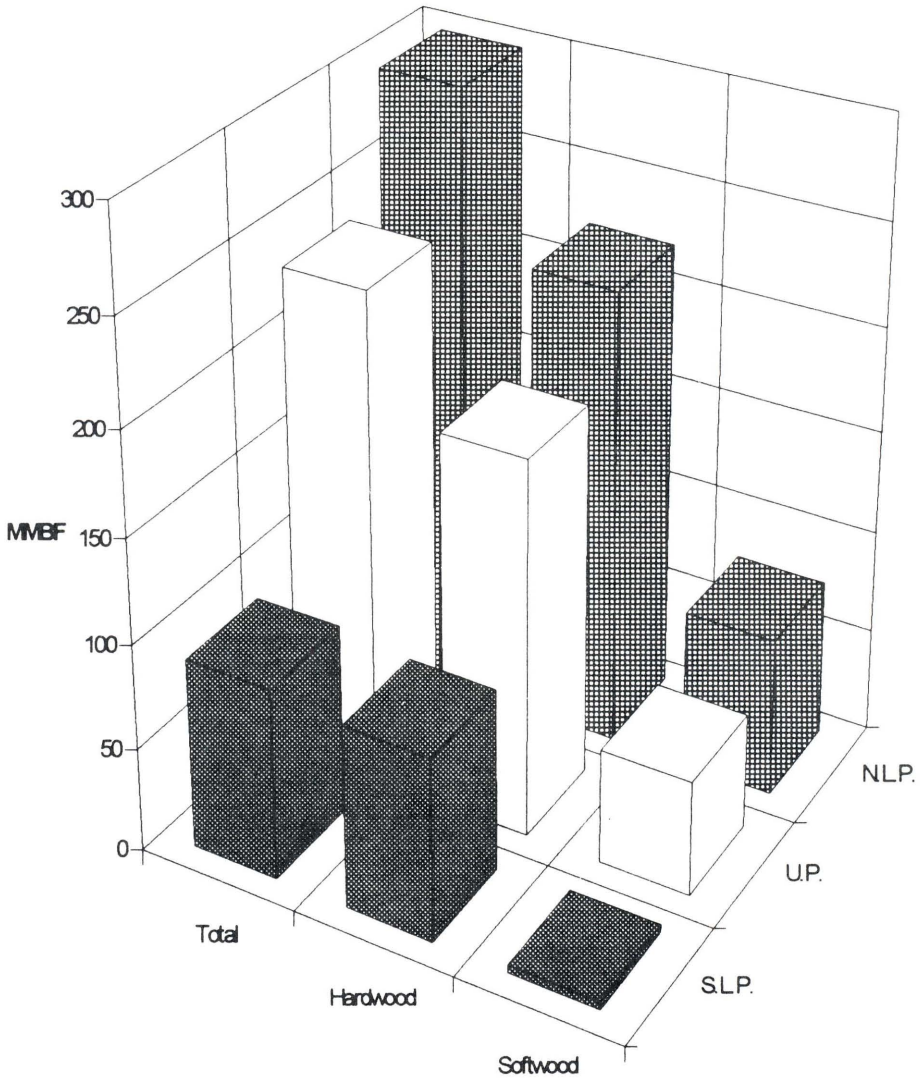
Figure 1. Percentage of forested land and population in Michigan, by region, 1993.



Note: SIC Codes are defined in the Appendix.

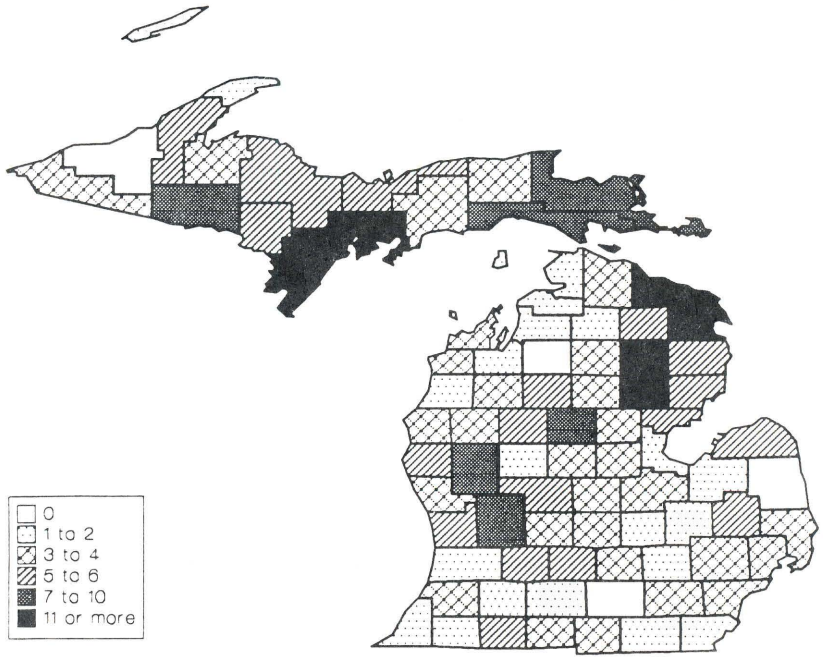
Source: U.S. Department of Commerce, 1992.

Figure 2. Number of forest products establishments, by industry, by region, 1990.



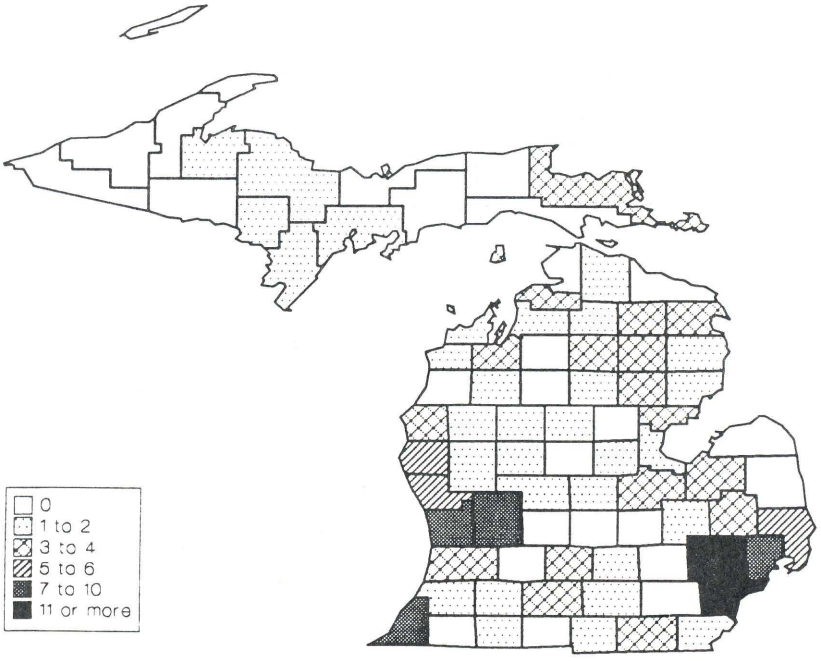
Source: Hackett and Pilon, 1993.

Figure 3. Michigan sawlog production, by region, 1993.



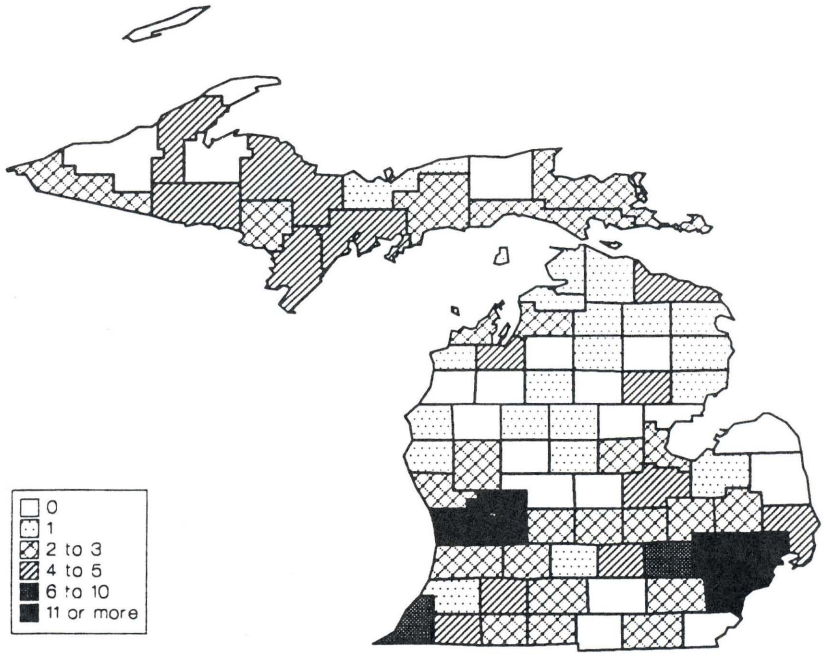
Source: Michigan Department of Natural Resources, 1993.

Figure 4. Number of sawmills in Michigan, by county, 1993.



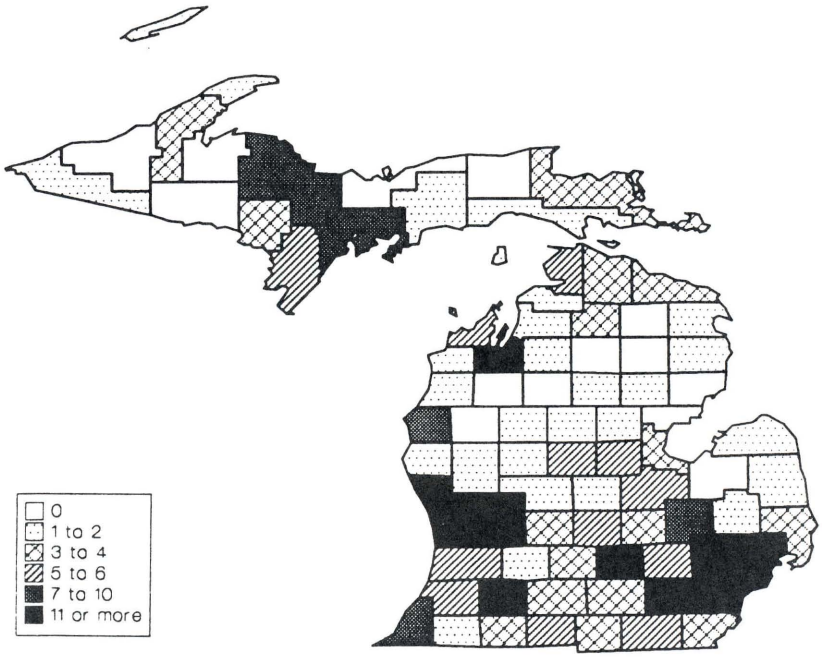
Source: Michigan Department of Natural Resources, 1993.

Figure 5. Number of pallet and wood container mills in Michigan, by county, 1993.



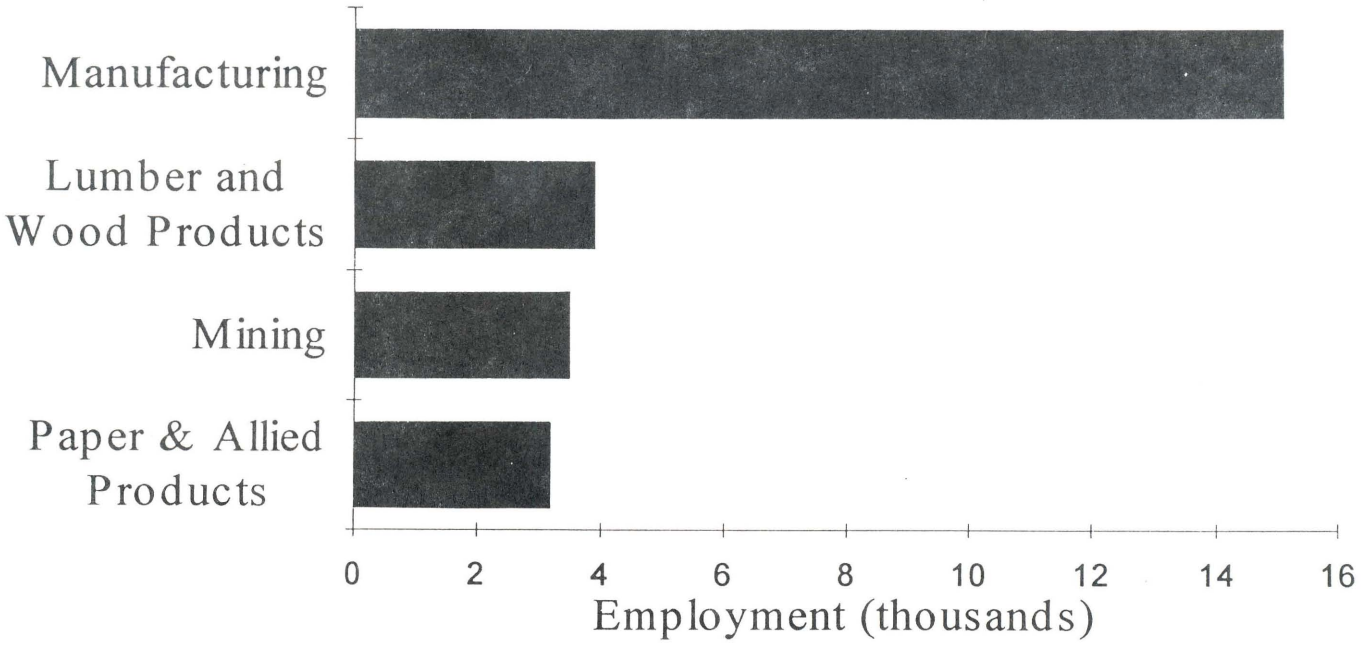
Source: Michigan Department of Natural Resources, 1993.

Figure 6. Number of dimension products and millwork plants in Michigan, by county, 1993.



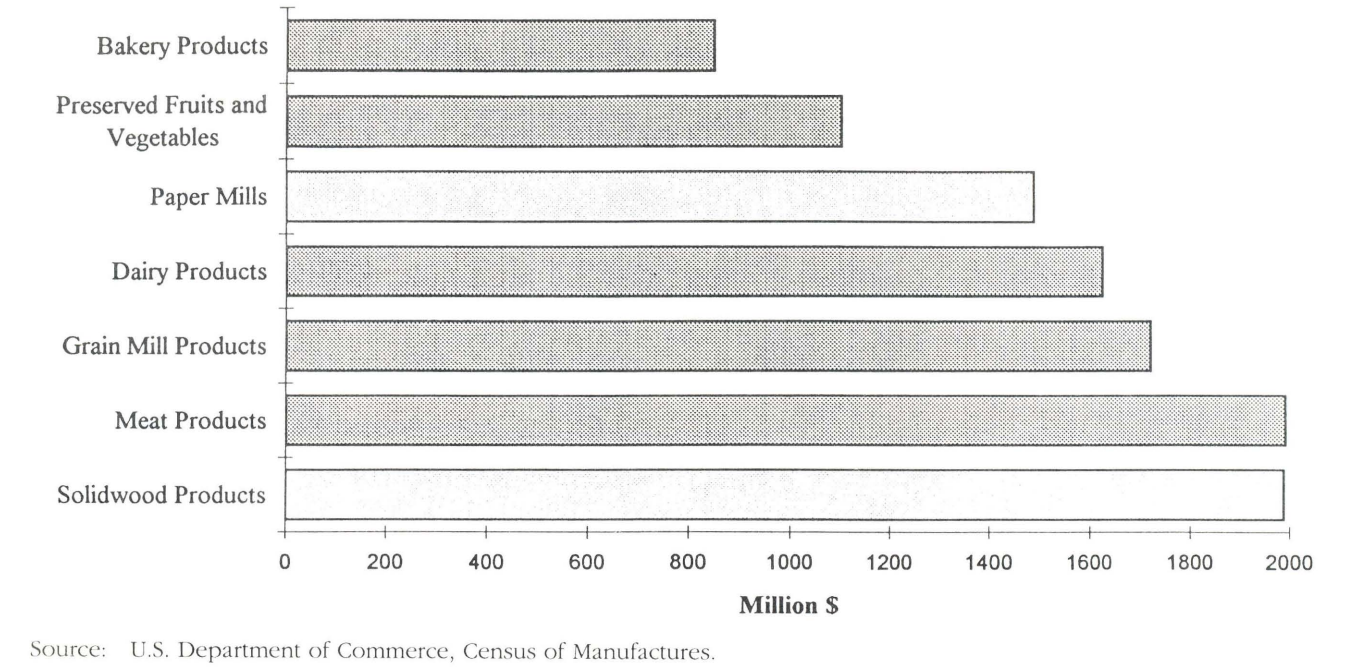
Source: Michigan Department of Natural Resources, 1993.

Figure 7. Number of furniture and cabinet manufacturers in Michigan, by county, 1993.



Source: Michigan Employment Security Commission (MESC), 1st quarter 1993. (MESC data do not include sole proprietors and partnerships, nor some family-owned businesses that do not employ non-family members, so employment is underrepresented, particularly in SIC 24, which includes logging.)

Figure 8. Employment in the Upper Peninsula by industry type, 1993 (thousands).



Source: U.S. Department of Commerce, Census of Manufactures.

Figure 9. Michigan value of shipments, solidwood products and processed foods, 1987.

Table 1. Michigan forest products industry value-added (million 1991 dollars), 1977, 1982, 1987 and 1991.

Sector	1977 Census	1982 Census	1987 Census	*1991 Census
Logging camps	32.8	29.2	52.3	83.1
Sawmills	81.0	60.6	91.7	92.6
Millwork	143.5	99.3	212.4	216.6
Wood containers	55.3	40.7	57.1	66.0
Prefabricated buildings	56.9	14.3	47.4	D
Miscellaneous	102.5	99.0	161.2	188.3
SIC 24 Total	471.4	343.1	622.1	684.9
Household furniture	133.6	163.8	170.9	199.5
Wood household furniture	77.6	71.7	81.9	NA
Upholstered furniture	23.6	D	14.7	NA
Office furniture	537.5	1,045.7	1,455.7	1,453.6
Wood office furniture	D	D	73.7	NA
Public buildings	88.9	87.5	114.4	216.6
Partitions and fixtures	117.4	139.0	142.1	140.4
Wood partitions	57.5	111.5	57.6	NA
Wood SIC 25 total	247.5	270.8	342.3	**419.3
SIC 25 Total	1,104.0	1,254.3	2,005.9	2,060.0
Pulp mills	D	D	D	D
Paper mills	510.8	394.8	685.7	695.4
Paperboard	155.6	127.3	D	D
Converted paper	336.1	342.8	D	D
Containers	363.1	272.4	310.2	258.1
SIC 26 Total	1,324.4	1,045.3	1,699.7	1,669.6
Forest products (FP) total	2,043.3	1,659.2	2,664.0	2,773.8
SIC 24,25 & 26 total	2,899.8	2,642.7	4,327.6	4,414.5
Manufacturing (MANU)	62,484.3	42.227.8	62,307.4	63,351.0
FP% of MANU	3.3%	3.9%	4.3%	4.4%

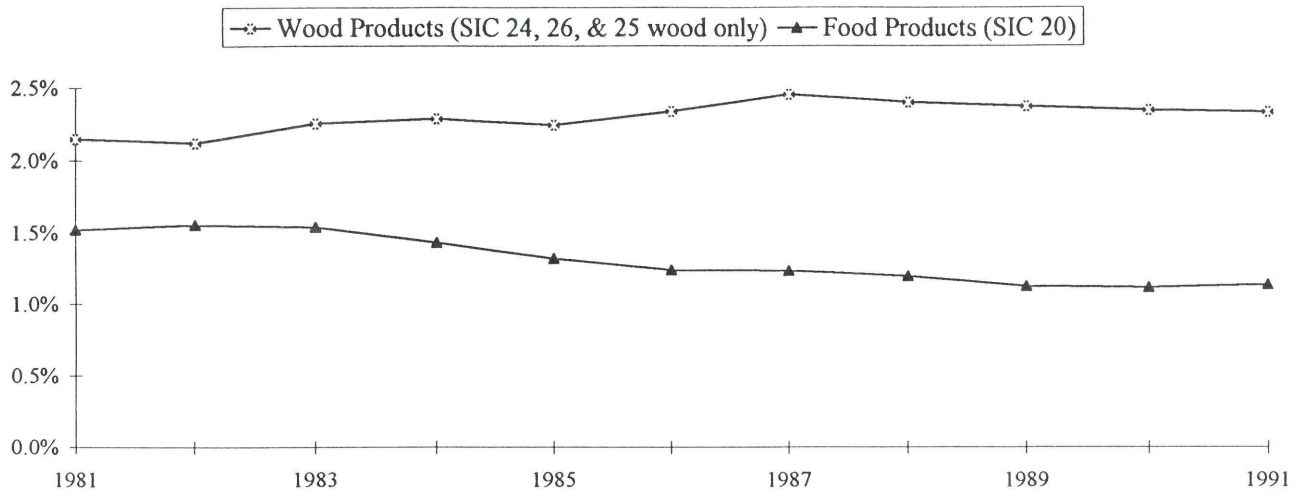
D = Not disclosed by Census of Manufactures.

NA = Three- and four-digit SIC detail not given in Annual Survey of Manufactures.

*Annual Survey of Manufactures.

**Estimated as average percentage of total SIC 25 from previous three censuses.

Source: USDOC, Bureau of Census, Census of Manufactures 1977, 1982, 1987; Annual Survey of Manufactures, 1991.



Source: County Business Patterns, 1993.

Figure 10. Wood products and food products employment as a percent of total Michigan employment, 1981-1991.

Table 2. Percentage of employees and number of firms in Michigan, by industry, 1993.

Number of Employees	Sawmills	Pallets	Dimension	Furniture	Veneer
			Percentage		
1-5	56	44	33	44	21
6-15	24	30	26	25	7
16-30	12	13	15	11	14
31-50	6	7	10	6	14
51-100	1	4	7	5	7
101-200	1	2	6	3	3
201-500	0	0	2	4	0
501-1000	0	0	0	1	0
1001+	0	0	1	1	0
			Number of firms		
Total firms	385	215	216	560	14

Source: MDNR wood products directory.

Products

The solidwood/composite products produced in the state are derived from three log categories: veneer logs, sawlogs and pulp bolts. The largest diameter, highest quality logs of certain hardwood species, such as walnut and northern red oak, go into veneer log production. Though veneer logs can generically include relatively low value products, such as packaging, matches and chopsticks, the emphasis here is on the high value, sliced or peeled, furniture-quality veneers. Because of the high value of these logs, the rule to process close to the harvest site is often broken. Table 3 shows the destinations for initial processing of veneer logs harvested in Michigan. There is anecdotal evidence, thus far undocumented by any study, of increasing exports of veneer logs from Michigan to Europe and the Pacific Rim.

Lumber

The mid-value range of products produced in Michigan is from sawlogs that are converted into lumber. The lumber is dried and manufactured into furniture, cabinet work and pallets, or used directly to produce flooring, paneling, moulding and millwork. Higher quality lumber is mainly graded and sold as factory lumber or processed into dimension parts and finished products. Factory lumber comes in random widths and is graded by the number and size of clear cuttings that may be obtained. Most hardwood sawlogs are processed to produce the highest possible appearance grade lumber. After the yield of high value lumber is maximized during the sawing process, lower grade lumber or pallet parts are cut either at the same mill or a pallet plant.

Kiln-dried lumber has a number of advantages over green lumber, and for many manufactured wood products it is essential. Hardwood lumber drying is more critical than softwood lumber drying. Hardwood lumber must be dried to 6 to 8 percent moisture content for furniture, compared with 15 to 19 percent for softwood construction material. Furniture hardwood lumber must also be dried more slowly to avoid drying problems such as splits, checks, warping and staining, which reduce the value and usefulness of the lumber.

The lumber kiln drying industry in Michigan has gone through some important changes since World War II. Before 1945, most furniture companies had their own dry kilns and bought fresh cut lumber from the sawmills. After 1945, custom kiln drying done by specialists at concentration yards became popular. In the past 10 years, more sawmills have installed dry kilns, thereby opening up new markets for themselves, especially for export. Sawmill-based drying has also reduced transportation degrade and inventory costs associated with wet, heavy lumber. Kiln drying lumber could almost be considered a separate industry essential for further value-added manufacturing of hardwoods. Currently about 300 companies are doing kiln drying in Michigan.

Pallets

The largest market for hardwood lumber is for the manufacture of pallets. Made from the lowest grade lumber, pallets are used extensively in transporting manufactured and agricultural goods. For this reason, most of the pallet industry in Michigan is concentrated in the southern part of the state (Figure 5). Michigan has more pallet firms than any other state. This reflects the industrial demand as well as the high volume of low quality timber available. Many of these firms produce wood containers and other shipping materials as well. Because pallets do not travel far, success in this industry is closely tied to the health of the *regional* economy, particularly manufacturing and agriculture.

Table 3. Veneer log production in Michigan, 1978-1990, by state of destination (million board feet).

	Michigan	Wisconsin	Lower North Central States	Other	Total
1990	21.7	14.4	1.0	0.7	37.8
1988	18.6	12.5	4.4	0.7	36.2
1986	15.7	13.0	3.2	0.9	32.8
1984	11.0	9.4	0.0	11.3	31.7
1980	22.1	9.0	0.0	5.6	36.7
1978	22.6	8.7	1.8	2.1	35.2

Source: USDA Forest Service.

Dimension Stock

The second group of products associated with lumber inputs consists of those produced by the hardwood dimension industry (SIC 2426). This industry produces rough, semi- and fully-machined wood components used in the production of a variety of products, including furniture, kitchen and vanity cabinets, interior trim and mouldings, staircases, and specialty items such as wall plaques, picture frames, musical instruments, kitchen items, tool handles and vehicle parts. Nationally, furniture and cabinet components account for about 80 percent of the dimension industry's output. Success of the industry is tied to improvements in the general economy, specifically to increases in residential construction and remodeling, and increasingly to export markets.

Furniture

Michigan sawnwood is also an important input for the furniture industry. Though many furniture manufacturers are vertically integrated—that is, they produce their own wood component parts—there is a move in the industry to become more profitable by assembling purchased components. The majority of Michigan's furniture industry is classified as non-wood office furniture, but these firms use a substantial amount of wood components and sell to households as well. The top three contract office furniture producers in the United States—Steelcase, Herman Miller and Haworth—all headquartered in Michigan, use 40, 90 and 31 percent wood, respectively in their metal/wood material mix (Derning, 1993). The office furniture sector in general uses the most wood for desks, storage units and seating, with wood furniture accounting for about 40 percent of the $3.5 billion value of shipments of these products in 1992 (Sullivan, 1994).

Slightly over 50 percent of the state's total furniture industry employment is concentrated in and around Grand Rapids (MESC, 1993). This concentration of furniture firms accounts for a significant proportion of the total U.S. office furniture market. Michigan's importance is much greater within certain segments of the industry. For example, Michigan leads the nation in production of non-wood seating, non-wood office storage units, and public building and related furniture, and it accounts for 75 percent of all modular furniture systems built in the United States (Michigan Jobs Commission, 1993). Michigan accounted for 14 percent of total U.S. office furniture employment in 1989 (Davis, 1991).

Composition Panels

The lowest value solid wood or composite input is pulpwood. These small diameter bolts have traditionally gone into pulp, paper and paperboard products (see SAPMINR Special Report 73). Increasingly, however, they have been used in the production of fiberboard, oriented strand board (OSB) and particleboard, all of which use wood shavings and/or wood flakes as their primary furnish.

Panel products are generally divided into two groups: structural panels (softwood plywood, OSB and waferboard) and non-structural panels (hardwood plywood, insulating board, hardboard, medium density fiberboard [MDF] and particleboard). New residential construction is the largest consumer of structural panels, accounting for approximately 37 percent of production, followed by repair and remodeling (29 percent), industrial applications (13 percent) and non-residential construction (8 percent) (Haynes, 1993). Though lumped together by end use, non-structural panels are distinctly different. Hardwood veneer and plywood are made from logs that are either peeled or sliced. Hardboard, insulating board and MDF are produced from thermo-mechanical wood pulp. Fiberboard, OSB and particleboard plants use roundwood, chips or shavings as their primary furnish. Both particleboard and hardboard are marketed beyond the Lake States, principally to furniture plants in the Lower North Central States (Stier, 1990).

Flakeboard (OSB and waferboard) production had a huge capacity increase in the Lake States in the 1970s and early 1980s. OSB now makes up about 30 percent of structural panel shipments in the United States. In Michigan, this increase is closely tied to use of aspen. In fact, most of the increase in wood pulp consumption can be accounted for by increased use of aspen for flakeboard production.

Other Products

Many other industries in Michigan use wood products to some degree. The Michigan Department of Natural Resources (MDNR) directory lists 338 firms that produce miscellaneous wood products. These range from crafts to automobile parts. In-depth discussion of these firms is beyond the scope of this report. Suffice it to say that many companies in addition to those traditionally associated with the forest products industry depend on the timber resource for all or part of their production.

A final industry, treated wood products, though small, should be included. Of the 10 wood-preserving firms in Michigan, nine have fewer than 30 employees. Their products include treated utility poles, fences and decking, railroad ties, bridge timbers and products for other uses where moisture and insect or decay attack are potential problems.

Assumptions to 2000

This section identifies the trends in four areas–international trade, raw material availability, environmental issues and technology–and discusses assumptions about their continued impact on Michigan forest products industries.

Lowering of Trade Barriers

The recent passage of the North American Free Trade Agreement (NAFTA) and the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) continue trade liberalization policies that the world has

adopted since the end of World War II. As these tariff reduction schedules go into effect over the next decade, U.S. exports, particularly of more highly processed products such as furniture, should be expected to increase. On January 1, 1993, for example, tariffs on particleboard, waferboard and OSB were eliminated under the U.S.-Canada Free Trade Agreement. This action followed resolution of issues relating to performance standards for softwood plywood and other structural panels in construction applications. The total value of wood products exports to Canada, the industry's largest foreign market, increased 18 percent to about $99 million that year. NAFTA calls for a five-year phaseout of Mexican tariffs on MDF, hardboard and insulation board, and a 10-year phaseout of tariffs on particleboard and OSB. These reductions should enhance export opportunities.

Exchange rates are an important factor in trade flows. At constant prices, a decrease in the value of the U.S. dollar relative to the currency of a trading partner makes U.S. forest products delivered to that country less expensive and therefore more competitive. Over the past 25 years, the value of the U.S. dollar has weakened relative to the currencies of two major trading partners, Japan and Germany (360 yen/$ and 4 marks/$ in 1967 vs. 100 yen/$ and 1.55 marks/$ today). Over the same period, the dollar has strengthened vs. the currencies of two other major partners, Canada and Great Britain (1.07 Cn$/U.S.$ and .36 pound/$ in 1967 vs. 1.38 Cn$/U.S.$ and .66 pound/$ today). One of the results of these fluctuations in exchange rates is that they can buffer (or exaggerate) increases in prices. During the past three years, the Hardwood Review export index of 31 key North American hardwood items has gone from about $965 to $1,284 (a 33 percent increase). Because of the weakening of the U.S. dollar compared with the yen, the export index for hardwood products shipped to Japan during the same period actually decreased from 151,981 yen to 149,556 (-2 percent), making exported forest products cheaper in Japan in spite of their increases in U.S. dollar prices. The index to Germany increased from DM 1,836 to 2,310 (+26 percent) and the British index increased from 618 pounds to 935 (+51 percent). Given a (probably less drastic) continuation of the exchange rate trends discussed above, the buffering effect of exchange rates should continue with Japan and Germany and will probably continue to work against exports to Canada and Britain.

Regional trade agreements will be expanded as plans go forward to implement a North America/South America Free Trade Agreement covering a region with 835 million people. As other non-tariff barriers are reduced, such as restrictive building codes or lumber regrading requirements, trade in primary products will increase. Increased overseas acceptance of U.S. species and wood products should continue as the benefits of years of international marketing efforts by companies and trade associations accrue. Continued implementation of the U.S.-Japan Wood Products Agreement should help open the Japanese residential construction market to U.S. exports.

Free trade is a double-edged sword, and imports of hardwoods are likely to increase as lumber becomes available from areas in the former Soviet republics, Argentina, Chile and possibly China. Hardboard increases are also likely from Brazilian eucalyptus plantations. An exception to the increase in free trade will be the continued pressure for the restriction of log exporting as all countries, including the United States, attempt to capture more value-added processing.

Regional Raw Material Scarcity

If present trends continue, there will be continued pressure on supply for some species in certain regions of the state. Notable examples are the demand for aspen in the northern Lower Peninsula for pulp and panel production and the statewide demand for veneer quality oak, primarily for furniture and cabinet manufacture. There are reports of northern white cedar scarcity as well. In contrast, the recent hard maple price increases indicate expanding demand for this abundant species.

The dominant Michigan forest type is maple-birch, accounting for 44.6 percent of the growing stock volume, followed by aspen-birch (14.4 percent), oak-hickory (11 percent) and pine (10.2 percent). Of the valuable oak-hickory type, 44 percent is pole timber and only 20 percent is sawtimber. On the consumption side, in contrast, red or white oak accounts for 50 percent of hardwood volume used in furniture manufacture, 56 percent of export volume, 95 percent of flooring, and 67 percent of stock kitchen and bath cabinets (*Weekly Hardwood Review,* October 1, 1993).

Environmental Issues

Environmental issues will continue to be critical to all forest products industries. Forest managers and the industries that use forest products will need to be increasingly aware of public sensitivity to environmental issues. The need for educational programs about forest resource management will continue. This awareness may lead to more "green marketing" as certification programs become established to show that wood products have come from sustainable, environmentally sound operations. *Ecosystem management* concepts will move increasingly from theory to application, with potential implications for timber availability. This is likely to remove some areas from timber production but may also lead to the designation of other areas for intensive forest management.

Access to Technology

The industry will see a continued increase in the use of computers and other sophisticated electronics in both manufacturing and sales. Many of the technological advances are detailed in a later section. Those producers that can adapt to an increasingly computerized manufacturing atmosphere will be the most likely to prosper.

The advent of the fax machine and low-cost computing has allowed small businesses to compete in world markets that previously were open only to larger, more well-financed operations. As the globalization of markets continues to increase, more businesses will be able to respond effectively to customers across the state, across the country or across the ocean.

Issues and Projections

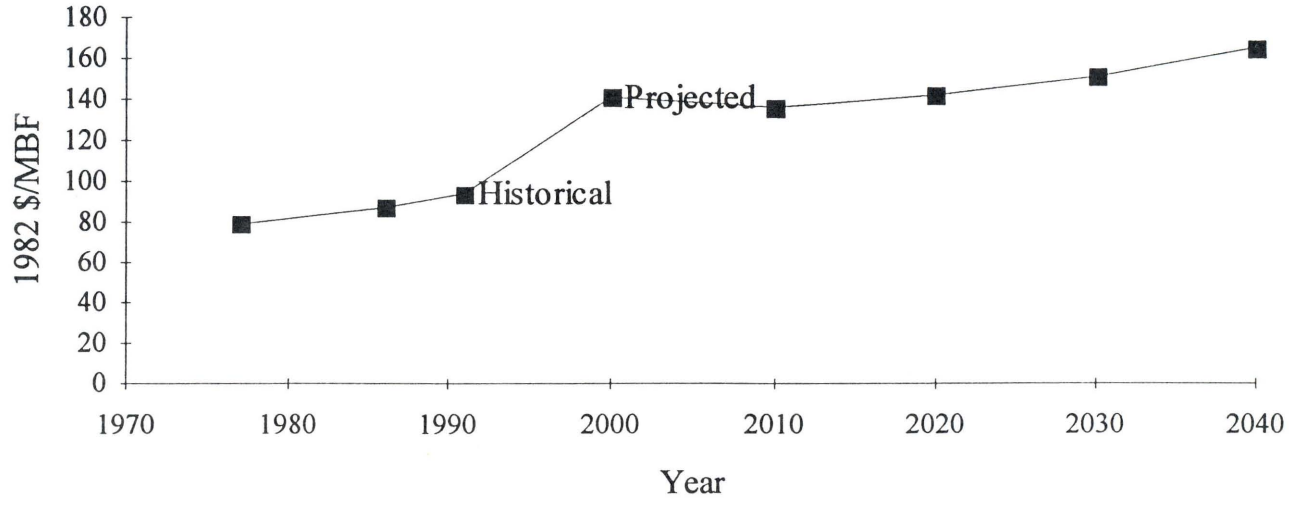
The most important issues facing Michigan's forest products industry center on four interrelated areas: supply of raw material, changes in demand, technological change and changes in operating requirements. Underlying all these issues is the concern for jobs.

Wood Supply

Detailed analysis of Michigan's timber supply can be found in SAPMINR Special Report 71. Though the state's inventory of standing timber is increasing, there is cause for concern about the future availability of both private and public timber. The recent increases in stumpage prices of many species, while worrisome to processors, have the potential to bring more timber on the market and encourage increased forest management activities by landowners. Much of the pressure has been on the smaller diameter trees used in the production of paper and panels. Though a market for small diameter trees is essential to grow higher value products economically by creating outlets for intermediate harvests, increased prices for smaller diameter trees may discourage the longer term investments necessary for long-rotation timber.

Another obvious trend is the changing demographic picture in the state. Many owners of timberland are second-home owners, hunting clubs and others whose primary interest is with other values besides timber. Land is also increasingly being fragmented into smaller parcels as larger blocks are subdivided into home sites. A recent study by Nelson (1994) showed that though 40 percent of landowners surveyed in the northern Lower Peninsula had sold timber from their land, only 8 percent had management plans. Sustained timber production may be a low priority with many landowners.

Competition from other wood-using sectors is increasing. Many energy co-generation plants have been built in the state; in some cases, these plants are competing for the same raw materials as the wood products industries. A related issue is the increased competition among the various producers of forest products. As mentioned earlier, producers generally use the smallest diameter trees for pulp and composite boards, mid- to large diameter logs for lumber and the largest, highest quality logs for veneer. The need to keep pulp and composite plants supplied to near full capacity has meant that the diameter of the furnish to these plants fluctuates and sometimes includes larger diameter bolts. At the same time, there are fewer of the large diameter logs, as the oldest, highest quality logs are harvested. This puts additional pressure on sawlog availability in the mid-diameter classes and has been a contributing factor in the rise and projected continued increase in sawtimber prices (Figure 11).



Source: Haynes et al., 1993.

Figure 11. Hardwood sawtimber price projections to 2040, North Central United States (1982 $/MBF).

Demand Issues

On the consumption side, a number of factors will affect the forest products industry in Michigan. These include substitution of non-wood materials for wood, substitution of lower cost wood products for increasingly expensive traditional wood products, changes in demand for particular end products and changes in export markets.

Substitution

As prices increase, consumers look for lower cost substitute products. Recent trends suggest that Michigan producers may benefit from this substitution to the extent that hardwood can substitute for traditional softwood construction uses. This process is likely to accelerate as the domestic softwood supply, particularly from public lands in the West, is reduced through increased harvesting restrictions. Another example of wood for wood substitution is the displacement of dimension lumber by sheathing, first by plywood and more recently by composition panels. On the other hand, possibilities exist for non-wood materials to be substituted for traditional wood uses. An example is recycled plastics currently being used in deck construction and outdoor furniture.

End Product Demand

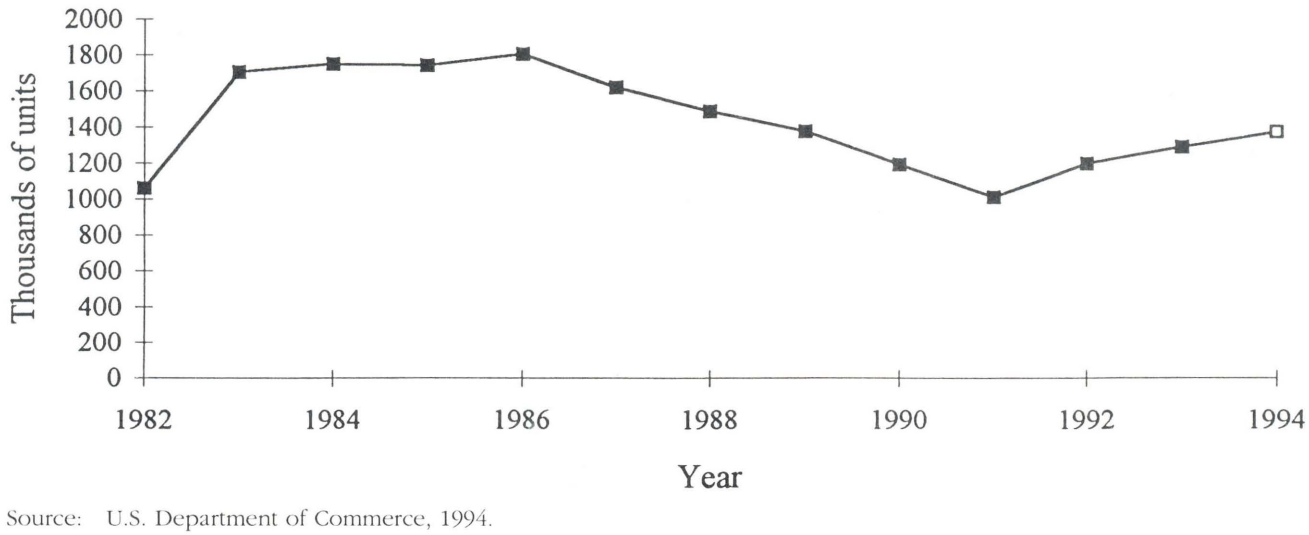
The demand for softwood products is cyclical, with the housing market in the United States being the largest contributor to this pattern (Figure 12). Demand for most hardwood products, though still tied to housing, is more closely correlated with the measures of the general health of local and national economies and, increasingly, the international economy. Table 4 shows the U.S. Forest Service's projections of domestic timber consumption for the next 50 years. Though shipping, manufacturing and residential upkeep all started at roughly the same level in the early 1960s, residential upkeep and improvement has greatly outdistanced the other two. This level is projected to double over the next 50 years.

Pallets and Dimension Products

Demand for both pallets and dimension products is expected to rise over the next decade. Pallets are expected to increase nationally from 420 million to 550 million units (Figure 13). Dimension product demand is projected to grow at an average rate of 2 percent per year over the next 10 years (Banzhaf, 1992). This indicates that a steady market will exist for the smaller diameter, lower quality hardwoods that Michigan has in abundance. The major growth areas for hardwood dimension products will be in remodeling and export markets (Lawser, 1993).

Furniture

The office furniture industry (SIC 252) is divided into wood (SIC 2521) and non-wood (SIC 2522) sectors. Tremendous growth in U.S. office furniture sales occurred from the mid-1970s through the late 1980s. Sales grew from $1.4 billion in 1976 to more than $7.8 billion in 1989, reflecting the expansion in the economy's service sector and an office construction boom. Correspondingly, office furniture sales have flattened out or slightly declined in recent years because of corporate staff reductions and a lack of new office construction in light of excess capacity and vacancies in existing commercial office buildings. This lack of expansion will dampen growth in domestic office furniture sales.



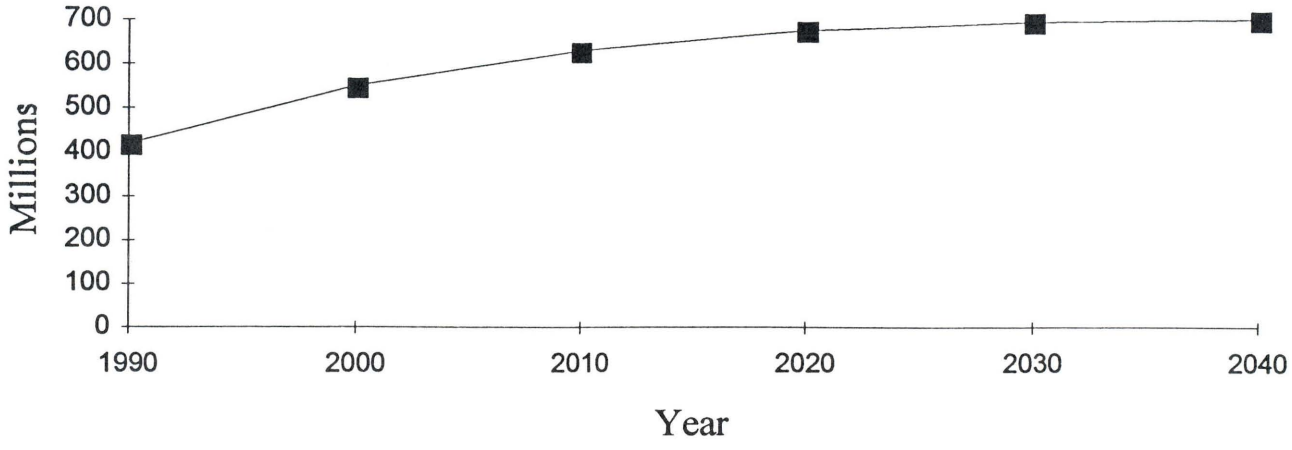
Source: U.S. Department of Commerce, 1994.

Figure 12. New housing starts, 1982-1984 (□ = 1994 projection).

Table 4. U.S. lumber consumption (historical and projected), by species group and end use (billion board feet).

	Softwoods	Hardwoods	Total	New housing	Residential upkeep & improvements	New non-residential construction	Manu-facturing	Shipping	All other
H 1962	30.8	8.5	39.1	14.5	4.4	4.2	4.5	4.6	6.9
i 1970	32.0	7.9	39.9	13.3	4.7	4.7	4.7	5.7	6.8
s 1976	36.6	8.0	44.7	17.0	5.7	4.5	4.9	5.9	6.7
t 1986	48.0	9.0	57.2	19.3	10.1	5.3	4.8	6.8	10.9
1991	44.0	10.8	54.6	15.0	11.6	5.4	5.6	8.2	8.8
P 2000	46.8	11.0	57.9	15.2	13.4	6.3	5.3	9.3	8.5
r 2010	49.9	11.9	61.8	14.6	15.5	6.7	5.7	10.2	9.1
o 2020	56.6	12.6	69.2	16.1	17.5	7.3	6.3	10.8	11.0
j 2030	59.6	13.1	72.7	14.9	19.0	8.1	7.1	11.2	12.4
2040	61.8	13.8	75.6	13.8	20.1	9.0	7.9	11.5	13.3

Source: Haynes et al., 1993.



Source: Haynes et al., 1993.

Figure 13. Projected U.S. pallet production, (millions), 1990-2040.

Nationally, household furniture shipments were relatively stable from the late 1980s to the early 1990s, at just below $20 billion annually (Department of Commerce, 1994). However, in contrast to the office furniture market, the household furniture market should experience growth in the near term, and this growth may well continue for several years.

The two major positive influences on the market are fairly certain: low interest rates and favorable demographics. Also, unlike the office furniture market, which is tied to an overbuilt commercial sector that may take years to absorb the excess supply of office space, household furniture is tied to the home construction industry, which appears more poised for growth.

Housing starts are the single major determinant of household furniture demand, and interest rates, in turn, are a major determinant of housing starts. Most forecasts and industry sources predict that interest rates may rise only modestly for the next several years and that the level of housing starts may increase as a result.

Growth in remodeling of existing homes has increased more than new housing starts, contributing to significant growth in both furniture and cabinet sales. The aging baby boomer group is also expected to add to furniture demand as they enter their prime income-earning years and replace their low- to medium-priced furniture purchased in the 1980s. In this vein, Michigan's household furniture firms are well positioned, as they are largely considered "high-end" or "upscale" furniture makers, primarily selling expensive, quality pieces.

Epperson (1993) offers this summary of the positive and negative trends that will affect the furniture industry:

Negatives	*Positives*
Fewer household formations	Larger homes being built
Reduced mobility	Longer time horizon
More minimum-wage jobs	More disposable income
Increased insurance costs	Second homes
Growth in service sector	Inheritances
Fewer manufacturing jobs	Higher savings
Convenience shopping	Demand for high product value

Export Demand Trends

Forest products exports from Michigan have shown a strong positive trend over the past four years (Table 5). As might be expected by its proximity, Michigan's biggest customer is Canada. The Canadian numbers may be misleading, however, because as much as 20 percent of the products exported to Canada are being re-exported to Europe (Armstrong et al., 1992). If the economies of the biggest U.S. trading partners pick up over the next few years, it is anticipated that exports will increase significantly. To insulate themselves from cyclical domestic demand and to exploit new markets, Michigan producers in most wood product categories have increased their export activities. An MDNR survey of Michigan wood products manufacturers showed that 472 firms are currently exporting and that another 388 are interested in exporting. The outlook for increased foreign trade in unassembled wood furniture and furniture parts looks particularly promising. From 1986 to 1992, U.S. furniture exports dramatically increased (at greater than a 33 percent annual rate); however, furniture imports still exceed exports by 4 to 1.

Technological Development

Much of the change in technology evident in Michigan wood production is in response to the changing nature of the raw materials available. As average wood size decreases, processes such as finger jointing and gluing of smaller pieces of wood are more commonly used. Other efforts to stay competitive include adoption of labor-saving technology and increased value-added production. The following sections give an overview of the types of technological change taking place by product. The discussion is predominantly drawn from the U.S. Forest Service publication *An Analysis of the Timber Situation in the United States: 1989-2040* (Haynes, 1990).

Hardwood Lumber and Dimension Stock

The main pressures to improve or change hardwood lumber processing techniques stem from the need to manufacture sufficient better grade material to meet export and domestic demand. Modernization, computer-aided manufacturing and computer-controlled processing are key elements in this change. Computerized log shape scanning and computerized sawing decision technology are available and being adopted by some large mills. Computer-aided edging and trimming are also coming into use. Saw kerfs will continue to get narrower in an attempt to reduce the 12 to 18 percent of a log that ends up as sawdust.

Table 5. Value of Michigan forest products (SIC 24) exports, by destination, 1989-1993 (U.S. $).

	1989	1990	1991	1992	1993
Canada	15,595,668	31,079,719	26,603,920	40,454,616	51,139,417
Europe	38,381,206	35,461,508	47,553,254	30,607,017	33,771,044
Asia	5,669,470	8,319,474	7,626,397	6,005,17	6,422,466
Latin America/Caribbean	693,034	948,657	1,891,502	1,669,976	1,874,534
Middle East/Africa	545,663	649,547	765,580	485,062	1,164,018
World Total	60,885,041	76,458,905	84,440,653	79,221,842	94,371,479

Source: MISER, 1994.

A system that incorporates many of the above technologies is the Automated Lumber Processing System (ALPS). In the ALPS, logs are scanned internally to locate the position of internal defects. Computers use the position of defects to determine and control log breakdown to maximize grade or value yield of boards. After drying and superficial surfacing, video image analysis locates and classifies defects on each board. Cutting is then carried out by computer-controlled conventional cutting or high-powered laser cutting.

Greater use of predryers and computer controls that allow smooth or continuous curve drying are improving grade recovery by reducing degrade in the drying process. The use of vacuum kilns will increase but, because of the energy costs per board foot, they will continue to be a very small percentage of the new kiln market. Dehumidification kilns will become less attractive because of the high cost of approved (R134A) freon (Mathews, 1993). The emphasis will be on increasing the energy efficiency of existing technology.

New products such as hardwood laminated veneer lumber—thick, defect-free panels produced from low-grade timber—may replace hardwood lumber in some markets. Another potential technology being studied is the production of various composites of wood and other materials, such as wood and plastic (Balatinecz and Woodhams, 1993) or wood and cement (Moslemi, 1993).

Lumber manufacturers will move into producing rough dimension lumber, while rough dimension manufacturers will produce more semi- and fully-machined wood component parts. Dimension producers are developing ways to use more of the lower grades of lumber and the less popular species of wood. The use of computerized optimizing saws is increasing in dimension plants.

The Forestry Department at Michigan State University is addressing the issue of increased utilization through a research project on efficient conversion of hardwood sawlogs to furniture dimensions. This conversion is currently a two-step process, with the grade lumber being produced as a commodity in the sawmill and furniture dimensions being manufactured from grade lumber in the furniture plant. This system encourages the optimization of grade lumber value yield from the log in the sawmill. Evidence exists that this occurs at the expense of dimension volume yield which, of course, is of primary interest from the standpoint of prudent resource utilization. The research effort will explore various sawing methods and modification of lumber grading rules and the economic impacts of adopting these changes.

Panel Processing

Technology developments in processing oriented strand board and waferboard are likely to focus on two areas: increasing their range of applications and decreasing wood loss during the flaking, forming and trimming processes.

Oriented strand board and waferboard have been used as sheathing in walls and roofs and for floor underlayment. The technology has recently been developed for applications such as concrete forms and siding. Suitable performance is being achieved by using phenolic paper overlays to stabilize the surface and to provide a suitable basis for paint or concrete forming. To improve panel stability, the trend has been to replace phenolic adhesives with isocyanate adhesives, though problems of toxicity and adhesion to steel presses have limited the substitution.

Technology improvements in structural and non-structural panel processing will increase the substitution of panels for lumber. As a result, demand will increase for hardwood veneer and for panels using paper overlays. This substitution will reduce the demand for medium to high grade hardwood lumber as a greater proportion of product volume uses more efficient panel-making techniques to convert logs to products.

The most likely change in veneer processing technology is the trend to thinner veneers. Veneers in the United States measure from 0.61 to 0.71 mm; European veneers measure around 0.51 to 0.61 mm, and Japanese veneers, 0.2 to 0.4 mm. New standards have been proposed (Wood & Wood Products, 1993), but the transition involves investment in new machinery and increased difficulty in handling that may slow the change.

Pallets

Sawmills have traditionally used the lower grade lumber they produce for pallets. Today up to half of all pallets are produced using nailing machines, and a limited number of producers have large modern facilities with automated sawing, lay-up and nailing. Pallet recycling has become a significant part of the industry

Pallets have traditionally been designed to support the heaviest possible load. This results in excessive lumber use. Computerized pallet design systems permit producers to quickly change pallet design to suit the type of load. A trend toward expendable pallets is reversing because of increased emphasis on source reduction in packaging, higher raw material costs and general environmental concerns. Lumber consumption in pallets may also decrease as more composite materials are used in pallets. Growth in pallet production is also expected to be held down by the virtual saturation of industries that can use palletized shipping.

Furniture

Technology developments such as the ALPS may reduce the amount of wood needed to make a given furniture part or reduce the proportion of high grade lumber needed to make a given set of parts. Growth and improvements in existing technologies such as edge, end and finger jointing and computer-assisted cross- and rip sawing are now increasing both lumber recovery value and volume. Better finishing of less desirable species is increasing as well. Other technologies, such as

computer numerical control of woodworking operations in furniture plants, are lowering costs by speeding production, improving accuracy and using labor more efficiently. Overall, hardwood lumber use per unit of furniture production is expected to fall, even though use for high value furniture may increase (Haynes, 1990).

Changes in Operating Requirements

To make business investment decisions, firms would like to be able to predict the future with certainty. This, of course, is not possible, but firms form expectations of future demand and prices on which to base investment decisions. There is probably no area of greater uncertainty than the extent of future public regulation. In the past decade, the forest products industry has had to become more involved in the public decision making process as political decisions have had more impact on the industry than ever before. The need for this involvement has been brought about by increased public awareness of environmental issues and concern for the environment. Legislatures have responded by intervening more frequently in decisions that have traditionally been left to land managers and landowners. For example, laws have been passed at state and national levels regulating clear-cuts and designating approved management practices.

Some policy decisions may have a positive effect on regional demand. As domestic softwood timberlands are withdrawn from harvest, there will be a general trend toward greater use of hardwood lumber for structural applications. A grading system has been established and lumber grading agencies have been certified by the American Lumber Standards Committee for hardwood structural lumber. The hardwood structural lumber grading system has been approved for use by model building codes.

Other laws and public policy decisions have impacts on forest products industries. Many of these are directly related to timber supply and are covered in SAPMINR Special Report 71. These include the Commercial Forest Act and the Forest Practices Act, below-cost timber sales, threatened and endangered species, wetlands and other issues, as well as changes in management policy as forest management moves from stand-level decision making to landscape (or ecosystem) management. Other legislative issues relevant to the forest products industries relate to worker protection from pesticides, wood dust and other noxious substances, and hazardous waste disposal regulations.

The forest products industry, like other manufacturing industries, produces some amount of hazardous material requiring safe disposal. The amount of hazardous materials generated varies greatly among segments of the forest industry. The furniture industry, the pressure-treated wood preservative industry (mainly softwoods in Michigan), and the pulp and paper industry (discussed in SAPMINR Special Report 73) probably generate the largest volume of hazardous materials within the industry.

Most wood furniture produced in Michigan undergoes some type of finishing treatment (such as painting or staining and lacquering) as part of the manufacturing process. Traditionally, many of these finishes have been petroleum-based and chemically very volatile. Thus, many pose environmental and health risks that require safe disposal of wastes as well as protection of workers applying these finishes.

Current trends within the furniture industry are focusing on ways to minimize use of these finishing compounds to achieve compliance with air quality regulations and worker protection standards. Some states, such as California, already have strict air quality laws that greatly restrict the amount of emissions from furniture plants. This trend is expected to continue in other states, too. Consequently, many furniture industries are researching the use of water-based paints, stains and lacquers and high volume, low pressure spraying systems.

Another segment of the wood industry in Michigan that generates hazardous wastes is the pressure-treated wood preservative industry. Wood preservatives, by their chemical nature, tend to be potent (many preservatives contain heavy metals) because they must protect lumber from invasion by both insects and wood-rotting fungi. Many wood treatment plants in Michigan, because of the state's strict environmental regulations, no longer use certain types of preservative treatments, such as pentachlorophenol and creosote.

Consequently, most of the treatment plants operating in Michigan use chromated copper arsenate (CCA) and related compounds. Many of these plants are required by law to reuse and recycle as much of the chemical preservative as possible through the use of reclamation pads to collect drippings and other methods of capturing unused preservative not taken up by the lumber being treated. However, certain amounts of preservative and preservative-treated wood scraps are generated and must be disposed.

The pressure-treated wood preservative industry is researching new chemicals that pose fewer environmental and/or health risks and new treatment processes or methods that minimize exposure to both workers and end users of the treated wood product (e.g., the addition of sealers into the wood preservative solution). Stricter environmental laws in Michigan could further curtail the preservative-treated wood industry in the state.

A related area of public concern is the recycling of wood waste. The Environmental Protection Agency estimates that 56 million tons of wood and paper currently go into U.S. landfills—a quantity three times the 1990 timber harvest from national forests. Though wood accounts for only 7 percent of landfill volume, a variety of new technologies are being explored to use recycled wood (Dietzman, 1993).

Closely related to the hazardous waste issue affecting the forest industry is worker protection from noxious substances. In addition to the hazardous substances

described above, other noxious substances found within the wood industry workplace include wood dust and pesticides. Both of these substances require the industry to protect workers and minimize exposure.

Exposure to fine-textured wood dust particles that woodworkers can inhale is a controversial issue that has lately received much attention. There is some medical evidence that indicates that long-term exposure to wood dust can cause health problems ranging from chronic respiratory problems to possibly more serious problems such as lung cancer.

Consequently, at issue is the amount of fugitive wood dust that should be permissible in the workplace. The wood industry considers 5 mg/m^3 of wood dust to be an acceptable standard, but woodworking unions are seeking to make 2.5 mg/m^3 the accepted maximum standard. This issue is still not resolved, and a recent court decision has temporarily suspended the OSHA regulation that governs wood dust and more than 400 other noxious substances found in the workplace.

Pesticides in the workplace are also a concern in some segments of the forest industry. The forest industry in Michigan, unlike forest industries in the southern or western states, does not use large amounts of pesticides on forested lands for site preparation, conifer release or pest control, but use of pesticides and herbicides in the production of some tree species does occur on both public and private lands.

Other uses of pesticides in the forest industry include the use of pesticides that prevent wood-staining microorganisms (primarily fungi and bacteria) from discoloring logs and/or freshly sawn green lumber. Also, as mentioned above, the pressure-treated wood preservative industry depends totally on pesticides (i.e., wood preservatives) in the manufacturing of their particular product lines.

Another public policy issue is the state's commitment to encouraging new businesses. Michigan has been active in attracting new forest products industries to the state. Promotion of a proposed medium density fiberboard plant in McBain is a current example. Though new plant investments have been made in the state over the past few decades (e.g., the Champion paper mill in Quinnesec, the Georgia Pacific particleboard plant in Gaylord and the Weyerhaeuser oriented strand board plant in Grayling), studies (PHH Fantus, 1993, for example) have suggested that Michigan's most promising employment future is in retaining and expanding existing industries. State efforts and incentives to encourage expanded value-added manufacture in the wood products industries should continue to be the cornerstone of employment enhancement initiatives.

Emerging Issues and Research Needs

The *status* of the solidwood industries in Michigan is quite healthy. Michigan is well situated with ample resources, a well developed infrastructure, proximity to major markets and a highly skilled work force that produces quality wood products. The *potential* for the industries to prosper and grow into the next century depends on how well they adapt in two critical areas: the sustainability of the resource and competitiveness.

Resource Sustainability

Forest resource sustainability—making sure that resources are at least as available to future generations as they are today—depends on good forest management and on continued improvement of resource utilization. As land management philosophy moves away from *stand management* to *ecosystem management,* foresters and the wood products industry must adjust to the new realities. They must be involved in research and applications that allow the compatible use of wood resources within the larger ecosystem setting. This is a unique opportunity for land managers and researchers to have a significant input into how the concept of ecosystem management is implemented. Geographic information systems could become the primary tool for analyzing the complex and multifaceted ecosystem approach. The data requirements for ecosystem management are formidable. Projects should be undertaken now that begin the data collection and analysis process on a subregional scale to develop the tools necessary to tackle state and regional ecosystem analysis in the near future.

Improved utilization is the second requirement for resource sustainability. The wood-using industries cover a wide range of production technologies. The industries covered in this report range from the small, labor-intensive types such as pallet operations to large, capital-intensive panel mills (Table 2). They also range from relatively unprocessed materials such as green rough-sawn lumber to furniture. The trend in new investment has been toward increasingly more efficient resource utilization. A particleboard plant or an OSB plant has utilization rates as high as 80 percent. These enterprises use smaller diameter bolts, which require less labor to harvest than larger diameter trees. The output from these operations, in turn, largely goes to the most efficient manufacturers, such as the ready-to-assemble furniture companies.

This increased efficiency has important employment implications. The inevitable result of increased productivity is that these industries generate less employment per ton of resource and less income per unit of output than older or more labor-intensive technologies. The uncertainty of the sustainability of specific timber resources in certain regions of the state means that the impact of resource-intensive industries can be great. Resource availability/sustainability should be a key consideration in attracting and offering incentives for expan-

sion of wood products industries. With more emphasis placed on sustainable resource use and with a balanced mix of resource-intensive and labor-intensive industries, sustainable employment levels will follow.

Competitiveness

The continued competitiveness of Michigan forest products industries can be maintained if companies are flexible enough to adapt to changing technology and market conditions. Those companies that keep up with the pace of technological innovation mentioned earlier in this report will be able to continue to offer the reasonably priced, high quality products that consumers demand. Many Michigan companies have already made significant investments in improved technology and are leading the way in this effort. To assist the others, institutions such as Michigan State University must be committed to offering continuing training in state-of-the-art manufacturing techniques.

The other aspect of competitiveness is the ability to expand existing markets. Small businesses need assistance in developing market analyses and strategies to allow them to compete in national and international markets, where the greatest opportunities for expansion exist. As noted earlier, the technology exists for modest-sized firms to compete globally, but start-up assistance is often essential. Many organizations in the state, both public and private, offer marketing assistance. A coordinated effort within the state to increase access to these various services should be a top priority.

Appendix

Standard Industrial Classification

SIC Number	Description
24	**Lumber and Wood Products, except Furniture**
241	Logging
242	Sawmills and planing mills
2421	Sawmills and planing mills, general
2426	Hardwood dimension and flooring mills
2429	Special product sawmills not elsewhere classified
243	Millwork, veneer, plywood, and prefabricated structural wood members
2431	Millwork
2434	Wood kitchen cabinets
2435	Hardwood veneer and plywood
2436	Softwood veneer and plywood
2439	Structural wood members not elsewhere classified
244	Wooden containers
2441	Nailed and lock-corner wood boxes
2448	Wood pallets and skids
2449	Wood containers not elsewhere classified
245	Wood buildings and mobile homes
2451	Mobile homes
2452	Prefabricated wood buildings and components
249	Miscellaneous wood products
2491	Wood preserving
2493	Reconstituted wood products
2499	Wood products not elsewhere classified
25	**Household Furniture**
2511	Wood household furniture, except upholstered
2512	Wood household furniture, upholstered
2517	Wood television, radio, phonograph and sewing machine cabinets
252	Office furniture
2521	Wood office furniture
253	Public buildings and related furniture
254	Partitions, shelving, lockers and office and store fixtures
2541	Wood office and store fixtures, partitions, shelving and lockers
259	Miscellaneous furniture and fixtures

Glossary

Biodiversity. The diversity of life forms sharing a specific location.

Board foot. Common unit of measurement for lumber and sawlogs, represented by a hypothetical board 1 foot long, 1 foot wide and 1 inch thick.

Bolt. Short log, cut to a specific length for processing, as in pulpwood bolt.

Composition board. The full range of panels, including plywood, waferboard, strand board, flakeboard, particleboard, fiberboard, hardboard and insulation board; synonymous with panel board, reconstituted wood panels.

Dry kiln. Chamber used for seasoning lumber through control of air flow, temperature and relative humidity.

Ecosystem management. Concept of managing entire forest systems, or landscapes, with emphasis on diversity.

Fiberboard. Panel board made from fibers of wood or other lignocellulosic material; manufactured by an interfelting of the fibers and consolidated under heat and pressure in a hot press. Unlike particleboard, only a minimal amount of resin is used in production. Fiberboards are classified according to density and method of manufacture.

Hardboard. Fiberboard of 0.50 to 1.20 grams per cubic centimeter (31.5 to 75 pounds per cubic foot) density, to which other materials may have been added to improve board properties.

Medium density fiberboard (MDF). Dry-formed fiberboard compressed to about 0.50 to 0.80 gram per cubic centimeter density, normally using urea formaldehyde as a bonding agent; manufactured for use in furniture and similar applications.

Finger joint. System used to join two pieces of lumber stock or moulding endwise to extend the length. Matching "fingers" are sawn in each end and the pieces are fit together.

Flakeboard. Oriented strand board or waferboard.

Furnish. Blended particles, binders and additives ready for the panelboard forming process.

Hardwoods. Broad-leaved, deciduous trees and the wood derived from them. The term does not indicate the actual hardness of the wood.

Lumber. Product of a sawmill or planing mill. Types include:

Boards. Lumber nominally less than 2 inches thick and at least 2 inches wide.

Dimension. Solid or glued hardwood or softwood lumber pieces produced in specified sizes related to end use; e.g., furniture components.

Factory or shop lumber. Lumber intended for further manufacture.

Finish lumber. High or upper grade as opposed to common or lower grades.

Millwork. Surfaced and patterned lumber for finish work, including sashes, doors, cornices, panels, and other interior or exterior trim, but not flooring, ceiling or siding.

Rough lumber. Lumber that has been sawn, edged and trimmed but not surfaced.

Surfaced lumber. Lumber that has been dressed by processing it through a planer.

Moulding. Profiled strip of wood used as decorative trim in residences and other structures.

Oriented strand board (OSB). Structural panel product composed of wood flakes, oriented in layers at right angles to one another and bonded under heat and pressure; used for floor underlayment, roof decking and sidewall sheathing.

Pallet stock. Low grade lumber used to make pallets.

Panel. Sheet of plywood or panel board cut to a standard size.

Particleboard. Panels manufactured from wood particles bonded with resins and consolidated through heat and pressure. Lower grades are used for underlayment and mobile home decking; higher quality board is used in industrial application, principally as core stock for furniture and cabinets.

Plywood. Panel made of veneer layers glued tightly under heat and pressure, with the grains of adjoining layers at right angles to one another.

Primary manufacturing. Term generally applied to the manufacture of primary wood products; i.e., lumber, plywood and panel board.

Pulpwood. Stems, logs and bolts cut or sorted primarily for manufacture into pulp for the paper industry.

Sawlogs. Logs suitable in diameter, length and quality for the production of lumber.

SIC. Standard Industrial Classification. See Appendix.

Structural panels. 1. Term generally applied to the grouping of softwood plywood, waferboard, oriented waferboard and oriented strand board. 2. Panels designed for certain structural applications.

Stumpage. 1. Uncut commercial timber. 2. The value of timber as it stands uncut in the woods.

Veneer. Thin sheets of wood combined in layers to form plywood.

References

Armstrong, James P., Thomas G. Ponzurick and William G. Luppold. 1993. "A New Look at the Canadian Market for U.S. Hardwood Lumber." *Northern Journal of Applied Forestry* 10:3, 128-131.

Balatinecz, John J., and Raymond T. Woodhams. 1993. "Wood-Plastic Composites: Doing More with Less." *Journal of Forestry* 91(11):22-26.

Banzhaf & Company. November 10, 1992. *Survey of Hardwood Dimension Users in Twenty-three Northeastern States*. Prepared for the Michigan Department of Natural Resources, Lansing, Michigan.

Chappelle, D.E., S.E. Heinen, L.M. James, K.M. Kittleson and D.D. Olson. 1986. *Economic Impacts of Michigan Forest Industries: A Partially Survey-Based Input-Output Study*. Research Report 472. East Lansing, Mich.: Michigan State University Agricultural Experiment Station.

Chappelle, Daniel E., and Larry D. Pedersen. 1991. *Economic Contributions of Michigan Forests: Progress During the 1980's and Future Prospects*. Research Report 514. East Lansing, Mich.: Michigan State University Agricultural Experiment Station.

Davis, Donna K. February 1991. *An Overview of Michigan's Office Furniture Industry*. Lansing, Mich.: Michigan Department of Commerce.

Derning, Sean. February 1993. "Economy Still Top Concern of Contract Furniture Manufacturers." *Wood and Wood Products*. Lincolnshire, Ill.: Vance Publishing.

Dietzman, Debra. 1993. "Forest Products Research: Not Just Wood as Usual." *Journal of Forestry* 91(11):13-15.

Epperson, W.W. 1993. "The Furniture Industry." *Weekly Hardwood Review,* October 16-19, 1993.

Hackett, Ronald L., and John Pilon. 1993. *Michigan Timber Industry—An Assessment of Timber Product Output and Use, 1990*. Resource Bulletin NC-144. St. Paul, Minn.: USDA Forest Service North Central Forest Experiment Station.

Haynes, Richard W. 1990. *An Analysis of the Timber Situation in the United States: 1989-2040*. General Technical Report RM-199. Ft. Collins, Colo.: USDA Forest Service.

Haynes, Richard W., Darius M. Adams and John R. Mills. May 7,1993. *The 1993 RPA Timber Assessment Update* (draft).

Lawser, Steven V. 1993. "Hardwood Dimension." *Weekly Hardwood Review,* October 16-19, 1993.

Mathews, Dan. 1993. "Dry Kiln Outlook." *Weekly Hardwood Review,* October 16-19, 1993.

Michigan Employment Security Commission. 1993. *Michigan Employment Data for Wood Products Sectors*. Lansing, Michigan.

Michigan Jobs Commission. July 1993. *Customer Assistance and Research Services, Michigan's Office Furniture Industry*. Lansing, Michigan.

MISER (Massachusetts Institute for Social and Economic Research. 1994. *State of Origin of Exports*. Amherst, Mass.: University of Massachusetts.

Moslemi, A.A. 1993. "Inorganic-bonded Wood Composites: From Sludge to Siding." *Journal of Forestry* 91(11):27-29.

Nelson, Charles M. 1994. (Unpublished survey of recreational use). East Lansing, MI: Michigan State University, Department of Park and Recreation Resources.

PHH Fantus Consulting. December 1993. *Report to Michigan Jobs Commission: Michigan Business Climate and Development Program Bench Marking Analysis*. Lansing, Michigan.

Stier, Jeffrey C. April 4, 1990. "Lake States Forest Product Industry Trends and Regional Wood Flows." *Wood-Based Economic Development in the Lake States: Proceedings of a Symposium on Specific Forest Products Opportunities*. St. Paul, Minnesota.

Sullivan, John P. May 19, 1994. "Overview of the United States Furniture Industry"—presentation given at Forest Products Society, Great Lakes Chapter, Spring Seminar, McBain, Michigan.

U.S. Department of Agriculture, Forest Service. Various years. *Veneer Industry and Timber Use, North Central Region*. Resource Bulletins. North Central Forest Experiment Station.

U.S. Department of Commerce, Bureau of the Census. 1992. *Annual Survey of Manufactures, 1991*.

U.S. Department of Commerce, Bureau of the Census. Various years. *Census of Manufactures, 1977, 1982, 1987*.

U.S. Department of Commerce, International Trade Administration. 1994. *U.S. Industrial Outlook – 1994*.

U.S. Department of Commerce. February 1994. *Survey of Current Business*.

Weekly Hardwood Review. October 1, 1993. Editorial.

Weekly Hardwood Review. Various issues.

Wood and Wood Products. May 1993. Editorial. Lincolnshire, Ill.: Vance Publishing.

New–1:95–.75M–TCM–CW

printed on recycled paper using soy based ink