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Michigan Exports and Ballast Water Treatment Requirements

A Look into the Economic Potential of Michigan Commodities

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Introduction

Ballast water legislation became a scrutinized topic in the Great Lakes and St. Lawrence Seaway region when the U.S. Coast Guard enacted the Nonindigenous Aquatic Nuisance Prevention and Control Act in 1990[1]. As the title suggests, the act was created to prevent invasive species from entering the Great Lakes region as a result of ballast water discharge from ocean-going vessels. Between 1990 and 2012, the National Ballast Water Management Requirements subpart of the Code of Federal Regulations has been amended six times[2], most recently in March of 2012. In 2001, the State of Michigan amended part 3101 of the Natural Resources and Environmental Protection Act to require ballast water treatment methods, in addition to deep-sea ballast exchange, from ocean-going vessels[3]. Michigan requires one of the following methods to be utilized by ocean-going vessels in order to approve ballast exchange in Michigan waters: filtration, application of biocides or ultra-violet light, thermal treatment, or other treatment methods approved by the Michigan Department of Environmental Quality. These methods are either impractical or have not been developed yet, resulting in the inability of ocean-going vessels to export cargo directly to overseas destinations from the State of Michigan.

Among the affected parties are international shipping companies with vessels ranging from 430 to 730 feet, exporters located in Michigan, Michigan ports, and ultimately buyers overseas. International shipping companies have the option to incur costs as a result of the ballast water policy, or forego loading cargo in Michigan all together. For example, a salty[1] discharging cargo at the Port of Detroit can leave the dock, exchange ballast water across the state border in Windsor, Canada, and re-dock in Detroit, incurring both additional sailing costs, and mooring costs. Companies attempting to export products over the Atlantic Ocean from Michigan incur costs as a result of inefficient transport. Michigan exports are typically transported by rail, truck, or laker[2] to ports in other Great Lakes states or the East Coast, where the products are loaded onto an international vessel and shipped directly to the intended destination as opposed to being shipped directly from Michigan.

Objective

The objective of this study is to provide a basis for understanding the short and long term economic impact and potential of Michigan exports in the event that the current Michigan ballast water treatment requirements are amended to a form that is consistent with the U.S. Coast Guard's ballast water treatment policy.

Findings

Multiple fundamentally inefficient costs can be identified in Michigan's export shipping process as a direct result of the current ballast water policy. First, additional handling fees are incurred

[1] An ocean-going vessel
[2] A domestic vessel intended for use in the Great Lakes and St. Lawrence Seaway system

when transshipment[3] occurs. When cargo is discharged from rail, truck, or laker, loaded onto an international vessel, and discharged at its final destination there are additional handling fees to be paid for transshipment. Second, the economies of scale yielded by water transportation are greater than that of rail and truck. A vessel's rate per metric ton of cargo is typically lower than rail and truck rates because the vessel can carry more cargo at one time. This cuts the amount paid for fixed costs like fuel and wages, and reduces the time of shipment. While Michigan products can utilize the economies of scale provided by lakers in the export process, the cargo will still realize transshipment costs. With the option to utilize salties in export processes, Michigan commodities would be able to avoid excess handling fees, while gaining the benefits of economies of scale. Finally, initiating business opportunities in Michigan and importing products from Michigan are both less attractive because of the additional costs incurred by inefficient transportation.

This study finds that amending the current ballast water policy would directly lead to significant cost reductions in the process of exporting Michigan commodities, a long-term increase in business development, and a long-term increase and diversification of international exports.

- Short-Term Benefits – In the short-term (time frame 1-3 years), immediate cost reductions in the export process would be realized as a result of a more efficient transport option becoming available. This affects ports and companies located in Michigan that currently export products to countries across the Atlantic Ocean. Given the nature of the current ballast water policy, few companies fit the aforementioned description.
- Long-Term Benefits – In the long-term (3 years on), Michigan would be a more attractive site for new business projects involving exports if an amended policy were in place. Additionally, the state would likely realize an increase in the amount of exports and diversification of countries to which exports are destined. The long-term benefits would likely be realized by Michigan ports, commodity companies located in Michigan that currently export products across the Atlantic Ocean, commodity companies located in Michigan that would like to source customers from countries across the Atlantic Ocean (but currently export solely to Canada), and international vessel-owning and –operating companies.

These findings can be applied with a framework (Figure 1) to analyze how any Michigan commodity might add value given a change in ballast water policy. The idea is that the destination of the intended export will drive short- and long-term benefits given a change in policy. Any party currently involved with exporting commodities from Michigan to a country across the Atlantic Ocean will, at times, incur inefficient transportation costs. In the event of a change in policy, these parties would be able to realize short-term benefits by immediately utilizing salties to directly transport the cargo that they are *already sending* across the Atlantic. These parties would also realize the long-term benefits of increased economic development in the state of Michigan. Parties involved with exports to Canada do not have to utilize international vessels. Thus, these parties would not realize the short-term benefits, but would realize the long-term benefits of increased diversification of export destinations and economic development.

[3] Moving cargo from one mode of transport to a different mode of transport while the cargo is en route to its destination

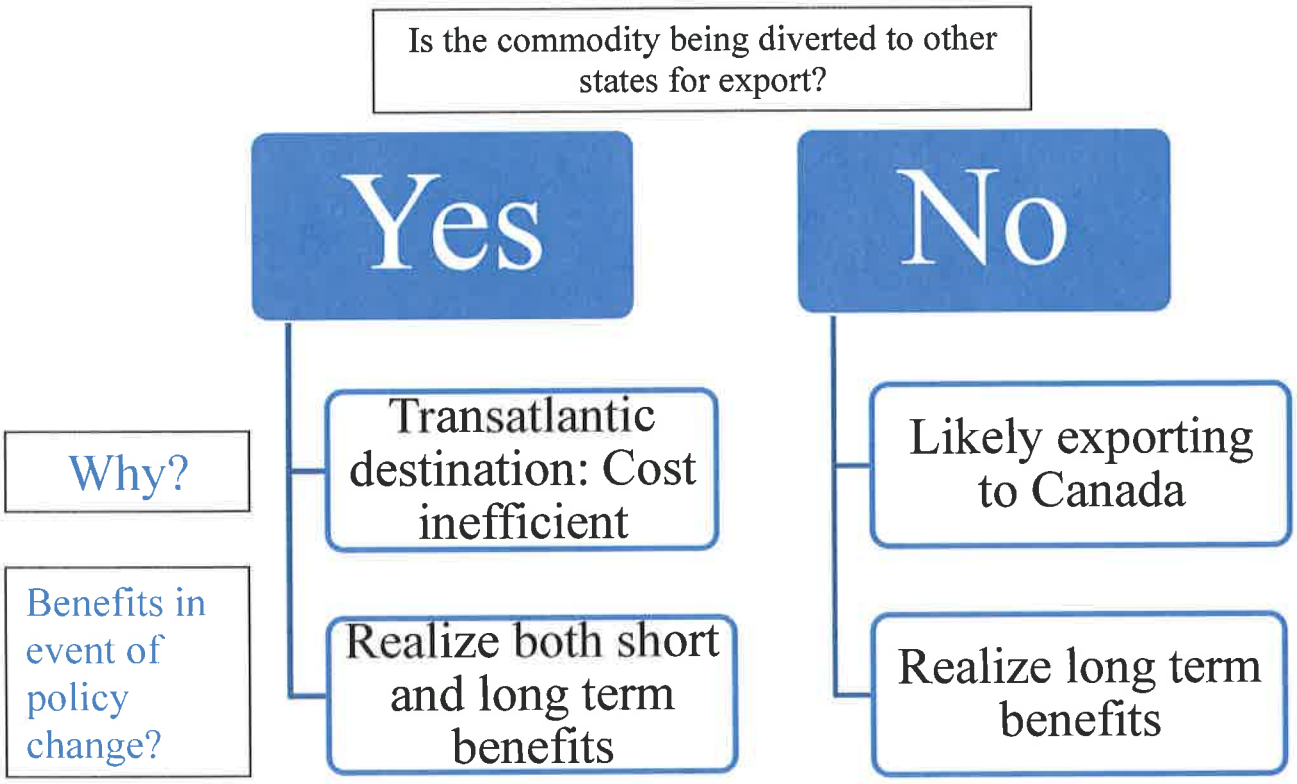

Figure 1: Michigan Commodity Benefit Framework

Methodology

To approach the issue of Michigan's ballast water policy as it relates to exports, the important elements of the relationship must be determined. The initial step in this study is to identify representative commodities exported from Michigan. I say "representative" because I select commodities that are both significant in Michigan's economy, and good examples of the different ways the current ballast water policy affects exports. Then, I determine both the countries to which key products are being exported, and the quantity of each commodity. This is a necessary first step because the amount of exports indicates the level of economic potential to be gained from a change in the ballast water policy for the parties mentioned above. If Michigan did not have sufficient quantities of product to export, then the current policy would be irrelevant. The next step in this study is to locate key ports in Michigan and determine their viability for exporting. To do this, I gathered information on various ports' infrastructure and evaluated the industries surrounding the ports. An important next step was a cost analysis of transportation modes and routes. To determine the value to be gained from a change in policy, I compared the cost of shipping directly from Michigan to overseas destinations to the cost of transporting commodities via laker, rail or truck to ports in other states and then shipping them overseas. Note that the costs in this study were obtained through industry estimates and that actual costs will differ depending on numerous systematic variables. Finally, I considered the future implications of a policy change. Michigan's current ballast water policy is a factor considered by companies looking to start new projects in Michigan – one that may divert those projects to other states. Thus, an amount of Michigan's export potential could be realized by

examining the projects that are diverted to neighboring states as a direct result of Michigan's ballast policy.

Data Sources

Note about Data Sources[4]

The majority of the data used in this study was procured from the USA Trade Online database. The database organizes commodities by two different methods: International Harmonized System (HS) and North American Industry Classification System (NAICS). HS breaks commodities into more specific categories than NAICS. This difference poses a threat to the accurate comparison of values across datasets. For instance, port-level data is available only in HS, and while state-level data is available in HS and NAICS, the HS state-level data does not contain tonnage values for commodities exported. To minimize this threat, I grouped and compared HS commodity categories to a single NAICS commodity category. For example, the NAICS category "111 Agricultural Products" contains the HS categories "7, 8, 9, 10, 12, 14, 17, 18" – these are the HS categories pertaining to this study. While slight variations in data may still occur, the sets are comparable.

Port-level & State-level Data

Datasets are gathered by USA Trade Online in different ways. Port-level data pertains to the total value ($US) [4], vessel value ($US) [5] and vessel quantity (kg) [6] of a commodity that is exported by air or vessel from a particular state or region. State-level data pertains to the total value, vessel value and, for NAICS datasets, vessel quantity.

Origin of Movement Data

As a subset of state-level data, important comments must be made about the nature of Origin of Movement data. Origin of Movement data measures a state's exports by the point at which a cargo is consolidated. Take, for example, an agricultural export transaction. A farm in Michigan may sell an amount of grain to a larger, commodity trading company. The farm moves the grain by truck to a loading point where ownership of the product now moves from the farm to the trading company. The trading company has storage facilities and export operations in Ohio, and can now move the grain to be *consolidated* in Ohio along with purchases from other farms. When the grain from the Michigan farm is exported, it will appear as an Ohio export, because that is where the grain was mixed into a larger shipment group.

Commodity Analysis

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[4] Selling price in dollar value of goods exported including freight, insurance and port-charges
[5] Dollar value of goods exported by vessel
[6] Shown as vessel SWT – the weight of goods exported by vessel. SWT is measured in kilograms and can be converted into metric tons by dividing by 1,000

This section discusses two Michigan commodity categories that serve as examples of the current ballast policy's effect on Michigan exports. I developed a framework to select commodities that a) would serve as representative examples for how Michigan commodities may react to an amended ballast water policy, and b) would be the most likely to add economic value for the parties mentioned in the introduction after a change in the ballast water policy. The criteria I used to determine the commodity categories are as follows:

- *Significant Vessel Tonnage* – A commodity category needs to have enough tonnage shipped annually in order to be representative of Michigan's commodity base. The vessel tonnage cutoff value is 100,000 DWT. If any less is produced within a category, it is unlikely that commodities within the given category will ship in loads large enough to be considered viable cargo for international vessels.
- *Type of Shipment* – Categories that are shipped primarily in containers or by tankers will not be included for further analysis. The nature of this study is an analysis of bulk, and break-bulk commodities. Liquid-bulk will not be analyzed because of issues regarding the scope of this study, and commodities carried primarily by container will be excluded because of the lack of a containerized vessel shipping system in the Great Lakes and St. Lawrence Seaway System.
- *Nature of Movement* – Different commodities are moved in different ways depending on the commodity's physical attributes, sourcing location, and global demand. For example, examining both iron ore, which is sourced in the Upper Peninsula of Michigan and is a heavy commodity, and manufactured products, which are produced in southern Michigan but are also heavy, would not represent Michigan's commodity portfolio in the most exhaustive way. In essence, I use commodities that have differing characteristics.

Given these criteria, two commodity categories stand out as holding value-adding potential given a change in ballast water policy. Note that these are not exhaustive categories and that other Michigan commodities may add value as international exports given a change in ballast policy:

1. *Minerals & Ores* – This category accounts for the majority of Michigan's export tonnage and is shipped in bulk. Most of the commodities in the category are sourced from the Upper Peninsula.
2. *Agricultural Products* – While initial tonnage and dollar amount values suggest that agri-products do not hold added export potential, a significant percentage of this category is likely not accounted for because it is consolidated in other states as a result of the current ballast policy. Agri-products are shipped in bulk and are sourced in southern Michigan.

Minerals & Ores

Minerals and ores are a significant Michigan export and historically account for over half of Michigan's annual export tonnage[5]. The commodity segment "212 Minerals & Ores" in the NAICS dataset includes subsets of coal and petroleum products, metal ores, and nonmetallic minerals. The commodity is of interest to this study because it is shipped in large quantities as a bulk shipment. To determine the value-adding potential of minerals and ores we first examine the current vessel quantity exported. Then, an analysis of cargo destinations allows us to understand the location of established export destinations. This is important because

understanding which countries import the most Michigan ore means we can make inferences about shipping modes, and the potential customers gained from a change in Michigan's ballast policy.

Minerals & Ores: Key Assumptions

1) The vast majority of tonnage is accounted for in the data for Michigan's current exports. There are very few products in this segment that are consolidated in states other than Michigan.
2) In order for long-term potential to be realized, the various minerals and ores that make up this segment must maintain demand from transatlantic countries.

As Figure 2 depicts, minerals and ores account for approximately 3.75 million tons of Michigan's 6 million tons of total vessel exports in 2011, or 62.5%. This percentage is consistent with minerals and ores' average percentage of total exports from 2008 to 2010 of 64.3%[5].

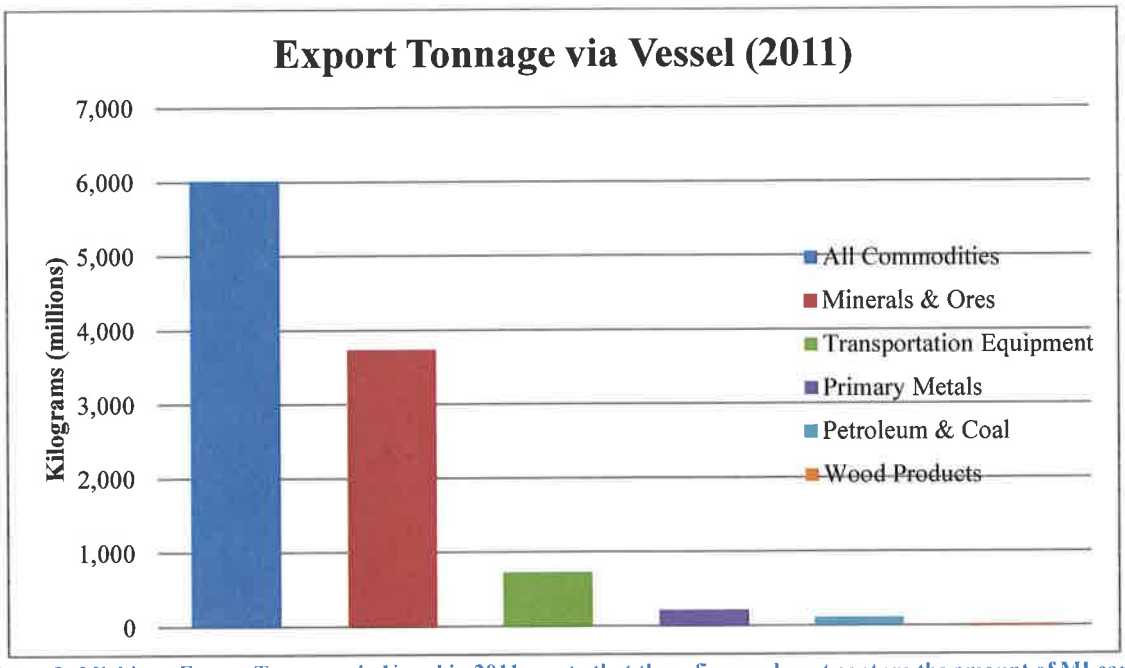


Figure 2: Michigan Export Tonnage via Vessel in 2011 – note that these figures do not capture the amount of MI cargo consolidated in other states for export

Established Export Locations

In 2011, 84% of minerals and ores were sent to Canada – about 3.15 million tons. France and Germany imported 510,000 and 81,000 tons, respectively. While 600,000 tons is a significant quantity available for shipment over the Atlantic, Michigan exports far more minerals and ores to Canada in a typical year. Figure 3 depicts the vast percentage of Michigan minerals and ores that are historically imported by Canada. Canada is the destination for over 99% of Michigan's mineral and ore exports essentially every year aside from 2011[6]. It is likely that the jump in 2011 of ore being exported to countries other than Canada is a result of a short-term mining project

initiated by a company located in France or Germany, because that is where the abnormal quantity was sent.

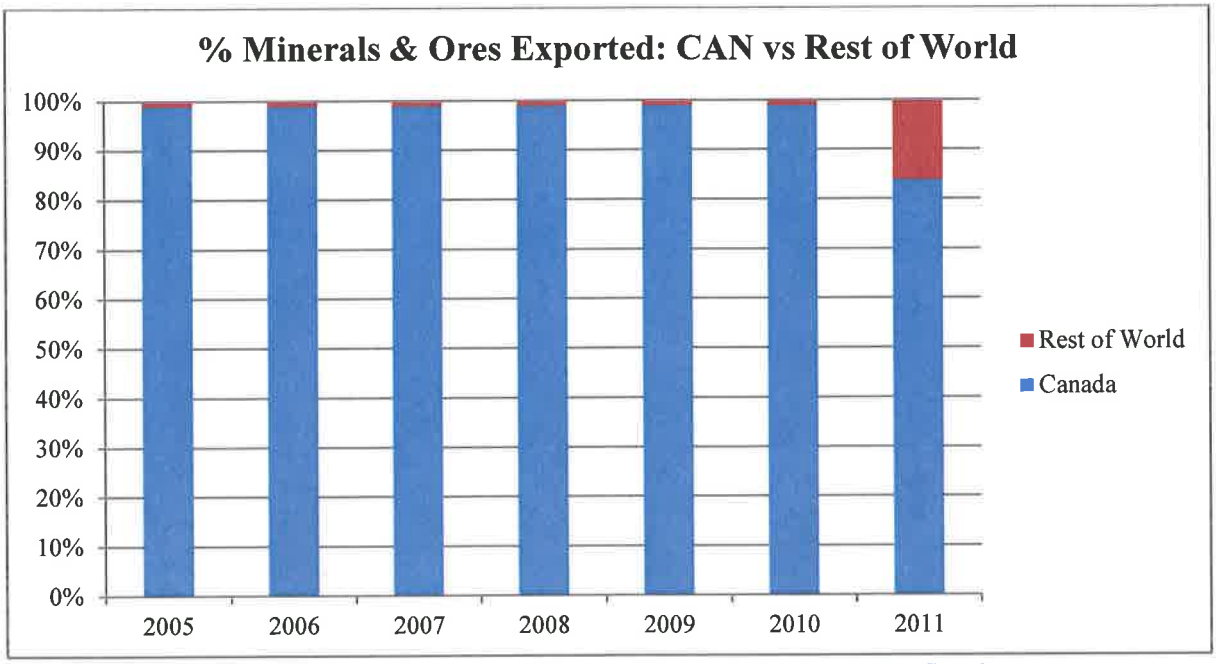


Figure 3: Annual Percentage of Michigan Mineral & Ore Exported to Canada

Implications for Transportation Modes

The large annual vessel SWT of minerals and ores exported to Canada indicates that these cargoes are usually transported by way of domestic laker. This indication is not surprising because large lakers (~1,000 ft.) are utilized specifically to carry ores from mines in the Upper Peninsula of Michigan to refineries in Canada.

The 600,000 tons exported to France and Germany in 2011 would have been loaded onto a seagoing vessel at some point. Walking through the routing options for this example is a good way to illustrate how Michigan's ballast policy affects the movement of commodities. Because the ballast policy would not have allowed a salty to export any cargo, a shipment of ore destined for France would not have had the option to move directly from a Michigan port to France. Thus, the shipment could have been moved by three other routes:

1. Rail or truck to a neighboring state with ports on the Great Lakes – because the majority of minerals and ores are procured from the Upper Peninsula, the state would likely be Wisconsin, Minnesota, or Canada. Then, load the cargo on a salty to export directly to France or Germany.
2. Domestic laker to a deep-water port on the East Coast like New York or Montreal. Then, consolidate with other small ore shipments to be shipped across the Atlantic to France or Germany on a large vessel.
3. Rail to a port on the East Coast. Then, consolidate with other small ore shipments to be shipped across the Atlantic to France or Germany on a large vessel.

A cost comparison of related modes of transportation can be found on page 21.

Determined Commodity Potential

The fact that Michigan's minerals and ores are almost exclusively exported to Canada means that a change in ballast policy would not immediately create a new opportunity for vessel-owning and -operating companies, mineral and ore related companies, or Michigan ports in this commodity segment. However, that conclusion assumes that importers of minerals and ores, or customers, will remain the same if Michigan changes the ballast policy – an assumption that could very well be inaccurate. For example, mineral and ore trading companies in Michigan may currently confine promotional efforts to areas that would not utilize Great Lakes salties for shipment because of the ballast policy. These areas include Canada, other states, and Michigan itself.

Essentially, the current ballast policy may limit interest from transatlantic countries in Michigan-based mining projects because of the potential costs of diverted cargo and inefficient trade routes added as a result of the policy. These costs are estimated in the "Cost Comparison of Trade Routes" section (page 21). If the policy were to change, there is a good possibility in the long-run that more minerals and ores would be exported from Michigan to transatlantic countries because of the cost reductions of shipping cargo directly to the destination via salties. Although, the quantity of new exports created as a result of a policy change cannot be determined. Additionally, if Canada has the market to maintain the quantity of imports that it has in the past then the only reason for minerals and ores to be exported elsewhere is the price offered for the commodity. This concept is explored further in the "Future Implications of Amending Ballast Water Policy" section (page 23).

Assuming that the majority of Michigan's mineral and ore exports are accounted for in the current data sets, we can apply the framework from page 4 to summarize the potential benefits of the minerals and ores commodity segment given a change in policy. The commodity is not currently diverted to other states for export because the majority is sent to Canada. Thus, parties involved in the export of minerals and ores would realize the long-term benefits described on page 3.

Agricultural Products

Agriculture is one of Michigan's largest industries and perhaps the most affected by Michigan's current ballast water policy. The NAICS dataset "111 Agricultural Products" includes the subsets "Oilseeds & Grains, Vegetables & Melons, Fruits & Tree Nuts, Mushrooms, and Other Agricultural Products." Michigan's primary crops include soy beans, corn, wheat, and sugar beets[7].

Michigan export datasets are not an accurate representation of the amount of Michigan-grown agri-product that is exported because of the nature of the origin of movement classification system. As mentioned in the "Terminology & Data Sources" section, the origin of movement classification system assigns the state where the commodity is *consolidated* as the state of export. The example provided in the "Terminology & Data Sources" section likely occurs in Michigan a great deal. A farmer sells his or her product to an agri-product trader, who then moves the product by rail or truck to a storage location in another state with Great Lakes port access. The trader then sells the same product in a large shipment with other similar products to

an overseas buyer. The product was consolidated with other products in a state other than Michigan, thus it is considered an export for said state.

Specialized Methodology

Because a large amount of Michigan agri-products may be consolidated for export in other states, a more complex methodology is required to determine the ballast water policy's effect on the commodity's movement. Refer to Figure 4 below for a visual of the methodology used for this section.

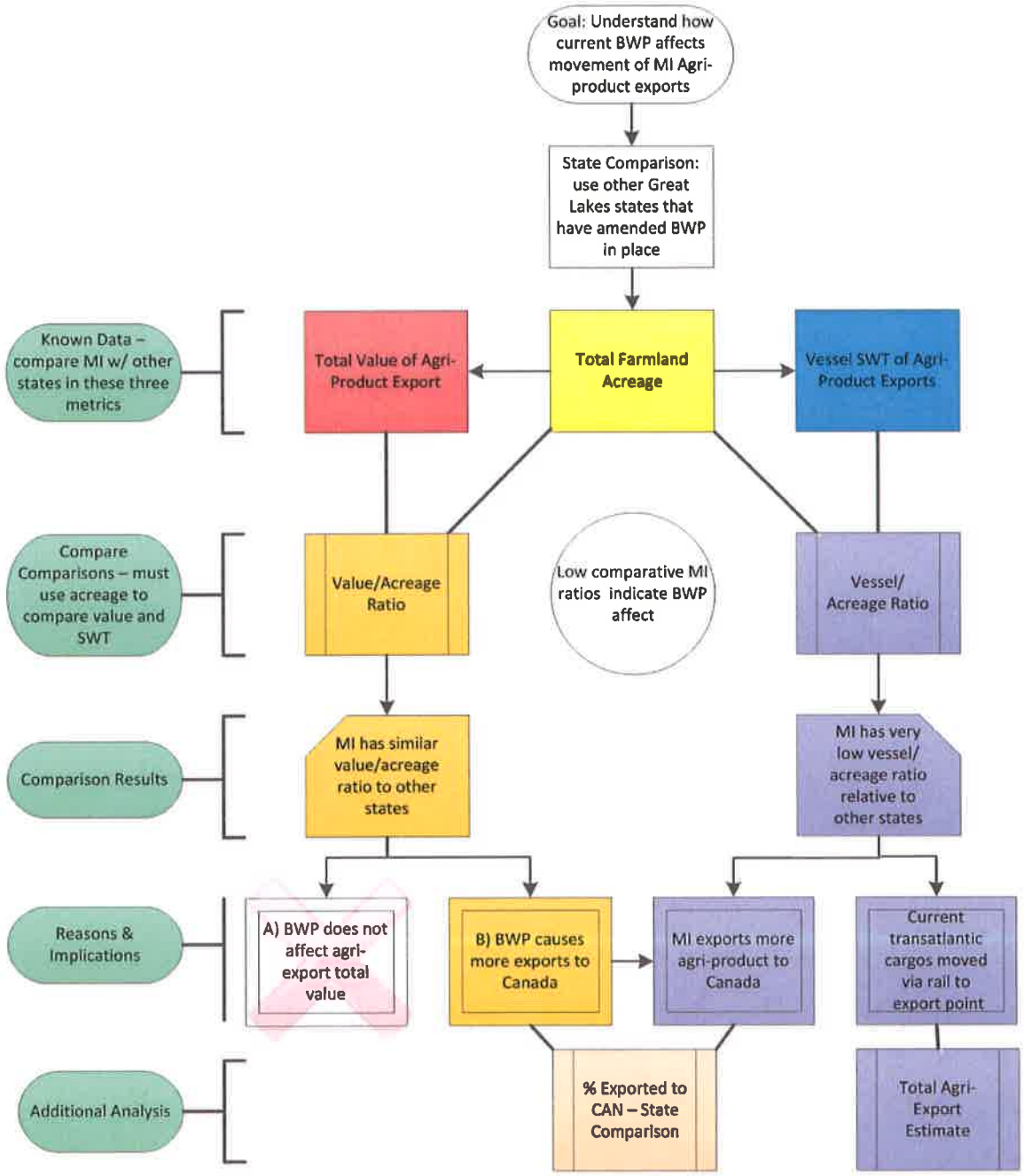


Figure 4: Hierarchy of Analysis Methodology

To walk through the reasoning behind this more complex methodology, we start with the goal of this section – to understand how the current ballast water policy affects the movement of Michigan's agri-product exports. Because other Great Lakes states already have the "amended" ballast water policy in place, we can compare Michigan's current export metrics to other Great Lakes states to understand how Michigan's ballast water policy may affect export metrics currently. The states selected are Ohio, Illinois, and Wisconsin. Given the consolidation method of classification used by the database from which the commodity data was retrieved, we do not know the exact numbers for actual agri-product exported. However, the metrics of in-state consolidation are known because the current agri-product exports classified under Michigan have to be consolidated in Michigan. We do not know the metrics of Michigan agri-products that are consolidated out-of-state because the shipments are classified as another state's export. As Figure 4 depicts, we know the following metrics on a state-level basis:

- Total Value of Agri-Product Exports[8]
- Total Farmland Acreage[9]
- Vessel SWT of Agri-Product Exports[8]

Given the measures of export available to us, we can further understand the following concepts:

1. The ballast water policy's affect on the proportion of Michigan's total crop that is exported relative to other states' proportion of their total crops
2. The proportion of Michigan's exported crops that are transported via vessel relative to other states

Again refering to Figure 4, we need make two comparisons:

1. The state-relative total value ratio to the state-relative total farmland acreage ratio
2. The state-relative vessel SWT ratio to the state-relative total acreage ratio

Essentially, we are comparing the first state comparisons we made. *This needs to be done because each state harvests a different amount of agri-product, and comparisons need to be consistent with crop size*. As the circle in the middle of Figure 4 indicates, we can interpret low comparitive ratios for Michigan as indications of the Michigan ballast water policy's affect on agri-product exports. We can interpret the results in this way because the differentiating factor between Michigan and the compared states is that all of the compared states follow the U.S. Coast Guard ballast water treatment policy and Michigan's policy is more stringent. The findings of these comparisons, and the expected reasons for the findings are as follows:

1. Michigan has a similar total value of agri-products exported to total farmland acreage ratio relative to Ohio, Illinois, and Wisconsin. This means that relative to its average annual crop harvested, Michigan exports a proportion of that crop that is similar to the compared states' proportions of total crop exported. There are two possible reasons for this finding: the current ballast water policy does not affect the exported proportion of Michigan's total crop, or Michigan is able to export the majority of its agri-product to Canada without international vessels, while the ballast water policy largely restricts Michigan to this market. As Figure 4 depicts, the reason for Michigan's comparatively

similar value to acreage ratio results from Michigan's ability to export to Canada without the use of international vessels. This subject is analyzed further with a state comparison of the proportion of agri-products exported to Canada.

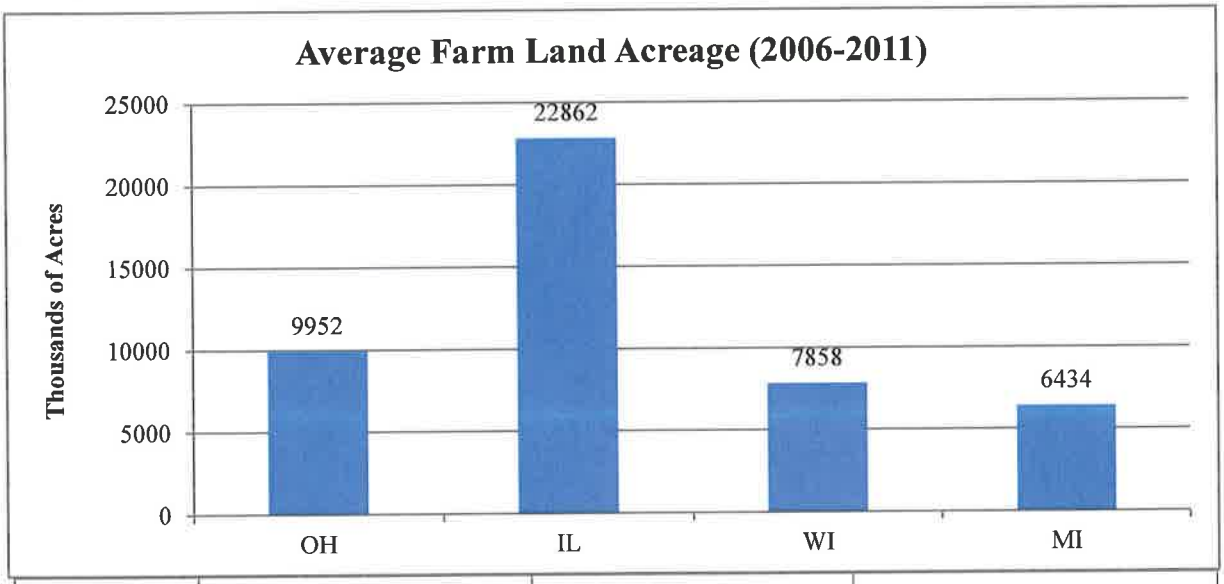
2. Michigan has a very low vessel SWT to total farmland acreage relative to Ohio, Illinois, and Wisconsin. This means that Michigan exports a significantly smaller proportion of their harvested crop via vessel than the other three states do. There are two reasons for this finding. First, proportionate to its crop size, Michigan exports more agri-product by land than other states because the majority of the agri-product exported goes to Canada. Second, the majority of agri-product that is destined for a country across the Atlantic Ocean is moved via rail or truck to an export point in another state. This second reason is analyzed further with an estimate of the total tonnage of Michigan's agri-product exports.

Agricultural Products: Key Assumptions

1) Proportion of farmland acreage of compared states yields similar proportions for crops harvested.
2) Each state will export a consistent proportion of their total harvested crop annually.
3) Each state's crops are similar in value and weight.
4) The differentiating factor between Michigan and other states is ballast water policy.

Comparative Analysis: Michigan and the Great Lakes States

Many of Michigan's agricultural export shipments have been noted to move through ports in Ohio or Illinois for export as opposed to ports in Michigan. This analysis first examines the acres of farmland harvested in each of the four states to estimate the states' annual harvested crop. Then, it examines the total value and vessel SWT of each state's annual agri-product exports. By

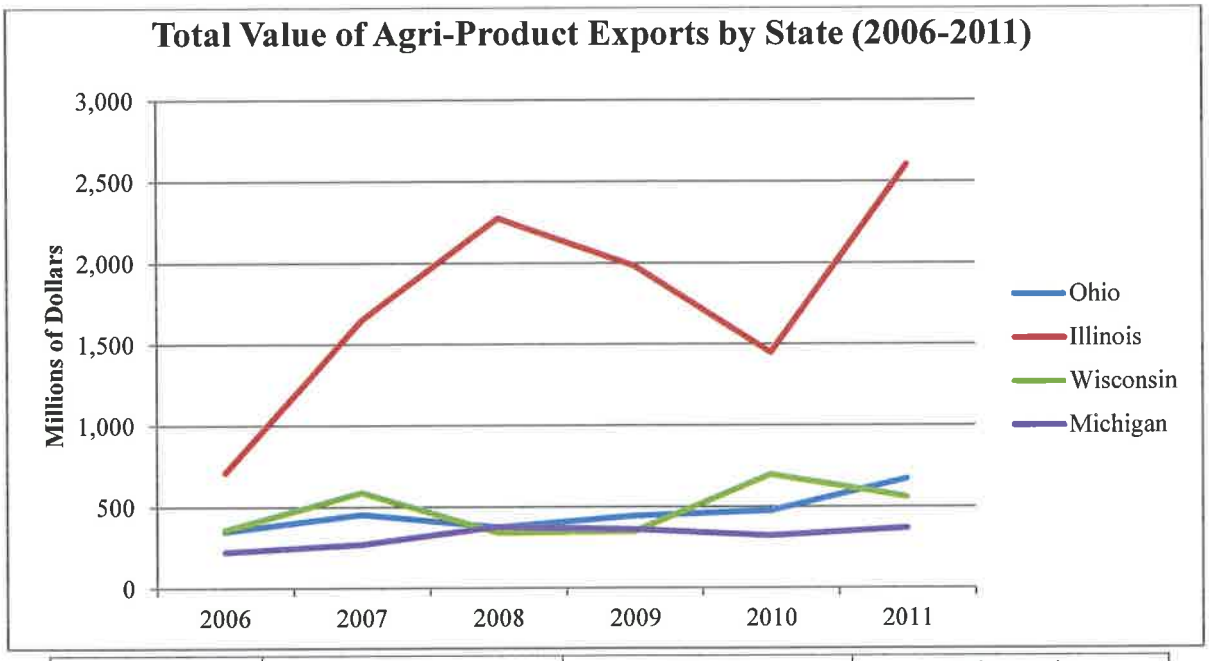


	Ohio	Illinois	Wisconsin
MI Ratio	0.646	0.281	0.819

Figure 5: Average Farmland Acreage of Compared States (2006-2011)

comparing Michigan to other Great Lakes states in these areas, a better understanding of the relationship between state production and export shipments can be gained.

Figure 5 (above) shows the average acres of principle crops harvested from 2006-2011 for Ohio, Illinois, Wisconsin and Michigan. To streamline the comparison of Michigan to the three other states for different metrics, proportions are used. Figure 5 is accompanied by a table containing the proportion of average Michigan acres harvested to each state's average harvest acres[9]. For example, the Michigan/Ohio ratio of 0.646 comes from Michigan acres divided by Ohio acres or, 6434/9952. The purpose of comparing Michigan to other states by farmland acreage is to understand Michigan's total crop size relative to other states' crop sizes. As noted in the "Specialized Methodology" section above, we will use this metric to proportionally compare Michigan to the other three states.



	Ohio	Illinois	Wisconsin
Avg. MI Ratio	0.716	0.199	0.726

Figure 6: Total Value of Agri-Product Exports for Compared States

Figure 6 (above) indicates the total value of agri-product exports for Ohio, Illinois, Wisconsin, and Michigan from 2006 to 2011[8]. An average Michigan proportion of the total value relative to Ohio, Illinois, and Wisconsin accompanies Figure 6. For example, Michigan's total value proportion to Illinois is 0.199. The purpose of comparing Michigan's total value of agri-product exports to the other states' total value of agri-product exports is to gain an understanding of the proportion of the total crop that Michigan exports relative to the other states. Realize that this metric does not accomplish this on its own and must be compared to the farmland acreage proportions in Figure 5.

Finding #1 Explained

Comparing the ratios from Figures 5 and 6, we realize the first finding stated in the "Specialized Methodology" subsection above – relative to its average annual crop harvested Michigan exports a proportion of that crop that is similar to the compared states' proportions of total crop exported. The Michigan/Ohio ratio for farmland acres is 0.646, compared to the Michigan/Ohio ratio for total export value of 0.716. The Michigan/Illinois ratio for farmland acreage is 0.281, while the total export value ratio is 0.199. The Michigan/Wisconsin ratio for farmland acreage is 0.819, while the total export value ratio is 0.726. While minor differences are seen in the proportions, Michigan's total export value ratio is not significantly lower than its farmland acreage ratio for the three states. The Michigan/Ohio total export value ratio was actually higher than the compared farmland acre ratio. This means that Michigan exports, on average, a higher proportion of its total crop value-wise than Ohio does. Additionally, the ratios compare in a relatively stable fashion. If the total value ratio was less than half of the acreage ratio for one or all of the states – for example, if the total value ratio for Michigan/Wisconsin was 0.400 instead of 0.726 – then that would be an indication that something was prohibiting Michigan from exporting a comparable proportion of its annual crop. But this is not the case.

As was stated previously, the fact that Michigan is similar to the other three states when comparing the total value/acreage ratios does not mean that the current ballast water policy has no effect on Michigan's exported total value of agri-products. It is likely the case that Michigan is able to export a comparable proportion of its total crop because it exports a larger proportion to Canada than any of the other three states[10] (Figure 7). Michigan is able to do this with the current ballast water policy in place because exporting to Canada does not require the use of an international vessel. That being said, Michigan exports far less proportionally to the rest of the world than the other three states. The current ballast water policy is likely a causal factor of this.

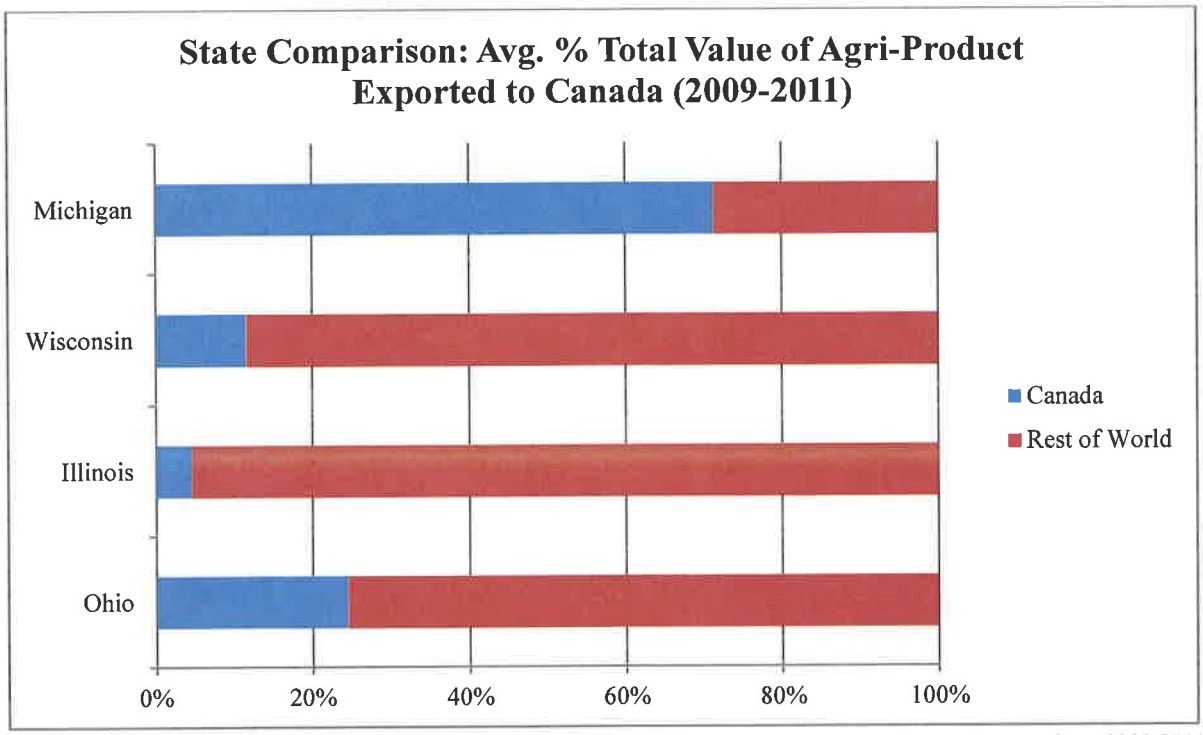
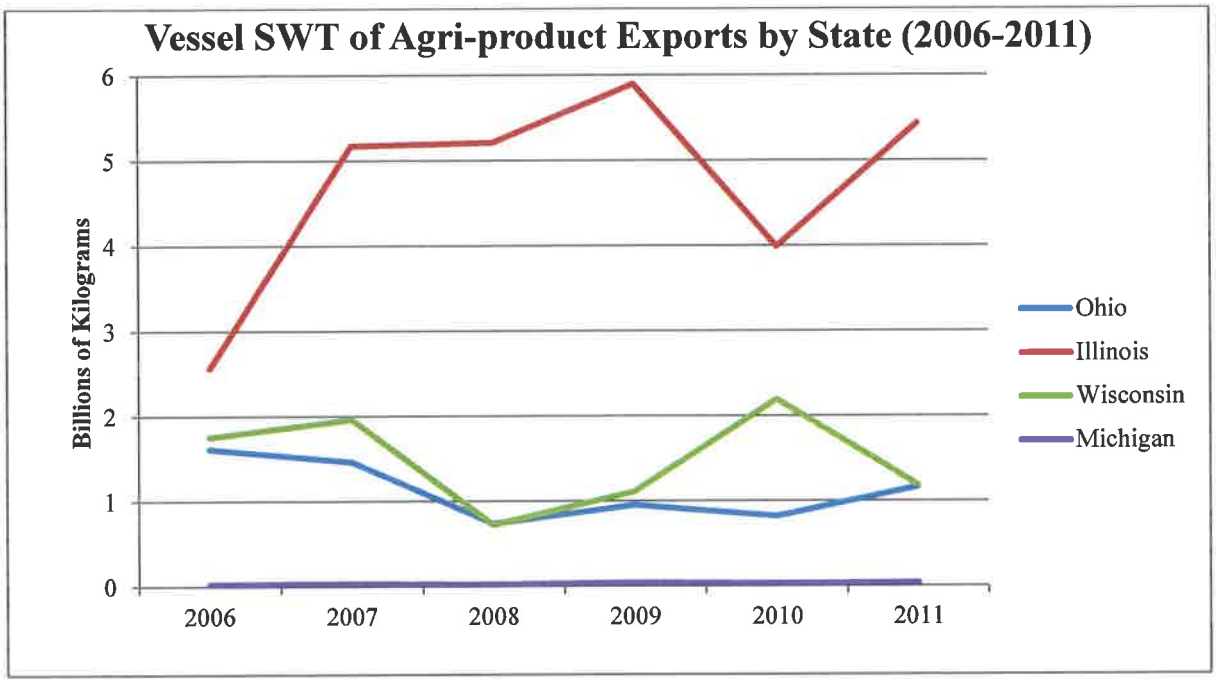


Figure 7: State Comparison of average percentage of the total value of exported agri-product to Canada from 2009-2011

Figure 8 (below) indicates the vessel SWT of agri-product exports for Ohio, Illinois, Wisconsin, and Michigan from 2006 to 2011[8]. A table similar to the one below Figure 6 depicts the proportions of Michigan vessel SWT relative to Ohio, Illinois, and Wisconsin for Figure 8. For example, Michigan's vessel SWT proportional to Wisconsin's vessel SWT is 0.027. The purpose of comparing Michigan's vessel SWT of agri-product exports to the other states' vessel SWT is to understand the tonnage of agri-product that Michigan exports on vessels relative to other Great Lakes states. We can compare this measure to the farm acreage proportions in Figure 5 to compare the estimated proportion of Michigan's total crop exported via vessel relative to other Great Lakes states. Note that the vessel SWT comparison best highlights the impact of the current ballast water policy on agri-product exports.



	Ohio	Illinois	Wisconsin
Avg. MI Ratio	0.034	0.008	0.027

Figure 8: Vessel SWT of Exported Agri-product for Compared States

Finding #2 Explained

By comparing the ratios from Figures 5 and 8, we realize the second finding stated in the "Specialized Method" subsection above – Michigan exports a significantly smaller proportion of their harvested crop via vessel than do the three compared states. Looking again at Figure 5, the Michigan/Ohio farmland acreage ratio is 0.646, while Figure 8 shows a Michigan/Ohio proportion of 0.034. The Michigan/Illinois farmland acreage ratio is 0.281, while the vessel SWT ratio is 0.008. The Michigan/Wisconsin farmland acreage ratio is 0.819, while the vessel SWT ratio is 0.027. Again, a lower vessel SWT ratio relative to the farmland acreage ratio indicates that Michigan utilizes less water transport for the export of agri-products than the comparative

state relative to the states' total crop. The values seen here are significant. Comparing the two Michigan/Ohio ratios of 0.646 and 0.034, we see that Michigan utilizes about 3.4% of the amount of vessel transport that Ohio uses for the export of agri-products, and about 5.3% of Ohio's amount of vessel usage relative to the states' crop size. In fact, in terms of relative crop size, 5.3% is the largest comparative proportion of Michigan's vessel usage for the export of agri-products.

As was stated previously, there are two likely reasons for this second finding. First, proportionate to its crop size, Michigan exports more agri-product by land than other states because the majority of the agri-product exported goes to Canada. Second, the majority of agri-product shipments that are destined for a country across the Atlantic Ocean are moved via rail or truck to an export point in another state.

The first reason is obviously closely related to the reason for finding #1. Because the current ballast water policy largely confines Michigan exports to Canada, and because Canada can be reached by land from Michigan, the amount of agri-product exported over land is higher than the agri-product exported by water. While Figure 7 depicts how much more Michigan exports to Canada proportionally than the other three states, it does not explain the entire difference in Michigan's vessel usage for exports.

Finding #2 for agri-product exports also suggests that Michigan agri-products are subject to trade route deviation because of the ballast water policy. This is why the second reason for this finding is heightened use of rail and truck for the initial movement exports. In other words, instead of loading onto a vessel immediately in Michigan, a good sum of agri-product shipments *that are consolidated in Michigan* are likely moved by rail or truck to a port in another state. It is probable that a portion of other Great Lakes states' vessel SWT would be shipped out of Michigan ports on vessels should Michigan amend its ballast water policy. Evidence for this statement lies in the previously mentioned significant values (derived from Figure 8) indicating that Michigan utilizes no more than 5% of the amount of vessel transport utilized by other Great Lakes states for export. Such a low comparative value indicates that there must be a fundamental difference between Michigan and the other three states. The most significant difference is the ballast water policy.

Considering the second reason for finding #2, the cost of diverted trade routes for exports leaving Michigan is a crucial determinant of how much value could be added by amending the current ballast policy. First, however, we must estimate a tonnage amount for Michigan's agri-product exports.

Agri-Product Total Tonnage Estimate

An additional metric – the vessel value for agri-product exports of each state – is necessary to estimate Michigan's total tonnage of agri-product exported. The visual of vessel value includes total value exported to provide an additional reference point for how little Michigan utilizes vessels for export relative to other Great Lakes states. The example given earlier in this section notes that the state of consolidation is what determines the state of export. Thus, the vessel value to total value ratio essentially supplements the vessel SWT ratio. Although, including the vessel value of each state's exports ensures that the exporting of crops of differing values (but perhaps the same weight) does not confound the values in Figure 8. Figure 9 (below) depicts Michigan's

total value and vessel value of agri-product exports in 2011 as they relate to the total value and vessel value of Ohio and Wisconsin[11]. Illinois is not included because its total value of agri-product exports is relatively large and makes the rest of the states' vessel value measures unreadable. Michigan's relatively low vessel value, despite having comparable total values, is a historical trend.

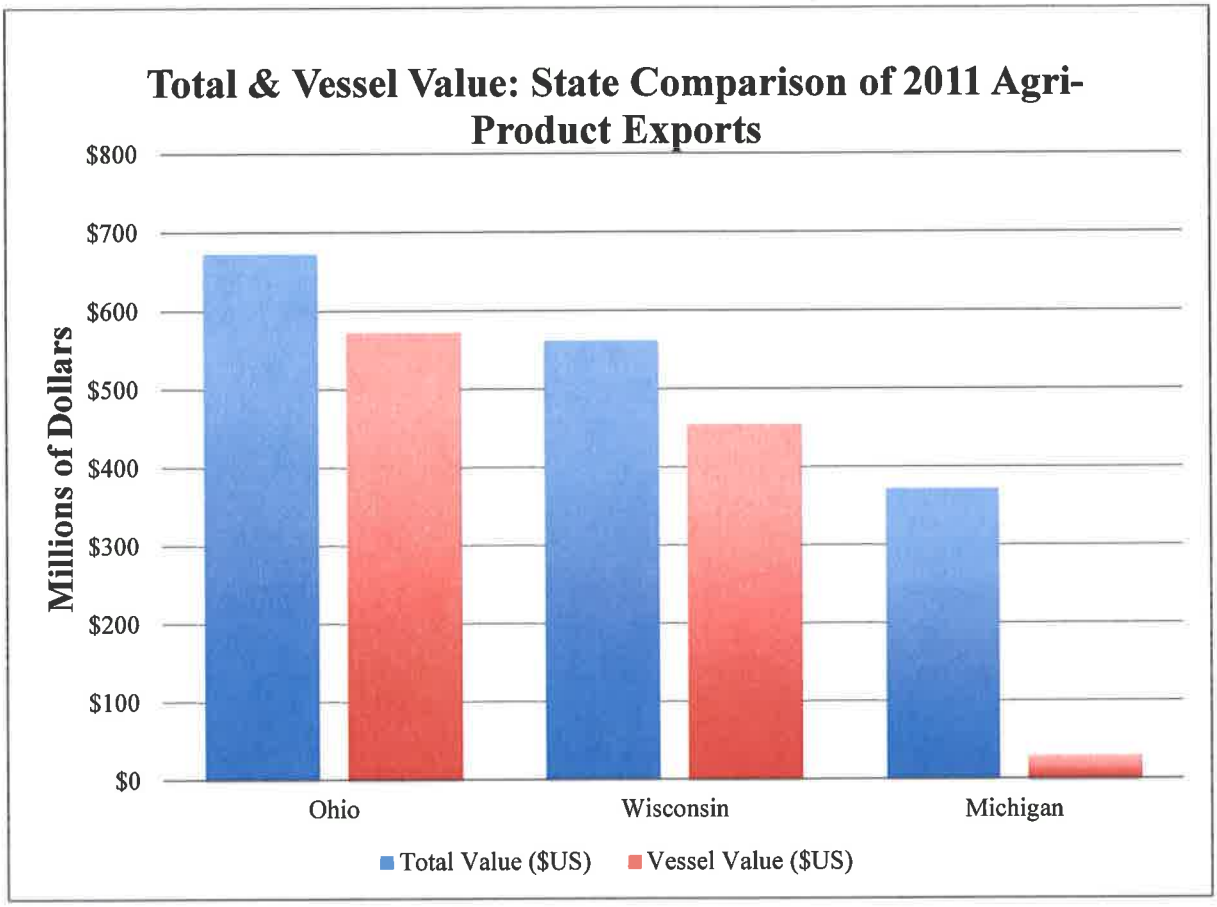


Figure 9: Total Value vs Vessel Value: State Comparison (2011)

The total tonnage of exported commodities is not available for specific states. Only the vessel SWT is available, which can be converted into tons. So Figures 6, 8, and 9 are used to estimate the total tonnage of agri-product exported from Michigan. Because vessel value is the value of the cargo exported, and vessel SWT is the weight of the cargo exported, we can understand the value/weight relationship by dividing vessel value by total value. The vessel SWT is then divided by the ratio found in the last step to calculate an estimated total tonnage for Michigan's exported agri-product. Using 2011 as a benchmark, we know that total value, vessel value, and vessel SWT are $371 M, $29.8 M, and 41,622 metric tons, respectively[11]. $29.8/$371 = approximately 8%. 41,622/.08 = approximately 520,000 tons. Thus, we estimate that Michigan exported a total of 520,000 tons of agri-product in 2011. This value will be used in the "Cost Comparison of Trade Routes" section (page 21).

Determined Commodity Potential

This study argues that a change in Michigan's current ballast water policy would add value to Michigan's agri-product export industry. Although it appears as if Michigan's total value of agri-product exports is proportionally consistent with other Great Lakes states', its vessel utilization for exports is clearly not. With a consistent ballast policy among Great Lakes states, Michigan would increase utilization of vessels for transporting its agri-product exports. Even if Michigan were able to utilize half as much vessel transport as other Great Lakes states, numerous parties would realize added value in agri-products. The state's ports would realize a large increase in traffic – approximately 1300% more agri-product would flow through ports if the state utilized half as much vessel transport as other states. Agri-product trading companies would realize a reduction in transportation costs because vessels offer greater economies of scale relative to rail or truck, and because of the increase in competition among shipping alternatives.

One could argue that because Michigan exports a large proportion of its agri-product to Canada, changing the ballast water policy would not have many benefits for the industry. However, the fact that Michigan exports more to Canada than any other Great Lakes state could be because businesses are disadvantaged in selling to overseas customers by the extra costs of diverted trade routes as a result of the ballast water policy. Other states do not incur these costs, thus they sell far more crops to countries other than Canada. In the long term, Michigan would be on a level playing field economically when selling its crops to countries across the Atlantic. Numerous parties benefit from this. International shipping companies will realize the benefits of additional cargo traveling across the Atlantic. Agri-product related companies will realize the benefits of increased demand for their products as a result of lowered shipping costs. Finally, Michigan will become a more attractive site for agri-business projects because of increased supply chain efficiency.

We can apply the framework from page 4 to summarize the potential benefits of the minerals and ores commodity segment given a change in policy. The commodity is currently diverted to other states for export because 20 to 30% is destined for transatlantic counties. Thus, parties involved in the export of agri-products would realize the short- and long-term benefits described on page 3.

Additional Commodities of Interest: Project Cargo

Although this study includes two main commodities to model the effects of the ballast water policy, Michigan is home to additional products that could have economic potential given a change in policy. Note that project cargoes are only affected by the ballast water policy when the cargoes are exported in shipments large enough to cause vessels to discharge ballast. Some project cargoes are specialty[7] shipments that do not require the discharging of ballast because they are not heavy enough to affect the buoyancy of the vessel. Thus, this section briefly describes the auto industry and manufactured products industries in Michigan, two industries that may export large enough cargos to be affected by the ballast water policy.

[7] Specialty shipments are individual, or a small number of objects that are likely not standardized for mass production.

Auto Industry

Often regarded as Michigan's largest industry, the auto industry does contribute a huge dollar value amount to Michigan's total value of exports. Although declining in recent years, Michigan still exported over $28 billion of vehicle parts in 2011[12]. The interesting thing about this is that less than 9,000 MT of vehicle parts were exported from Michigan via vessel. Additionally, while Michigan vehicle parts are sent mostly to Canada, there is still demand for the parts in countries across the Atlantic. It is likely that many of these parts are railed or transported by truck elsewhere to be shipped to a final destination via containerized vessels, so the vessel tonnage measure will not include this diverted tonnage. However, the high total value of exported vehicle parts indicates a high total tonnage, in turn indicating a large volume of standardized products. If the auto industry in Michigan produces standardized parts in a large enough quantity, some bulk ships could effectively transport the parts overseas as a single cargo.

Manufactured Products

The manufactured products industry includes nuclear reactors, boilers, and other machinery. Manufactured products are similar to auto industry products because they have an enormous share of Michigan's total value exported and a relatively low vessel tonnage exported. In 2011, these manufactured products accounted for over $21 billion of Michigan's total value exported, and about 30,000 MT were exported on vessels[12]. These values are historically consistent. What these values suggest is similar to the auto industry's current shipping methods – they are likely railed or trucked to another state for export from a marine port. Again, a fair amount of project cargo is specialty cargo, and will be shipped in relatively small tonnage quantities. This likely takes place with manufactured products more frequently than auto parts because things like nuclear reactors and boilers are not mass produced like engines, for example. However, there may be some benefit for manufactured products in the event of a policy change because these products are more diverse in their destinations. About 85% of industry exports were transported to Canada, which sounds like a lot, but that leaves about $3.2 billion in manufactured products that are exported to other countries – a significant amount[6].

Port Infrastructure

The nature of Michigan's ballast water policy implies that the state's naval ports will handle more imports than they will exports. Michigan will have potential for increased exports only if it has the port infrastructure to sustain more traffic. Port infrastructure is not as important to this analysis as commodity potential because infrastructure can be created if the cost benefits of a new transportation location are great enough. However, it is still an important topic.

Michigan has a large number of ports, but most of them are marinas for recreational use. Figure 10

Figure 10: Map of Prominent Michigan Ports

highlights Michigan's largest ports, most of which are specialized for a particular type of cargo. While many of the ports discussed are equipped to handle minerals and ores, Michigan does lack agricultural port infrastructure such as grain elevators. As the map indicates, Detroit and Muskegon are the two largest ports (infrastructure-wise) in the state[13]. Saginaw-Bay City and Manistee are also ports that are regarded as prominent in Michigan[14].

When determining the capacity of Detroit, Muskegon and Saginaw-Bay City, an analysis of the ports' current traffic was completed. Traffic metrics include total value of cargo, vessel value, and vessel SWT to account for the variation of types of cargo among ports. Figure 11 contains Michigan's top four ports sorted from greatest to least by vessel value for 2011[15]. The contents of Figure 11 are surprising. Neither Muskegon nor Saginaw-Bay City is among the top four ports in any of the three categories, and Detroit does not maintain nearly as much vessel SWT as Port Huron or Marquette. The rankings in Figure 11 are historically consistent (back to 2003), although Detroit has typically been the leader in vessel value in past years.

Ports	Total Value ($US)	Vessel Value ($US)	Vessel SWT (kg)
Port Huron	44,833,272,611	1,452,957,763	3,226,229,609
Detroit	74,764,714,893	1,420,730,089	783,287,304
Marquette	413,938,741	412,176,895	2,887,850,997
Sault St. Marie	1,329,183,770	30,685,462	226,176,054

Figure 11: Michigan Port Traffic Metrics – includes all products handled at respective ports

Variation in types of cargo is the main reason for the surprising values in Figure 11. Port Huron, Marquette and Sault St. Marie handle a large amount of ore, slag and ash. Because ores and other bulk commodities have a high weight-to-value ratio (one ton of most ores typically carries less value relative to one ton of another product) ports that handle more of them will yield high SWT figures and lower vessel value figures. One of Port Huron's top exports is mineral fuel and oil, accounting for 2.6 billion SWT and $817 million vessel value of the totals for 2011[16]. Additionally, Detroit handles a large amount of project cargo because of the auto industry. Project cargo typically has a low weight-to-value ratio (costs more for one ton of project cargo relative to a ton of another product), which is why Detroit handles less cargo weight-wise than Port Huron and Marquette.

Implications of Port Infrastructure

Muskegon, Saginaw- Bay City and Manistee are prominent infrastructure ports relative to other Michigan ports, but they handle less cargo than Port Huron, Marquette, Sault St. Marie and Alpena. This finding strongly suggests that there is underutilized infrastructure in Muskegon, Saginaw-Bay City, and elsewhere that would be able to support a higher amount of export traffic. Additionally, an interview with a professional in the Great Lakes/St. Lawrence Seaway maritime industry confirms that the system is under-utilized[17].

As previously noted, the nature of Michigan's ballast policy implies that naval ports will handle more imports than they do exports. Thus, it is logical to assume that the majority of Michigan ports have excess handling capacity for exports.

Cost Comparison of Trade Routes

This section attempts to build a rough cost comparison between rail, laker, and salty transport methods to further understand the cost savings that would potentially be realized by changing Michigan's ballast water policy. The rates for the different modes of transport were gathered from various industry experts in the international shipping field and the maritime brokerage field[18]. The cost structure estimates that approximately $3.58 million of unnecessary cost is potentially incurred because the ballast water policy makes export via salties nearly impossible.

Again, this cost comparison is an estimate. Economic and market factors such as supply and demand, cargo location, transport positioning, etc. will cause transportation rates to vary. However, this comparison attempts to deliver rates in the purest form possible, noting that economies of scale and handling fees will be constant factors in all transportation modes' rates.

Simplifying the Trade Route

In the interest of simplicity, the same commodity, tonnage, load port and destination port are used for every mode of transport. The laker and rail methods must stop at a different port to transfer the cargo, likely to a larger panamax[8] vessel, so the shipment can cross the Atlantic to Hull. This comparison selects Montreal as the transfer point for laker and rail because it is one of the closest deep-water[9] ports to Detroit. The handling fees for Detroit and Hull are not included because they apply to all three transportation methods. However, handling fees for Montreal apply. Handing fees are estimated at $3-$7 per MT, varying by port. For simplicity, a rate of $5 per MT will be included in Montreal. The trade scenario is as follows:

Commodity: Grain
Tonnage: 20,000 MT
Load Port to Destination: Detroit, MI to Hull, UK

1) Rail: Estimated rate from Detroit to Montreal – roughly $53 per metric ton (MT). Handling fees of $5 per MT to discharge grain from railcars in Montreal and load onto panamax vessel apply. The panamax rate from Montreal to Hull is about $22 per MT.

Summary: ($53 x 20,000 MT) + ($5 x 20,000 MT) + ($22 x 20,000 MT) = $1.6 M

The map below (Figure 12) shows the rail to panamax trade route as it is described above.

[8] Larger salty vessel – cannot fit through locks in St. Lawrence Seaway – must load in deep-water port
[9] Ports with drafts deep enough to harbor larger sea-faring vessels like panamax vessels

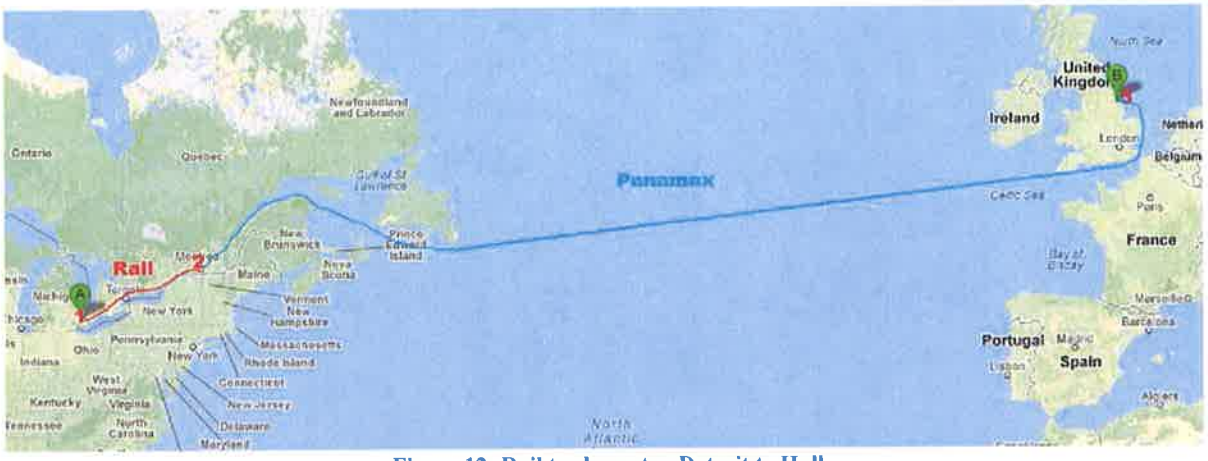


Figure 12: Rail trade route - Detroit to Hull

2) Laker: Estimated rate from Detroit to Montreal – roughly $30 per MT. Handling and berthing fees of $5 per MT to dock the laker, discharge cargo, and load onto panamax apply. The panamax rate from Montreal to Hull is about $22 per MT.

Summary: ($30 x 20,000) + ($5 x 20,000) + ($22 x 20,000) = $1.14 M

The map below (Figure 13) shows the laker to panamax trade route as it is described above.

Figure 13: Laker trade route - Detroit to Hull

3) Salty: Estimated rate from Detroit to Hull is about $48 per MT.

Summary: ($48 x 20,000) = $960,000

The map below (Figure 14) shows the salty trade route as it is described above.

Figure 14: Salty trade route - Detroit to Hull

Implications of Cost Comparison

As is noted in the "Agricultural Products" section, this study estimates about 520,000 MT of agri-product was exported from Michigan in 2011. Also noted in the "Agricultural Products" section is the 70-80% proportion of Michigan crops that are exported to Canada. Applying a 75% proportion to the estimated total tonnage in 2011, we find a measure of 390,000 MT was exported to Canada. This means that 130,000 MT was exported to other countries – the remaining 25%. Because the majority of the agri-products sent to Canada will be moved by rail regardless of the ballast water policy changing, the 130,000 MT that moves to other countries will be examined for the upcoming example[19]. Roughly 25,000 MT is carried by lakers to a transshipment point, while the other 105,000 MT must be moved by rail or truck, eventually reaching a port for the final export[19]. If we apply the cost structure laid out above, this 130,000 MT of exported agri-product incurs approximately $3.58 million of unnecessary cost because the ballast water policy makes export via salties nearly impossible. This number is derived by taking the estimated amount of agri-product that is not exported to Canada – 130,000 MT – and applying the cost savings of transporting via salty to the amount of cargo transported via rail and laker – about 105,000 MT and 25,000 MT respectively. *Remember, this comparison is derived from rate and tonnage* estimates.

Future Implications of Amending Ballast Water Policy

Amending the current ballast water policy would be economically beneficial in the long-run for virtually all parties affected by it. This section explains the basic economics of competition and free markets, and how the ballast water policy is a factor in the Midwestern economy. Additionally, this section will discuss specific examples of the ballast water policy as a deterrent for initiating business opportunities in Michigan.

Free Market Economics and the Ballast Water Policy

As previous commodity sections discuss, the ballast water policy increases the price of Michigan commodities in the global market. By using minerals and ores as an example of this price increase for all Michigan commodities, the economics of the situation can be better understood. Over 99% of Michigan-sourced minerals and ores are currently exported to Canada, typically via laker. The "Minerals & Ores" section discusses the additional cost of exporting to countries other than Canada because exporting directly to the destination country currently requires shipping of the cargo via rail or laker to a different state. The additional cost to transport *any* commodity in bulk to other states stems from 1) lack of economies of scale and 2) lack of competition.

1) Lack of Economies of Scale – Water transport has been established as the most efficient means of transporting bulk commodities because more cargo can be shipped at one time relative to other shipping methods. Because additional shipping is required to utilize these economies of scale under the current ballast water policy, Michigan commodities cost more to ship to countries over the Atlantic Ocean relative to other Great Lakes states' commodities.
2) Lack of Competition – Given that companies attempting to export from Michigan have fewer options for transporting their goods, basic economics would suggest that these companies experience price discrimination for shipping rates. Essentially, shipping companies will charge a higher rate for transporting Michigan commodities because fewer competitors exist to offer lower rates.

Given these additional transportation costs, Michigan commodities either trade at a lower price in the transatlantic market or they do not trade at all. The latter is currently the case, as over 99% of Michigan minerals and ores are exported to Canada. What this means is that the ballast water policy creates a micro economy between Michigan and Canada. Should the policy be amended, the additional costs incurred to ship Michigan commodities will be reduced, and the commodities will be able to compete in the international market. This long-term benefit is a characteristic of any commodity that is exported almost exclusively to Canada.

Current Examples of Deterred Business Opportunities[14]

During a meeting with various Michigan port officials in Detroit, a few "lost" business opportunities were brought up, and the ballast water policy was a key deterrent. Company names and/or locations that were mentioned during the meeting are not included. One such business opportunity involved a grain company interested in developing infrastructure in Michigan because of the state's strong agriculture industry. The company was informed of the implications of the ballast water policy and they have not currently proceeded with the project. Another example involves aluminum slab. From what was said at the meeting, a "tremendous tonnage" of aluminum slab is shipped from Canada to Detroit, where the cargo is stored until it is shipped internationally. When the aluminum slab is sold, it typically must be railed to a location in Ohio to be exported internationally, as opposed to being shipped directly from Detroit.

Summary of Future Implications

A large benefit of amending the ballast policy lies in the future. By reducing the cost of exporting commodities, Michigan will be better suited to compete on an international scale. That

means the state of Michigan will be a more attractive site for business opportunities targeting an international customer base. In turn, this benefits international vessel-owning and –operating companies, as well as Michigan ports, by increasing the amount of cargo shipped directly over the Atlantic Ocean from Michigan and increasing traffic through ports. Note that these changes would likely take a matter of years to fully develop, and the benefits described in this study would require a coordinated strategic effort between political, maritime industry, and commodity industry parties.

Limitations

General Limitations:
Because Michigan's current ballast water policy was last revised in 2001, data from before and after 2001 would be optimal to compare the before and after metrics of exports. However, the earliest year for most of the datasets I use is 2002 or later.

The framework laid out on page 4 does not account for commodities that may be shipped via container or tanker.

Commodity Selection:
Some of Michigan's largest industries like iron and steel, plastics, etc. are not included because a significant tonnage is not currently exported via vessel. Although agri-products are currently the same way, Michigan maritime professionals said that agri-products were being sent to other states for export. Just because a commodity is not mentioned in the paper does not mean it would not add value in the event of a change in ballast water policy.

Agricultural Products:
The estimate of total farm acres in Michigan and Ohio is only a general measure of farm production. Actual farm yield metrics were not available in an annual form at the time this study was completed. Thus, the ratio of agricultural tonnage and value produced by each state may differ from the ratio provided by this study.

Additionally, total value for each state depends on the type of crops exported. While Figure 9 partially accounts for this issue, the variance in value of crops state to state should be noted while using the vessel SWT metric. Also, each of the compared states is comparable value-wise for main crops like wheat and corn.

The fourth assumption in this section states that the differentiating factor between Michigan and the other three states is the ballast water policy. While I cannot think of any other reason that Michigan's export metrics would appear the way they do, there are likely other, less significant differentiating factors between states. These other factors may or may not contribute to Michigan's export metrics in a significant way.

The total export value to total acreage ratio comparison would tell us more about Michigan's agri-product if Michigan's comparable total export value ratios were lower. The original intent of this comparison was to identify the value of agri-product that may be consolidated in other states

for export. Because the findings from the comparison are not significant, we cannot determine if any quantity of Michigan agri-product is, or is not, consolidated in other states for export.

Port Infrastructure:
Measures of port infrastructure were not obtainable for some ports. I relied more heavily on information from interviews with various industry professionals.

Cost Analysis:
As mentioned in the section, fluctuating prices in the market will affect the cost structure for trade routes. For example, the laker method has recently been on par cost-wise with the salty method because global panamax vessel supply is high, thus rates are low. The mode of transport also depends largely on vessel positioning because voyages last for long periods of time. Thus, whichever vessel is closer to the cargo will likely offer a cheaper rate.

Because the cost structure is simplified, only one route is compared for the estimation. Costs may vary for different load or discharge destinations.

The rail transshipment rate is the same as the laker transshipment rate. In reality, the rail transshipment rate would be slightly lower on a per ton basis than that of a laker.

This estimation does not include tonnage that was consolidated out-of-state. Because we have no way of determining the quantity of Michigan tonnage that is consolidated out-of-state, this cargo is not added to the cost estimate. The more cargo that is consolidated out-of-state the more the cost benefits of changing the ballast policy would be realized.

Future Implications:
The discussion of economics in this section is concerned with price on a basic level, not the differentiating factors of products state-to-state. Thus, if Ohio wheat is higher quality than Michigan wheat, this is not accounted for when discussing Michigan's increased global competitiveness as a result of a change in ballast water policy.

Conclusion

This study has identified substantial evidence for the following given Michigan amends its current ballast policy to that of the rest of the Great Lakes states and the U.S. Coast Guard:

- Short-term benefits could be realized by Michigan ports and companies located in Michigan that currently export products to countries across the Atlantic Ocean. These benefits include, but are not limited to, access to a more efficient transportation mode in a salty for current exports, and increased business for ports.
- Long-term benefits could be realized by all parties involved in exporting across the Atlantic Ocean – Michigan ports, commodity companies located in Michigan that currently export products across the Atlantic Ocean, commodity companies located in Michigan that would like to source customers from countries across the Atlantic Ocean (but currently export solely to Canada), and international vessel-owning and –operating

companies. These benefits include, and are not limited to: Michigan being a more attractive site for new business projects involving exports if an amended policy were in place, and Michigan likely seeing an increase in the amount of exports and diversification of countries to which exports are destined because of greater access to the global market.

- For parties involved with the Minerals & Ores commodity segment, the long-term benefits listed above could be realized.
- For parties involved with the Agricultural Products commodity segment, the short- and long-term benefits listed above could be realized.
- The majority of Michigan ports have excess handling capacity for additional exports.
- There are significant cost reductions to be realized in the transatlantic export process from Michigan. For agri-product exports, this study estimates approximately $3.58 million could be saved in a typical year.

If Michigan's ballast water policy is amended in the future, the framework for commodity analysis laid out on page 4 is a simple way to begin thinking about the benefits that may be realized for a particular commodity segment. Any questions pertaining to the content or methodology of this study can be directed to psean@umich.edu.

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