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GREAT LAKES SHIPPING, TRANSPORTATION AND MARKETS FOR MICHIGAN'S FOREST PRODUCTS: A PRELIMINARY ECONOMIC INQUIRY

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Cover photo courtesy of Dr. Otto Suchsland, Department of Forestry, Michigan State University.

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SUMMARY

Markets for Michigan's Forest Products

The most important markets for Michigan forest products are located within Michigan. Most of the primary forest products firms are located near their source of supply. Forty-nine percent of Michigan's wood-using facilities are in the northern Lower Peninsula, thirty-one percent are in the southern Lower Peninsula, and twenty percent are in the Upper Peninsula. Pulpwood is the major wood used, followed by sawlogs and veneer logs. Wisconsin is the major market for Michigan forest products outside Michigan.

Significant potential exists for increased demand for Michigan forest products in domestic markets. This has been demonstrated by the growth in timber industries located in Michigan and other Great Lakes states. This growth has been aided by both lower timber prices resulting from low utilization rates, and the scarcity of softwood fiber in world markets. Michigan is more dependent on demand for forest products in the pulp and paper industries than in the construction, manufacturing and shipping industries. Demand for forest products in the pulp and paper industry has been less affected by the depressed condition of the economy, so demand for Michigan forest products in the pulp and paper industry should remain strong.

The use of wood chips is increasing at pulp mills. Wood for fuel has also increased in homes and industry. Wisconsin has been cited as a potential market for growth especially for pulpwood. Increasing demands on existing supplies could force users to go further for future wood supplies.

Almost ninety percent of the exports from the Great Lakes region go to Canada, mostly by rail or truck. Overseas traffic is generally insignificant and irregular. Forest products which are exported overseas are usually shipped by rail to Atlantic Coast ports. Poor conditions in foreign economies were cited as one reason for low potential in these markets. Also, domestic demands are large enough to attract most of Michigan's forest products. However, the National Forest Products Association projects that U.S. exports will double between 1975 and 2000 due to an improved competitive position of U.S. forest products firms. This position is projected to result from the large domestic inventory, an efficient infrastructure for reaching foreign markets, and increasing costs of production and transportation for foreign suppliers.

There are forty-nine active commercial ports and harbors in Michigan. Shipments through the ports are increasingly in the form of bulk commodities. Forest product shipments plus lumber and wood products are only .3 percent of the total Michigan waterborne commerce. Most forest products are transported by truck, and there are also some shipped by rail. Many ports are located near forest products firms. There is a large concentration of firms near Menominee, Escanaba, and Gladstone on Lake Michigan. Another large concentration is located near Alpena on Lake Huron. Many of the other forest product firms are located near Michigan ports.

Economic Analysis of Forest Products Shipments by Water

The economic analysis compared the costs of shipping wood chips, timber, and lumber by truck and by four different barges. For wood chips, the distance at which barge transport was less expensive than shipping by truck varied between 85 and 225 miles, depending on the transhipment distance to or from the port. If the transhipment distance is 25 miles, then water shipments cost less than truck transport at distances greater than 85 miles. If the distance required to bring forest products to port is as great as 100 miles, land transportation is less expensive for hauls less than 225 miles.

The results indicated that transhipment costs were the most significant factor affecting the economics of water transport. For a barge shipment of 100 miles with a 25-mile transhipment, more

than 75 percent of all costs were related to the transhipment. Even for barge movements of 300 miles, the cost of a 25-mile transhipment was greater than the cost of water transport.

The cost of shipping timber by barge is slightly less than wood chips, relative to truck costs. The barge that had the lowest cost of those tested was less expensive than truck transport at shipment distances greater than 60 miles, assuming a 25-mile transhipment and excluding port costs. The economics of transporting lumber by barge also was quite favorable, but the analysis looked at a self-unloading vessel that was specifically designed for lumber shipments on the West Coast.

A critical factor that will affect the economics of barge shipments are the costs associated with delays due to weather. The smaller of the barges studied must remain in port if wave heights exceed five or six feet. If there were no delays, this barge could ship wood chips for less cost than a truck at distances greater than 130 miles, assuming a 50-mile transhipment. If there was a 24-hour delay, the barge would only be less expensive at distances greater than 290 miles. The larger barges studied would not be as likely to encounter delays.

Another potentially critical factor is the port cost associated with loading and unloading forest products from a barge. Costs as high as ten dollars per ton have been quoted, and would have a significant impact on the relative economics of water transportation. Due to the high variability of these costs between ports and the different forest products, they were not specifically considered in the analysis.

The analysis compared the cost of shipping forest products from a distant source where product prices were lower, as opposed to buying them from a closer source where they were more expensive and transported by truck. The analysis showed that it was less expensive to barge wood chips from northern Michigan to Green Bay than to transport them by truck from a source 85 miles away. However, this advantage was only possible if the cost of chips per ton at source in Michigan was three dollars less than in the 85 mile range comparison. Also, a cost saving was predicted for shipments of firewood brought in by barge from Alpena to Detroit.

MARKET ANALYSIS FOR MICHIGAN FOREST PRODUCTS

Introduction

The authors obtained information on markets for Michigan forest products to provide a context for the economic analysis. The authors were interested in primary forest products, excluding products such as paper and furniture. However, paper mills and furniture manufacturers may be considered markets for the products of concern in this analysis. Products such as pulpwood logs and wood chips were used in the analysis of transportation costs.

Unfortunately, there is no single source of data on markets for Michigan forest products. Data generally does not exist for specific markets, origins, destinations, prices, etc., for Michigan forest products. Therefore, it was necessary to obtain market information through conversations with people working in a variety of forest industries, forestry experts employed by state and federal agencies, port operators, and transportation companies, and a review of current literature. A detailed market study was not within the scope of this analysis. To do that would require a detailed survey of forest product producers, transporters, and users. The Michigan Department of Transportation will soon publish results of a detailed survey of commodity movements from the Upper Peninsula. These results should be helpful in further evaluating the markets for forest products and the economics of transporting forest products.

The following pages present some basic data on domestic and foreign markets obtained from the literature, and the results of the telephone contacts. A brief section discussing the role of the ports is also included.

Domestic Markets

The most important markets for Michigan forest products are located within the state. In general, these primary forest products industries are located near the major sources of wood, the northern Lower Peninsula, and the Upper Peninsula. Most of the timber cut in Michigan is destined for these in-state mills with a large portion of the remainder going to Wisconsin mills. Some of the mills are located near water and, therefore, offer some opportunity for water transportation.

The strength of the domestic markets for Michigan forest products is highly dependent on the general level of economic activity in Michigan and throughout the United States. Demand for raw timber is primarily tied to the demand for pulpwood and hardwood sawlogs. The Michigan Department of Natural Resources has made an assessment of Michigan's forest resources and their ability to meet future demands from the state and national economies.[1] This assessment assumes that demands for forest products will continue to increase and concludes that Michigan's large forest resource base provides the opportunity to meet these demands and to provide economic development in Michigan.

Changing demands for primary forest products could influence the potential for water transportation, especially if the relationship between the locations of the suppliers and users is altered. For example, if demand increases, this could increase the amount of wood available for bulk movements of forest products. Large quantities might also help assure barge or ship operators of long-term service requirements. Also, a user may want to change his source of supply to areas which are more amenable to water transportation. Therefore, market size and location should both be evaluated when analyzing the feasibility of water transportation.

Domestic Market Location

The Michigan forest resource assessment[2] of 1979 outlines the major domestic markets. In 1972 about 78 percent of industrial timber production remained in-state, while 22 percent went to other states. Most of the primary forest products firms which use this timber are located near their source of supply. This industry is concentrated in the northern half of the Lower Peninsula where 49 percent of the total number of facilities is located. The Upper Peninsula has 20 percent of the facilities, while the southern half of the Lower Peninsula has 31 percent of the total facilities. Table 1 shows the number of primary wood-using plants in Michigan in 1977. Most of the timber in the state goes to these firms.

Pulpwood is the major use for Michigan timber, followed by sawlogs and veneer logs. Other primary products made from Michigan timber include such products as posts, piling, poles, and mine timbers. Table 2 lists 1975 production data for these products.

Between 1972 and 1976, Michigan sent an average of 30 percent of pulpwood production to other states. Wisconsin was the major user outside Michigan. In 1976, 16 percent of Wisconsin's pulpwood came from Michigan. Tables 3 and 4 show the market destinations for Michigan pulpwood and sawlogs. Table 5 lists the destinations of timber to other miscellaneous users.[3] In 1976, veneer production was 3.6 million cubic feet and 45 percent was delivered out-of-state, mostly to Wisconsin.

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[1]State of Michigan, Department of Natural Resources, Michigan's Forest Resources 1979 An Assessment, 1979.

[2]The data throughout this section on Domestic Market Location is all taken from the State of Michigan report: Michigan's Forest Resources 1979 An Assessment, 1979.

[3]Blyth, E., A.H. Boelter, and C.W. Danielson, "Primary Forest Products Industry and Timber Use, 1972," Forest Service Resource Bulletin, U.S.D.A., NC-24, 1975.

TABLE 1.

Number of Primary Wood-Using Plants in Michigan - 1977

Plant Type	
Saw Mills	
More than 5 million bd. ft.	10
1-5 million bd. ft.	74
Less than 1 million bd. ft.	225
Total	309
Veneer Mills	9
Pulp Mills	8
Miscellaneous(1)	36
Charcoal	1
State Total	363

(1)Includes shingle mills, log cabin plants, particle plants, treating plants, fence plants, and chip plants. Source: State of Michigan, Department of Natural Resources, Michigan Forest Resource 1979 An Assessment, 1979.

TABLE 2

Industrial Roundwood Production in Michigan - 1975
(in million cubic feet)

	Softwood	Hardwood	All Species
Pulpwood	32.3	54.4	86.7
Sawlogs	7.6	46.4	54.0
Veneer logs	(1)	3.6	3.6
Other products	3.7	.9	4.6
Totals	43.6	105.3	148.6

(1)Less than 50 thousand cubic feet. Source: State of Michigan, Department of Natural Resources, Michigan's Forest Resources 1979 An Assessment, 1979.

TABLE 3

Michigan Pulpwood Production and Destination - 1976
(Thousand Standard Cords, Roughwood Basis)

	Quantity	Percent of Total Cut
Michigan	1,081	70
Wisconsin	434	28
Other	26	2
Total Cut	1,541	100

Source: State of Michigan, Department of Natural Resources, Michigan Forest Resources 1979 An Assessment, 1979.

TABLE 4

Sawlog Production by Region and State of Destination - 1972
(in thousand board feet, international 1/4-inch rule)

Region	Michigan	Wisconsin	Indiana	Other	Total
Upper Peninsula	190,744	24,502			215,246
Northern Lower Peninsula	133,955				133,955
Southern Lower Peninsula	102,263		2,884	83	105,230
Total	426,962	24,502	2,884	83	454,431

Source: State of Michigan, Department of Natural Resources, Michigan's Forest Resources 1979 An Assessment, 1979.

TABLE 5

Other Markets for Michigan Timber - 1972

Industry	Industry Concentration	Quantity of Final Product
Piling	northern Lower Peninsula	83,000 linear feet
Cabin log	eastern Upper Peninsula and northern Lower Peninsula	414,000 board feet
Post	south central and eastern Upper Peninsula northeastern Lower Peninsula	2,962 million pieces
Pole	eastern Upper Peninsula and northern Lower Peninsula	53,903 units
Particleboard	northern Lower Peninsula	(not available)

Source: State of Michigan, Department of Natural Resources, Michigan's Forest Resources 1979 An Assessment, 1979. Data originally supplied by the U.S. Forest Service in "Primary Forest Products Industry and Timber Use 1972," Forest Service Resource Bulletin, U.S.D.A., NC-24, 1975.

Potential Domestic Market Demand

The State of Michigan has taken timber production and use data and used it to project the future demand for Michigan forest products. Based on these projections and the forest resource potential in the state, it has been concluded that there is a great opportunity to expand the Michigan forest products industry. Some of these projections and assumptions about future demand are discussed below. If these projections hold true, then the demand for transportation services could increase and this could result in increased opportunities for water transportation.

A draft recommended program for Michigan's forest resources, by the Michigan Department of Natural Resources was published in February, 1981.[4] That report cites the expansion of timber industries in Michigan and other Lake States as a sign of an increasingly favorable competitive position. The low utilization rate of Lake States timber is resulting in lower timber prices, and scarcity of softwood fiber in world markets is creating an opportunity for Michigan forest industries.[5]

As part of the recommended program, the state set targets for the year 2000 for national, state, industrial private, and non-industrial forest lands. This timber will all have to be transported to a primary wood-using industry. Pulpwood harvests will increase the most, from 101.8 million cubic feet to 420.4 million cubic feet, between 1977 and 2000. That would be a 313 percent increase. The target for the saw timber harvest over the same period is an increase from 99.1 million cubic feet to 195.8 million cubic feet, nearly a 98 percent increase.[6]

[4]State of Michigan, Department of Natural Resources, Michigan's Forest Resources - A Recommended Program, Draft, February 1981.

[5]State of Michigan, Ibid., February 1981, p. 10.

[6]State of Michigan, Ibid., February 1981, p. 42.

The domestic demand for forest products is influenced by the level of activity in industries which use forest products. Industries which strongly influence demand for forest products include pulp and paper, housing, new industrial construction manufacturing, and shipping.

The Michigan forest products industry is more dependent on the pulp and paper industry than on the construction, manufacturing, and shipping industries. Michigan grows large quantities of aspen for pulpwood. Demand for paper products has continued to increase despite the general low condition of the economy. Therefore, demand for Michigan pulpwood should remain strong.[7]

The U.S. Forest Service has projected industrial roundwood demands based on the activities in these industries, population growth, income, and wood products prices relative to the general price level.[8] The projections are not specific to Michigan but they do indicate the level of demand which might be expected in some of the domestic markets for Michigan timber.

In general, demand will grow substantially for the industrial roundwood products which include pulpwood, sawlogs, veneer logs, poles, piling, and posts. Table 6 shows the roundwood demands on U.S. forests after subtracting imports from total demand. If the markets for Michigan roundwood reflect these increases in national wood use, then demand for Michigan timber would increase by 45 percent between 1976 and 1990, and by 64 percent between 1976 and 2000.

[7]Tear, Jacqueline, "Increasing demand for paper holds promise for Michigan," The Ann Arbor News, Sunday, December 20, 1981, p. E-6.

[8]The following data are from: Stone, Robert N. and Robert B. Phelps, "Prospective U.S. Wood Use Situation," Forest Products Journal, Vol. 30, No. 10, October 1980.

TABLE 6

U.S. Roundwood Demands in 1976 and Projections to 2030

Year	Quantity (billion feet)	Percent Increase From 1976
1976	12.1	—
1990	17.5	45
2000	19.8	64
2010	12.2	83
2020	23.8	97
2030	25.1	107

Source: Stone, Robert N. and Robert B. Phelps. "Prospective U.S. Wood Use Situation." Forest Products Journal, Vol. 30, No. 10, October, 1980.

The growth in demand for some Michigan timber will be related to the demand for primary forest products such as lumber, plywood, particle board, and paperboard. The Forest Service projections for national forest products show that timber consumption is expected to rise from 47 billion board feet in 1977 to 56 billion board feet in 1990, or by 19 percent. This growth will result from an increase in the demands for housing and pallets. Demands for lumber will grow more slowly between 1990 and 2030 due to a decline in softwood lumber use.

Demands for plywood, waferboard, particle board, fiberboard, and structural composite panels should increase from 22 billion square feet (3/8-in. basis) in 1977 to 29 billion in 1990, then up to 34 billion in 2030. These are increases of 32 percent from 1977 and 55 percent over the entire period.

Forest Service projections for board, which includes particle board, show an increase from 14 billion square feet (3/8-in. basis) in 1977 to 37 billion in 2030, for an increase from 78 million cords in 1977 to 109 million cords in 1990, then up to 178 million cords in 2030. These are increases of 40 percent between 1977 and 1990, and 128 percent between 1977 and 2000. Even though pulpwood demands will continue to increase, the annual rate of increase in pulpwood demand may decline because domestic paper and paperboard consumption is strongly related to population size.

Other products produced from roundwood such as poles, piles, and posts are not expected to experience much of an increase over current levels of demand. However, fuelwood use for the production of industrial and residential heat is expected to increase dramatically between 1976 and 2030. Residential wood use for fuel was 6 million cords in 1976 and is projected to be 26 million cords by 2030. This would be an increase of more than 333 percent.

These figures illustrate some of the national trends in forest products demands which will affect demands for Michigan forest products. During the analysis of water transportation of forest products, these general trends were cited by many of the contacts who believe that the market for Michigan forest products shows great potential. If factors such as large available supply and lower relative prices are considered, then the growth in demand for Michigan's forest resources might outpace national trends. The following section outlines some of the trends as they affect the demand for Michigan forest products.

Other Trends Affecting Domestic Demand

The increasing use of wood for energy was mentioned as a major development affecting demand for Michigan timber. The Draft Recommended Program of managing Michigan's forests recognizes that wood use for fuel in Michigan markets may increase dramatically.[9] This would be consistent with the U.S. Forest Service projections. The Recommended Program report states that 18 percent of the 3.2 million homes in Michigan are heated at least partially with wood, and that domestic wood fuel use in Michigan is estimated at 3.5 million cords per year. Unfortunately, accurate market information such as quantities, market location, species used, prices, and sources is limited.

Michigan industries also use wood for fuel, and telephone contacts suggested that this type of use will also increase. Many forest products firms already use wood for energy in their plants. Other industries are also reportedly looking at the feasibility of

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[9]State of Michigan, op. cit., February 1981, p. 16.

installing wood fired boilers. Dow Corning Corporation in Midland is building a $30 million power plant fired by wood. The plant will use 180,000 dry tons/year of wood. Most of the wood will be logs and chips, while 35 percent of the supply will come from sawmill trimmings currently landfilled.

Forest residues could play a significant role as an energy source. Michigan's sawmills produce 748,000 tons of residue per year. Of this residue, 48,000 tons are already used for fuel in sawmills, while 461,000 tons are sold. The remaining 239,000 tons are sold or unused and incinerated as waste or dumped. The Recommended Program draft report states that additional demands from homes, industries, and institutions could shortly increase the quantity of wood used for fuel to 3.9 million cords per year.

Another possible trend is an increase in the use of wood chips for making pulp at pulp and paper mills. By using chips instead of logs, the mills can lower on-site handling costs. Chips can be handled by cranes with buckets, pneumatic blowers or conveyors. One mill commented that it would be desirable to increase the use of wood chips from its current 30 percent to 100 percent because the handling costs would be much lower. Wood chips can be handled relatively inexpensively when unloaded from bulk cargo vessels such as barges and ships with front-end loaders, pneumatic blowers, conveyors, or buckets on cranes. The ability of water transportation to contribute to the efficiencies of chip handling could increase the interest in transporting this particular forest product by water.

One forest products firm suggests that the Wisconsin pulpwood market is a domestic market which has potential for Michigan forest products. Michigan already ships nearly 30 percent of its total pulpwood to Wisconsin. Michigan supplies 16 percent of Wisconsin's pulpwood. Wisconsin is also currently experiencing a pulpwood shortage. More than 60 percent of the Wisconsin pulp and paper industry's softwood is coming from other states and Canada. Problems with transportation costs, dependence on outside sources, and cutting constraints for western pulpwood supplies threaten to decrease the availability and increase the price of timber products needed in Wisconsin. As a result, Wisconsin may show some opportunity as an expanding market for Michigan products. Also, its location relative to Upper and Lower Michigan forests and Lakes Superior and Michigan could increase the potential for water transportation.

Another issue was mentioned by some of the contacts which might have some effect on the potential for water transportation of forest products. The increased use of forest resources (timber and non-timber uses) in Michigan may force primary forest product firms to obtain wood supplies from more distant sources. Since water transportation becomes more competitive with alternative modes as distances increase, this market trend could also favor the increased use of water transportation of forest products. Michigan currently has an ample timber inventory to allow for further expansion. However, developments such as the Mead plant in Escanaba, the new Champion plant in Quinnesec, the new Weyerhauser plant in Grayling, and the increase in wood use for energy were cited as a signal that competing demands on the forests could force some users to go further for their wood supply.

Increased water transportation could result from an increase in demand for Michigan forest products. Increased demand could result from an increase in the national demand for wood products, construction of new wood-using facilities, and the need to go further distances for wood supplies. Export markets could also provide opportunities for water transportation of Michigan forest products. These export markets are discussed in the next section.

Export Markets

Most of the exports from the Great Lakes region go to Canada and are usually shipped by rail or truck. The economics of water transportation to Canadian markets would be similar to the economics of water transportation to domestic markets. The overseas exports are usually shipped by rail to Atlantic Coast ports such as Montreal, New York, and Baltimore. Some forest products have also been shipped by rail to the West Coast, then by ship to Japan.

In general, the telephone contacts during this study revealed that current exports of the forest products from Michigan to overseas destinations are significant. No one contacted could identify any significant, and regular, export activities. There are some export activities, but they seem to be isolated examples rather than large volumes of widespread trade.

There are several firms contacted who shipped forest products in the Great Lakes from Michigan, or nearby, to overseas destinations. During 1980, 9,000 tons of hardwood logs were shipped to Northern Europe through the Port of Toledo. The hardwood shipments through Toledo were expected to be lower in 1981 due to lower demands in Europe. High quality veneers have also been sent from the Upper Peninsula to overseas markets. However, these veneer shipments are irregular and the contact who mentioned this export did not have specific information on destination or transportation costs. These types of products, higher value hardwoods and veneers, may have the best potential for export since the transportation costs would be a lower proportion of the delivered price.

Another contact mentioned that there is some potential to ship pulpwood by Great Lakes vessel to Scandinavia. One Michigan firm said that they recently exported railroad ties through the Great Lakes to the Mediterranean on a foreign flag vessel and hope to make a similar shipment to Europe during 1982. This same firm evaluated shipping wood chips to foreign destinations via the Lakes, but draft restrictions and the light weight of the cargo made it technically difficult. They mentioned that waferboard may have the highest potential for exporting through the Great Lakes because of its increased use in foreign markets.

One of the Great Lakes ports said that they evaluated the feasibility of shipping birch or aspen overseas through their port but they could not compete with the Eastern Canadian ports. These Canadian ports receive wood by rail, then load it on a ship. This contact mentioned hearing of other potential shipments through the Lakes, but they had no data on the strength of those markets. These shipments included wood chips to Scandinavia, railroad ties from Wisconsin to Egypt, match splints to Egypt, flakeboard from the western end of the Lakes, and lumber from the western states through the Lakes to the Mediterranean.

Most of the contacts that do export forest products ship them in containers by rail to East Coast ports loading them on a vessel for overseas destinations. One firm has experience sending lumber, veneer, and logs to Japan and Taiwan. This is also common for paper produced from Michigan timber. A regular container service has also taken forest products to Montreal where they are loaded on vessels bound for Antwerp and Rotterdam. Some veneer has also been sent by rail to the West Coast where it is loaded on ships bound for Japan. Trucks have normally been used to get the forest products to the rail terminals.

Resources for the Future in Washington, D.C., has collected data from the Department of Commerce and the Maritime Administration on foreign trade in forest products.[10] Data is presented for the Great Lakes region which includes Michigan, Ohio, Kentucky, Indiana, Illinois, Wisconsin, Minnesota, Missouri, Kansas, Nebraska, and Iowa. Exports between 1967 and 1976 are listed for a variety of forest products.

In 1976, the Great Lakes region accounted for 11 percent ($426.7 million) of all U.S. forest product exports, which ranks close to the North Atlantic, South

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[10]Sedjo, Roger A. and Samuel J. Radcliffe, Postwar Trends in U.S. Forest Products Trade A Global, National, and Regional View, prepared for Resources for the Future, Inc., Washington, D.C., Research Paper R-22, 1980.

Atlantic, and Gulf regions.[11] More than 90 percent of these exports were to Canada. Solid wood products accounted for 38 percent of the exports from the region. These products include: softwood lumber ($68.1 million); hardwood lumber ($45.9 million); plywood ($24.5 million); hardwood logs ($14 million); and pulpwood except chips ($6.3 million). The remainder of the exports include paper, paperboard, wood pulp, building board, and newsprint.

Table 7 shows 1976 export statistics for the Great Lakes states to Canada and non-North American destinations. Only 11.5 percent of the solid wood products went to non-North American destinations, and most of these were hardwood logs and hardwood lumber. Other than these hardwood products exports from the region to non-North American destinations were fairly insignificant.

Table 7

Great Lakes Region's Exports to Canada and Non-North American Destinations - 1976

Solid Wood Products
(Value in Millions of 1980 Dollars; Board-feet and Square-feet in Millions)

Product (Units)	Exports to Canada		Non-North American Exports		Total Exports		Non-North American Exports-% of Total	
	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity
Softwood Lumber (board-feet)	67.861	226.532	.460	1.005	68.142	227.537	.7	.4
Softwood Logs (board-feet)	2.130	10.085	0	0	2.130	10.085	0	0
Hardwood Lumber (board-feet)	36.101	117.770	9.821	15.965	45.923	133.744	21.4	11.9
Hardwood Logs (board-feet)	4.689	16.875	9.335	9.355	14.011	26.231	66.7	36.4
Pulpwood Exc. Chips (1000 cords)	6.310	152.630	0	0	6.310	152.630	0	0
Pulpwood Chips (1000 STW)	1.468	31.374	0	0	1.468	31.374	0	0
Plywood (square feet)	24.537	121.632	0	0	24.537	121.632	0	0
Wood Veneer (square feet)	5.518	94.272	.292	.672	5.810	94.944	5.0	.7
Reconstituted Wood (square feet)	4.516	21.010	0	0	4.516	21.010	0	0
Total	152.95	—	19.908	—	172.847	—	11.5	—

* STW is Standard Wet Tons

Source: Sedjo, Roger A. and Samuel J. Radcliffe, Postwar Trends in U.S. Forest Products Trade A Global, National, and Regional View, Prepared for Resources for the Future, Inc., Washington, D.C., Research Paper R-22, 1980.

[11] Sedjo, Ibid., 1980, pp. 478-503.

Potential for Exporting Michigan Forest Products

In general, opinions are mixed about the potential for exporting Michigan forest products on the Great Lakes. Competition with the Canadian Maritime's ports, and ports of New York and Baltimore, and the associated rail and container services seems stiff. The additional cost and technical difficulties of shipping through the locks, and the limited shipping season were all mentioned as possible constraints to shipping in the Lakes. Despite these problems, the relative competitiveness of Great Lakes shipping was unclear to many of the contacts. Some did not know the actual transport costs on the Lakes because the foreign buyer paid the charges, and because they had little experience with shipping forest products on the Lakes. Others mentioned that increasing rail rates would make exporting forest products through the Lakes more competitive.

Opinions are also mixed about the potential demand for forest products in foreign markets. The primary reason given for low export potential is the condition of the economies in foreign countries. One contact noted that demands for hardwood in Europe are down 50 to 75 percent below last year's levels. Another reason given for low potential export activity is that domestic markets have been strong enough to use domestic production. So it has been, and will be, unnecessary to export forest products.

On the other hand, other analysts suggest a higher potential for forest products exports. The National Forest Products Association (NFPA) has published a report which concludes that the export of U.S. forest products has great potential.[12] They base this finding on statistics which show that world wood markets will nearly double between 1975 and 2000, and that

[12] National Forest Products Association, Increased Wood Products Exports: A Bonus for the Industry and Nation, Washington, D.C., Fall 1981.

the U.S. share of world wood trade has increased from 13 percent to 17 percent in the last ten years. The favorable competitive position of the U.S. is another reason for optimism. The U.S. has the third largest timber inventory in the world, after Russia and Canada. However, the high level of productivity in U.S. forests results in annual forest growth rates close to Russia's and much greater than Canada's. The U.S. is also the world's largest wood products producer and has the infra-structure to support export markets. Also, both Russia and Canada are experiencing increasing costs since they must go further into their forest lands to cut timber.[13]

The current lack of forest products exports from Michigan, and the mixed information about the potential for increasing exports throws doubt over the possibility of increasing water transportation of forest products to foreign markets. However, there may be some potential for specific products, such as hardwoods. Also, if foreign markets expand as the NFPA projects, there may be great potential. In this case, the export potential of Michigan's forest products would depend on the economics of shipping to foreign markets, which is discussed in a later section.

Role of Michigan Ports

The authors contacted several Great Lakes ports to obtain information on markets for forest products and quantities moving through the ports. Another objective was to identify how the role of the ports affect water transportation of forest products. An important source of information was the Michigan Port Needs Study, published in August 1981 by the Bureau of Transportation Planning within the Michigan Department of Commerce.[14]

This study reports that there are 49 active commercial ports and harbors in Michigan, and 14 of them account for 93 percent of the annual waterborne commerce. This commerce has increasingly become bulk commodities and the overall level of exports has decreased. The increased use of large vessels for export is resulting in a concentration of export shipments through Atlantic and Gulf ports. Future tonnage increases will continue to be mainly bulk cargo, especially coal.[15]

Forest products shipments and related commodities are generally insignificant relative to shipments of other commodities. In 1978, forest products shipments were 2,087 tons, or less than .1 percent of total Michigan shipments. Lumber and wood products shipments were 182,863 tons, or .2 percent of the total, while pulp, paper, and allied products shipments were 421,335 tons, or less than .4 percent of the total.[16]

The telephone contacts made by the authors generally confirmed these figures which show the relative insignificance of forest shipments. Several reasons were given for this. One reason is the trend toward larger ships for exports which attracts traffic toward the Atlantic and gulf coasts. Another is the extensive use of truck and rail for domestic shipments.

Competition with other modes is significantly influenced by handling costs and proximity of the ports to the sources of timber supplies and to the users. The shipper has to consider transhipment costs to the port for transferral of cargo from truck or rail to the Lakes vessel, plus the transport costs to the user. High labor costs and expensive capital equipment such as cranes contribute to high handling costs. In some cases the use of conveyors and pneumatic tubes can lower the transhipment time, but they add to capital costs. A company which has access to water but has not developed docking facilities to receive

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[13]National Forest Products Association, Ibid., 1981, Executive Summary.

[14]State of Michigan, Michigan Department of Transportation, Bureau of Transportation Planning, Michigan Port Needs Study, August 1981.

[15]State of Michigan, Ibid., 1981, p. 1.

[16]State of Michigan, Ibid., 1981, p. II-9.

shipments could also incur large capital costs. Technical aspects of the port such as channel depth and width could also be a problem in some cases, depending on the type of vessel used. A shallow barge would not have much problem in most cases.

Figures 1 and 2 are presented to illustrate the relationship between Michigan ports and Michigan primary wood using companies. Note the large concentration of companies near the ports at Menominee, Escanaba, and Gladstone. The Mead Corporation pulp and paper mill is located in Escanaba, the Menominee Paper Company in Menominee. The large number of facilities clustered here illustrates some of the accessibility to water transportation.

The cluster of firms in the northeastern Lower Peninsula is not as close to commercial ports as the firms in the Escanaba area. However, they are still within a short distance of Alpena, Port Gypsum, Alabaster, and Saginaw. Other examples of large mills located near ports include: S.D. Warren, Muskegon; Abitibi-Price, Alpena; Packaging Corporation of America, near Manistee; and Hoerner Waldorf Corporation, Ontonagon.

The ports in Figure 2 have been placed in five functional categories defined below:

1. Overseas Ports - waterborne movements include imports and exports.
2. Great Lakes - St. Lawrence Seaway Ports - commercial activity includes inter-lake shipments and shipments to St. Lawrence River ports.
3. Single Purpose Ports (deep draft) - serving single purpose shipments on vessels with at least an 18-foot draft.
4. Local Service Ports - provide only local ferry service.
5. Occasional/Potential Ports - receive commercial cargoes but not on a regular basis.[17]

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[17]State of Michigan, Ibid., 1981, p. III-15.

Some of the examples used in the economic analysis are based on the type of shipments which could occur between these ports and pulp and paper mills, as well as other wood-using industries. Any analysis of increasing forest products shipments through the ports should consider both the economics of water transportation and the technical characteristics of the ports.

ECONOMIC ANALYSIS OF WATER TRANSPORT OF FOREST PRODUCTS

This section will present the results of an economic analysis of the transportation of forest products by water. This analysis is principally directed at primary forest products such as timber, wood chips, and lumber since the greatest economic advantage of water transportation is usually for bulk commodities. Water transport of pulp was not considered because paper mills in Michigan rely on pulpwood and wood chips.

Methodology

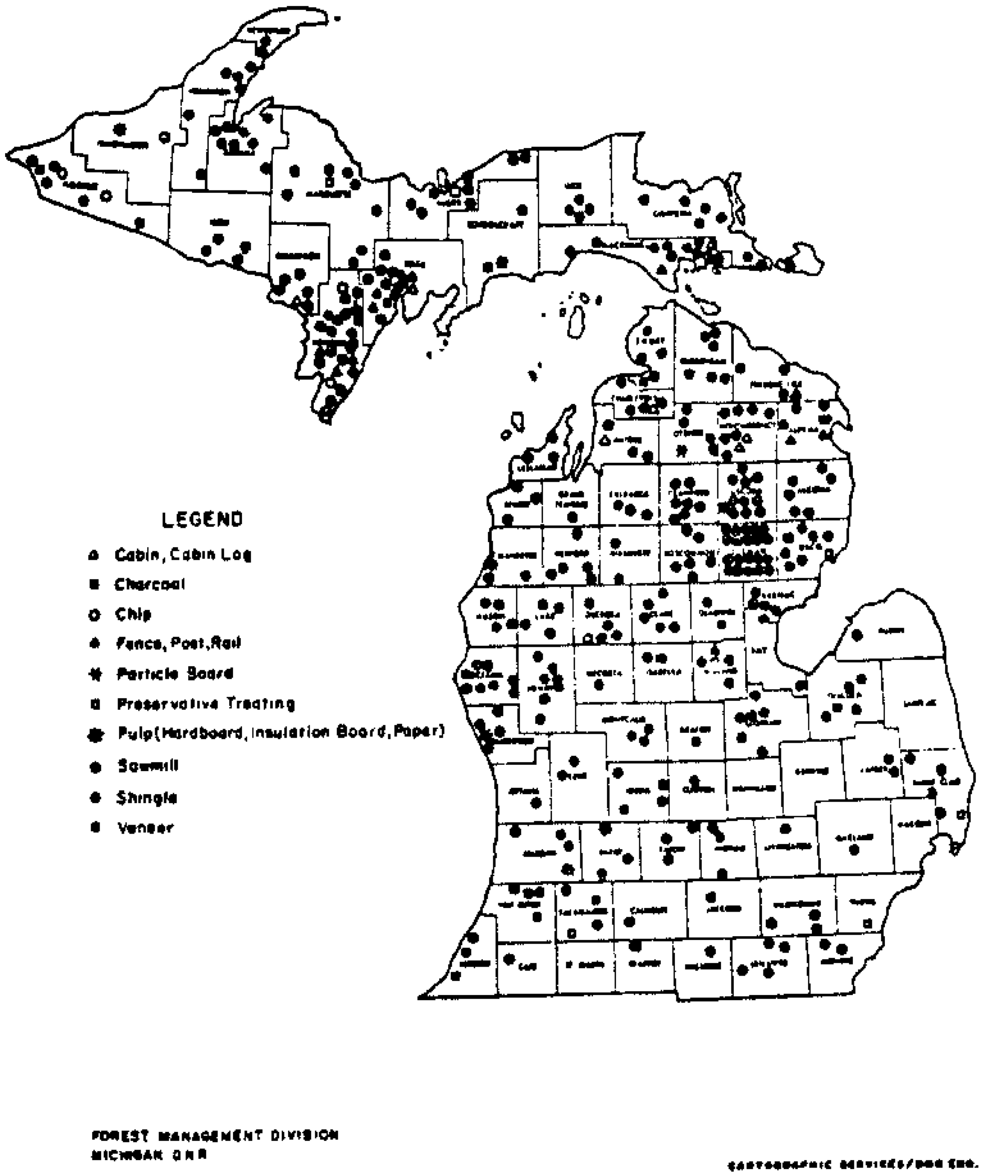
There is currently very little movement of forest products by water on the Great Lakes within the Lakes or for export through the St. Lawrence Seaway. Therefore, there is no published data on rates or costs on which to base the analysis. Further complicating the data problem is the fact that most of the potential shippers that were contacted could not estimate the cost of moving forest products by water since they had no experience with such shipments.

One region that does have a substantial amount of experience with water shipment of forest products is the Pacific Northwest, including British Columbia, Washington, and Oregon. Shipping companies own barges of all sizes specifically designed for wood chip, timber, and lumber movements. These companies provided a great deal of data regarding rates, costs, and the suitability of barges for different operating environments. This information was translated into equations that were used in the economic analysis.

There was some information on Great Lakes vessels that was used in the analysis.

FIGURE 1

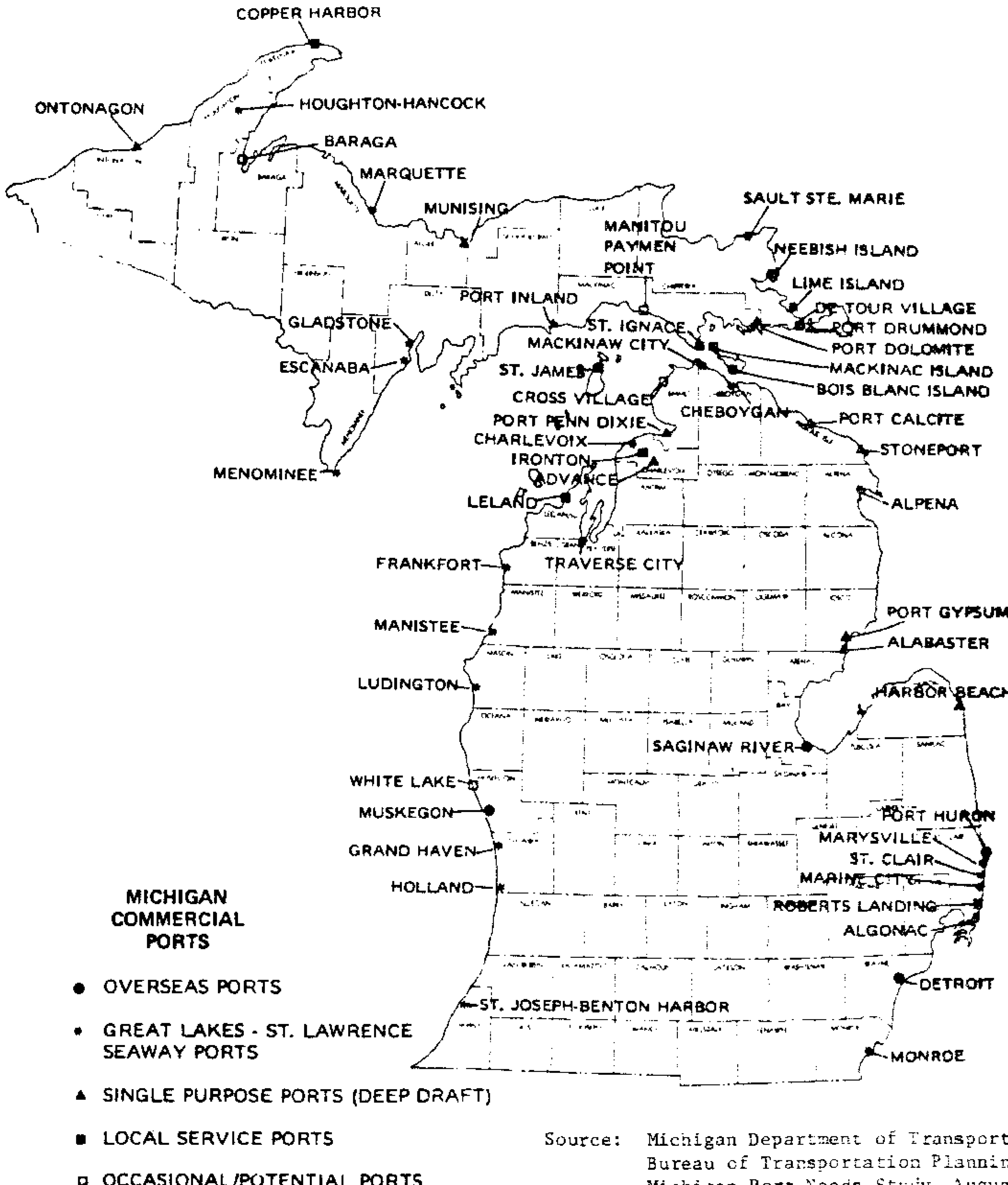
Location of Primary Wood Using Companies, 1977



Source: State of Michigan, Department of Natural Resources, Michigan's Forest Resources 1979 An Assessment, 1979.

FIGURE 2

Location of Michigan Commercial Ports



Source: Michigan Department of Transportati Bureau of Transportation Planning, Michigan Port Needs Study, August 1981.

The data provided were fixed and variable charges for shipping any commodity. To determine rates for shipping forest products, the size of each vessel was translated into capacity estimates for each forest product, and the approximate speed for a given load was estimated. Loading and unloading times were also estimated, either by the shipper or by extrapolating information obtained from shippers in the Pacific Northwest.

Most shipments of primary forest products in Michigan currently move by truck. Rail, which was extensively used in the past, has declined in importance because of abandonments, reliability of service, and rate increases vis-a-vis trucks. Forest product transport by rail is still less expensive than trucks for long hauls, when it is available. However, for this analysis truck-water comparisons were made, both because of the preponderance of truck transport and the extreme variability of rail rates over various distances.

Information on truck rates for each forest product was obtained directly from the buyers of these products (e.g., paper mills and sawmills). Such direct acquisition of rate information from shippers or wood users was the method used for acquiring cost data on all transportation services in this analysis. Other techniques could have been applied, such as determining capital and operating costs and discounting them over a given period to come up with a "required rate". However, there may be wide divergence between required rates and rates actually charged by shippers. Acquiring information on actual rates ensures accuracy in the economic analysis.

Even with the direct acquisition of rate information, there is likely to be some discrepancy between the costs outlined in the succeeding section and what a forest product user would pay if they were to contract for water shipments of wood chips, timber, or lumber. The greatest uncertainty in this analysis is due to the fact that water shipments of forest products on the Great Lakes currently are quite rare. Also, transportation rates are greatly influenced by utilization percentages, particularly where capital costs are a large percentage of total costs, as they are for water transport. If a forest product consumer was only interested in occasional shipments by water, the cost may be somewhat higher than those indicated in the analysis. More importantly, if only one or a few users decided to contract for water shipments such that a barge could not be fully utilized, either costs would be higher or they would be unable to arrange for water transport. It is also conceivable that a single large buyer such as a paper mill could fully utilize a small barge.

Another source of uncertainty is the costs associated with loading and unloading forest products from the barges. In some areas the barges analyzed in this study are self-unloaders, while others are not. However, even in the case of self-unloaders, the costs do not reflect any additional handling equipment necessary to move wood chips or timber from dockside to the mill (if necessary), or land and equipment at the port of origin. Handling costs as high as ten dollars per ton have been quoted,[18] which could have a significant impact on the economics of water transportation. Unless the port of origin and destination are known, as well as the wood handling characteristic of a particular mill, cost projections may be greatly in error. To some extent then, the cost estimates presented below are understated.

The analysis was conducted using a computer program designed specifically for this study. The program accepted cost equations, capacity and speed of the different modes, prices for the different products and other variables, and then calculated the costs for transporting the products over varying distances in different vessels and by truck. The program allowed a great deal of sensitivity analysis to be performed, which identified the key variables affecting the economics of forest product shipments by water. Extended analysis, beyond the scope of this study,

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[18]Personal communication, Terra, Inc., 1982.

could be conducted quite efficiently with the use of this computer program.

Development of the Economic Analysis

In order to conduct the economic analysis, information on barge and truck costs and capacities, volumes, weights, and prices of forest products was obtained. This information was then used to develop equations for the computer model. This section will present some of the more important relationships and assumptions that are the basis for the model.

Information on the cost of shipping wood chips, timber, and lumber by truck was obtained directly from users of these products (e.g., paper mills). The most commonly used truck for hauling all of these products is a 40,000-pound tractor-trailer which will carry approximately 20 cords of timber, 25 tons of wood chips, and 7.5 mbf (thousand board feet) of lumber. Based on information relating distance with specific charges per cord, the following equation for shipping timber was derived:

$$\$/\text{cord} = 9.35 + 0.0579\ (\text{miles})$$

The same equation was used to calculate the cost of shipping wood chips except that a conversion factor was applied that accounts for volumetric differences between a cord of timber and a ton of wood chips. Similarly, an equation was developed for the cost of shipping lumber:

$$\$/\text{mbf} = 10.25 + 0.14\ (\text{miles})$$

In order to determine the cost of transporting wood products by water, cost data and operating characteristics of five different barges were obtained. Three of these barges currently operate on the West Coast, while two are Great Lakes vessels. Since all of these barges are currently operating, the calculated costs reflect actual charges.

The first barge considered is a 1200 unit (1 unit = 200 cubic feet) barge specifically designed for wood chip transport, although it could also carry lumber. This barge operates mainly along the coast, and may not be suitable for Great Lakes shipments where heavy seas could be encountered. These barges are usually towed in groups of two or three and the cost per barge is \$300 per day. Either a 1200 or 1800 horsepower (hp) tug is used to tow the barges at speeds of six knots (1 knot = 1.15 mi) for two, and four knots for three barges. The cost per day for the 1200 hp tug is \$5,300 and \$6,200 for the 1800 hg tug, with operating costs approximating \$400 per day.

The second barge considered is a 700 unit barge that also transports lumber products on the West Coast. Either one or two barges are towed behind a 1200 hp tug at speeds of seven and five knots, respectively. Total charges for both the tug and barges are approximately \$175 to \$200 per hour. Neither this barge nor the 1200 unit barge are self-unloading, and estimates of loading and unloading times with a conventional bucket crane are twelve hours.

A 640 unit barge that currently operates throughout the Great Lakes was also evaluated. A 1250 hp tug pulls two hopper barges for a daily fee of \$5,300. Loading and unloading times are similar to the 1200 and 700 unit barges, and there is no self-unloader. This barge was built for a Great Lakes environment, but usually will remain in port if seas are greater than five to six feet. Towing speeds with two barges are approximately six knots.

In order to make the analysis more complete, two relatively large vessels were also considered. The first is a ship that was converted to a barge that currently operates on the Great Lakes. The barge is 525 feet long, 54 feet wide, and 30 feet deep. It has two cranes for loading and unloading which eliminates the cost of shoreside cranes that would be required with the first three barges discussed. It is also substantially larger (2000 units), and travels at 9.6 knots per hour. The cost per day, including loading and unloading, is \$12,000-\$13,000.

Another barge of approximately 2000

units that currently operates on the West Coast, and was specifically designed for the transport of primary forest products, was also evaluated. This barge is self-unloading and is towed by a 2400 hp tug. The tug charge is $9,000 per day and the barge cost is $2,000 per day. The vessel speed is substantially less (6-6.5 knots) than the other 2000 unit barge, but both will operate on heavier seas than the smaller barges previously discussed.

There are other alternatives for transporting forest products that could have been considered, principally self-propelled lakers of 500 feet or greater. The problem with these ships is that large loads and regular service are necessary to justify the high capital and operating costs. If water transport of forest products was increasingly used by a number of different shippers, then the economics of transporting these products by large lakers might look more favorable.

The basic cost and operating data presented in this section is input to the computer program which makes calculations and provides the results of the economic analysis. There are many more variables than are discussed here, such as water distance, transhipment distance, volumetric and weight transformations, and prices of different forest products in different markets. Instead of discussing each of them in this section, the key variables that affect the economics of water transportation of forest products are presented in the next section.

Results of the Economic Analysis

The economic analysis compared the transportation costs of shipping wood chips, timber, and lumber over various distances by either truck or several different barges. It also calculated potential savings in the case where a buyer transported lower cost wood resources from a distant source by water, as opposed to buying higher cost wood from a closer source. The analysis will also focus on critical variables such as transhipment distance and delay costs.

Wood Chips

Figure 3 shows the costs per ton of shipping wood chips by truck or by the 1200 unit barge over distances up to 300 miles. The solid lines represent barge costs for various transhipment distances. Transhipment is the process of moving forest products from the woods to the port where they will be shipped by water. Since transhipment is by truck, these costs are derived from the trucking cost equations presented earlier. The transhipment costs are added to the barge costs to determine the total costs of shipping by water.

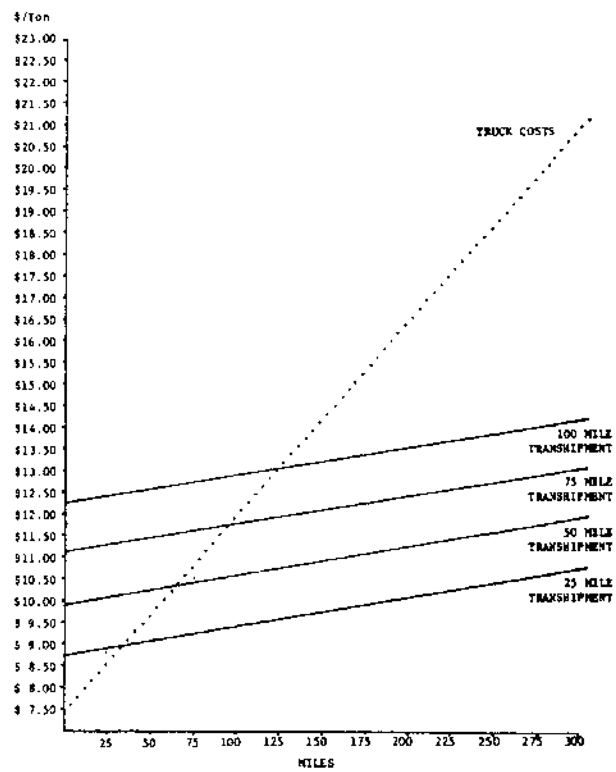

FIGURE 3 WOOD CHIP TRANSPORTATION COSTS - 1200 UNIT BARGE

In Figure 3, and in each of the following figures (except Figure 4A), the mileage shown on the horizontal axis represents the distance of the water haul. It does not include the transhipment distance. However, the transhipment cost is included in the cost per ton estimates on the vertical axis. In fact, most of the cost shown at the intersection of the curves with the vertical axis represents the transhipment cost. The only other cost included in the point of intersection is the barge cost when it is loading or unloading. The remaining barge cost varies with distance, and is accounted for by the upward slope of the cost curves (see Appendix 1). If handling costs at the port had been included, it would shift all of the curves vertically by the amount of the handling cost per ton. It should be noted that the curves represent the total cost of transporting forest products various distances. Thus, the total cost of shipping wood chips 200 miles (with a 25 mile transhipment) in the 1200 unit barge shown in Figure 3 is approximately ten dollars per ton.

In the case of the 1200 unit barge, the economics of shipping by water looks very good. If the transhipment distance is only 25 miles, then it is less expensive to ship by water than truck for distances greater than 35 miles. If the transhipment distance was 75 miles, then water transport would be less costly at any distance greater than 100 miles. It should be reiterated that the 1200 unit barge is not a self-unloader, so additional loading and unloading costs would have to be included.

The figures in this section can also be used to determine the comparative costs of transporting forest products from different sources by different modes. For example, it would cost about the same to barge wood chips 300 miles with a 50-mile transhipment as it would to bring in wood chips by truck from a distance of 85 miles. One paper mill that was contacted was concerned that its supply of wood chips and timber within a 100 mile radius, that is currently brought in by truck, would become increasingly scarce, and the firm would have to look to more distant sources. In that case, such multi-modal cost comparisons would become important.

Figure 4 depicts wood chip transportation costs for the 640 unit barge. It is immediately apparent that the costs of shipping by this barge are substantially more than those associated with the 1200 unit barge. However, there is some question about the capability of the 1200 unit barge operating in a Great Lakes wave environment. On the other hand, the 640 unit barge is not designed specifically for the movement of forest products. It is conceivable that a barge specifically designed for wood chip shipments on the Great Lakes would have cost curves lying somewhere between the 1200 unit and the 640 unit barges.

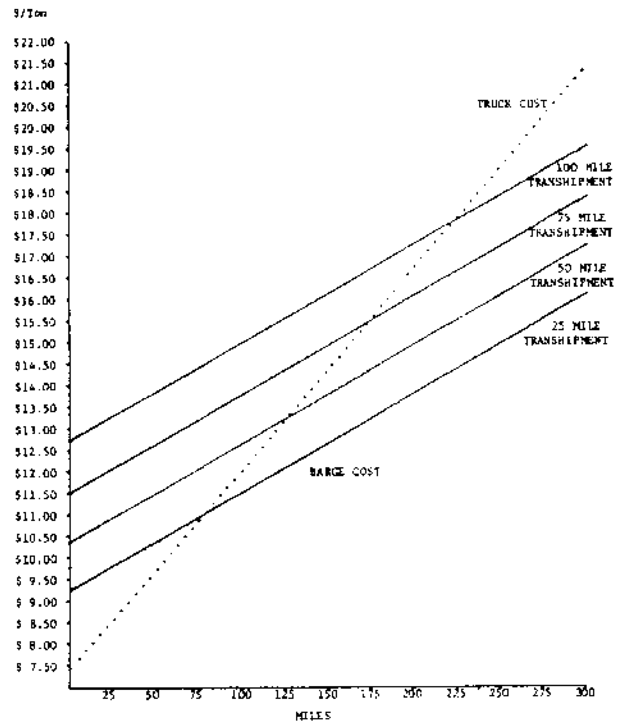

FIGURE 4 WOOD CHIP TRANSPORTATION COSTS – 640 UNIT BARGE

Figure 4 shows the critical importance of transhipment costs in the economics of water transport of forest products. If the transhipment distance is only 25 miles, water transport is the least cost alternative beyond 85 miles. However, if the transhipment distance is 100 miles, barge costs are less than truck charges only for distances greater than 225 miles. Unless wood chips are less expensive from a distant source, it is unlikely that mills would find it necessary to buy wood chips from sources more than 225 miles away.

The cost curves for the 640 unit barge in Figure 4 include transhipment cost. If the actual cost of operating the barge and tug are determined separately, the importance of transhipment costs becomes even more apparent. For example, the total cost of transporting wood chips 100 miles by the 640 unit barge, with a 25 mile transhipment, is $11.45 per ton. Of this total, only $2.81 (25 percent) is the cost of barging the wood chips. The rest, $8.64, is the transhipment cost. If the water distance is 300 miles (25 mile transhipment), the total cost is $16.07, of which $7.43 (46 percent) is the barge cost. Thus, the cost of a 25 mile transhipment is greater than a 300 mile shipment by barge. The proportion of total costs related to transhipment is, of course, even greater the longer the transhipment distance.

In contrast to the total cost curves shown in the other figures, Figure 4A shows the average costs of shipping wood chips in a 640 unit barge over various distances. As in the other figures, the horizontal axis represents only the water haul portion of the trip, but the average cost includes both the water and the transhipment distance. The average cost per mile is quite high for the first 25 to 50 miles because it includes transhipment costs, which are the same for short water hauls as they are for long water hauls. As the distance of the water shipment increases, the effect of the transhipment cost is greatly reduced, and the cost per mile approaches the average cost per mile of barge shipments. Average cost curves for other barges would appear quite similar.

Figure 5 shows wood chip transportation costs for the 2000 unit barge/ship that operates on the Great Lakes. The transport costs were quite similar to the 2000 unit barge operating on the West Coast, although the Great Lakes barge is less expensive at distances greater than 175 miles. The break-even distance between truck costs and barge costs for a 25 mile transhipment is about 140 miles, and 235 miles for a 100 mile transhipment.

Figure 6 combines all of the previous figures for a 50 miles transhipment. If the

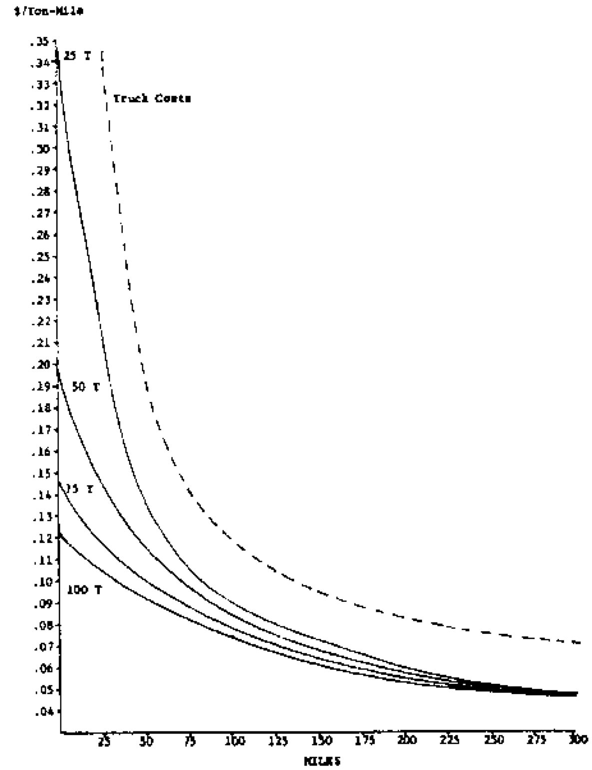

FIGURE 4A AVERAGE COSTS FOR WOOD CHIP TRANSPORTATION - 640 UNIT BARGE

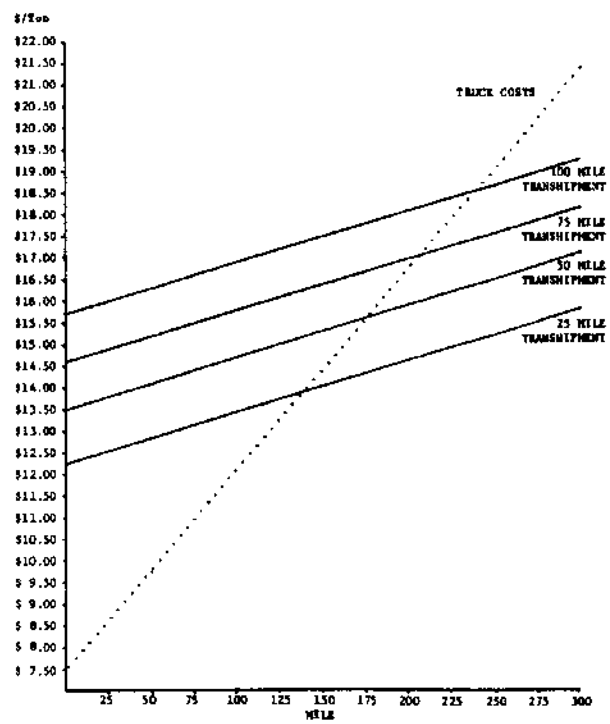

FIGURE 5 WOOD CHIP TRANSPORTATION COSTS - 2000 UNIT BARGE

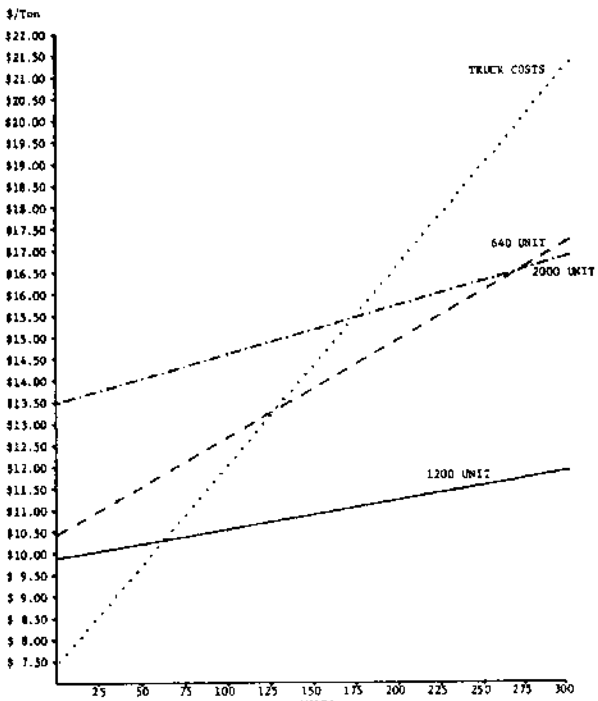

FIGURE 6 TRANSPORTATION COST OF SHIPPING WOODCHIPS BY TRUCK; 640, 1200, AND 2000 UNIT BARGES (50 MILE TRANSHIPMENT).

1200 unit barge was seaworthy enough for the Great Lakes, it would be the least cost alternative among barges, and less expensive than truck transport at distances greater than about 62 miles. The cost of the 640 unit barge is less than the 2000 unit barge for distances less than 265 miles, although the latter is a self-unloader so it may be cheaper to operate at somewhat shorter distances.

Timber

The economics of transporting timber by barge are slightly better than for wood chip shipments, although this may be offset by higher handling costs. Figures 7 and 8 show the cost curves for transporting timber by the 640 and 2000 unit barges as well as for trucks. The breakeven distance between a barge and a truck is 60 miles for the 640 unit barge and 135 miles for the 2000 unit barge, assuming a 25 mile transhipment. If the transhipment distance is increased to 100 miles, the breakeven points are 180 miles for the 640 unit barge and 225 miles for the 2000 unit barge.

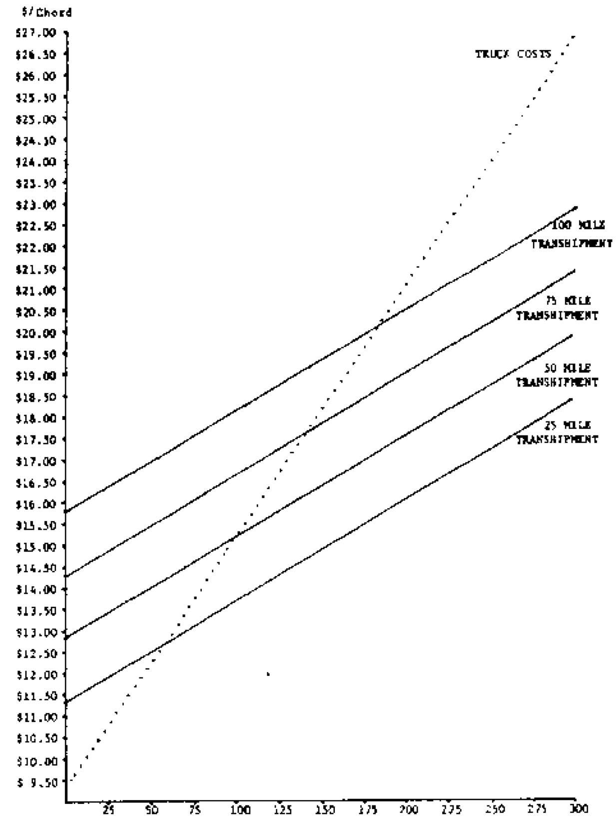

FIGURE 7 TIMBER TRANSPORTATION COSTS - 640 UNIT BARGE

Transhipment costs are even a higher proportion of total water transport costs than they were for wood chips. Approximately 80 percent of total barge costs (640 unit) for a 100 mile trip with a 25 miles transhipment are transhipment costs. Even for a 300 mile barge shipment, a 25 mile transhipment accounts for 59 percent of total costs. The proportion is slightly less for the 2000 unit barge, but transhipment costs are still the most significant variable affecting the economics of water transportation.

Delay Costs

Another critical factor that will affect the economics of barge shipments is the costs associated with delays due to weather. For example, the 640 unit barge will remain in port (or put in at the nearest port) if wave heights exceed five or six feet. Since barge charges are based on an hourly or daily rate, the company receiving the shipment will incur the cost of such

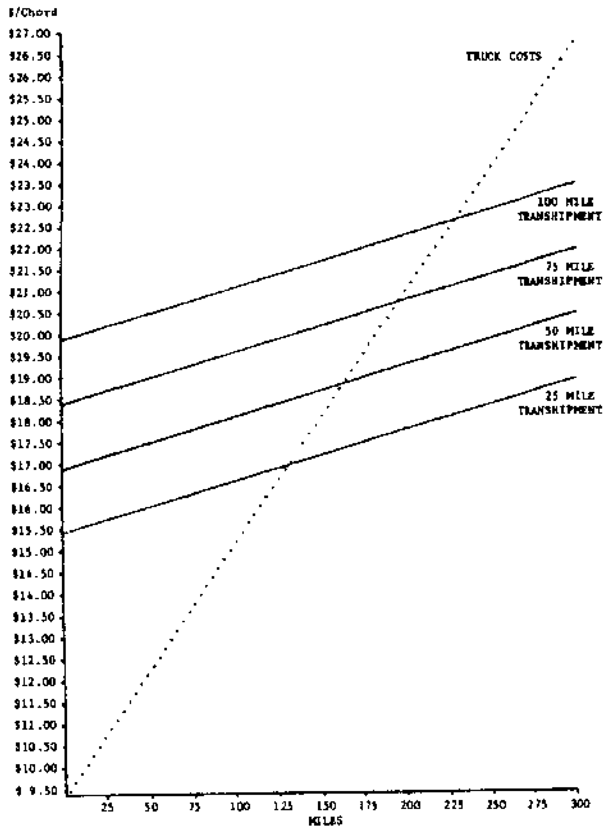

FIGURE 8 TIMBER TRANSPORTATION COSTS - 2000 UNIT BARGE

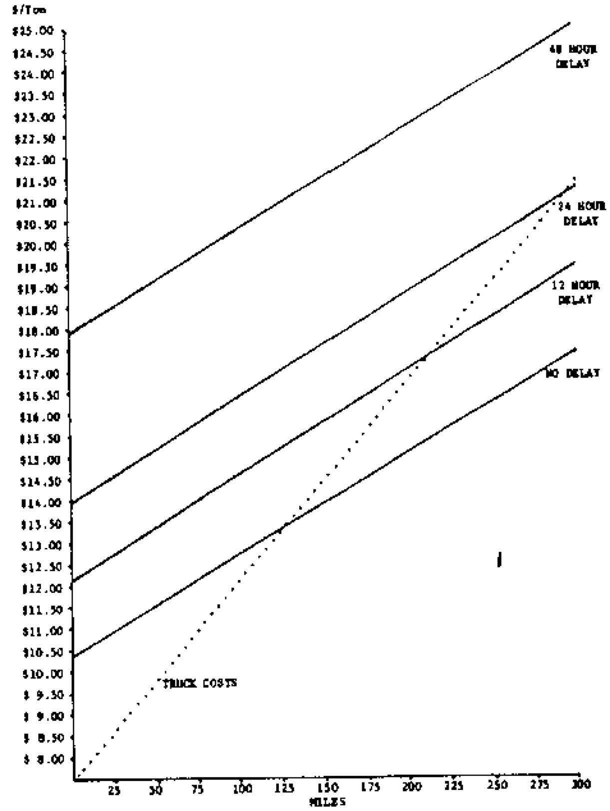

FIGURE 9 DELAY COSTS OF SHIPPING WOODCHIPS BY A 640 UNIT BARGE (50 MILE TRANSHIPMENT)

delays. Figure 9 shows the effect of these delay costs on the economics of water shipments. For a 50 mile transhipment and no delay, the breakeven distance between truck and barge costs is about 130 miles. If there was a 12 hour delay, the breakeven distance increases to 220 miles; and for a 24 hour delay, the breakeven distance is 290 miles. For each 12 hour delay, the barge cost per ton increases $1.75. Thus, one day of bad weather can negate the economic advantage of a barge shipment for a 300 mile trip.

Figure 10 depicts the delay costs for the 2000 unit barge that currently operates on the Great Lakes. This case is interesting in that the cost of shipping wood chips with no delay is more expensive than for the 640 unit barge, but the economic impact of delays are not as great. The slope of the cost curves for the 2000 unit is less, so the intersection with the truck cost curve is further down when there is an equivalent vertical shift. In effect, the minimum cost

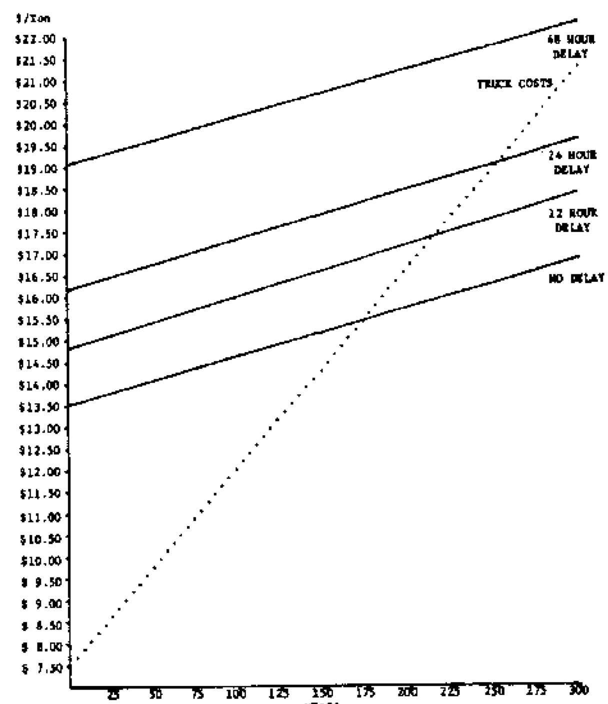

FIGURE 10 DELAY COSTS OF SHIPPING WOOD CHIPS BY A 2000 UNIT BARGE (50 MILE TRANSHIPMENT)

of transporting goods in a larger barge are higher; but once this cost is incurred, the additional cost of shipping goods each mile is less.

Another interesting aspect of delay costs for the 2000 unit versus the 640 unit barge is that the occurrence of delay will be much less for the former. The 2000 unit barge is a converted freighter designed to operate during heavy seas. Since the probability of occurrence of a storm that will delay the 2000 unit barge is much less than the probability of a storm that will force the 640 unit barge into port, the actual difference in cost of shipping wood chips by either barge may be less than indicated by the figures omitting delay costs. To determine which barge would be the least cost option, and whether either would be less than shipping by truck, an analysis of the probability of various wave heights in the section of the Great Lakes that the forest products would be barged would need to be conducted.

Figure 11 shows the effect of delay costs on the economics of shipping timber by the 640 unit barge. The effect is very similar whether wood chips or timber are being carried, except that the breakdown distance with no delay is less with timber than it is for wood chips. Therefore, the addition of delay costs will not have as adverse an effect as it did for wood chips. For example, a 12 hour delay when timber is being shipped means the breakeven distance is 160 miles, versus 220 miles when wood chips were transported by the same barge.

Lumber

Figure 12 shows the relative costs of shipping lumber by truck and by barge on the Great Lakes. The barge has a capacity of three million board feet and was specifically designed for shipping lumber on the West Coast. The economics of transporting lumber in this barge appear to be quite favorable. If the transhipment distance is 25 miles, barge costs are less than the cost of shipping by truck after 62 miles. The breakeven distances for a 50,

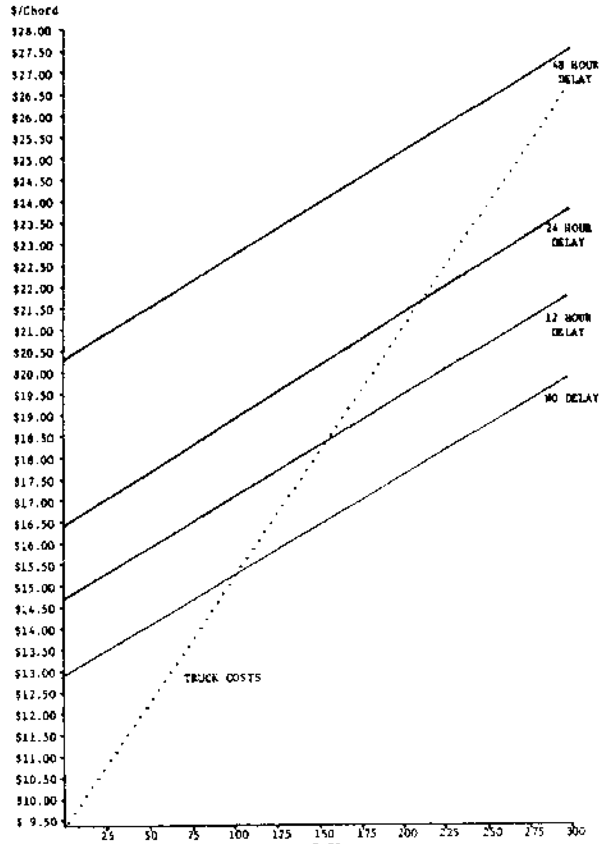

FIGURE 11 DELAY COSTS, 640 UNIT BARGE CARRYING TIMBER (50 MILE TRANSHIPMENT)

75, and 100 mile transhipment are approximately 100, 125, and 150 miles, respectively.

The barge shown in Figure 12 is a self-unloader, so loading and unloading costs are included. However, unlike wood chips and timber which may be delivered to a mill located close to an off-loading point, lumber will probably have to be transhipped from the port to destinations inland. Since transhipment costs are a significant percentage of total barge costs (65 percent for a 200 mile trip with a 50 mile transhipment), double transhipments will reduce the economic advantage of water transport over shipment by truck.

Figure 13 compares the cost of transporting lumber by the barge described in Figure 12 (Larger Barge) and the 640 unit barge (Smaller Barge) discussed earlier. The 640 unit barge is less expensive over

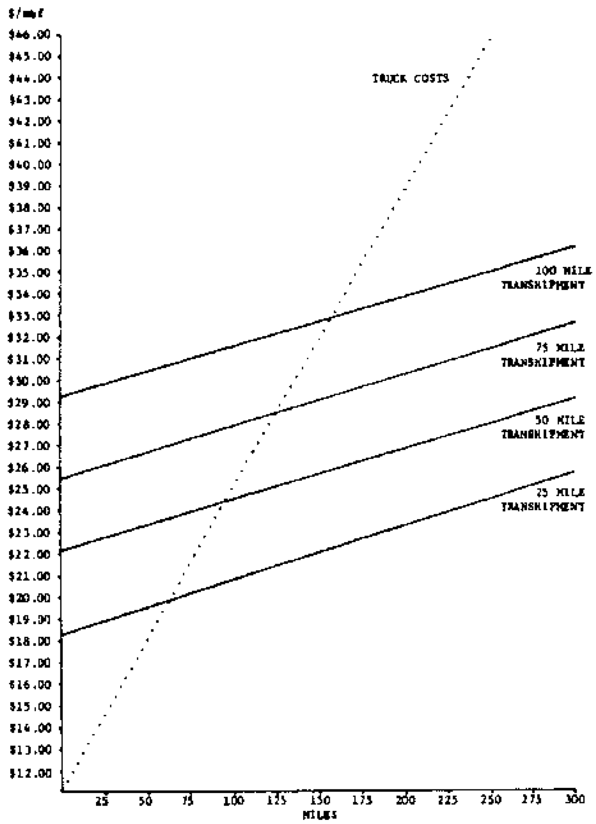

FIGURE 12 TRANSPORTATION COSTS OF SHIPPING LUMBER BY TRUCK AND BARGE

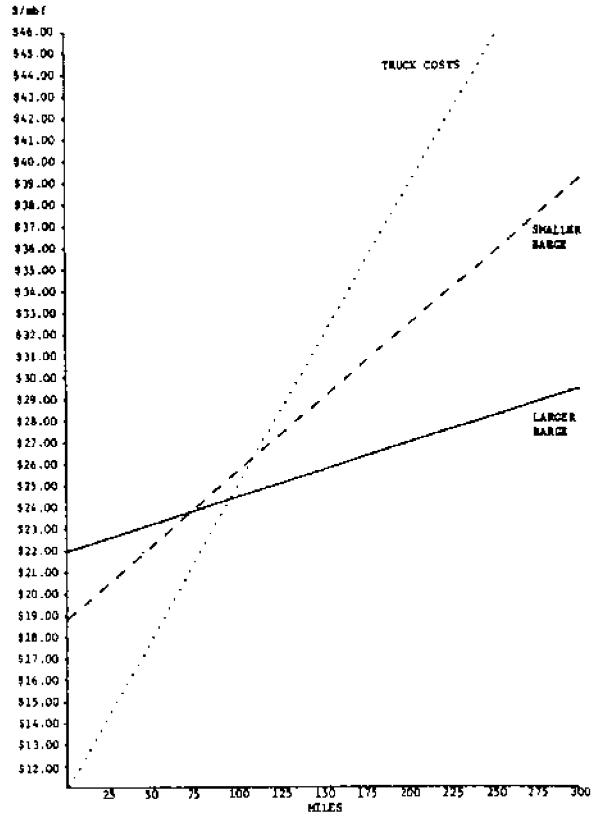

FIGURE 13 TRANSPORTATION COSTS OF SHIPPING LUMBER BY TRUCK AND TWO TYPES OF BARGES (50 MILE TRANSHIPMENT)

distances less than 75 miles, but truck transport is the cheapest alternative in this range. For distances greater than 100 miles where water transport becomes the least cost alternative, the smaller barge becomes much more expensive. Since the smaller barge is not a self-unloader, the actual costs are even greater than those shown in Figure 13. The comparison between these two barges illustrates the potential for economic savings when a barge is specifically designed for the shipment of different types of forest products.

Buying From Distant Markets When There Is A Price Difference

The results of the economic analysis presented thus far have indicated that barge shipments of forest products may be economically feasible when the transport distance is quite long (i.e., greater than 200 miles, depending on transhipment distance). Given these results, it would be interesting to evaluate the feasibility of transporting forest products from a distant source by barge, versus transporting those products by truck from a closer source where the products are more expensive.

For example, suppose that a paper mill in Green Bay requires 20,000 tons of wood chips, and it can buy them for $10 per ton at a source 85 miles away, and they will be transported by truck. Alternatively, assume the company can purchase the same quantity of wood chips in Northern Michigan for $7 per ton, and they will be shipped out of Cheboygan by barge for the 216 mile trip to Green Bay (25 mile transhipment). When evaluating the two alternatives, the company finds that it will save $5,728 if it buys the wood chips in Michigan and ships the product by the 640 unit barge. This savings includes the total cost of the wood chips and transportation costs. (Since the 640 unit barge is not self-unloading, loading and unloading costs were not considered.)

If the company had chosen to ship by the 2000 unit barge, it would be about $6,000 more expensive than buying from the source in Wisconsin. However, if the difference in price between wood chips in the Wisconsin and Michigan markets was increased one dollar per ton to $11 and $7, respectively, shipment by the 2000 unit barge from Cheboygan would save about $14,000. The savings by using the 640 unit barge would increase to more than $25,000.

The same analysis could be conducted for shipments of timber from Cheboygan to Green Bay. Assuming timber prices are $15 per cord in the Wisconsin market and $10 per cord in Michigan, the company would save approximately $30,000 if it bought 10,000 cords of timbers in Michigan and had the wood transported by the 640 unit barge. If the difference in price was only two dollars per cord, the company would face about the same costs if it were to buy from either source.

Another example that was evaluated was the shipment of wood chips or timber from Thunder Bay, Canada, to Green Bay, via Lake Superior, the Soo Locks, and Lake Michigan; a distance of 487 miles. This was compared to buying these forest products from a source 125 miles from Green Bay that ships by truck. If 20,000 tons of wood chips are needed, and the wood chips are four dollars per ton cheaper in Thunder Bay, then it would be $8,500 more expensive to buy the wood chips in Thunder Bay than from the closer source. This difference is based on the cost of shipping by the 2000 unit barge from Thunder Bay. If the 640 unit barge had been chosen, the cost would have been $54,000 more expensive. Evaluating timber, it would be $7,000 less expensive to buy 10,000 cords from the source in Thunder Bay if the price in that market was five dollars per cord less than in the market 125 miles from Green Bay.

Recently, there has been a dramatic increase in the demand for firewood in Michigan. It is well known that the price for a cord of firewood is substantially higher in the Detroit area than it is in northern Michigan. Therefore, it would be interesting to evaluate the cost of shipping firewood from northern Michigan by barge, versus buying it at the higher price in the Detroit market. In order to conduct this evaluation, prices of $150 per standard cord (not a face cord) were assumed for the Detroit market, and $75 per cord if firewood was purchased in northern Michigan.[19] It was also assumed that there would be a transhipment of 25 miles to the port of Alpena, and another 25 miles transhipment from the Port of Detroit to local retailers. The water distance from Alpena to Detroit is 215 miles. The quantity of firewood shipped is 10,000 cords.

The savings realized by shipping firewood from Alpena is quite substantial. Assuming that the 2000 unit barge is used to ship the firewood, the savings amount to $463,000, or $46.30 per cord. These figures do not include port costs, but they are unlikely to negate such large savings. Also, the difference in firewood prices may not be as great as that reported in Timber Mart-North, but the potential for such significant savings does make water shipments of firewood an interesting possibility.

Export Shipments

An earlier section of this paper discussed exports of forest products to Europe, and indicated that very few shipments are made from Great Lakes ports. Numerous contacts were made with shipping companies that transport goods overseas, but very little cost data on the shipment of forest products could be obtained. Therefore, this study was unable to evaluate the relative costs of transporting forest products by water to foreign ports.

Winter Navigation

One of the problems associated with water transportation of any products on the Great Lakes is the cessation of shipping during the winter months. With regard to forest products, a company relying on barge

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[19] Timber Mart-North, Michigan Vol. 1, No. 1, 1st Quarter-1981.

shipments would have to have adequate space to stockpile wood during the winter months. It might contract for land transport during the winter, but this could prove to be difficult. Furthermore, capital costs related to barges must be spread over a shorter year. The U.S. Army Corps of Engineers has proposed to maintain navi-gation during the winter months, but the idea has received strong opposition and its fate is uncertain at this time.

CONCLUSIONS

The transportation of forest products on the Great Lakes can be economically feasible if the source of supply is greater than 150 to 200 miles from the user. However, there are factors that will tend to increase this distance. The most important is the distance that forest products must be transhipped to or from a port. If the transhipment distance is more than 50 miles, it is unlikely that water transport will be the minimum cost alternative. If a double transhipment is required, both from the woods and from the port of destination to the user, the economic viability of water transportation is doubtful at transhipment distances greater than 25 miles.

Another factor that will impinge on the economics is the possibility of delays due to bad weather. If a vessel must remain in port more than one day, water transportation at distances less than 250 miles is more expensive than shipments by truck. Handling costs at ports may also have a substantial negative influence on the prospects for water shipments of forest products, as does the closing of the Great Lakes during the winter months.

The analysis in this study was based on the cost of shipping by barges that were not specifically designed for forest products. It is quite likely that water transport costs could be significantly reduced if such barges were used, as they are on the West Coast. In addition, if major users of forest products were to begin using water transportation, efficient loading and unloading facilities would be put into place, using systems that are readily available. Lower prices for Michigan's forest products relative to other states, and differences in fuelwood prices between Upper and Lower Michigan may make barge shipments quite attractive. Overall then, economic potential does exist for water transportation of Michigan's forest products.

APPENDIX I
EQUATIONS OF THE COMPUTER MODEL

Inputs

Water Distance (miles)
Transhipment Distance (miles)
Land Distance (miles)
Tons of Wood Chips
Cords of Timber
mbf of Lumber
Price of Wood Chips, Local and Distant Markets
Price of Timber, Local and Distant Markets

Conversions

Units of Wood Chips = Tons of Wood Chips / 2.25
Tons of Timber = (Cords of Timber X 4800) / 2000
Units of Timber = Tons of Timber / 5.35

Capacities

Truckloads of Wood Chips = Tons of Wood Chips / 25
Truckloads of Timber = Cords of Timber / 20
Truckloads of Lumber = mbf of Lumber / 7.5
Bargeloads of Wood Chips = Units of Wood Chips / Barge Units
Bargeloads of Timber = Units of Timber / Barge Units
Bargeloads of Lumber (640 Unit Barge) = mbf of Lumber /493
Bargeloads of Lumber (2000 Unit Barge) = mbf of Lumber /3000

Trip Duration (Hours)

One Barge = Water Distance / 9.21
Two Barges = Water Distance / 6.91
Three Barges = Water Distance / 4.61
2000 Unit Lake Barge = Water Distance / 10.5
Barge Shipping Lumber = Water Distance / 6.91

Costs of Shipping by Truck

Cost of Shipping Wood Chips = (((0.0579 X Land Distance) + 9.35)20) Truckloads of Wood Chips

Cost of Shipping Timber = ((0.0579 X Land Distance) + 9.35) Cords of Timber

Cost of Shipping Lumber = (((0.1422 X Land Distance) + 10.25) X 7.5) X Truckloads of Lumber

Transhipment Costs

Same equations as were used for the Cost of Shipping by Truck except that transhipment distance is substituted for land distance.

Barge Costs

640 Unit Barge:

((((24 + Trip Duration - Two Barges) X 30) + (Trip Duration - Two Barges X 200)) X Number of Bargeloads) + Transhipment Costs

Great Lakes 2000 Unit Barge:

(((32 + Trip Duration) X 520) X Number of Bargeloads) + Transhipment Costs

Sea Barge - 2000 Units:

((((32 + Trip Duration - Two Barges) X 500) - 2400) X Number of Bargeloads)

1200 Unit Barge:

((((24 + Trip Duration - One, Two or Three Barges) X 12.50) + (Trip Duration X 215)) X Number of Bargeloads / Number of Barges) + Transhipment Costs

Cost Savings When Wood Products are Purchased in Distant Markets

((Quantity of Wood Products X Price of Products in Local Markets) + Truck Costs) − ((Quantity of Wood Products X Price of Products in Distant Market) + Barge Costs)

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