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Brian Slack
Claude Comtois

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Bureau de Montréal
Université de Montréal
C.P. 6128, succ. Centre-Ville
Montréal (Québec) H3C 3J7
Tél : 1-514-343-7575
Télécopie : 1-514-343-7121

Bureau de Québec
Université Laval,
2325, rue de la Terrasse
Pavillon Palasis-Prince, local 2415
Québec (Québec) G1V 0A6
Tél : 1-418-656-2073
Télécopie : 1-418-656-2624

Contemporary Challenges of United States Great Lakes Ports

Brian Slack[1,2], Claude Comtois[1,3,*]

1. Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)
2. Department of Geography, Planning, Environment, Concordia University
3. Department of Geography, Université de Montréal

Abstract. This study examines contemporary challenges confronting the US ports on the Great Lakes. Historically, the 29 largest ports served the primary industries located along the shores, and their traffic was dominated by bulk cargo shipments within the inland waterway. These relationships are evolving, mainly because of industrial and technological changes, and port traffic in general is in decline. There is a consensus among industry and government bodies that ports need to diversify their cargo profiles, and the rich hinterland of the Mid West would appear to provide opportunities for new commercial activities. This paper suggests diversification may be difficult to achieve. Little association between growth and diversification of port traffic is demonstrated, and factors including the state of the fleet, port governance, regulations, access for international shipping, and competition from other modes inhibit change. The study concludes that the dominance of a few bulk shipments on ports is unlikely to weaken, but that the best hope for broadening of the commodity mix is through greater use of barges.

Keywords: Inland ports, industrial chains, Great Lakes, port governance.

Corresponding author: claude.comtois@umontreal.ca

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1. Introduction

The Great Lakes of North America represent one of the great inland waterways of the world. Their southern shores constitute the fourth coast of the United States and provide access to one of the major industrial regions of the world: the US Mid-West. The ports located along these shores have grown to serve this industrial complex. In recent years, however, there has been considerable industrial change. While inland ports all over the world are confronting market, technological and environmental challenges, those on the Great Lakes are facing other specific challenges. This paper examines the operational, regulatory, and governance issues that constrain their ability to adjust to new market realities, and expand from their traditional bases.

The paper examines the 29 largest US Great Lakes ports. It demonstrates that in common with inland ports elsewhere they handle largely bulk cargoes, serve the needs of large industrial customers, and move a narrow mix of commodities. Several features differentiate Great Lakes ports from other inland waterways: first, is the nature of shipping activity since vessels are larger than most other inland waterways, and, because most of the US flagged vessels are self-unloading, port infrastructures are different; second, locks impact on traffic intensity both internally and externally; third, the role of public actors in port management is relatively small; fourth, there is an interrupted navigation season; and fifth, there is significant modal competition. These differences are shaping how the ports adapt to changing markets and supply chains. The paper suggests that while bulk trade functions will continue to be a prime component of port activity, diversification will depend upon how they adapt to regulatory, commercial, and governance factors.

2. Profile of Great Lakes Ports

There are over 100 US ports recognised by the US Army Corps of Engineers (USACE) on the Great Lakes. Here, only the largest are considered, defined as those whose annual traffic exceed one million tons. Twenty-nine ports meet this criterion (Table 1). The total traffic in 2016 of the 29 ports was 234 million tons.

Table 1. United States Great Lakes Ports whose traffic exceeds 1 million tons

Duluth	30 277	Stoneport	5 751	Ashtabula	2 616
Chicago	16 423	St. Clair	5 463	Marble Head	2 590
Two Harbors	15 431	Connaut	5 061	Milwaukee	2 465
Detroit	13 266	Calcite	4 658	Alpena	2 131
Cleveland	12 422	Escanaba	4 576	Green Bay	1 790
Indiana Harbor	12 216	Port Inland	4 102	Fairport Harbor	1 712
Presque Isle	8 789	Silver Bay	3 399	Buffington	1 388
Burns Waterway	8 595	Port Dolomite	2 708	Grand Haven	1 302
Toledo	8 393	Monroe	2 679	Marquette	1 105
Gary	8 206	Sandusky	2 646		

Source: USACE Waterborne Statistics 2016 (000 short tons)

There is a very specific pattern of distribution of the ports. Although it is the smallest of the Great Lakes, Lake Erie has the largest number of ports with ten. Lake Michigan, the only lake entirely in the US, has nine ports. Lakes Huron and Superior each have five ports, and there are none on Lake Ontario. Lakes Superior, Michigan and Erie each possess at least one port whose traffic exceeds 10 million tons. This pattern reflects in part the demographic and industrial distributions around the Lakes, but there is also the influence of locks (MARAD 2013). Between Lakes Michigan, Huron and Erie there are no locks, and only one lock separates Lake Superior from these three. On the other hand, there are seven locks between Lakes Erie and Ontario, and a further seven between Lake Ontario and Montreal. Because one of the parallel locks between Lake Superior and Lake Huron is longer and wider than all other Seaway locks, «upper lakers» or «1000 footers», vessels engaged between ports on all but Lake Ontario, are up to 70 meters longer than the «lakers» that pass below Lake Erie, and thus offer important scale economies. The locks also impact on ocean-going vessels (salties), because in order for them to enter the Upper Lakes they have to negotiate 14 locks, and their carrying capacities are always less than ships designed to squeeze through the 14 locks (lakers), and lower still than the «1000 footers» (MARAD 2013).

3. US Great Lakes ports: traffic

The 29 largest US ports on the Great Lakes are dominated by bulk shipments. Iron ore accounted for nearly half the total traffic by volume in 2016 (Table 2). This traffic includes

the loading of the ore at ports on Lakes Superior and Michigan, such as Two Harbors and Escanaba, and its discharge at the blast furnaces at Gary and Cleveland. A total of fourteen ports are involved in iron ore. The steel industry also figures in the third largest traffic of the system, with coal accounting for 14 % of all traffic. Rail shipments of coal from Wyoming are transferred at Duluth and from Pennsylvania at Sandusky for delivery to steel mill locations on the Great Lakes as well as coal-fired thermal electricity plants. Thirteen ports are engaged in the coal trade. Iron ore and coal are at the heart of US Great Lakes shipping.

The second largest commodity group by volume is aggregates. This comprises stone, gravel and limestone that is mined around the Great Lakes. It accounts for 18 % of the total traffic and is widely distributed, involving eighteen of the ports. It is a commodity class that is important for the construction industry, especially roads, and cement manufacture. Its low value and high weight make it particularly dependent on waterborne transport.

Table 2. Principal commodity breakdown of traffic at major US Great Lakes ports, 2016

Port	TOTAL ('000 tons)	Agriculture	Coal	Petroleum	Aggregates	Iron ore	non-met. Minerals	Cement
Chicago	16 424		3 %	21 %	26 %			11 %
Indiana Harbor	12 217			17 %	8 %	71 %		
Burns Waterway	8 595				11 %	72 %		
Buffington	1 389				84 %			
Gary	8 206					95 %		
Two Harbors	15 432					100 %		
Duluth	30 278	6 %	34 %		10 %	48 %		
Presque Isle	8 790		16 %			84 %		
Marquette	1 016		19 %		90 %			
Grand Haven	1 032		13 %		42 %		41 %	
Milwaukee	2 465	15 %		3 %			35 %	29 %
Green Bay	1 790	17 %	22 %	10 %	29 %			
Alpena	2 131		6 %	6 %				83 %
St Clair	5 463		100 %					
Detroit	13 267	3 %	8 %	5 %	15 %	53%		8 %
Monroe	2 680		85 %		12 %			
Calcite	4 658				100 %			
Escanaba	4 576					97%		
Stoneport	5 751					99%		
Toledo	8 393	22 %	36 %	7 %	9 %	18%		2 %
Sandusky	2 647	5 %	92 %					
Cleveland	12 423				19 %	60%	5%	5 %
Fairport Harbor	1 713				73 %		17 %	
Ashtabula	2 616		15 %		46 %	24%		
Connaut	5 061					99%		
Port Inland	4 102				100 %			
Port Dolomite	2 708				100 %			
Silver Bay	3 399					97%		
Marblehead	2 709				100 %			

Source: USACE Waterborne Statistics 2016

The US Mid-West is an important agricultural region and its ports are used to ship the products, especial grains to overseas markets. This involves using «lakers» to haul the cereals from the Great Lakes to elevators in Quebec where they are transhipped to ocean vessels. Six ports are involved, particularly Duluth and Toledo, and the volume of shipments represent 3 % of total tonnage.

Manufactured goods represent a relatively small part of port traffic. Three groups are present: petroleum products (4 %), cement (3 %) and steel products (1 %). The number of ports engaged in these commodities is small, seven for petroleum products, six ports for cement, and five for steel products.

Table 2 indicates that with a few exceptions, ports are largely specialised in a narrow range of commodities. In order to measure this, the specialisation index (SI) is calculated:

$$SI = {\sum_i t_i^2}\Big/{\left(\sum_i t_i\right)^2}$$ Where t_i is the tonnage of commodity group i

A SI of 1.000 indicates that all shipments are accounted for by one commodity group. The lower the index the greater the diversity.

The results in Table 3 confirm a high degree of specialisation with 20 out of the 29 ports possessing indexes of 0.500 or greater.

Table 3. Specialisation Indexes for the largest US Great Lakes ports, 2016

1.000	.999 - .750	.749 - .500	.499 - .250	< .249
Two Harbors	Gary	Indiana Harbor	Duluth	Chicago
St Clair	Marquette	Burns Waterway	Grand Haven	Milwaukee
Calcite	Escanaba	Presque Isle	Detroit	Green Bay
Port Inland	Stoneport	Alpena	Cleveland	Toledo
Port Dolomite	Sandusky	Monroe	Ashtabula	
Marblehead	Connaut	Fairport Harbor		
	Silver Bay	Buffington		

There is only a weak association between port size and degree of specialisation. The Pearson correlation coefficient between total traffic and specialisation is -0.273.

In common with inland ports elsewhere US inland ports on the Great Lakes are components of industrial supply chains (Slack and Comtois, 2016). Large corporations play a central role in most of the chains on the US Great Lakes. In the steel industry ore and coal production is either under the direct control of the steel conglomerates or is shipped under long-term contracts by the large mining companies such as Cliff Resources. Ships are owned by the steel corporations themselves or leased under long term contracts with Great Lakes shipping companies. Coal and iron ore are loaded and unloaded at private terminals. The grain trade is similarly organised and controlled by corporations such as Archer Daniels Midland (ADM), and Cargill which operate their own elevators at ports.

The involvement of private companies confers a distinct character to many inland ports, where the volumes handled, the scheduling of throughput and vessel arrivals, and the kinds of equipment used is quite different from general cargo ports where there are many cargo owners and intermediaries that use public terminals. Private ownership of terminals in the Great Lakes ports is very extensive (Fawcett, 2007), and in some locations such as Escanaba or Fairport Harbour they are under the entire control and ownership of a corporation. Most of the facilities are private even in the largest «public ports». In Cleveland, for example, only four of the terminals are public, while 13 terminals are private. In the US the functions of several public inland port authorities are largely financial because of their ability to raise capital by issuing bonds. Most of the capital investments tend not to be in port related activities but in other manufacturing, tourism and real estate projects (Port of Cleveland, 2018).

The private ownership of terminal operations along with control over cargo flows confers a degree of stability and predictability of business over periods of time. Corporations have to amortise their heavy initial investments in mines and factories over decades, so that inland bulk ports tend to change rather slowly. However, when the industrial system undergoes a market change, a technological transformation, or a life-cycle change the

impact on ports may be very dramatic. These transformations have played a big role in the Mid West.

4. US Great Lakes ports: recent changes

The iron and steel industry of the Mid West lay at the heart of a massive industrial complex that sustained the automobile industry and other metal-using industries (Florida, 1997). Vertical integration was a distinctive feature of the iron and steel industry through a large part of the Twentieth Century, with blast furnaces producing the pig iron which was then turned into steel by the open-hearth method. In this way the US became the biggest steel producer in the world. By the 1970s the first winds of change were encountered. Foreign competition, changing demand for steel, especially by the automobile industry, and the increasing obsolescence of plants resulted in declining output, with immediate effects on employment as well as on port traffic. At its peak in 1973 the US produced 229 million tons of steel and employed 521 000 people. Ten years later output had fallen to 107 million tons, but by the late 1980s it had recovered to a level of 140 million tons. Since then, output has varied year to year but has tended towards a decline, falling to 87.9 million tons in 2016. As documented in a recent study of the US steel industry the decline in output has been marked by an even greater change in manpower, the industry having shed «about 75 % of its workforce between 1962 and 2005, or about 400 000 employees» (Collard-Wexler and De Loecker, 2015, p 136). These dramatic changes took place due to technological factors, principally the retirement of most of the old integrated plants and by production advances in those that remain, and by the proliferation of mini-mills that use the electric arc furnace method that use a large proportion of scrap iron in the charge. Collard-Wexler and De Locker (2015) demonstrate that both the integrated steel mills and the mini-mills achieve comparably high levels of productivity, but that the mini-mills are more profitable because of their lower capital requirements.

These changes have impacted on Great Lakes ports. First, the closure of old integrated plants has been great with only nine left in the US, seven being on the Great Lakes. Today there are 112 mini-mills located throughout the country where scrap is available. Second, the consumption of coal by the steel industry has fallen because of internal efficiencies,

and because scrap is the primary input in mini-mills the demand for iron ore has declined as well. Third, many of the iron ore mines that have been exploited for over a century have become exhausted, and mine closures have impacted on local shipment ports. Coal shipments have been impacted also by the closure of coal-fired thermal electricity generating plants (MARAD, 2013).

When the port traffic over the last ten years is considered an overall pattern of decline is evident. The total traffic throughput of between 2007 and 2016 fell from 234 million tons to 192 million tons or -17.1%. The pattern of change is uneven however. Thirteen of the 29 ports experienced declines in traffic greater than the overall average, eight exhibited relative declines, and eight underwent growth (Table 4).

Table 4. Relative changes in US Great Lakes port traffic, 2007-2016

Absolute decline (Loss worse than average)	Relative decline (Loss better than average)	Positive increase
Duluth[a,b] Chicago	Detroit	Grand Haven[c,d]
Toledo[b] Sandusky[a]	Gary Stoneport	Two Harbors[b]
Fairport Harbor	Marquette	Burns Waterway[b]
Calcite[c] Milwaukee	Presque Isle[a,b]	St Clair Buffington
Silver Bay[b] Indiana Harbor[b]	Cleveland	Port Inland
Ashtabula[a,b] Alpena	Marble Head	Monroe[c,d]
Green Bay[a] Escanaba[b]	Port Dolomite	Connaut[b]

Note: a (coal); b (ore); c (aggregates); d (cement) are commodities accounting for the greatest change

Table 4 identifies the commodities that have produced the greatest amount of change, positive and negative. While declines in coal and iron ore shipments are the most important factors behind overall traffic losses, it may be noted that iron ore accounted for growth at three ports. Changes in aggregates have been less marked, but significant

growth at Monroe and Grand Haven were due to increases in both the unloading of aggregates and cement shipments.

The detailed patterns of change reveal several surprises. It may be noted that many of the largest ports experienced important traffic declines. Correlation between the traffic totals for 2007 and the percentage changes between 2007 and 2016 of the 29 ports indicates there is a weak inverse relationship that is not statistically significant at .05 (Table 5). Although the result accounts for only 7 % of variance it suggests that initial port size may in fact be a negative factor in determining future performance.

It is widely held that diversity of commodity mix provides ports with better security over time. This is not borne out in the case of the US Great Lakes ports. Table 5 indicates that with a correlation of 0.271 between the specialisation index and traffic change the two variables are only weakly related.

Table 5. Correlations between traffic change and port size and specialisation

Variable a	Variable b	Pearson r
% Traffic change 2007-2016	Traffic 2007	-0.268
% Traffic change 2007-2016	Index of Specialisation	0.271

An attempt was made to investigate if change in traffic between 2007 and 2016 could be explained by both 2007 traffic totals and diversification indexes as independent variables in a multiple regression. The resultant R^2 was 0.32, but the p values of each of the independent variables were shown to be not statistically significant, and the adjusted R^2 value was 0.03.

The overall conclusion from this analysis of change in port activity is that it is a system in decline. While individual port activity over the last 10 years may be shaped changes in the commodity markets they serve, when the system of ports as a whole is considered more general factors have to be considered. Why have the ports not been able to adapt to changing demands and develop new activities? This question is explored in the following section.

5. Challenges of adaptation in US Great Lakes ports

5.1. The fleet

A study of the US flagged Great Lakes fleet MARAD (2013) revealed that the average age of vessels in 2012 was 46 years, but that 12 of the ships had an average build date of 1948, with the oldest having been constructed in 1906! The report points out that the age of vessels on the Great Lakes is less important a factor than elsewhere, because they operate exclusively in fresh water, and most have received updates and modifications. It is true that the winter lay-up gives owners the opportunity to undertake repairs and modifications without sacrificing business, but this does not change the fact that the vessels were designed for specific conditions that have changed. Their dimensions and capacities were determined by the bulk trades, and they offered scale economies that protected those trades from modal competition. However, they are unsuited to handle general cargo. It makes no commercial sense to use large bulk carriers to haul general cargo, which today is largely containerised. Container vessels have their own design and operational characters which are costly and involve required changes to port terminals. Thus, in a region that is one of the greatest generators of general cargo in the world the domestic market has been captured by trucking and rail. Overseas containerised trade is also handled by rail shipments to East and West Coast ports and not by the St. Lawrence Seaway (Slack, 2001).

The cement trade has adopted a different approach. Sixty per cent of this trade is handled by tug-barges, which, because of lower manpower requirements and greater flexibility, are attractive where shipment size is less importance. Indeed, several older «lakers» have had their engine rooms and crew accommodation removed and a docking notch added that allows a push tug boat to lock on to provide propulsion. While the capacity of most barges is lower than the largest «lakers» they possess the advantage of being able to serve docks constrained by shallow water (Lapinski, 2012). The degree to which barges can penetrate other trades is one of the most important in factors in determining the future of ports in the Great Lakes.

One of the major determinants of changes to the fleet is the Jones Act (Slattery *et al*, 2014). It restricts cargo transfers between US ports to US built, owned, flagged and

manned vessels. This protects US carriers from foreign competition. This protection is a factor that provides stability to the US fleet on the Great Lakes but it also inhibits innovation. In direct contrast, the Canadian fleet is much younger and more technologically sophisticated because regulations there allow carriers to purchase new ships overseas (MARAD, 2013).

The nature of the US fleet has a negative effect on US Great Lakes ports. US carriers focus on the closed system of the Upper Great Lakes where they dominate the bulk trades. As mentioned above the use of «upper lakers» confines them to ores, coal and aggregates. Because general cargo is not practical in such vessels the general cargo traffic that is handled by US Great Lakes ports involve shipments (mainly imports) carried by foreign-flagged deep-sea ships. With one exception this traffic is non-containerised. The general cargo trade remains small because access to US Great Lakes ports involves passage through 14 locks, a time consideration, and the ships have limited capacities because of their hull designs and the dimensions of the locks themselves. In addition, to warrant a voyage from overseas into the Great Lakes requires a return cargo, usually grain, but that trade faces competition from grain transported by Canadian «lakers» to deep-water transhipment ports on the St Lawrence River where large deep-sea bulk carriers can take on grain for overseas delivery.

The container trade has not taken hold among the Great Lakes ports because of competition from the railroads. An exception is a small service between Antwerp and Cleveland operated by a Dutch carrier. It employs 12,000 DWT ships that are multi-purpose. While capable of handling containers its main business in fact is the haulage of project cargo and steel products.

A further regulatory issue is pilotage. US-flagged ships are exempt from the requirement to engage a pilot during passage on the Great Lakes-St. Lawrence Seaway. The USACE regulates pilotage, including the setting of fees. The American Great Lakes Ports Association (2018) suggests that US pilotage costs are excessive. Fees have increased by 165 % over the last decade, and now cost approximately 10 000 US$ per day, which is more than the typical vessel and crew daily charter. This has become an obstacle for ports to attract international shipping.

5.2. Environmental conditions

Ice conditions have always represented important physical and commercial challenges to shipping. The Seaway locks are closed from late December to early April because of ice build-up. On the Great Lakes themselves conditions vary from year to year and between lakes. In some years navigation is feasible throughout the year between certain ports on the Upper Great Lakes, and while there has been an overall reduction of ice extent since the 1980s there are several recent years when shipping was shut down completely (Pietrocarlo *et al*, 2017). The US Coast Guard maintains a fleet of eight ice breakers, only one of which is a modern vessel. Even though carriers try to maintain some services throughout the winter season, uncertainties and the closure of certain ports because of local ice conditions make such services less frequent. Lake Erie is particularly susceptible because it is the shallowest of the Great Lakes and freezes over most easily.

The annual closure of the locks for three months or more prevents «salties» from entering the system. This interrupts supply chains, and is particularly challenging for general cargoes that depend on regular service frequencies. Customers have to use other modes and routing. In the case of the Antwerp-Cleveland service shipments are diverted to the Port of Baltimore for onward rail delivery. Previous container services into the Great Lakes failed because the railways were able to offer steep freight rate discounts (at least in the short term) if the rail service was used throughout the year.

Variable water levels are a feature of the Great Lakes. They are not served by any major rivers and therefore depend on the balance between local precipitation and evaporation. Water levels change from day to day, season to season and year to year. The annual pattern appears to be cyclical and can vary by as much as two meters. Extremely low years were recorded in the late 1920s and early 1930s, the 1960s, and the early 2000s. During this latest low water stage there were impacts on shipping. The shipowners claim that for every inch of water level decline the «1000 ft lakers» lose 267 tons of capacity. Estimates of future declines due to climate change vary wildly, from 10 cm to 36 m on Lake Superior and from 25 cm to 104 cm on Lake Michigan (USACE, 2013, p. 61). Were the lowest estimates ever realised this would have a major effect on ports and shipping (Millerd, 2011).

5.3. Port governance

Port governance in the United States is complex (Fawcett, 2007). The States have jurisdiction over ports, but in most cases those responsibilities have been devolved to lower tier units: counties, cities and special districts. The federal government exerts considerable influence through its control over USACE, environmental legislation, federally chartered bodies such as the St. Lawrence Seaway Administration, an in particular, financial contributions through Congressional appropriations.

Individual port administration is carried out by local port authorities, such as the Port of Green Bay, Detroit Wayne County Port Authority, and the Illinois International Port District (Port of Chicago). Their responsibilities are complicated by the fact that many or most of the infrastructure and operations are private. This led J. Loftus, the Executive Director of the Detroit Wayne County Port Authority, to state:

> «Legislation allows port authorities to do a variety of things for their facilities. The trouble is that it defines facilities as a facility owned by the port authority. There's only one cargo facility we own, and our building. There are 25 different facilities that we can't do anything with because we don't own them» (Raven, 2016).

If the port authorities have little control over the port area, the issue is complicated further because they may have other responsibilities. For example, the Port of Cleveland has an important general economic development role as the only local government agency «whose sole mission is to spur job creation and economic vitality in Cayahuga County» (Port of Cleveland, 2018). Because it has power to issue bonds, it invests in a variety of projects in the County totalling 3.6 billion US$, most of which have nothing to do with the port.

The ports report to the individual States. For them the Great Lakes ports are but one element in their transport portfolios, that include other river ports on the Mississippi (Minnesota, Wisconsin, Illinois) and Ohio (Michigan and Ohio) river systems, as well as the major issue of the highways. Inevitably the road systems are their most important concerns and investment pre-occupations. The ports have been largely neglected by most States and have been offered only limited financial support. In the case of Minnesota, for example, annual grants to ports for infrastructure projects are in the

order of 1 million US$ (MinnesotaGO, 2014), an amount that is inadequate to realise major renovations or build new facilities.

It is the Federal government that exerts the greatest influence on port development. Dredging is under the direct control of the USACE. The selection of which ports are selected for dredging is dependent upon congressional approval and funding. While the USACE undertakes studies of all the cases its priorities may be overturned as a result of political lobbying. Port infrastructure investments are also subject to political interference, as the selection of grants under various federal transportation programmes such as TIGER grants, Port Security Grant Program, and the Transportation Infrastructure Finance and Innovation Act, involve approval by elected officials. While the Federal government plays a key role in the port financing, the effects may not reflect the greatest needs and broader strategic goals. The Federal government also influences ports through safety and security issues and its regulatory powers over shipping.

The complexity of public governance coupled with the fact that so much infrastructure is under private control means that port planning is disjointed or absent. This makes it very difficult for the public port authorities themselves to confront the challenges they face. They have neither the mandates nor resources required to bring about changes. The States, which in theory possess the authority and means, have exhibited only limited understanding and commitment to the port business.

6. Recent Attempts to Bring About Change

Over the last 10 years there has been a growing awareness that the Great Lakes waterway is facing difficulties and needs to be revitalised. This awakening has occurred at various levels and in a variety of ways. The US Department Transportation Maritime Administration has examined the status of shipping and the future commodity trends (MARAD, 2013); intergovernmental and industry organisations such as St. Lawrence Seaway Management Corporation, the St. Lawrence Seaway Development Corporation, the Chamber of Marine Commerce, the American Great Lakes Ports Association, the Lake Carriers Association have been active in identifying challenges and measuring the economic impact of ports (Martin Associates, 2018); some States

have produced reports on the strategic importance of their ports and the Great Lakes system (MinnesotaGo, 2014; Wisconsin, 2016) others are lacking; and, some individual ports have undertaken strategic planning (Green Bay, 2015; Duluth-Superior Metropolitan Interstate Council, 2016; Cleveland, 2017) others have not (Chicago, Detroit).

There is a good deal of consensus from the reports that the traditional trades – iron ore, coal and aggregates will continue to play a major role in ports and shipping. There is also agreement that the Great Lakes St. Lawrence system is a unique waterway that needs to be developed. General cargo is identified as a commodity class that has a potential to be diverted from congested highways. To achieve this transformation containers are seen development. In 2007 MARAD introduced the concept of marine highways, waterway corridors that run parallel to the major national highways, which will reduce road traffic congestion and help reduce greenhouse gas emissions (US Department of Transport, 2018). It is based on the European Union's «Motorways of the Sea» project (European Commission, 2001). Several corridors were identified, including M90, the corridor linking the St. Lawrence River and the Great Lakes. Two of the proposed corridors, M95 and M5 running along the East and West Coasts parallel to I95 and I5 interstate highways, were examined in detail by consultants' reports, and in 2016 MARAD issued a call for project funding (US Department of Transport, 2018).

The M90 corridor was examined in an economic study of Wisconsin ports (National Center for Freight & Infrastructure Research & Education, 2016). One part of the report compared container services from Antwerp, one using the Seaway (M90) with another via the port of Baltimore, and onward road service to Wisconsin. The comparison suggested that there was a significant cost difference, with the M90 route being cheaper as well as generating important CO_2 savings. This part of the study is seriously flawed. First, road transport from Baltimore to Wisconsin is impractical, since rail services are far more competitive in price, and account for nearly all present traffic. Second, it did not consider that there is already a competing container port at the eastern edge of M90, the port of Montreal which uses rail connections to deliver containers directly to the Mid West. Third, it did not assess the commercial practicality of an international container service

into the Great Lakes. The study assumed a ship with the capacity of 332 FEUs (forty-foot containers) which it compared the 1 FEU capacity of a truck. But the capacities of ships serving the East Coast ports now are in excess 5 000 FEUs, and even those serving Montreal have capacities of 2000 FEUs. What container carrier would be willing to invest in a service that involved a return transit time of over one month compared with one with a turnaround of one half that but with a revenue generating potential ten times greater? Finally, the issue of winter disruptions was never considered.

7. Conclusions

The assumption that containers have the potential to diversify Great Lakes ports can diversify must be challenged. It is true that on many other inland waterways, such as the Rhine and Yangzi, container shipments are booming, but that on the Great Lakes and Mississippi they are absent, and a service such as the one between Antwerp and Cleveland is dependent upon a subsidy and other cargoes such as project cargo for commercial viability. The main reason is that in the US railroads offer effective competition that is absent in other countries, and there is no evidence that the advantages of rail are likely to change in the near future.

There is little chance that the Jones Act will be repealed. This makes it very difficult for new types of vessels to be introduced into domestic trades on the Great Lakes, since US shipbuilding costs are extremely high. One possible solution is to follow the action of Canada to allow the building of vessels overseas in specific cases, that could still meet the other stipulations of the Jones Act, that ships should be US owned, flagged and crewed. Smaller general-purpose vessels are required to handle domestic general cargo on the Great Lakes, but at present there are no commercial reasons to justify such investments.

One trend that has a potential to mitigate the capital costs on shipping and facilitate new service connections on the Great Lakes is that of barges. Cement, petroleum and aggregates already are transported by barges. Start-up costs are lower than those for normal self-propelled vessels, and offer flexibility in use for a wide range of cargoes. For example, primary metals are already shipped by barge between the St. Lawrence River and a Great Lakes port. Barge services have the potential to grow still further and extend

to other trades. This could be a solution for shipments of semi-finished products between different industrial plants, and provide opportunities for corporations, the owners of many port terminals, to reconsider the internal distribution of their product flows. A further advantage of barges is that their drafts are lower than regular shipping and thus are less impacted by water level declines.

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