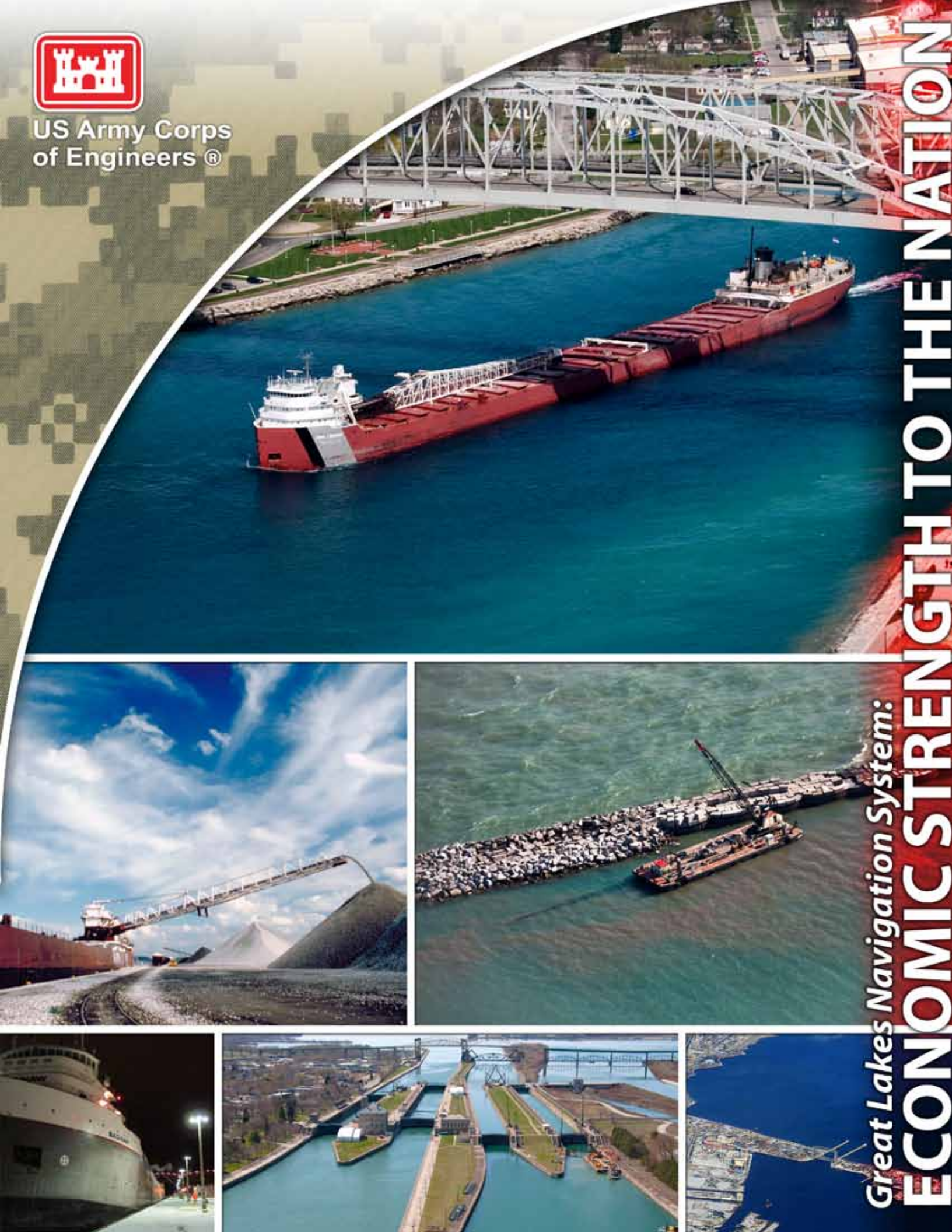
US Army Corps of Engineers ®



Great Lakes Navigation System: ECONOMIC STRENGTH TO THE NATION


Photo by Rod Burdick, 2010

The Great Lakes Navigation System (GLNS) is a complex deepwater navigation system stretching 1,600 miles through all five Great Lakes and connecting channels from Duluth, Minn. to Ogdensburg, NY. It is a non-linear system of interdependent locks, ports, harbors, navigation channels, dredged material disposal facilities and navigation structures. Maintaining Great Lakes navigation infrastructure as a viable, functional system is essential to preserving the health and vitality of the region and the nation in an environmentally sustainable manner.

The GLNS is a vital component of America's transportation system. It contains nearly a quarter (22) of the nation's top 100 harbors by tonnage. Commodities transported on the Great Lakes Navigation System represent 10 percent of all U.S. waterborne domestic traffic. The 60 large and smaller federal commercial ports on the Great Lakes are linked in trade with each other, with Canadian ports, and with ports throughout the rest of the world. Unlike ports along the eastern and western U.S. coasts that compete against each other for trade business, the GLNS is unique in that its ports do not compete with each other for trade business. Great Lakes ports are part of an overall system that competes against other modes of transportation that are less economically viable and far less environmentally sustainable. Compared to the next least costly mode of transportation, the navigation system on the Great Lakes saves industry $3.6 billion dollars annually. The GLNS provides jobs directly related to the maritime industry and indirectly related through associated industries.

The GLNS moves 145 million tons of commodities annually. This activity is vitally important to the nation's economy. The ports and channels support over 128,000 jobs in the U.S. and bring a total of $18.1 billion in business revenue to the U.S. annually. The waterway network provides a very safe, efficient and environmentally sustainable mode of transportation for raw materials, agricultural commodities and manufactured products. It is crucial to the region; industry in the Great Lakes region could not succeed without it.

Great Lakes Navigation System: Economic Strength to the Nation

Creating Positive Economic Benefits

The Great Lakes Navigation System is vitally important to the nation's economy. According to a study conducted by Martin & Associates on the Great Lakes - St. Lawrence Seaway system completed in 2011, the ports and channels of the Great Lakes-St. Lawrence Seaway system support over 226,000 jobs in the U.S. and Canada and bring a total of $33.5 billion in business revenue to the U.S. and Canada annually. In the U.S. alone, the system supports over 128,000 jobs and produces a total of $18.1 billion in business revenue annually. Ensuring a strong manufacturing base in the Great Lakes is essential to maintaining global competitiveness. The GLNS allows regional industries to stay competitive by supporting the least cost mode of transportation of raw materials to manufacturing plants. If the cost of transporting domestic raw materials increases, then industries may pass this cost onto the end user, look to import raw materials instead, or shift production overseas, any of which would have a significant negative impact on the region and U.S. economy.

Great Lakes vessels transport iron ore from Minnesota and northern Michigan ports to the integrated steel mills and trans-shipment ports situated on southern Lake Michigan and Lake Erie as shown in Figure 1. This is a critical link in the supply chain for the U.S. steel industry.

Iron ore made up the largest sector of commerce moved on the Great Lakes in 2010. Most of the iron ore that was moved on the GLNS waterways originated in Lake Superior ports, with over 50 million tons of iron ore shipped in 2010. The GLNS also moves vast quantities of coal from Montana and Wyoming through Lake Superior ports to power-generating stations in many metropolitan areas of the Great Lakes. Coal shipments on the Great Lakes in 2010 totaled 31 million tons. Other commodities shipped through the system include limestone, cement, coke, salt, grain, petroleum products, processed iron and steel, aggregates, chemicals and a variety of other goods. Economic forecasts project that the tonnage on the GLNS will continue to grow at a modest pace.

The true importance of the GLNS rests with its geographic location: the GLNS is located in the core of North America's industrial and manufacturing heartland. The prosperity of several key sectors of the U.S. economy depends on the GLNS. These sectors include iron and steel, cement manufacturing, energy production and agricultural exports. These industries depend on the availability of reliable, low-cost waterborne transportation. Compared to the next least costly

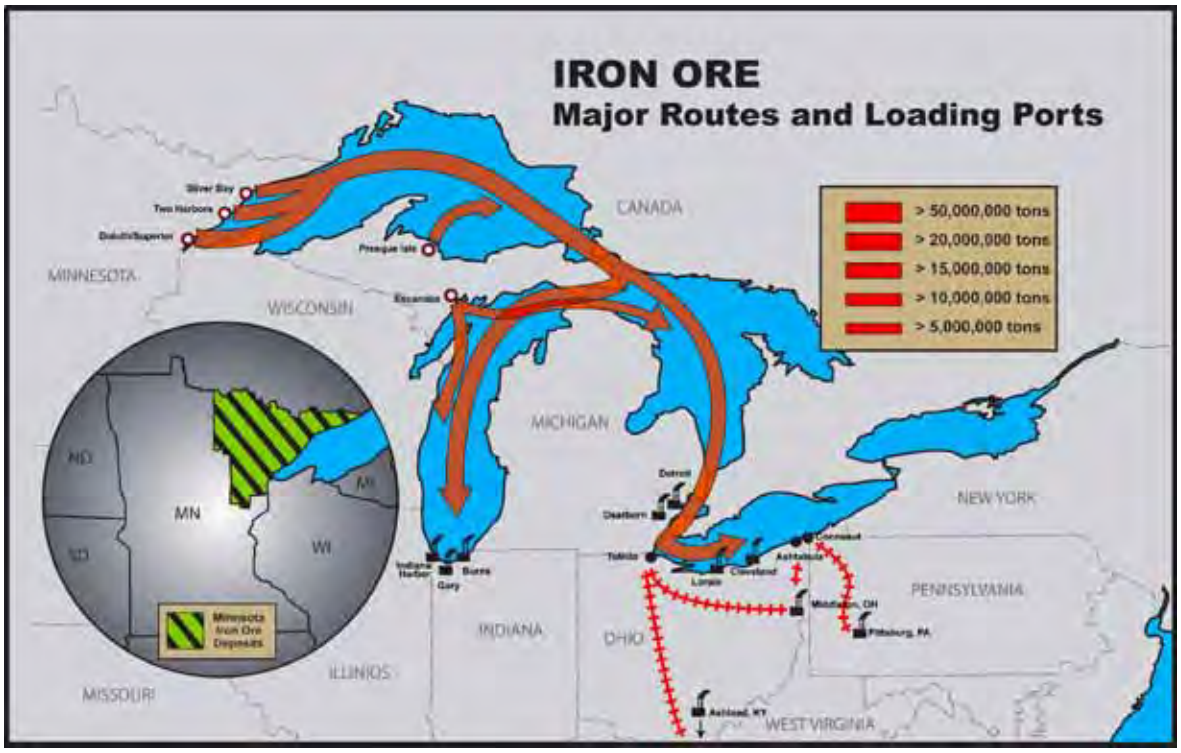


Figure 1. Iron Ore: Major Routes and Loading Ports

mode of transportation (rail or truck), the GLNS saves U.S. businesses and ultimately consumers approximately $3.6 billion per year. This translates directly into more competitive American steel, lower cost energy and lower cost aggregate and concrete for construction in our cities and on our highways.

The GLNS also provides a positive economic impact to the U.S. economy as a jobs provider. As published in Martin and Associates 2011 study of the Great Lakes - St. Lawrence Seaway System, the GLNS supports over 226,000 total direct jobs. Over 42,000 of these are direct jobs in the iron ore and steel industry. The American Iron and Steel Institute reports that the steel industry supports over 150,000 direct jobs and seven times that (over one million jobs) in upstream and downstream related jobs. The U.S. steel industry is very important to the U.S. economy and the GLNS plays a vital role in the continued viability of the steel industry. In addition to being the backbone of the U.S. manufacturing sector, the U.S. steel industry is essential to a strong and resilient national defense capability. The GLNS transports approximately 95 percent of the iron ore used in the U.S. steel industry.

Providing a Low-Cost, Low-Emission Mode of Transportation

The GLNS plays a key role in preserving our nation's fuel. The fuel economy of maritime transportation is significantly higher than any form of ground transportation. For example, a Great Lakes carrier averages 631 miles on one gallon of fuel per ton of cargo. In contrast, a truck averages 91 miles on one gallon of fuel per ton of cargo and a freight train only 553 miles on one gallon of fuel per ton of cargo. In one delivery, a 1,000-foot Great Lakes carrier supplies 70,000 tons of cargo. It would

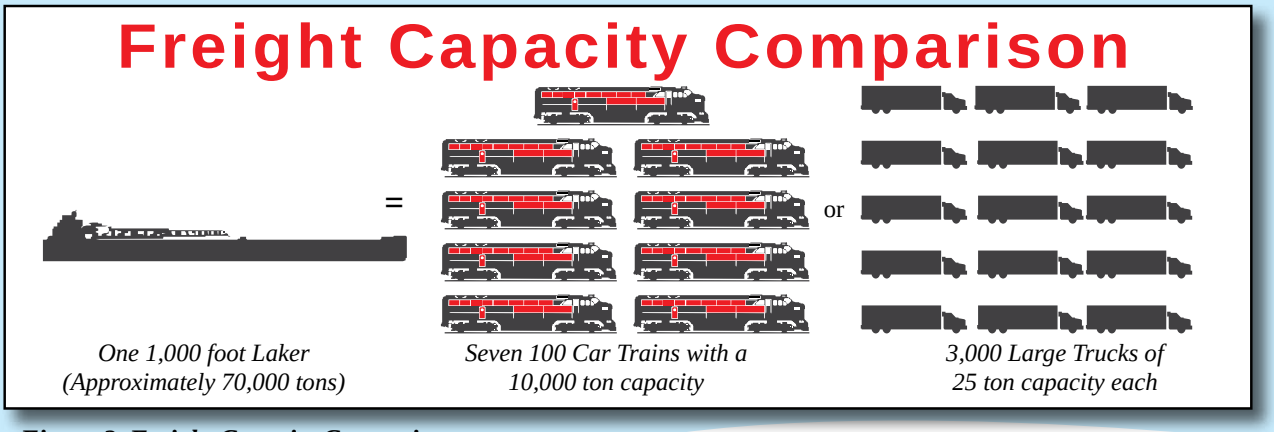


Figure 2. Freight Capacity Comparison

take nearly 3,000 semi-truckloads to haul the same load (as shown in Figure 2.) The trucking mode of transportation not only is much less fuel efficient, it creates significant wear-and-tear on the nation's infrastructure and increases congestion on already clogged roadway arteries.

The amount of greenhouse gas emissions is also significantly lower in maritime transportation as compared to ground transportation, as shown in Figure 3. A cargo of 1,000 tons transported by truck emits over 537 percent more greenhouse gases than the same tonnage transported by Great Lakes carrier. The same cargo carried by rail would produce 21 percent more greenhouse gases than if the cargo was transported by Great Lakes carrier. The GLNS offers a fuel-efficient, low carbon producing and low-cost option of transportation for millions of tons of bulk material that are vital to this country's industrial strength.

When harbors do not recieve adequate dredging funding, shippers may be forced to seek alternate

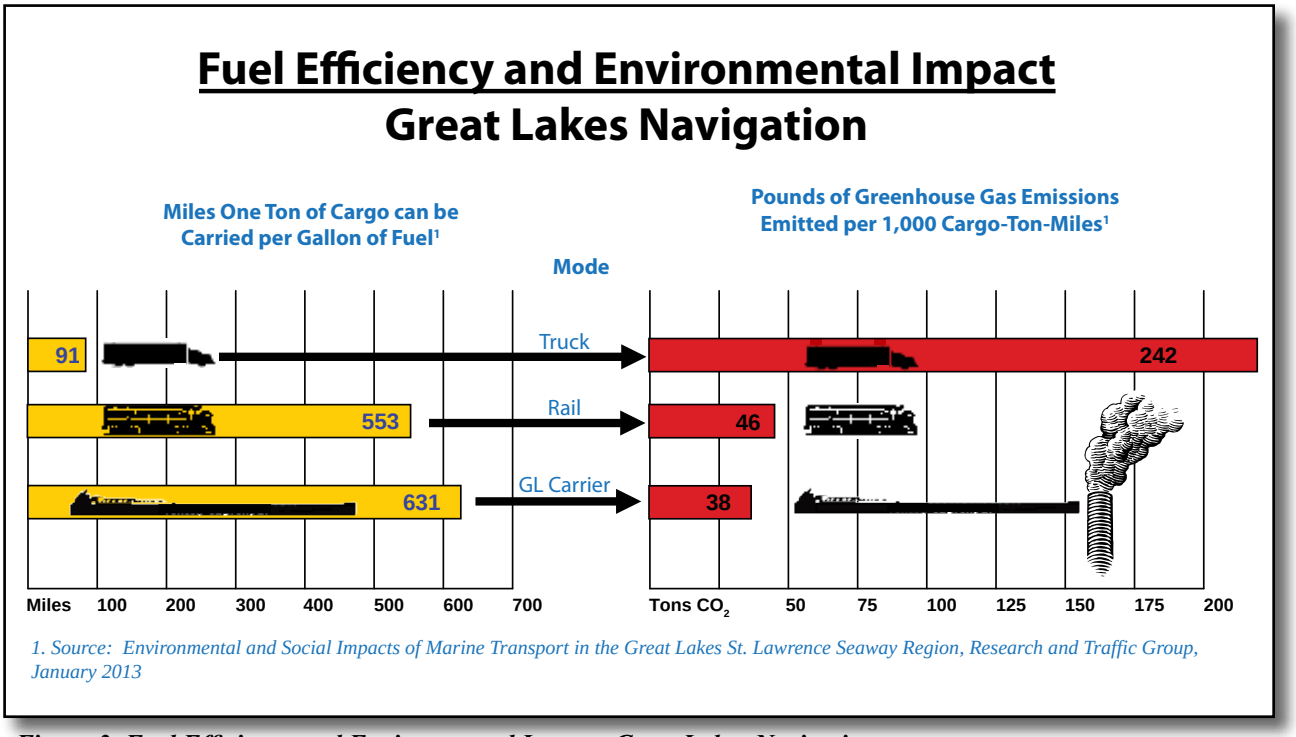


Figure 3. Fuel Efficiency and Environmental Impact: Great Lakes Navigation

St Marys River, Sault Ste. Marie, Mich.

modes of transportation that come with higher costs and negative environmental impacts. For example, the Lake Carriers' Association reports that a lack of dredging at Dunkirk Harbor, Ohio ended coal trade in 2006 when the user switched to rail as their only available method of transport.

Leveraging Mother Nature's Natural Shipping Lanes

The GLNS has a distinct advantage over other modes of transportation such as truck and rail: 90 percent of the shipping lanes in the GLNS use the lanes exactly as the glaciers left them. There is no need for maintaining them because they were gouged deep by the glaciers. The nation has entrusted the maintenance of the remaining 10 percent to the U.S. Army Corps of Engineers. This includes dredging the connecting channels and harbors and maintaining locks in proper working condition. This is tremendous leverage that is unrivaled in other modes of transportation – maintain 10 percent and get 90 percent free.

Strengthening the Navigation System

The U.S. Army Corps of Engineers has managed the GLNS since the 1820s. In recent years however, shrinking federal budgets combined with aging infrastructure and lower lake levels have strained the Corps' ability to adequately maintain the system. Consequently, a backlog of maintenance needs has accumulated, including rehabilitation and modernization of the locks at Sault Ste. Marie, Michigan (Soo Locks); dredging of over 18 million cubic yards of material from harbors and channels; construction or expansion of many critical dredged material disposal facilities; and repairs to many of the over 100 miles of breakwaters on the system. In addition, construction of a new lock at the Soo Locks is important to ensuring the reliability of the system.

The total system tonnage is beginning to recover after the U.S. recession of 2009. System tonnage increased by 20 percent from 2009 to 2010. The five year average (2006-2010) tonnage is approximately 145 million tons.

Rock Cut, Sault Ste. Marie, Mich.

Figure 4. Condition of Federal Projects on the Great Lakes

In addition to being a vital component of the U.S. manufacturing supply chain, the GLNS also supports a strong export market. The majority of commercial traffic on the GLNS is shipped to or from other ports within the system; however, a significant amount of commodities are exported from the U.S. to both Canadian and overseas ports. In 2010, of the 130 million tons shipped on the GLNS, 24.1 million tons (nearly 20 percent) of the total system traffic was exported from U.S. ports in the Great Lakes Navigation System - 22.2 million to Canada and 1.9 million to overseas ports.

Aging infrastructure, persistent low water levels and constrained budgets have combined to produce a situation in the GLNS where over half the harbors and projects are rated either failing or failed; that is, they are not adequately serving the navigation needs for which they were designed. The Corps conducted a condition assessment that identified the situation at each harbor and project on the Great Lakes, as shown in Figure 4. The dredging need, structure condition and availability for placement of dredged material were all considered in determining the rating at each harbor. Locks were rated on their condition assessment using the Corps' Asset Management System.

The Corps' Great Lakes Navigation team has taken the condition assessment illustrated in Figure 4 and identified a plan to address the critical needs of this regional system. The plan serves as a program implementation guide to engage stakeholders and focus resources on the system's most critical needs in terms of reducing risk and optimizing reliability.

The plan describes the investments required for the GLNS with the goal of developing a regional asset management plan in coordination with stakeholders that articulates system priorities.

The plan focuses on the following four components:

1. **Restoration of Locks**
2. **Removal of Dredging Backlog**
3. **Expansion and Construction of Dredged Material Disposal Facilities**
4. **Repair of Navigation Structures**

The following sections describe each of the specific needs of the Great Lakes system in detail and explains the risks and consequences of not meeting those needs.

Locks: Important Keys to the System

The Corps operates and maintains three lock systems on the Great Lakes: The Black Rock Lock in Buffalo, NY; the Chicago Lock in Chicago, Ill.; and the Soo Locks (Poe and MacArthur Locks) located in Sault Ste. Marie, Mich.

The Black Rock Lock in Buffalo, New York provided safe passage for 340 commercial and 1,650 recreational boats in 2012. The lock and a two-mile-long Bird Island pier separates the channel from the Niagara River allowing vessels to bypass the swift and dangerous waters of the Niagara River. Routine annual operation and maintenance funding does not support needed repairs to the lock, which include guide wall repairs, chamber resurfacing and repairs to the electrical system.


Chicago Locks, Chicago, Ill.

The Chicago Lock is one of the busiest locks in the nation with over 10,800 lockages in 2012, passing 32,700 commercial and recreational boats. The lock allows safe passage of boats navigating the 2-to 5-foot water level difference between Lake Michigan and the Chicago River. The lock also serves as a flood damage reduction structure with gates that must reliably open when needed to prevent the Chicago River from flooding downtown Chicago. Routine annual operation and maintenance funding does not support additional needed repairs to the lock, which include utility tunnel restructuring and gate modifications.


Black Rock Lock, Buffalo, NY

Soo Locks, Sault Ste Marie, Mich.

The St. Marys River is a water channel connecting Lake Superior with Lake Huron and serves as a critical link in the Great Lakes - St. Lawrence Seaway System. The Soo Locks facility is located on the St. Marys River at Sault Ste. Marie, Michigan on the international border with Canada. The locks allow ships to navigate the 21-foot drop between Lake Superior and the St. Marys River, making them the most crucial locks in the Great Lakes system. There are two operating locks at the Soo: the MacArthur Lock, completed in 1943 and the Poe Lock, completed in 1968. In 2012, the Soo Locks provided safe passage for 6,108 commercial vessels carring over 75.2 million tons of cargo. In the same year, the locks also provided passage for 457 recreational vessels.

On average, upwards of 80 million tons of commercial commodities pass through the Soo Locks annually. However, only the Poe Lock has the necessary dimensions to pass all Great Lakes vessels that are currently in operation. In the event that the Poe Lock is out of service, approximately 70 percent of commercial cargo would be unable to transit the facility. Based on this fact, the Poe Lock is the single point of failure that can cripple Great Lakes shipping. A recent Great Lakes - St. Lawrence Seaway Study, completed by the Corps in 2007 estimated that a 30-day unscheduled closure of the Soo Locks would have an economic impact to industry of $160 million. In fact, the Poe Lock has the greatest economic impact for an unscheduled outage of all the Corps of Engineers' locks throughout the country. Without the Poe Lock, America's steel industry would be severed from its major source of iron ore and power plants throughout the Great Lakes would not have sufficient coal to supply electricity to major cities such as Detroit. There are two major efforts underway to ensure the reliability of the Soo Locks: maintaining the existing infrastructure through the Asset Renewal program and adding redundancy with the construction of a new lock with the same dimensions as the Poe Lock.

Soo Locks Asset Renewal Plan: Improving Efficiency and Reducing Risks

The Poe Lock is the lynch pin of the GLNS. There is currently no redundancy for the Poe Lock. If the Poe Lock goes down, nearly 60 million tons of commerce would have to go by alternate modes of transportation. However, existing rail and truck infrastructure is insufficient to support the vast quantities of tonnage that would have to bypass the lock. This underscores the tenuous situation that the Great Lakes shipping industry faces. To reduce the risks of lock down time and vessel delays, the Corps is in the process of implementing a multi-year plan to rehabilitate and modernize the existing infrastructure of the Soo Locks facility.

The Corps has developed a detailed Soo Locks Asset Renewal Plan that defines the project requirements needed to maximize reliability and reduce the risk of catastrophic failure at the Soo Locks. This plan outlines the work necessary over the next five years to prevent unscheduled closures and to provide reliable infrastructure at the Soo Locks through the year 2035. Although construction of a new lock would provide the desired redundancy, a new lock would not be operational for a minimum of 10 years from the begining of construction. In the meantime, the Corps must conduct the asset renewal of the existing infrastructure at the facility to reduce risks of unscheduled closures. To date, over $30 million of the approximately $100 million Soo Locks Asset Renewal Plan has been funded.


Current Soo Locks configuration

The Soo Locks Asset Renewal Plan includes completely replacing the Poe Lock hydraulics system. The Poe hydraulics system was responsible for six unscheduled outages from 2008 through 2012, which delayed shipping at a significant cost to shippers. Each piece of equipment has its own hydraulic power unit, requiring a total of 24 separate hydraulic power units. Hydraulic units have no redundant pump or motor, which results in 24 separate points of failure. The new hydraulic system will have only four hydraulic power units, each of which will be equipped with a redundant pump and motor. The new hydraulics system has been procured and will be completely installed by 2014. A new air compressor system, which is critical for controlling ice at the locks, has also been procured under the Soo Locks Asset Renewal Plan. Additional key items that are still needed under the plan include Poe electrical rehabilitation, replacement of the Poe gates and modernization of the MacArthur Lock by updating the electrical and controls system and installing interlocks. Remaining funding needed for the full Soo Locks Asset Renewal Plan is $68 million, approximately $12-15 million per year. This is a cost-effective investment considering that the economic impact of a single 30-day unscheduled outage of the Soo Locks is $160 million.

New Soo Lock: Providing Critical Redundancy

The Poe Lock is a 45-year old structure, that handles 70 percent of commercial cargo at the Soo. The Poe Lock is requiring increased maintenance due to the long term exposure to severe ice and vessel forces. A new lock parallel to the Poe would decrease the risk of a major unscheduled outage. It would also lower maintenance costs because maintenance could occur more efficiently during the summer months.

Congress has recognized the need for a second Poe-sized lock for nearly 30 years. The 1986 Water Resources Development Act (WRDA) authorized construction of a new lock but the project has had many funding challenges over the years. The 2007 WRDA authorized construction of the new lock at full federal expense.


Artist rendition of New Soo Lock

Having full redundancy at the Soo Locks also offers many benefits to the regional and national economy. However, another important aspect of the project is the economic benefits of the construction itself. An economist from the University of Tennessee has estimated that construction of the new lock would

generate approximately 1,000 jobs per year over the expected 10-year construction period. This equates to an estimated $360 million in wages over the same period. These are jobs related not only to the construction industry, but also include all the associated jobs for suppliers and service providers.

If Congress directs initiation of construction of the new lock at the Soo by providing funding, the Corps is prepared to execute $125 million, which includes awarding contracts for construction of the upstream and downstream approach walls and upstream excavation. In 2009, Congress provided $17 million for construction of the cofferdams and downstream channel deepening. The current working estimate for construction of the entire project is $580 million.

Backlog Dredging: Restoring Channel Functionality

Dredging is vital to the functionality of the GLNS as a whole. Constrained funding over the past 12 years has allowed a critical dredging backlog to grow to an unprecedented level in major navigation channels and harbors. The growth of backlog, especially combined with low water levels over the past 14 years, increases costs to shippers and industry and therefore the consumer. This has become even more important as the Great Lakes experienced low water levels throughout the system. Levels below long-term average and in some locations, record low water levels and levels significantly below chart datum caused serious impact to harbors and channels throughout the Great Lakes.

When harbors and channels shoal in, ships have to light load, which increases the transportation cost because more trips are required. The Lake Carriers' Association reports that for every one foot in lost draft, a Great Lakes carrier forfeits more than 3,000 tons of cargo each trip. This equates to over 16 million lost tons per year per foot of lost draft, which has a large negative impact on our national economy.

The Corps was provided additional funding in 2008 and 2009 that allowed some backlog to be dredged; this was the first time in eight years that funding exceeded the annual dredging requirement, which allowed some of the backlog to be removed. In addition to the increased funds, the Corps was also given flexibility in terms of regional dredging provisions in FY2008, 2009 and 2010, which proved to be an efficient means to meet critical system needs and optimize scarce dredging funds. The provisions allowed the Corps to work with stakeholders in an open, technically-based process using current shoaling conditions, water levels and contractors bids to decide on the best allocation of scarce dredging funds. These provisions increased the flexibility and improved the effectiveness of the dredging program. The federal budgeting process requires the Corps to

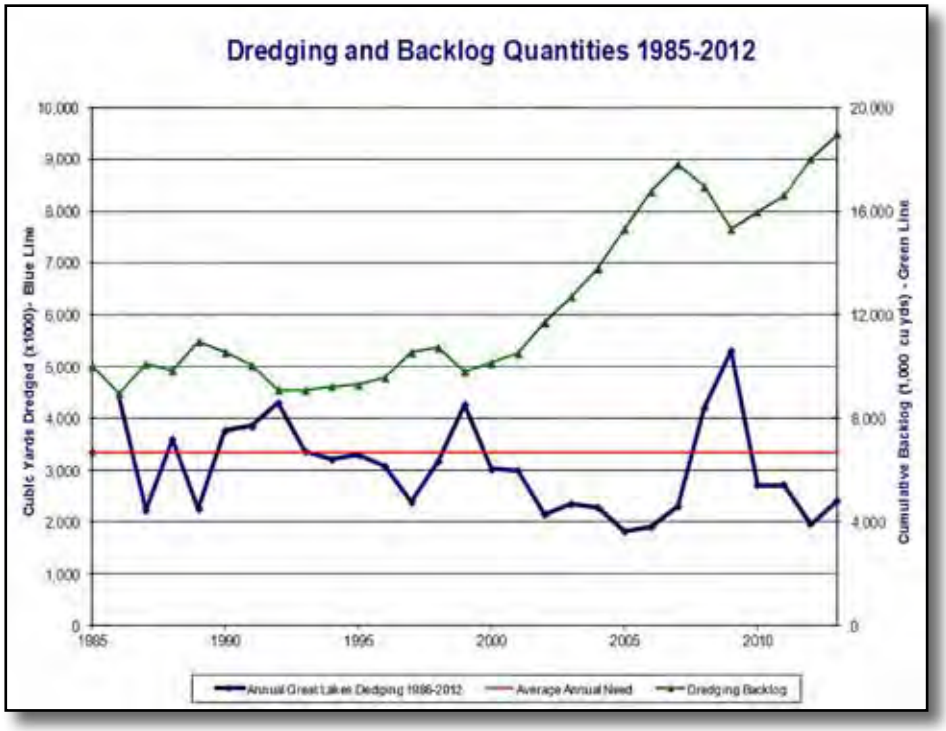


Figure 5. Dredging Backlog Quantities 1985-2012

project system needs two years in advance. However, the regional dredging provisions allowed the Corps and stakeholders to take a holistic view of the system and apply the funds to the most critical needs in the year they were required, thus increasing the efficiency of dredging funds by applying the funds to real-time needs.

The Corps has identified system needs to restore the Great Lakes navigation channels to full functionality (maintenance of channels to authorized depths, at sufficient widths and lengths so that navigation is not impeded under normal conditions). Currently, due to limited funding, most commercial navigation channels are maintained at less than the fully functional level, which has resulted in a backlog of dredging needs throughout the system.

Approximately 3.3 million cubic yards of material is deposited annually in the federal harbors and channels of the Great Lakes. From the mid-1990s to the present time, constrained funding led to a growth of dredging backlog quantities, as shown in Figure 5. Over $40 million is required each year to keep up with the annual dredging requirement. Another $200 million would be required to completely remove the dredging backlog and restore the harbors and channels to full functionality.

Dredged Material Disposal Capacity: Ensuring Dredging Ability in the Future

Dredged material from about 40 percent of the harbors and channels on the Great Lakes must be disposed in confined disposal facilities (CDFs). There are 20 active CDFs on the Great Lakes. CDFs provide important environmental benefits in that they serve as a secure containment facility for material that is not suitable for open water placement. However,


Erie Pier, Duluth, Minn.

nearly a third of the existing CDFs have no more than five years remaining capacity. Without adequate CDF capacity, dredging operations will be limited, leaving shoaled material in the harbors and channels. For example, dredging of Cleveland Harbor, Ohio is constrained by CDF capacity as the Corps and local sponsor work to develop a new long-term management plan.

Funding on the order of $30-40 million per year is needed to keep up with CDF construction needs. The increasing cost of CDF construction and increased environmental concerns make expanding the practice of beneficial use and reuse of dredged material essential. Removing material from CDFs for beneficial uses creates additional capacity and extends the life of the facility. Programs that prevent soil erosion in the watershed can reduce sediment load to harbors, which decreases dredging needs. These initiatives have multiple environmental and economic benefits; two of which are a reduced need for dredging and reduced need for disposal capacity.

Navigation Structures: Providing Critical Protection

There are over 100 coastal cities and towns on the Great Lakes with federal navigation projects that include breakwaters; 46 of these projects currently support commercial navigation by keeping the navigation channels clear of shoaled material and protect the channels from wave energy. Originally built to safeguard navigation in the federal harbors from waves and ice, these structures also provide critical flood and storm damage protection for buildings, roads, facilities and municipal infrastructure. In many cases, cities and downtowns have developed behind and are now safeguarded by federal breakwaters. The structures have also created safe harbors of refuge for boaters to seek shelter during fast approaching Great Lakes storms. They also protect the 43 U.S. Coast Guard Stations, along with their large fleet of vessels that include cutters, as well as air rescue stations and Marine Safety Units.

More than 50 percent of the coastal structures on the Great Lakes were built prior to World War I (1918) and 80 percent are older than their typical 50-year design life. Federal funding for maintenance of projects is prioritized based on economic benefits related to commercial navigation. Federal breakwaters at harbors with small amounts of commercial navigation are a low priority for funding. Funding for structure repairs at harbors with significant levels of commercial navigation has also been below what is needed for over a decade.

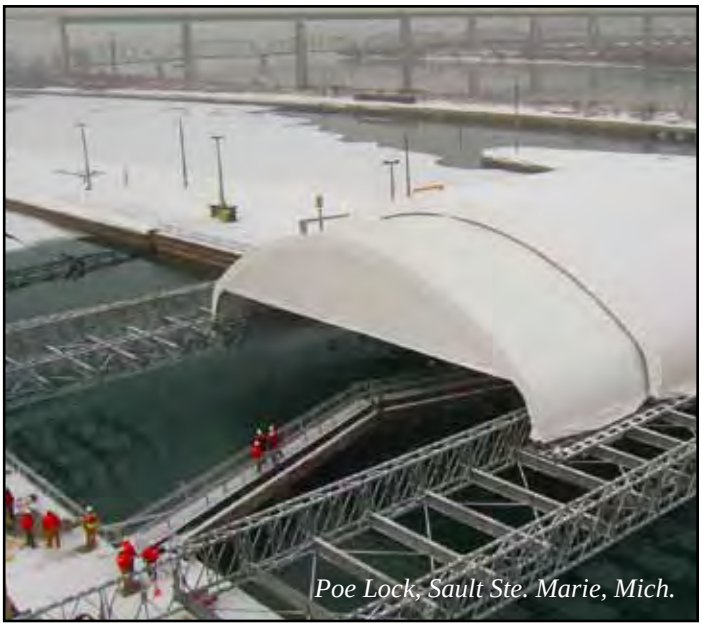
Cleveland Harbor, Ohio

The Corps' floating plant performs some preventive maintenance and repairs of the most urgent needs but does not have the capacity to perform major repairs or reconstruction.

The GLNS has approximately $50 million in annual needs for structure repairs. The majority of these needs represent significant repairs or reconstruction of navigation structures. The three Great Lakes Districts formed a regional, multi-disciplined breakwater assessment team to develop technical assessment criteria and conduct consistent condition assessments of the navigation structures throughout the Great Lakes. The team has inspected all of the Great Lakes structures and has provided a rating for each federal harbor structure. The breakwater assessment team's work allows the Corps to prioritize these needs on a regional level so that the most urgent structures are given priority in the budgeting process. The findings of the breakwater assessments are also shared with the public through a series of Risk Communication Meetings, which began in 2011 and will be completed by 2014. Each meeting covers six to 15 harbors in a geographical area and aims to communicate the risk of breakwater and structure conditions to local stakeholders and navigation system users.

Summary of Critical System Needs

Significant investments are needed to effectively and efficiently operate and maintain the GLNS for the benefit of the Great Lakes region and the nation. The combined needs of the system amount to over $200 million each year for commercial projects alone, as shown in Table 1. This does not include an estimated $15 million per year for dredging and structure repair at shallow-draft recreational harbors. The table identifies the operation & maintenance needs and construction needs for CDFs, but does not include the Construction General funding that would be needed for the new lock at the Soo.



Poe Lock, Sault Ste. Marie, Mich.

Great Lakes Navigation System – Anticipated Needs for Commercial Harbors *Values are represented in millions of dollars*									
FY	Annual Maint. Dredging	Backlog Removal Dredging	DREDGING TOTAL	CDFs & DMMPs	Breakwater Prev. Maint. & Rehab.	Lock Asset Renewal	Strike Removal	Other Navigation O&M Costs[1]	Total System O&M Need
FY14	$42.8	$25.0	**$67.8**	$22.9	$54.0	$29.6	$6.5	$33.1	**$213.9**
FY15	$43.6	$25.5	**$69.1**	$9.6	$58.4	$23.7	$6.7	$33.2	**$200.7**
FY16	$44.5	$26.0	**$70.5**	$37.9	$47.6	$29.5	$6.9	$32.7	**$225.1**
FY17	$45.4	$26.5	**$71.9**	$37.1	$66.7	$16.7	$7.1	$33.0	**$232.5**
FY18	$46.3	$27.0	**$73.3**	$35.9	$34.4	$17.2	$7.4	$34.0	**$202.2**
1. Other Navigation costs include routine operation and maintenance of locks, project condition surveys, environmental activities, and other support staff									

Table 1. Great Lakes Navigation System - Anticipated Needs for Commercial Harbors

Individual Pieces Working Interdependently to Form a System

The Great Lakes is a unique system consisting of 140 individually authorized projects. The 60 individual commercial projects range from handling less than one million tons of cargo to over 45 million tons. These ports ship to and from each other in a complex pattern of interdependency. The long-term viability of each port is dependent on the long-term viability of other ports in the system. This interdependency among U.S. ports is unique compared to most other U.S. ports that are either in a linear river system or major coastal ports that compete with each other for foreign trade. Loss of outbound or inbound tonnage on the GLNS not only affects one port, it also represents a loss at each of its interconnected ports. Consequently, when smaller commercial ports and harbors are closed due to a lack of dredging funds, it affects all other interdependent harbors in the system.

Adolph Ojard, Executive Director of the Duluth Seaway Port Authority expressed concern about the lack of funding and the potential closing of low-use harbors when he stated in the Duluth Seaway Port Authority's Fall 2011 report, "These closings will begin a process, if left unchecked, of restricting trade and maritime activity that will reduce jobs at every Great Lakes port. With over 40 million tons of commerce, the Twin Ports of Duluth-Superior will begin to see the negative effects of these budget shortfalls." Loss or diminishment of any single project in the long-term potentially affects the viability of the system as a whole and will lead to increased costs in the manufacturing, power generation and agricultural sectors.

Figure 6 illustrates the interdependent shipping patterns of the Duluth-Superior port and Figure 7 depicts the interconnected system of eight selected ports on the Great Lakes system. These figures illustrate the complex pattern of interdependency on a small subset of the 60 commercial ports on the Great Lakes system.

Duluth-Superior is interconnected with 24 U.S. ports on four of the five Great Lakes, supporting the

Figure 6. Federal Harbors that ship to/receive from Duluth-Superior Harbor

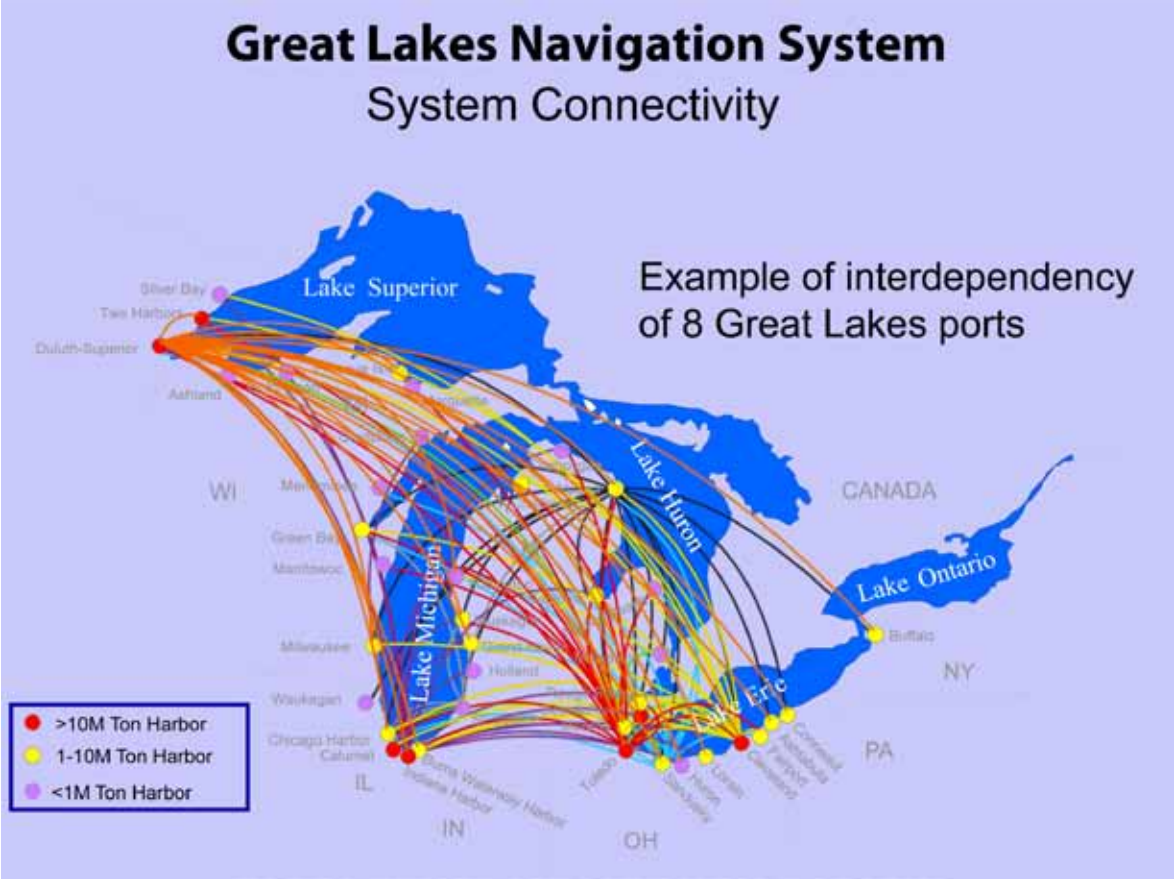


Figure 7. Great Lakes Navigation System: System Connectivity

economy in seven states. Interestingly, Duluth is connected with only six ports that are greater than 10 million tons, 14 ports that are one - ten million tons and four ports that are less then one million tons.

SUMMARY: Great Lakes Navigation System - Economically and Environmentally Crucial to the Nation

If the GLNS is to remain reliable, its infrastructure must be maintained. The system consists of locks, shipping channels, ports, navigation structures and confined disposal facilities. Locks can experience deterioration to components such as walls and gates, or mechanical failures that affect gate movement or the control of water in and out of lock chambers. Navigation channels accumulate sediment over time and must be dredged regularly to maintain required depth. Entry channels into ports are especially prone to shoaling due to storms. Failure to adequately fund dredging operations increases costs to shippers and industry, limits production capabilities and ultimately harms the national economy. Investments in the GLNS pay off many times over in economic benefits on a local, regional and national level.

According to a study conducted by Martin & Associates on the Great Lakes - St. Lawrence Seaway System, completed in 2011, U.S. ports generated about $18.1 billion of revenue and $2.7 billion in federal, state and local tax revenues in 2010. The GLNS provides jobs directly related to the maritime industry and indirectly related through associated industries. The system also offers significant savings over alternate modes of transportation. Compared to the next least expensive mode of transportation, the GLNS saves industry $3.6 billion dollars annually.

Failure to provide adequate capacity to place contaminated dredged material limits the amount of dredging that can occur. Dredging and confined dredged material disposal capacity go hand-in-hand and must be planned accordingly. Failure to adequately maintain navigation channels affects safe navigation into and out of ports, through connecting channels, and also affects the ability of these structures to reduce flood damages to the critical infrastructure that has built up in the cities behind the structures.

The GLNS offers an environmentally sustainable mode of transportation, providing significant savings in fuel economy and greenhouse gas emissions over rail and truck transportation. If all federal navigation channels of the GLNS were closed to commercial traffic, commodities would have to be transported by rail and truck (assuming that sufficient additional rail and highway trucking capacity existed). This would increase annual emission rates by over 4.2 billion tons of harmful particulate matter (PM-10) and increase costs by $55 million due to increased railroad related accidents and $163 million due to increased trucking related accidents. If all ports that receive less than one million tons of commodities annually are no longer dredged and commodities would have to be transported by other means (rail or truck), this would result in an annual increase of over $149 million in transportation costs to the industry.

The GLNS also has a distinct advantage over other modes of transportation such as truck and rail because 90 percent of the shipping lanes in the GLNS are usable exactly as the glaciers left them. The nation has entrusted the maintenance of the remaining 10 percent to the U.S. Army Corps of Engineers. This includes dredging the connecting channels and harbors and maintaining locks in proper working condition. This is tremendous leverage that is unrivaled in other modes of transportation – maintain 10 percent and get 90 percent free.

A reliable, cost effective transportation network is one advantage that American businesses have in the global economy. The GLNS offers this economical and environmentally sustainable network. Maintaining Great Lakes navigation infrastructure as a viable, functional system is essential to preserving the health and vitality of the region and the nation in an economical and environmentally sustainable manner.

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