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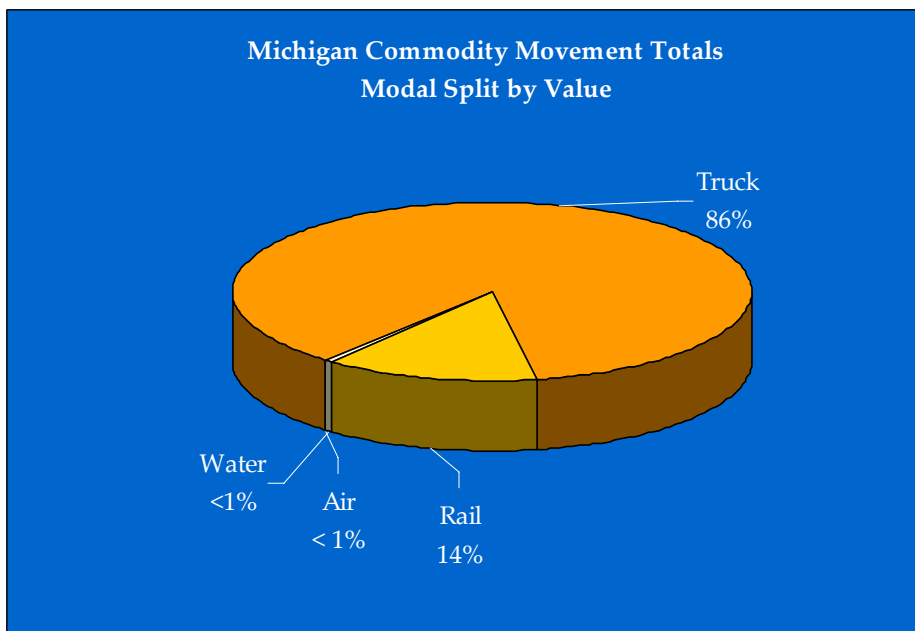
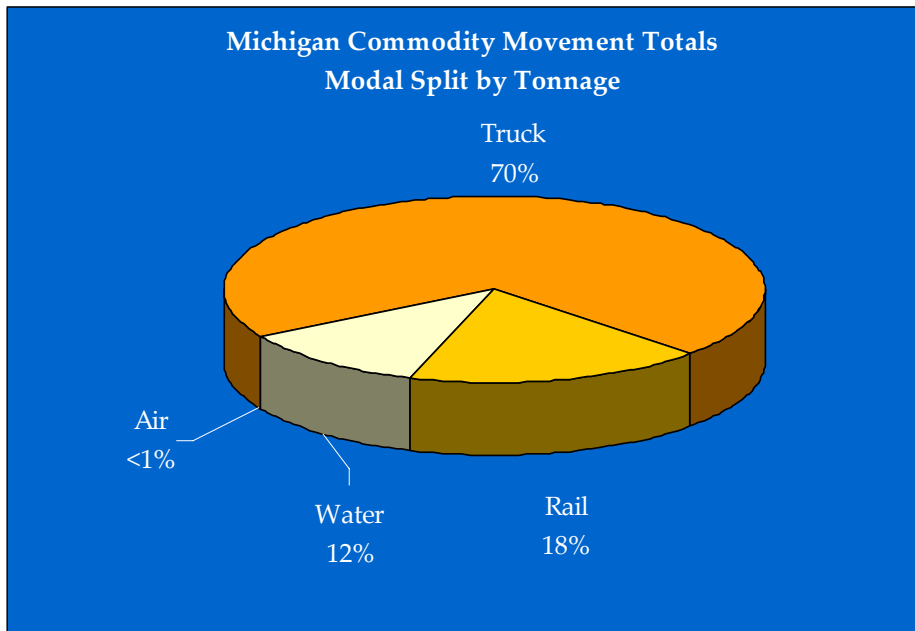
Executive Summary

In today's business environment, cost-effective, time-sensitive transportation services are increasingly a strategy for competitive advantage in manufacturing and service-based industries. Globalization of the US economy has grown at a rapid pace over the past several decades, and Michigan has been at the forefront of the industrial globalization trend. Michigan's manufacturers shop the world for components and subassemblies to manufacturing processes. Advances in technology and management practices are also allowing US firms to develop strategies that enable customized products for mass-market distribution. The movement of goods by truck, rail, air, and water is vital to Michigan's economy, especially manufacturing and agriculture, two of Michigan's largest economic sectors. The safe, reliable movement of freight on the state's highway corridors and intermodal connections are keys to Michigan's future economic vitality and quality of life.

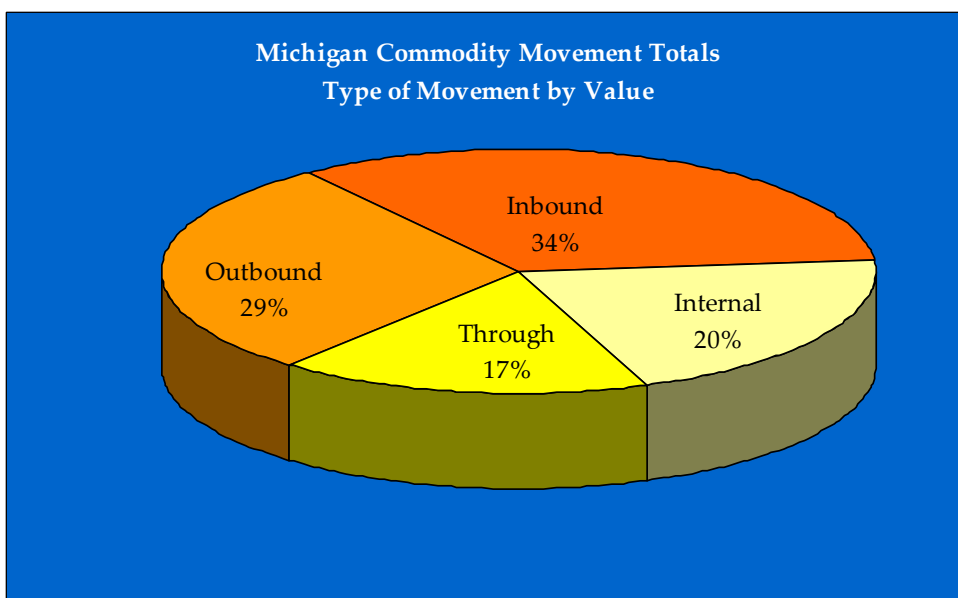
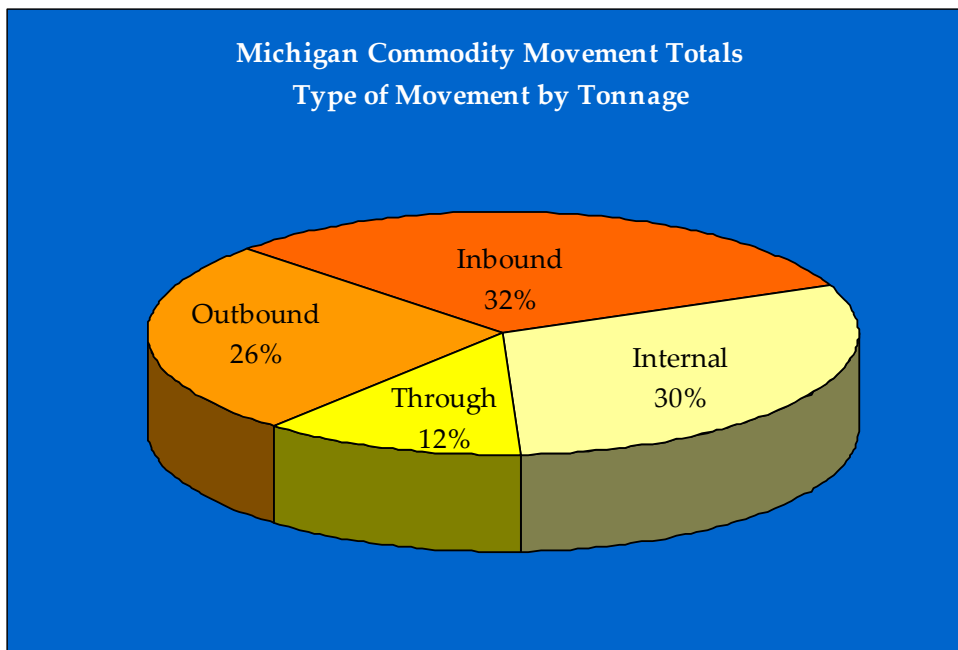
Michigan Freight Movements by Mode:

This *Freight Profile Technical Report* describes the nature and characteristics of commodity flows to, from, within, and through the state of Michigan, and provides an indication of the commercial demands upon Michigan's transportation networks. In 2003, Michigan's multi-modal transportation systems: highway, rail, water, and air cargo networks, facilitated the movement of approximately 670 million tons of freight with an estimated value exceeding \$1 trillion. When examining all of the freight moving in, out, within, and through Michigan, in terms of volume by weight, approximately 70 percent of Michigan's freight flows move by truck, 18 percent by railroad, 12 percent by water, and less than 1 percent by air.

Commodity movements measured by value further increase the importance of highways as the underpinning of Michigan’s commerce, as the truck modal share increases to 86 percent. In terms of value, the modal share carried by railroads declines slightly to 14 percent, while the water transport mode drops precipitously to approximately 1 percent. Air cargo flows, while often carrying high-value cargoes, remain less than 1 percent of the overall value of freight movements. The figure below shows the modal share by tonnage and value for Michigan freight movements.



Inbound shipments comprise the largest type of freight movement in Michigan. In 2003, inbound commodities accounted for 32 percent of all freight movements in Michigan by tonnage and 34 percent by value. Outbound commodities accounted for 26 percent of all flows by tonnage and 29 percent by value. Internal movements accounted for 30 percent of the total by weight, but only 20 percent by value. The relatively low value of internal freight movements reflects the large volumes of farm and natural resource products moving locally which carry a lower value per ton than most manufacturing products. Through shipments, those goods-movement trips where the origin and destination both lie outside the state of Michigan, accounted for 12 percent of the total movements by weight and 17 percent by value. The figure below shows the nature of Michigan freight movements for shipment direction by tonnage and value.



International Trade:

The world's largest bilateral trade relationship exists between the United States and Canada, with Michigan positioned as a leader in international trade. Goods and people moving across Michigan's borders significantly impact the economies of Michigan and Ontario, and the economies of the United States, Canada, and other nations.

US trade with Canada averages \$1.2 billion per day, more than US trade with the entire European Union. In 2005, surface transportation trade between the US and Canada totaled \$458 billion, up 12 percent compared to 2004. Over the past 30 years, US/Canada cross-border trade has grown faster than the gross domestic product (GDP), at an annual rate of approximately 11 percent.

The strong growth in trade between Michigan and Canada was first boosted by the US – Canada Free Trade Agreement that took effect in 1989. This treaty was superseded by the North American Free Trade Agreement (NAFTA) in 1994, which now includes Mexico. These trade agreements abolished or reduced all tariffs on exports between the countries. In the last decade, trade between the US and Canada has increased over 75 percent, and trade between Michigan and Canada was up 32 percent. The province of Ontario imported nearly 97 percent of Michigan's total exports to Canada in 2002. These figures show that US – Canada trade is ever increasing, and that Michigan is at the forefront.

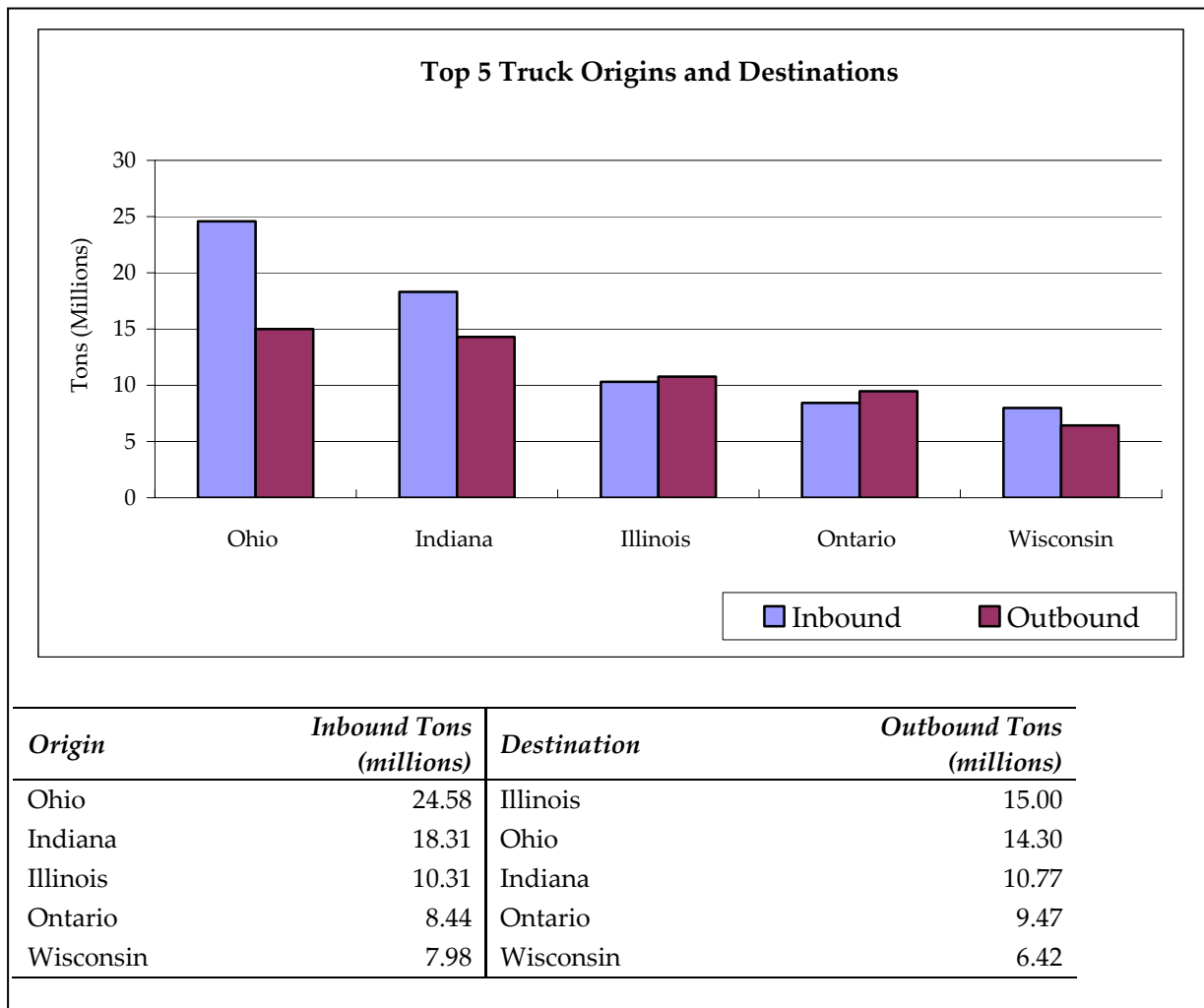
Truck Movements:

Nearly every product consumed in the US at some point is transported upon a truck. The trucking industry plays a key role in today's globally integrated economy, employing 8.6 million people nationwide. In Michigan, the trucking industry employs one in every 11 residents of the state. Nationally, trucking accounts for 68.9 percent of freight movements by weight and 86.9 percent by value. Michigan closely mirrors the national modal split profile with 70.5 percent of freight tonnage moving by truck and 86.0 percent by value. Trucking accounted for nearly 474 million tons of commodity movements in, out, within, and through Michigan in 2003, with an estimated value exceeding \$1 trillion. The heavy dependence of the US economy upon the trucking industry has also contributed to increasing congestion on state and national highways.

In 2003, Nonmetallic Ores and Minerals was the top commodity type moved by truck in Michigan, in terms of weight, with over 111 million tons. Sand and gravel shipments from mining sites to construction areas make up the largest portion of the movements. By value, Secondary Traffic was the leading commodity moved by truck. Secondary Traffic includes truck movements to and from warehouse and distribution centers, intermodal terminals, and air cargo facilities. Several commodities or mixed shipments can be included in this category. The table below provides a summary of the top ranking commodities, by tonnage and value, moving by trucks in Michigan.

<i>Commodity Tonnage Rank</i>	<i>Total Truck Tons (millions)</i>	<i>Commodity Value Rank</i>	<i>Total Truck Value (billion \$)</i>
Nonmetallic Ores and Minerals	111.4	Secondary Traffic	\$344.5
Secondary Traffic	62.0	Transportation Equipment	\$159.3
Clay, Cement, Glass or Stone Products	49.9	Machinery	\$100.3
Food Products	32.7	Fabricated Metal Products	\$62.2
Farm Products	31.6	Electrical Equipment	\$57.9

In 2003, 111 million tons of outbound truck freight were shipped from Michigan to other destinations, while 127 million truck tons were shipped into Michigan from outside origins. Nonmetallic Ores and Minerals was the top commodity leaving the state while Secondary Traffic was the number one commodity entering the state. By value, Transportation Equipment was the leading outbound commodity and Secondary Traffic was, again, the top inbound commodity. The top origins and destinations of out-of-state truck movements are concentrated in the Great Lakes region. Ohio, Indiana, Illinois, Wisconsin, and the Canadian province of Ontario make up the top five origins and destinations of truck tons coming to and from Michigan. Together they account for over 50 percent of all such movements. The figure below shows their truck tonnage totals.



Approximately 7 percent of Michigan’s truck commodity movements by tonnage travel through the state. Michigan’s unique peninsular geography contributes to a relatively low percentage of through-traffic, compared to other Midwest states. While free trade has been a catalyst in Michigan’s economic growth in terms of imports and exports, free trade has also generated more traffic, contributing to congestion and wear on Michigan highways. The province of

Ontario is by far the single largest source of commodities being generated for Canadian exports into the US, passing through Michigan, destined to other states as far away as California. The province of Ontario also ranks as the top destination for through truck tonnage.

Internal, or intrastate, freight shipments account for about 40 percent of all the goods moved by truck, but only 23 percent by value. This relatively large percentage difference between tonnage and value reflects the low-value, high-weight commodities that typically make up a large share of short-haul intrastate movements. By weight, not surprisingly several commodities groups related to natural resource extraction and agriculture rank in the top 10 including Nonmetallic Ores and Minerals, Clay, Cement, Glass, or Stone Products, Farm Products and Logs, Lumber, and Wood Products. By value, many of the typically bulk commodity groups rank significantly lower and are replaced by commodities related to the service and manufacturing sectors such as Secondary Traffic and Transportation Equipment.

Rail Movements:

In 2003, Michigan's railroads carried nearly 120 million tons of freight, accounting for approximately 18 percent of Michigan's total commodity movements. The estimated value of these rail flows exceeded \$162 billion. The table below shows the top five rail commodity movements by tonnage and value.

<i>Commodity Tonnage Rank</i>	<i>Total Rail Tons (millions)</i>	<i>Commodity Value Rank</i>	<i>Total Rail Value (billion \$)</i>
Coal	19.41	Transportation Equipment	\$80.52
Chemical Products	14.49	Miscellaneous or Mixed Shipments	\$22.99
Transportation Equipment	13.54	Primary Metal Products	\$20.43
Paper and Pulp Products	7.93	Chemical Products	\$13.45
Primary Metal Products	7.81	Paper and Pulp Products	\$7.45

In 2003, over 26 million tons of outbound commodity movements left Michigan by rail to domestic and foreign destinations, with a value exceeding \$66 billion. Commodities leaving the state by rail accounted for approximately 15 percent of all outbound goods movements from Michigan by tonnage. Among outbound rail movements, the most common commodity type is Transportation Equipment, accounting for 36 percent of outbound rail movements by tonnage and nearly 80 percent by value. Illinois, Ohio, and Indiana are the leading destinations by tons with very similar totals, while Illinois is by far the leader when ranked by value. The large amount of expensive transportation equipment sent to the Chicago rail hub for delivery throughout the country is the primary source of the value.

Of the approximately 42 million tons of inbound rail shipments, the greatest volume by weight is Coal, which ranks eighth by value. Coal accounts for almost half of all rail tons entering Michigan and is primarily used to generate electricity. Transportation Equipment is the top inbound rail movement by value. The primary origins of inbound rail freight are from Illinois,

Kentucky, West Virginia, Ontario, and Pennsylvania. Besides Ontario, the other four are the sources of the coal coming into Michigan.

Approximately 46 percent of all overland commodity tonnage passing through Michigan moves by rail. Through rail freight is widely distributed across many groups. Chemical Products is the highest volume through-commodity group (24%), followed by Paper and Pulp Products (14%), Transportation Equipment (8%) and Logs, Lumber, and Wood Products (8%). Transportation Equipment is the top through-flow commodity by value. The influence of free trade agreements is also evident upon the volume of goods moving by rail transport, as Ontario is both the top origin and top destination for rail flows moving through Michigan.

Michigan transports just over 14 million tons of commodities intrastate by rail, with a value of \$2.9 billion. Since shipping costs promote longer hauls of low-value bulk goods, Michigan does not have many internal rail movements. Two of these movements, however, are very prominent and need mention. Iron ore that is mined in Marquette County is moved by rail from the mine to the ports in Marquette and Escanaba. Almost 7.5 million tons of iron ore are transported to docks in Marquette, which are then transported by water primarily to Ontario, Detroit, and other industrial cities around Lake Erie. About 3.5 million tons of iron ore are transported by rail to Escanaba to be shipped by water to southern Lake Michigan steel industry in Illinois and Indiana. Other lesser internal rail shipments include Nonmetallic Ores and Minerals, Transportation Equipment, and Farm Products.

Rail intermodal shipments, which include ocean and domestic containers and truck trailers loaded on rail flatcars, are most often used for consumer goods and subassembly components. While the US railroad market is still dominated by carload freight, the volume of intermodal shipments has been growing at a much faster rate. Between 2001 and 2005, railroad intermodal volume grew by 32 percent. In 2003, the truck-rail intermodal business became the number one source of railroad freight revenue, surpassing even coal.

The table below shows Michigan's rail intermodal movements for inbound, outbound, and through shipments. There are no internal rail intermodal movements in Michigan.

<i>Nature of Movement</i>	<i>Tons (millions)</i>	<i>Value (billion \$)</i>
Outbound	1.81	\$5.69
Inbound	1.66	\$5.01
Through	4.20	\$13.47
Total	7.67	\$24.17

Water Movements:

In 2003, Michigan's ports handled more than 78 million tons of freight valued at more than \$5 billion. Most of the waterborne commerce at Michigan's 40 cargo ports consists of bulk cargoes. Stone, sand, iron ore, and coal accounted for 86 percent of the freight total. Cement, petroleum, and chemicals account for another 12 percent. These materials are used in the steel, construction, agriculture, and petroleum industries throughout the Great Lakes region. The steel industry alone

accounts for about half of Michigan's total waterborne commerce. Iron ore, coal, coke, and limestone (used as a flux) are used in the manufacture of steel.

Detroit is the largest port, handling about one-sixth of the state's total tonnage. Several large ports in northern Michigan, including Calcite, Stoneport, Port Inland, Port Dolomite, Port Drummond, Alabaster, and Port Gypsum, are privately-owned and were built to ship stone produced in nearby quarries. Most of the traffic at Escanaba and Marquette consists of iron ore pellets mined and processed in the Upper Peninsula and destined for Great Lakes steel mills.

In 2003, Michigan's ports handled more than 38 million tons of outbound freight. The top outbound commodity by water was Nonmetallic Ores and Minerals (primarily limestone), accounting for 6 percent of outbound movements by weight. By value, Metallic Ores, valued at more than \$361 million, was the top outbound waterborne commodity. Eighteen ports in Michigan recorded outbound commodity movements, lead by Marquette (iron ore) with just under 7 million tons, followed by Calcite (limestone) with 6.7 million tons, and Stoneport (limestone) with 6.3 million tons.

In 2003, inbound waterborne freight totaled over 40 million tons. Nearly 15 million tons of Coal moved into Michigan ports, making it the top inbound commodity, accounting for 36 percent of total inbound movements. Nonmetallic Ores and Minerals accounted for an additional 34 percent, followed by Metallic Ores (iron ore) and Clay, Cement, Glass or Stone Products (cement). The top inbound commodities by value were Primary Metal Products, which exceeded \$1.3 billion, accounting for 34 percent of total value. For inbound water flows, Detroit is by far the leading destination port by tonnage, accounting for 32 percent of all inbound water movements. Saginaw River, with docks in both Bay and Saginaw Counties, holds the next highest ranking, handling primarily bulk commodities for construction and agriculture.

Air Movements:

Generally, air cargo services are provided for high-value and time-sensitive commodities to ensure secure, expeditious delivery. Air cargo is often used to ship manufactured goods when problems arise with individual truck or rail shipments, or when mechanical failures occur. Three primary segments of the air cargo industry include integrated express service, commercial service passenger airlines/freight forwarding, and all-cargo carriers.

Integrated express carriers (e.g., FedEx, UPS, and DHL) operate a fleet of scheduled aircraft, trucks, and couriers offering door-to-door delivery service. These carriers operate extensive hub-and-spoke networks providing expansive geographic coverage. Integrated express carriers move customer materials door-to-door, providing shipment pickup, transport via air or truck, and delivery.

Commercial airlines with scheduled passenger service provide "belly space" in the passenger aircraft to move cargo airport-to-airport. Commercial air carriers account for the majority of international air cargo lift, yet provide limited domestic lift. Freight forwarding companies handle a wide range of freight, from small packages that are consolidated into container loads, to oversized, one-time freight shipments. The forwarder acts as a broker between the shipper and the carrier.

All-cargo carriers operate airport-to-airport services for their customers but do not offer passenger service. All-cargo carriers offer scheduled service to major markets throughout the world using wide-body and/or containerized cargo aircraft.

Michigan airports report statistics by total cargo and total mail, not by specific commodity. In 2003, Michigan airports handled over 300,000 tons of air cargo. Detroit is the leader, with its Willow Run facility handling the most cargo. Grand Rapids, Lansing, and Flint have similar sized operations, quite often moving integrated express freight. The table below shows the top airports handling freight in Michigan.

Top Air Cargo Airports by Tonnage (2003)

<i>Airport</i>	<i>Total Tons</i>	<i>Inbound Tons</i>	<i>Outbound Tons</i>
Detroit	217,221	123,844	92,376
Grand Rapids	34,971	19,036	15,935
Lansing	25,053	13,555	11,497
Flint	15,419	9,358	6,061
Traverse City	2,357	1,287	1,069

In addition to the air cargo, Michigan airports handled about 28,500 tons of mail. Detroit accounted for 93.1 percent and Grand Rapids 6.8 percent of all airmail in the state. Airmail quite often can be loaded into the belly of commercial airlines and, since Detroit would handle the most passenger planes, this comes as no surprise.

Integration:

The information in this technical report has linkages with the *Integration Technical Report*, carrying forward into the *Conditions and Performance Technical Report* and the *Corridors and Borders Report*. The 17 technical reports that integrate into *MI Transportation Plan* can be categorized into two types: (1) reports about transportation supply (assets, infrastructure, services, and resources) and (2) reports about transportation demand (users, markets, travel segments, and industries utilizing freight). This technical report examines how different modal assets and services meet Michigan's demand for the movement of goods into, out of, within, and through Michigan.

Integrating freight into an overall transportation plan supporting Michigan's economic vitality entails structuring policy and decisions for freight infrastructure and services within the context of key industry and shipping segments using the system. Integration involves ensuring the system supports key freight-dependent activities, identifying, and removing any key barriers to effective utilization of intermodal and multi-modal freight systems and implementing any freight transportation activities that may serve to catalyze economic vitality.

Chapter 1. Introduction

The rapid and inexpensive movement of goods throughout the US supply chain, particularly through our ports and critical trade corridors, is key to securing America's economic future and maintaining our competitiveness in world markets. Trade, as a percentage of the US GDP, has been steadily increasing during the past quarter century, rising from just over 12 percent in the early 1970s to approximately 25 percent in the mid-1990s. Explosive growth over the last ten years, improvements in manufacturing processes and new technology are continuing this trend and placing ever-greater strain on the capacity of our trade gateways. The US DOT estimates that freight traffic will nearly double in the next 20 years.¹

In today's business environment, cost-effective, time-sensitive transportation services are increasingly a strategy for competitive advantage in manufacturing and service-based industries. Businesses today shop the world for raw materials, parts, and labor, managing far-flung supply chains using real-time information integrated with reliable, efficient transportation.

The effects of growing demand and limited capacity are felt as congestion, upward pressure on freight transportation prices, and less reliable trip times as freight carriers struggle to meet delivery windows. Higher transportation prices and lower reliability can mean increased supply costs for manufacturers, higher import prices, and a need for businesses to hold more expensive inventory to prevent stock outs. The effect on individual shipments and transactions is usually modest, but over time the costs can add up to a higher cost of doing business for firms, a higher cost of living for consumers, and a less productive and competitive economy.²

Michigan's storied auto industry is just one example of an industry that relies heavily on dependable freight transportation. Auto manufacturers strive to keep inventory low and their business processes depend upon a high degree of reliability in transportation performance, with pickup and delivery windows often measured in terms of minutes. Interruptions in the manufacturing supply chain due to delivery delays can result in higher carrying costs for inventory, or require that assembly line processes be temporarily shut down.

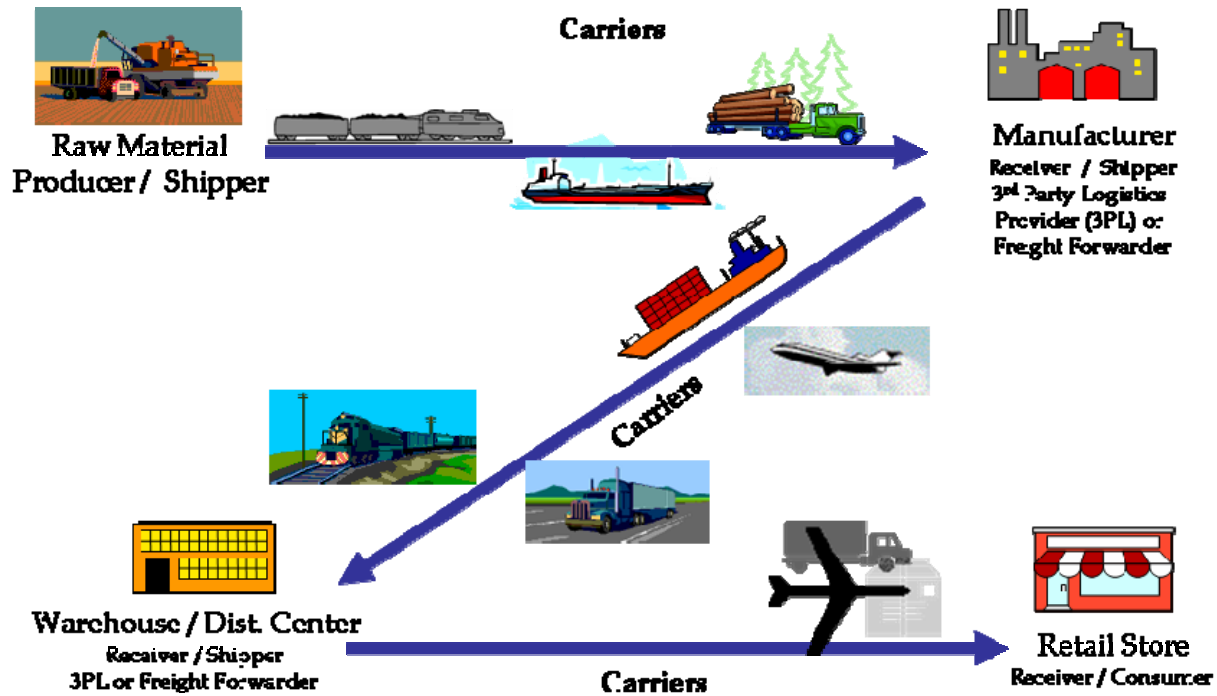
¹ Coalition for America's Gateways and Trade Corridors, online at:

<http://www.tradecorridors.org/thechallenge.html>

² USDOT, FHWA: "An Initial Assessment of Freight Bottlenecks on Highways" Page 1, accessed via the worldwide web on 8/23/06 at: <http://www.fhwa.dot.gov/policy/otps/bottlenecks/chap1.htm>

Figure 1 is an example of a basic supply chain. This simple supply chain illustration shows there are multiple parties that must be closely coordinated to make the system work smoothly and efficiently. Many companies now outsource coordination tasks to freight forwarders or third-party logistics (3PL) firms. Freight forwarding is important to all modes and is explained in more detail later in the report.

Figure 1: Illustrative Supply Chain Network



Globalization of the US economy has grown at a rapid pace over the past several decades and Michigan has been at the forefront of the industrial globalization trend. Advances in technology and management practices are also allowing US firms to develop strategies that enable customized products for mass-market distribution. The movement of goods by truck, rail, air, and water is vital to Michigan’s economy, especially manufacturing and agriculture, two of Michigan’s largest economic sectors. However, as is often the case, increasing economic activity also increases commuter and freight traffic, putting pressure on regional transportation networks. During the 2003 Transportation Summit hosted by MDOT, the business community identified urban traffic congestion as one of Michigan’s weaknesses for sustaining a vital economic future. The safe, reliable movement of freight on the state’s highway corridors and intermodal connections are keys to Michigan’s future economic vitality and quality of life.

This *Freight Profile Technical Report* describes the nature and characteristics of commodity flows to, from, within, and through the state of Michigan. The analyses for goods moving by truck and rail are based primarily on commodity flow estimates taken from the 2003 TRANSEARCH

database provided by Global Insight, Inc. Waterborne movements are based on data supplied by the US Army Corps of Engineers (USACE), local agencies, and marine terminals. Air cargo data has been assembled by MDOT from reports completed by individual airports. While every effort has been made to ensure the accuracy of the commodity flow estimates, it must be noted that the data compilation for this technical report reflects calculated estimates of generalized commodity flows and should not be regarded as an empirical inventory of shipments.

Throughout the report, freight movements will be classified by four types: Inbound, Outbound, Internal, and Through. Inbound shipments are those that originated outside of Michigan and have a Michigan destination. Outbound movements are those that originated in Michigan and are destined to locations outside of Michigan. Internal movements are intrastate shipments that have both an origin and a destination within Michigan. Through shipments have an origin and a destination outside of Michigan, but the movement traverses Michigan on its route. It must be noted that internal and through commodity movement totals were analyzed for truck and rail modes only, as the data for such movements by water and air is considered insufficient or unreliable. Also, commodities moving by pipeline were not analyzed.

The analysis of commodity movements is presented in most cases by volume expressed as tons, and by total value of the commodities expressed in 2003 US dollars. The volume of commodity movements by weight is an important factor in assessing the demands being placed upon the physical infrastructure in particular for surface modes. The physical assets of surface transportation networks such as bridges, pavements, and track are consumed over time by repetitions of heavy vehicle movements. Commodity volumes also contribute to congestion across all modes of transportation. Value expressions of commodity movements provide an indicator of the economic importance of the transportation system to the continued vitality of Michigan's economy.

1.1 International Trade with Canada

The world's largest bilateral trade relationship exists between the United States and Canada, with Michigan positioned as a leader in international trade. Goods and people moving across Michigan's borders significantly impact the economies of Michigan and Ontario, and the economies of the United States, Canada, and other nations.

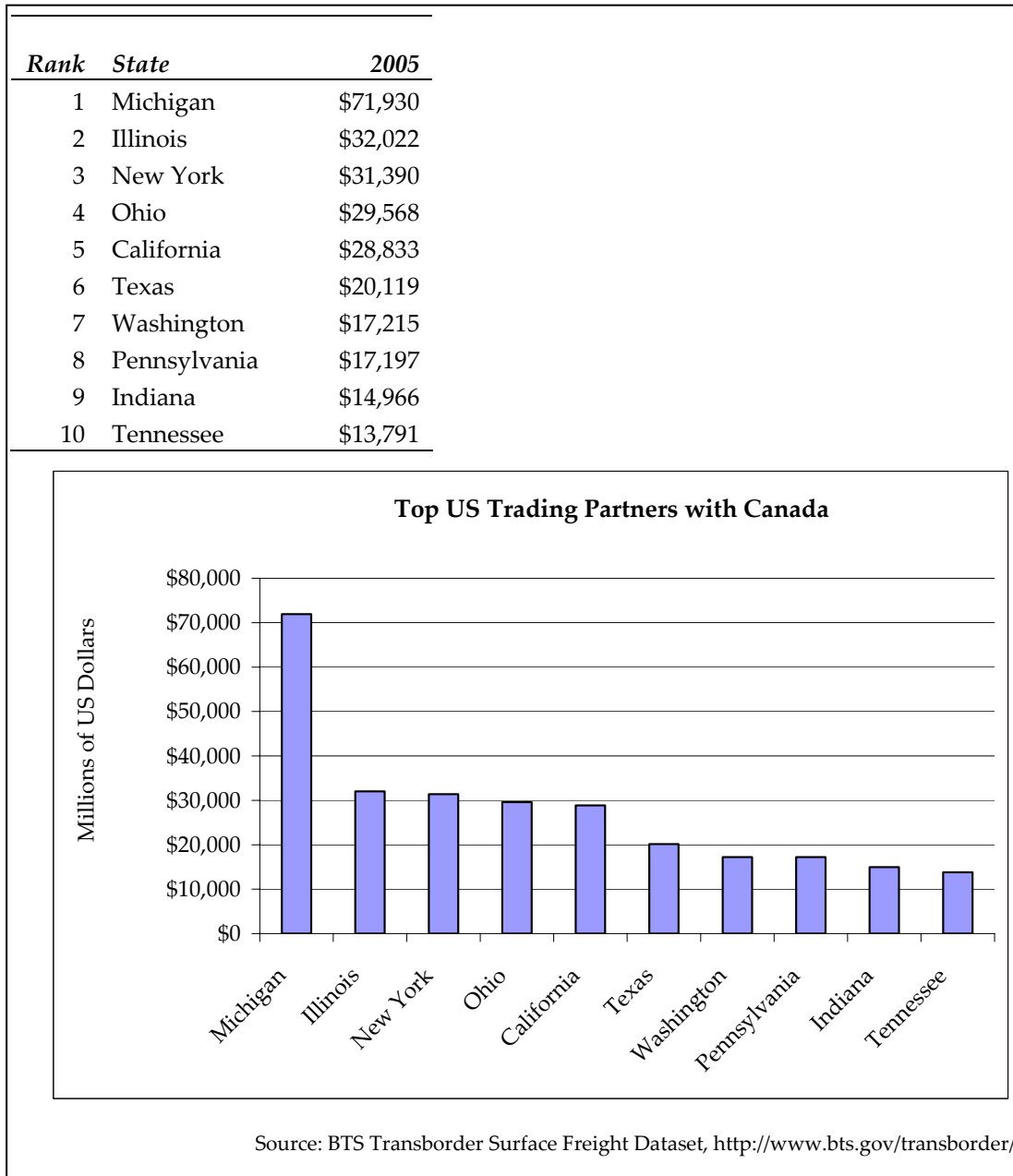
Michigan's international border crossings are vital links for international commerce and are critical to the well being of the local, state, and national economies. Canada's exports to the US constitute one third of its GDP and 87 percent of its exports. US trade with Canada averages \$1.2 billion per day, more than US trade with the entire European Union. In 2005, surface transportation trade between the US and Canada totaled \$458 billion, up 12 percent compared to 2004. Over the past 30 years, US/Canada cross-border trade has grown faster than the GDP, at an annual rate of approximately 11 percent.

The strong growth in trade between Michigan and Canada was first boosted by the US – Canada Free Trade Agreement that took effect in 1989. This treaty was superseded by the North American Free Trade Agreement in 1994, which now included Mexico. These trade

agreements abolished or reduced all tariffs on exports between the countries. In the last decade, trade between the US and Canada has increased over 75 percent, and trade between Michigan and Canada was up 32 percent. The province of Ontario imported nearly 97 percent of Michigan's total exports to Canada in 2002. These figures show that US – Canada trade is ever increasing, and that Michigan is at the forefront. **Figure 2** shows that Michigan's trade with Canada is more than twice any other single state, and more than Illinois and New York combined.

Two-thirds of the US/Canada trade moves by truck. Most of the truck flows crossing the 4,000-mile border used 22 principal crossings. From 2001 through 2005 approximately 43 percent of all US/Canada trade moved through just two of Michigan's international crossings (the Ambassador Bridge in Detroit and the Blue Water Bridge in Port Huron).

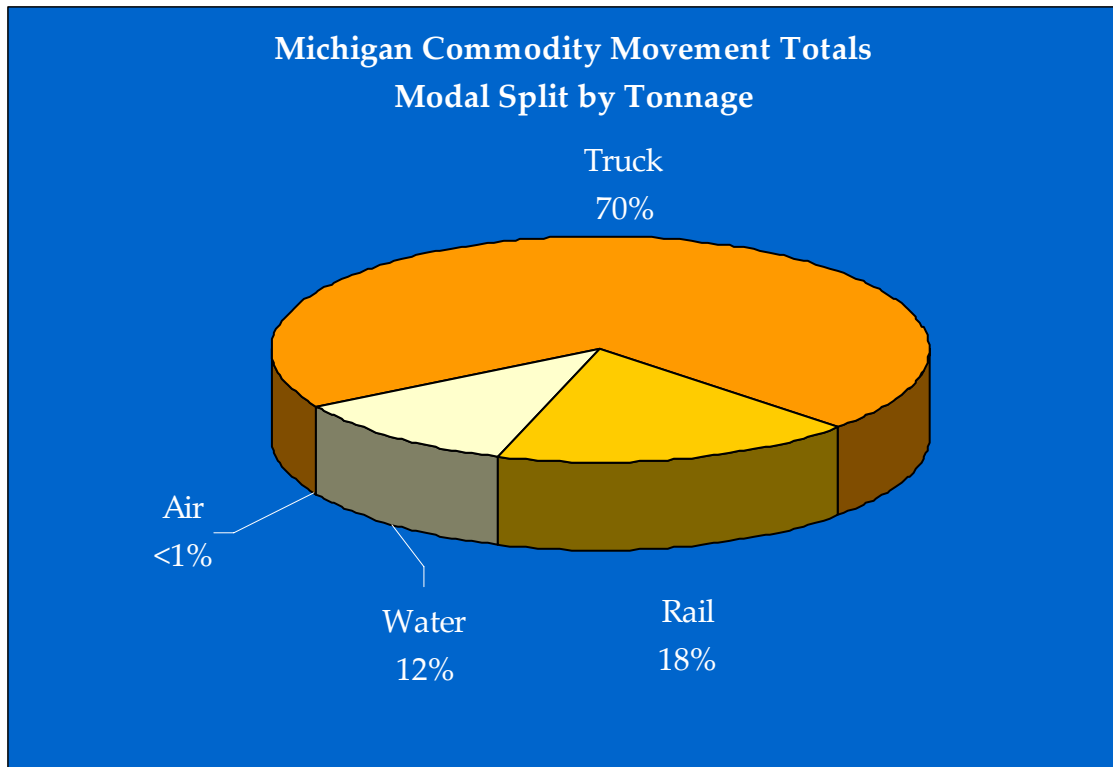
Figure 2: Top US Trade Partners with Canada by Value in 2005 (million \$)



1.2 The Nature of Freight Shipments in Michigan

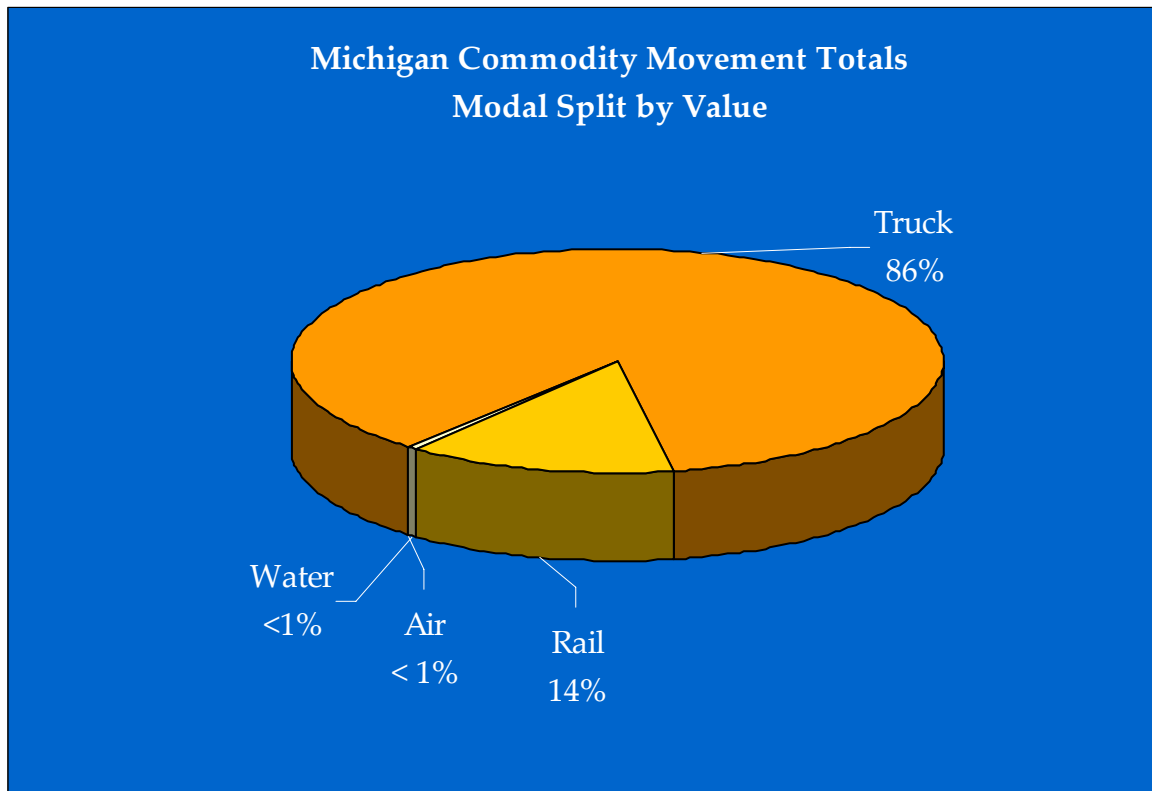
In 2003, Michigan’s multi-modal transportation systems: highway, rail, water and air cargo networks, facilitated the movement of approximately 670 million tons of freight with an estimated value exceeding \$1 trillion. When examining all of the freight moving in, out, within and through Michigan, in terms of volume by weight, approximately 70 percent of Michigan’s freight flows move by truck, 18 percent moves on railroads, 12 percent moves on water, and less than 1 percent moves by air (see **Figure 3**).

Figure 3: Michigan Freight Shipments by Tonnage



Commodity movements measured by value further increase the importance of highways as the underpinning of Michigan's commerce, as the truck modal share increases to 86 percent. In terms of value, the modal share carried by railroads declines slightly to 14 percent, while the water transport mode drops precipitously to approximately 1 percent. Air cargo flows, while often carrying high-value cargoes, remain less than 1 percent of the overall value of freight movements. The relative market share of each mode in terms of cargo value is shown in **Figure 4**.

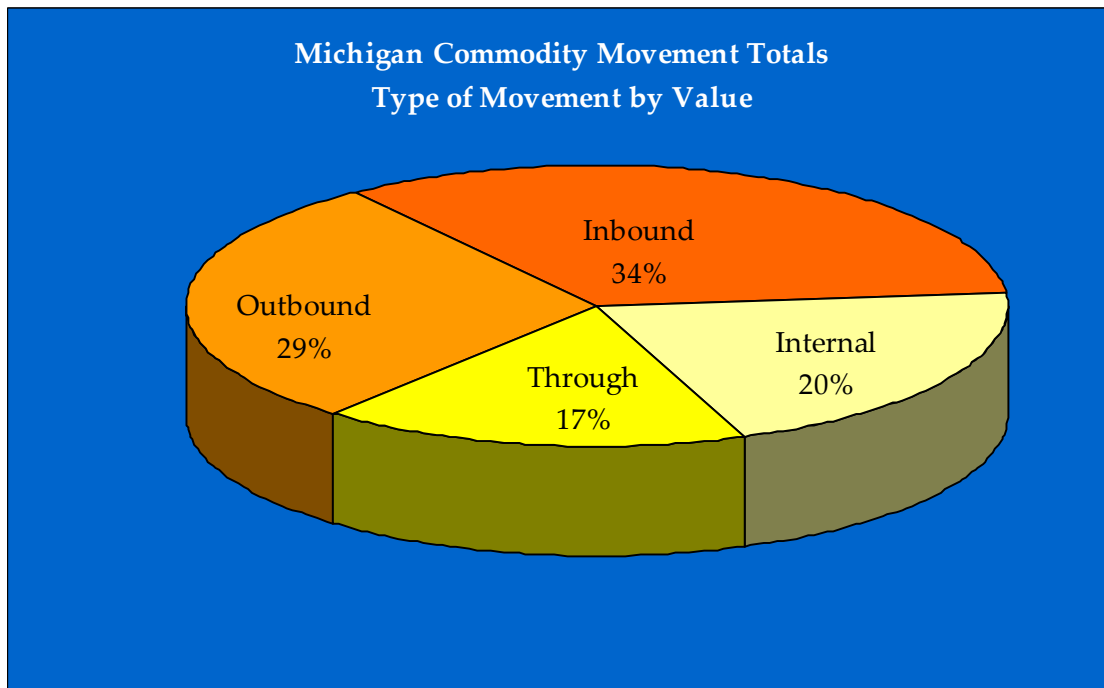
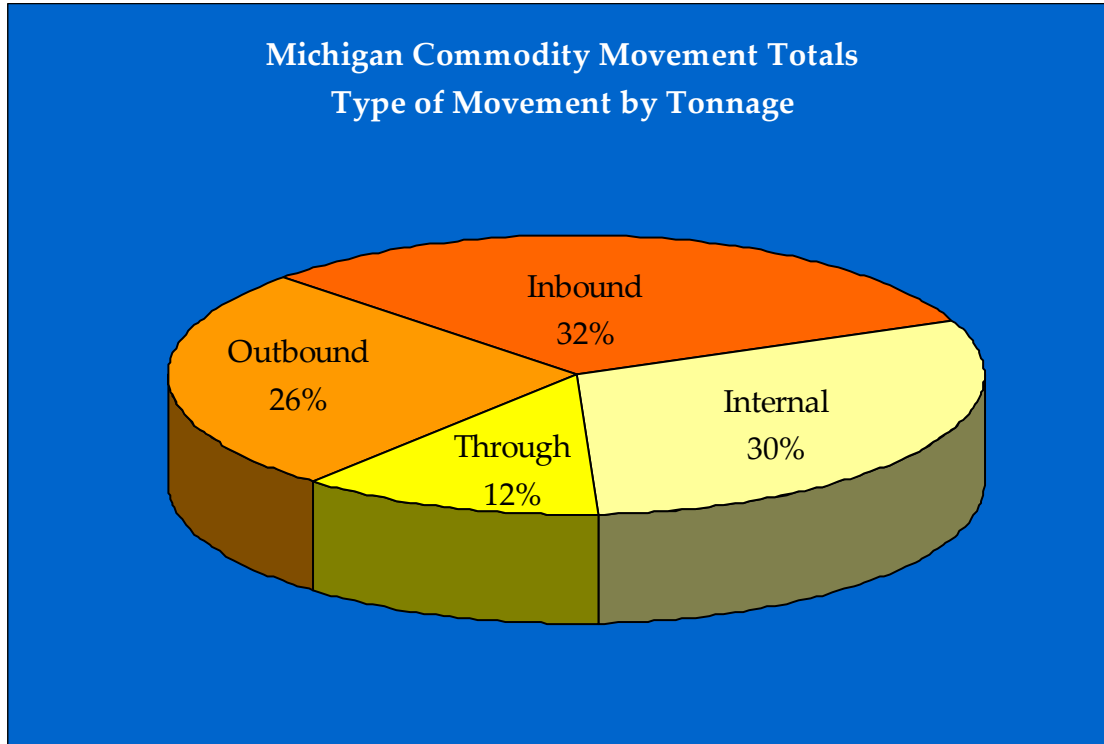
Figure 4: Michigan Freight Shipments by Value



Inbound shipments comprise the largest type of freight movement in Michigan. In 2003, inbound commodities accounted for 32 percent of all freight movements in Michigan by tonnage and 34 percent by value. Outbound commodities accounted for 26 percent of all flows by tonnage and 29 percent by value. Internal movements accounted for 30 percent of the total by weight but only 20 percent by value. The relatively low value of internal freight movements reflects the large volumes of farm and natural resource products moving locally which carry a lower value per ton than most manufacturing products. Through shipment commodities accounted for 12 percent of the total movements by weight and 17 percent by value.

Figure 5 presents information about the nature of Michigan’s freight flows in terms of tonnage and value.

Figure 5: The Nature of Michigan Freight Flows by Tonnage and Value



Commodity value by weight is important background data for interpreting commodity flows in the context of economic importance to Michigan. Some commodities, like Coal and Nonmetallic Ores and Minerals, account for large weight and volume flows, but have relatively low values compared to other commodity groups. **Table 1** lists average values per ton for two-digit Standard Transportation Commodity Code (STCC) applied to the freight movements in this analysis. Global Insight, Inc. provided average value per ton at a more detailed four-digit STCC level. These have been aggregated to the two-digit level and weighted by the amount of the four-digit detailed commodity amount moved in Michigan.

Table 1: Average Value per Ton of Michigan Freight Commodities

STCC2	Commodity Descriptions	Average Value Per Ton		
		Truck	Rail	Water
1	Farm Products	\$335	\$242	n/a
8	Forest Products	\$3,937	\$3,064	n/a
9	Fresh Fish	\$2,684	\$8,018	n/a
10	Metallic Ores	\$39	\$22	\$34
11	Coal	\$28	\$28	\$28
13	Crude Petroleum and Natural Gas	\$460	n/a	n/a
14	Nonmetallic Ores and Minerals	\$11	\$61	\$6
19	Ordnance	\$81,274	\$2,402	n/a
20	Food Products	\$1,179	\$913	n/a
21	Tobacco Products	\$36,314	n/a	n/a
22	Textile Mill Products	\$4,704	\$3,684	n/a
23	Apparel or Finished Textiles	\$10,858	\$7,405	n/a
24	Logs, Lumber, and Wood Products	\$532	\$479	\$180
25	Furniture and Fixtures	\$4,699	\$4,364	n/a
26	Paper and Pulp Products	\$1,572	\$943	n/a
27	Printed Matter	\$7,651	\$9,548	n/a
28	Chemical Products	\$1,704	\$1,039	\$263
29	Petroleum or Coal Products	\$335	\$373	\$323
30	Rubber and Plastics	\$3,771	\$3,680	n/a
31	Leather Products	\$11,796	n/a	n/a
32	Clay, Cement, Glass or Stone Products	\$230	\$361	\$68
33	Primary Metal Products	\$2,090	\$2,465	\$2,920
34	Fabricated Metal Products	\$4,126	\$5,513	\$2,298
35	Machinery	\$12,955	\$12,269	\$10,732
36	Electrical Equipment	\$11,835	\$6,722	n/a
37	Transportation Equipment	\$5,721	\$5,064	n/a
38	Technical Instruments and Equipment	\$27,289	\$23,836	n/a
39	Misc. Manufacturing Products	\$12,912	\$27,028	\$12,986
40	Waste or Scrap Materials	\$36	\$464	n/a
41	Misc. Freight Shipments	\$343	\$2,440	n/a
43	Mail or Contract Traffic	\$2,065	\$2,065	n/a
44	Freight Forwarder Traffic	n/a	\$2,440	n/a
46	Misc. or Mixed Shipments	\$3,639	\$1,048	n/a
49	Hazardous Materials	\$343	n/a	n/a
50	Secondary Traffic	\$5,554	n/a	n/a

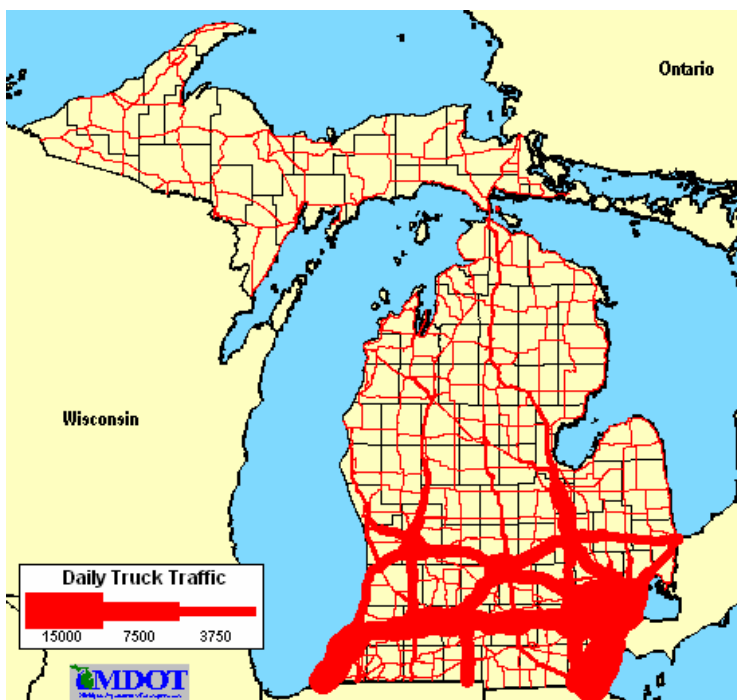
Chapter 2. Modal Summaries

The following section discusses Michigan commodity movements by each of the major modes: truck, rail, water, and air.

2.1 Truck Movements

Nearly every product consumed in the US at some point is transported upon a truck. The trucking industry plays a key role in today's globally integrated economy, employing 8.6 million people nationwide. In Michigan, the trucking industry employs one in every eleven residents of the state. Nationally, trucking accounts for 68.9 percent of freight movements by weight and 86.9 percent by value. Michigan closely mirrors the national modal split profile with 70.5 percent of freight tonnage moving by truck and 86.0 percent by value. Trucking accounted for nearly 474 million tons of commodity movements in, out, within, and through Michigan in 2003, with an estimated value exceeding \$1 trillion. The heavy dependence of the US economy upon the trucking industry has also contributed to increasing congestion on state and national highways. The map in **Figure 6** shows the average annual daily truck traffic on Michigan's highway system. Major interstates I-94 and I-75 have the greatest truck volumes. I-75 between Detroit and Toledo, Ohio carries an average of 16,000 trucks a day. I-275/I-96, near Livonia and Novi, carries over 15,000 and I-94, near Benton Harbor, averages over 14,000 per day.

Figure 6: Average Annual Daily Truck Traffic on Michigan Highways



In 2003, Secondary Traffic was Michigan's largest commodity movement by truck (by value), accounting for 34 percent of the total. Secondary Traffic is a growing commodity group in today's multi-modal economy. Secondary Traffic includes truck movements to and from warehouse and distribution centers, intermodal terminals, and air cargo facilities. Several commodities or mixed shipments can be included in this category. Transportation Equipment ranked second in total value with 16 percent, followed by Machinery with 10 percent.

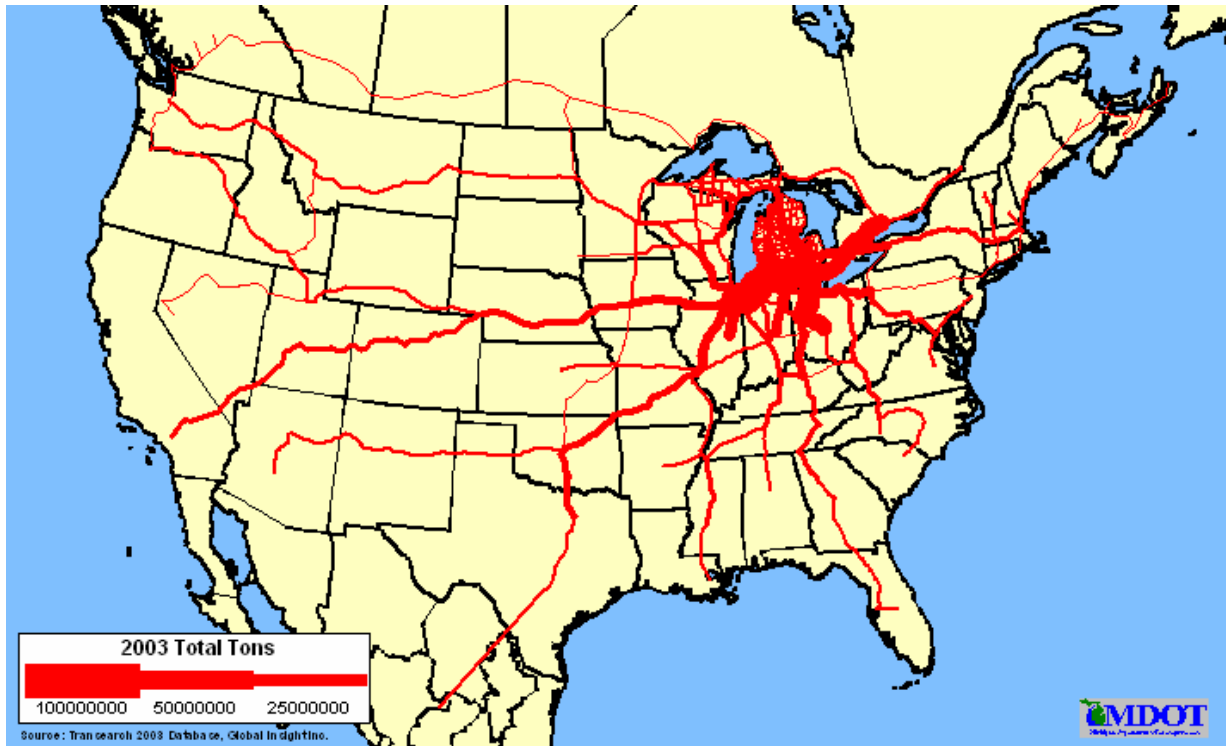
Nonmetallic Ores and Minerals are the leading commodity shipped by truck in terms of weight, accounting for approximately one-quarter (24%) of all tonnage moving by truck. Secondary Traffic ranks second by tonnage, with 13 percent, followed by Clay, Cement, Glass or Stone Products (11%), and Food Products (7%). Michigan has enormous production of sand and gravel for industrial and construction purposes, which comprises much of the nonmetallic mineral tons. **Table 2** below provides a summary of the top ranking commodities by both tonnage and value, moving by trucks in Michigan.

Table 2: Total Commodity Movements by Truck, Ranked by Tons and Value

<i>Commodity Tonnage Rank</i>	<i>Total Truck Tons (millions)</i>	<i>Commodity Value Rank</i>	<i>Total Truck Value (billion \$)</i>
Nonmetallic Ores and Minerals	111.36	Secondary Traffic	\$344.50
Secondary Traffic	62.02	Transportation Equipment	\$159.31
Clay, Cement, Glass or Stone Products	49.91	Machinery	\$100.31
Food Products	32.66	Fabricated Metal Products	\$62.20
Farm Products	31.60	Electrical Equipment	\$57.97
Logs, Lumber, and Wood Products	28.09	Chemical Products	\$43.56
Transportation Equipment	27.84	Primary Metal Products	\$43.37
Chemical Products	25.57	Food Products	\$38.49
Petroleum or Coal Products	22.44	Rubber and Plastics	\$24.79
Primary Metal Products	20.75	Misc. Manufacturing Products	\$23.14
Other Commodities	61.40	Other Commodities	\$129.94
Grand Total	473.64	Grand Total	\$1,027.58

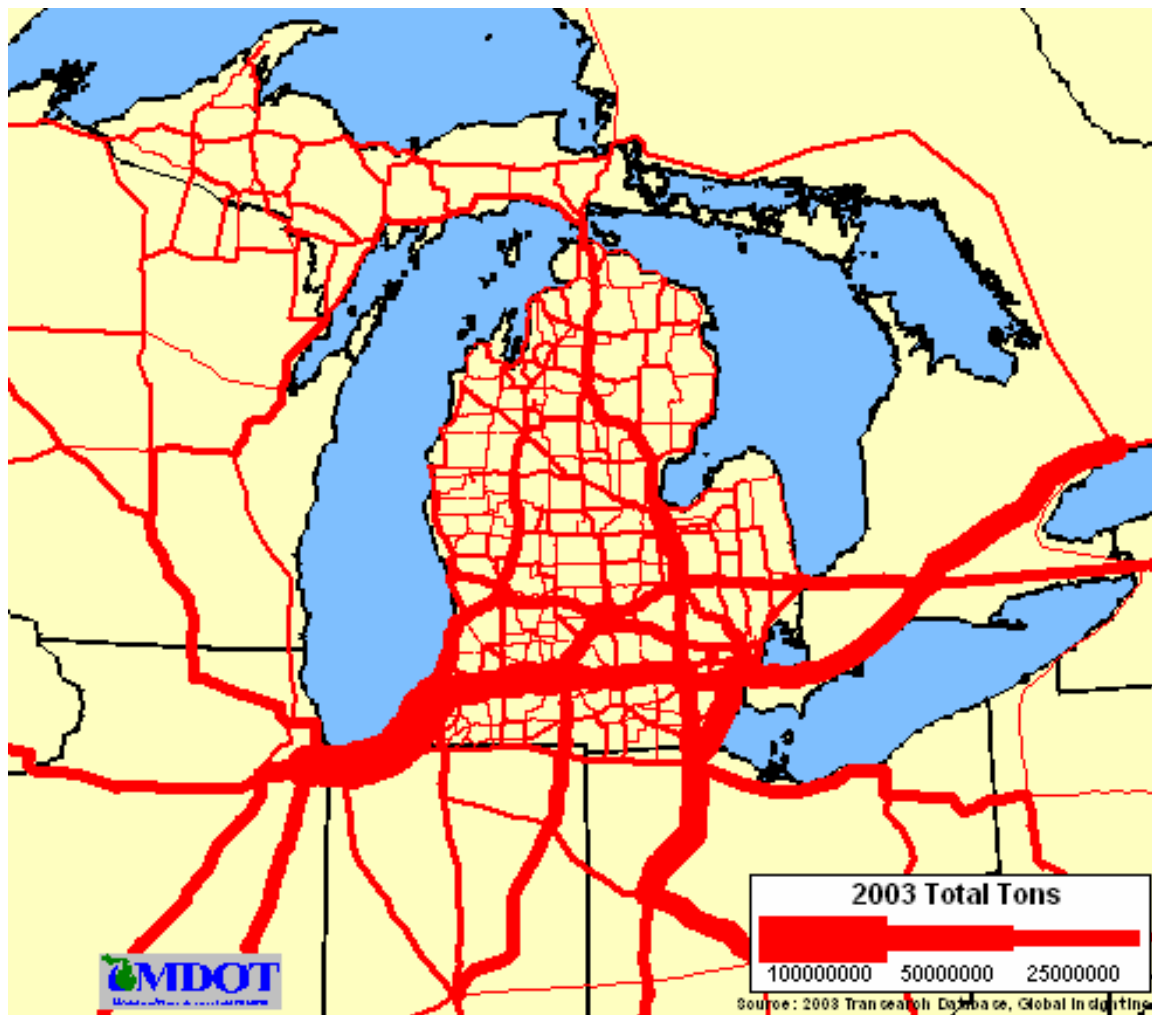
The map in **Figure 7** shows the commodity volume movements by truck being generated by Michigan commerce. The national map in the graphic shows a strong trade relationship between Michigan and neighboring jurisdictions in the Great Lakes region, as well as the long reach of Michigan’s economy in the US and North America. A significant volume of goods are being trucked to and from Michigan, the Ports of Los Angeles/Long Beach in Southern California, the eastern seaboard, and Texas. The map also demonstrates that the commerce generated by Michigan’s economy touches every state in the contiguous 48 states.

Figure 7: National Truck Movement Volumes for Michigan Commodities



The regional map in **Figure 8** provides a more detailed look at the key highway corridors serving the trucking industry in Michigan and the surrounding Great Lakes region. The highway facilities supporting the largest volume of commodity flows is the east/west I-94 corridor traversing Michigan and providing a link between Ontario, to the east, with Chicago, to the west. The I-94 corridor near the Indiana state line carries about 100 million tons of freight annually, the most of any highway facility. Nonmetallic mineral, agricultural, and manufacturing commodities make up much of the tonnage. As expected, the interstates and US highways support the most freight volumes.

Figure 8: Key Regional Highway Corridors for Michigan Commodities Moving by Truck



2.1.1 Outbound Truck Movements

In 2003, more than 176 million tons of freight flowed out of Michigan, with approximately 63 percent of these outbound flows leaving the state on trucks. Michigan's highway system, in 2003, carried 111 million tons of commodities in route to destinations outside the state. The most common outbound commodity movements via truck include Nonmetallic Ores and

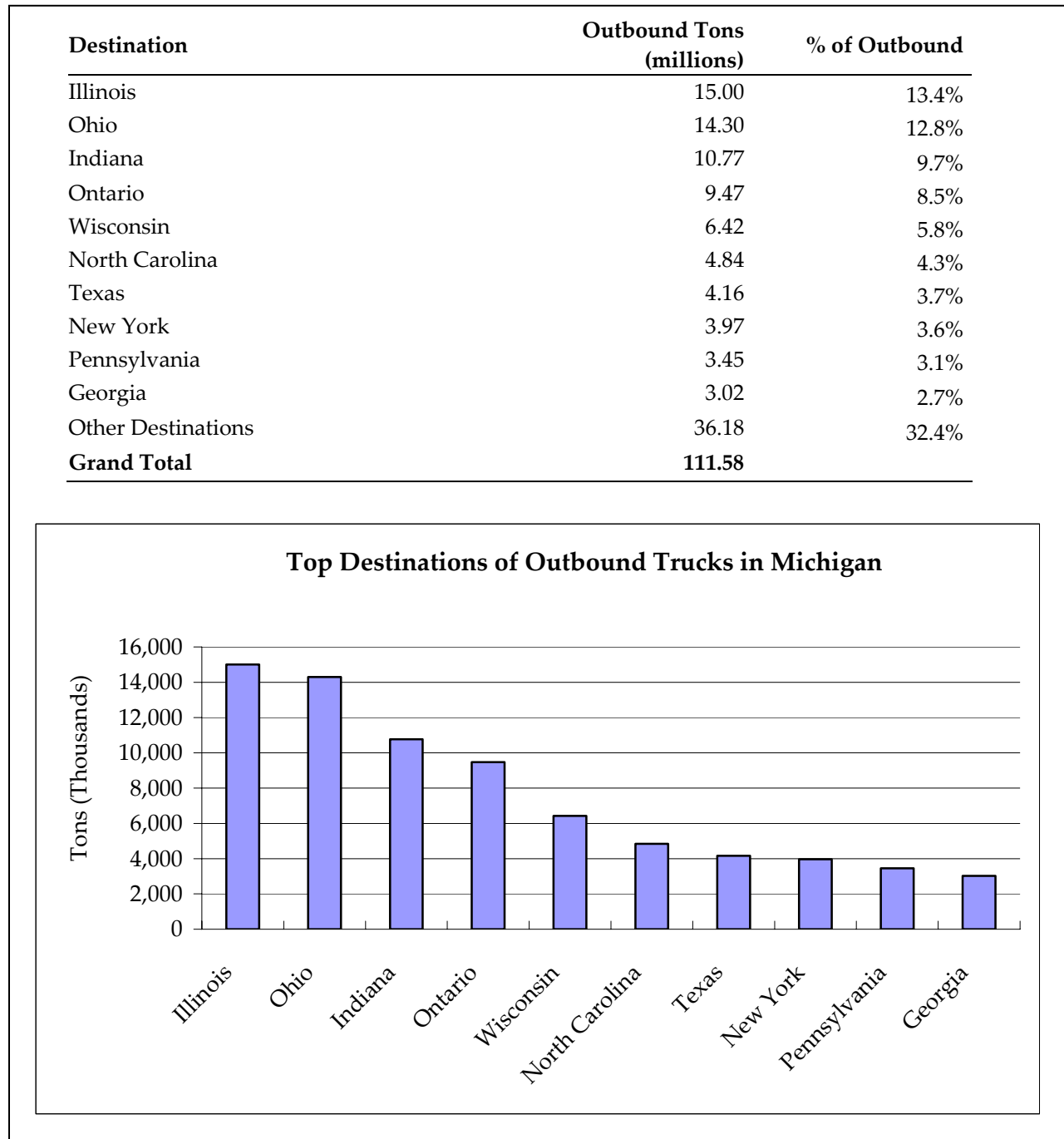
Minerals (16%), Farm Products (13%), Transportation Equipment (10%), and Secondary Traffic (9%). These four commodity groups together comprised nearly half of all the outbound truck tonnage leaving the state. **Table 3** shows the top commodity groups for outbound truck movements from Michigan by both tonnage and value.

Table 3: Top Outbound Truck Movements from Michigan by Value & Tons

<i>Commodity Tonnage Rank</i>	<i>Outbound Tonnage (millions)</i>	<i>Commodity Value Rank</i>	<i>Outbound Value (billion \$)</i>
Nonmetallic Ores and Minerals	17.69	Transportation Equipment	\$62.74
Farm Products	14.25	Secondary Traffic	\$58.15
Transportation Equipment	11.65	Fabricated Metal Products	\$31.18
Secondary Traffic	10.19	Machinery	\$28.94
Primary Metal Products	7.95	Primary Metal Products	\$15.68
Fabricated Metal Products	7.94	Chemical Products	\$15.52
Food Products	7.55	Electrical Equipment	\$14.02
Clay, Cement, Glass or Stone Products	7.26	Food Products	\$11.51
Chemical Products	6.86	Rubber and Plastics	\$8.22
Paper and Pulp Products	4.24	Furniture or Fixtures	\$6.98
Other Commodities	16.00	Other Commodities	\$23.87
Grand Total	111.58	Grand Total	\$276.81

In 2003, Illinois was the top destination for outbound freight moving from Michigan by truck in terms of weight. Overall, Illinois and Ohio each accounted for approximately 13 percent of truck exports by weight, together accounting for more than one-quarter of the total outbound truck freight. Indiana ranked third as an outbound truck destination (10%), and the Province of Ontario was fourth (9%). Together the top five jurisdictions, including Wisconsin, account for over 50 percent of Michigan's outbound truck movements. This shows how strong the trade is between Michigan and its Great Lakes neighbors. **Figure 9** shows the top destinations of freight moving via the highway system from Michigan, ranked by tonnage.

Figure 9: Top Destinations for Michigan’s Outbound Truck Movements by Tons



2.1.2 Inbound Truck Movements

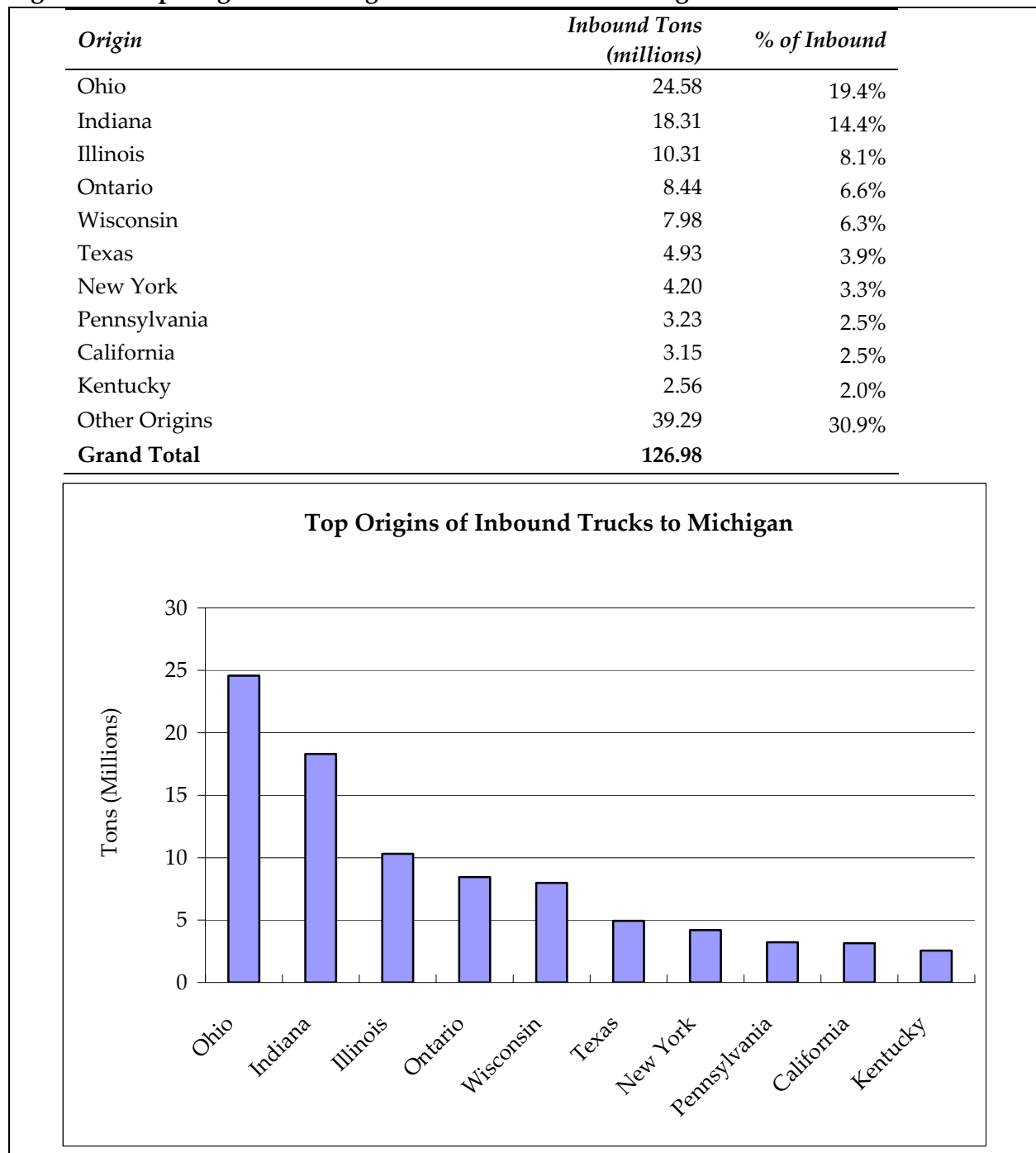
Of the 210 million tons of commodities flowing into Michigan, 60 percent entered the state in a truck. Of the nearly 127 million tons of inbound freight moving on trucks, the most common commodity types included Secondary Traffic which accounted for 16 percent of inbound truck movements, Nonmetallic Ores and Minerals accounted for about 15 percent, Food Products another 12 percent, while Petroleum and Coal Products and Chemical Products each accounted for another 10 percent. These five commodity groups make up over half of all truck commodity imports by tonnage to Michigan. **Table 4** shows the top commodity flows by truck, moving as imports to Michigan by tonnage and value.

Table 4: Top Ten Inbound Truck Movements into Michigan by Value and Tons

<i>Commodity</i>	<i>Inbound Tons (millions)</i>	<i>Commodity</i>	<i>Inbound Value (billion\$)</i>
Secondary Traffic	20.42	Secondary Traffic	\$113.03
Nonmetallic Ores and Minerals	18.50	Transportation Equipment	\$53.63
Food Products	15.64	Machinery	\$37.00
Petroleum or Coal Products	13.05	Electrical Equipment	\$32.78
Chemical Products	12.80	Chemical Products	\$16.62
Clay, Cement, Glass or Stone Products	6.70	Fabricated Metal Products	\$16.54
Transportation Equipment	6.13	Food Products	\$16.07
Logs, Lumber, and Wood Products	6.04	Primary Metal Products	\$12.14
Primary Metal Products	5.46	Misc. Manufacturing Products	\$12.12
Farm Products	3.70	Technical Instruments and Equipment	\$7.74
Other Commodities	18.55	Other Commodities	\$46.57
Grand Total	126.99	Grand Total	\$364.24

Like outbound movements, inbound trucks come from locations concentrated primarily in Michigan’s neighboring jurisdictions in the Midwest and Canada. Ohio, Indiana, Illinois, Ontario, and Wisconsin are the top five origins of truck tons into Michigan. These account for 55 percent of inbound movements. The remaining truck tons come from a broadly dispersed geography with some concentration in states located in the East and South Central regions of the US. **Figure 10** provides a list of the top 10 locations generating inbound trucks to Michigan.

Figure 10: Top Origins of Michigan’s Inbound Truck Tonnage



2.1.3 Through Truck Movements

Approximately 7 percent of Michigan's truck commodity movements by tonnage move through the state. Through commodity movements refer to those goods movement trips where the origin and destination both lie outside the state of Michigan. The percentage of through truck movements in Michigan increases to 12 percent by value. Compared to many other states in the Midwest and Ohio Valley, Michigan's percentage of through-traffic is relatively small. For instance, in the state of Missouri approximately 70 percent of all commodity flows are through movements. Michigan's unique peninsular geography contributes to the relatively low percentage of through-traffic. Of the roughly 44 million tons of freight passing through Michigan via truck, the most common commodity types include Transportation Equipment (17%), Food Products (10%), Paper and Pulp Products (10%), and Chemical Products (9%). These four groups comprise nearly half of the through truck movements in Michigan. **Table 5** below shows the top commodity groups for truck shipments through Michigan by tonnage and value.

Table 5: Top Michigan Highway Through Commodities by Tonnage and Value

<i>Commodity</i>	<i>Tons</i>		<i>Value</i> <i>Through</i> <i>(billion \$)</i>
	<i>Through</i> <i>(millions)</i>	<i>Commodity</i>	
Transportation Equipment	7.80	Transportation Equipment	\$31.94
Food Products	4.63	Machinery	\$28.00
Paper and Pulp Products	4.40	Primary Metal Products	\$9.59
Chemical Products	3.92	Paper and Pulp Products	\$8.16
Primary Metal Products	3.49	Misc. Manufacturing Products	\$7.66
Farm Products	3.36	Chemical Products	\$7.48
Logs, Lumber, and Wood Products	2.56	Rubber and Plastics	\$7.06
Machinery	2.38	Electrical Equipment	\$7.05
Rubber and Plastics	1.85	Fabricated Metal Products	\$7.01
Nonmetallic Ores & Minerals	1.73	Food Products	\$6.44
Other Commodities	8.42	Other Commodities	\$24.09
Grand Total	44.54	Grand Total	\$144.48

While free trade has been a catalyst in Michigan's economic growth in terms of imports and exports, it has also generated more through traffic, which contributes to congestion and wear on Michigan highways, while benefiting surrounding jurisdictions. **Figure 11** shows the origins of truck tons shipped through Michigan by truck. The province of Ontario is by far the single largest source of commodities being generated for Canadian export into the US. The majority of through movements include trips between Ontario and its Great Lake neighbors, California, and Texas. Also, trips to and from the Northeast and the Midwest are common. These movements use Ontario as part of the shortest distance for long trips to save time and money.

Figure 11: Origins of Michigan’s Through Freight Traffic by Truck

<i>Origin</i>	<i>Tons of Through Movement (millions)</i>	<i>% of Total</i>
Ontario	12.27	27.5%
Ohio	3.75	8.4%
Illinois	3.29	7.4%
Quebec	3.17	7.1%
Wisconsin	2.79	6.3%
California	2.39	5.4%
Indiana	2.26	5.1%
Maine	1.45	3.3%
Texas	1.13	2.5%
Kentucky	.965	2.2%
Other Origins	11.01	24.9%
Grand Total	44.47	

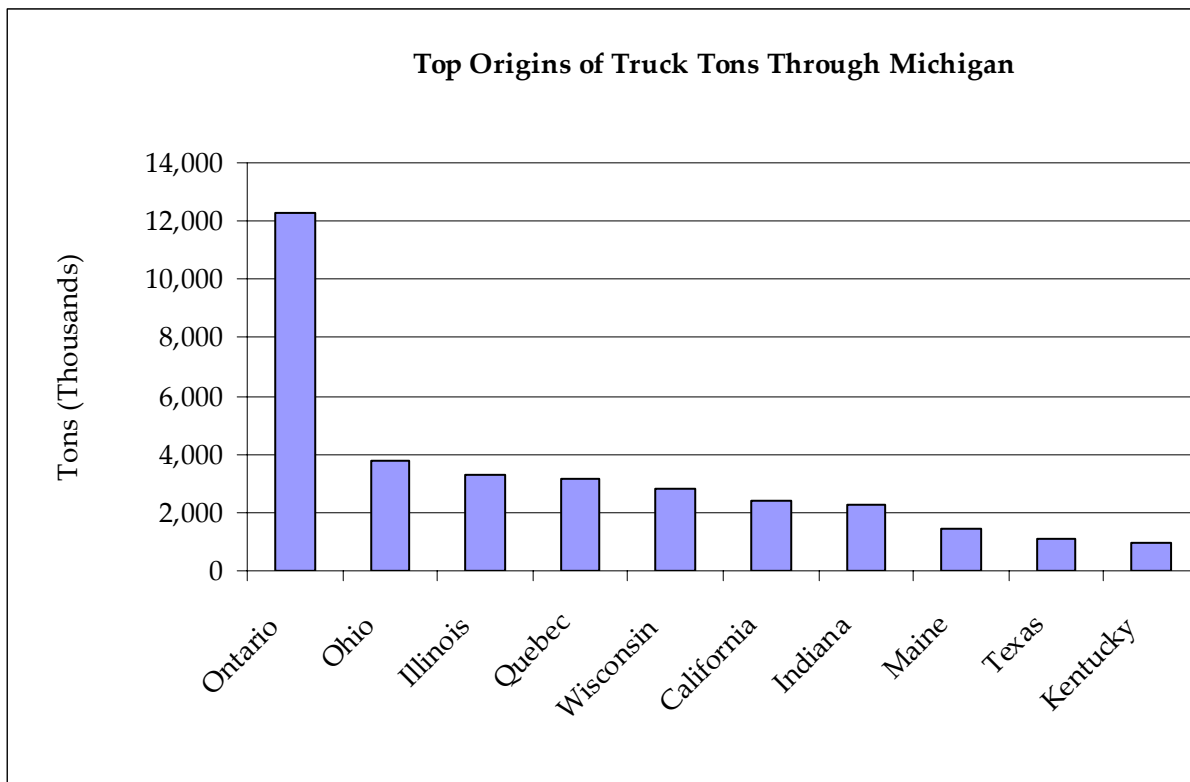
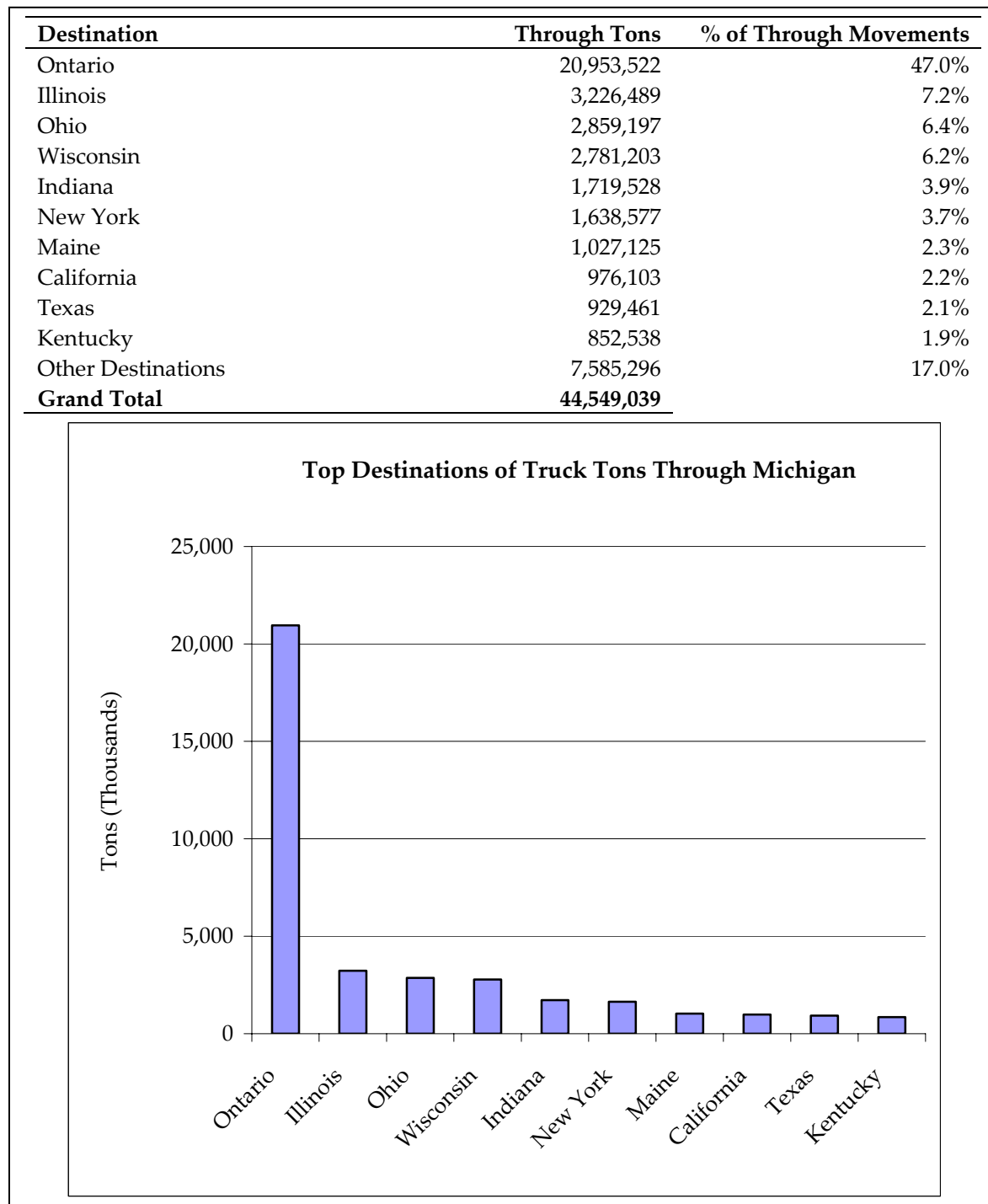


Figure 12 shows the destinations of commodities passing through Michigan by truck. The province of Ontario also ranks as the top destination for through truck tonnage. The group of Great Lakes states - Illinois, Ohio, Wisconsin, and Indiana account for the next largest destinations of through truck commodities, although all with significantly lesser shares.

Figure 12: Top Destinations for Michigan’s Highway Through Commodities



2.1.4 Internal Truck Movements

Internal, or intrastate, freight shipments moving by truck account for nearly 30 percent of Michigan's total freight movements by weight and about 20 percent of the total by value. Within just the trucking mode, commodity movements internal to Michigan account for about 40 percent of all the goods moved by truck, but only 23 percent by value. This relatively large percentage difference between tonnage and value reflects the low-value, high-weight commodities that typically make up a large share of short-haul intrastate movements. **Table 6** displays the top internal commodity movements by tonnage and value. By weight, not surprisingly, several commodities groups related to natural resource extraction and agriculture rank in the top 10 including Nonmetallic Ores and Minerals, Clay, Cement, Glass, or Stone Products, Farm Products and Logs, Lumber, and Wood Products. By value, many of the typically bulk commodity groups rank significantly lower and are replaced by commodities related to the service and manufacturing sectors such as Secondary Traffic and Transportation Equipment.

Table 6: Top Internal Truck Commodities by Tonnage and Value

<i>Commodity Tonnage Rank</i>	<i>Tons</i>		<i>Value</i>
	<i>Intrastate (millions)</i>	<i>Commodity</i>	<i>Intrastate (billion \$)</i>
Nonmetallic Ores and Minerals	73.44	Secondary Traffic	\$172.28
Clay, Cement, Glass, or Stone Products	34.73	Transportation Equipment	\$10.99
Secondary Traffic	31.22	Fabricated Metal Products	\$7.47
Logs, Lumber, and Wood Products	15.31	Machinery	\$6.37
Farm Products	10.29	Primary Metal Products	\$5.97
Petroleum or Coal Products	5.73	Logs, Lumber, and Wood Products	\$5.74
Food Products	4.84	Food Products	\$4.47
Primary Metal Products	3.85	Electrical Equipment	\$4.11
Transportation Equipment	2.26	Chemical Products	\$3.95
Paper and Pulp Products	2.21	Printed Matter	\$3.46
Other Commodities	6.66	Other Commodities	\$17.24
Grand Total	190.55	Grand Total	\$242.05

Table 7 displays the top county origins and destinations for Michigan's internal truck movements by tonnage. The most tons originate in Oakland County, due to the large gravel and aggregate operations, and in Wayne County, since it continues to lead in manufacturing production. The top county destinations closely mirror the top 10 in population and employment, which shows that the freight is moving to where the people and the jobs are. Only Muskegon County is a top commodity destination by tonnage that is not in the top 10 in population.

Table 7: Top Origin/Destination Counties for Intrastate Truck Movements

<i>Origin</i>	<i>Tons (millions)</i>	<i>Destination</i>	<i>Tons (millions)</i>
Oakland County	24.31	Wayne County	24.18
Wayne County	22.50	Oakland County	17.85
Allegan County	8.46	Macomb County	12.12
Monroe County	8.38	Kent County	11.51
Ottawa County	8.06	Ottawa County	5.85
Muskegon County	7.76	Kalamazoo County	5.60
Kent County	7.75	Muskegon County	5.23
Macomb County	7.65	Genesee County	4.54
Kalamazoo County	6.32	Ingham County	4.04
Calhoun County	4.92	Washtenaw County	3.83
Other	84.43	Other	95.79
Grand Total	190.55	Grand Total	190.55

2.2 Rail Movements

Michigan has 27 freight railroads that operate across 3,590 miles of track in the state. In 2004, freight railroads in the state employed approximately 4,000 people. **Figure 13** shows the extent of Michigan’s railroad system.

Figure 13: Michigan’s Railroad System



In 2003, Michigan's railroads carried nearly 120 million tons of freight, accounting for approximately 18 percent of Michigan's total commodity movements. The estimated value of these rail flows exceeded \$162 billion. The largest rail commodities by tonnage include Coal, Metallic Ores, Chemical Products, and Transportation Equipment. Michigan's most valuable rail movement commodity is Transportation Equipment, followed by Mixed Shipments, Metal Products, and Chemical Products.

The maps in **Figures 14 and 15** show the key rail freight corridors for goods moving in, out, within, and through Michigan in 2003. Much like the highway maps in the previous section, **Figure 14** highlights the key role that Michigan plays in the national economy, as well as the significant volume of commerce being conducted between Michigan and its neighbors in the Great Lakes region. The regional map detail in **Figure 15** further emphasizes the large volumes of cross-border trade traveling by rail through Port Huron and Detroit. The map also illustrates the key role played by Chicago in the North American railroad network.

Figure 14: Key National Corridors for Michigan Commodities Moving by Railroad

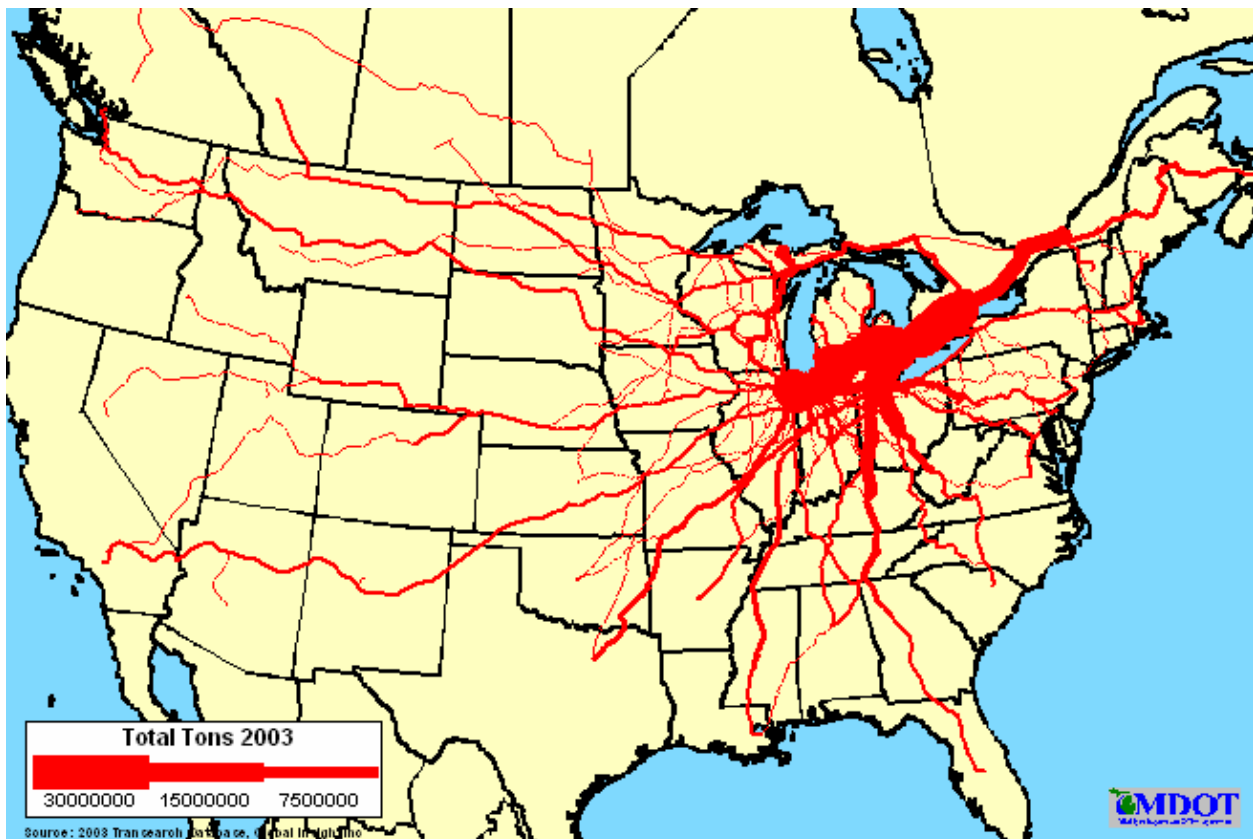
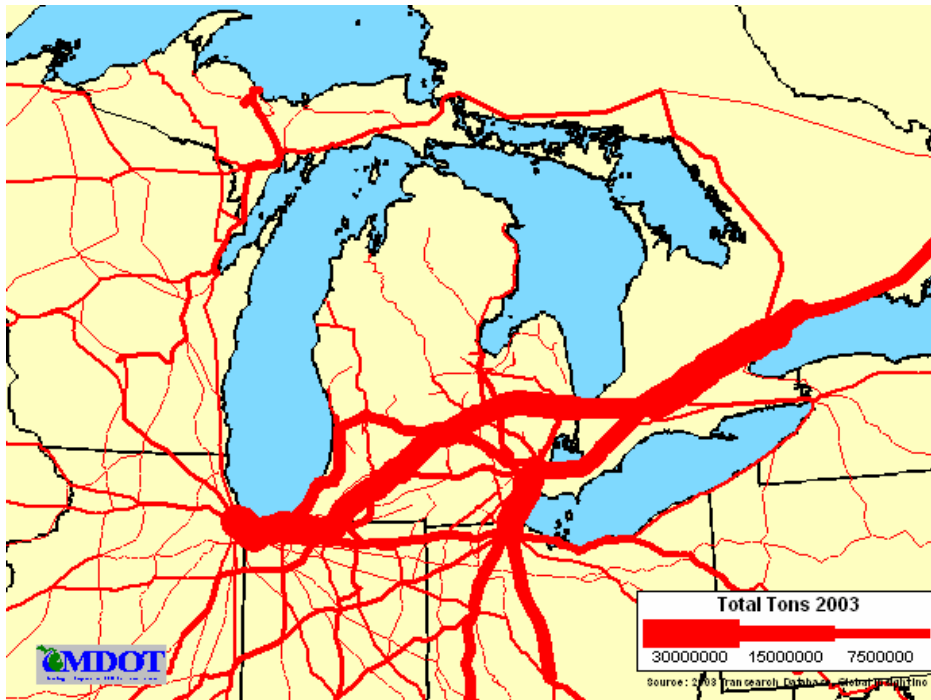


Figure 15: Key Regional Links for Michigan Commodities Moving by Railroad



2.2.1 Outbound Rail Movements

In 2003, over 26 million tons of outbound commodity movements left Michigan by rail to domestic and foreign destinations, with a value exceeding \$66 billion. Commodities leaving the state by rail accounted for approximately 15 percent of all outbound goods movements from Michigan by tonnage.

Among outbound rail movements, the most common commodity type is Transportation Equipment, accounting for 36 percent of outbound rail movements by tonnage and nearly 80 percent by value. Farm Products and Waste or Scrap Materials rank second and third, accounting for 12 percent and 11 percent respectively of all outbound rail movements by weight. However, Farm Products and Waste or Scrap together account for only 1 percent of the total value of the movements. **Table 8** shows the top commodity groups for outbound rail movements from Michigan in terms of tonnage and value.

Table 8: Top Outbound Rail Movements from Michigan by Tonnage and Value

<i>Commodity</i>	<i>Outbound Tons (millions)</i>	<i>Commodity</i>	<i>Outbound Value (billion \$)</i>
Transportation Equipment	8.56	Transportation Equipment	\$50.43
Farm Products	2.80	Misc. or Mixed Shipments	\$5.30
Waste or Scrap Materials	2.61	Primary Metal Products	\$4.79
Primary Metal Products	1.73	Paper and Pulp Products	\$1.26
Chemical Products	1.66	Chemical Products	\$1.17
Paper and Pulp Products	1.54	Food Products	\$0.60
Metallic Ores	1.48	Farm Products	\$0.39
Misc. or Mixed Shipments	1.46	Waste or Scrap Materials	\$0.17
Nonmetallic Ores and Minerals	1.33	Metallic Ores	\$0.05
Food Products	0.81	Nonmetallic Ores and Minerals	\$0.02
Other	2.53	Other	\$2.45
Grand Total	26.50	Grand Total	\$66.62

Table 9 lists the top destinations of outbound rail movements by tonnage and value. Illinois, Ohio, and Indiana are the leading destinations by tons with very similar totals, while Illinois is by far the leader when ranked by value. The large amount of expensive transportation equipment sent to the Chicago rail hub for delivery throughout the country is the primary source of the value.

Table 9: Top Destinations of Outbound Rail Carload Freight

<i>State/Province</i>	<i>Tons (millions)</i>	<i>State/Province</i>	<i>Value (billion \$)</i>
Illinois	4.01	Illinois	\$17.16
Ohio	3.29	Ohio	\$7.07
Indiana	3.02	Missouri	\$6.57
Ontario	2.96	Florida	\$3.97
Missouri	1.33	Indiana	\$3.73
Wisconsin	1.07	Ontario	\$3.48
Pennsylvania	1.04	New Jersey	\$2.36
North Carolina	0.91	Maryland	\$2.16
Georgia	0.86	Pennsylvania	\$2.08
Virginia	0.84	Georgia	\$2.02
Other	7.24	Other	\$21.34
Grand Total	26.58	Grand Total	\$71.94

2.2.2 Inbound Rail Movements

Approximately 20 percent of all commodity tons moving into Michigan arrive by rail. By value, rail carries about 9 percent of all commodities moving into the state. Inbound movements comprise about 36 percent of all rail moves by weight and 22 percent by value. Of the approximately 42 million tons of inbound rail shipments, the greatest volume by weight is Coal, which ranks eighth by value. Coal accounts for almost half of all rail tons entering Michigan and is primarily used to generate electricity. Chemical Products rank second by weight and fourth by value. Transportation Equipment is the top inbound rail movement by value. **Table 10** shows the top inbound rail movements by tonnage and value.

Table 10: Top Inbound Rail Commodities by Tons and Value

<i>Commodity Rank</i>	<i>Tons (millions)</i>	<i>Commodity Rank</i>	<i>Value (billion \$)</i>
Coal	19.41	Transportation Equipment	\$10.79
Chemical Products	4.27	Primary Metal Products	\$9.29
Primary Metal Products	3.34	Miscellaneous or Mixed Shipments	\$6.33
Petroleum or Coal Products	2.68	Chemical Products	\$3.61
Logs, Lumber, and Wood Products	1.95	Paper and Pulp Products	\$1.12
Clay, Cement, Glass or Stone Products	1.77	Waste or Scrap Material	\$1.00
Transportation Equipment	1.77	Logs, Lumber, and Wood Products	\$0.78
Miscellaneous or Mixed Shipments	1.74	Petroleum or Coal Products	\$0.64
Nonmetallic Ores and Minerals	1.49	Coal	\$0.54
Paper and Pulp Products	1.37	Food Products	\$0.45
Other	2.69	Other	\$2.04
Grand Total	42.50	Grand Total	\$36.58

The primary origins of inbound rail freight are from Illinois, Kentucky, West Virginia, Ontario, and Pennsylvania. Except for Ontario, the other four are the sources of the coal coming into Michigan. **Table 11** shows the rankings by tons and value for origins of inbound rail movements.

Table 11: Top Origins of Inbound Railroad Freight

<i>State/Province</i>	<i>Tons</i>	<i>State/Province</i>	<i>Value</i>
Illinois	15.98	Ontario	\$7.00
Kentucky	4.19	Illinois	\$5.28
West Virginia	3.67	Indiana	\$3.62
Ontario	3.63	Ohio	\$3.43
Pennsylvania	2.22	Quebec	\$3.03
Ohio	1.98	Georgia	\$1.79
Quebec	1.72	Texas	\$1.24
Indiana	1.47	Pennsylvania	\$1.11
Georgia	0.96	Kentucky	\$0.90
Texas	0.81	New Jersey	\$0.87
Other	9.20	Other	\$7.06
Grand Total	45.83	Grand Total	\$35.31

2.2.3 Through Rail Movements

Approximately 46 percent of all overland commodity tonnages passing through Michigan move by rail. Through rail freight is widely distributed across many groups. Chemical Products make up the highest volume through commodity group (24%), followed by Paper and Pulp Products (14%), Transportation Equipment (8%) and Logs, Lumber, and Wood Products (8%). Transportation Equipment is the top through-flow commodity by value. **Table 12** shows the top through Michigan rail movements by both tonnage and value.

Table 12: Top Michigan Rail Through Movements by Tons and Value

<i>Commodity Rank</i>	<i>Tons (millions)</i>	<i>Commodity Rank</i>	<i>Value (billion \$)</i>
Chemical Products	8.58	Transportation Equipment	\$19.31
Paper and Pulp Products	5.01	Miscellaneous or Mixed Shipments	\$11.35
Transportation Equipment	3.21	Chemical Products	\$8.70
Logs, Lumber, and Wood Products	3.16	Primary Metal Products	\$6.36
Misc. or Mixed Shipments	3.12	Paper and Pulp Products	\$5.08
Primary Metal Products	2.74	Logs, Lumber, and Wood Products	\$1.45
Food Products	2.35	Food Products	\$1.40
Petroleum or Coal Products	2.26	Machinery	\$1.05
Clay, Cement, Glass or Stone Products	2.24	Petroleum or Coal Products	\$0.84
Farm Products	1.36	Electrical Equipment	\$0.31
Other	2.27	Other	\$1.73
Grand Total	36.29	Grand Total	\$57.58

The influence of free trade agreements is also evident upon the volume of goods moving by rail transport, as Ontario is both the top origin and top destination for rail flows moving through Michigan. Other top origins of through rail freight include Illinois, Ohio, and Quebec. Additional key rail origins and destinations (O/Ds) for through freight are listed in **Table 13**.

Table 13: Top O/Ds of Michigan's Through Freight Traffic by Rail

<i>Top Origins of Through Rail Freight</i>			<i>Top Destinations of Through Rail Freight</i>		
<i>State/Province</i>	<i>Tons (millions)</i>	<i>Value (billion \$)</i>	<i>State/Province</i>	<i>Tons (millions)</i>	<i>Value (billion \$)</i>
Ontario	12.56	\$24.14	Ontario	8.71	\$11.51
Quebec	6.86	\$11.71	Illinois	8.05	\$19.35
Illinois	5.42	\$8.58	Ohio	3.81	\$5.12
Texas	1.20	\$1.86	Quebec	2.06	\$4.27
New Brunswick	1.06	\$0.69	Wisconsin	1.99	\$1.54
Nova Scotia	0.99	\$1.99	Texas	1.19	\$1.88
Wisconsin	0.82	\$0.56	Indiana	0.97	\$1.09
Louisiana	0.79	\$0.93	Pennsylvania	0.93	\$0.41
Ohio	0.71	\$1.10	Tennessee	0.79	\$1.11
Maine	0.68	\$0.76	New York	0.71	\$0.43

2.2.4 Internal Rail Movements

Michigan transports just over 14 million tons of commodities intrastate by rail, with a value of \$2.9 billion. Since shipping costs promote longer hauls of low-value bulk goods, Michigan does not have many internal rail movements. Two of these movements, however, are very prominent and need mention. Iron ore that is mined in Marquette County is moved by rail from the mine to the ports in Marquette and Escanaba. Almost 7.5 million tons of iron ore are transported to docks in Marquette, which are then transported by water primarily to Ontario, Detroit, and other industrial cities around Lake Erie. About 3.5 million tons of iron ore are transported by rail to Escanaba to be shipped by water to southern Lake Michigan steel industry in Illinois and Indiana. Other lesser internal rail shipments include Nonmetallic Ores and Minerals, Transportation Equipment, and Farm Products.

2.2.5 Intermodal / Containerized Rail Services

Freight transportation functions as a system, with a marked and growing degree of inter-reliance among modes. The origins of intermodal railroad practices date back to the loading of circus wagons on flatcars more than a century ago; however, modern trailer-on-flatcar (TOFC) or container-on-flat-car (COFC) service is a post World War II development. Rail intermodal services were advanced to compete with the emerging motor carrier industry and to serve ocean shipping. During the first three decades rail intermodal service offerings were only modestly successful, primarily due to the heavy regulatory environment of the rail industry. However, since deregulation in 1982, rail intermodal loadings have increased by a factor of

more than three, and successful partnerships have been forged between railroads, intermodal marketing companies (IMCs), steamship lines, and motor carriers.

Railroads typically do not market intermodal services directly, but rather wholesale terminal-to-terminal line haul services to other wholesalers and various kinds of door-to-door retailers using several different marketing channels. These retailers buy the rail services, the local trucking, and any other required services and provide a door-to-door package to shippers on a single bill.

The intermodal concept fits well with the transportation needs of the modern integrated economy. Intermodal services attempt to draw from each mode the best in service attributes they offer. Typically, rail line haul costs are less than those for motor carriers while motor carriers have greater flexibility and nearly unlimited access to industrial and commercial locations.

Rail intermodal shipments, which include ocean and domestic containers and truck trailers loaded on rail flatcars, are most often used for consumer goods and subassembly components. While the US railroad market is still dominated by carload freight, the volume of intermodal shipments has been growing at a much faster rate. Between 2001 and 2005, railroad intermodal volume grew by 32 percent. In 2003, the truck-rail intermodal business became the number one source of railroad freight revenue, surpassing even coal. **Table 14** shows Michigan's rail intermodal movements for inbound, outbound, and through shipments. There are no internal rail intermodal movements in Michigan. These totals were included in the total rail movements discussed earlier, but have been separated here to help detail the intermodal freight portion of Michigan's rail movements.

Table 14: Rail Intermodal Movements in Michigan

<i>Nature of Movement</i>	<i>Tons (millions)</i>	<i>Value (billion \$)</i>
Outbound	1.81	\$5.69
Inbound	1.66	\$5.01
Through	4.21	\$13.47
Total	7.67	\$24.17

Table 15 shows the top O/Ds for Michigan's rail intermodal flows. Of particular note is the number of O/Ds that lie beyond the Great Lakes regions. Many of the O/Ds' jurisdictions in the table lay claim to major port facilities that receive container ships from overseas locations. It is likely that a high percentage of rail intermodal shipments contain commodities with foreign origins or foreign destinations.

Table 15: Top Origins and Destinations of Michigan Rail Intermodal Movements

<i>Inbound Origins</i>	<i>Tons</i>	<i>Value (million \$)</i>	<i>Outbound Destinations</i>	<i>Tons</i>	<i>Value (million \$)</i>
Quebec	576,558	\$2,070.48	Illinois	419,726	\$1,466.51
Illinois	227,586	\$589.55	Ontario	392,210	\$513.58
New Jersey	148,294	\$387.64	Quebec	359,642	\$1,670.16
Washington	110,218	\$398.39	New Jersey	153,300	\$522.34
Nova Scotia	93,940	\$316.44	Washington	98,538	\$321.86
Ontario	90,258	\$102.82	California	97,506	\$296.77
British Columbia	89,212	\$292.32	Virginia	92,730	\$326.89
Virginia	88,146	\$307.24	Florida	82,198	\$285.35
California	84,110	\$304.97	Texas	37,164	\$99.42
Florida	46,214	\$60.72	Mississippi	20,000	\$61.98
Totals	1,554,536	\$4,830.55		1,753,014	\$5,564.86

moving by other modes, generally consists of lightweight, high-value commodities such as the following:

- Aerospace - equipment and parts;
- Automotive - equipment and parts;
- Pharmaceuticals;
- Computers and computer components;
- Diagnostic equipment;
- Medical equipment;
- Software;
- Textiles – garments;
- Consumer electronics;
- Perishables - flowers, fruit, vegetables and seafood;
- Economically perishable materials - printed material;
- Telecommunications equipment - cell phones, blackberries, etc.; and
- Photographic film.

Air cargo services are typically provided by several types of carriers that are differentiated by the services they offer. In addition to the occasional air cargo charter operation, there are three primary segments in the air cargo industry:

- **Integrated Express Operators / Integrated Express Service:** Integrated express carriers (e.g., FedEx, UPS, and DHL) operate a fleet of scheduled aircraft, trucks, and couriers offering door-to-door delivery service. These carriers move customer materials door-to-door, providing shipment pickup, transport via air or truck, and delivery. Express companies provide next-day, document, and small package (two to 70 pounds) service to customers. Increasingly, express operators are transporting heavy freight, identified as shipments of more than 70 pounds. In addition to overnight service, express carriers offer deferred services, such as second-day and third-day, time-definite delivery. These expanded service offerings are significantly changing the dynamics of the air cargo industry. Deferred service options are predicted to surpass overnight (express) deliveries of letters, documents, and packages in the near future. These carriers operate extensive hub-and-spoke networks, similar to the passenger airline, providing expansive geographic coverage.. The hub is the backbone to the integrated express carrier since it provides connections to each market in the integrator’s system. Each day flights from around the US arrive at integrator hubs where packages are offloaded, sorted by the destination market, and reloaded onto aircraft.
- **Commercial Service Passenger Airlines / Freight Forwarding Services:** Commercial airlines with scheduled passenger service provide “belly-space” in the passenger aircraft

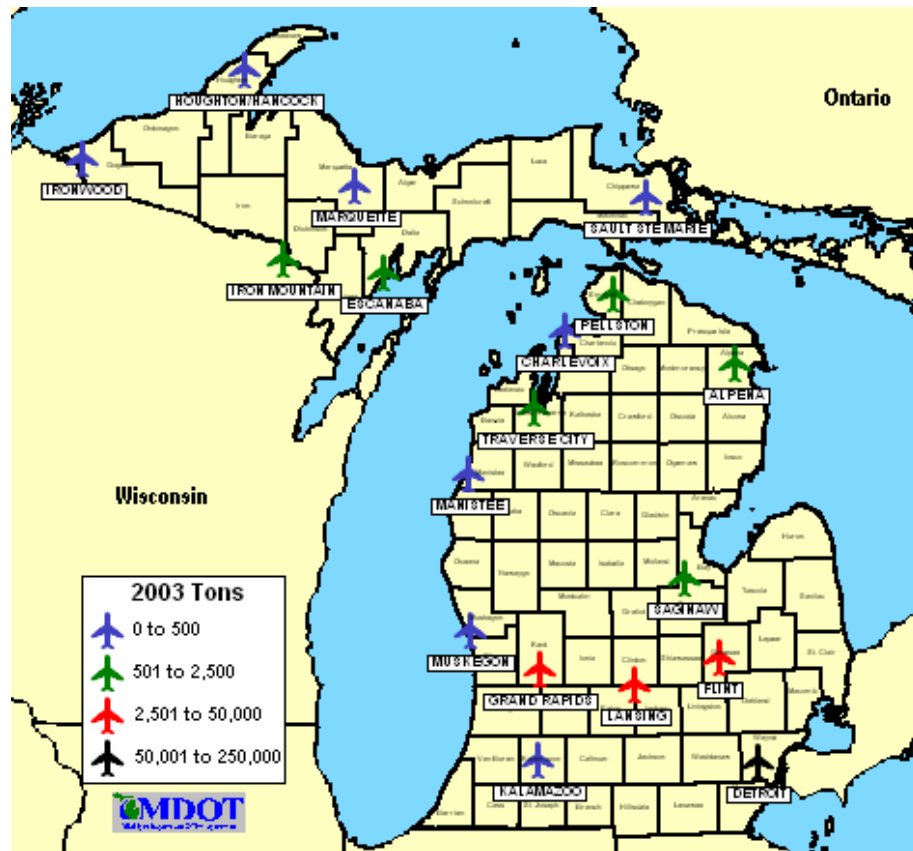
to move cargo airport-to-airport. Commercial air carriers account for the majority of international air cargo lift, yet provide limited domestic lift. It is estimated that 50 percent of US international air cargo traffic is moved in the cargo holds of passenger aircraft. Freight forwarding companies handle a wide range of freight, from small packages that are consolidated into container loads, to oversized, one-time freight shipments. The forwarder acts as a broker between the shipper and the carrier (i.e., all-cargo, commercial passenger, or on-demand charter). The forwarder receives a load from a customer (the shipper) and subsequently tenders the shipment to an air cargo carrier or commercial carrier. The carrier moves the shipment airport-to-airport then tenders the shipment to the forwarder's agent at another airport. From this point, the forwarder makes the final delivery to the customer.

- **All Air Cargo Carriers / Airport-to-Airport Service:** All-cargo carriers operate airport-to-airport services for their customers, but do not offer passenger service. All-cargo carriers offer scheduled service to major markets throughout the world using widebody and/or containerized cargo aircraft. Due to their airport-to-airport service structure, all-cargo carriers are concentrated in large, high-volume-market airports; geographic coverage is limited. Approximately 10 to 15 percent of the world's air cargo traffic is moved by all-cargo carriers, primarily on long-haul international or trans-continental routes. In 2003, scheduled all-cargo operators accounted for 19 percent of the US domestic market. Freight handled by all-cargo carriers is dropped off at the airport by the shipper, or the shipper's freight forwarder, and is picked up at the destination airport by the customer, or the customer's agent (i.e. freight forwarder).

2.3.1 Michigan's Air Cargo Service Airports

Figure 17 shows the 18 Michigan airports that provide scheduled air service capable of supporting air cargo operations. Of these airports, seven provide 100 or more weekly flights, six provide 25 to 99 weekly flights, and five provide less than 25 weekly flights. As would be expected, Detroit represents the state's largest market and highest respective air cargo volumes. (Note: Air cargo statistics for Detroit include Metro, Willow Run, Oakland/Pontiac, and Detroit City airports).

Figure 17: Michigan Airports with Scheduled Air Service



Given the complexity of air cargo services it is difficult to accurately track the movement of air cargo by commodity with great certainty. For this portion of the analysis, air cargo statistics compiled by MDOT were used to gather information about the level of air cargo demand in the state. Michigan airports report statistics for total cargo and total mail, not by specific commodity. Figure 17 also shows the relative volume of air cargo handled by Michigan's airports.

2.3.2 Michigan's Air Cargo Volumes

Table 16 shows the top airports in Michigan based upon total cargo moved in 2003. Michigan airports handled over 300,000 tons of air cargo. Detroit is the leader, with its Willow Run facility handling the most cargo. Grand Rapids, Lansing, and Flint each have similar-sized operations, quite often moving integrated express freight.

Table 16: Top Michigan Airports Handling Air Cargo by Total Weight

<i>Top Air Cargo Airports by Tonnage (2003)</i>			
<i>Airport</i>	<i>Total Tons</i>	<i>Inbound Tons</i>	<i>Outbound Tons</i>
Detroit	217,221	123,844	92,376
Grand Rapids	34,971	19,036	15,935
Lansing	25,053	13,555	11,497
Flint	15,419	9,358	6,061
Traverse City	2,357	1,287	1,069
Iron Mountain	1,304	865	439
Alpena	813	528	285
Saginaw	775	391	368
Pellston	679	553	126
Escanba	603	375	227
Other Origins	856	484	372
Total	300,051	170,276	128,755

In addition to the air cargo, Michigan airports handled about 28,500 tons of mail. Detroit accounted for 93.1 percent and Grand Rapids 6.8 percent of all airmail in the state. Airmail quite often can be loaded into the belly of commercial airlines so, since Detroit would handle the most passenger planes, this comes as no surprise.

2.4 Waterborne Movements

The Great Lakes and St. Lawrence River form a maritime transportation system extending 3,700 kilometers (2,300 miles) from the Gulf of St. Lawrence on the Atlantic Ocean to the western end of Lake Superior. Michigan's 5,150 kilometers (3,200 miles) of shoreline along four of the five Great Lakes contain approximately 90 ports serving commercial and recreational navigation. Forty of these ports accommodate commercial cargo movements. An additional 50 ports primarily serve recreational boating. Other types of commercial activities, including marine contractors, shipbuilding, ferry services, commercial fishing, charter boat operations, or excursion services, may be located in either cargo or recreational ports.

Since the opening of the St. Lawrence Seaway in 1959, Michigan's total annual waterborne commerce has ranged from 53 million to 114 million tons. The mean annual tonnage during this period is 93 million. Most of Michigan's waterborne traffic is generated by the steel and

construction industries and is therefore susceptible to variations in the general economy and government policies concerning steel production and importation. The restructuring of the steel industry during the 1980s also affected waterborne commerce. Volumes can be expected to remain in the 75-100 million-ton range for the next few years.

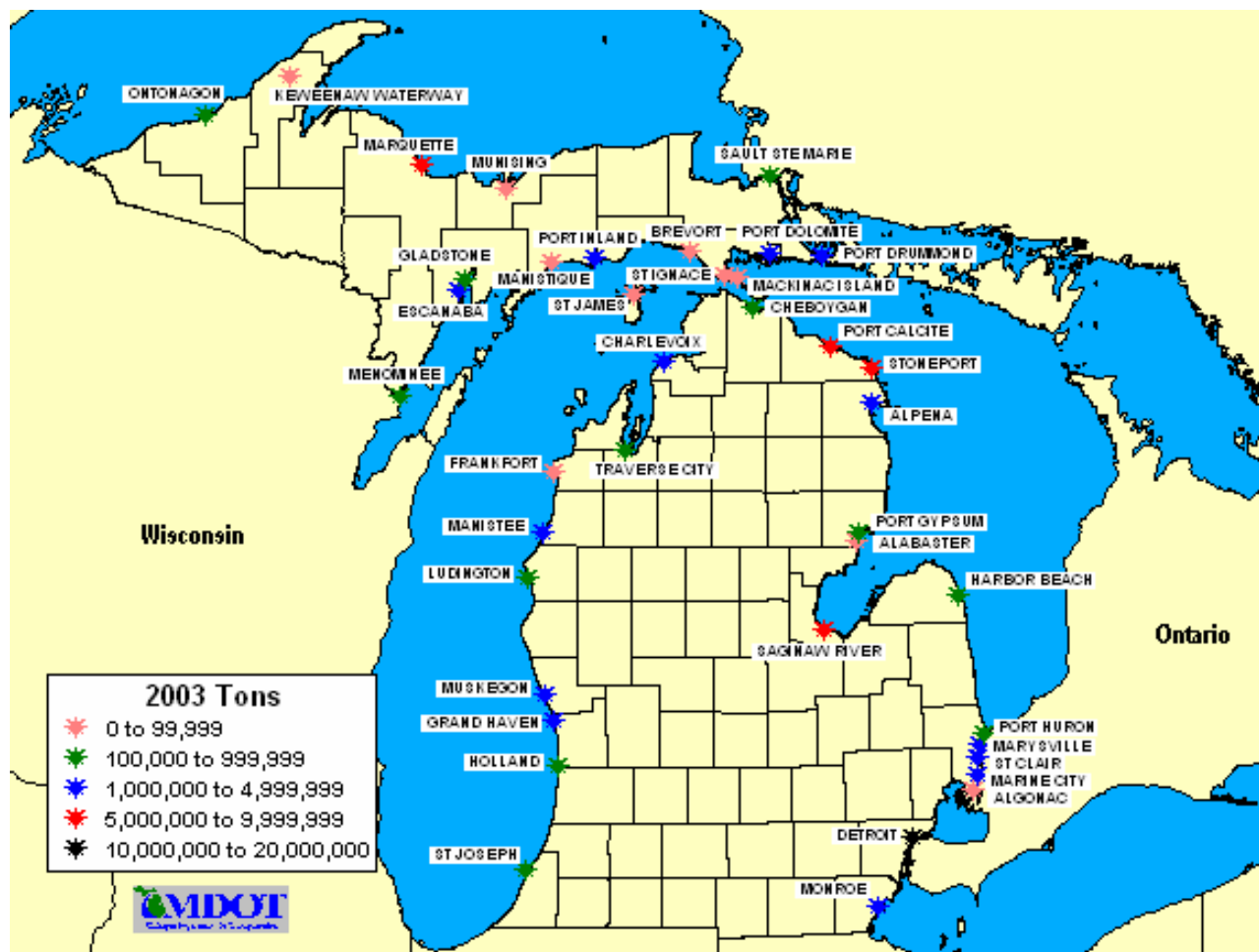
The vast majority (99%) of Michigan's waterborne commerce is shipped to or from US and Canadian ports on the Great Lakes and the St. Lawrence River. Less than 2 percent of the cargo handled at Michigan ports travels to or from an overseas port. Most of this direct overseas traffic consists of steel or Logs, Lumber, and Wood Products, and passes through the ports of Detroit and Menominee. Michigan's businesses and industries generate a large volume of overseas trade, but nearly all of it is transported overland by truck or rail to Pacific, Atlantic, or Gulf coastal ports for ocean shipping.

Most of the waterborne commerce at Michigan's 40 cargo ports consists of bulk cargoes. Stone, sand, iron ore, and coal accounted for 86 percent of the total of nearly 78 million tons of traffic in 2003. Cement, petroleum, and chemicals account for another 12 percent. These materials are used in the steel, construction, agriculture, and petroleum industries throughout the Great Lakes region. The steel industry alone accounts for about half of Michigan's total waterborne commerce. Iron ore, coal, coke, and limestone (used as a flux) are used in the manufacture of steel.

In 2003, Michigan's ports handled more than 78 million tons of freight valued at more than \$5 billion. Information about Michigan's commodity movements by water was compiled by MDOT from data supplied by the US Army Corps of Engineers, local agencies, and marine terminals. The information was provided in terms of port destinations and port origins. As with the air mode, internal and through movements were not captured in the water data. It is also noted that the variety of commodities moving by water is much more limited than for other modes. As such, the tables presented include all commodity groups recorded by Michigan's ports. The Other category is primarily movements of slag. Slag is a by-product of the smelting process whereby metallic ores are purified. Slag has many commercial uses, and is often reprocessed to separate any other metals that it may contain. Recovered material can be used in railroad track ballast, cement, and fertilizer.

Detroit is the largest port, handling about one-sixth of the state’s total tonnage. Several large ports in northern Michigan, including Calcite, Stoneport, Port Inland, Port Dolomite, Port Drummond, Alabaster, and Port Gypsum, are privately owned and were built to ship stone produced in nearby quarries. Most of the traffic at Escanaba and Marquette consists of iron ore pellets mined and processed in the Upper Peninsula and destined for Great Lakes steel mills. Other ports typically receive a variety of cargoes for local and regional consumption. Michigan’s cargo ports and the relative volume of freight they handled in 2003 are displayed in Figure 18.

Figure 18: Michigan’s Cargo Ports



2.4.1 Waterborne Commodities

Stone, sand, and salt are mined in northern and western Michigan and shipped to the steel and construction industries. The steel mills are located in Detroit, Indiana, Ohio, Pennsylvania, and Ontario. Construction companies are served via ports throughout the Great Lakes.

Iron ore is mined and processed into pellets in the Upper Peninsula of Michigan, Minnesota, and Quebec, and is shipped to steel mills in Detroit, Indiana, Ohio, Ontario, and Pennsylvania. Coal is

shipped to electric utilities and industries throughout Michigan. It includes eastern coal, produced in Ohio, West Virginia, Kentucky, and Illinois and western coal produced in Montana and Wyoming. Both eastern and western coal is transported from the mines to Great Lakes ports by rail for water delivery to other ports. Cement is produced in plants in the Lower Peninsula and Ontario and is shipped to distribution terminals throughout the Great Lakes. Petroleum is produced at refineries in Indiana, Ontario, and Michigan and is shipped to various Great Lakes ports for distribution. Chemicals are shipped to and from producers in Detroit, the Saginaw Valley, and Ontario. Potash, for agricultural application, is produced in western Canada and shipped to various ports in the southern Great Lakes.

2.4.2 Outbound Waterborne Flows

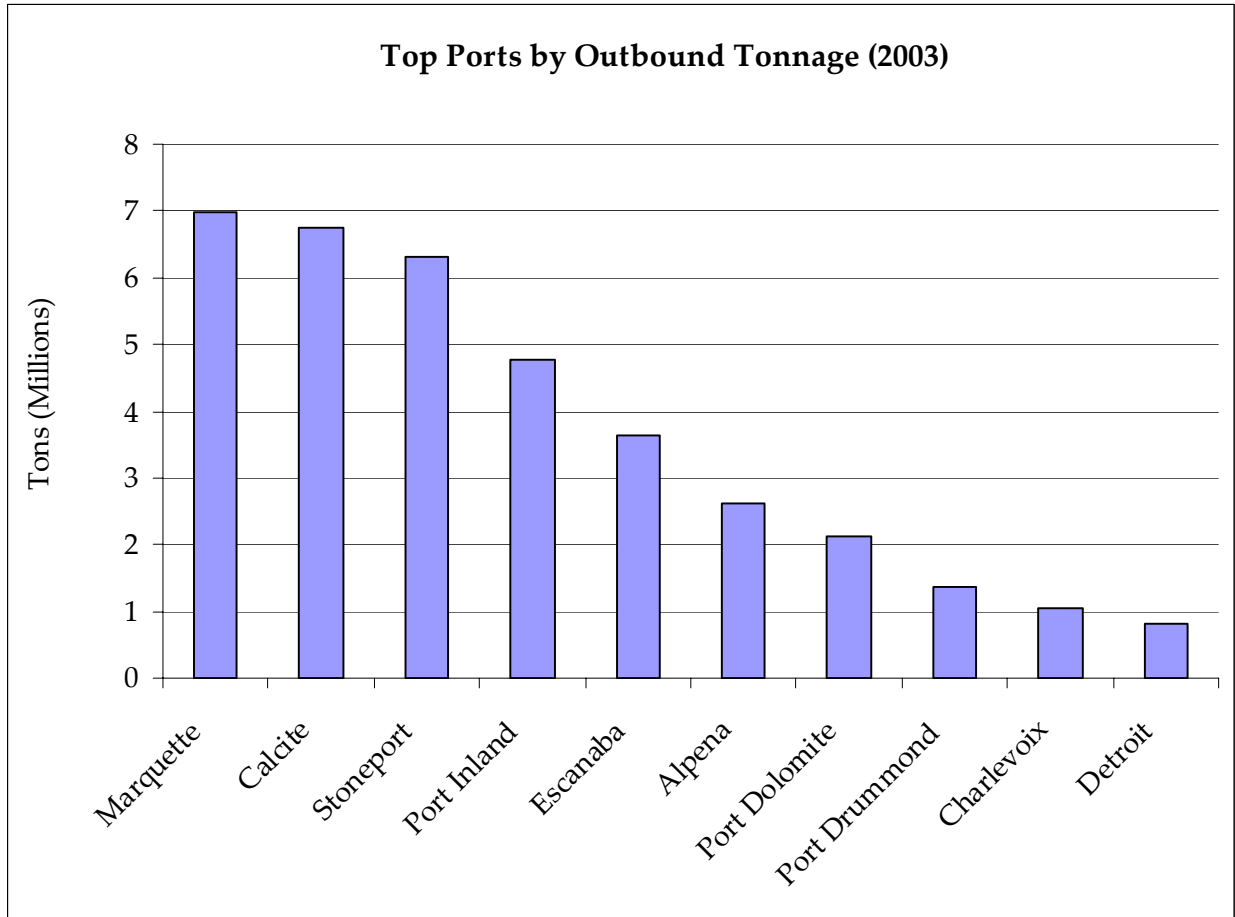
In 2003, Michigan's ports handled more than 38 million tons of outbound freight. The top outbound commodity by water was Nonmetallic Ores and Minerals (primarily limestone), accounting for 6 percent of outbound movements by weight. Metallic Ores (iron ore) accounted for an additional 28 percent by tonnage. Metallic Ores, valued at more than \$361 million, was the top outbound waterborne commodity, accounting for 28 percent of the total, followed by Cement with 19 percent of the total. **Table 17** shows all of the outbound commodity groups leaving Michigan ports in 2003 ranked by value and tonnage.

Table 17: Outbound Waterborne Freight Flows by Value and Tonnage

<i>Commodity Rank</i>	<i>Tons (thousand)</i>	<i>Commodity Rank</i>	<i>Value (million \$)</i>
Nonmetallic Ores and Minerals	22,230	Metallic Ores	\$361.28
Metallic Ores	10,626	Clay, Cement, Glass or Stone Products	\$244.66
Clay, Cement, Glass or Stone Products	3,598	Petroleum or Coal Products	\$169.25
Chemical Products	607	Primary Metal Products	\$163.52
Petroleum or Coal Products	524	Chemical Products	\$159.64
Coal	138	Nonmetallic Ores and Minerals	\$133.38
Primary Metal Products	56	Fabricated Metal Products	\$45.96
Fabricated Metal Products	20	Coal	\$3.86
Logs, Lumber, and Wood Products	18	Logs, Lumber, and Wood Products	\$3.24
Other	55	Other	\$0.39
Total	37,872	Total	\$1,285.19

Eighteen ports in Michigan recorded outbound commodity movements, lead by Marquette (iron ore) with just under 7 million tons, followed by Calcite (limestone) with 6.7 million tons, and Stoneport (limestone) with 6.3 million tons. The chart in **Figure 19** shows the top ports by outbound tonnage in Michigan

Figure 19: Top Michigan Water Ports by Outbound Tonnage



2.4.3 Inbound Waterborne Flows

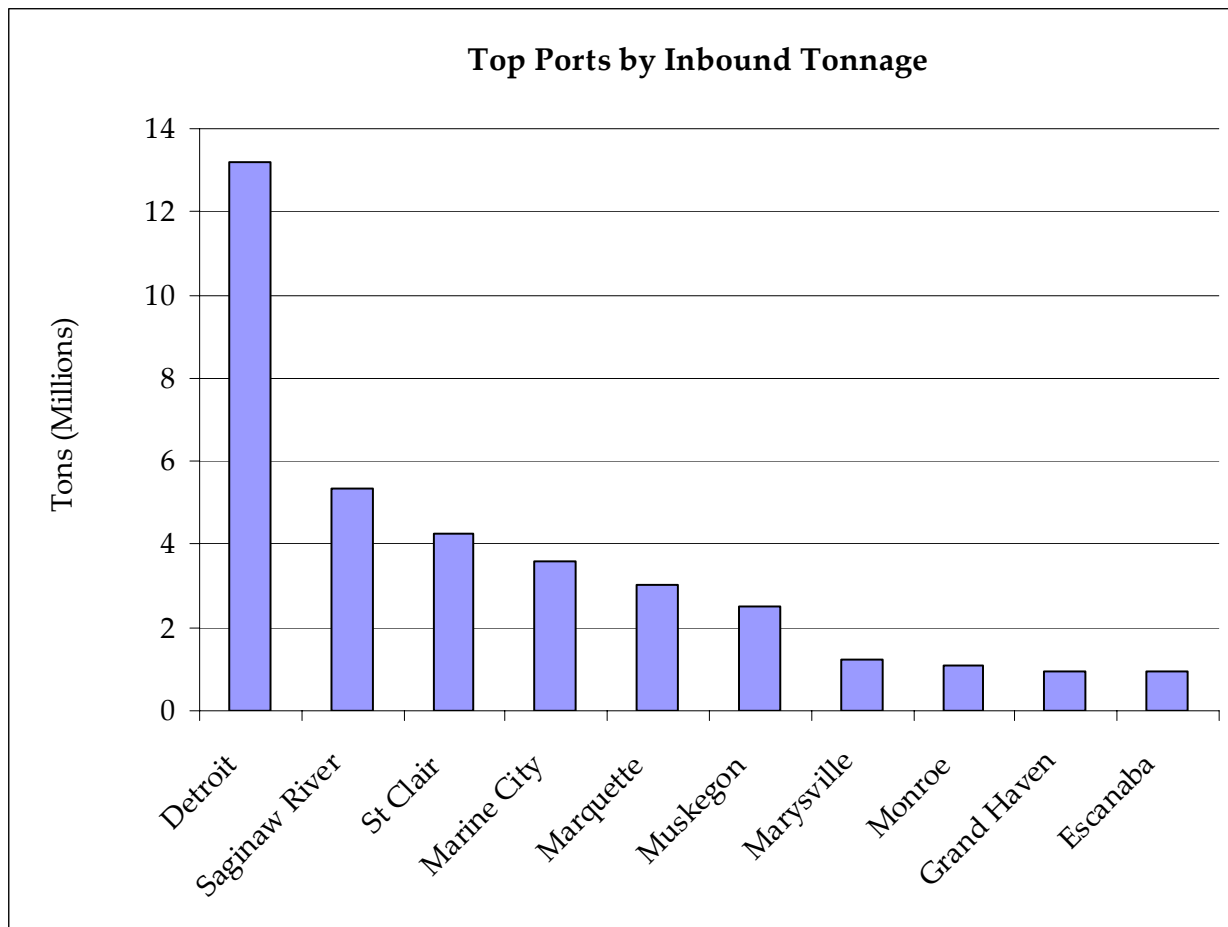
In 2003, nearly 15 million tons of Coal moved into Michigan ports, making it the top inbound commodity, accounting for 36 percent of total inbound movements. Nonmetallic Ores and Minerals accounted for an additional 34 percent, followed by Metallic Ores (iron ore) and Clay, Cement, Glass or Stone Products (cement). The top inbound commodities by value were Primary Metal Products, which exceeded \$1.3 billion, accounting for 34 percent of total value. A list of all inbound commodity groups is shown in **Table 18** ranked by tonnage and value.

Table 18: Inbound Water Flows by Value and Tonnage

<i>Commodity Rank</i>	<i>Tons</i>	<i>Commodity Rank</i>	<i>Value (million \$)</i>
Coal	14,693,111	Primary Metal Products	\$1,326.41
Nonmetallic Ores and Minerals	13,692,711	Machinery	\$590.26
Metallic Ores	6,621,000	Petroleum or Coal Products	\$453.57
Clay, Cement, Glass or Stone Products	2,495,000	Coal	\$411.41
Petroleum or Coal Products	1,404,250	Misc. Manufacturing Products	\$363.61
Primary Metal Products	454,250	Metallic Ores	\$225.11
Chemical Products	291,000	Clay, Cement, Glass or Stone Products	\$169.66
Logs, Lumber, and Wood Products	166,000	Fabricated Metal Products	\$117.20
Machinery	55,000	Nonmetallic Ores and Minerals	\$82.16
Fabricated Metal Products	51,000	Chemical Products	\$76.53
Misc. Manufacturing Products	28,000	Logs, Lumber, and Wood Products	\$29.88
Other	897,000	Other	\$6.28
Total	40,848,322	Total	\$3,852.08

For inbound water flows, Detroit is by far the leading destination port by tonnage, accounting for 32 percent of all inbound water movements. Saginaw River, with docks in both Bay and Saginaw Counties, holds the next highest ranking, handling primarily bulk commodities for construction and agriculture. St. Clair and Marine City are third and fourth, respectively, handling much of the incoming coal. The chart in **Figure 20** shows the top ports in the state by inbound tonnage.

Figure 20: Top Michigan Ports by Inbound Tonnage



Chapter 3. Integration

For the integrated *MI Transportation Plan*, the information in this technical report has linkages to the *Integration Technical Report*, carrying forward into the *Conditions and Performance Technical Report* and the *Corridors and Borders* report. The technical reports can be categorized into two types: (1) reports about transportation supply (assets, infrastructure, services, and resources) and (2) reports about transportation demand (users, markets, travel segments, and industries)

utilizing freight). This technical report examines how different modal assets and services meet Michigan's demand for the movement of goods into, out of, within, and through Michigan.

Integrating freight into an overall transportation plan supporting Michigan's economic vitality entails structuring policy and decisions for freight infrastructure and services within the context of key industry and shipping segments using the system. Integration involves ensuring the system supports key freight-dependent activities, identifying and remedying any key barriers to effective utilization of intermodal and multi-modal freight systems, and implementing any freight transportation activities that may serve to catalyze economic vitality.

3.1 Freight Intensive Industries

This report has explored the commodities in Michigan's economy, which are dependent on different modes of the freight transportation system. These commodity flows represent raw materials sourced by Michigan companies to produce intermediate and final products, then shipped to wholesale, retail, and direct consumer markets. Commodity flows also represent demands on Michigan's transportation system and the need for efficient transport to create value in Michigan's economy.

By volume, Michigan's freight system users are segmented based on the nature of shipments, modes, and trading partners. Some key segments based on the findings regarding significant commodities of this technical report are described below.

3.1.1 Farms and Agri-Business

Farm products are one of Michigan's largest commodity exports by tonnage, with 20 percent of these moving by rail. Grain (7.6 million tons) and Oils, Kernels, Nuts, or Seeds (2.4 million tons) account for the largest share of these exports (65% and 20% respectively). While these commodities have relatively low values per ton (they are bulky exports), they represent the magnitude of tonnage required to support Michigan's agricultural base. Agricultural shippers are more sensitive to the cost and availability of export destinations than to transit time or reliability. However, some of the downstream consumers (such as food manufacturers) may be somewhat sensitive to reliability to support manufacturing operations. The key for this segment is a consistent and affordable means for transporting basic agricultural commodities from Michigan's farming economy to global markets.

3.1.2 Extractive Industries

Nonmetallic Ores and Minerals is the leading commodity moved in Michigan by tonnage, as it ranks first in both trucking and water movements. The primary materials moved by truck include sand, gravel, and aggregates from rocks such as limestone or granite. Michigan ranks second in the nation in sand and gravel production; the southern Lower Peninsula has a multitude of operations. The truck movements are mainly short distance, from mining source to construction areas. The water movements are primarily made up of limestone, flowing from the quarries in northern Michigan to the industrial cities of the Great Lakes. Since this commodity is made up of low-value materials, the trucking will continue to be of short

distance, while the Great Lakes will continue to provide the best means of transporting longer shipments. A key in this sector is to maintain effective shipping channels at all of the major ports, primarily a responsibility of the US Army Corps of Engineers.

3.1.3 Transportation and Warehousing

Secondary Traffic is the second leading trucking commodity moving in Michigan by value, and the seventh leading commodity by tonnage. Michigan's transportation system represents important nodes for carriers transporting products to and from warehouses and intermodal facilities serving the Great Lakes, Canada, and different regions of the United States. The trucking and warehousing industry plays an important role in Michigan's economy. The impact of transportation investment scenarios on this important sector is further examined in the *Economic Outlook Technical Report* and the *Economic Impact Analysis* report elements of *MI Transportation Plan*.

3.1.4 Automotive Industry

Transportation Equipment comprises the top ranked commodity moved in Michigan by value, and the fifth ranked commodity by tonnage. Automobile and other transportation equipment manufacturers have long been mainstays of the manufacturing sector. Over \$138 billion worth of transportation equipment moves on Michigan's transportation system by truck alone, although all modes figure prominently in the movement of automobile parts and products in the state.

The emergence of supply chain management technologies and strategies like just-in-time manufacturing make this segment more sensitive than ever to the reliability and predictability of delivery times.

3.1.5 Other Manufacturers

Manufacturers of products other than transportation equipment are also important shippers in Michigan's economy. Fabricated metal products, machinery, and chemical products are all commodity groups representing the means of production for manufactured goods. Efficient, timely, and reliable delivery of these commodities (generally sold to manufacturers, as opposed to end users) are essential to the vitality of Michigan's entire manufacturing sector. These manufacturers have similar needs to those of transportation equipment; however, many of these sectors' value chains may be shorter, and the impact of delays or unreliable shipments may be more directly felt.

3.1.6 Food Vendors

It is notable that Food Products factor prominently among freight commodities moved in Michigan. Food is a major commodity moved in Michigan, accounting for one of the largest tonnages and values of any commodity imported to the state. Food vendors may include grocers or food service providers. Because the highest value food items are often perishable, transit time and reliability are especially important for this commodity.

3.1.7 Mail and Express Carriers

While mail and contract traffic accounts for only a small share of Michigan's freight traffic (by value or tonnage), this commodity and this type of freight service has special importance for Michigan's emerging service economy. The *Socioeconomic Technical Report* highlights the role of service industries in Michigan's economy. Express and overnight mail and contract delivery play an important role in many high-value service industries such as legal, finance, insurance and real estate firms. The availability and reliability of overnight and express mail and contract delivery is often a factor in location decisions for service establishments as well as their success.

3.2 Freight-Dependent Activities

The above segments engage in activities, which contribute directly to Michigan's economic performance. To support the state's economic vitality, Michigan's transportation system must ensure that the freight transportation system provides seamless and complete access to key activities important to each segment. Some key activities supported by the freight transportation system include manufacturing, wholesale trade, retail trade, and personal and professional services.

3.2.1 Manufacturing

As discussed in **Chapter 1, Introduction**, technology and innovative operational management techniques have made manufacturing a highly time-sensitive industry. Delays in supply and value chains directly undermine the profitability of manufacturing enterprises; however, the unpredictability of delays (or lack of reliability of shipments) is often more costly. This is because technology and operations management techniques may enable managers to adjust upstream and downstream activities to predicted or recurring delays; sporadic or unexpected delays are more difficult to manage. Consequently, an integrated transportation system must offer (1) reliable freight service and (2) current information about potential delays in shipments for shippers.

3.2.2 Wholesale Trade

The emergence of information technology-driven supply chain management strategies and methods has precipitated a paradigm shift in logistics and supply chains. Freight movement has shifted from a "push" driven paradigm (whereby manufacturers once produced and warehoused products making them available to vendors, dictating the real-time supply and distribution) to a "pull" paradigm (whereby retailers communicate very specific demands to suppliers, dictating how much is supplied at any given point in time).

Much of this shift has created efficiency by reducing the cost of warehousing for wholesalers, as order quantities are smaller and more time-sensitive. Consequently, wholesale trade depends increasingly on timely delivery of custom-sized lots and orders and less on the consistent delivery of larger quantities of commodities to warehouses. This change makes wholesalers increasingly sensitive to the consistent reliability of freight shipments.

3.2.3 Retail Trade

It is retailers who now drive supply chains with real supply chain information. For retailers who rely increasingly on managing the costs of carrying inventory, the key threat to profitability is more the threat of stock-outs than of carrying excess. Because in-store inventories are lower under today's supply chain management strategies, retailers are increasingly dependent on the freight transportation system to deliver quantities in a timely manner, responsive to changing market conditions. Consequently, reliability, consistency, and availability are key requirements retail activities place on the freight transportation system.

3.2.4 Personal and Professional Services

As discussed above, personal and professional services rely heavily on mail and contract traffic. The provision of legal, accounting, financial, and educational services often depend on the urgent delivery of parcels, documents, media, and other items by overnight and express delivery. While many of these activities are increasingly supported by online Internet-based services, there continues to be a need for readily available express and overnight delivery at locations where high-value professional services are to be concentrated.

3.3 Opportunities and Performance Barriers

"Performance barriers" are conditions on the transportation system that make it more difficult, more expensive, or impossible for an activity to take place. In the economic impact element of *MI Transportation Plan*, performance barriers are represented as "costs of doing business;" however they also include barriers to households and individuals. In the *Conditions and Performance Technical Report* of *MI Transportation Plan*, performance barriers are described by performance measures. "Opportunities" are conditions on the transportation system that make it easier, less expensive, or possible for an activity to take place that may not otherwise occur. In the economic impact element of *MI Transportation Plan*, opportunities are represented as "amenities;" however, they also include opportunities for households or individuals in addition to businesses. For the purposes of this report, opportunities are understood as special ways in which system performance may stimulate users to engage in more or better activities.

As described above, activities vital to Michigan's economy are tied to the performance of the transportation system for freight. Opportunities for Michigan may be realized by enhancing the system with features that support or catalyze activities important to Michigan's future. Particular issues impeding freight system operation can become barriers to economic performance as well. Developing and managing a freight transportation network to support Michigan's economy entails understanding and overcoming performance barriers that interfere with economic activities on the freight system. These barriers are often challenges to the transportation system infrastructure, but sometimes are also equipment or personnel challenges.

The private sector plays a very significant role in freight transportation, controlling virtually all transportation services and shipment decisions. With few exceptions, private sector producers

or consumers own the freight, which moves by private carriers in privately-owned freight vehicles. The public sector has a varying role, dependent upon the mode, in the provision of the infrastructure used to move freight. For example, the public sector provides highways used by privately-owned trucking companies and their vehicles. Rail freight services are privately provided on rail lines, which are nearly all owned by the private sector. (Michigan is one exception, where several hundred miles of rail line are owned by the state and operated by private companies.) In the marine mode, the waterways are publicly owned and maintained (generally by the federal government), while terminals, docks, carriers, and services are primarily privately-owned. Some terminals and docks are owned by public sector authorities or agencies. In aviation, the airways and most airports are controlled by the public sector, with freight services provided by private carriers. Finally, pipelines are privately owned and operated. The public sector does have a regulatory function in all modes, primarily dealing with safety issues.

3.3.1 Performance Barriers

All of the freight-sensitive user segments can suffer economic losses when cargo is not moved in a reliable fashion. When delay is predictable, it is possible for business operations to adjust to accommodate a different timetable or a longer delivery time. However, unpredictable delay, often weather or crash induced, can cause higher costs in plant operations and supply chains, bringing a stop to manufacturing activity and damaging the viability of Michigan's freight-dependent industries. Prevention and management of safety and other incidents associated with sporadic delays on the highway, aviation, port, and rail systems is likely to enhance the efficiency of freight movement in Michigan, removing freight barriers to Michigan's economic performance.

3.3.1.1 Long Travel Times/Recurring Delay

Long travel times can result from congestion or a lack of connectivity between freight intensive activity centers and major corridors and intermodal facilities. The importance of travel time varies greatly by industry. For example, travel time is very important to the auto industry and others involved in the movement of high-value products. Travel time is much less important to shippers of lower value bulk cargoes, such as stone, iron ore, and forestry products. Agricultural products also tend to fall into this latter category, but may suffer spoilage if delay is extensive.

3.3.1.2 Crashes

All modes share the risk of crashes, most notably trucking and rail. Crashes for these modes directly hinder the operations of shippers, both by interfering with deliveries and damaging goods, as well as by causing extensive incident-induced and unpredictable delays for carriers. A highway crash, whether it involves a truck or not, can create the congestion discussed in the previous challenge. A train derailment can also create challenges, as shippers and railroads experience long delays and higher costs. Exceptionally high crash

rates may also be reflected in higher insurance and shipping costs of doing business in Michigan.

3.3.1.3 Long Recovery Time for Damaged Infrastructure

Due to the nature of freight infrastructure, when a natural disaster or other problem disables Michigan's freight infrastructure, it may take weeks or months for the system to become functional again. Extended recovery times interfere with Michigan's economic performance. For example, as a result of a major storm in 2005, St. Joseph's commercial port became unusable due to sand deposition. Because there was no ability to immediately dredge the channel, terminal operators sustained heavy financial losses, and since materials had to be brought from other distant sources, construction projects incurred higher costs and delay. Any measures that provide means for freight infrastructure to rapidly recover from natural or other incidents are likely to have a direct and positive impact on economic performance for Michigan industry.

3.3.1.4 Willow Run Airport Limitations

Willow Run Airport in Ypsilanti is the primary freight handling aviation facility in the state. Due to the short length of its runways, fully-loaded and fully-fueled widebody aircraft cannot take off. Therefore, these planes must take off with only enough fuel to get them off the ground and fly to Detroit Metro Airport, 10 miles away. There, the plane can obtain a full tank of fuel and use the longer runways to re-embark on its flight. This is enormously costly, but due to the availability of the surrounding land lengthening the runways may prove difficult.

3.3.1.5 Navigation Policy Issues

Restrictive provisions of the federal Jones Act hinder the development of short-sea-shipping or other domestic shipping services. Maintaining the navigation channels is difficult due to a lack of adequate funding and due to environmental regulations. The lack of availability of funds from the federal Harbor Maintenance Trust Fund has contributed to the deterioration of port conditions and capacity. State regulation of ballast water discharge discourages shipping on the St. Lawrence Seaway. When issues of funding and regulatory problems are resolved at the national level, barriers arising for Michigan's waterborne shippers may be resolved.

3.3.1.6 Lack of Truck Parking

Truck parking has generated considerable national attention. There is debate about whether government rest areas or private sector truck stops should provide parking for trucks. This issue is influenced by Federal Hours-of-Service rules and strategies to improve truck safety.

3.3.1.7 Jurisdictional Issues for Truckers

Trucks pay taxes for use of road facilities. However, trucks are not permitted on all roadways due to local ordinances. A lack of consistency in truck access into, out of, and

through trade centers with special regulations on trucks creates a barrier for the movement of goods to centers and markets where activities utilize these goods.

3.3.1.8 Truck Size and Weight Enforcement

Truck enforcement for size and weight is funded by MDOT but under the jurisdiction of the Michigan State Police. MDOT and Michigan State Police, Motor Carrier Division are reviewing the efficiency and effectiveness of current weigh station operation and alternative enforcement strategies. When weigh station operations are inefficient, the activities of shippers and carriers are affected by the delay. Highway preservation and safety may suffer for all users.

3.3.1.9 Border Delay for Trucks

Michigan has four highway border crossings with Canada. The Ambassador Bridge in Detroit and the Blue Water Bridge in Port Huron are ranked first and third, respectively, in number of truck crossings each year of all US-Canada border locations. Heightened security risks due to world events have led the Department of Homeland Security to impose stricter inspections of trucks, resulting in longer wait times and higher costs for shippers. Congestion at the border crossings is becoming more of an issue.

3.3.1.10 Rail Track Limitations

Rail cars capable of carrying 286,000 pounds are becoming the nationwide standard for certain commodities, particularly agricultural products. These cars are often preferred by freight shippers and receivers because they allow for more efficient handling of the products. The sheer weight of the cars requires a more substantial track infrastructure than may exist on some lines, especially with respect to bridges and other structures. This is most likely to be true for lines owned by short line or regional carriers. Unless improvements are made to these facilities, shippers may encounter an increasingly limited market for their products.

3.3.1.11 Air Cargo Inspection

While heightened security inspections may be deemed necessary, this can lead to delay of air cargo freight movements. Cargo airlines are generally viewed as less secure than passenger airlines, and legislation in Congress has vowed to “close the gap.” This affects many small packaged freight shipments and cargo that is needed just-in-time.

3.3.1.12 Funding Restrictions

MDOT's ability to undertake freight projects is limited by both the amount of funds available and restrictions on the use of its federal funds. Traditional federal transportation funding received through the Federal Highway Administration cannot be spent for freight projects that are not a part of the highway system. For example, federal highway funds cannot be used for improving or expanding railroad lines or terminals. Highway-related freight projects must compete with other highway projects. MDOT does have two state-

funded rail assistance programs, which are discussed in this report, but their funding levels are insufficient for major freight projects.

3.3.2 Opportunities

MDOT is involved in several planning projects and many programs that do and will make Michigan attractive for freight-sensitive businesses. Manufacturing and Agriculture, two of the state's most prominent industries, need the transportation system to be as efficient as possible to remain competitive. The bulk goods from the extraction industries have had transportation processes in place for several years and they need to be maintained. Michigan's key geographic location to Canada makes it important for foreign trade, so the border crossings need to be efficient in order to continue the trade with our neighbor.

3.3.2.1 Truck Laws and Enforcement

Michigan's truck weight law encourages the efficient movement of heavy commodities by trucks. This reduces costs due to the higher capacity and reduces pavement damage by limiting the allowable weight per axle. These vehicles are among the most efficient in the nation. MDOT is working with the Michigan State Police Motor Carrier Division to encourage the use of technology for selective enforcement of overweight trucks. Patrol cars are outfitted with receivers and officers are able to detect overweight vehicles as they cross MDOT's Traffic Monitoring Weigh-in-Motion (WIM) instrumentation. This project has generated impressive early results and is being expanded beyond the test phase.

3.3.2.2 Detroit River International Crossing (DRIC)

The high-volume of trucks on the Ambassador Bridge in Detroit has led to the need for improved capacity at the crossing. This project for a second Detroit River crossing is in the planning stage. A preferred alternative is anticipated by late 2007, following completion of the planning process. The selected crossing is targeted to be finished by 2013.

3.3.2.3 Soo Lock Improvements

The St. Mary's Falls Canal, including the Soo Locks, is owned and operated by the US Army Corps of Engineers. The canal is part of the St. Mary's River, which connects Lake Superior with Lake Huron. Congress has authorized construction of a new large lock, which will replace two functionally obsolete locks that were constructed during World War I and are now closed. The lock will be similar in size to the existing Poe Lock, which is the only lock capable of accommodating 1,000-foot-long vessels and other large vessels. These vessels account for approximately two-thirds of the US Great Lakes' fleet capacity. Federal law requires the eight Great Lakes states to share the costs with the federal government for construction of the new lock. Michigan has entered into a contract to provide its share, which is currently estimated at \$14.1 million. Efforts continue to secure the remaining funding from Congress and other Great Lakes states. There is also a congressional initiative to provide full federal funding for the project because of homeland security issues, which would obviate the need for state funds.

3.3.2.4 Detroit Intermodal Freight Terminal (DIFT)

MDOT has been working to help develop the Detroit Intermodal Freight Terminal, which will expand the capacity of intermodal terminals to accommodate the volumes of traffic expected in 2025. The inefficiency of having several terminals throughout the metro Detroit area hampers the growth of this freight mode in Michigan. Consolidation of intermodal facilities would provide the equipment and infrastructure availability needed to remain competitive.

3.3.2.5 Flint Bishop Intermodal Freight

Bishop International Airport in Flint will begin development of an intermodal freight hub. The project, when completed, is expected to facilitate the handling of larger container freight, improve safety conditions, increase commercial air traffic at the airport, and create up to 200 new jobs in the Flint area. The first phase of the project is expected to be completed in 2009.

3.3.2.6 Highway Infrastructure Improvements

MDOT continues to rehabilitate and reconstruct poor highway pavements and bridges each year. The 2006-2010 Five Year Transportation Program anticipates Michigan's evolving economic and transportation needs by first ensuring that MDOT will substantially achieve the State Transportation Commission's 1997 system preservation goal of 90 percent of state roads and bridges in good condition by 2007 and 2008 respectively. The department's initiative to meet this goal will help create transportation related benefits such as travel time savings for households and businesses, and investment in construction and engineering. This investment in transportation results in economic benefits for Michigan, creating a system attractive to freight industry.

3.3.2.7 Intelligent Transportation Systems (ITS)

The US DOT has defined Intelligent Transportation Systems (ITS) as systems which collect, store, process, and distribute information relating to the movement of people and goods. Examples include systems for traffic management, public transportation management, emergency management, traveler information, advanced vehicle control and safety, commercial vehicle operations, electronic payment, and railroad grade crossing safety. Michigan has been a national leader with its ITS program, having created large systems in the Detroit and Grand Rapids areas. Variable message signs, closed circuit television cameras, ramp meters, inductive highway loops, and advisory radios are included in the systems. ITS can help alleviate commercial freight movement travel times by forewarning shippers of problems ahead of time. MDOT is taking a lead role in preparing an implementation plan for expediting traffic flow across the border at the Ambassador and Blue Water bridges and the Detroit-Windsor Tunnel using ITS technologies.

3.3.2.8 Rail Assistance Programs

The department maintains two competitive financial assistance programs designed to enhance existing infrastructure and help rail users gain access to or make greater use of the freight rail system. The Freight Economic Development Program assists rail users in constructing new or expanded spur tracks, rail yards, or transload facilities. To qualify, the rail users must be creating jobs in Michigan and adding rail traffic to the system. The second program, the Michigan Rail Loan Assistance Program, or MiRLAP, is geared toward preserving or improving existing infrastructure and keeping rail lines viable. Both programs are intended to improve Michigan's climate for rail-dependent businesses.

3.3.2.9 Rail Accessibility

From the mid-1970s through the mid-1980s, MDOT purchased rail lines that were either abandoned by private carriers or owned by companies in bankruptcy. The goal of the program was to continue to make rail access available to rail-dependent businesses on those lines. Many of the lines were in disrepair and the department invested heavily to return them to a more viable condition. MDOT currently owns approximately 550 miles of rail line and contracts with four private rail operators to provide service to shippers on those lines. Three of the lines are scheduled to be returned to the private sector over the next several years as part of a legislatively-mandated divestiture process.

3.3.2.10 All-Weather Airports

An initiative has been underway to make Michigan airports all-weather accessible, utilizing new instrument approaches with GPS and readily available automated weather information. This can greatly improve the facilitation of freight, as seasonal changes in certain freight movements will be reduced.

3.3.2.11 Border Programs – FAST and ACE

Two programs have been initiated at our border crossings to help relieve congestion and delay. The Free and Secure Trade (FAST) program is a joint Canada-US initiative involving the Canada Customs and Revenue Agency (CBSA) and the United States Bureau of Customs and Border Protection (CBP). It is a commercial clearance process offered to pre-approved importers, carriers, and registered drivers. Shipments for approved companies, transported by approved carriers using registered drivers, will be cleared into either country with greater speed and certainty and at a reduced cost of compliance. The Automated Commercial Environment (ACE) and its related e-manifest are an entirely new approach to border security that also promises to speed up truck clearances at the land crossings. This is still a developmental, voluntary program; however, truck freight will soon be required to use ACE to submit electronic data on freight moved into the country.

3.4 Integrating Freight

An integrated transportation system for Michigan entails freight connections that are responsive to the needs of the shipper and carrier communities. Increasingly, decision support technologies and architectures will play a role in managing information about delays and incidents on highways, bridges, ports, and aviation systems to support freight operations. Furthermore, the safety of localized roadway connections to intermodal facilities as well as warehouses and major distribution centers is critical to ensuring an integrated system that functions to support freight efficiencies.

Unlike many areas of infrastructure, the performance of the freight system is also highly dependent on the operations of the private sector. Supporting the private sector (shipper and carrier) communities is vital to ensure freight plays a productive role in the transportation system. Driver training and safety, supporting the selection of manufacturing, warehousing, and distribution sites with adequate infrastructure, and the sharing of information about system performance with carriers are areas that will be increasingly important. The area of homeland security is another key area for collaboration regarding freight. Highway, port, shipper, and carrier communities have a role in ensuring homeland security needs are addressed in the most efficient manner possible. This topic is covered in more detail in both the *Corridors and Borders Report* and the *Security Technical Report of MI Transportation Plan*.

3.4.1 General Freight Expectations

Looking at national and regional economic forecasts and using past trends, MDOT can better prepare itself for future freight concerns. Some general freight expectations can be made that will provide the basis behind planning strategies and operations. These include:

- The private sector will continue to control the movement of freight using both privately- and publicly-owned infrastructure.
- Trucks will continue to move more freight than any other mode.
- Highway congestion will continue in the future. Truck freight will continue to experience predictable and unpredictable delays.
- Productivity gains are expected to be realized through use of more efficient truck configurations.
- The rail system will continue to shrink in terms of miles of track, but will carry more tons of cargo. Additional double tracking on major corridors may occur.
- Rail intermodal traffic will continue to grow in major traffic corridors.
- If/when, mergers occur between eastern and western US railroads, additional Michigan intermodal traffic will be shifted to rail.
- Michigan's ports will continue to handle predominantly bulk cargoes.
- Custom delivery and current supply chain methods are expensive. High fuel costs and driver shortages will likely result in an evolution back to larger deliveries and more

emergency stock on hand (in manufacturing and in retail), especially if interest rates are low.

- Increased consumer demand for online shopping and overnight delivery of purchases will increase air cargo volumes.

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