Fluid Intelligence:

Foundational Study on Cross-Border Short-Sea Shipping Opportunities

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Final Report

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EXECUTIVE SUMMARY

Overview

This study examines available freight data sources to assess the potential for short sea shipping services that can serve regional needs. The geographic focus is on cross-border movements between Canada and the US in the Great Lakes region centred on Southern Ontario. The study is foundational in the sense that freight data sources are evaluated for their strengths and weaknesses to support the types of evidence-based insights that are needed; and in developing and suggesting tools that could leverage such data and that could be utilized going forward to support cargo insights on potential cargoes. The approach is data-driven and focused on regional cross-border cargo flows as opposed to examining the detailed operational aspects of prospective services. The simultaneous use of federal sources from both sides of the border and a key provincial trucking origin-destination source is something new. In terms of the goods that are moving, the study emphasizes tonnage over value because quantities moved are of prime importance for marine and its ability to remove GHG's from the transport system.

Definitions of short sea shipping shown in Chapter 1 and quantitative results in Chapter 3 show that there is already a lot of regional, cross-border short sea shipping taking place. This existing marine activity is a huge benefit for the economy of the Great Lakes region. But it has generally become understood that prospective marine opportunities could focus more on cargoes that are somewhat higher value, somewhat more time sensitive and associated with somewhat smaller quantities than has traditionally been the case – cargoes that traditionally have moved by road. Containerized movements that originate and terminate in the region is one potential mechanism to pursue in this regard. Port and intermodal infrastructure requirements in the containerized, and other, short sea contexts are not covered here and may be a topic to address in the future.

For the current study, opportunity is assessed mostly on how marine could be complementary to trucking as opposed to being a competitor. New marine services could reduce dependence on cross-border trucking movements (which are more involved and complex), keep scarce drivers closer to home and help reduce emissions, traffic congestion and other negative externalities. Accordingly, much of the study emphasizes learnings from trucking data. Perhaps counter-intuitively, marine data is not a focus of this research. The report offers some consideration of marine complementarities with rail, but stakeholders did not emphasize rail and detailed rail data was not available for analysis by Fluid Intelligence.

Other Jurisdictions, past work and stakeholder input

A brief review is conducted in Chapter 1 of high-level short sea shipping contexts from around the world and past studies and cases in North America. Stakeholder engagement activities were part of this study as well and key emerging themes are outlined in Chapter 4. The Great Lakes marine context is unique in that road and rail corridors to serve the cross-border region all months of the year are well-developed, while the marine corridor has seasonal limitations. Other cases examined do not have this combination. Moreover, historical population growth and development in the region has tended to align with, and support, these road and rail corridors.

For stakeholder engagement the intent was to emphasize the identification of potential new data sources and ways to collaborate on leveraging data. No new data sources were identified that could add meaningful value to the sources covered in Chapters 2 and 3. With a lack of newly identified sources to discuss, engagements naturally gravitated to opportunities and challenges for new types of short sea shipping in the cross-border region and coverage of these aspects had been planned. Some of the challenges, such as seasonal factors, are well-known and arise in Chapter 4. The current study looks past these challenges and focuses instead on evidence-based insights, supported by data, on the expanded role that marine can play in the region. The engagements reminded us of the challenges of other modes as well. For example, the approval of significant new rail facilities to address bottlenecks at or near existing locations has been problematic. In this light, marine solutions were seen to offer redundancy and a safety value.

Review of Freight Sources

Since the available freight data sources are the most foundational elements of this study, Chapter 2 conducts a detailed examination of each data source and considers the potential to assist with short sea shipping insights. A high-level summary of the most important pros and cons per data source is presented in the table above. Each source has its strengths but also a fundamental weakness that precludes any one source from reaching the status of a total solution.

The key insight suggested by the data review is that there is potential to jointly leverage the StatsCan trade data and the Ontario Commercial Vehicle Survey to benefit from the advantages, while mitigating the disadvantages, of both. Discussions with stakeholders and third parties indicate that the Commercial Vehicle Survey is a rare data source of a type not duplicated in other jurisdictions. It shows what is actually carried on trucks. The CVS can serve as an on-going anchor of regional short sea shipping investigations provided that it is updated in the future. Meanwhile, detailed Canada-US trade data has not typically been used in freight transport applications but works well in the current context where a border cuts through the heart of the Great Lakes region study area.

Most important Pros and Cons of Key Data Sources

Data Source	Pros	Cons
Statistics Canada US-Canada Trade Data	High commodity detail over time, especially in value terms; good high-level geographic context and detail on where goods cross and by what mode	No sub-provincial or sub-state insight and limitations on extracting actual tonnages due to diverse units of measure; not trip or shipment-oriented
Ontario Commercial Vehicle Survey (CVS)	Good characterization of actual sampled cross-border trucks trips in terms of the geography of their movement and good detail on what is carried	Fixed in time, trucking only, and dependent on a complex process to adjust the sample to the true population of truck trips
US Bureau of Transportation Statistics Transborder Freight	A good but not highly detailed all round source that captures tonnages flowing from Canada; updated monthly	No detail on road and rail tonnages into Canada; not trip or shipment oriented
US Commodity Flow Survey	Best source for characterizing individual shipments into Canada by road and rail and offers tonnage estimate for those flows	Fixed in time and last reported for 2017; no coverage of Canada-US flows; subject to the limitations of samples

Quantitative and other results of interest

Chapter 3 takes some substantial steps forward in the joint leveraging of these and other key freight data sources. Analytical results are developed and described and shown in tables, charts, graphs and maps. Results from each source are displayed on their own merits. The current study does not “fuse” sources together in any way to infer new modelled output data, though that is a topic worthy of future research. Recognizing that other investigations of refreshed data will be needed in the future, perhaps on an on-going basis, a prototype spreadsheet tool is developed that aggregates StatsCan trade data in an intuitive way to assist stakeholders who might want to explore cargo opportunities themselves without the burdens of working with large and complex sources in their raw form. Along these lines, a rough dashboard prototype is presented as well.

To give a sense of the scale of goods movement in the Great Lakes Region and by extension, the level of activity within which short sea shipping could play an expanded role, consider the following:

- Including all modes of freight movement, 54.5 million tonnes of goods originated in Ontario and flowed into the US in 2021 with 68% of that being destined for a Great Lakes state. A lower bound estimate derived from 2019 is 49 million tonnes that were cleared into Ontario from the US with 61% originating from a Great Lakes state[1].
- For the truck mode, 28.5 million tonnes of cargo originated in Ontario in 2021 and crossed into the US. 70% of this total was destined for a Great Lakes state. A lower bound estimate for 2019 imports clearing into Ontario by truck from the US is 24 million tonnes, as indicated by trade data with 55% originating from a Great Lakes state.
- For 2021 exports crossing by truck and originating from Ontario, the largest tonnage category was iron and steel which accounted for about 3.3 million tonnes moving to Great Lakes states – especially Michigan and Ohio.
- For rail, 13.5 million tonnes crossed into the US from an Ontario origination in 2021 with 54% destined for a Great Lakes State. The Statistics Canada trade data for 2019 offers a lower bound estimate of 9 million tonnes with 46% originating from a Great Lakes state. For higher value cargoes that are measured by Statistics Canada in kilograms, only 17% of the rail import tonnage originates from a Great Lakes state. The implication is that rail has challenges competing with trucking in the Great Lakes region for higher value cargoes (relative to the wider region extending well-beyond the Great Lakes).

The Ontario Commercial Vehicle Survey also gives a good sense of the scale of activity and can characterize other detailed aspects of truck movements that are not possible with the other available sources. For example:

- The CVS indicates that approximately 1 million tonnes of cargo per week crossed at Sarnia/Windsor and Niagara (export + import trips of over 100km in length) in 2019.

[1] The true total is higher. The lower estimate reflects limitations in characterizing quantity of goods in the Statistics Canada Trade Data. US data also has limitations in characterizing actual quantities (as opposed to value of goods) flowing into Canada.

- The CVS estimates 27,500 cargo-carrying truck trips (100km+) per week crossing into Canada via Windsor/Sarnia, with 24,800 trips being the corresponding flow towards the US.
- The CVS estimates that 28% of 100km+ trucks trips crossing into the US via Windsor/Sarnia are empty trucks whereas only 20% are empty in the reverse direction.

In short-sea shipping contexts, we received feedback that defining a catchment area around individual ports is of prime importance in assessing potential for marine. The CVS allowed us to act on feedback by defining 50 and 100km catchment areas around specific US ports and then assessing potential with Southern Ontario/Greater Toronto Hamilton Area on that basis:

- As an example, it was estimated that there are 2733 cargo-bearing truck trips (carrying an estimated 35,320 tonnes) flowing weekly between the GTHA and the area defined by a 50km radius around the Port of Chicago. If all Ontario/Quebec geographies are included on the Canadian side, these totals increased to 4196 trips carrying 56,227 tonnes per week. The connection with Chicago does not depend on a larger 100km radius around the Port of Chicago to capture very significant flows. Trucking flows appear quite diversified across cargo-types to and from Chicago. Further details on this and connections with other US port vicinities are available for study in Section 3.2.3 of the report.
- A GHG analysis associated with defined catchment areas showed that approximately 220 tonnes of GHGs per week could be saved if 10% of existing truck tonnage between the Chicago vicinity and the GTHA was moved by marine.

Inclusion of the US Commodity Flow Survey in this study conferred several benefits but one of the most prominent was that it was an excellent source for estimating shipment size. As examples:

- the average shipment size for cargoes carried in trucks and crossing from Michigan into Ontario was: approximately one tonne for shipments related to automotive supply chains, 7.5 tonnes for shipments related to pulp/newsprint/paper/paperboard and about 19 tonnes for shipments related to waste and scrap. There is wide variation in shipment size across commodity types, which may also be related to shipment frequencies. Unlike for the CVS, these results include all trip lengths (i.e., also those less than 100km).

Core Findings and Future Work

The brief summary of this section is not a substitute for more detailed and extensive conclusions in the main body of the report, but some prominent findings are as follows:

- Results of this project advocate the development of partnership opportunities for multi-modal transport so that the transportation system and the surrounding environment benefit from advantages of each mode. Modes can be complementary more so than competitive.

- Results suggest the most potential for new services that connect Southern Ontario to ports on Lake Michigan and Lake Erie. The vicinities around Chicago and Milwaukee are major metropolitan anchors of the Great Lakes region and trucking distances to the GTHA are relatively large which aligns with possible GHG reductions. The data suggest solid existing cargo connections that marine can seek to complement. A Chicago-Toronto service could theoretically operate year-round if Port Colborne, for example, was developed as a multi-modal hub. Year-round opportunities on Lake Erie have potential as well although a lot of movements to and from the Detroit vicinity are focused on time-sensitive automotive supply chains but large quantities of iron and steel products are moving by truck. Connections to Cleveland and Toledo seem possible. At Toledo, there is potential to tap into massive flows of Interstate 75 cross-border goods that are drawn from a wide region and funneled through that single corridor.

- Lake Ontario is obviously integral to the Seaway but the potential for a cross-border cross-lake freight operation appears limited; likely due to low population and industrial concentrations east of the GTA and near the south shore of Lake Ontario. Such a service linking at Rochester, for example, would essentially have to act as another way to join Buffalo and the GTHA.

- The CVS did not yield evidence of significant trucking flows between southern Ontario and United States port vicinities on Lake Superior, suggesting that it would be difficult for a service to complement existing cross-border trucking activity between the regions. This is not a comment on domestic possibilities between these two regions.

- Further investigation of regional rail flows is warranted but is dependent on data availability. While the CVS gives good insight on important origins and destinations of cross-border trucking movements, a counterpart data source for rail would be helpful to better understand this other entire class of regional cargo flows and potential implications for short sea shipping.

- In the future, research on the fusion of freight data sources in support of investigation of ongoing short sea shipping opportunities is prudent. Such efforts that would seek to leverage CVS data and Statistics Canada trade data in a tightly integrated way could lead to monthly updates. Relying only on the CVS means that fresh data feeds occur only once every several years.

- It should also be considered that future data fusion activities can be multi-modal in nature. For example, rail origin-destination data and AIS data relating to marine traffic can be included in integration efforts with the CVS and trade data. In a nutshell, research on fusion presents opportunities that can assist in short sea shipping and other freight contexts.
- Data sources that are compiled by government entities, or made available by such entities, appear as central to on-going efforts to identify short sea opportunities. It appears crucial that sources such as the Ontario CVS are able to persist well into the future.
- As is discussed in more detail in the conclusion, there is also potential for a short course on short sea shipping to raise regional awareness on the concept among a wide range of stakeholders.

1.0 INTRODUCTION AND BACKGROUND

1.1 Objective and Scope

The primary objective of this report is to provide evidence-based insights, and to inform of new tools and capabilities, to assist industry stakeholders in assessing the potential for new cross-border short sea shipping services within the Great Lakes St. Lawrence Seaway system. Apart from drawing conclusions about the results we see, we are also intent on communicating that there is on-going value in leveraging data sources that are presented in this report.

The focus of the study on potential marine cross-border movements between Canada and the US in the Great Lakes vicinity, with a particular emphasis on Southern Ontario. Since this study is a product of the Fluid Intelligence partnership between the Hamilton-Oshawa Port Authority and the McMaster Institute for Transportation and Logistics, the study emphasizes leveraging data and analytics to help improve regional supply chains (as is consistent with the mission of Fluid Intelligence).

In discussing short-sea opportunities, some tend to emphasize connections to other continents and improving marine linkages of the Great Lakes region with those foreign connections. This context is certainly a worthy one for the future of regional short sea shipping but is not considered within the scope of the current report. Also, new services between Canadian ports are not the emphasis of this report.

This study is not premised on modal shift. The underlying rationale is aligned instead with modal diversification, adding resiliency to supply chains, and finding better ways to deal with a range of congestion and land use issues, labour force issues and other matters associated with road and rail. Should new marine operations be unable to gain a foothold, then they will not be there to help when the next set of external shocks arrive to challenge system resiliency. There is a high likelihood, with continued population growth in southern Ontario alone, that the volume of goods that moves is likely to increase accordingly. In that scenario, increased marine activity need not imply reduced demand or even reduced growth for other modes.

One way of characterizing short sea shipping is on the basis of what it is not: it does not involve moving goods across oceans. In this light, much of the current activity associated with the Great Lakes-St. Lawrence Seaway system could be defined as short sea shipping, as it involves movements between various inland locations. See Table 1-1 for some definitions. Existing movements also have the property that they involve large tonnages of cargoes that are not highly time sensitive. However, it has generally become understood that prospective short sea opportunities in this region could be focused on the types of cargo that are essentially new for the inland marine context and that diverge from the past experience (i.e., those that might have somewhat higher levels of time sensitivity and value and perhaps move in smaller tonnages per vessel). Overall, there appears to be increasing recognition of a possible expanded role for marine in the Great Lakes region (Starr, 2022).

Table 1-1 Short Sea Shipping Definitions

Organization	Definition
European Commission	The movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non-European countries having a coastline on the enclosed seas bordering Europe (link)
U.S. Department of Transportation Maritime Administration (MARAD)	"Marine Highway" refers to specific coastal or inland waterways that have been designated by the Maritime Administration (MARAD). Short sea shipping defined as transportation of freight and/or passenger by navigable marine highways without crossing an ocean (link)
Transport Canada	The movement of cargo or passengers by water over relatively short distances. It can occur within lakes and river systems and along coast lines. It consists of mainly domestic shipping but can also include cross-border traffic (Canada–US–Mexico). It does not consist of shipping across the world's major oceans.
Hamilton-Oshawa Port Authority	1. Feeder Service – the moving of container cargo from a bigger vessel to a small vessel to move into the Great Lakes region. 2. Interlake – the movement of vessels between Great Lakes ports.

In contemplating a future for the Great Lakes-St. Lawrence Seaway that involves an increased role for short sea shipping, it is worth reminding ourselves of the potential benefits as outlined in Figure 1-1. In addition to enhanced modal balance and reduced GHG's, one attractive benefit of short sea shipping is reduced congestion in urban areas through reduction or at least reallocation of trucks to other corridors. This can improve safety, improve air quality in heavily populated areas, reduce tax payer costs for the maintenance of roads and highway and reduce the risk of dangerous goods incidents on roads. Increased marine activity has the potential to increase the resilience of transportation infrastructure overall and improve its reliability.

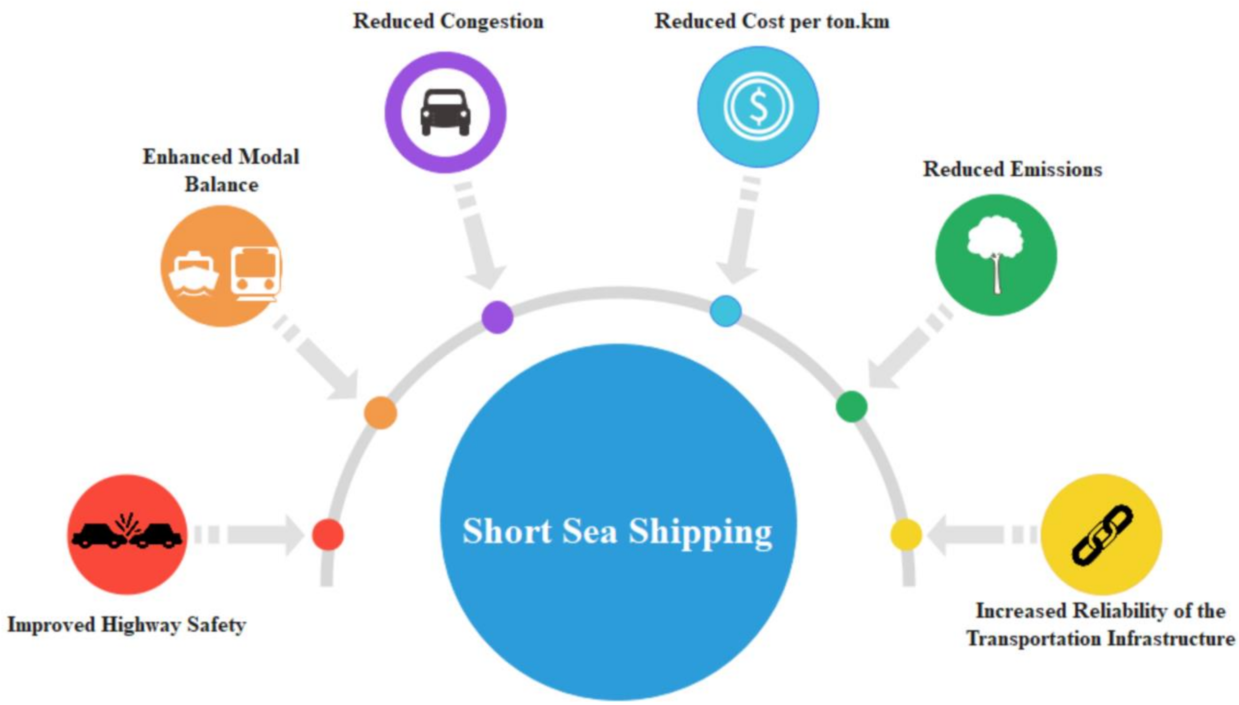

Figure 1-1: Potential Short Sea Shipping Benefits

GHG emissions and decarbonization are central to discussions on freight nowadays. From 1990 to 2019 (Figure 1-2) for Canada, the share of GHG emissions produced by the less environmental-friendly trucking mode has steadily increased in relative and absolute terms. Electrification has a future role to play in alleviating the problem but is the most challenging to implement for heavy trucks. Especially with regional population growth, it is hard to imagine that the demand for freight movements will decline. The nearshoring and reindustrialization phenomenon, which appears to be taking place, is also likely to increase movements that are more regional in nature. Multi-modal solutions that incorporate short-sea shipping are one approach to altering the trends seen in Figure 1-2 and which help the region prepare for greater freight volumes.

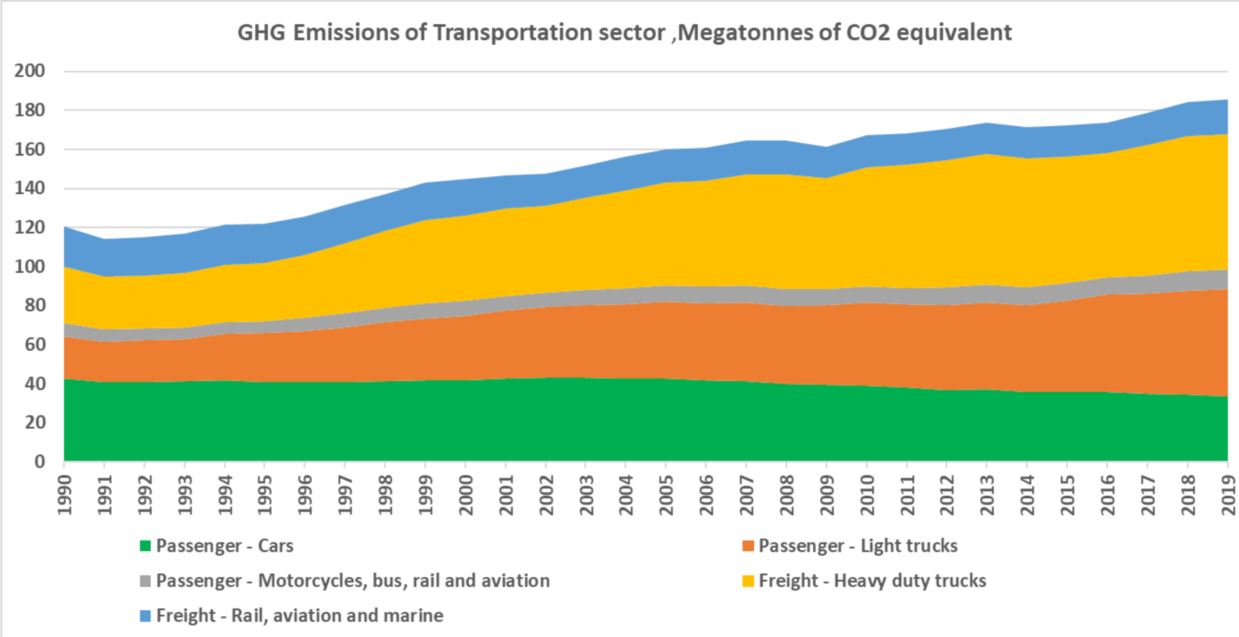

Figure 1-2: GHG Emissions of Canadian Transportation sector, Megatons of CO2 equivalent (Data Source: STATSCAN)

1.2 Brief Jurisdictional Overview

The European short sea shipping industry is the most long-established example in the world. Due to its unique geography and prominent river system, short sea shipping plays an important role in the continent's transportation infrastructure. The short sea shipping network and its main regional associations are depicted in Figure 1-3.

Short sea shipping has been prioritized since the early 1990s and has attracted considerable policy attention and promotion (e.g., Marco Polo program). According to Figure 1-4, despite these efforts, the modal split shares for freight transportation show minor changes over time. The relative importance of marine has actually declined slightly over the past decade.

Figure 1-3: Short sea shipping routes in Europe - Source: (Papadimitriou, Lydris, Koliousis, Sdoukopoulos, & Stavroulakis, 2018)

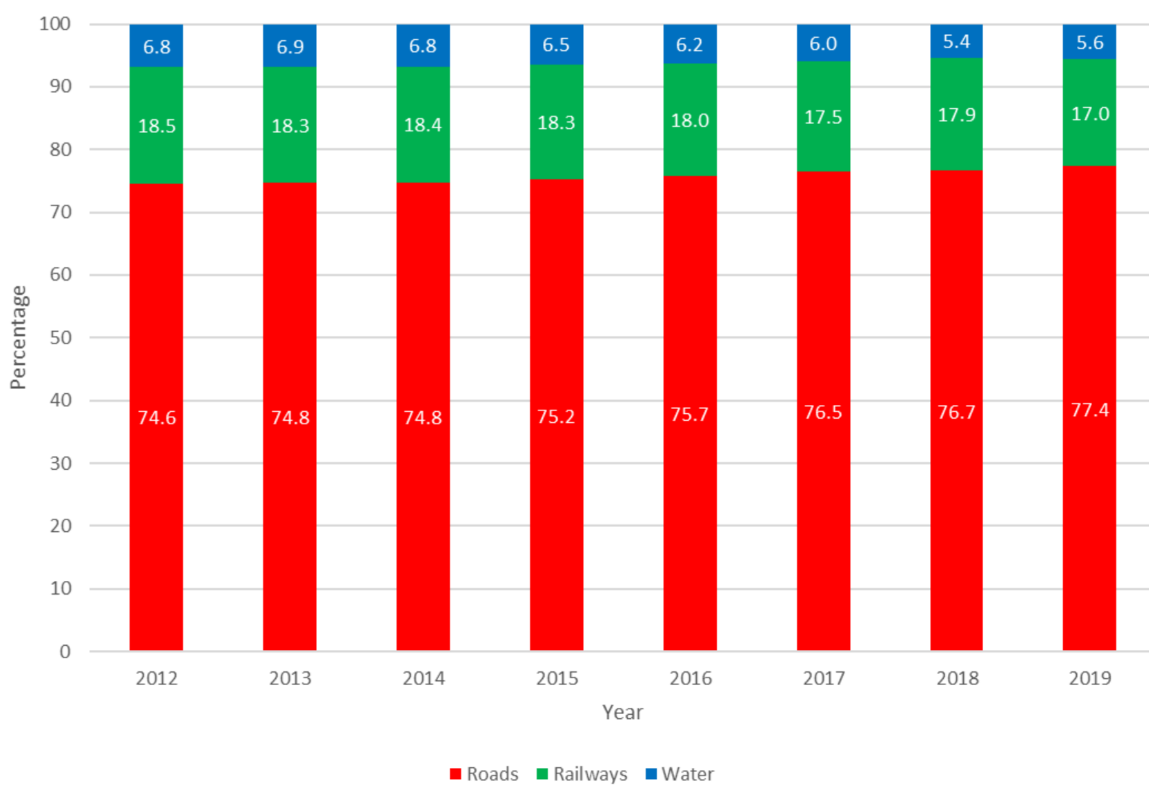

Figure 1-4: European Freight Modal Split (Allocation of total tonne.km) - Source: EuroStat

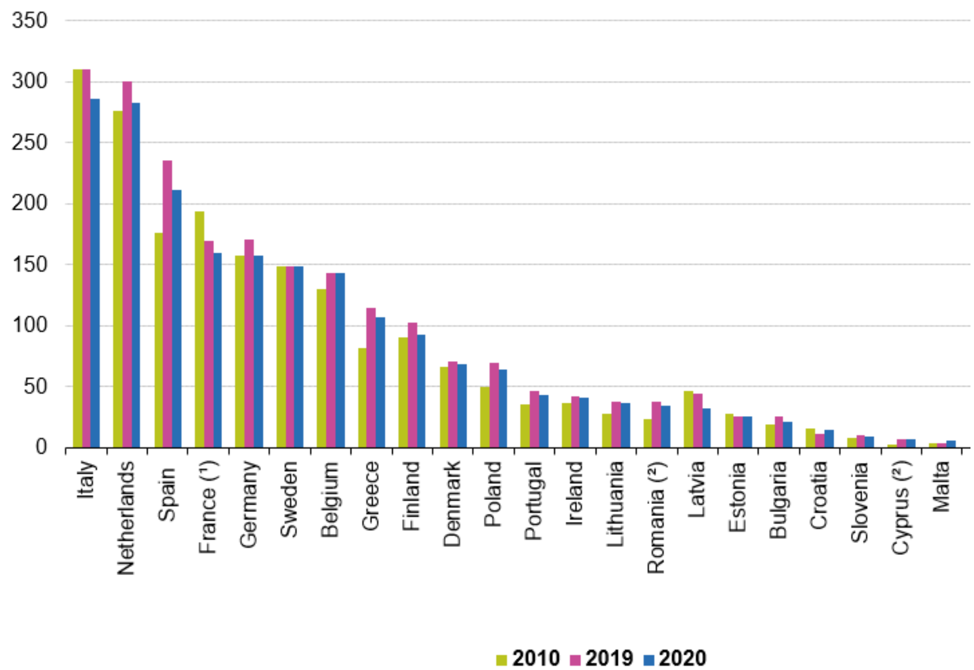

Figure 1-5: Short Sea Shipping of Freight (million tonnes) - Data Source: Eurostat

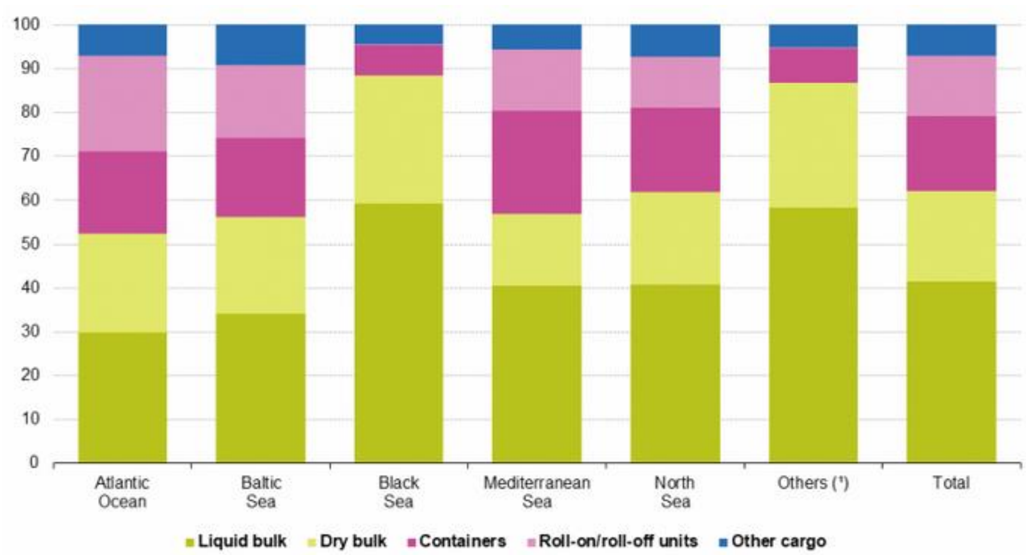

Figure 1-6: Allocation of Cargo types in Short Sea Shipping (Source: Eurostat 2020)

In absolute terms, a considerable amount of European cargo is handled by short sea shipping Figure 1-5 and the diversity of application across many European countries is quite impressive. The majority of short sea operations occur in the Mediterranean Sea with lesser levels of activity in the North Sea and Baltic Sea. Figure 1-6 illustrates that diversity as well in terms of the cargo-types that are handled across primary geographies, with each having significant shares, even if there are some prominent regional differences. For example, containers are far more prominent in the Mediterranean than they are in the Black Sea. In terms of differences with the Great Lakes system, the movement of containers is certainly notable along with a larger role in the movement of liquid bulk cargoes.

Moving on to Asia, the region is noted for having some of the largest ports in the world, with high growth in recent decades. Six of the world's ten largest ports are in this region. Accordingly, there is considerable coastal concentration with the majority of industrial and population centres being located in the vicinity of maritime gateways. China, Japan, and South Korea are the major players in short sea shipping in the region and have developed strong marine trade links with each other. An overview of the short sea shipping network in east Asia is presented in Figure 1-7.

Figure 1-7: Key short sea shipping corridors and regions in North-East Asia and container volumes transported in 2013 - Source: (Papadimitriou, Lydris, Koliousis, Sdoukopoulos, & Stavroulakis, 2018)

The North American context is of course the one that is most relevant for the current project. There are certainly some significant differences between major world jurisdictions. For example, rail freight is much more prominent in North America than it is in Europe and this no doubt impacts prospects for domestic short-sea shipping (Ferguson & Lavery, 2012). Figure 1-9 offers partial evidence for why rail offers strong competition to short sea shipping in the US context, though the metrics shown favour marine services slightly. The particular marine statistics offered by MARAD are for barge services, which are highly prominent in the US. Winter is generally much less of a factor in the European context. For the sake of high-level comparison with other major jurisdictions above, the basic geographic structure of the short sea shipping market in North America is presented in Figure 1-8.

Figure 1-8: Short sea shipping in North America (2007) - (Rodrigue, Comtois, & Slack, 2009)

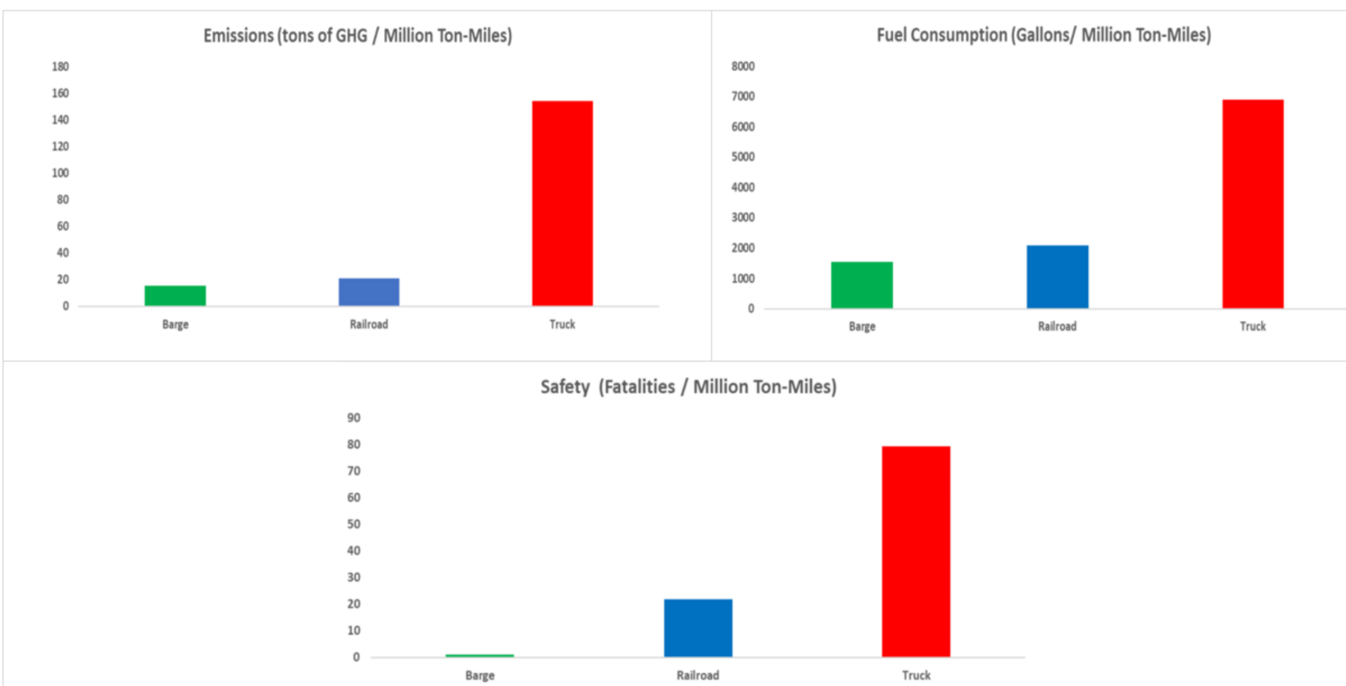

Figure 1-9: Comparison of Modes in US (Adapted from MARAD)

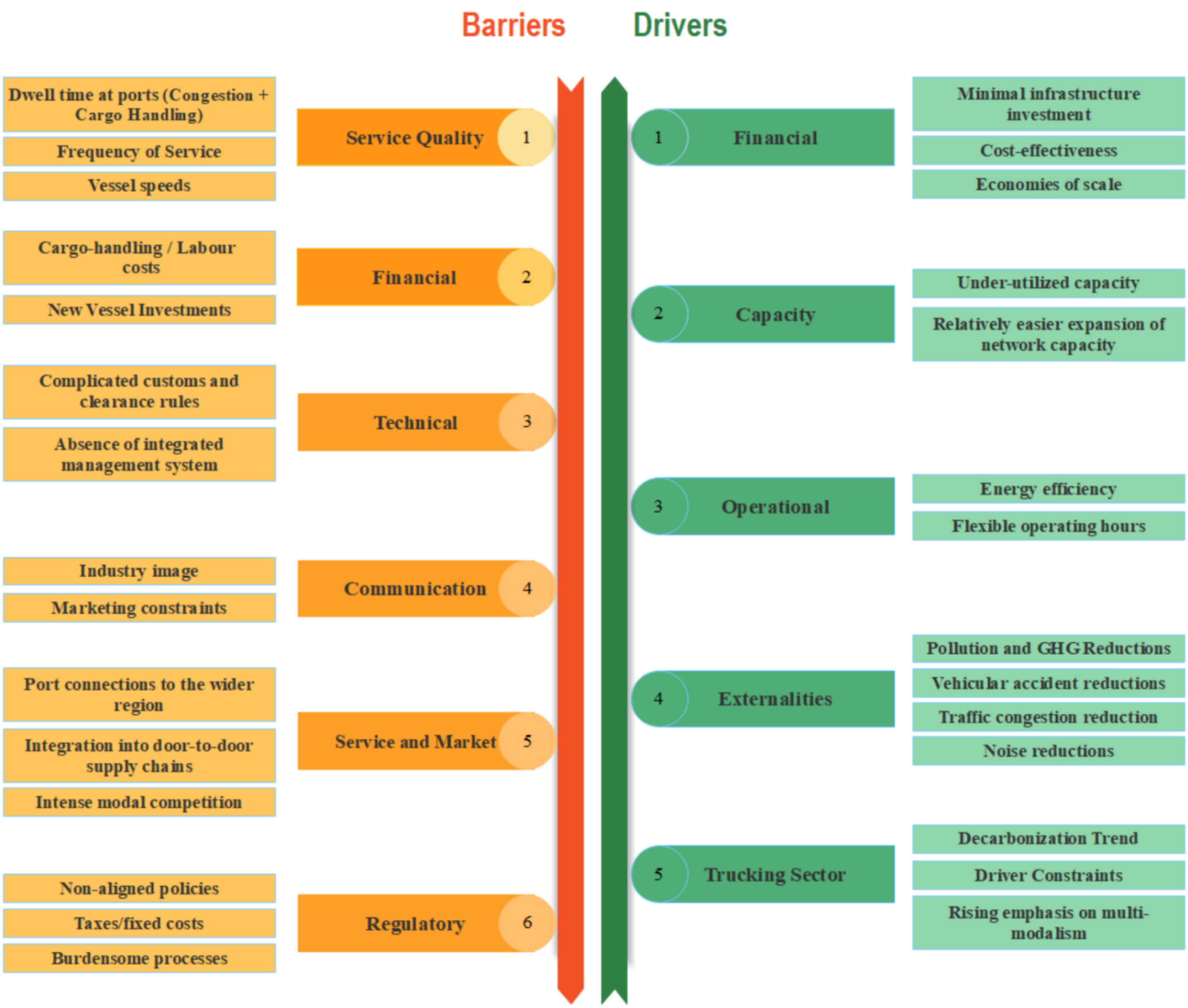

Figure 1-10: Short Sea Shipping drivers and barriers (Adapted and updated from Raza et al. - 2020)

To conclude this overview, a schematic (Figure 1-10) has been developed on some of the most prominent barriers and drivers with which short sea initiatives around the world can be associated. The figure has been adapted and developed based largely on a comprehensive review (Raza, Svanberg, & Wiegmans, 2020) that examined 58 sources, mainly from Europe, and other countries including the US, Canada, India, China, and Japan. Many quoted studies developed questionnaires answered by varied actors, such as freight forwarders, trucking companies, cargo owners, and regulators. Other sources were case studies. Certain noted barriers and drivers are perception-based to some extent. Raza et al. (2020) quotes incidents around the world that have impacted the marine sector such as labour unrest and successful cyber-attacks. Not that these incidents are unique to the marine sector.

To some extent, Figure 1-10 is reflective of the short sea context in the Great Lakes St. Lawrence Seaway system, but the local situation has its own unique factors (as will be discussed). Continuing population growth in Southern Ontario, for example, is likely to further enhance the externality drivers shown in the figure that benefit marine's future. To the extent that some noted barriers in Figure 1-10 apply in the local context, there are no doubt avenues that can be pursued to address them, and a barrier that is effectively addressed can become a driver.

1.3 Overview of Selected Domestic Studies and Cases

The purpose of this section is to focus mostly on the North American context and with an eye on the relationship with potential enhanced short sea shipping to support the Great Lakes region. To this end, brief overviews are given of prominent domestic research that has been done on short sea shipping and relevant cases in North America are briefly reviewed. The section offers some context in preparation for the data-intensive work that follows in subsequent chapters. To the best of our knowledge, the emphasis of this study on synthesizing information on the surface movement of cargoes, in a region of interest, differs from work that has been done in the past.

Genivar (2008) released a comprehensive report that assessed various Canadian short sea shipping scenarios based on the environmental and social impacts. Marine, road and rail were compared for each scenario. Components of costs evaluated per scenario were Criteria Air Contaminants (CACs), GHGs, Accidents, Noise and Congestion. Across the scenarios, which were generally longer distance in nature, and involving fairly large amounts of cargo, trucking did not fare well because of the large number of trips required to move the same amount of cargo as a single vessel. In terms of aggregate distance travelled by "vehicles", trucking results were larger in the scenarios by factors of several hundred depending on scenario. However, social costs attributed to accidents was actually calculated as the leading cost component for trucking in each of the scenarios. Overall, the report is effective in making the case that long-distance movements of cargo are best not done by diesel truck, from a social and environmental perspective, if a good marine or rail option is available. Favourable marine results relative to rail appeared to be driven by less vehicle-km distances travelled.

The Research and Traffic Group (2013) reinforced Genivar results and offered new ones. The report assessed "renewed" or updated fleets for each mode and determined that trucking would emit 708% more GHGs than marine in moving one tonne of cargo a distance of one kilometre. Rail would emit 64% more on the same basis. For criteria air contaminants, the report notes that renewed fleets that are up to new regulatory standards will actually benefit the marine value proposition most of all, relative to other modes. The report also notes that *where* emissions take place (e.g., on open water versus built up areas) is a significant consideration in terms of societal impacts. Finally, the report is effective in communicating how single marine movements can do the work associated with hundreds of rail cars or trucks.

Marinova Consulting (2015) provided an overview of short sea shipping in Canada as an input into the Canadian Transportation Act Review process. The report stresses the importance of "port-centric logistics" for short sea shipping solutions to have a chance of addressing first mile-last mile issues and to truly reach its potential. Cabotage regulation, which restricts the ability to service a wide range of ports on both sides of the border with the same service is noted as the "biggest issue" that holds back short sea shipping. Oceanex is assessed as being potentially the best example of a short sea service in North America. At the time of review, the firm operated 3 vessels in the 1000 TEU or more range with versatile cargo capabilities involving Montreal and Atlantic Ports. The services run once or twice a week. McKeil Marine is mentioned for the movement of aluminum ingots from Quebec. The overall tone of the report in reference to short sea shipping is perhaps one of cautious optimism.

In a recent report, Innovation Maritime (2021) offers a detailed review of marine cost components with an emphasis on scenarios that are linked to the St. Lawrence but with some Great Lakes involvement. A series of typically one-way transits are presented that result in total costs that range from about $60,000 to $180,000 depending on the transit scenario. In most scenarios, fuel costs are the largest expense, typically accounting for half or more of total transit costs but there are scenarios where pilotage fees and the costs of transiting Seaway locks could exceed fuel costs. Such scenarios appear to be ones with shorter distances travelled (e.g., Montreal-Sarnia) and with dangerous goods being moved (e.g., petroleum products). Costs to transit locks stand out as being very substantial and whether a transit involves going through both sets[2] of locks is a factor. Note that pilotage fees can be avoided if on-board navigation officers hold compulsory pilotage certificates and often this is possible if the vessel is not international. Further stakeholder feedback on the topic is offered in Section 4.2 below. One additional note is that Innovation Maritime also breaks down costs of loading and unloading at ports.

A 2018 report prepared for Transport Canada (Logistics Solution Builders Inc., 2018), characterizes the operating costs of trucking in detail. The report quotes an average of $2.02 in operating costs per kilometre for 2017 with this average being derived across a range of trucking configurations and geographies. The results highlight that the financial decision to send a truck

[2] There are two sets of locks: A system of locks that enables vessels to move between the Montreal region and Lake Ontario and secondly, the Welland Canal that enables movements between Lake Ontario and Lake Erie.

1000km to move a load of cargo is a comparatively "lower stakes" decision than the decision to send a vessel, carrying much larger quantities of cargo, over the same distance. This is especially the case if the decision is seen from a service start-up perspective. Smaller vessels and more frequent services can perhaps imply a closer analogy to trucking, which will reduce per transit fuel costs. But the cost breakdown from Innovation Maritime makes it clear that the possible evolution of significant cost components such as pilotage and lock transits will have an impact on how "nimble" new short sea services can be. See Section 4.2 for related feedback from stakeholders. Regulatory barriers and the winter closure are additional complicating factors.

The circumstances associated with the Great Lakes and the Seaway appear to be unique but there is value in considering lessons from recent short sea shipping cases that have garnered attention. Several container-on-barge services are being funded in the US (Angell, 2020). Also, brief comparisons are made with recent BC studies and a service in the US Pacific Northwest. The case of an entrepreneurial firm, located on Lake Ontario, that has been seeking to leverage the marine mode is introduced as well.

A prominent barge example is the Virginia Container Barge Service (The Maritime Executive, 2018; Rago, 2020), which moves containers approximately 150km inland from the Port of Virginia to the Richmond Marine Terminal. The service has been operating since 2008 and is classified by the consulting firm Cascadia Partners as an ocean terminal extension service. The particular marine route has an interstate running in parallel. Through this service, there has been an opportunity to reduce truck activity and associated externalities near the Port of Virginia and help generate some additional economic and land use activity where it was more needed in the Port of Richmond vicinity. Approximately 130,000 containers were processed at Richmond in the first decade of this service. The service is said to work well in terms of its daily timing. Loading and unloading is handled during the day and the barge can travel overnight (Hiom and Friedman, 2018). The service has been a significant factor in the likes of Amazon, Lidl, Bissell and Brother International locating logistics facilities near the Richmond Marine Terminal in recent years.

Another interesting case is the Tidewater barge service that operates over 465 miles on the Columbia River in the states of Washington, Oregon and Idaho. Five intermodal terminals are involved intrinsically in the service but other facilities are called on. Road and rail are apparently quite viable alternatives along this span, so in this sense there is a parallel with the Great Lakes scenario. Cargoes moved include petroleum, grain, export containers, solid waste, and paper products which appear to be in more of an unfinished state. So, container movements are part of the offering but not as the primary rationale for the service. Various recent and upcoming investments/initiatives seek to promote the role of containerized movements linked to the Great Lakes region.

In British Columbia, two main thrusts have been better marine connections of the mainland with Vancouver Island (Hiom, Friedman, & Basilij, 2019) and greater marine prominence to help alleviate congestion problems in the Vancouver metropolitan area (Hiom & Friedman, 2018). For the former, one obvious difference from the Great Lakes context is that there is not direct competition with trucking and rail (although trucks can be ferried to and from the island). Proposals for Vancouver Island have some similarity with the Richmond case in that there is an apparent need to use a new service as one means to disperse activity away from a heavily congested area to one that could use more economic and logistics activity. Both the Virginia and BC cases may offer a parallel with the Greater Toronto and Hamilton region where there is a huge reliance on freight flows to and from Peel Region. Some dispersion of associated trucking activity to connect with marine could have desirable side effects.

In the Ontario context, the story of Doornekamp Construction Limited is an interesting case study. From humble beginnings, the firm has become increasingly involved in short sea shipping ventures. In past MITL industry consultations, two major Canadian organizations that are major shippers have mentioned Doornekamp favourably for its entrepreneurial efforts and this motivated an interest to examine this smaller player in more detail. For the interested reader, the background and progression of Doornekamp Construction Limited is discussed in Appendix B.

1.4 Outline of Report

This initial chapter has clarified the objective and scope of the research. It has also done a high-level overview of short sea shipping for some of the key regional cases around the world. The chapter concluded by focusing on the domestic context, highlighting past research on short sea shipping while examining specific cases, including some close to Southern Ontario.

The focus of the report shifts now to the Great Lakes cross-border context, with a particular emphasis on better understanding what moves by truck. Chapter 2 reviews key data sources that can help stakeholders better understand the potential for a more prominent marine role. Chapter 3 gives a sense of what can be done with the data and describes tools that have been developed to leverage the data. These might cater to specific future cargo inquiries. Chapter 4 outlines the themes that have emerged from qualitative data gathered from stakeholder engagement. Chapter 5 offers some concluding thoughts based on a synthesis of what has been found.

2.0 REVIEW OF KEY DATA SOURCES AND RELATED ISSUES

The rationale for this chapter is that it is worthwhile for interested stakeholders to have a reasonable working knowledge of available data sources that shed light on how goods move between Ontario and US locations within the larger Great Lakes region. An understanding of relative strengths and weakness per source and how one source can complement another is worthwhile. An absence of this understanding could lead to drawing the wrong conclusions about what data says or reaching conclusions that are not well supported. Nevertheless, some readers may wish to skip to the next chapter which presents relevant results without much attention paid to the contextual issues that are presented in this chapter.

Figure 2-1: Key Data Building Blocks for this Study

Figure 2-1 offers an overview of the key sources of data that are leveraged for this study. In this chapter, the data sources are discussed in descending order of their judged importance to the study (and ultimately to stakeholders).

2.1 STATSCAN Trade Database

2.1.1 Overview

A large and detailed trade database from Statistics Canada was obtained for this project, covering cross-border goods flows between Canada and the US. Although it is perhaps difficult to do it full justice in this report, it can be argued that the Statscan data is the most powerful source of those available to help assess regional cross-border short sea shipping opportunities.

The data spans the years 2016 to 2020 inclusive. The data set does not show individual shipments or trips and the maximum level of geographic detail (in terms of cargo origins and destinations) is by provinces in Canada and states in the United States. However, the specific ports of entry/exit are captured in detail. The data are also very detailed in terms of commodity codes down to the level of eight-digit HS[3] codes for exports from Canada and ten-digit HS codes for imports into Canada. The database shows the mode used for clearing the border but there is no certain way to assess whether that mode is used for the whole trip between origin and destination. In all probability, the mode employed at crossing is a very good indicator for the overall trip but ultimately, there is no way to account for multi-modal movements through this data source.

Table 2-1: Statscan Canada-US Trade Database: Pros and Cons

PROS	CONS
• Excellent ongoing visibility into detailed commodities that are being traded: by value and quantity and by travel mode of border crossing (not a sample) • Potential to deal with cargoes in an aggregated or disaggregated manner by HS codes • Ability to filter based on specific ports of entry/exit • Very detailed in terms of the value of goods traded • Good temporal characteristics (i.e., monthly empirical variations in trade flows can be evaluated) • Possible to query all available dimensions at once (better than BTS in this regard)	• The data are not geographically detailed (it is at the level of flows between provinces and states) • Different commodities have different units of measure (making general quantity summaries difficult) • Some of the data is missing any information on the quantity of goods traded • No visibility into individual shipments, truck trips or the like • Imports into Canada not geographically tracked to the province of destination (i.e., not beyond port of entry) • Captures the mode of crossing/clearance but nothing more in a modal sense

Table 2-1 offers a review of the pros and cons of the Statscan data source. One aspect to highlight is that the import data into Canada is less geographically precise than the export data. On the export side, the state of destination is known as well as the port of clearance to get there. For imports, the port of entry is known, and this is recorded as the province of entry as well but there is no coverage of the destination province per se or whether it differs from the province of

[3] HS is the acronym for the Harmonized System. This is a classification system for goods used by customs authorities around the world.

clearance. As an example, flows from the Midwest might clear in Windsor, and are destined for Quebec, but the data will not reflect any connection to Quebec.

2.1.2 Gaps in Quantification of Cargoes

Statscan trade data are complete in terms of capturing the value of goods and but uneven in capturing the actual traded quantities of goods. In fact, a good share of the trade is not quantified at all in terms of the amount moved. There are other cases where the goods are entirely quantified but the unit of measure used is problematic for analysis. For example, motorized vehicles are measured in terms of their number as opposed to weight. While it is clearly possible to approximate how some number of motor vehicles translates into tonnes, this becomes a far more taxing exercise for numerous highly specific cargoes such as classes of auto parts, reported in units rather than weight, that make up a vehicle. There are many other examples.

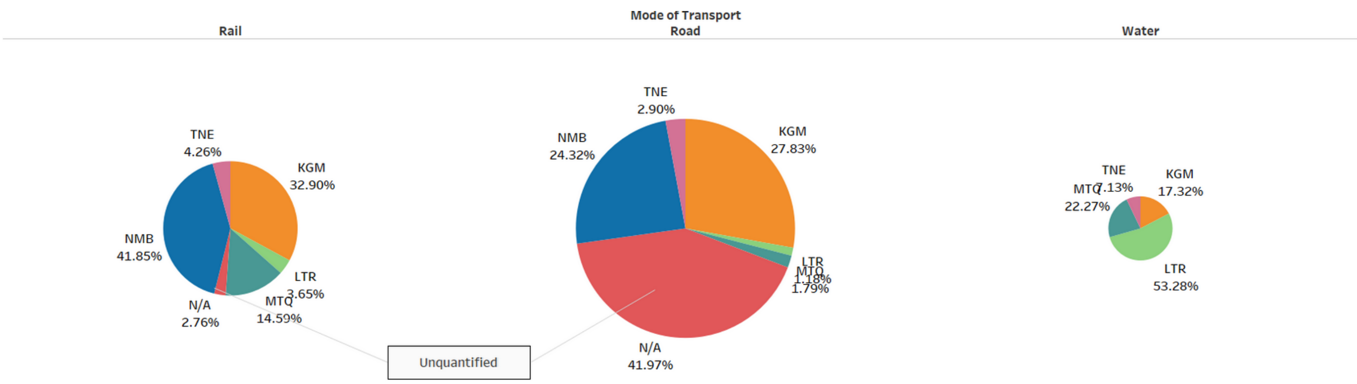

Figure 2-2: Ontario exports to US by mode: How value of goods is allocated by Unit of Measure

Figure 2-2 provides an overview of quantification of goods for exports from Ontario to the US based on Statscan data. Bigger pies indicate larger value and Road is largest in that regard. What stands out above all else is that 42% of the value of Ontario exports that move by truck to the US are classified as “N/A” meaning that there is no quantity, such as weight, associated with them (i.e., there are no units of measure offered – UOM). For rail, the problem appears minor and for marine there appears to be no problem.

Figure 2-3, which covers the period 2016 to 2020, enables a deeper dive into the quantification issue for trucking to better understand the unquantified 42%. HS codes at the 2-digit level are sorted by the value of the goods associated with the given 2-digit category. The value of goods that are not quantified with UOM are shown in red while quantified goods are allocated by the applicable units of measure. Only units of measure that are prominent in terms of value are shown in Figure 2-3.

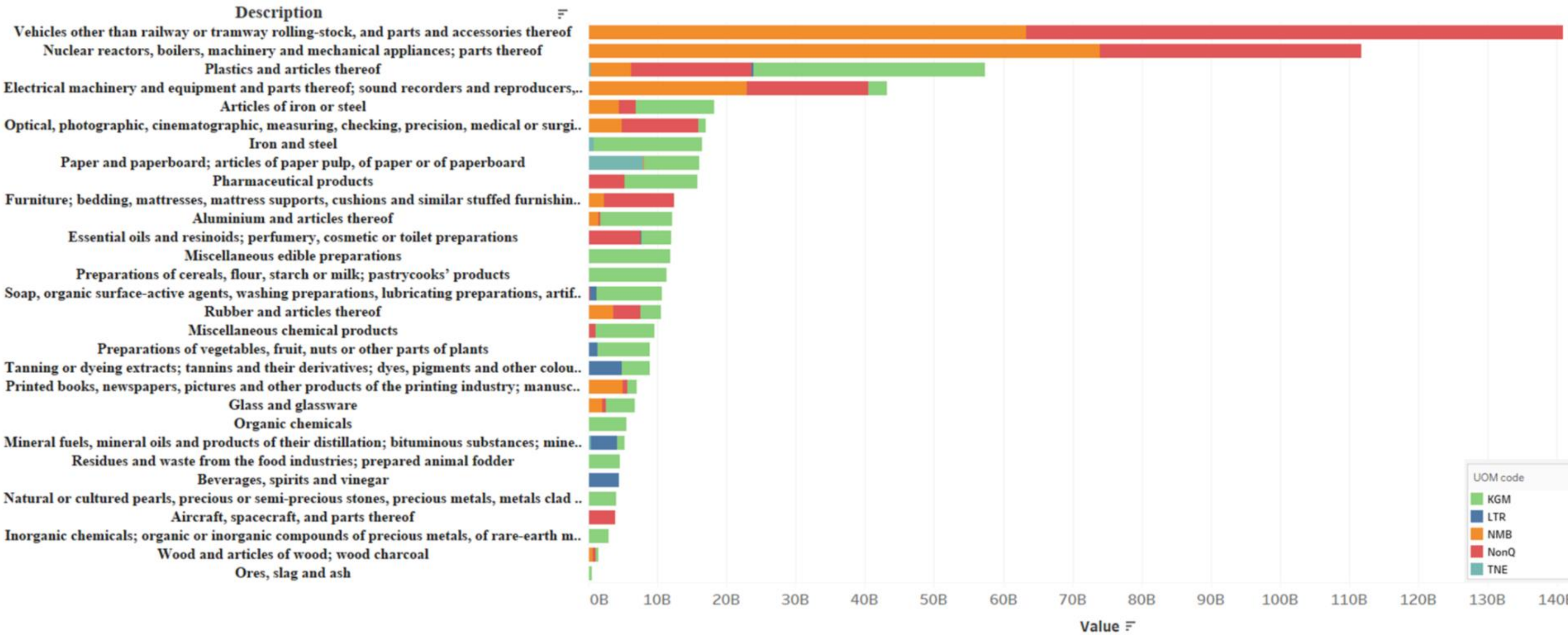

Figure 2-3: Trucking Exports from Ontario – Allocation of Value by Units of Measure and Commodity Classes (2016-2020)

The interested reader can work their way through the table to see the quantification situation per HS code. As examples:

- Code 87 associated with vehicles of all different types and a diversity of automotive parts (first item in 2-3) is a large export category in terms of truck movements from Ontario at $140 billion for the period 2016-2020. It is more unquantified than not with any quantification being in terms of number of vehicles or units of applicable parts. Many of the parts categories (not directly shown) are unquantified.

- Code 48, relating to paper and paperboard (eighth item in 2-3) is quite well quantified and almost all in kilograms and tonnes.

- Code 76 associated with aluminum-related products (11^{th} item in 2-3) is also well-quantified though some sub-categories are in number of units.

- Code 94 related to furniture and associated product-types (10^{th} item in 2-3) is largely unquantified in the database, though other sources (BTS,CVS) offer some assistance in this regard.

By and large, it appears that assessment of quantities moved by truck is most problematic for several types of manufactured end-products. Food products is a very well quantified cargo type and is an exception in this regard. Raw materials and a variety of industrial inputs appear well-quantified also.

2.2 Ontario Ministry of Transportation Commercial Vehicle Survey

The commercial vehicle survey (CVS) is a large-scale truck intercept survey conducted mostly at selected highway locations, and other strategic locations, across the province of Ontario. We see this as arguably the second most important database although its role in this study is rather indispensable. Table 2-2 offers a review of some of the pros and cons of the data.

In providing 3^{rd} parties with access to CVS data, the Ontario Ministry of Transportation (MTO) tailors their deliverable according to the needs of the project. MTO agreed to share micro-level data, providing most fields contained in the database, but precise locations associated with origins and destinations of truck trips were not provided. Instead, origins and destinations were associated with zones rather than points. The association was with census sub-divisions in Canada and counties in the United States. While not capturing point locations, this compromise nevertheless provided good spatial resolution on where trips originate and terminate. While the CVS offers trip origins at the census sub-division level, results in this report are typically presented at the higher census division level to help combat problems with relatively small sample sizes. The 2012 version of the data was shared early in 2022 and the recently finalized 2019 version of the data was shared with the research team in early June of 2022. The current report has essentially used the more recent 2019 version.

The second significant difference relative to providing the whole database is that records were filtered based on trip length. In particular, MTO agreed to provide all truck trips in the data of length greater than 100km. The reasoning was that lengthier truck trips would offer the most potential insight for potential marine opportunities. In addition, MTO prefers to restrict its sharing of data in support of a project to the data that is absolutely necessary. For the current study, implications of the 100km+ minimum is that cross-border truck movements from Niagara to Western New York or Windsor to Detroit (as examples) are not covered. Any insights that might be gleaned from shorter distance connections between trucking and other modes cannot be assessed.

Based on the 2012 version of the CVS received, 30,251 records were shared which, in weighted terms, is associated with an estimated 361,986 weekly truck trips of 100km or more. Of this total, 91,601 (44,415 for exports to the US and 47,186 for imports into Canada) of the estimated weekly trips are cross-border in nature and are thus most aligned with the focus of this study. The CVS estimates that 100+ km trips for exports into the US generate 39.6 million km of truck travel in aggregate per week, including empty trucks.

Some of these cross-border trips are trucks moving containers – but not a large share. The data suggests that 1221 of the weekly export trips (2.75%) and 1292 of the weekly import trips (also 2.75%) involve the movement of containers. Simply put, the vast majority of goods that move by truck over longer distances in the region are not containerized. This seems to suggest a natural, built-in obstacle to a marine container service intended to deal with cross-border trade.

One caveat with the CVS data is that the 100km+ trip endpoints (zones) captured by a truck trip in the data may not represent the true origin or destination of the cargo being carried. In some cases, the true origin/destination may be tied to a shorter feeder trip or some separate trip that is also 100km+. Almost always, any given CVS record indicates that the trip origin or destination is at the same location as the commodity origin/destination. Perhaps that information needs to be taken with a "grain of salt" as it could depend on the knowledge of the truck driver for example. Some analysis of connecting trips would be merited except that such connections are not captured to the best of our knowledge.

Table 2-2: Ontario Commercial Vehicle Survey: Pros and Cons

PROS	CONS
• Survey efforts located in the heart of the Great Lakes Region with trip visibility deep into the US • Good visibility into what is carried by trucks (quantities, commodity types) and the nature of the vehicle • Good geographical visibility into where truck trips originate and terminate and where they cross the border • Ability to leverage actual individual collected and detailed records from the survey	• The data collection is labour intensive • Data refreshed only every 6-7 years • Due to pandemic implications, the 2019 data contains some 2012 records • The version of CVS data used for this project contains no truck trips shorter than 100km (by agreement with MTO) • There is no time dimension in the data other than comparing results across the different CVS surveys every 6-7 years • Only the trucking mode is covered • Inherent limitations of a sample (e.g., being representative, weighting factors)
Other Considerations	• Have to be careful about trying to draw detailed insights/conclusion beyond what the sample data can realistically support. • For a given sampled truck trip, is the true origin of the cargo the same location as the origin of the truck trip?

2.3 United States Bureau of Transportation Statistics

The US Bureau of Transportation Statistics (BTS) summarizes trade data that is made available by other agencies within the federal government. See Table 2-3 for a summary of the pros and cons of the data. The summaries are quite detailed and are done in a manner that is useful for transportation researchers. The summaries do not allow the exploration of all dimensions of the data at once. For example, there is one summary that covers province-state flows very well but it does not permit a simultaneous investigation of the flows at specific crossing points. Conversely, a summary that shows details on crossing points does not offer detail on origins and destination at the province-state level. With Statscan data made available, it is possible to query these dimensions at the same time.

Table 2-3: BTS Transborder Data: Pros and Cons

PROS	CONS
• Readily available and updated monthly • Excellent quantification of exports from Canada in standardized mass units (e.g., tonnes or as desired) • Good geographical visibility for movements between states and provinces • Coverage of all modes • A good historical database	• Commodity detail only to 2-digit HS codes • Imports into Canada are not captured in quantity terms for trucking or rail • Not possible to comprehensively query all data dimensions at once • No information on individual trips or shipments

2.4 United States Commodity Flow Survey

The US Commodity flow survey (Table 2-4) represents a major undertaking that is carried out once every several years. The survey is unique in that it extensively samples **individual shipments** that originate in the US and this is done by gathering data from shippers who are in the best position to know how the shipments travel. Compare this approach with that of the CVS where trucks are intercepted in the midst of their trips. While the means of data collection are different, both surveys are intensive efforts that can be completed only every several years.

Most shipments captured are internal to the United States (since the focus of the effort is on the United States) but there is generally good representation for exports clearing into Ontario. Marine appears to be an exception in this regard. There are empirically many fewer marine movements into Ontario than trucking movements and these few movements do not seem to be getting sampled at the appropriate rate.

Table 2-4: US Commodity Flow Survey: Pros and Cons

PROS	CONS
• Individual records available at the level of single shipments • Enables a direct estimate of import tonnage into Ontario • Good geographical visibility for origin state of cross-border shipment • Coverage of all modes • Possible to analyze shipment size relationships (e.g., across commodities) • Multi-modal shipments are captured	• Commodity detail only to 2-digit SCTG codes • Updated only every several years (2017 version released in 2020) • No coverage of exports from Canada into US • Subject to the limitations of sampling and associated weighting processes. • Appears not to sample Great Lakes marine adequately

2.5 Canadian Freight Analysis Framework

The Canadian Freight Analysis Framework (CFAF) database provides detail on road, rail and air movements of cargo and offers some sub-provincial spatial detail for origins and destinations within Canada and also estimates of cross-border flows.

The source provides more information on origin-destination patterns associated with rail movements than any other data source that we have available to us at this point. A comparison of nationally oriented origin-destination matrices for trucking and rail derived from the CFAF shows a very different visual pattern between the two. The trucking matrix shows concentration of activity near the diagonal of the matrix, indicating more in the way of localized, shorter distance movements. The rail matrix emphasizes more of a “corridor effect” with large movements toward the US and to the west coast at Vancouver.

The CFAF is not highly detailed in terms of commodities but does offer about a dozen categories as is shown in Figure 3-5, for example. One significant limitation is that the most recent version is from 2017 and we are not aware of plans for an updated version. The road component in particular relied on inputs from the Federal Trucking Commodity Origin-Destination survey that is not being repeated to the best of our knowledge. Overall, the CFAF has acted as a supporting data source for this project more so than as a primary source.

Table 2-5: Canadian Freight Analysis Framework: Pros and Cons

PROS	CONS
• Offers coverage of how tonnage is related to shipments • Offers sub-provincial detail in Canada linked to census metropolitan areas • Some insights into rail movements by commodity type though only up to 2017 • Estimates of shipment counts are provided along with associated tonnages	• Most recent data are from 2017 and not likely to be updated • Commodity breakdown is limited • No clarity into particular US states of origin or destination • Trucking elements developed based on sample and dependent on weighting scheme • The data are aggregated and not shown at the level of individual shipments

In summary, a review of data sources reveals no single one that can answer all the required needs. If cross-border trade data were released with more geographic detail, then that single data source could answer many of the questions which motivate this report. However, this is not the reality. The diverse units of measure used in Statscan trade data make it more complicated to use for assessing aggregate quantity across diverse cargo types. The fact that the BTS source does not have this problem is an attractive aspect but then the BTS data cannot help with quantity for imports into Canada. The Statscan source is the best combination of commodity detail and temporal information. The BTS source does not offer the same level of commodity detail but is reliably available and accessible over time. The trade data sources use HS codes that underlie international trade whereas the CVS in particular is based on SCTG codes. Conversions are possible though this has not been carried out below.

The CVS data cannot help with temporal detail but offers the best combination of geographic detail and in providing an understanding of the specific commodities that are moving by truck. It is a “sampled understanding” however and relies on expansion factors that can only provide estimates of the true volumes that moved. The version of the CVS data that we received actually had a lot of geographic detail removed, but it remained head and shoulders above other sources in this regard. The fact that trade data captures where goods cross the border is one important favourable geographic element. The US Commodity Flow Survey is a useful source for providing detail on what is flowing into Canada across certain crossings. Tonnage estimates are possible across main commodity classes and actual shipments are the units of sampled observations. Since the CFAF appears unlikely to be updated, it is likely best viewed as a one-time source that was useful to consider for this report.

3.0 ANALYTICAL RESULTS

This chapter seeks to provide an overview of results that have come out of this study in relation to the data sources that have been leveraged. It needs to be stressed that there have been two main thrusts in the analytical work that has been done:

- one is tools and capabilities that have been developed or are in early stages of development and which can be useful in the future
- the second is analytical results that are summarized here and which account for the vast majority of Chapter 3.

In either case, the emphasis is on understanding the movement of goods by road and rail between Canada and the United States through an appropriate utilization of the data sources. The efforts support modal diversification and a potential greater role for multimodal freight transport that includes the marine mode. On the Canadian side, the focus is on Southern Ontario and on the US side, the focus in on the Great Lakes states.

3.1 All Modes

The map in Figure 3-1, which utilizes the BTS source, captures the total tonnage (in metric tonnes) of export flows which originate in Ontario and reach destinations in US states. Tonnage that might, for example, originate in Quebec and pass through Ontario on its way to the US is not included. Tonnage is divided into modes by each destination state. This is an excellent, high-level characterization of 54.5 million tonnes of export trade flows, by all modes, from Ontario. As Table 3-1 shows, 37 million tonnes (or about 68%) of this "all-modes" tonnage was destined for a Great Lakes state in 2021.

Table 3-1: All Modes Export Tonnage from Ontario to Great Lakes States (2021)

Total	Michigan	Ohio	Illinois	New York	Pennsylvania	Indiana	Wisconsin	Minnesota
37.15	12.95	5.72	4.67	4.18	3.20	2.75	2.37	1.33

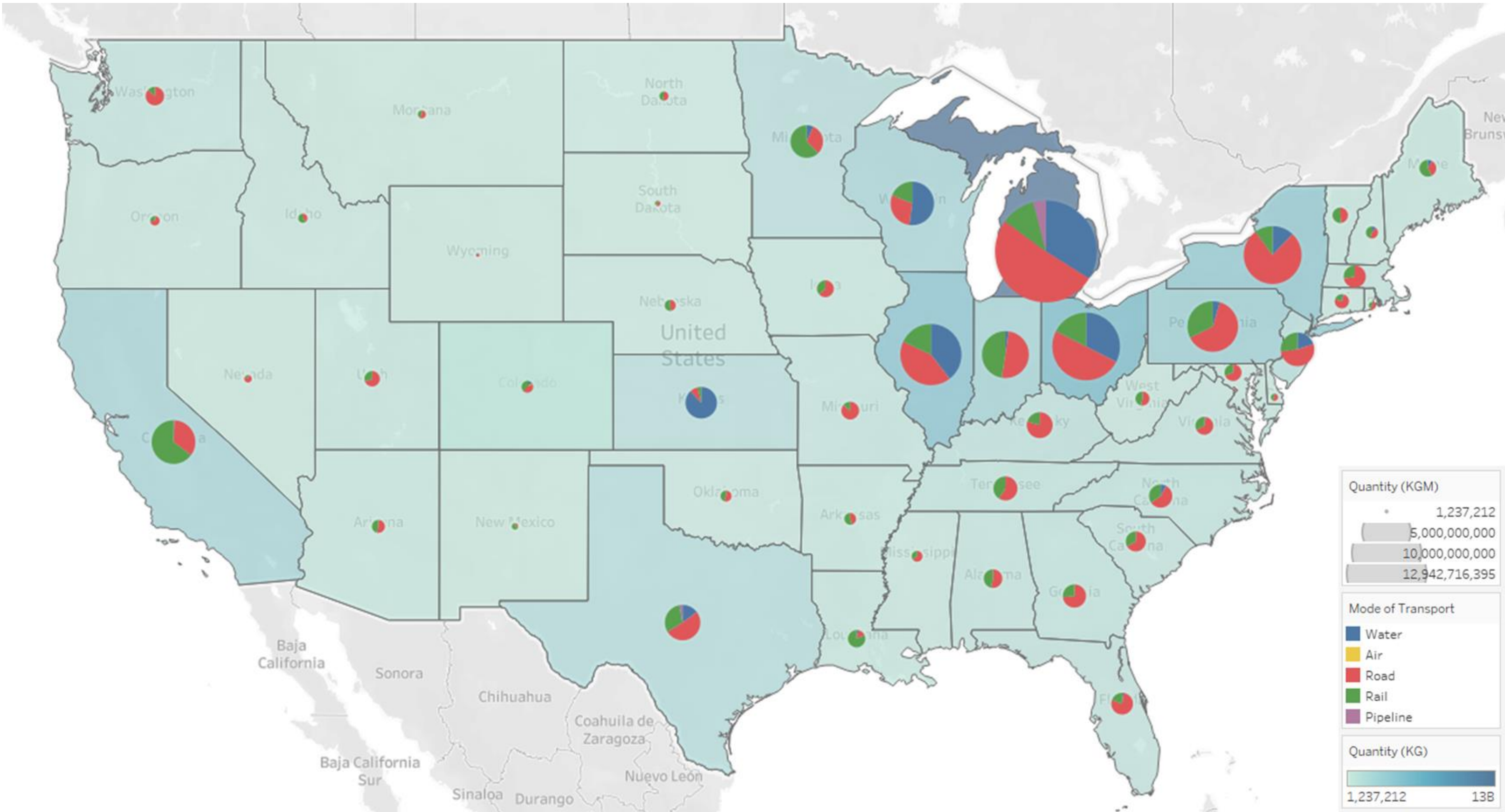

Figure 3-1: Ontario Export Quantities by Mode Flowing to US (2021) – Compiled from BTS

The Michigan pie in Figure 3-1 characterizes the largest Ontario-to-state interaction but each of the other large connections are all with states that share a boundary with the Great Lakes system. The already high-impact of the marine sector in moving cross-border tonnage into the US is readily apparent, though less so for New York state which relies more heavily on trucking. The most heavily populated areas in New York state are fairly remote from the Great Lakes Seaway system, which may help explain the depicted lesser role of marine. Typically, trucking is appearing as the most important mode for moving tonnage from Ontario to the Great Lakes states, though not to the same extent in New York. Trucking, of course, is relatively even much more important if the assessment is made in terms of value.

Figures 3-2 and 3-3 are associated with characterizing import flows into Ontario in a similar manner. But the US BTS does not provide tonnage information to enable an imports counterpart to Figure 3-1. As such, Statscan trade data is a better source for the current need. But as noted in Chapter 2, issues with quantification and varying units of measure make it very difficult to produce a single, accurate tonnage summary map for imports. Also, Figures 3-2 and 3-3 depict cargoes that clear into Ontario. A minority of the tonnages may be destined for other provinces and there may be cargoes that clear in other provinces but are destined for Ontario. Note that the ”Other” category in 3-2 and 3-3 appears to capture goods unclassified by mode.

Bearing these caveats in mind, an absolute lower bound estimate of 49 million tonnes of goods originating from the US cleared into Ontario in 2019 (the last non-pandemic year captured in the Statscan trade data that we possess), with an estimated 30 million tonnes of that originating from Great Lakes States. These are underestimates because, for example, imported cargoes that are quantified with “number of units” are not included in this estimate. That would exclude significant tonnage from the automotive sector. Other units of measure are excluded as well.

In Figure 3-2, for cargoes that are captured in the Statscan data in the KGMs unit of measure (generally less bulk oriented and varied finished goods) it is evident that trucking is generally the dominant mode and especially so when the movements originate in the Great Lakes States. The further off Texas is a notable exception. In Figure 3-3, for cargoes captured in tonnes (TNE unit of measure, mostly bulk goods), it is interesting to note the dominance of marine. The notable strong exception is TNE imports from New York state. From Minnesota, marine dominates. Overall, the two figures for imports are broadly aligned with the prior exports figure: the Great Lakes region serves as a destination or origin for much of the non-marine tonnage that is linked to Ontario and trucking plays the leading role in the associated movements. Consideration of the three figures collectively suggests that the high prominence of trucking (most apparent in Figure 3-2) opens the door for greater modal balance and the potential for marine to do more in the Great Lakes region.

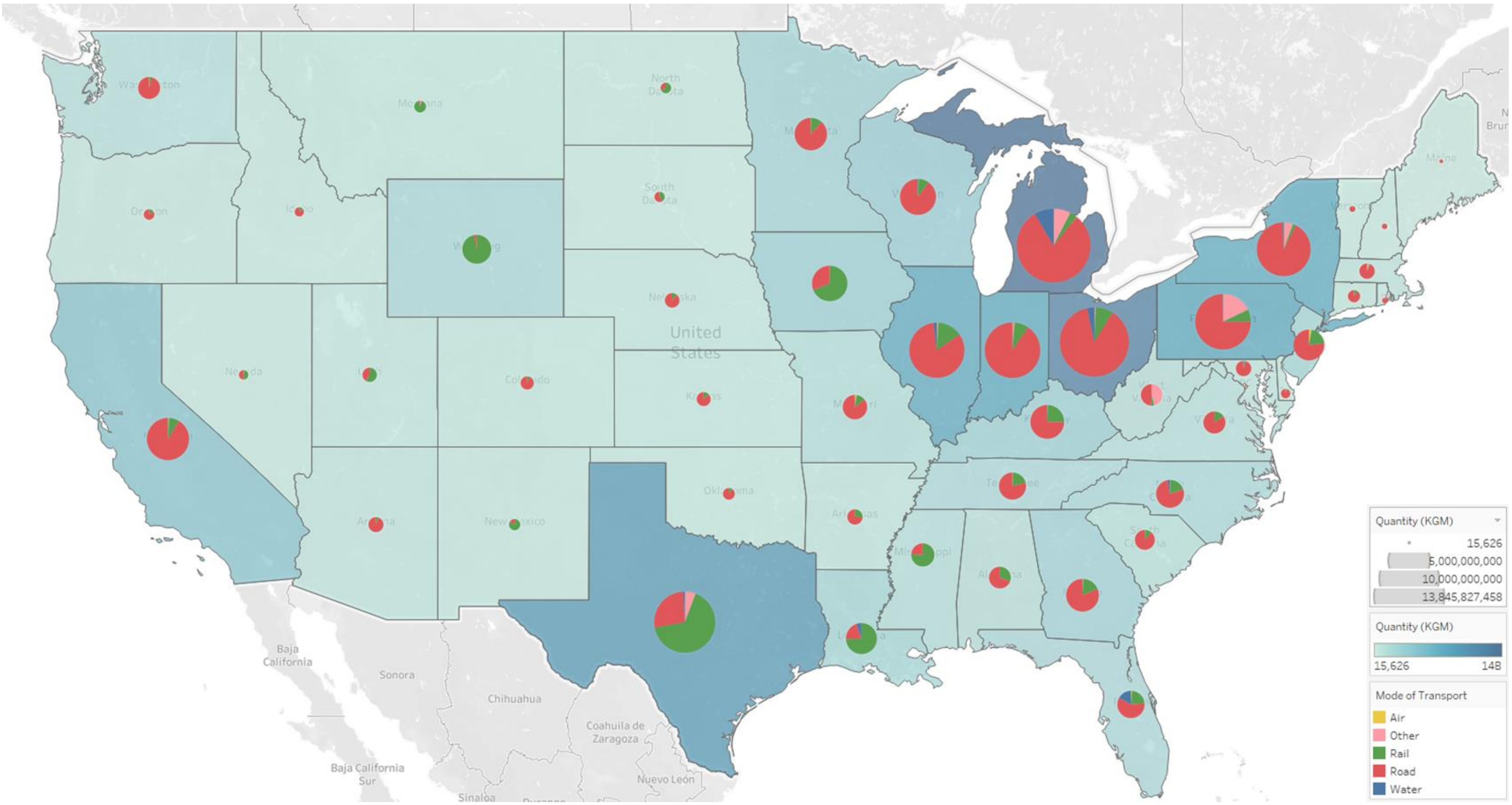

Figure 3-2: Import Quantities (KGM UOM) clearing into Ontario from US States (2016-2020)- Derived from StatsCan Trade Data

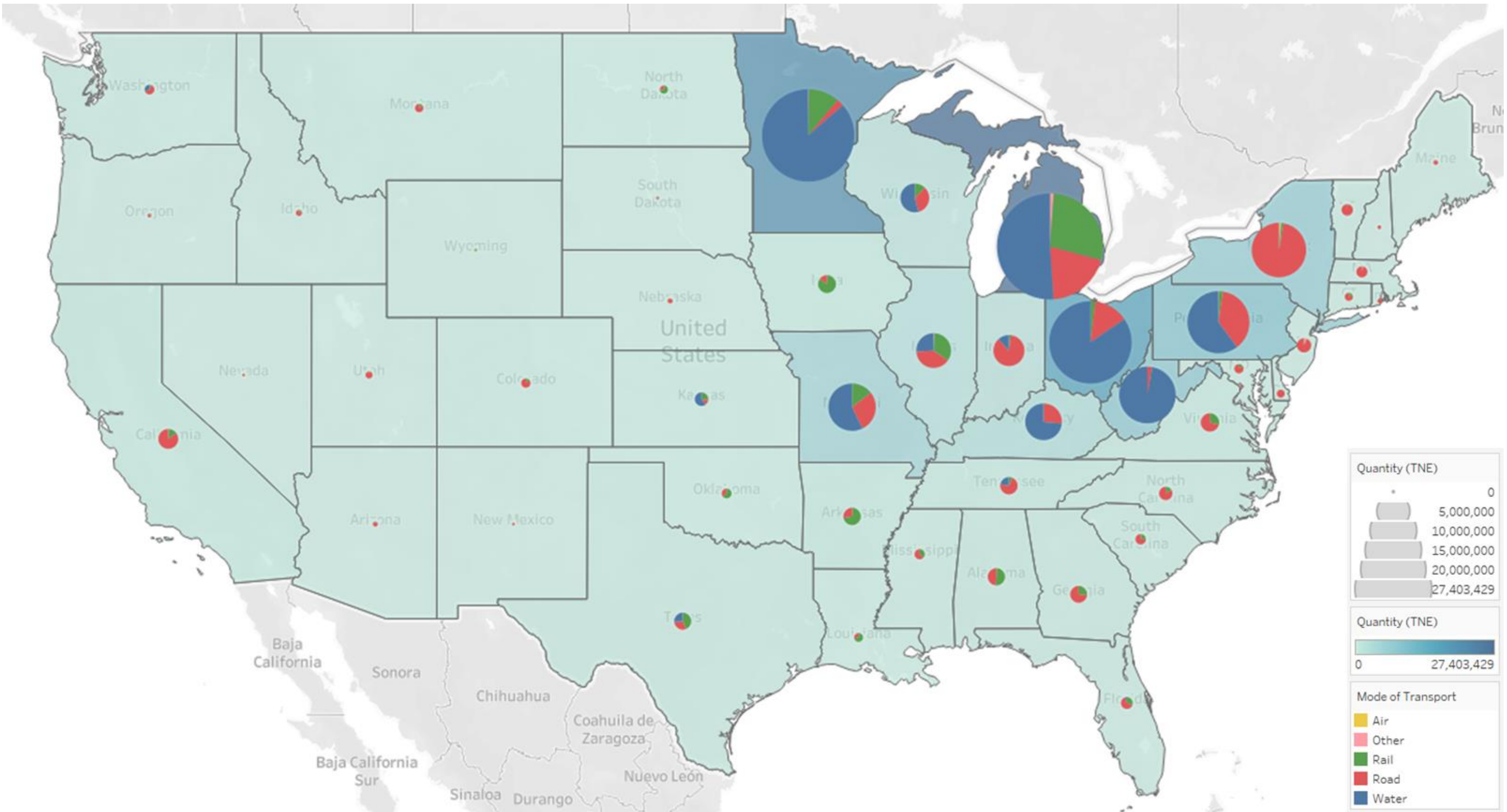

Figure 3-3: Import Quantities (TNE UOM) clearing into Ontario from US States (2016-2020) – Derived from StatsCan Trade Data

3.2 Road

In this important section on truck movements, there is a progression from larger geographies to smaller ones. For the former, the focus is on existing/historical movements between Ontario and US states while paying attention to the respective role of the modes. The discussion progresses towards movements that are examined from a sub-provincial or sub-state perspective. This includes an analysis of catchment areas around specific US Great Lakes ports and how they are connected to Ontario and Quebec by truck movements. Finally, there is examination of high-ranking commodities that may present potential for increased movements by marine. A briefer rail section follows a similar approach.

3.2.1 Province-State Flows

Exports

Figure 3-4, derived from the BTS data, can be seen as a trucking-specific complement to Figure 3-1. The road slices from Figure 3-1 are broken down by major two-digit HS Codes, while emphasizing the geographical allocation to the Great Lakes states. Of the 28.5 million tonnes of cargo that originated in Ontario and crossed into the US by truck in 2021, nearly 92% are captured in Figure 3-4, with the remainder dispersed among less prominent cargoes. Approximately 20 million tonnes was destined for the Great Lakes states and 12.3 million tonnes of this for Michigan in particular[4].

Figure 3-4 clearly illustrates large tonnages of iron and steel (code 72) and vehicles and parts (code 87) flowing into the US from Ontario. There are 8 to 10 different codes that are in the vicinity of 1 million tonnes flowing from Ontario to the US in 2021. And there are several others in the range of 500,000 tonnes per year and 250,000 tonnes per year. The figure merits careful examination by interested parties to see if combinations of commodity and geography are of interest. Also, it can be cross-referenced against the detailed port-specific charts shown in Section 3.2.3 (where commodities are classified a bit differently based on the source data).

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[4] Note that that the BTS data source will include cross-border movements that are less than 100km in length whereas our working CVS data source does not. For the purposes of the current report, this consideration is relevant for states that are very close to Ontario borders (e.g., Michigan) but not so for states that are further way (e.g., Illinois).

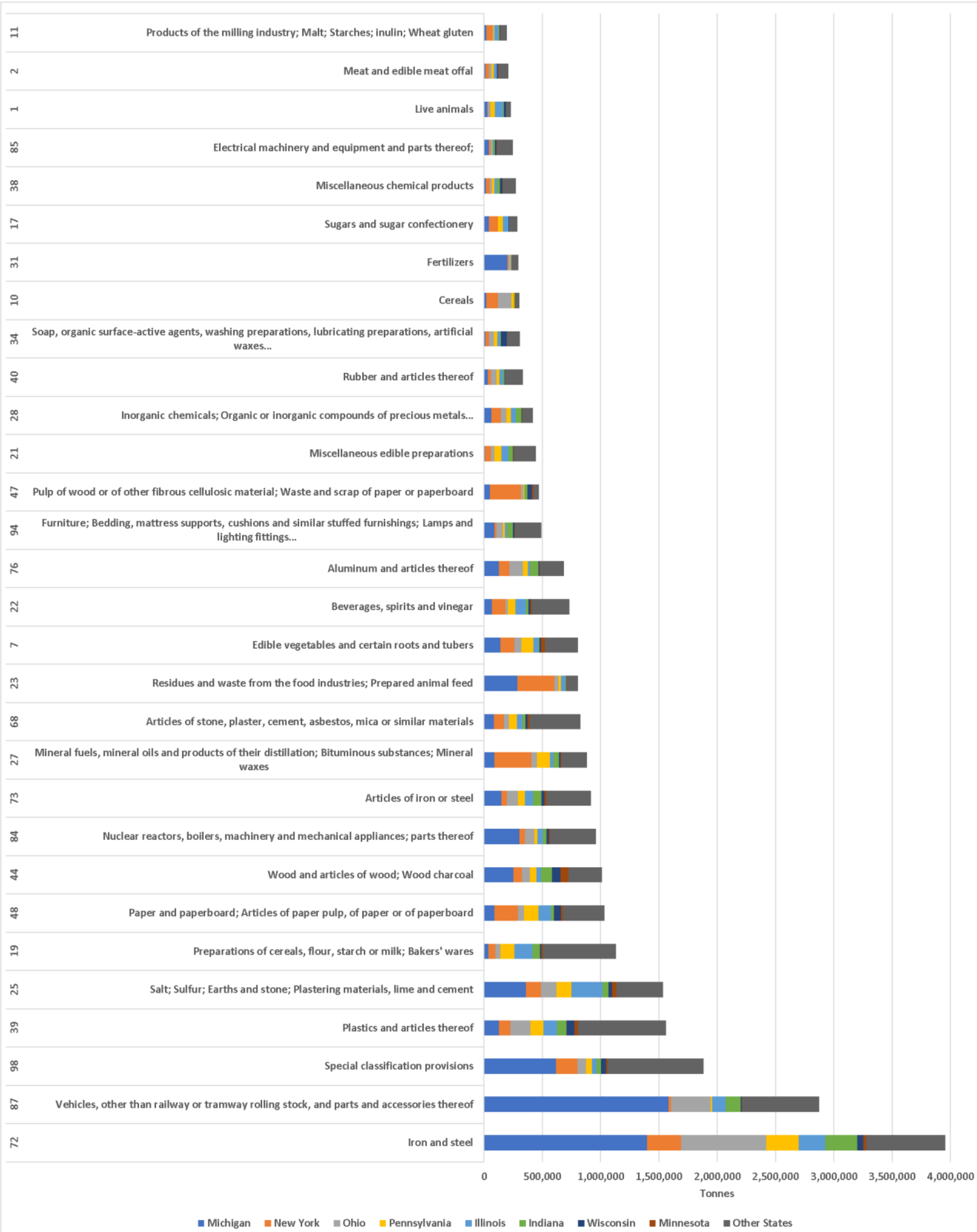
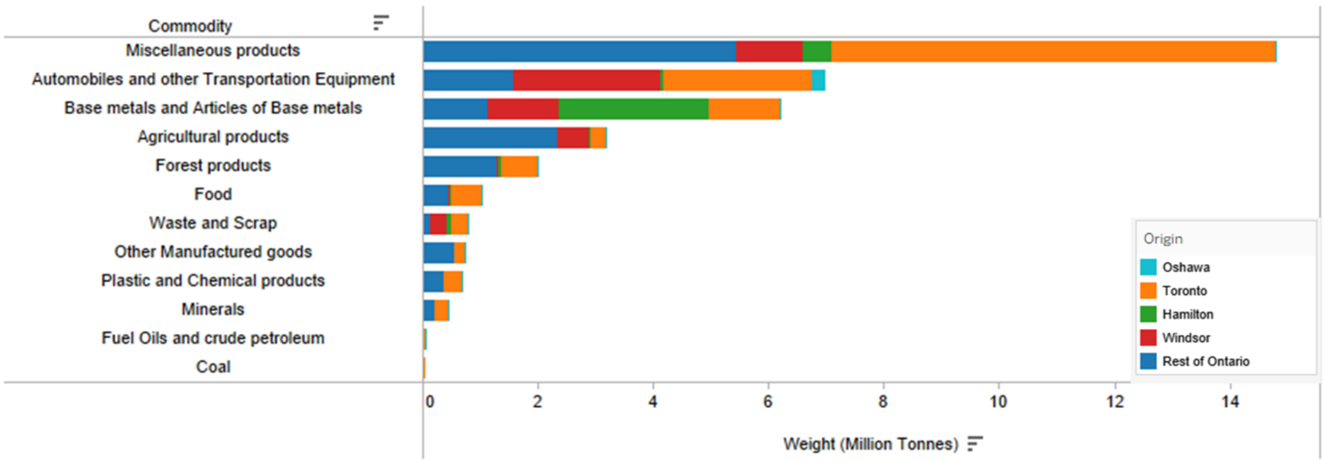


Figure 3-4: Ontario Export Tonnages Crossing by Truck into US States by Two-Digit HS Codes (2021) - Source: BTS

From Ontario to US and Mexico



Into Ontario from US and Mexico

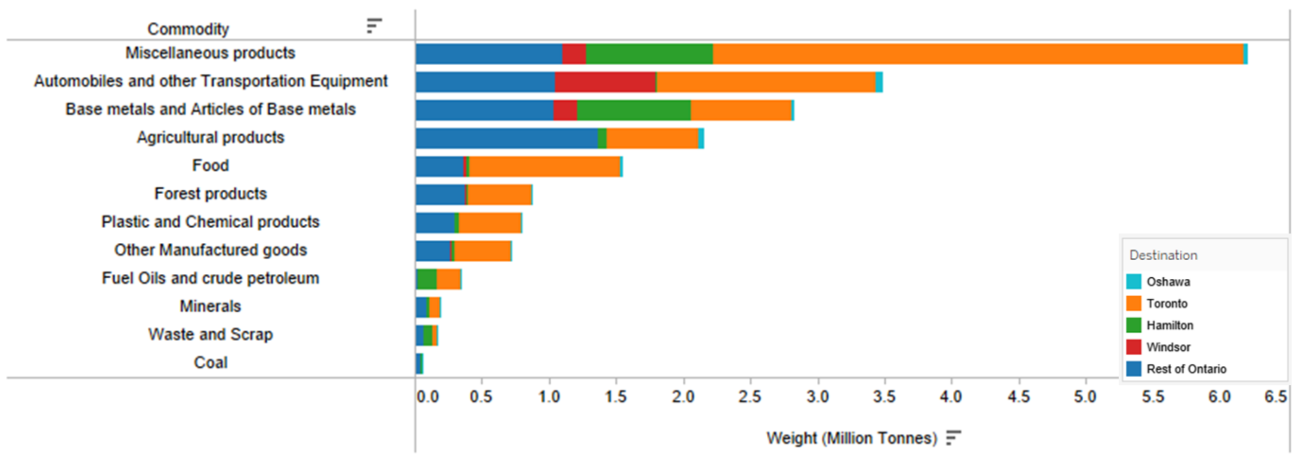


Figure 3-5: Trucking Tonnage Moving Between Ontario and US/Mexico by Ontario Geography and Commodity Class (2017) – Derived from CFAF

Figure 3-4 includes tonnages that move a short distance across the border. Figure 3-5 offers some clarity, for the Michigan crossings at least, on the magnitude of some of these shorter distance flows. The figures show trucking export tonnages from Ontario (an estimated 37 million tonnes) on the top panel and import tonnages on the bottom panel (an estimated 19.4 million tonnes) based on the 2017 data from the Canadian Freight Analysis Framework. The data geographically separates the Windsor Census Metropolitan area from remaining geographies in Ontario and shows shorter distance shipments from Windsor are quite prominent under "Automobiles and other Transportation Equipment" and to a lesser extent, under "Base metals and Articles of Base Metals."

Imports

As has been mentioned, tracking tonnage flows into Ontario in a nicely summarized way has proved more problematic. Figures 3-2 and 3-3 above have relied on Statscan trade data, while this section relies on the 2017 US Commodity Flow Survey, which theoretically gives a direct tonnage estimate of total import flows into Canada. Figures 3-6 and 3-7 show results for tonnage and number of shipments respectively for the primary Michigan crossings into Canada for 2017. The breakdown is done by 2-digit SCTG commodity codes and emphasizes the extent to which Great Lakes states acted as origins for the shipments. The estimated tonnage, by all modes, crossing into Ontario by Michigan that year is 28.9 million tonnes[5]. For trucking alone, the estimate is 16.2 million tonnes which is almost entirely captured in Figure 3-6. The actual final province of destination is not captured in the sample.

Of note for Figure 3-6:

- A code 36 automotive sector connection with Indiana stands out as does a code 23 Chemical products and preparations connection with Illinois.
- Ohio stands out for code 33 Articles of Base metal which reflects more refined products than the related and very significant code 32 class.
- The Great Lakes states tend to dominate the origin of trucking shipments for the largest tonnage classes, but this is much less the case for code 03 agricultural products, code 11 natural sands and code 07 related to foodstuffs, fats and oils among others.

For Figure 3-7, which focuses on the number of shipments that it takes to move the tonnages from Figure 3-6, the leading theme is the dominance of code 36- motorized and other vehicles (including parts) at nearly 3 million shipments crossing into Ontario in 2017. The frequency of shipments is very high, perhaps over relatively short distances back and forth across the border in some cases. The large associated bar is shown as a pie instead to better present visible shipment distributions for the other 2-digit codes. While Code 36 automotive is responsible for the largest movements in terms of tonnage and number of shipments, other 2-digit codes get re-sorted significantly from one context to the other. Code 34 Machinery and Code 35 Electronics oriented cargos are more prominent in shipment terms than tonnage terms. Bulk cargoes tend to ship much less frequently and in larger amounts as the upcoming Figure 3-8 makes clear.

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[5] The importance of the Marine mode for cross-border movements into Canada seems to be significantly underestimated by the 2017 Commodity Flow Survey

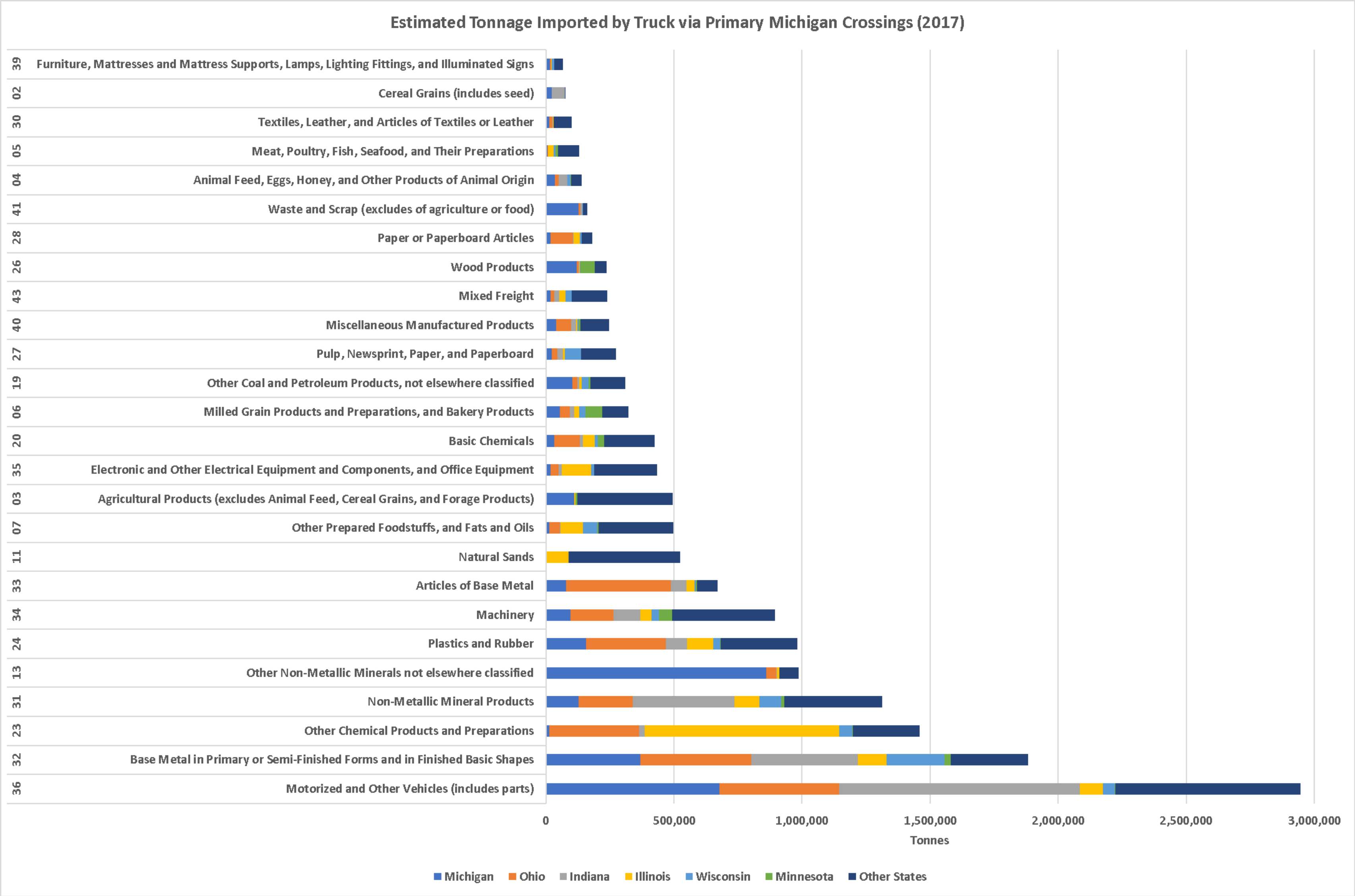

Figure 3-6: Estimated Tonnage by SCTG Commodity Codes Imported by Truck into Canada via Primary Michigan Crossings (2017) – Derived from Commodity Flow Survey

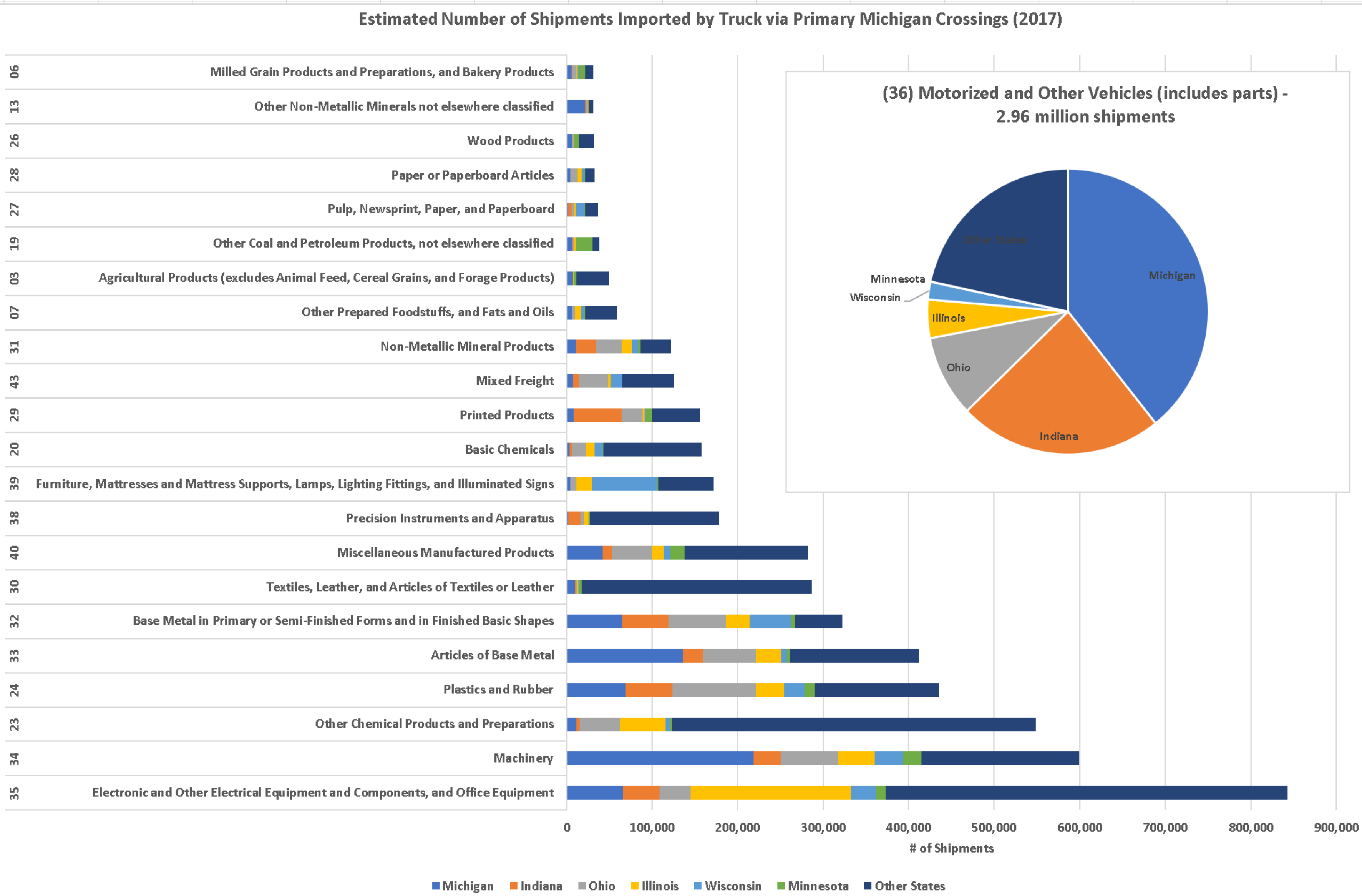

Figure 3-7: Estimated Shipments Imported by Truck into Canada via Primary Michigan Crossings (2017) – Derived from CFS

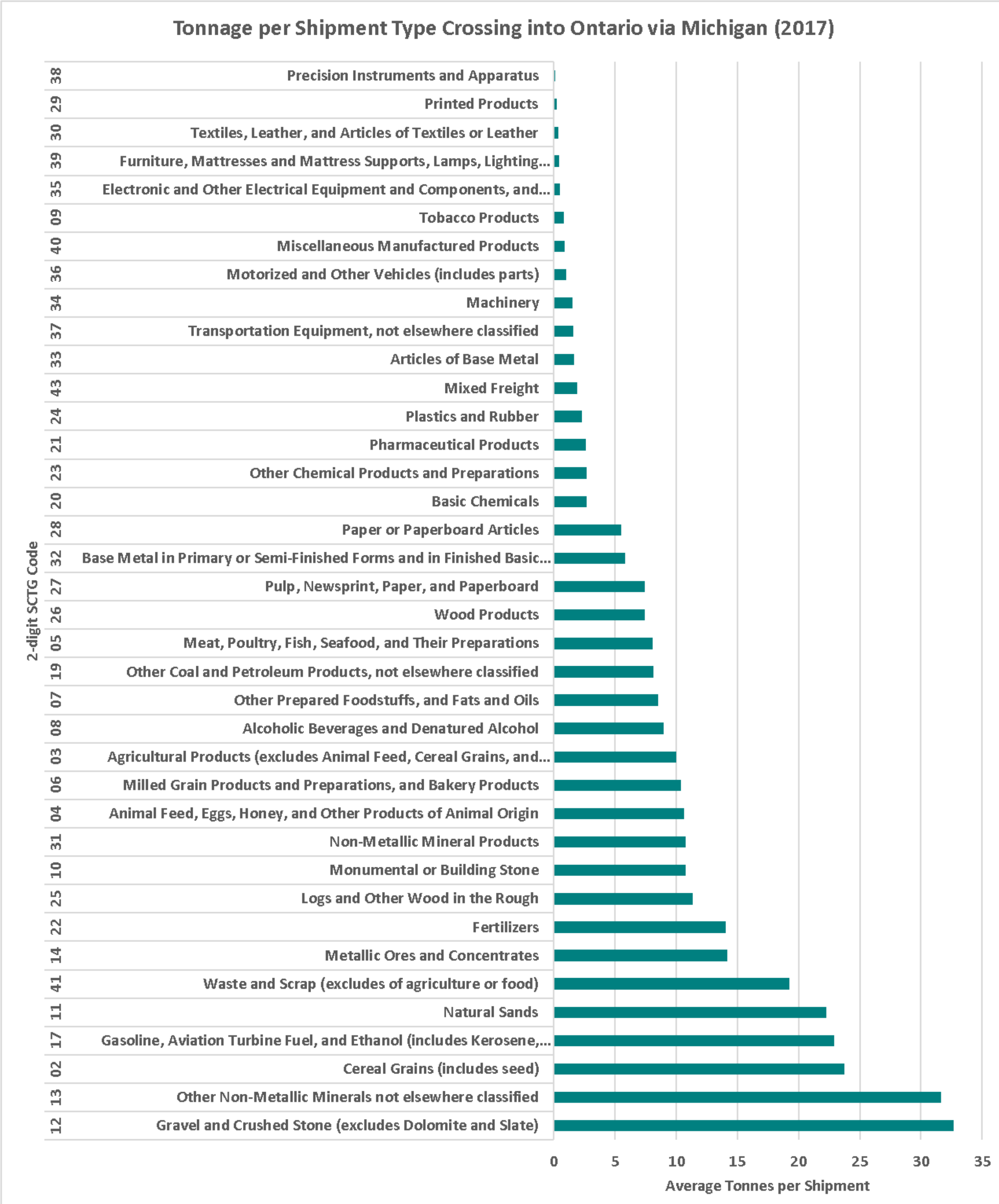

Figure 3-8: Average Tonnage per Shipment Type Crossing by Truck into Ontario via Michigan (2017) – Derived from US Commodity Flow Survey

Figure 3-8 above enables good perspective on how shipments and tonnage are related for the main trucking corridor from Michigan. There is very wide variation in the average tonnage per shipment. Code 36 vehicles and parts works out almost perfectly to 1.0 tonne on average per shipment but shipment size for most product classes is much larger. Some of the bulk categories are 20 tonnes or larger on average. On the other hand, the CVS indicates that 100km+ trips (when not empty) are generally carrying substantial tonnages, indicating the aggregation of shipments.

3.2.2 Sub-Provincial/Sub-State Flows

The following series of figures are illustrative of trucking flows that can be attributed to sub-provincial areas (census divisions in this case) and sub-state areas (US counties in this case). Extra geographic detail is enabled by the 2019 CVS survey.

Figures 3-9 to 3-12 are intended to emphasize the geographical patterns on the Canadian side but provide some idea of the commodity connections as well. The first two figures are focused on trucking flows associated with the critical Windsor/Sarnia connection to the US via Michigan. The first shows export flows to the US and the second shows import flows from the US. The latter two figures do the same for the Niagara crossing that connects to the US via New York state. Note that this series of figures considers trucking flows to and from ALL US states though the majority of movements are linked to Great Lakes States. Figures 3-14 and 3-15 below are counterpart figures, in a sense, that give a good idea of how 100km+ cross-border trucking trips connect down to the level of US states and counties. Too many US counties are involved for those upcoming figures to use the same format as Figures 3-9 to 3-12. All of these figures can be considered as close cousins of the more focused figures in Section 3.2.3 which are port specific.

Approximately 700,000 weekly tonnes are shown for the Michigan crossings (Figures 3-9 and 3-10), fairly evenly balanced between exports and imports whereas about 340,000 tonnes weekly are shown for the Niagara crossing (Figures 3-11 and 3-12) with a bit more associated with exports. The ordering of the items in the legend below each chart shows the prominence of each commodity type in tonnes. Waste and Scrap are most prominent for the two export crossings. Food products are high-ranking at both import crossings.

In terms of themes, all four charts and their associated contexts show that Peel region dominates over all other census divisions in terms of being an origin or destination for longer distance cross-border truck movements. Clearly, these charts enable many other observations with careful study. It is also worth reviewing Appendix C which offers some additional CVS based charts that were developed on the 2012 data. These give a strong sense of specific truck cargoes. Appendix E offers two maps (based on 2019 CVS) that give a good sense of overall flows within the Great Lakes region between Canadian census divisions and US counties.

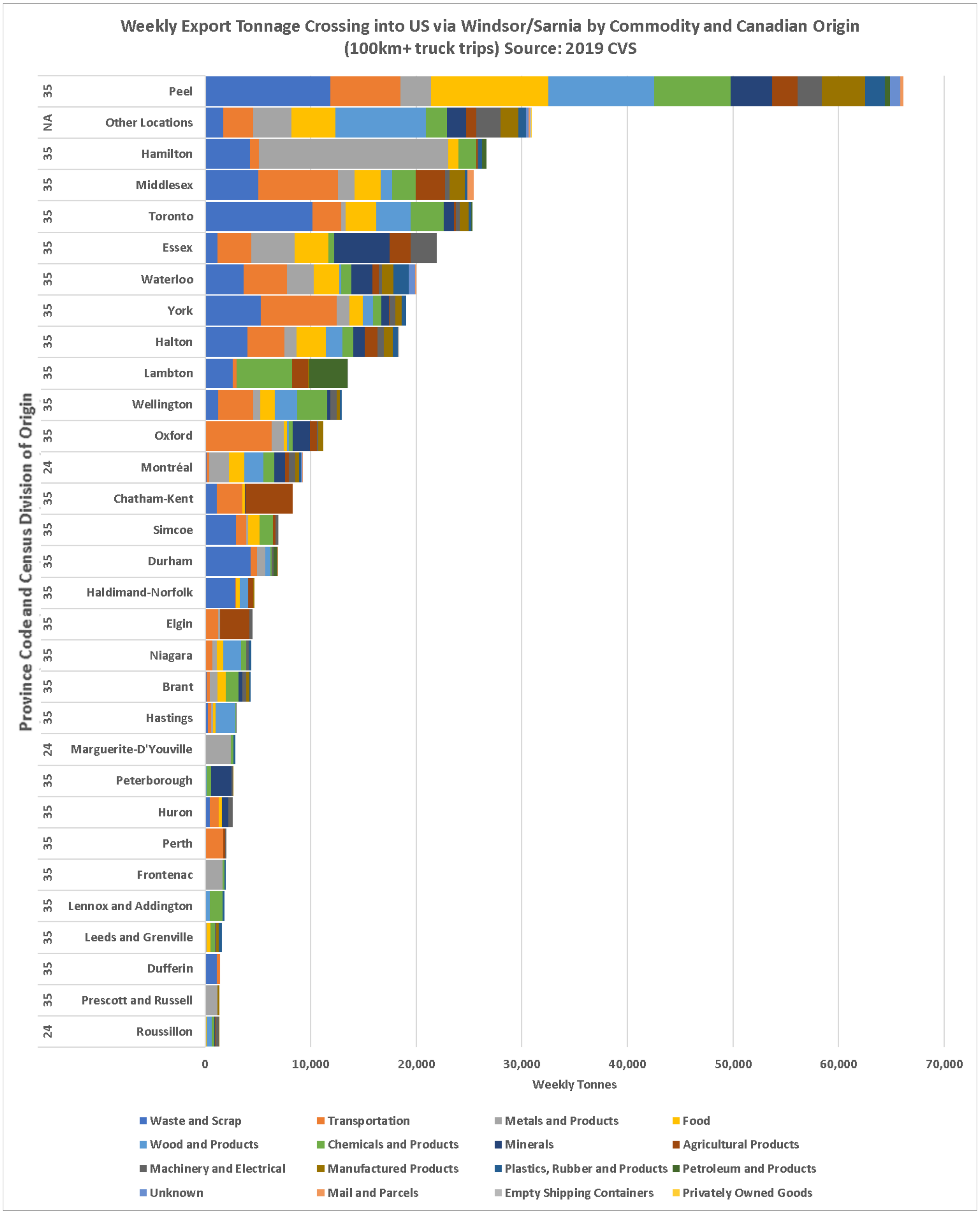

Figure 3-9: Weekly Export Tonnage Crossing into US via Windsor/Sarnia by Commodity and Canadian Origin (100km+ truck trips)

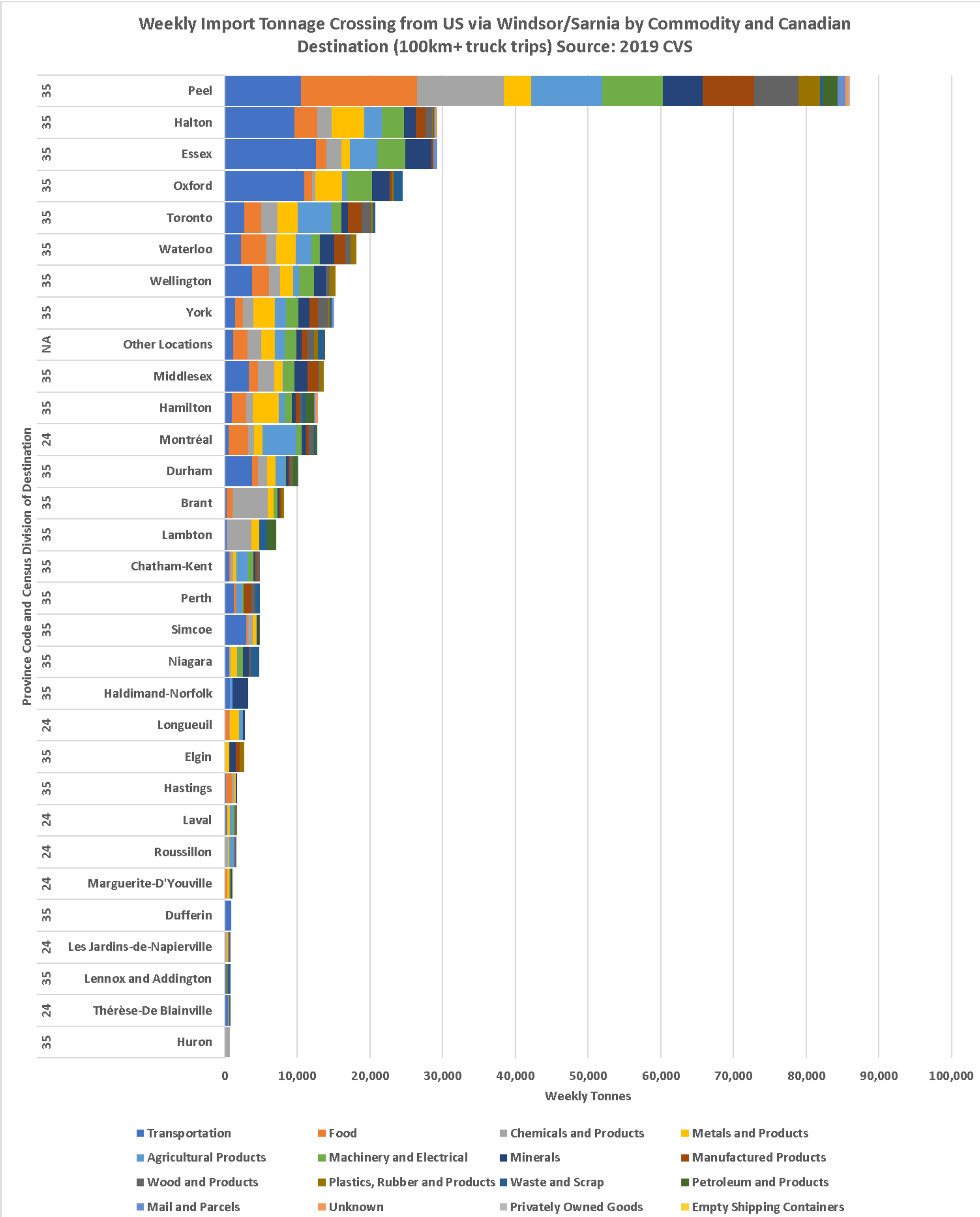

Figure 3-10: Weekly Import Tonnage Crossing from US via Windsor/Sarnia by Commodity and Canadian Destination (100km+ truck trips)

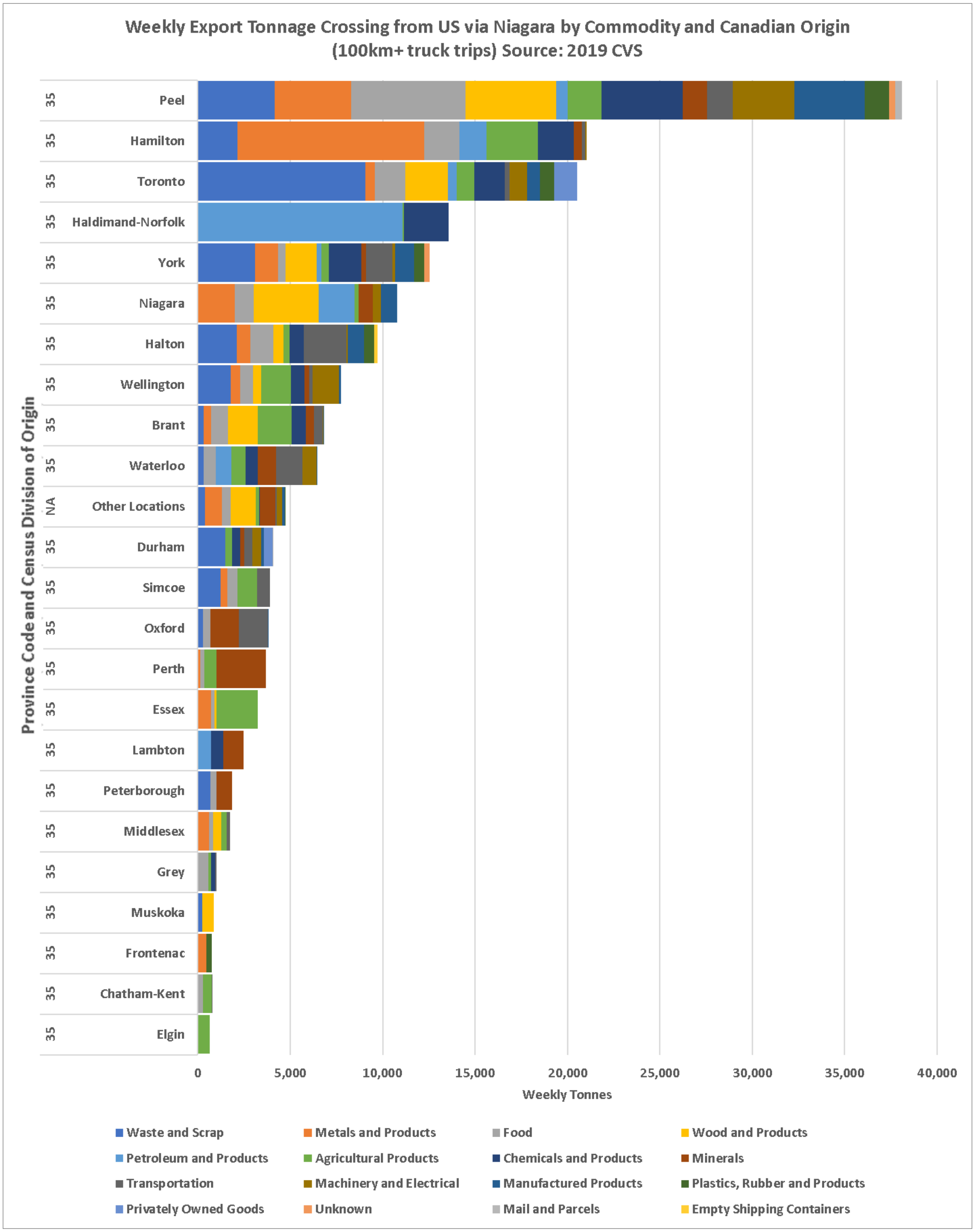

Figure 3-11: Weekly Export Tonnage Crossing into US via Niagara by Commodity and Canadian Origin (100km+ truck trips)

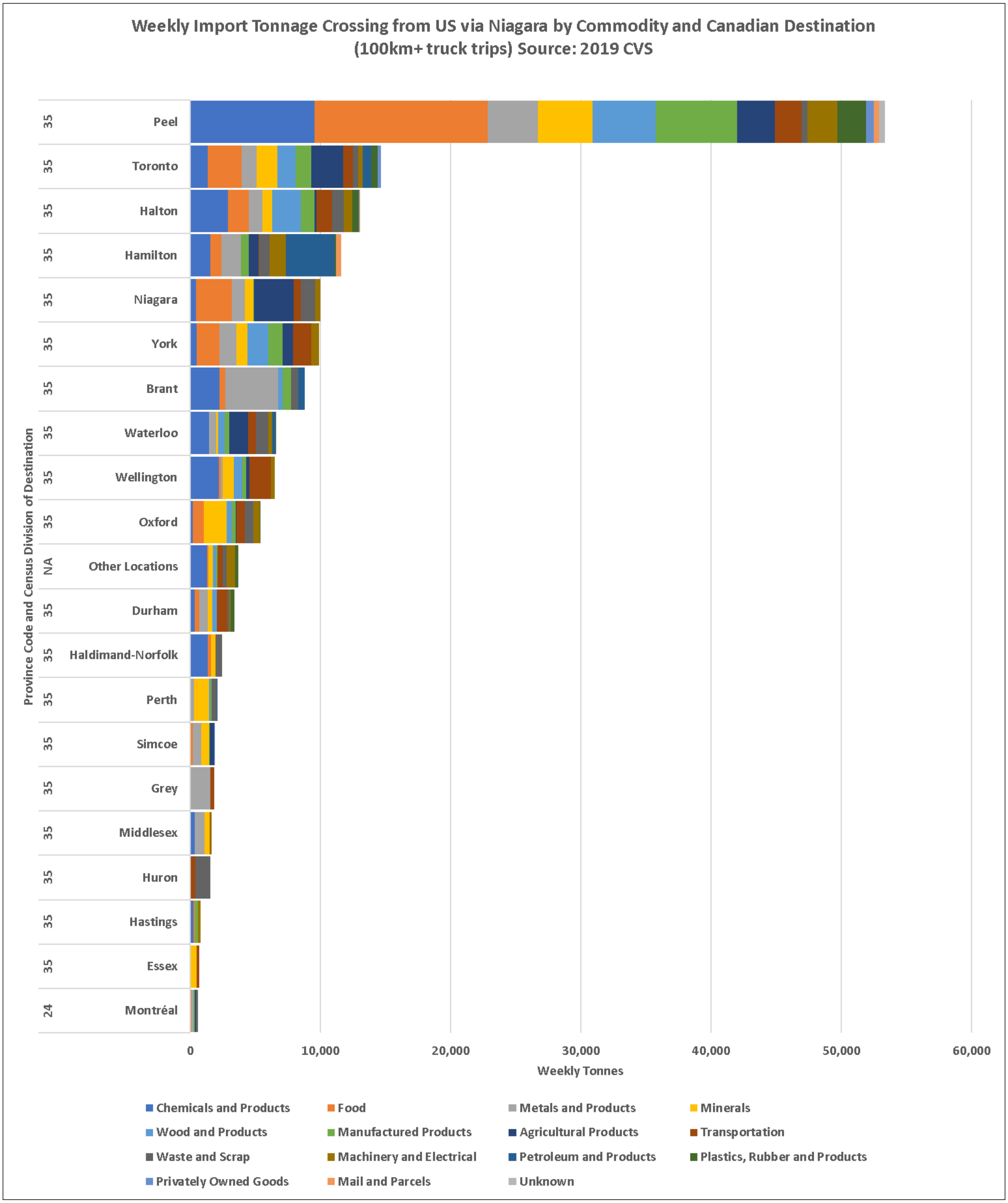

Figure 3-12: Weekly Import Tonnage Crossing from US via Niagara by Commodity and Canadian Destination (100km+ truck trips)

Mapping, which is not used extensively in the current report, offers another way to characterize spatial relationships. The map in Figure 3-13 shows detail on tonnages associated with 100km+ truck trip originations. This figure has some overlap with Figures 3-9 and 3-11 above which are focused on exports. However, the quantities in Figure 3-13 include domestic as well as cross-border movements. SCTG category 32 overlaps with the Metal and Products category from 3-9 and 3-11. SCTG category 32300, more precisely, is described as “Bars, rods, angles, shapes, sections and wire, of iron or steel”.

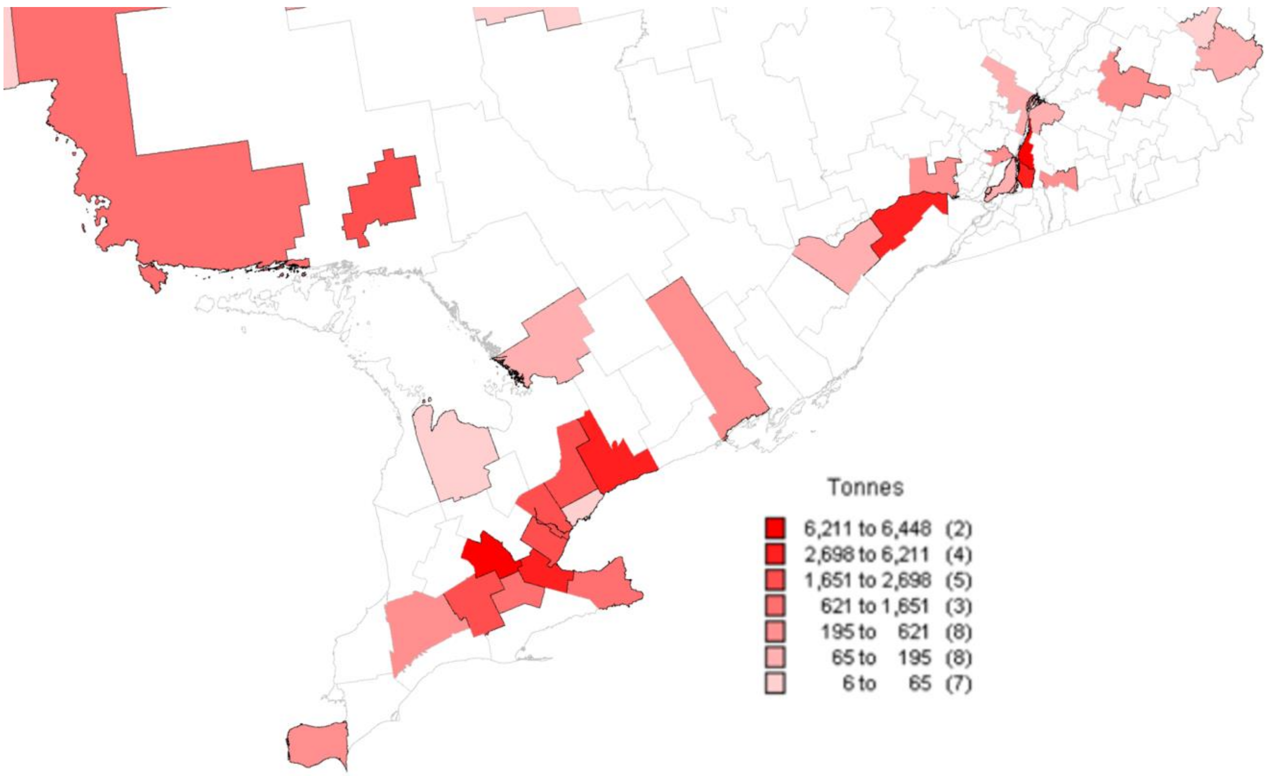

Figure 3-13: Weekly Outflows by Census Division – Bars, rods, angles, shapes, sections and wire, of iron and steel (SCTG – 32300)

The approach here, which includes longer distance domestic trips, assists with sample size and in giving a sense of industrial concentration. Many census divisions do not show any weekly outflows at all for this category, which offers some insight in itself. Areas of the Greater Golden Horseshoe Region, especially Hamilton and Regions of Waterloo and Durham are leading origins. There is a lesser concentration in the vicinity of Montreal. Maps like these offer worthwhile detail and can be used as a tool for inferring more about opportunities. Maps such as these can assist with Statscan Trade data, for example, that lack the same level of geographic specificity.

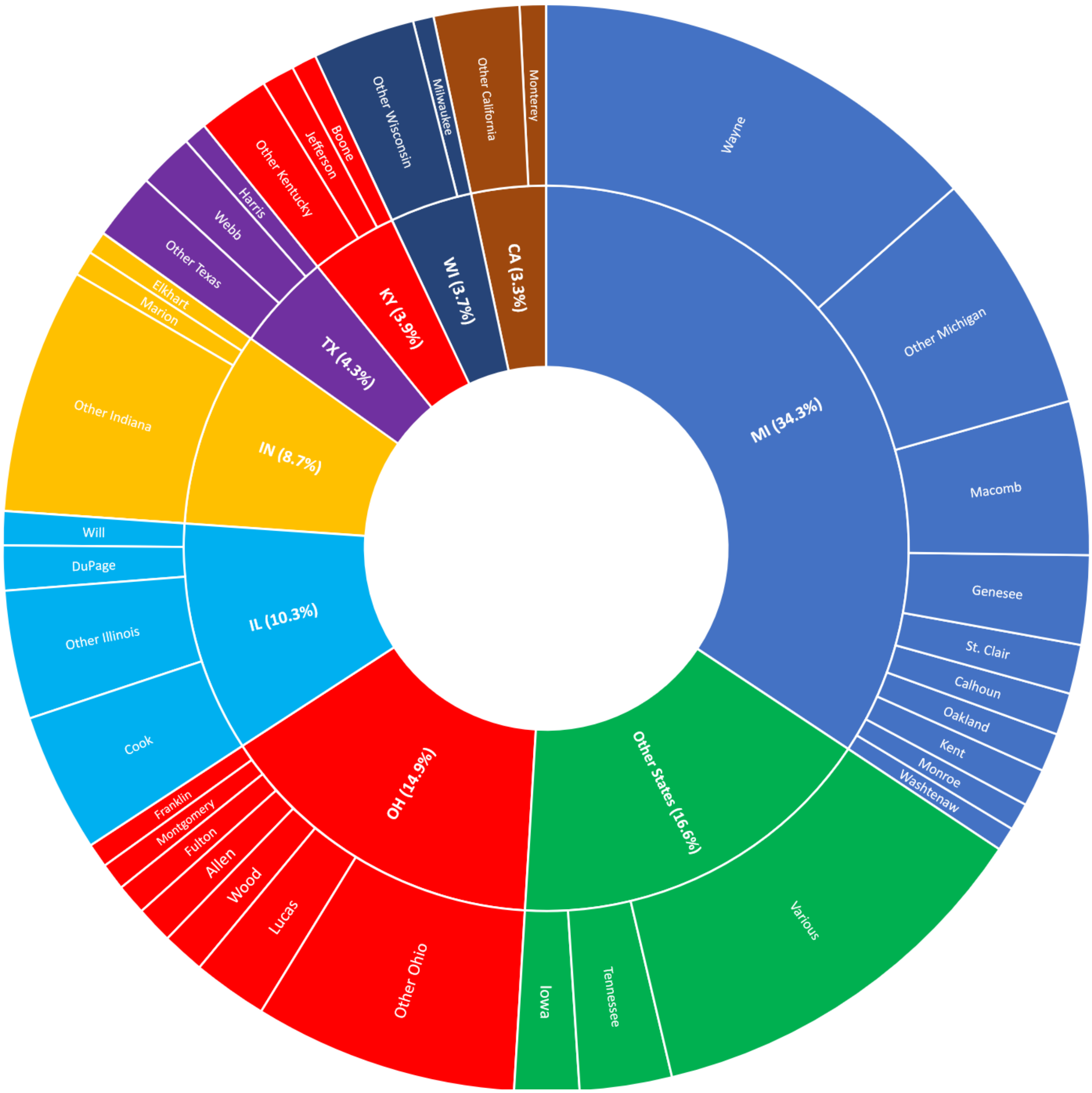

Figure 3-14: State/County Allocation of Import Trips Crossing into Canada Via Michigan

Figures 3-9 to 3-12 do a good job of summarizing trucking flows to and from the US with detailed reference to Ontario and Quebec geographies. Conversely, Figures 3-13 and 3-14 summarize corresponding connections to US geographies. Because many states are significantly involved, a hierarchical approach is used which identifies the state and the leading counties within[6]. Simple pie charts of trips to relevant US counties could have been executed, but the patterns are clearer

[6] Considering Figure 3-14 for the Michigan crossing, note that the Port of Toledo is located in Lucas County, Ohio; Port of Chicago is located in Cook County, Illinois; Port of Cleveland is located in Cuyahoga County, Ohio.

when the identity of the state is displayed as well. As it turns out, the patterns are fairly dispersed with many US geographies involved. The pies are based on truck trips rather than tonnage. Among other things, they give a good sense of the relative importance of Great Lakes States for longer distance truck movements relative to other important states outside the region.

Figure 3-14 above shows 100km+ import trips crossing via the primary Michigan crossings into Ontario (some destined for beyond Ontario). In total, there are an estimated 34,521 such trips each week, with 27,543 carrying at least some cargo. A bit more than a third of the total trips originate in Michigan. Of the 83 counties in Michigan, 9 of them show up as prominent origins for Canada-bound, longer truck trips. A significant share of Michigan trips is spread among the large number of remaining counties. Most of the specifically identified counties in the pie are quite close to the Canadian border either as part of the Detroit metropolitan area or closer to Port Huron/Sarnia. There is a prominent connection with Genesee County that houses Flint, MI, slightly less than 100km from the border. Note that for the flow from Ontario and crossing at Michigan, there are an estimated 34,521 trips with 24,781 being cargo-carrying. Empty trucks appear as more of a problem for trips flowing toward the US.

Other observations on the origins of truck trips in the US:

- Particular counties that stand out for Ohio are mostly in the western half of the state.
- The three counties that stand out from Illinois are linked to the Chicago metropolitan area.
- The pattern for Indiana is not particularly strong for any one county – origins appear dispersed.
- Milwaukee county, which captures a lot of the associated metropolitan area, is not relatively prominent as an origin for Wisconsin trips.
- Webb County in Texas is prominent for long truck trips and is associated with Laredo TX on the border with Mexico.
- There are strong connections with eastern interior states such as Kentucky and Tennessee.

Figure 3-15 focuses on the US destinations of 100km+ export truck trips from Canada, that are crossing at Niagara, and where they are terminating in the US. The data suggest that an estimated 16,053 trips of this type cross into the US each week with 12,552 of the trips carrying at least some cargo. Nearly half of the total trips are destined for New York state and the counties in the Buffalo/Niagara areas are by far most prominent. The reverse flows are 15,741 with 12,616 being cargo-carrying.

Figure 3-15: State/County Allocation of Export Trips Crossing into US via Niagara

Other observations include that:

- Connections to the New York Metropolitan area are fairly significant when considering aggregation across counties such as Kings and Queen, and New Jersey counties such as union, Essex and Middlesex which are essentially part of the larger metropolitan area.

- Erie County (including Erie, PA) is slightly more prominent than Allegheny County (including Pittsburgh, PA) even though the latter is much more populated (though further away).
- Franklin County, OH (including Columbus) is one of the only counties that is connected to Ontario through the Niagara and Michigan crossings (i.e. seen in both pie charts). Cleveland, OH is much more connected via Niagara.
- The counties of Ohio and particularly Pennsylvania are connected to Ontario in a fairly dispersed manner. Few particular counties stand out.
- For "other" states, those located along the eastern seaboard appear most prominent.

3.2.3 Port-specific Analysis of Truck Flows

An important analysis, based on the CVS data, is developed here to characterize goods flow connections, by truck, between US Great Lakes port vicinities and Canadian census divisions (almost entirely in Ontario with a few from Quebec). Using great circle distances (not drive times), US counties that are within 50 and 100km are identified around each of the US ports under consideration[7]. Each defined area has truck flow connections to Canadian geographies that can be characterized in terms of the strength of connection by geography and the types of commodities that are flowing. Through leveraging the CVS survey, these quantities can be captured for both export flows from Canada and import flows into Canada. Note that only cargo-carrying trips are tabulated in this exercise, not empty ones.

So, for example, the Port of Chicago vicinity shows 2,374 weekly export truck trips from Canada (Ontario-Quebec) that arrive in US counties located within a 100km radius of the port (see Table 3-2). This declines to 1,936 trips if a smaller 50km radius around the port is used. For import trips to Canada that originate near the port, the figures are 2,786 and 2,260 trips respectively.

Table 3-3 allows the same port vicinities to be examined but in terms of the connection just to the GTHA as opposed to Ontario/Quebec. With this narrower focus, the number of export truck trips to the Chicago vicinity declines from the 2,374 noted above to only 1,175. This reflects some strong export connections to Chicago from many counties in southwest Ontario and elsewhere. Note that an effort is made in Table 3-2 and 3-3 to choose a US port from each of the Great Lakes (Detroit may be the best option to attribute to Lake Huron).

[7] The states included in a radius are identified and modified if needed. For example, there are some Michigan counties that are less than 100km from Chicago as the crow flies across Lake Michigan, but these are omitted from the Port of Chicago catchment area.

Table 3-2: Estimated Weekly Cross-Border Truck Trips and Tonnage within 100km Radius around Selected US Great Lakes Ports

US Port	Export Trips (to US)	Import Trips (from US)	Export Tonnes (to US)	Import Tonnes (from US)
Within 100km				
Chicago	2,374	2,786	34,333	34,884
Cleveland	1,154	1,561	16,679	18,789
Detroit	7,111	5,235	116,488	74,456
Duluth	24	94	491	216
Milwaukee	562	591	7,967	7,807
Rochester, NY	1,659	1,913	32,550	29,324
Toledo	4,999	5,610	69,187	74,211
Within 50km				
Chicago	1,936	2,260	27,907	28,320
Cleveland	442	723	6,400	9,368
Detroit	5,593	3,910	91,799	55,606
Duluth	32	213	619	2,804
Milwaukee	296	302	4,631	3,863
Rochester, NY	326	537	3,890	7,294
Toledo	1,144	1,204	15,995	13,850

Table 3-3: Estimated Weekly GTHA-Linked Truck Trips and Tonnage within 100km Radius around Selected US Great Lakes Ports

US Port	Export Trips (to US)	Import Trips (from US)	Export Tonnes (to US)	Import Tonnes (from US)
Within 100km				
Chicago	1,175	1,985	16,920	24,223
Cleveland	651	823	9,146	8,836
Detroit	3,303	2,836	62,380	39,107
Milwaukee	251	341	3,379	4,389
Rochester, NY	1,023	786	19,730	9,622
Toledo	2,451	2,647	37,146	37,131
Within 50km				
Chicago	1,012	1,721	14,798	20,522
Cleveland	207	414	2,434	4,836
Detroit	2,826	2,336	53,176	33,003
Milwaukee	123	199	1,811	2,705
Rochester, NY	244	203	2,368	2,759
Toledo	469	432	8,571	5,584

A few observations from Tables 3-2 and 3-3 are as follows:

- The connections with the Detroit vicinity in terms of truck trips and tonnages is by far the strongest[8] relative to all the other ports. This is not surprising considering the close proximity of Detroit to the key Hwy 401 corridor and industrial activities connected to it.
- Chicago overall is a larger economic centre than Detroit, but the impacts of distance decay and a lesser connection related to the automotive sector reduce the magnitude of the trucking connection. Results suggest that Chicago is better centred on a larger critical mass of Canada-connected trucking activity than is Milwaukee.
- Toledo demonstrates the biggest relative difference between using a 50km and 100km radius, with the latter radius being influenced a lot by Detroit and areas to the west of Cleveland. No doubt there is a lot of cross-border truck activity near Toledo. There is a similar pattern with Rochester on Lake Ontario depending on the inclusion level of the Buffalo region.
- Duluth is chosen to represent Lake Superior but the CVS is not picking up strong trucking connections to the core of Ontario. What is picked up are connections to those parts of Ontario that are closest to the Minnesota border. The larger radius around Duluth includes Minneapolis-St. Paul and this offers a modest boost to the connection.

For each of the Ports covered in Tables 3-2 and 3-3 and for other potential ports and locations that are not shown, it is possible to derive more detailed breakdowns of the character of the trucking connections that are being assessed. For 6 of the 7 ports that are shown in these tables, this is done through a series of detailed graphs. It is not done for the port at Duluth because the CVS data captures insufficient evidence of trucking connections to southern Ontario through the data.

A series of 12 full-page figures follows that details the trucking connections between these port vicinities. The first six figures illustrate the nature of the commodity connections between the given port vicinity and Ontario/Quebec. The latter six figures illustrate the nature of the geographic connection between the given port vicinity and the specific census divisions within Ontario/Quebec that are showing material trucking flows.

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[8] Bear in mind that this analysis excludes truck trips that are less than 100km in length (based on the data made available). So, the actual trucking connections with Detroit are likely stronger than what is shown here. Also, the results for Detroit omit Ohio counties, closer to Toledo, that are within the 100km radius used. This latter point is not material for the 50km radius scenario.

For each of the two sets of figures, there is a chart that summarizes weekly trips and another that summarizes weekly tonnage. The combined weekly tonnage for imports and exports determines the ordering of commodities (for the first set) and geographies (for the second set) from the bottom of the tonnage chart, and the trips chart is made to align with the same ordering. For the first set of charts, commodities are characterized based on two-digit SCTG codes and for the second set, geographies are characterized by Canadian census divisions.

As the first example, Figure 3-16 focuses on the strength of the commodity connections between southern Ontario/Quebec and the Port of Milwaukee. The dark red colour summarizes exports from a given Canadian census division to the vicinity within 50km of the Port of Milwaukee. The lighter red colour shows what is incremental when the radius is increased from 50 to 100km. The dark blue and lighter blue colours respectively provide the same function for imports into Canada.

Figure 3-16 shows that Code 27 – pulp, newsprint, paper and paper board and Code 23 – Chemical products and preparations stand out in the connection to Milwaukee and especially in terms of exports from Ontario/Quebec. Note that Code 23 has more potential in the sense of requiring a smaller radius to the Port of Milwaukee. Code 43 Mixed Freight stands out for a tonnage import connection to Canada while Code 34 Machinery stands out for import trips into Canada.

The counterpart figure for Port of Milwaukee which focuses on geographies is Figure 3-22. There we see that Peel Region stands out for by far the strongest connection to the Milwaukee vicinity and especially so in terms of goods moving into Ontario. A variety of other census divisions in and around the GTHA are prominently connected as well with connections to Quebec being much more modest.

Going back to Tables 3-2 and 3-3, it is possible to obtain figures on the total tonnages and trips that are broken down in the charts. The CVS suggests that there are 1153 cargo-bearing weekly trips (import + export) by truck between Southern Ontario (primarily)[9] and the Port of Milwaukee vicinity associated with 15.7 thousand weekly tonnes based on the 100km radius.

This example gives a sense of how to use the charts and tables. Clearly, more detailed observations and conclusions are possible based on the Milwaukee charts alone and these could lead to deeper dives into other particulars of the CVS or into trade data.

[9] In the Milwaukee example, there are no doubt some significant truck flows to and from Manitoba. These would be almost entirely uncaptured in the current analysis.

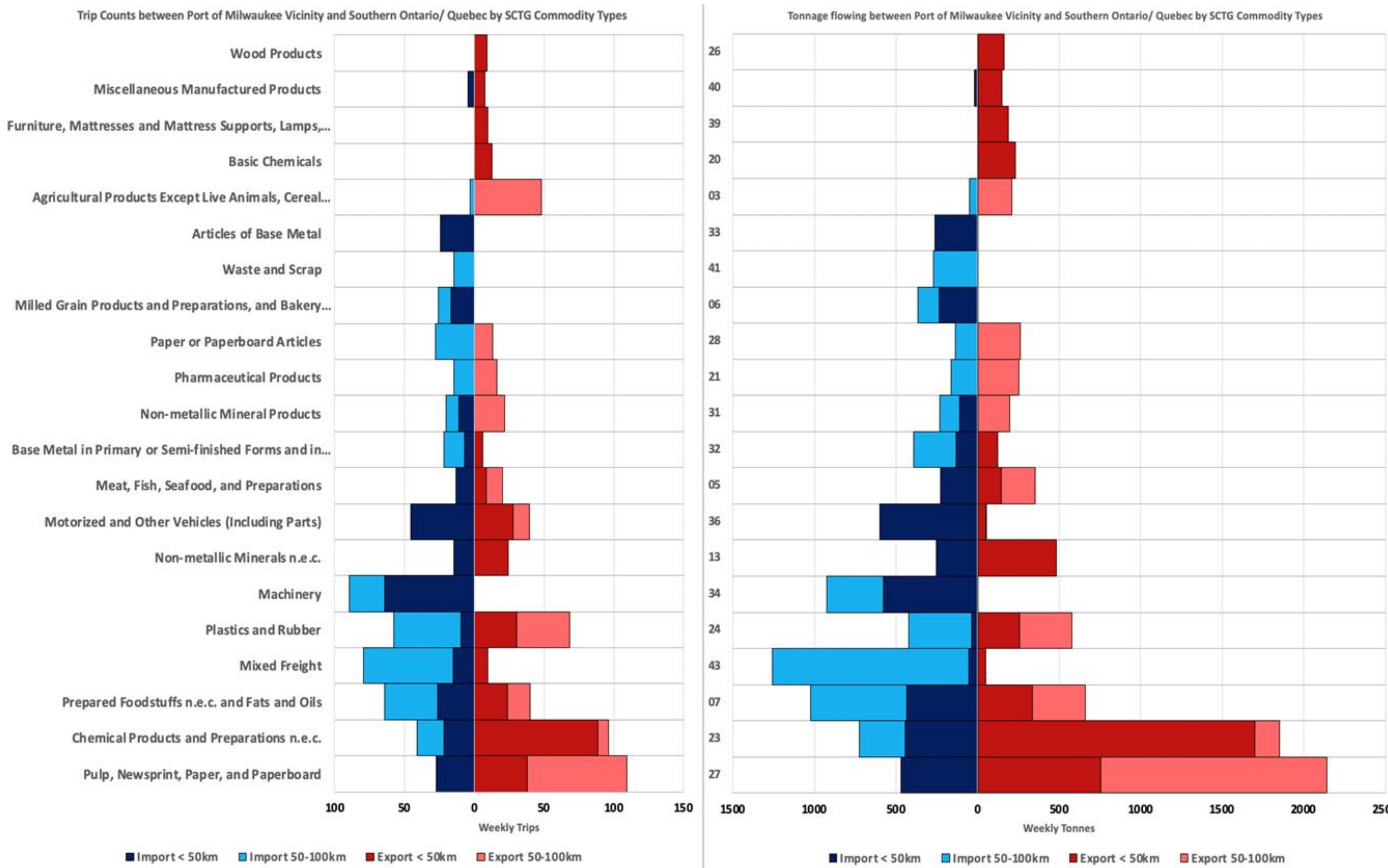


Figure 3-16: Commodity Connections by Truck between Port of Milwaukee Vicinity and Ontario/Quebec

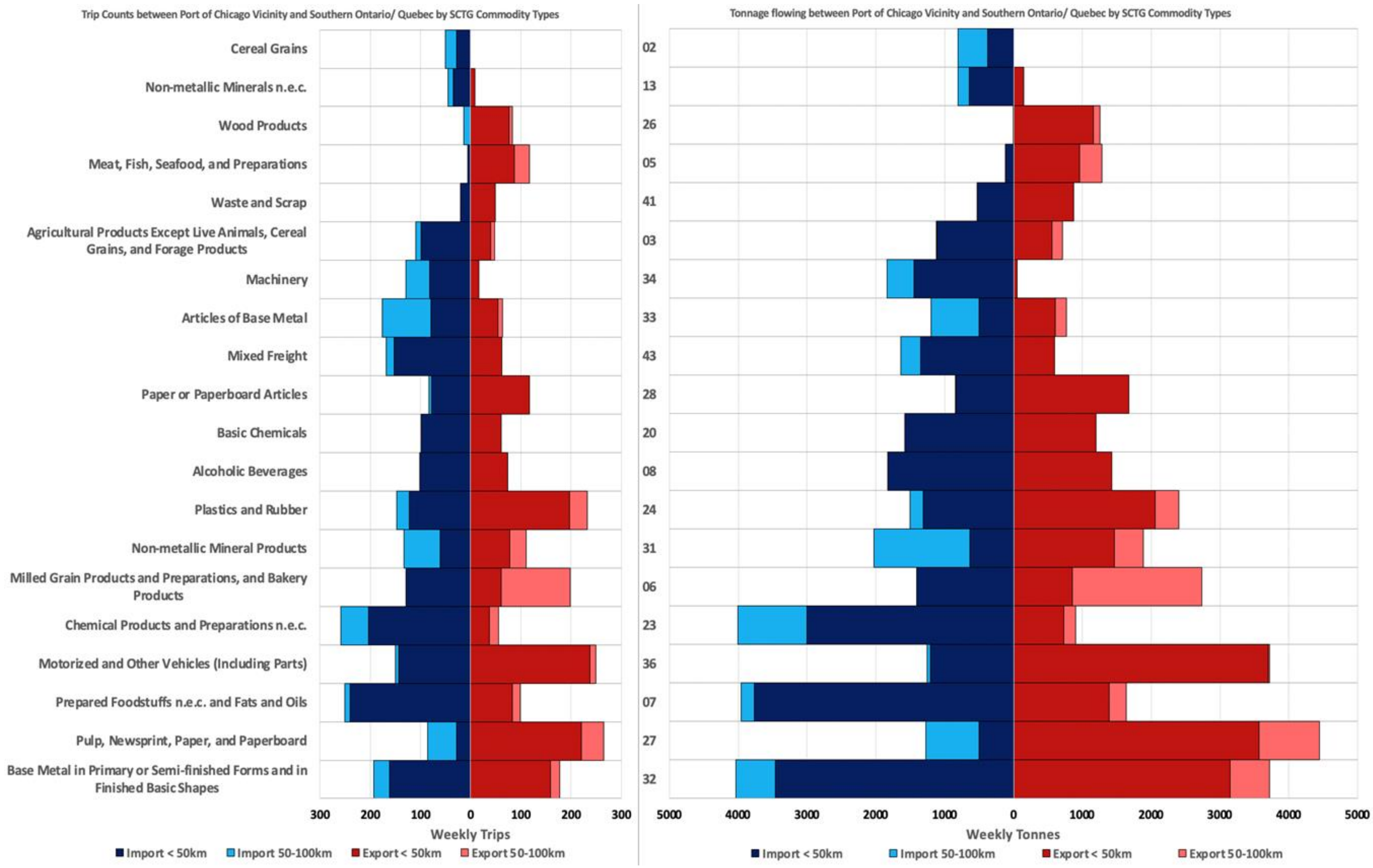


Figure 3-17: Commodity Connections by Truck between Port of Chicago Vicinity and Ontario/Quebec

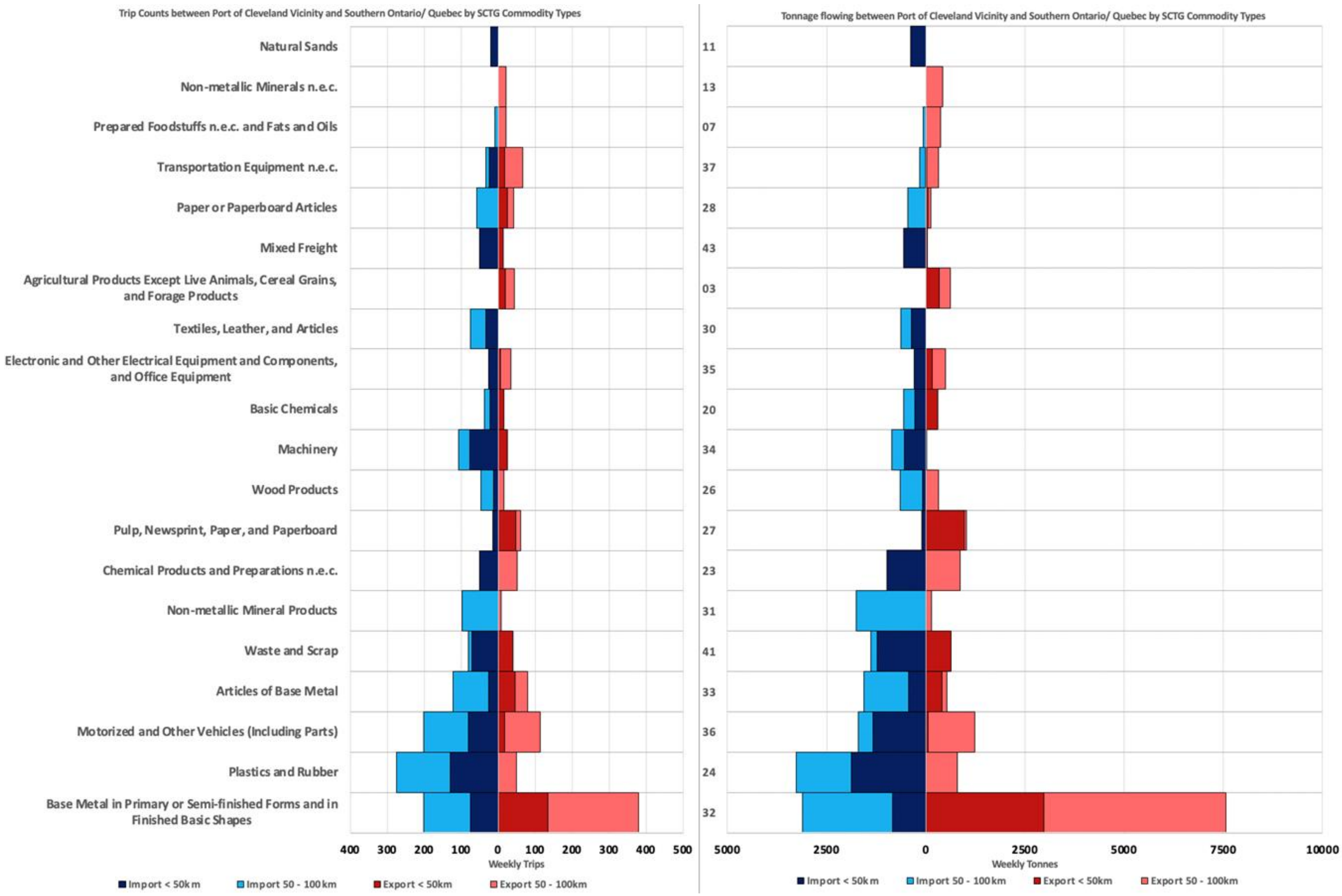


Figure 3-18: Commodity Connections by Truck between Port of Cleveland Vicinity and Ontario/Quebec

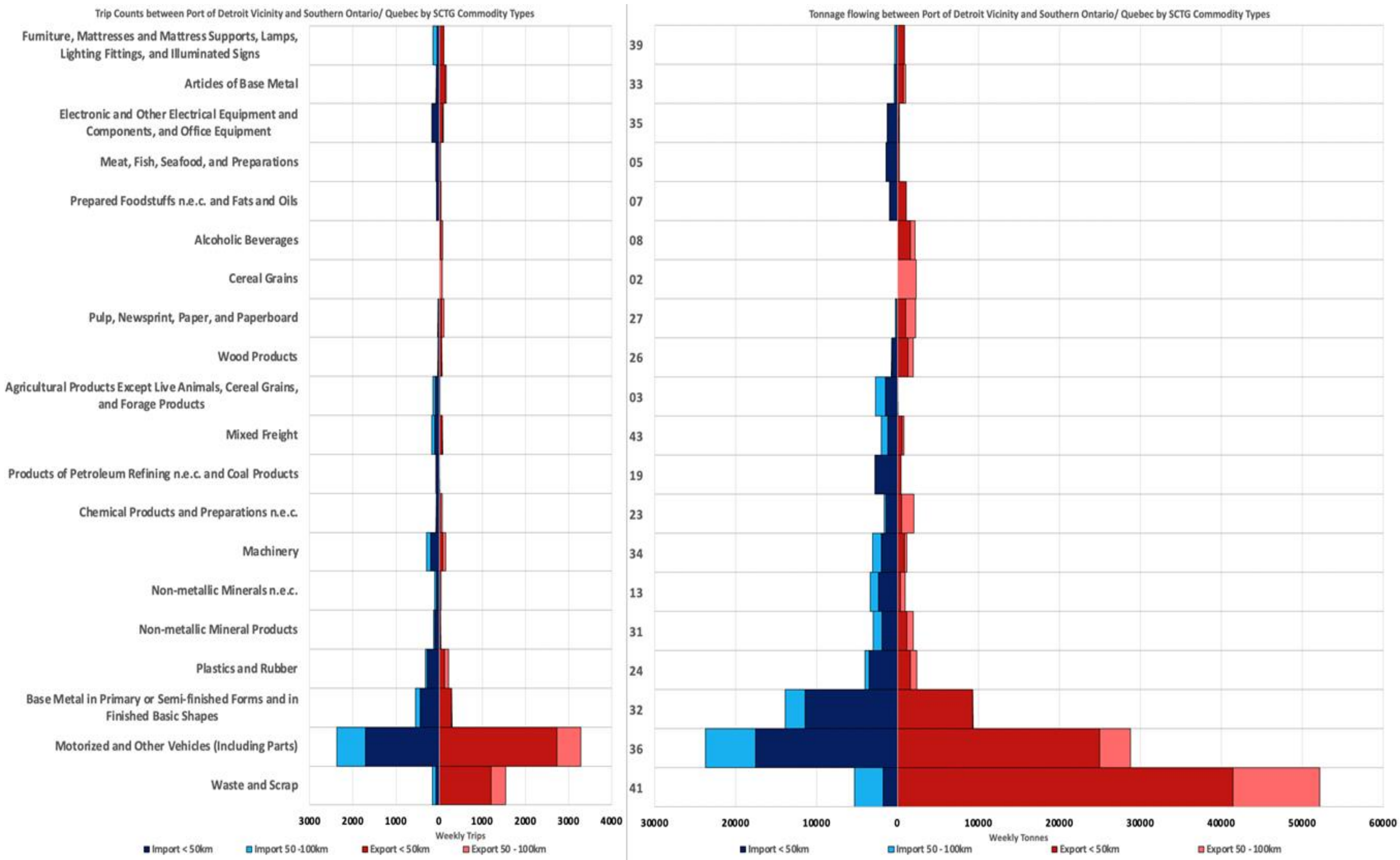


Figure 3-19: Commodity Connections by Truck between Port of Detroit Vicinity and Ontario/Quebec

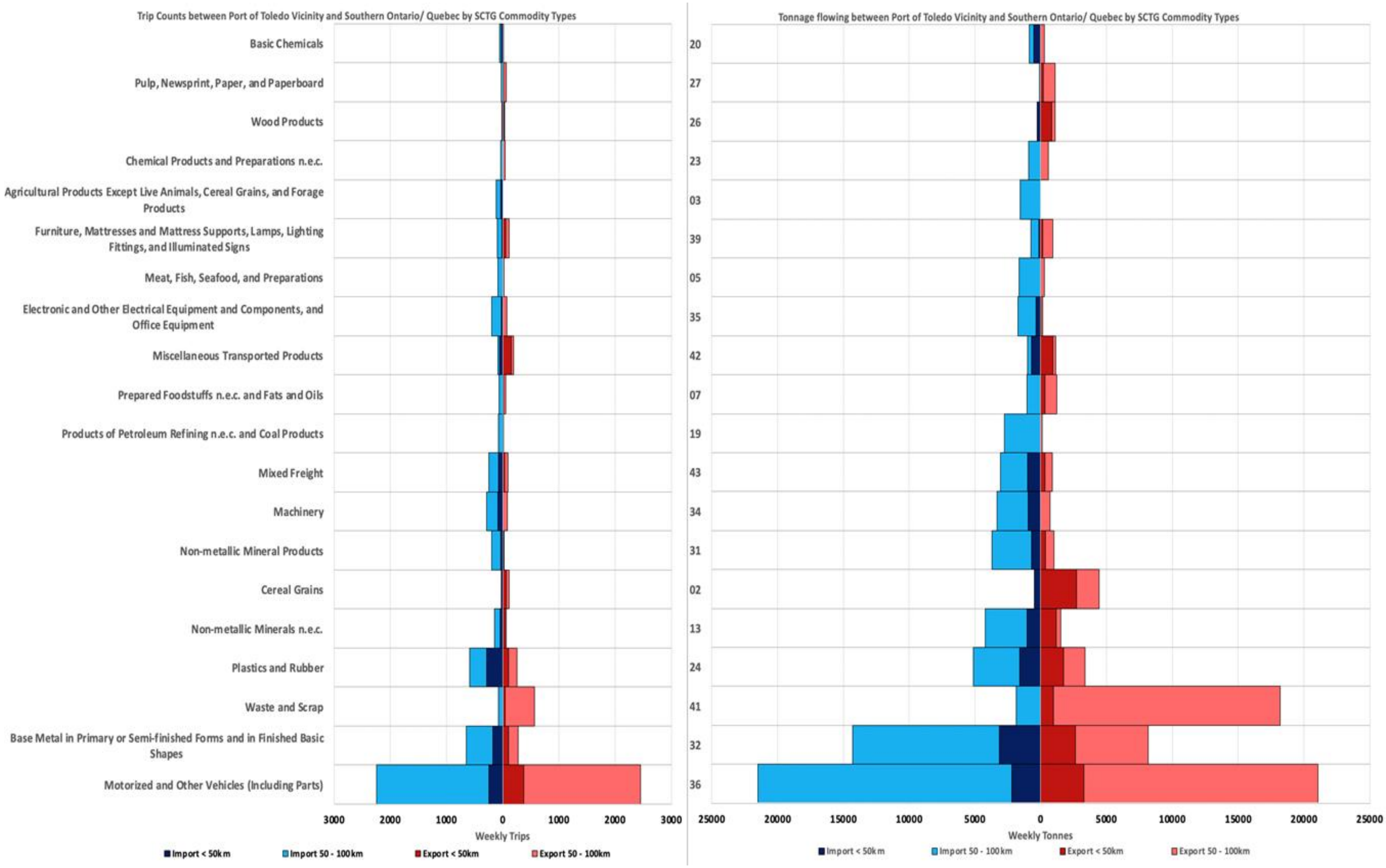


Figure 3-20: Commodity Connections by Truck between Port of Toledo Vicinity and Ontario/Quebec

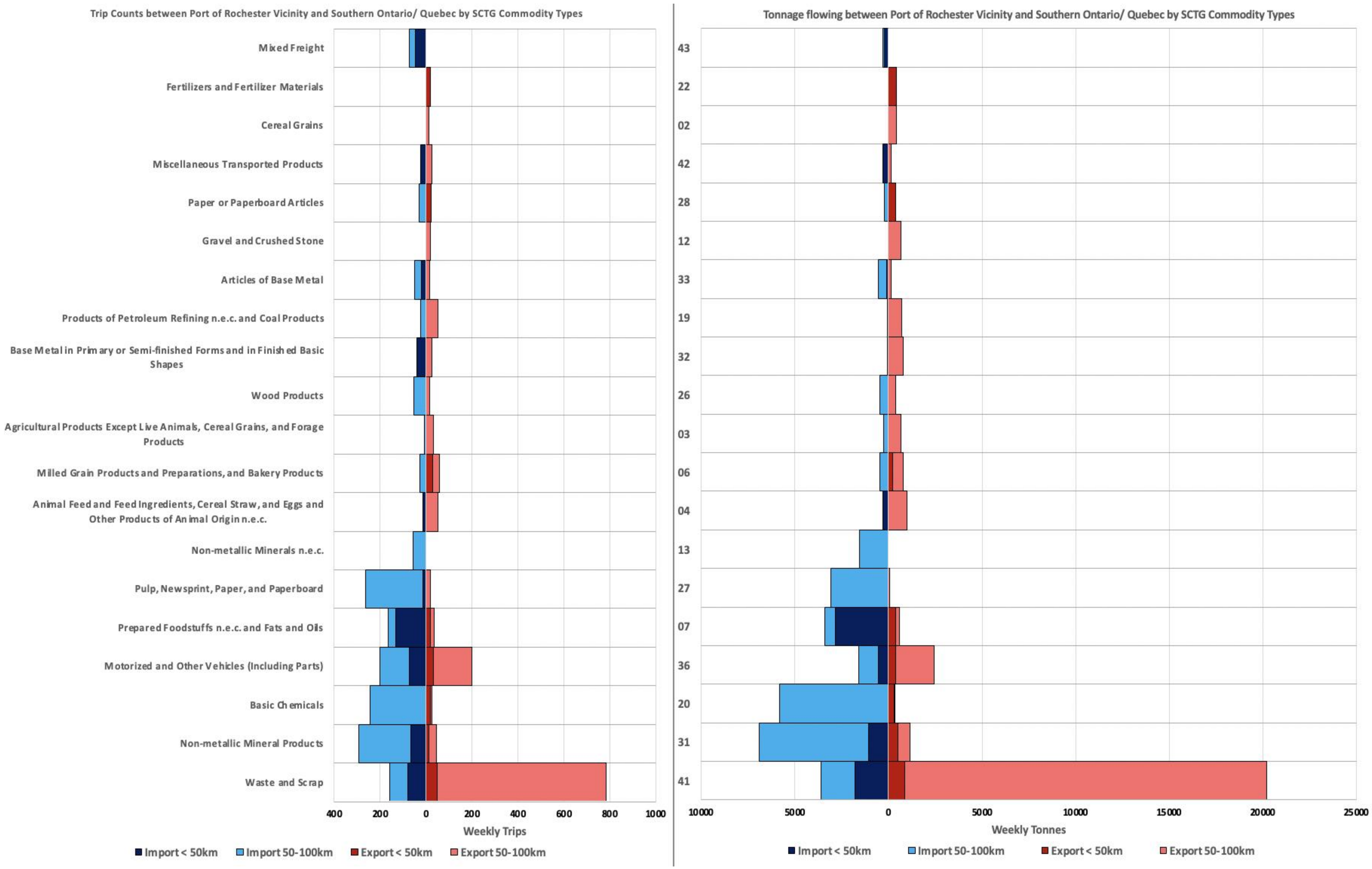


Figure 3-21: Commodity Connections by Truck between Port of Rochester Vicinity and Ontario/Quebec

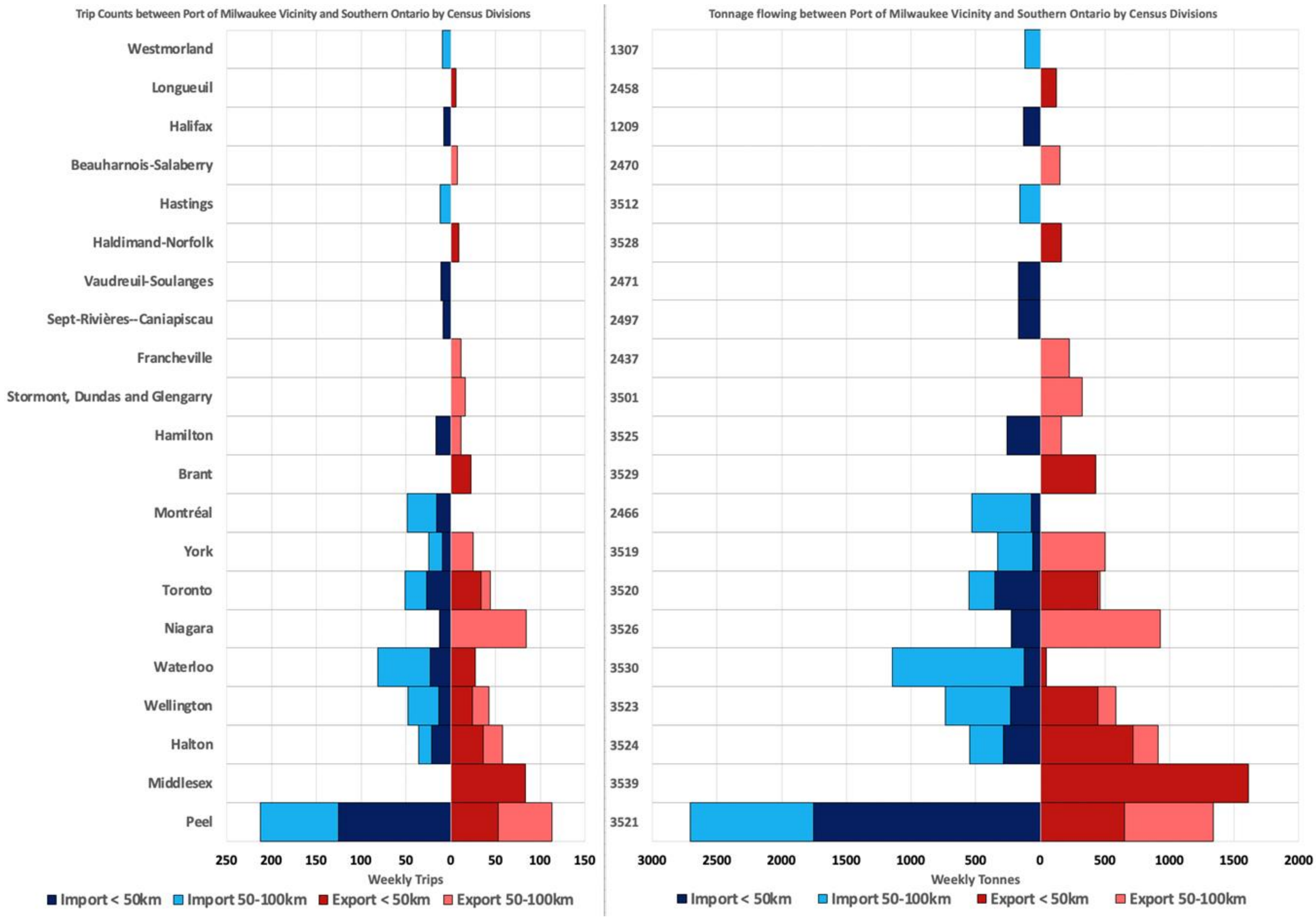
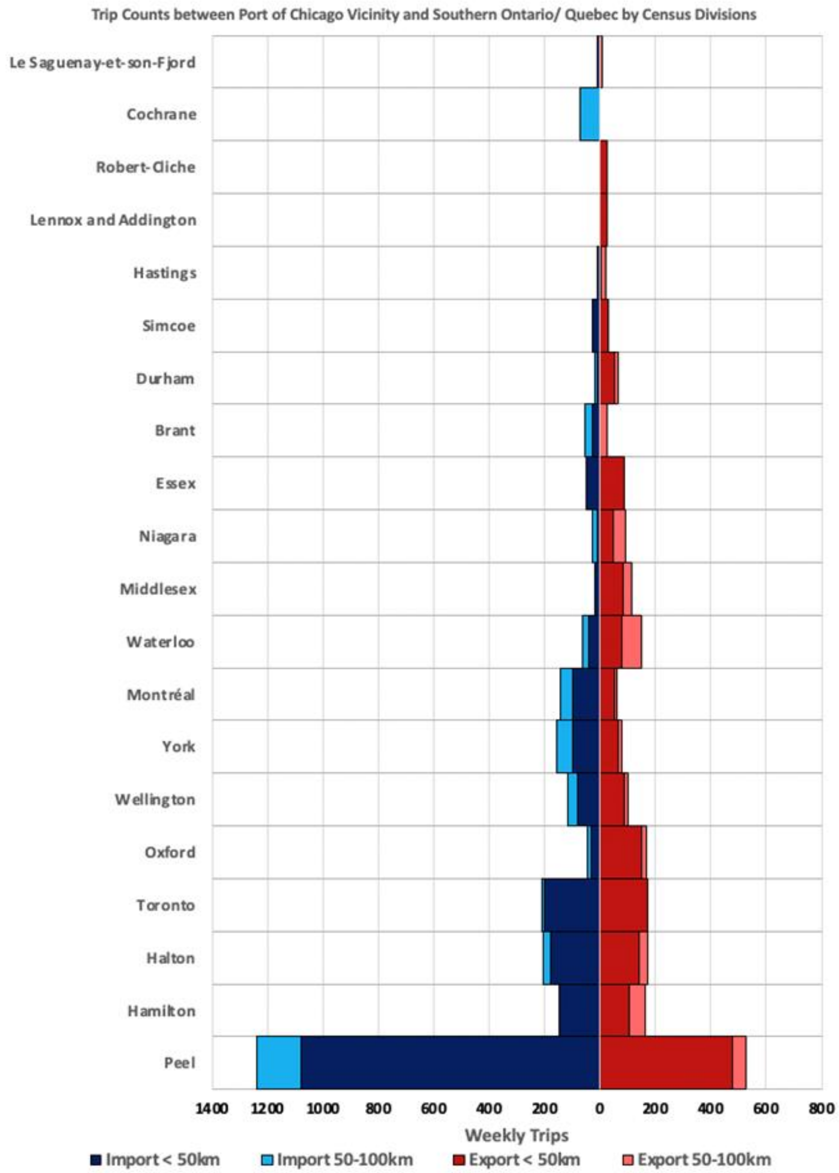


Figure 3-22: Geographical Connections by Truck between Port of Milwaukee Vicinity by Truck and Ontario/Quebec



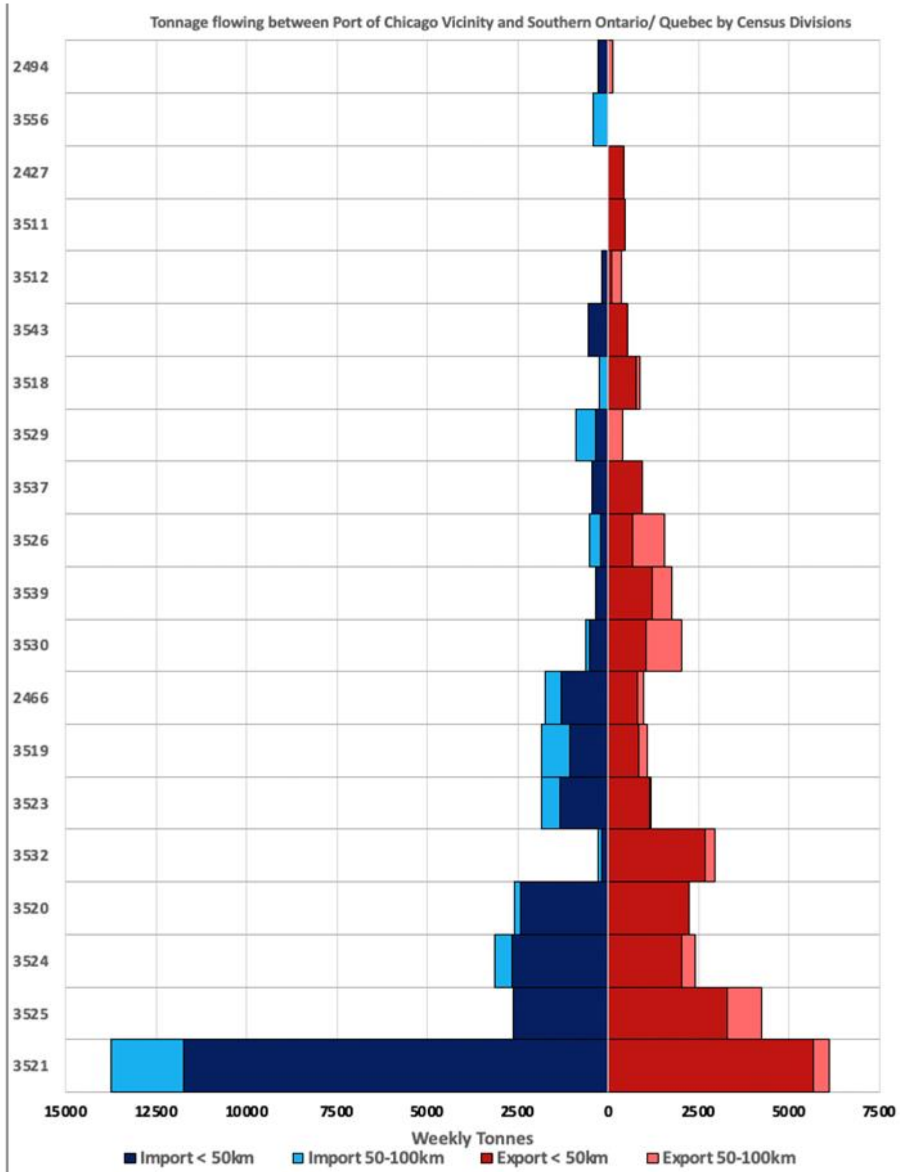


Figure 3-23: Geographical Connections by Truck between Port of Chicago Vicinity and Ontario/Quebec

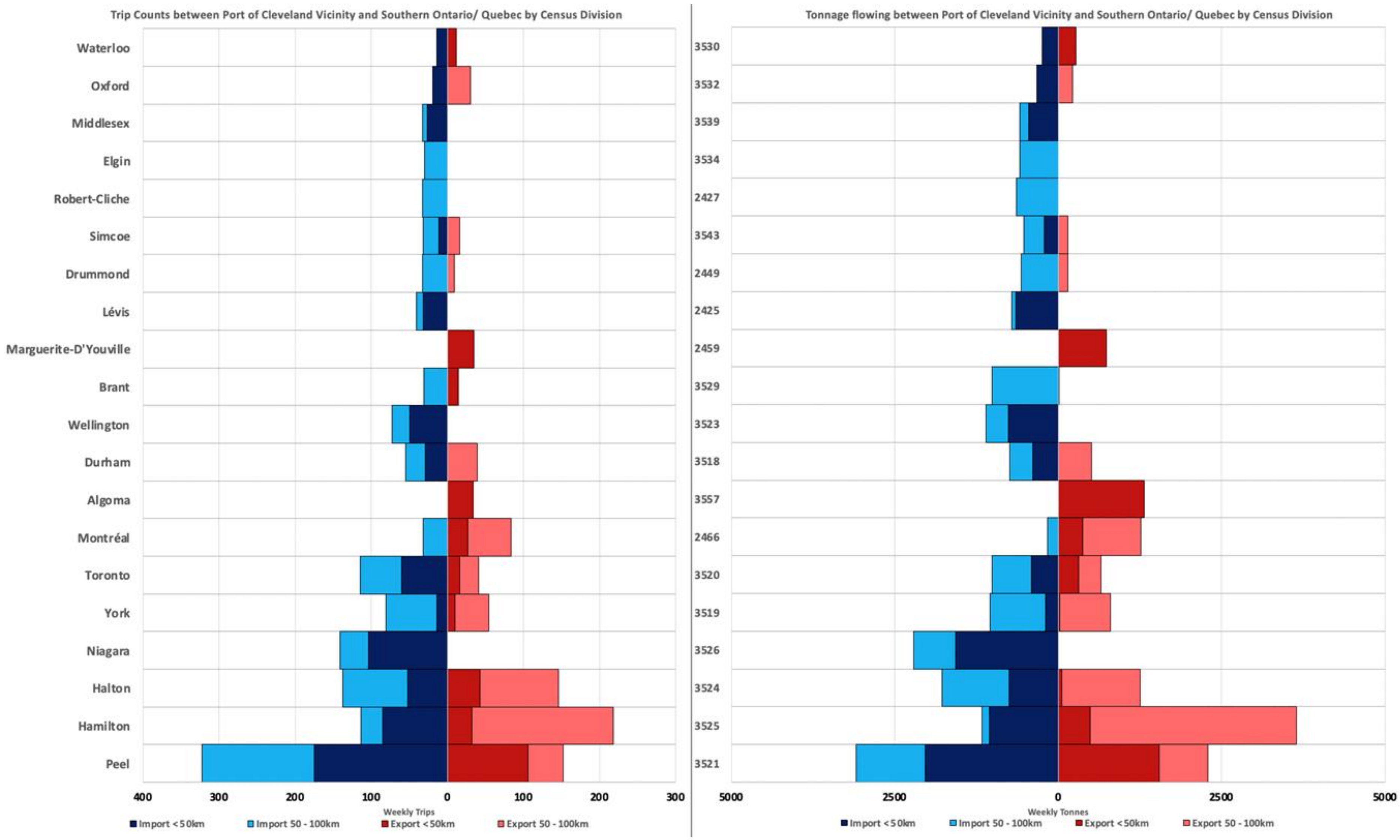


Figure 3-24: Geographical Connections by Truck between Port of Cleveland Vicinity and Ontario/Quebec

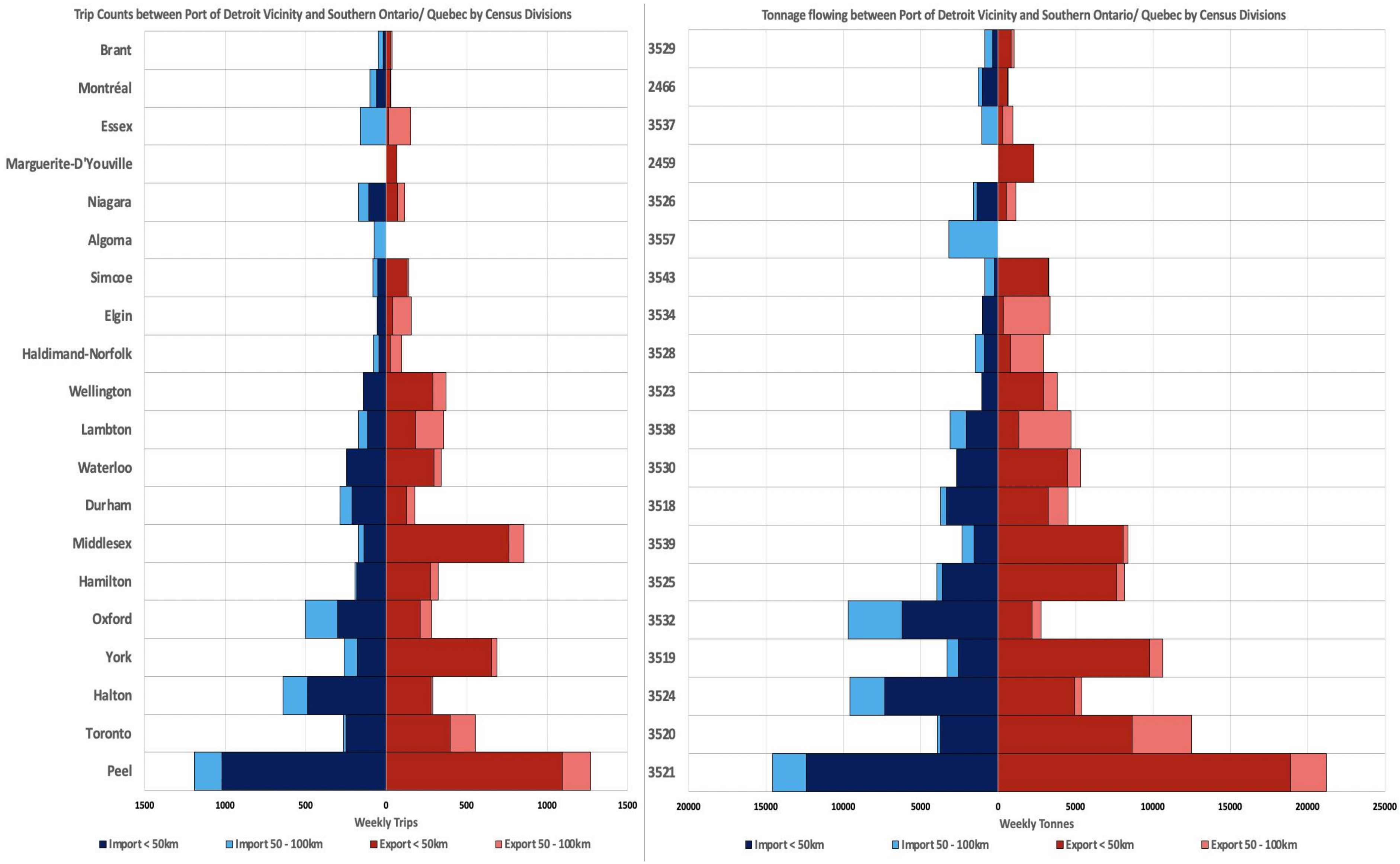


Figure 3-25: Geographical Connections by Truck between Port of Detroit Vicinity and Ontario/Quebec

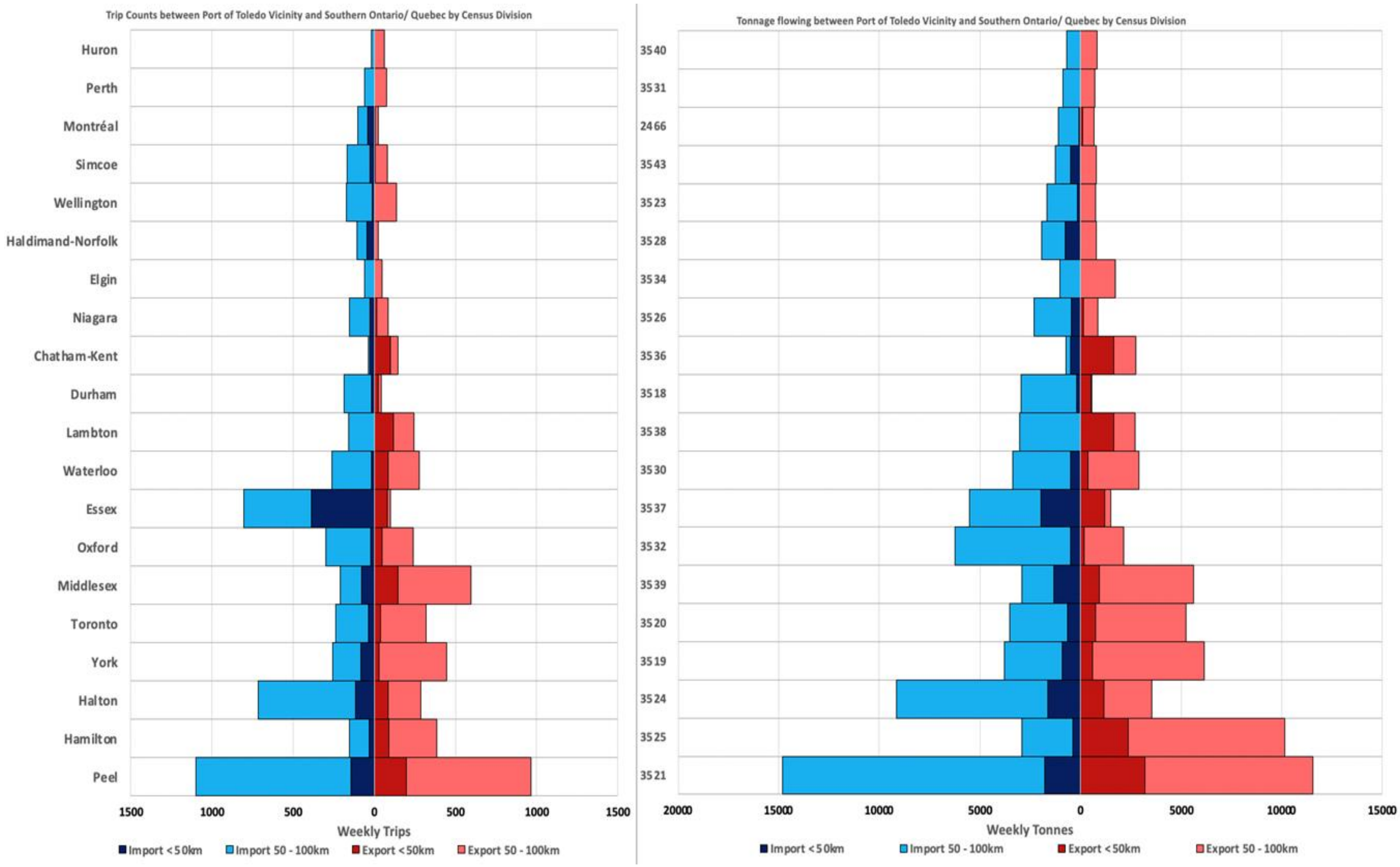


Figure 3-26: Geographical Connections by Truck between Port of Toledo Vicinity and Ontario/Quebec

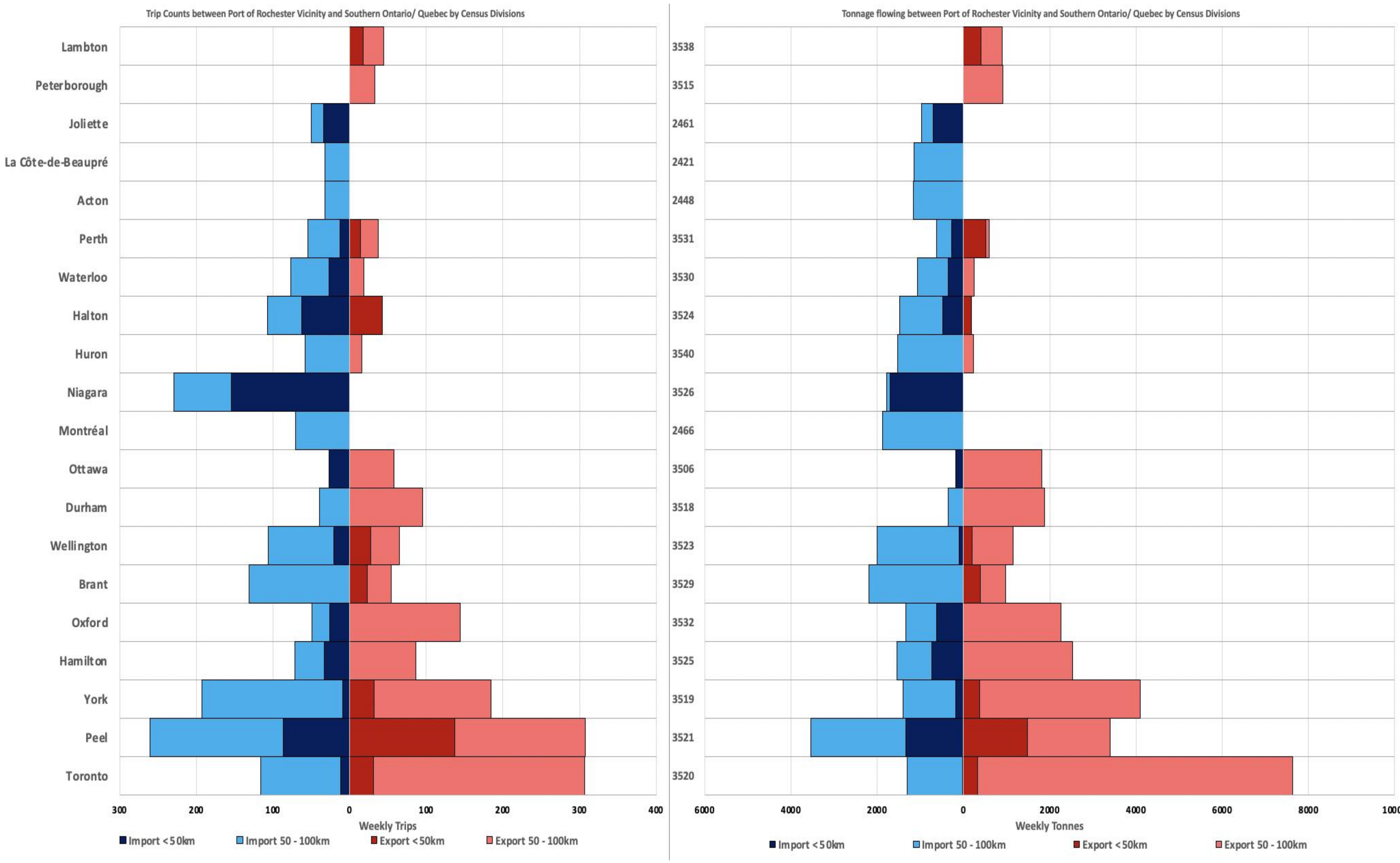


Figure 3-27: Geographical Connections by Truck between Port of Rochester Vicinity and Ontario/Quebec

To conclude the discussion on the port vicinity charts above, a few useful observations can be made:

- The colour patterns give a quick clue as to whether a given port vicinity relies a lot on the full 100km radius to generate a strong cargo connection. The Port of Toledo and the Port of Rochester stand out in this regard while conversely, for the Ports of Chicago and Detroit, a lot of the connection is accounted for within 50km. Any opportunity for the Port of Rochester is likely best interpreted as a means to exchange goods between parts of Ontario and the Buffalo region.

- For the Detroit vicinity, Code 36 relating to automotive supply chains really stands out on the import and export side. Given that the trips shown are for 100km+, the prominence is even more noteworthy. There are also large tonnage flows (and high tonnages per trip) associated with Code 41 waste and scrap coming from Ontario. Significant tonnages for Code 32 metals are also likely tied into automotive supply chains.

- The Port of Cleveland stands out for export flows into the US of Code 32 metals. On the import side, there are several commodity types with notable volumes and especially with a 100km radius.

- The Port of Chicago vicinity stands out for its diversity of cargoes relative to other port vicinities. This is consistent with that area's reputation as a major distribution hub. Geographically, the connection is by far strongest with Peel (another noted distribution hub) and especially so for goods moving into Ontario.

- The City of Hamilton stands out most for its connection to the Lake Erie ports of Cleveland and Toledo and there is evidence of a good Code 32 metals connection in this regard.

One important methodological note before moving on is that it is technically possible to develop charts that break down commodity connections between a given port vicinity and specific census divisions. In that scenario, a chart along the lines of Figure 3-16 could be done specifically for Peel Region, for example. Should there be future interest in further detail in this regard, it will be important to tread cautiously where there is a danger of over-interpreting a relatively small number of trucks that were actually sampled in the related contexts. The smaller the sampled flows associated with a given port vicinity-census division combination, the more ill-advised the more specific charts would be. Potentially, there are few candidates beyond Peel Region where this might be viable. On the other hand, it could be worthwhile to do for a concentrated region like the GTHA. Such a series of charts would be a counterpart to Table 3-3.

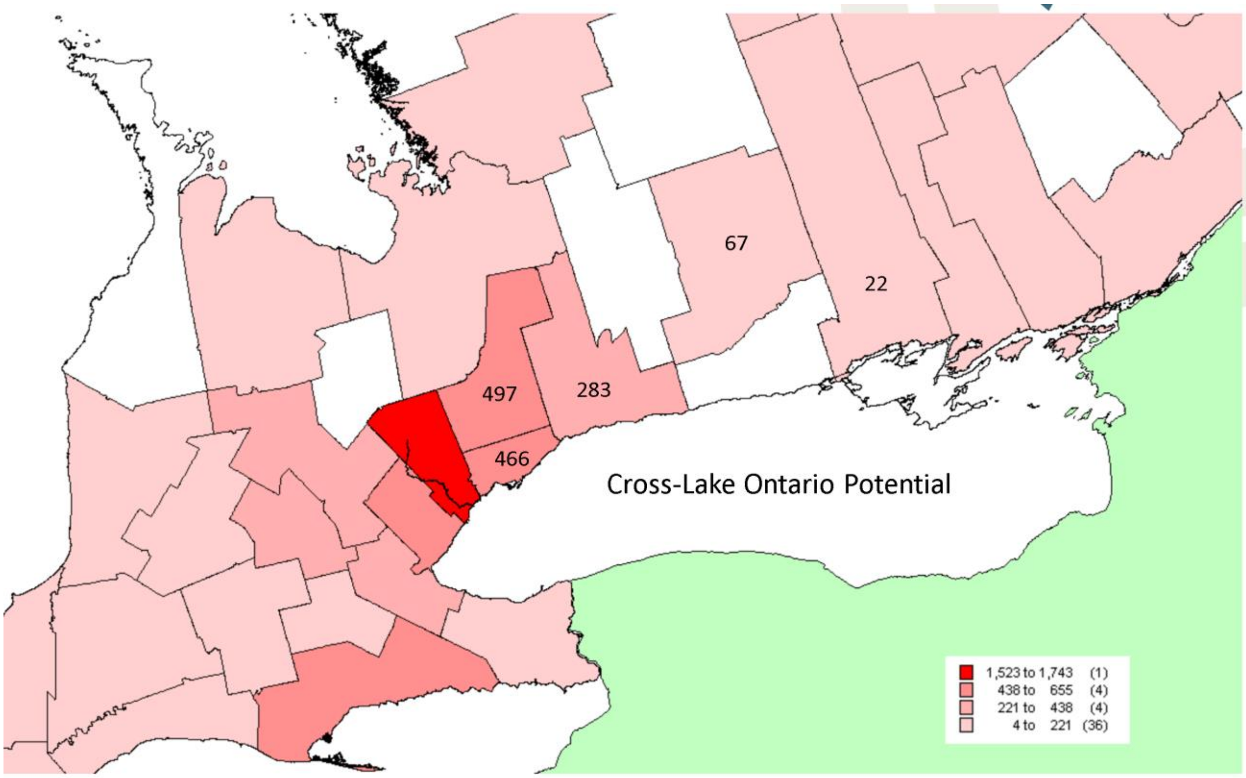


Figure 3-28: Estimated Weekly Truck Trips (100km+) flowing from Ontario Census Divisions to Western New York Region

Figure 3-28 can be considered an extension to the port analysis for the Port of Rochester case. The map shows estimated weekly truck trips flowing from Southern Ontario to the Western New York Region in green (excluding areas east of Lake Ontario). Results shown for Niagara region, on the Canadian side of the border, are significantly impacted by the omission of truck trips less than 100km driving distance. A few census divisions north of Lake Ontario are manually labelled. In principle, cross-lake marine potential might be considered strongest where it can most directly reduce the shipping distance, relative to other modes. Durham region, on the east of the Greater Toronto Area, seems the most promising in that regard and Peterborough shows very modest potential, but other counties to the east do not even register in the CVS for cross-lake potential moving to western New York. The strongest market potential for cross-Lake Ontario movements appears to lie in the GTA and to its west but these are also areas where the geographical advantage of marine, relative to trucking, is significantly reduced. This example helps to illustrate that economic activity has tended to organize itself so that road transport is best supported: accessibility has been an enormous consideration. And what is very accessible for road may be less relatively accessible for marine.

3.2.4 GHG Emission Analysis

In this section, the Ports analysis that has assessed the connection of US port vicinities to Southern Ontario is extended into a GHG analysis. The locational focus of the analysis within Southern Ontario is the six census divisions that compose the Greater Toronto Hamilton Area (Toronto, Hamilton, Peel, Halton, York and Durham). Effectively, the same data that supports the ports analysis also forms the basis for the GHG analysis. The scenario below assumes that 10% of the cross-border tonnage moving by truck between the GTHA and selected US Ports is moved by multi-modal trips instead. The vast majority of the distance is assumed covered by the marine mode and intra-metropolitan trucking is used to retrieve goods from the origin and deliver to the destination.

The steps supporting the GHG analysis are as follows:

1. The drive distances between GTHA census divisions (Durham, Halton, Hamilton, Peel, Toronto, and York) and selected US ports (Chicago, Cleveland, Detroit, Duluth, Milwaukee, Rochester, and Toledo) have been extracted from Google Maps API (Table 3-4) and captured as an origin-destination matrix.
2. These drive distances are multiplied by corresponding weekly tonnage flows in both the export and import directions to derive estimates of the total tonne-km that are removed from the road (by not employing these longer distance truck trips).
3. A trucking emission factor of 65.6 grams per tonne-km (Research and Traffic Group, 2013) is applied to the totals in 2) and the result is converted into tonnes of GHG emissions.
4. Estimates of *net* GHG reductions are obtained by calculating marine emissions based on 8.1 grams per tonne-km (Research and Traffic Group, 2013). Vessels tailored to short sea shipping could have higher emission rates than what is quoted here.

Table 3-4: US Great Lakes' ports and GTHA distance matrix in km

Road Distance	Chicago	Cleveland	Detroit	Duluth	Milwaukee	Rochester	Toledo
Durham	902	406	449	1506	1048	357	539
Halton	800	304	347	1404	946	255	437
Hamilton	761	265	308	1365	907	216	398
Peel	822	326	369	1426	968	277	459
Toronto	829	333	376	1433	975	272	466
York	846	350	393	1450	992	301	483

The results associated with the end-product of Step 3 are shown in Table 3-5 below[10]. Many of the totals that are seen are consistent with observations made about the ports analysis. Certainly, the impact of the radius assumed around any given US Port can be very significant. The results for Rochester and Toledo show this especially. GHG savings for Chicago are driven much more by the longer distances to the GTHA, whereas the similar savings for Detroit are driven more by the much larger tonnages involved. The large 100km Toledo result is determined by good access to Detroit-oriented tonnage but movement of Detroit tonnage to and from the GTHA via Toledo seems unrealistic. A large catchment area for Toledo that involves interior US states near Interstate 75 is another plausible approach not directly analyzed here. The totals for Cleveland are relatively minimal based on a combination of smaller tonnages and shorter distance to the GTHA.

Table 3-5: GHG Emissions Eliminated with Removal of Trucking Legs (10% share of tonnage)

Weekly GHG Emissions Saved from Removal of US Port-GTHA Trucking Legs: Based on Reallocation of 10% of CVS Estimated Tonnage to Marine						
US Port	**Export Trips 50km radius**	**Export Trips 100km radius**	**Import Trips 50km radius**	**Import Trips 100km radius**	**Total 50km radius**	**Total 100 km radius**
In Tonnes						
Chicago	78.8	89.9	109.5	129.7	188.3	219.6
Cleveland	5	18.3	10.1	18.8	15.1	37.1
Detroit	128.6	151.6	79.7	94.3	208.3	245.9
Milwaukee	11.4	21.4	17.1	27.8	28.5	49.1
Rochester, NY	4.3	36.2	4.7	17	9	53.2
Toledo	25.1	108.8	16.7	111.6	41.8	220.4

To close this analysis, it is worth examining the trucking emissions associated with truck trips from shipment origins to port origins and from port destinations to final destinations (when marine is involved). If an average of 75 km of combined travel for the total of both trips ends is assumed, then:

[10] It has to be acknowledged that over time, zero emission trucking is likely to become more prominent for long distance movements involving even heavy vehicles. At that time, per km distance-based forms of analysis like this one will not apply very well. In the case of battery-powered trucks, for example, emission footprints appear to shift to manufacturing and other processes linked to supply chains.

- For the 100km radius, it is roughly estimated that the Chicago and GTHA-linked trip end emissions would amount to 21% of the 219.6 tonnes of emissions saved (and shown in Table 3-5) or 45.4 tonnes per week.
- Corresponding trip end emissions for Cleveland and Rochester are relatively large and amount to about 40% of the GHGs saved and shown in Table 3.5. This is because intra-metropolitan truck movements at either end generate significant tonne-km relative to the shorter overall distances involved between the given US port and the GTHA.
- For Detroit and Toledo, trip end emissions represent approximately 30% of the Table 3-5 GHG savings.

To some extent, the emissions associated with trip ends also apply to long-distance point-to-point truck movements. The initial few or last few kilometres of trips from specific origins to specific destinations remain present in long truck trips and generate emissions as well. But these will be conducted more efficiently in direct movements relative to having two ports act as intermediate stops. So, for example, the 45.4 tonne figure expressed above for Chicago-GTHA would be reduced by some significant amount if expressed in true net terms. A more detailed simulation would be required to offer greater precision in this regard.

This brief examination of trip ends does not alter the fact that there are significant GHG savings to be realized (see Table 3-5) if marine is involved in the long-distance leg of cargo movements.

3.2.5 Examining 4-digit HS codes for marine opportunity

As has been mentioned, the Statscan trade database is possibly the most powerful source, on an ongoing basis, for assessing potential cargoes that could support short sea shipping opportunities. The shortcomings of the data (e.g., lack of geographic specificity) have been described already but the fact remains that this source captures a tremendous amount of detail. In its raw form, the trade data is not highly accessible to many who might want to use it for decision support. As such, the creation of useful tools to help leverage the data is needed. The properties of a basic spreadsheet tool, customized to examine StatsCan trade flows in the Great Lakes region, are outlined in Appendix D. The appendix also gives a sense of how that tool could help form the basis for a future dashboard.

The tool in Appendix D was used to quickly generate the results that form the basis of Figures 3-29 and 3-30. The process of exploring for specific cargo opportunities is very likely involved with looking more deeply into specific HS codes of 4 digits or more. Figure 3-29 looks at 4-digit codes for high tonnage codes moving into Ontario by truck from a Great Lakes state in 2019 (the last pre-pandemic year for which we have the Statscan trade data). The figure is based on cargoes with units of measure such as tonnes, kilograms or litres. Cargoes in automotive supply chains, as shown in Chapter 2, are not typically measured in these units and are not shown. Figure 3-30 is the exports counterpart.

In terms of specific observations:

- There were a combined approximate 400,000 tonnes of code 1201 soybeans clearing into Ontario from Michigan and New York state.
- There were over a million tonnes of products manufactured from coal (code 2701) that cleared into Ontario and originated in Michigan.
- There were about 650,000 tonnes of code 7204 ferrous waste and scrap that moved from Ontario to varied Great Lakes states.
- There are several records associated with the movement of flat-rolled iron and steel by truck to varied Great Lakes states. These are in the range of 200,000 to 400,000 tonnes for 2019 and would have required many truck trips.

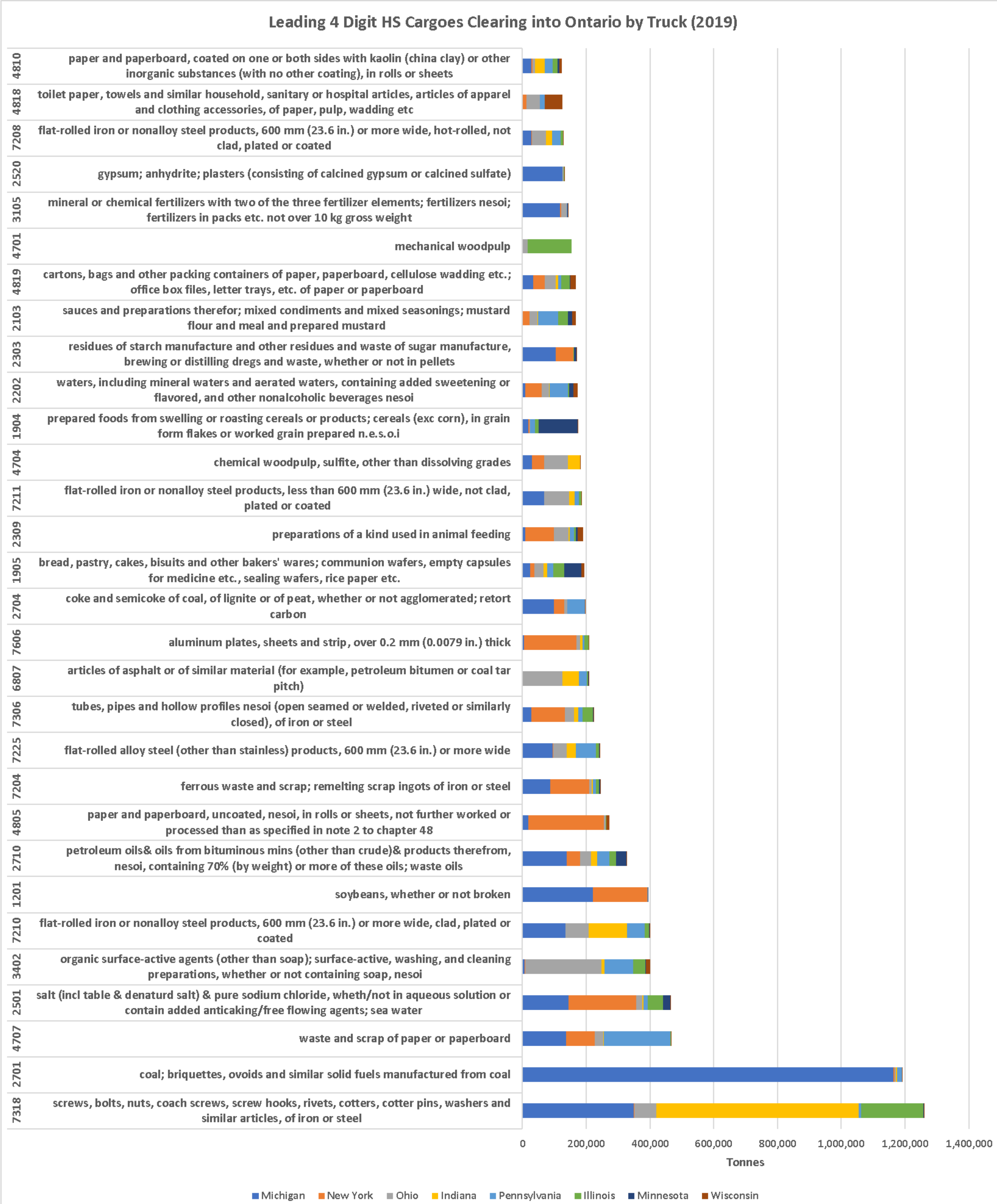


Figure 3-29: Leading 4-digit HS Cargoes Clearing into Ontario by Truck from Great Lakes States (2019) – Derived from StatsCan Trade Data

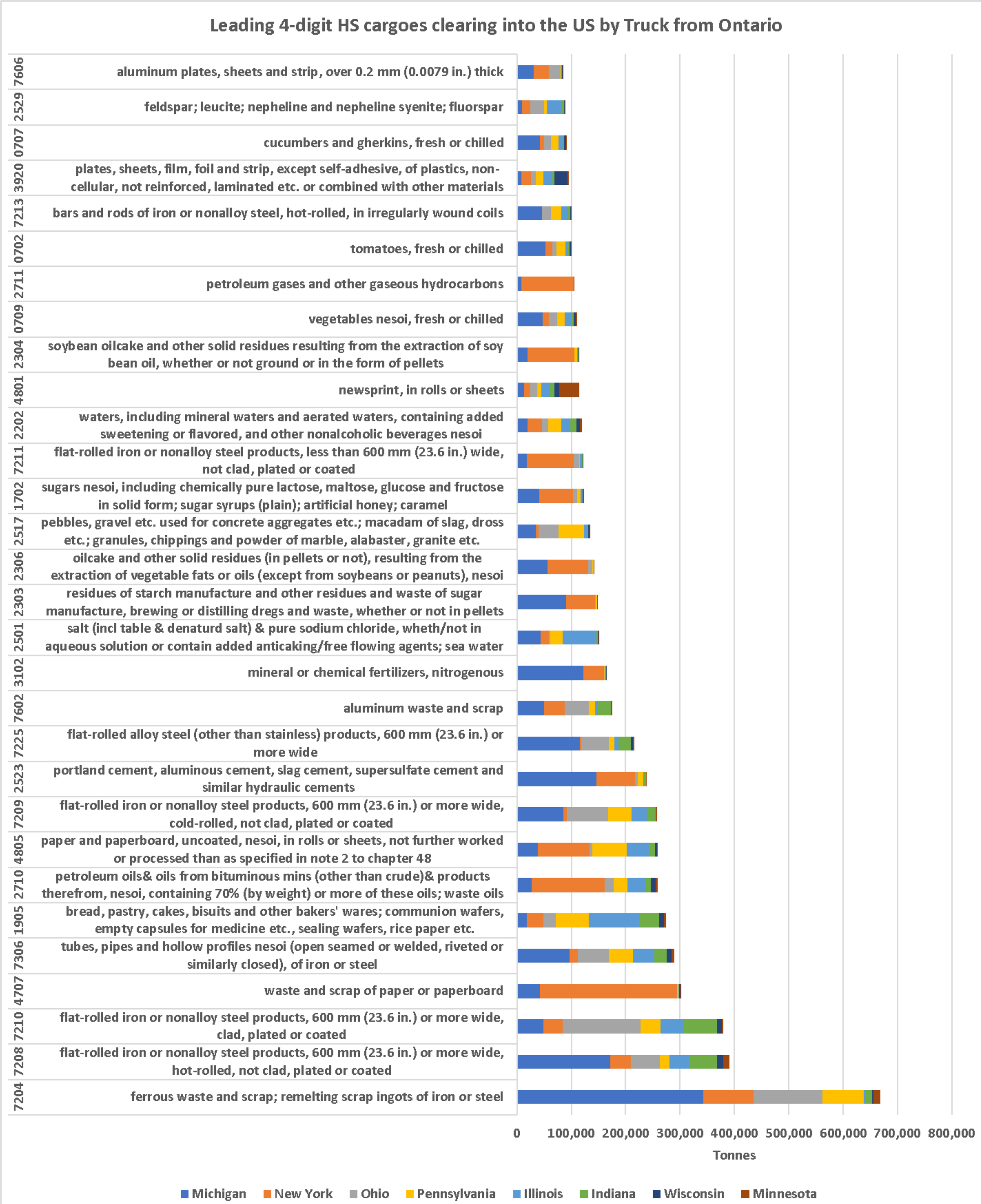


Figure 3-30: Leading 4-digit HS Cargoes Clearing from Ontario into Great Lakes States by Truck (2019) – Derived from StatsCan Trade Data

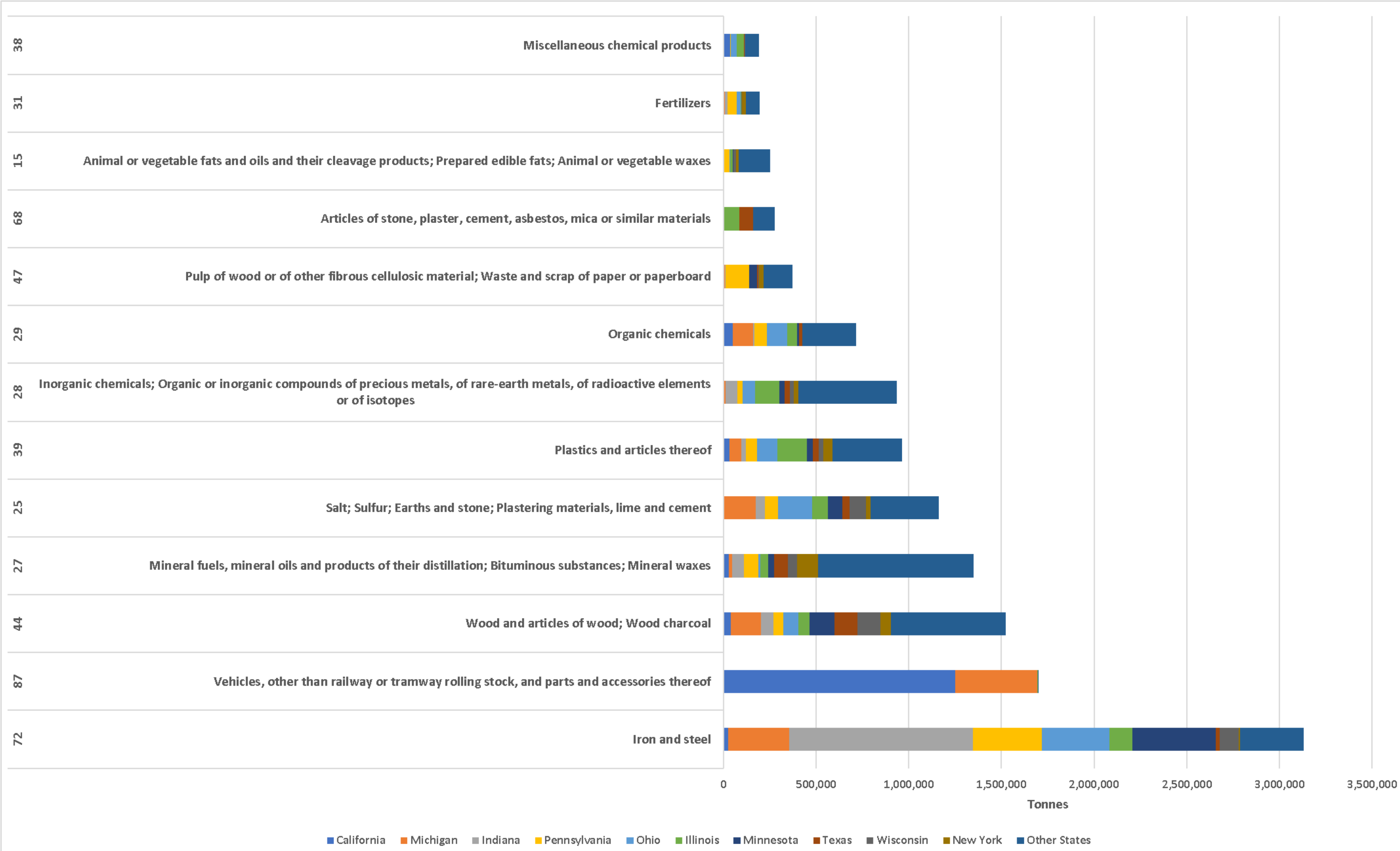
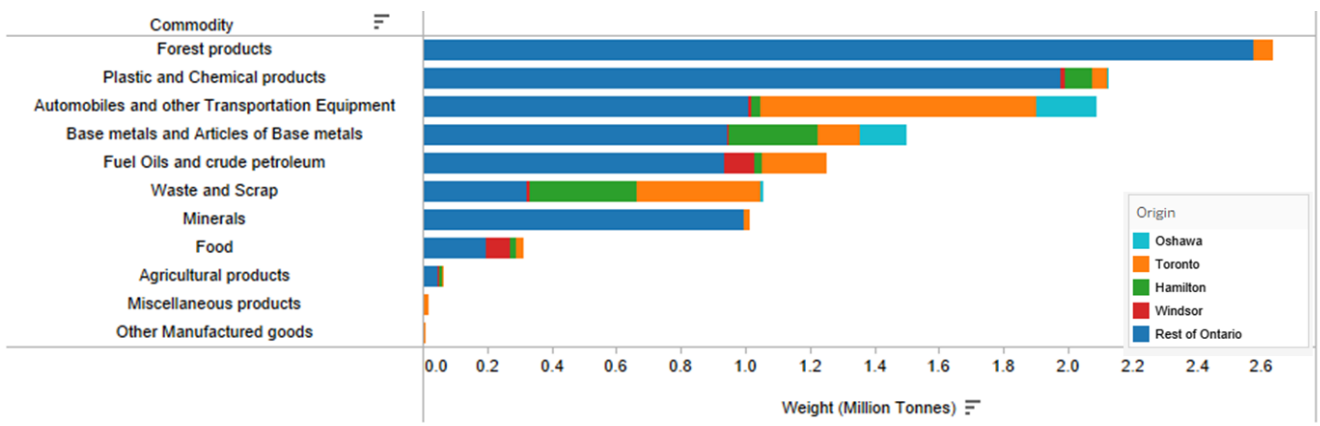


Figure 3-31: Ontario Export Tonnages Crossing by Rail to US States by HS Commodity Types (2021) (Source: Derived from BTS)

3.3 Rail

At the request of industry stakeholders and due to data constraints, this report has put much more emphasis on short sea shipping opportunities that may arise from collaborative cargo movement with the trucking sector. This section presents a compact review of cargo flows to and from Ontario in relation to the rail sector. The briefer nature of the section partly reflects that there is less data to analyze. The CVS data, for example, does not cover rail. As will become clear, there is also an apparent lesser diversity of cargoes that move by rail between Ontario and the US relative to what moves by truck.

From Ontario to US/Mexico



To Ontario from US/Mexico

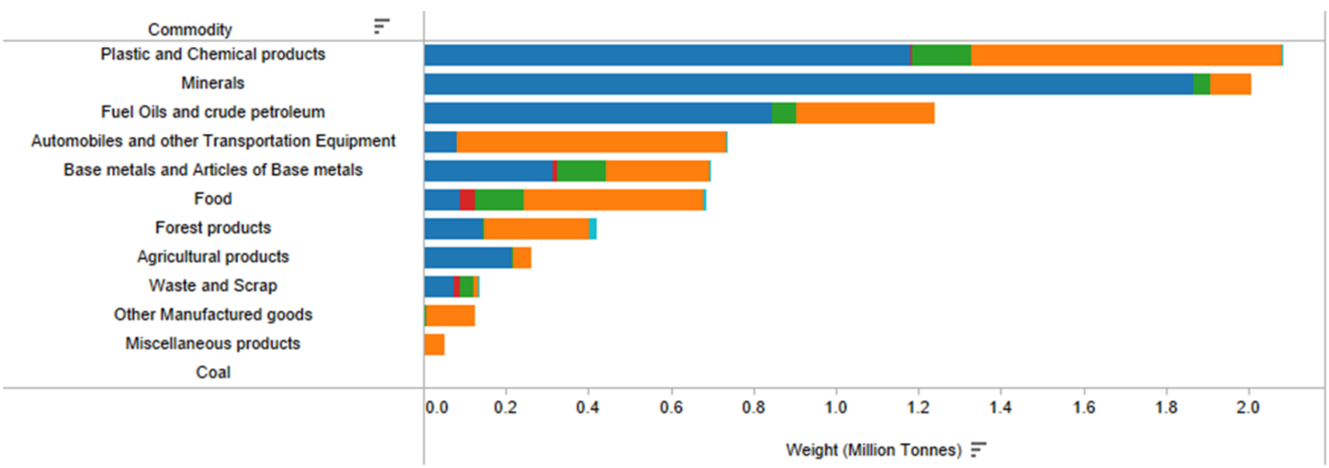


Figure 3-32: Rail Tonnage Moving between Ontario and US/ Mexico by Ontario Geography and Commodity Class (2017) – derived from CFAF data

Figure 3-31 on the preceding page shows export flows from Ontario that are associated with rail for the year 2021. BTS data based on 2-digit HS codes suggests that 13.5 million tonnes flowed from Ontario to the US and nearly 95% of the associated tonnage is shown here. The remaining 5% are spread among a rather diverse list of commodities but in fairly small quantities. It is interesting to note that more tonnage flowed to California than to any other state and finished vehicles appear primarily responsible for this outcome. The other top destination states in terms of export tonnage from Ontario by rail are all Great Lakes states with the exception of Texas. It appears clear that rail is a worthy competitor for the movement of Code 72 iron and steel outputs.

Figure 3-32 provides rail movements to and from Ontario with the US, based on the Canadian Freight Analysis Framework (CFAF). The latest results from CFAF are from 2017 and are thus somewhat dated. The top panel allocates 12.1 million tonnes of exports from Ontario and the bottom one allocates 8.4 million tonnes of imports into Ontario. It is not possible, based on the CFAF, to assess what US states are involved in these movements. The two total export quantities between 2021 and 2017 from the two different sources (BTS and CFAF) are in line, with some growth indicated from 2017 to 2021.

The commodity patterns evident in the BTS and CFAF data also appear reasonably well-aligned though based on somewhat different classifications. Generally speaking, it appears that raw commodities and other types of bulk commodities such as waste and scrap are most prominent. Vehicles are an obvious exception. The CFAF data in Figure 3-32 is geographically quite different from the trucking oriented CFAF from Figure 3-5. The “Rest of Ontario” is far more prominent as an origin and destination for rail than for trucking. The Census Metropolitan Area of Toronto is largely not involved as an origin for several raw commodity categories in the top (export) panel of Figure 3-32. Across commodity classes, the Toronto CMA is much more involved for rail imports into Ontario than it is for exports. Comparison with Figure 3-5 shows that the Windsor CMA, near the border, is also much more involved as an origin for road movements than it is for rail. On the US side, Figure 3-31 shows that for most of the commodity classes, rail appears to diversify its movements from Ontario to Great Lakes states quite effectively.

Some examination of the public use version of the US Rail Waybill Survey has been done. This source has similarities to the US Commodity Flow survey in that individual shipments (in this case rail) are tracked/sampled. In geographical terms, this source provides information on the province/state of origin or destination. For the purposes of the current report, it appears that the BTS data, tracking rail exports from Canada, does a satisfactory job in characterizing rail flows from Ontario. Additional details that the waybill sample can provide appear to be of a type beyond the needs of the current report. The waybill sample may add additional clarity for rail imports into Canada as the BTS data is weak in that regard, but we have also seen that the Statscan trade data appears well-quantified for rail in tonnage terms.

4.0 STAKEHOLDER ENGAGEMENT

This chapter offers an overview of themes that have emerged from engagement processes carried out with leading short sea stakeholders on both sides of the border. These were undertaken essentially to see if insights could be gleaned on how organizations think about cross-border short sea shipping opportunities and whether there are ways to work collaboratively on sourcing and using data to clarify such opportunities. An introductory overview document, shared with parties ahead of discussions, is included in Appendix A. These engagement efforts (being done under Fluid Intelligence) have built on a strong recent history of regional consultations by MITL in relation to supply chains and the movement of freight. See Ferguson and Pilla (2019) as an example of these efforts.

The primary questions that were posed during engagements (Appendix A), and which the engaged parties were able to review in advance, included the following:

1. Are there ways that you can foresee our organizations collaborating on these efforts?
2. What do you see as primary challenges and opportunities that are associated with the pursuit of new short-sea opportunities in the region? Any specific insights (e.g., with respect to potential cargoes) that you have along these lines will be much appreciated.
3. Are there data sources that your organization is able and willing to contribute to this collective research effort? Also, are there sources that you know of, that you think could help, that you might introduce to us?

In terms of primary engagements, anchored by the Appendix A script, the following organizations were involved:

- Algoma Central
- Niagara Region
- Ocean Group
- St. Lawrence Seaway Development Corporation
- Toledo-Lucas County Port Authority
- Windsor Port Authority
- Also, a prominent marine journalist[11]

[11] For the purposes of this report, we will not divulge the specific identities of persons consulted.

Follow-up engagement took place as well (with a subset of this list) in which specific results shown in this report were discussed for feedback. The sub-sections below are also supported by some informal and less structured secondary engagements through the course of this work. On-going input from the Hamilton-Oshawa Port Authority, through the Fluid Intelligence partnership, has been prominent and valuable. Other more informal engagements that have taken place include the Port of Montreal, the marine policy branch of Transport Canada, and the Cross-Border Institute at the University of Windsor.

Most discussion time in the engagement sessions revolved around the 2nd of the three questions outlined on the prior page but more so on the elements of challenges and opportunities. Insights on the identification of *specific* cargo opportunities, as opposed to general cargo categories, were essentially lacking. For the first question, there was a general stated interest in staying engaged with the initiatives of Fluid Intelligence and to be open to assisting. There were not well-formed ideas expressed about how exactly to collaborate. Further insights on the third question, on data sources, are offered below.

Taking account of the primary insights that have emerged from these discussions, some prominent themes that have emerged are identified below in the format of a sub-section per theme. The themes tend to gravitate towards challenges and secondarily to opportunities as it relates to short sea services. Aspects related to identifying, sourcing, leveraging and collaborating on data are much more in the background despite this theme being central to how the engagements were conceptualized.

4.1 Scarcity of Alternative Data Sources

Engagements did not identify meaningful new data sources, beyond ones already identified, that could inform analytics on the current project or into the future. Ports, for example, note that they are willing to share aggregate statistics about quantities of cargo moved. When current project data sources (e.g., the MTO commercial vehicle survey - CVS) were described, interest in the CVS was typically expressed along with speculation as to whether something similar exists in their own or a nearby jurisdiction. A recent engagement with the US Federal Highway Administration (FHWA) revealed no current knowledge of a source similar to the CVS in the US Great Lakes states. We received feedback that more in-depth investigation of US government sources (such as from the Bureau of Transportation Statistics – BTS) may reveal useful information. Indeed, BTS data has proven to be an important supporting source in Chapter 3.

4.2 Offering Services that are as Complementary as Possible

There was feedback that it is wise to align short sea shipping services to how they can be most complementary to other modes (trucking especially was stressed). For example, in the context of an ongoing truck driver shortage, we heard that it makes sense for trucking resources to consider shorter, faster cycles that emphasize cross-border truck trips less. This is consistent with observations that cross-border truck trips are far more demanding administratively and in other ways than domestic trips (Anderson, Tannous, Hamlin, Lynch, & Armstrong, 2021). Stakeholders with knowledge of the trucking industry stressed that faster cycling can translate into more pickups/deliveries and profitability. Clearly, cross-border trucking is something that takes place on a massive scale and is always going to be very significant, as major investments such as the Gordie Howe Bridge indicate, but short-sea shipping can offer a complementary approach as a middle mile partner.

4.3 Concerns about Aspects of Pilotage

In these engagements, various constraints associated with pilotage in the Great Lakes St. Lawrence system were portrayed as an obstacle for potential new short sea services. This is particularly true if a service offering with international crew or vessel is being considered but there were domestic concerns as well. The importance and necessity of pilotage services was not contested but regulatory and cost aspects were identified as sore spots that were viewed as holding back the prospects and flexibility for new short sea shipping initiatives[12].

It is well-known that the need to utilize a pilot from the Great Lakes Pilotage Authority or the Laurentian Pilotage Authority for a vessel movement is a costly endeavour. Domestic firms seek to avoid these costs by having their own pilots certified. However, it was noted by one respondent that the process to certify someone takes several years and at a cost that was estimated in the hundreds of thousands. In the past, if a candidate had completed a route, perhaps 15 times, they could be certified but it was noted that the number of required repetitions had increased dramatically. In practical terms, this has had the effect of driving up certification costs accordingly.

Nowadays, new short sea services that seek to be nimble and more frequent, with smaller than traditional tonnages, are being contemplated. The questions linked to pilotage services appear to cast a shadow on the creation of new short sea services. One party described that their conceptualization of the vessel to be used for a prospective new service was affected by pilotage. It was estimated that the use of a somewhat larger vessel, requiring navigation by pilot, would effectively double costs of the service per tonne of cargo.

Overall, there is a concern that the current pilotage environment has been designed more for the needs of the past than those of the future. History shows that high costs are bearable in the

[12] Note that feedback also tended to cover domestic short sea contexts (not just cross-border).

context of large vessels moving large quantities of cargo since the significant costs can be spread over many tonnes. But nimble and more frequent services that handle smaller amounts of cargo represent a different paradigm. As it was noted, fixed pilotage fees of $50,000, or similarly imposing certification costs, are much more difficult to reconcile for a 500 tonne vessel than a 50,000 tonne vessel. The Innovation Maritime report from 2021 (see section 1.3) offers some specific scenarios where estimated pilotage costs are provided.

4.4 Enhanced origin/destination ports in Southern Ontario

Potential new short sea services may require new port locations to operate. For example, the Port of Cleveland stated an interest in a cross-lake service (potentially a truck ferry) to better connect to Southern Ontario. Port Stanley was viewed as a logical location for the counterpart Canadian port as it offers direct access to London, the largest major urban centre in the vicinity. There is also good access to Hwy 401 connecting to the GTA. Port Stanley representatives apparently expressed concerns to US parties about heavy trucks operating near local recreational/tourist activities. Interest in such a service remains on the U.S. side apparently, but it proved challenging (from the Cleveland perspective) to generate similar interest on the Canadian side. Similar sentiments have apparently emerged at certain potential service locations on the north shore of Lake Ontario that have aspects in common with Port Stanley (e.g., Port Hope). Overall, as services develop, there is a need to identify a network of viable locations in southern Ontario to accommodate potential new marine shipments. Some of these locations will require enhanced infrastructure and equipment.

4.5 Seasonality and Weather

Some are of the view that the winter closure constitutes the biggest drawback of the Great Lakes-St. Lawrence Seaway system and is something that seriously limits the potential of short sea services. The implication is that a new service offering, with marine as a prominent component, must rely on other modes to span the closure period and achieve a full 12 months of service. One opinion was that the rail sector would not provide favourable rates to bridge this seasonal gap. Another option that is being noted to combat seasonality is an increased role for a hub at Port Colborne. This gives an all-season Lake Erie short sea shipping option at times when the lock system is not operating.

The winter closure was perceived to have another implication that is perhaps less well known. It was suggested that terminal operators are attracted to year-round opportunities as well and it was noted that the winter closure has a deterring impact on investments that they may make. The case for a strong return on investment can often be made more easily at a coastal port that operates year-round.

Multiple parties identified poor weather outside the winter closure period as a factor. Tug and barge services, which are being considered by some operators for an expanded role, do not deal as well with poor weather as vessels do and also do not travel as quickly as vessels[13]. The impacts of poor weather are described as being much more pronounced in the open water environments of the lakes versus the predominant river environment that characterizes the span between Lake Ontario and Quebec City. The month of November was described as being possibly the most unpredictable on open waters.

4.6 Containerization and Network Effects

In discussions about short sea shipping in this region, the potential movements of containers are top of mind for some. One prominent rationale for a focus on containers is to better tie the Seaway system into international trade which is heavily containerized. It has, in fact, been described by some as the future of the system. With containerization, the flexibility of marine transportation is noted to be considerably increased (Rodrigue et al., 2009). While connections to the wider international trading system are beyond the scope of the current project, engagement processes have revealed an interest in making more extensive use of containers in domestic or Canada/US contexts.

Among Great Lakes ports, the Port of Cleveland has been leading the way in developing container-handling capabilities. The Port of Duluth is imminently completing a facility to enable the handling of containers and has been working with border services for some time to enable international connections. The Port of Hamilton in partnership with Hamilton Container Terminal and Desgagnes has run a container-focused trial voyage. Naturally, with more and more Great Lakes ports that can handle containers, there is greater potential for services involving containers to be conceived. Having more container "nodes" can help to achieve a critical mass of the type that has been associated with high rates of growth in other contexts. Among ports that do not yet have container capability, we heard feedback that tenants ask when such capability might be forthcoming. Supporting services from the Canada Border Services Agency (CBSA) are another consideration.

4.7 Capacity Aspects and Service Priorities

While the Seaway is noted to function substantially below system capacity, there is feedback from stakeholders about a lack of suitable vessels to support short sea services. This was mentioned as an issue by the U.S. Seaway Development Corporation for the western Great Lakes.

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[13] To address the unique context of short sea services on the Great Lakes (including poor weather), industry stakeholders are apparently working together to investigate the design requirements of a purpose-built vessel.

To some extent this is explained by the emphasis of past decades on large bulk movements. No doubt the development of a more dedicated or specialized fleet over time will assist in the development of short sea services. Along with an expected gradual increase in the use of smaller vessels and barges, other creative solutions include the use of existing capacity on ocean vessels or the top deck on domestic vessels.

A theme of other priorities was mentioned as well. It was suggested that regionalized cross-border movements, of the type stressed in this report, simply had not been high on the radar screen of certain US stakeholders and that cross-ocean international movements/feeder services had attracted more attention. In terms of leveraging data, emphasis has been on the latter case rather than the former. It was suggested that Chicago, for example, has not really looked at the Hamilton-Chicago Lane.

Regarding capacity for containerized movements, these were described as more prominent in earlier days of the Seaway before the rise of mega-vessels on the oceans. Moreover, a correlation was identified between the size of vessels and the magnitude of required investments in on-shore infrastructure for loading/unloading. The implication was that smaller could be better in that regard. Tug and barge services are being advocated by some.

4.8 Congestion

We received multiple instances of feedback that road and rail congestion constitute one of the leading tailwinds in support of an increased prominence for marine in the region and as a "relief valve" for pressures and delays. There are some nuances though. For example, traffic congestion in Cleveland was identified as not being at the same level as congestion in Toronto. Congestion oriented to rail was focused on the idea that critical rail facilities (e.g., CN Brampton Intermodal) are operating at capacity and meanwhile, there are great challenges in getting the required new facilities approved and constructed (e.g., CN Milton Intermodal has been a long process to gain required approvals).

Alleviation of congestion is one aspect, but feedback was also received highlighting the potential for new marine movements to have economic development benefits. This is consistent with insights emerging from Section 1-3.

4.9 Competitive Concerns

Road and rail have potential to be complementary to new marine services, but they also offer intense competition (Ferguson & Lavery, 2012), particularly in moving some of the cargo types where marine aspires to increase its role. Engagements sometimes had an undertone of concern or a tentative sense about marine expanding its horizons, given the prominence of trucking and rail. This type of direct competition for marine is not present, for example, in the Vancouver Island case explored in Section 1.3.

One marine stakeholder described a typical situation with project cargo to illustrate the prominence of trucking as a solution for one-off, large shipments. Most cargo owners opt to break certain large project cargo into smaller pieces to separately move by truck rather than moving as a whole via marine. At the destination, the separately arriving pieces on trucks are then welded together. Marine offers an opportunity to avoid reassembly, but trucking tends to serve as a leading solution since many end-destinations are land-locked.

It was noted that short sea opportunities have historically often been promising in contexts where road and rail do not compete well. For example, tug and barge services are effective in servicing remote communities on the coast north of Vancouver and where road links are of lower quality. Tug and barge services have in the past served communities on Great Slave Lake and along the McKenzie River but better road links have diminished the needs for such services.

The supply chain challenges of this decade, along with other marine drivers that have been mentioned earlier, have illustrated that there is a future expanding role for new short sea services to make contributions even where trucking and rail are well utilized.

4.10 Potential New Marine Services

A list of potential marine services that have come up in discussions (some of them not cross-border and with a scope more general than this report) is as follows:

- A cross-Lake Erie service (possibly a truck ferry) connecting Cleveland to the north shore of Lake Erie
- Montreal/Quebec/Maritimes to/from GTHA
- Ontario/Quebec to Midwest Connections
- Southern US via Mississippi to Georgian Bay Service
- Utilizing the Erie Canal as a Marine Gateway to the US east coast
- A Lake Superior truck ferry from Thunder Bay to Sault. Ste. Marie

Regarding a Mississippi link to the Seaway, the major drought event of 2022 (Goldstein, 2022) that greatly reduced the capacity of the Mississippi to handle freight movements, highlights how an increased Seaway role for US cargo originations to overseas, can improve overall system resilience.

5.0 CONCLUSIONS

Prior consultations with regional marine industry stakeholders had revealed an appetite to understand more about freight data and the insights that it might provide about marine opportunities. Further engagement within this study reinforced the same basic notion. To this end, this study reviews available data sources for their strengths and weaknesses in support of cross-border marine, demonstrates how existing but separate sources are complementary, prototypes simple tools that industry participants could ultimately use themselves, and identifies some of the most promising opportunities for marine.

Overall, the study and the work behind it provides important foundational elements that can support the operationalization of new short sea shipping ventures. Apart from improving the knowledge and tools of industry stakeholders, this work ultimately has the potential to help reduce metropolitan traffic congestion and GHG emissions from trucks and ensure that increasingly scarce supply chain labour resources are more efficiently allocated. The study in a sense previews a future in which multi-modal transportation assumes a more important role and one in which marine is even more prominent.

5.1 Geographic-Oriented Observations

- Higher-level overviews of goods movement quantities between Ontario and US States (see Figures 3-1 to 3-3), show that an emphasis on the Great Lakes States for further marine opportunity is well-placed. Cross-border tonnages moved in the Great Lakes vicinity are very substantial in absolute terms and in relative terms compared to movements beyond the region. In terms of tonnages moved, marine already makes a large contribution for the Great Lakes region but trucking still moves more quantity over significant distances than does marine. There appear to be opportunities for marine to do even more in this region.
- One approach to evaluating opportunity, expressed by a major marine carrier in our engagements, is that it is more important to understand the intensity of cargo connections between geographies than the particular cargoes that might be involved. This carrier expressed more optimism for the expanded role of marine in longer-distance Great Lakes scenarios, drawing on tight catchment areas around ports. These observations formed the basis for the Port-specific analysis outlined in Section 3.2.3 of the report and this initial set of conclusions is also more geographically focused.
- Overall, southern Ontario has quite a strong focal area for potential multi-modal connections that would involve cross-border short-sea shipping, and this is the Greater Toronto Hamilton Area GTHA). Much of the goods that flow in or out of Ontario begin or end their trip in this

region. While other regions in Southern Ontario are associated with a lot of truck activity to the US, more prominence for short sea shipping is likely tied to capturing a larger share of the goods that flow over longer distances in their travels to or from the GTHA.

- In terms of new marine connections between Southern Ontario and Lake Superior states (primarily Minnesota and the north of Wisconsin) centred on Duluth, evidence from the CVS showed little potential based on an absence of sampled connections with Southern Ontario. To the extent there are cross-border movements, they appear to be more localized according to the CVS. Trade data confirms some significant cross-border activity, but we have to assume that this is localized to the Lake Superior region based on evidence from the CVS. Stakeholder engagement suggested a potential role for a Thunder Bay to Sault Ste. Marie truck ferry, but this would be more to assist with longer trips connected to out west. Such a service could be examined as future research.
- Southern Ontario connections to Lake Michigan may offer the most opportunity. The distances that need to be covered are relatively large although it is possible (perhaps not desirable) for a truck driver to go between Toronto and Chicago in a day. The volumes to and from Illinois are simply less than what they are with Michigan. However, the CVS suggests a solid 2,000 trucks a week per direction moving between the Port of Chicago vicinity and Southern Ontario. This volume applies even with a tight 50km catchment area around the port at Chicago. The Port of Milwaukee also appears to offer some opportunity centred more on Wisconsin though on a lesser scale. A larger catchment area around Milwaukee needs to be assumed to illustrate an existing connection of approximately 600 trucks a week per direction to and from Southern Ontario. Marine movements from Milwaukee to Southern Ontario have the additional advantage that they could potentially reduce traffic congestion, all at once, in the major metropolitan areas of Chicago, Detroit and likely Toronto in some scenarios. Perhaps the scale of marine movements could be enhanced by the diversion of more cargo to and from Chicago for longer marine transit elsewhere.
- The case of Lake Erie is possibly the most interesting one. There are several significant urban centres in the Lake Erie domain including Cleveland, Toledo and arguably Detroit. The area offers the potential to pursue all year-round marine movements that are not impacted by the Seaway closure, though winter ice clearance would be an issue for a Lake that can freeze quickly. The Port of Cleveland has speculated about Port Stanley as a possible connection point on the Ontario side while many Ontario stakeholders prefer the potential of Port Colborne, which is actually on the Seaway, offers the potential to bypass locks during the winter closure, and is closer to the heavily populated areas of Southern Ontario. Shorter marine distances involved and intense competition from some well-established trucking lanes could limit potential.

- A 100km catchment area around the Port of Cleveland is associated with an estimated 2,700 cargo-carrying truck trips a week, 57% of which are associated with imports into Canada (mostly Southern Ontario). Nearly 1,500 of the trips tied to the Cleveland vicinity are focused on the GTHA.
- The Port of Toledo may offer possibilities. Engagement with the Cross-Border Institute at the University of Windsor suggests that the Interstate 75 corridor, which passes directly through Toledo, is strategically important for connecting the border area to many interior US states. There may be potential to tap into this huge funnel of truck traffic to bypass Detroit for a share of truck movements and reduce the need for some longer-distance truck trips to cross the border. Apart from movements to and from the GTHA and southern Ontario, marine connections to Quebec and Eastern Ontario could be important as well for this option. The strategic nature of Toledo is highlighted by large changes in trucking potential based on the size of the catchment area that is used (See Table 3-2 and 3-3). A large catchment area that includes several US states beyond the Great Lakes is advisable to define the true potential.
- Cross-Border marine possibilities focused on Lake Ontario suffer from a lack of US population on the southern shore that reduces potential cargo volumes. Western Lake Ontario may ultimately offer potential to connect Toronto to Niagara through an operation that combines people/tourist movements with goods movement but that is a topic for future discussion. A Rochester-Toronto marine service from nearly 20 years ago focused mostly on people movement but could not be sustained. Analysis with CVS data reveals a Rochester-centred cross border connection that is comparable in scale to Milwaukee results, and even larger if some Buffalo flows are included. However, the same analysis reveals that much of the connection is to the western GTHA rather than eastern GTHA and points eastward. A Rochester-Port of Oshawa connection would have reduced potential if based on tight catchment areas around both locations.
- Prior observations in this section have been based on *existing* data and flows but there is the possibility (possibly a smaller one) that marine can induce new trade flows on its own. This would be in certain rare cases where marine offers more direct geographical connections than either trucking or rail.

5.2 Commodity-Oriented Observations

- The diversity of what is carried by trucks within the Great Lakes region is one of the strongest commodity themes in this analysis and this diversity is amplified by geographical dispersion of these commodities within the region. A review of the CVS data showed approximately 500 categories of goods at the 5-digit SCTG level. Rail movements show much less regional commodity diversity than trucking in this regard.

- There is also a lot of trucking diversity in terms of shipment size with the general trend being that higher-value cargoes translate into smaller shipments. The trucking mode appears effective in aggregating smaller shipments into truckloads that are viable for trips. But for lower value cargoes, the CVS survey indicates that the majority of 100km+ truckloads are based on single waybills that indicate single shipments. These types of trips may be the best initial candidates for more marine involvement. The bottom half of Figure 3-8, for example, illustrates the types of cargo classes most associated with large truck shipments.

- Data sources are consistent in showing the prominence of the automotive sector in terms of large cross-border quantities of goods, often over significant distances. The prevailing wisdom is that it will be difficult for marine to play a role in these supply chains. Iron and steel and related products are also moving by truck and rail in large quantities over large distances within the Great Lakes region. It seems that more could be done to involve marine for these heavy cargoes that are accounting for many truck trips, but here as well there are also strong ties to automotive supply chains.

- Turning our attention to potentially suitable cargoes from the automotive sector that are not showing up in the data sources of this study, we need to consider the case of electrification of transport. In the upcoming years, there is significant potential for the large- scale movement of cathode active material from Quebec and Eastern Ontario to the core of Ontario or the US Midwest. This battery precursor material is not considered hazardous for transport and is not "just in time" in nature. Potentially marine can play a role.

- Cargo flows have a "long tail" in quantity terms. Especially in the case of trucking, a few cross-border cargo types are associated with large quantities. But there is a much longer list of cargoes that move in relatively small, but still potentially significant, quantities. This demonstrated high diversity of trucking cargoes that cross the border poses challenges in terms of identifying markets of sufficient size to support short sea shipping. There may be pockets of opportunity that are not easy to identify. Particular cargoes may have their own logistics nuances for transport, which can be identified on a case-by-case basis. Attractive characteristics for marine are: non-perishable, larger quantities, lower value and less time sensitive.

- Containerization has worked on a massive scale around the world because it plays a major role in standardizing goods movement. Cargo type specific logistic nuances of the type just mentioned above are minimized. Diversified cargo is made more uniform. The CVS data reveals that few longer distance trucking movements between locations in the Great Lakes region involve the movement of containers. Therefore, to the extent that new services on the Great Lakes utilize containers, the service itself may have to do at least some containerization.

- Overall, the best cross-border short sea shipping opportunities for the region are likely to be a combination of the right geographical context and the right commodities and volumes. The port-specific commodity and geography charts in Section 3.2.3 of this report did the best job of uniting the geographic and commodity components for decision-support. These were based on the MTO CVS data which provides more geographic detail than other sources but has its own challenges.

- Based on these port-specific charts and the outputs derived from other data sources, the best apparent opportunities for marine to complement trucking are:

    - Code 32 Base metals in primary and semi-finished forms which are associated with truck movements on a large scale. Depending on the geography, this category applies for both import and export contexts and is tied prominently to Lake Michigan and Lake Erie.

    - Code 41 Waste and Scrap cargoes appear prominent for flows from the GTHA to the Detroit Vicinity.

    - Code 27 associated with paper and paperboard products, moves on a fairly large scale to the Lake Michigan vicinity.

    - If Code 23 Chemical products can be suitable for marine, these move in large quantities from the Chicago vicinity into Ontario.

    - There are many other cargoes moving in smaller quantities that could be suited and especially if aggregated via containerization. More detailed investigations on a commodity-by-commodity basis are needed along with the potential to accumulate and consolidate varied cargoes at Great Lakes ports.

    - As an example, Code 34 Machinery would be a new area for Great Lakes marine and the commodity flow survey suggests that about 500,000 tonnes per year cross into Ontario from the Great Lakes States. The same survey suggests that the average shipment size is a relatively small 1.5 tonnes indicating many shipments per year and potential time sensitivity. More investigation is needed to sift through these cases.

5.3 Data Source Observations

- The combination of Statscan trade data, the MTO Commercial Vehicle Survey and US BTS transborder data provides a solid combination to understand the longer-distance surface transportation of trucks and the cargoes they move, particularly within the Great Lakes region. The combination gives a good sense of what could be possible for the development of new multi-modal movements involving marine. Understanding Statscan trade data provides a lot of on-going detail on trade flows that are known to cross the border by truck, while the CVS offers a periodic “x-ray” of the system (admittedly a sampled one) to show what truck trips actually take place, between roughly where, and what is being carried. The combination offers a somewhat Ontario-centric view but there appear to be plenty of insights for other jurisdictions, including some in the US, to benefit as well.

- We would expect a stable future for trade data sources given the importance of trade for both Canada and the US and we wish a stable future for the MTO commercial vehicle survey. Over time, the utility of the 2019 CVS source, which has already been negatively impacted by the pandemic, will start to decline and become dated. A new version a few years from now, perhaps collected in ways that are influenced by new technologies, is an important tool in monitoring the landscape for marine opportunities, not to mention the myriad other applications of the CVS.

- Engagement efforts have been a key qualitative data source for this project. Perhaps the most important insight is that the key data sources of this report appear not to be significantly used by industry stakeholders in pursuing strategic opportunities. There appears to be a need that Fluid Intelligence has begun to address in this report and solutions that could be offered to interested stakeholders.

- On the other hand, engagement efforts to uncover new and applicable data sources to support analysis of short sea shipping opportunities have been notable mostly for their failure to uncover significant new sources to this point. It appears that the dominant data sources that can help are sourced from federal or provincial sources on either side of the border and are done on a large scale that does not necessarily focus on marine contexts per se. ATRI trucking GPS data, which is collected through the participation of private sector firms, could offer insights into potential marine connections to trucking.

- The engagements have probably revealed more familiarity with the challenges that confront new short sea services (e.g., winter closure, competition, cost competitiveness, scalability and others) relative to the familiarity with short sea opportunities. The data-driven approach advocated in this report is the best path to clarifying such opportunities.

- Our understanding of potential short sea opportunities to complement the rail mode will be enhanced if an entity like Fluid Intelligence gains access to better and more detailed data on rail. Rail was not covered extensively in this report partly because most of the available detail is readily accessible only in trade data sources. These sources highlight what crosses the border by rail but are less effective in showing where rail cargoes originate or where they are going.

5.4 Future Work

- Overall, there is potential to translate the types of efforts seen in this report, including tools that have been created or could be improved upon, into on-going efforts that seek to understand trends in cargo movements focused on the Great Lakes region. These efforts would rely on an array of data sources and would provide marine stakeholders the periodic information that they need. Such efforts require an ongoing flow of data with the associated financial and human resource commitments to make them happen.

- Efforts dedicated to data fusion are likely to create outputs that better inform marine stakeholders on an on-going basis. This would involve the development of new data outputs that contain more detail than any single data source on its own. In particular, the MTO CVS could be used to help add more sub-provincial and sub-state detail to the trade data sources. The trade sources are less geographically detailed for reasons of confidentiality.

- There is the potential for federal government to improve the utility of trade data sources for a wider audience. For example. Efforts to generalize quantity into standard units of measure (e.g. tonnes) across all commodities would be most welcome. Any further provision of geographic detail at sub-province or sub-state levels would be helpful though we recognize the sensitivities involved.

- This report gives a sampling of the charts and graphics that can make these data sources accessible to stakeholders. In the context of a spreadsheet deliverable, for example, charts can be explored interactively and more effectively than in the current report format. Also, a wider range and larger quantity of charts can be developed when the focus is on packaging data. These efforts may ultimately translate into a well-conceived dashboard tool that can be refreshed with updated data.

- There is more work that can be done to explore *particular* opportunities in certain commodities (or breakbulk) that may not be associated with large tonnages. Or for converting bulk/breakbulk into containerized units where it makes sense. In some cases, stakeholders may bring these to the table with an understanding that available data and tools housed at Fluid Intelligence can help to quantify potential. There is also the potential for such tools to be put in the hands of the stakeholders themselves, if so desired.

- There is the possibility to leverage trade data on an on-going basis, at detailed commodity levels, to explore temporal patterns at a monthly resolution. Temporal analysis has not been a focus of the current study but such analysis can portray the consistency of certain flows that may be of interest for short sea shipping. Such analysis may also reveal commodity flows that are trending up or down and associated with certain strategic border crossings.

- Related to the prior point, comparison of the 2019 and 2012 CVS sources may yield insight on temporal trends of goods flows by truck though it should be borne in mind that the pandemic-affected 2019 CVS relies on some 2012 records.

- There are likely *domestic* opportunities, not examined here, that can be evaluated in more depth. Evaluations are more challenging in that domestic flows, including those over meaningful distances, are not captured as well in data sources as cross-border trade flows.

- While this study has focused on opportunities linked to Southern Ontario, there is potential to look more deeply into Quebec connections with the US, including the Midwest, for an increased marine role. There is good available data to do this.

- Existing marine data sources that are housed at Fluid Intelligence -- see Ferguson and Sears (2020) for further discussion -- can give some insight into capacity that is created, for example, after an unloading event and is potentially available prior to an onward movement. Available data are focused on the Port of Hamilton, but Fluid Intelligence can investigate information from other Ports that is made available.

- For domestic contexts, there is a need for educational development via a short course on short sea shipping. During the completion of this work, it was observed that short sea terminology can mean different things to different stakeholders. Foundational concepts on short sea shipping do not seem incorporated into a solid theoretical foundation but instead seem defined more on an ad hoc basis according to unique situations.

- While it will be up to industry to lead, there is a need to investigate specific marine services to establish their business case. Such investigations would need to include aspects such as the nature of the vessel, the frequency of service and the role of cost components in influencing what is possible. Some services may be unlike what has occurred before in the Great Lakes system. Leading this type of work is beyond the mandate of Fluid Intelligence, although a supporting role anchored on an understanding of relevant data sources could be likely.

6.0 APPENDICIES

6.1 Appendix A: Brief Engagement Document

Identification of Cross-Border Short-Sea Shipping Opportunities

Earlier this year McMaster University's Institute for Transportation and Logistics – (MITL) partnered with the Hamilton-Oshawa Port Authority (HOPA) to form "Fluid Intelligence".

We're analyzing data, leveraged through our relationship with Transport Canada, to improve the competitiveness of supply chains operating in the Great Lakes region – emphasizing efficiency, multi-modality, environmental impact and resiliency.

Some of our early investigations pointed to possible opportunities for short-sea shipping (breakbulk, bulk and containerized) in the Great Lakes Region. We're taking a deeper dive to quantify these opportunities and to gain insights from the key players into the considerations necessary to pursue short-sea shipping investment strategies.

Our investigation includes all surface transportation alternatives for freight – not just marine – to better understand the range of possibilities for short-sea shipping. We understand that transportation and logistics is a highly competitive industry and we're sensitive to the need to maintain confidentiality.

We at Fluid Intelligence request your participation in our efforts, not only in relation to this project, but also in pursuit of the larger effort to help improve regional supply chains.

For the short-sea shipping project, we would like to engage with you on the following three main themes:

- Are there ways that you can foresee our organizations collaborating on these efforts?
- What do you see as primary challenges and opportunities that are associated with the pursuit of new short-sea opportunities in the region? Any specific insights (e.g., with respect to potential cargoes) that you have along these lines will be much appreciated.
- Are there data sources that your organization is able and willing to contribute to this collective research effort? Also, are there sources that you know of, that you think could help, that you might introduce to us?

We would be delighted to hold discussions with you, anchored on these main themes, but with the potential for you to communicate to us any other facts and/or viewpoints that you believe will inform our effort.

6.2 Appendix B: Doornekamp Case Study

The story of Doornekamp Construction Ltd. is an interesting and entrepreneurial one (Horwood, 2021), with some potential lessons for expanding the marine mode in the Great Lakes region. We know from MITL's prior consultations that this story has attracted attention from major players associated with the large-scale movement of freight. Over time, the Doornekamp entity has operated a larger group of companies under its umbrella with one of them being Picton Terminals located just outside of Picton, Ontario at a location well-shielded from rough waters. The firm has worked to refurbish the terminal site since acquiring it in 2014, with the result being a modern, privately-run port. The Picton Terminals were originally built in 1953 for the shipment of iron ore to the US but those shipments stopped after 1978 and the site has been used sub-optimally prior to its acquisition by Doornekamp. The new owners had conviction that Lake Ontario's marine market was underutilized and saw an opportunity to assist their construction business while investing in the future growth of Picton Terminals. Improvements included the refurbishment of an existing conveyer system (which is now more efficient than it had ever been), renovation of buildings, the purchase of a mobile harbour crane and the capability to store up to 2,300 shipping containers.

Doornekamp has been involved with Toronto's Ashbridges Bay Landform Project which entails the construction of breakwaters on Lake Ontario (Dupuis, 2021). Aggregates stored at the Picton Terminals site are loaded onto barges and move directly via marine to Toronto. The firm can move 4,000 tonnes of stone per week and avoids many unnecessary truck trips that would also take much longer to complete the task. Scenarios like this drove much of the original interest in acquiring the terminal.

More recently, the Doornekamp Lines subsidiary has been developed as a logical progression to maximize the potential of marine. The subsidiary has acquired a fleet of two container ships, two tug boats and 6 barges and expansions to the fleet are planned (Horwood, 2021). In a recent two-year period, $30 million of goods (containers and bulk cargo) was shipped with its fleet using a connection to Halifax. The Picton Terminals handled 150,000 tonnes of cargo in 2020.

On August 23, 2021, the Dutch firm Spliethoff announced that Doornekamp Lines was assisting in its "Cleveland Europe Express" service. In particular, Spliethoff leased the Doornekamp container vessel Peyton Lynn C, to employ it in a regular schedule between Antwerp and Cleveland. The possibility to unload inbound containers at Picton as part of the service has not been approved. The leased vessel has added container capacity (855 TEU) to a service that has moved varied cargoes since 2014. The estimated transit time between Antwerp and Cleveland is 15 days. The service exploits a market for a direct and predictable connection from Europe and deep into the interior of North America, with the ability to bypass some potentially congested major logistics facilities on the way.

Doornekamp Lines is on record as saying that expansion is in the works, with a larger fleet of vessels and ambitions to include other Great Lakes destination such as Oswego, Windsor, Chicago, Duluth and Thunder Bay (Horwood, 2021). As such, the firm is pursuing an integrated strategy that addresses Canada-US cross-border needs and potentially as well the larger international picture. Doornekamp has continued to express interest in a domestic Halifax to Picton container service and apparently that was the initial service for which the container vessel leased to Spliethoff had actually been acquired. Plans changed when Spliethoff approached Doornekamp (Frederick, 2022).

An important component of the Doornekamp strategy has been to own all the assets that make the overall value proposition work. The firm owns vessels, a port and trucks (Brock, 2021) meaning that all the essential ingredients are in place to enable the services being provided without the complications of a large number of parties being involved. Given that new short sea services on the Great Lakes are at early stages, this is an important consideration. Doornekamp notes that aspects such as the Seaway winter closure and the lack of ability of most Great Lakes ports to handle containers are less than ideal but still opportunities are being pursued. Economic Development entities in the Kingston region are pleased to be able to describe the possibilities that the Doornekamp operations enable for regional businesses (Horwood, 2021), especially in light of a strategic location between Toronto and Montreal and in close proximity to Hwy 401.

6.3 Appendix C: Discussion of 2012 CVS Pie Charts

The figures in this appendix (based primarily on 2012 CVS data analyzed earlier in this project) leverage the fact that one of the valuable roles of the CVS survey is to describe exactly what cargoes are in the trucks that are being intercepted. Few, if any, data sources offer that type of information. The two main figures show how tonne-km, that are incurred by truck movements to and from the US, are allocated across commodity types. Most of these movements are linked to Ontario but some will be linked to Quebec. The provincial aspect is not broken down here.

The CVS captures a detailed commodity description at the time of the intercept and our understanding is that MTO manually codes each sample observation after the fact. The distributions in Figures 6-1 and 6-2 are based on five-digit SCTG codes that were added to each observation by MTO. We used our own discretion in actually labelling some of the slices of the pie chart. Based on visual review of the actual truck contents captured in individual CVS records, we adjusted some SCTG default descriptions to better reflect what was actually in the trucks. For example, Peat Moss was seen to be very prominent as the actual cargo in trucks for SCTG category 13999 (other non-metallic minerals). We edited the label to reflect that.

A few other notes about the charts are relevant:

- Specific geographic corridors between Canada and the US (e.g., via primary Michigan crossings or Niagara) are not portrayed below but are included in the main part of the report.
- The charts portray only the top 50% of the trucking tonne-km that are captured in the CVS for the sampled cross-border truck trips. For exports, this amounts to 230.8 million tonne-km per week while for exports this is 268.2 million tonne-km per week.
- Within that top 50% there are a small enough number of five-digit SCTG codes that the results can be reasonably displayed in pie charts. The bottom 50% of tonne-km are much more highly diversified and fragmented in terms of the cargos. To give an idea, the entire set of export trips is diversified over 417 distinct 5-digit SCTG codes while import trips are even more spread across 500 distinct codes.
- Consider that shorter cross-border trips are omitted from the sample since only truck trips over 100km are included. So, for example, *short* cross-border trips having to do with the automotive supply chain are omitted. The share of trip distances that relate to Canadian or US territory varies.
- For the trips into Ontario shown in Figure 6-2, the large "produce" slice, reflecting highly perishable items is actually an aggregation of several SCTG codes related to varying types of fruits and vegetables. These types of cargoes are unattractive for short sea shipping.

Bearing those thoughts in mind, the following observations about the Figures 6-1 and 6-2 apply:

- The flow of goods by truck *into the US* has a more favourable profile for potential short sea shipping cargos (than the reverse flow) in that the presence of perishables appears to be much less. The estimated 78.3 million weekly tonne-km for imported produce suggests massive truck activity but it is difficult to see a role for marine in even partially addressing those needs. Also, many of these produce movements are over quite long distances moving far beyond the Great Lakes region.
- The automotive supply chain is highly prominent in both import and export flows.
- The absence of tanker cargoes is striking, suggesting that other modes such as rail are playing a prominent role in this regard.
- There are an estimated 12.9 million weekly tonne-km of waste/garbage that flow by trucks into the US. It is concerning that there is so much truck movement associated with this low value cargo. Much of this is destined for Michigan.
- There appear to be opportunities in the paper, newsprint, paperboard commodity types though this is more for flows into the U.S.
- Less-than-truckload freight (labelled as LTL in the figures) is relatively not prominent in the distributions considering it is a prominent class of freight movement in its own right. It is more prominent for imports than exports but in general is likely to be a difficult market for potential short sea shipping.
- The two figures show only part of the huge diversity of truck cargoes that cross the border. This high diversity, in itself, is challenging in terms of identifying markets of sufficient size to support short sea shipping. Containerization reduces this diversity and makes it more manageable but as has been noted, existing container movements account for only a small percentage of these types of cross-border movements. As such, attracting more of these diverse cargos to move by cross-border short-sea shipping would appear to require a far greater use of containers. Most trucks that are in use are inconsistent with containerized movements.

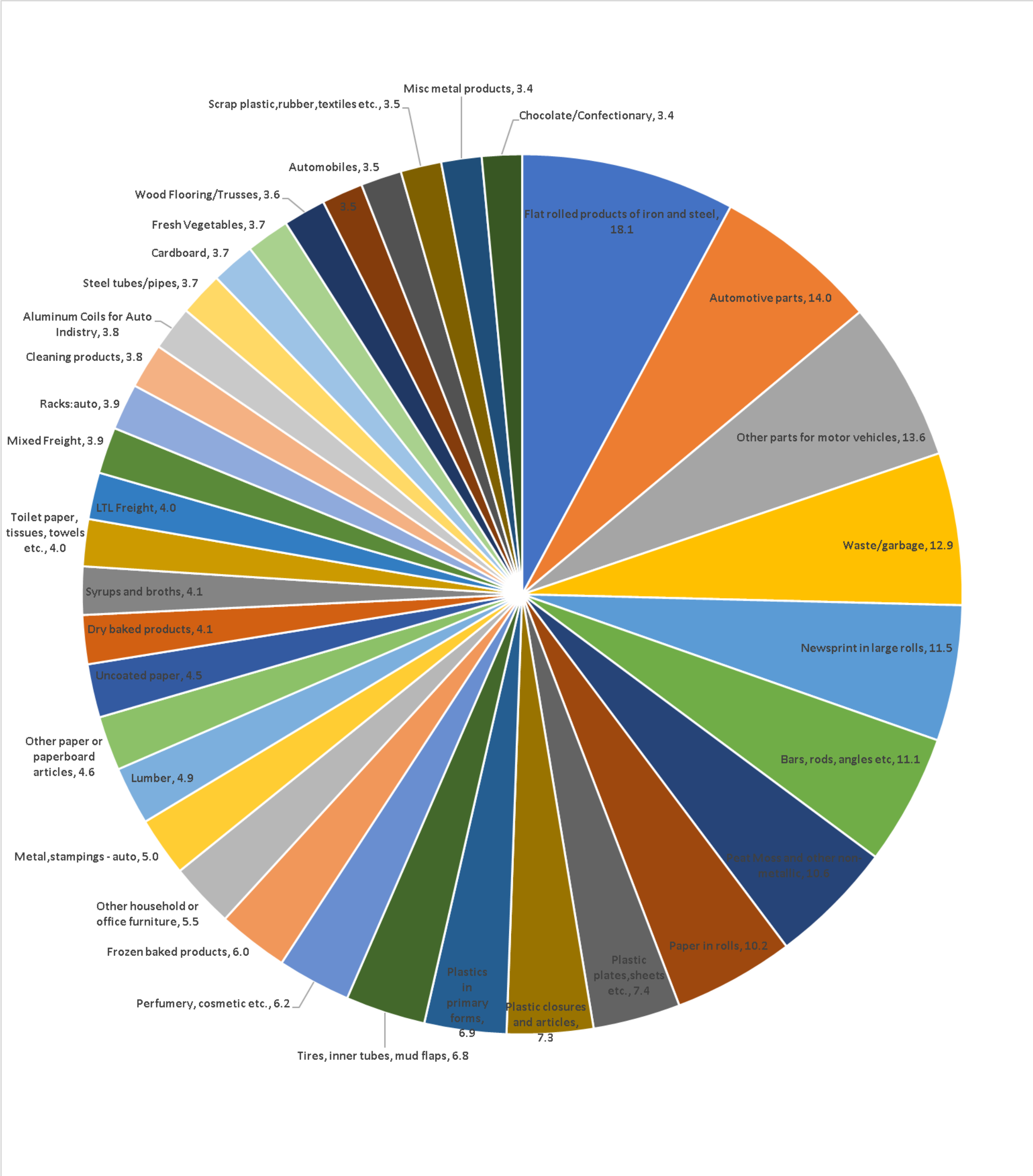


Figure 6-1: U.S. Bound Weekly Trips – Allocation of Leading Cargoes (millions of tonne-km)

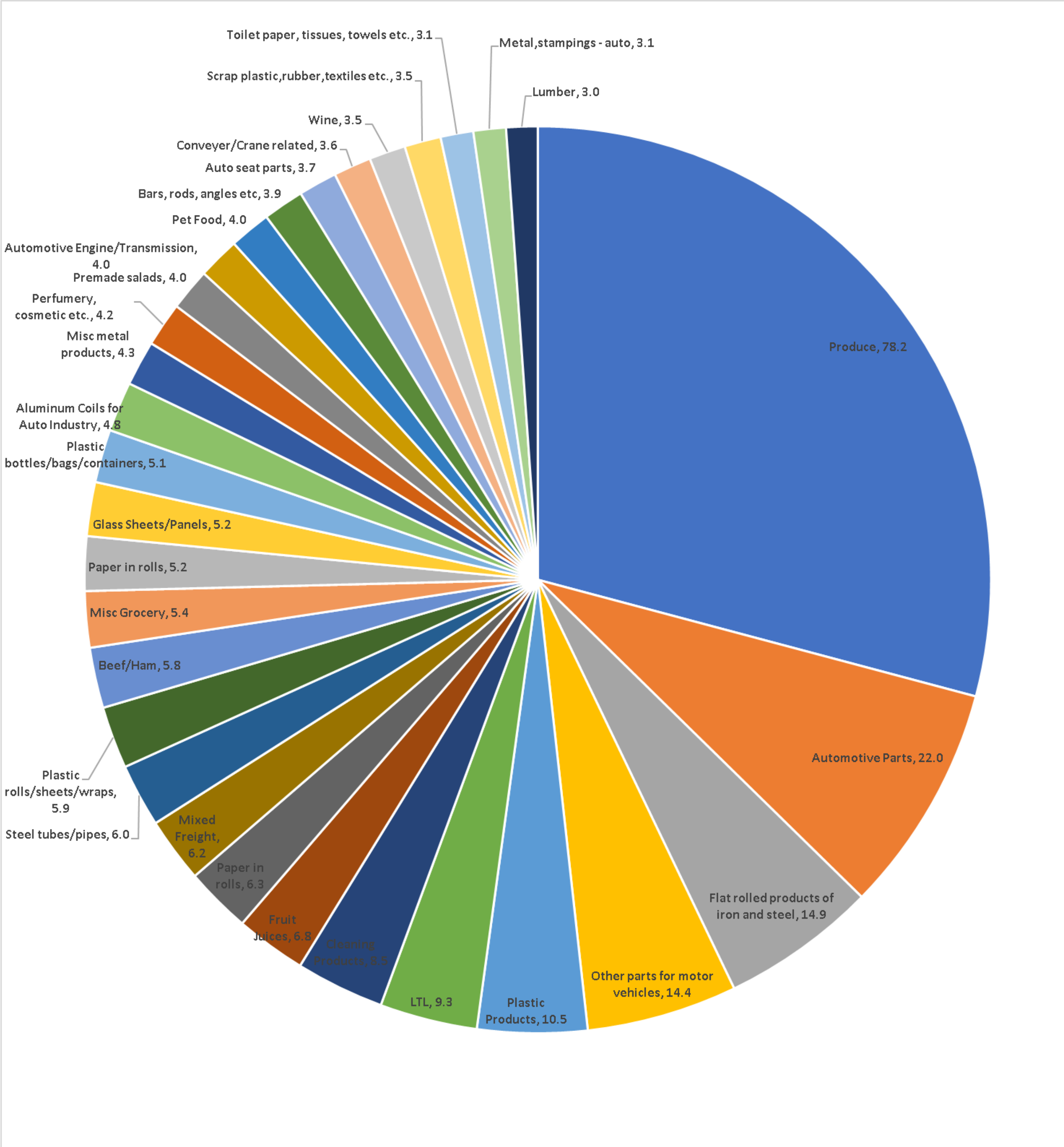
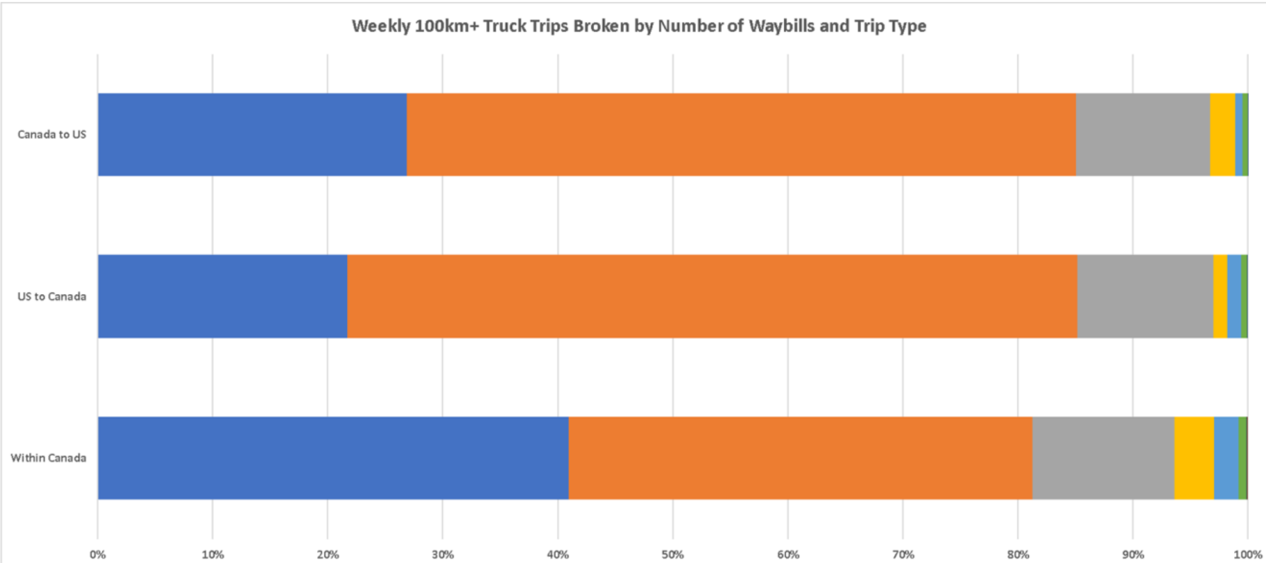


Figure 6-2: Ontario Bound Weekly Trips – Allocation of Leading Cargoes (millions of tonne-km)

Figure 6-3 below is also based on the CVS survey but in this case the more recent 2019 version. The graphic breaks down trips by the number of waybills that are associated with a trip. Also, export and import trips are differentiated from intra-Canada trips. The results show that a lot of 100km+ trucking trips that cross the border are based on one shipment (orange colour). Empty trips (coloured in blue) are also very prominent. In theory, the less complex logistics associated with single-shipment truckloads could signify a greater likelihood for marine to play an expanded role.



	Within Canada	US to Canada	Canada to US
N/A	131,584	12,209	15,334
1	129,574	35,709	33,223
2-5	39,701	6,662	6,652
6-10	10,905	673	1,259
11-25	6,965	694	348
26-50	2,175	302	269
51-100	211	32	20
101+	208	0	0

Figure 6-3: Number of Shipments Associated with 100km+ Truck Trips by Trip Type

6.4 Appendix D: A Spreadsheet Tool to Help Analyze StatsCan Trade Data in the Great Lakes Region

Figure 6-4 displays the primary layout components of a Statscan spreadsheet tool that has been developed. The particular case shown is of goods originating in Ontario but crossing by road into the US. There is another sheet that deals with the reverse flow of goods. The tool is based on a re-organization and aggregation of detailed trade data that was received. Using basic excel capabilities like filtering on values of any column and sorting any field as desired, a wide range of exploration scenarios are possible. The tool has the following properties/fields:

- Records are at the level of 4-digit HS coded (though finer detail can be used as well)
- The associated two-digit HS code is included to help with filtering records.
- The full description of the 4-digit HS code is provided to help understand the nature of the commodity category.
- The units of measure associated with the record is displayed. Note that the same 4-digit HS code may be associated with more than one unit of measure.
- The year of the data is displayed. Single years from 2016 to 2020 can be chosen and there is an option to choose the summation of all five years with a click.
- The total value of the goods moving from Ontario to the US is displayed for that record.
- The subset of that total value that moves to/from a Great Lakes state is displayed.
- The raw quantity of the record (quantity) as would be seen in the original data source is displayed.
- A converted quantity (q) is displayed. For example, goods that are shown in the quantity field in kg would be shown in the q field in tonnes. 1000 litres has been approximated as one tonne (though the exact tonnage would depend on the cargo and it properties). If the quantity field = q in the spreadsheet then no conversion has taken place for the given record. In this way, it becomes possible to derive fairly accurate estimates of total tonnage even by summing across different units of measure.
- q_gl – the quantity (q) is displayed for flows that terminate in a Great Lakes State (i.e. a border on one or more of the Great Lakes.
- As can be seen, the individual Great Lakes states are displayed in the subsequent 8 fields. Not shown in Figure 6-4 is that the flows to each state are displayed in the next 50 or so

fields in the spreadsheet. The total of the former will correspond to q_l and the total of the latter will correspond to q_gl.

The tool shown in Figure 6-4 has been effective in actual use but is not visual in its orientation. In Figure 6-5 an early prototype of a prior Statscan dashboard is shown. It has not been fully developed within the scope of this project but gives a sense of what might be possible. A future version could be guided by the approach shown in Figure 6-4.

code4	code2	desc	units	year	value	value_gl	quantity	q	q_gl	Illinois	Indiana	Michigan	Minnesota	New York	Ohio	Pennsylvani	Wisconsin
7204	72	ferrous waste and scrap; remelting scrap ingots of iron or steel	TNE	2019.0	300.9	286.0	697,207.0	697,207.0	668,139.0	4,108.0	12,287.0	343,122.0	12,788.0	92,229.0	126,228.0	75,961.0	1,416.0
7208	72	flat-rolled iron or nonalloy steel products, 600 mm (23.6 in.) or more wid	KGM	2019.0	366.6	337.2	417,748,858.0	417,748.9	390,346.1	37,471.7	50,968.0	171,306.6	10,496.0	37,926.4	53,941.1	16,830.4	11,405.8
7210	72	flat-rolled iron or nonalloy steel products, 600 mm (23.6 in.) or more wid	KGM	2019.0	925.7	678.5	562,635,087.0	562,635.1	379,965.9	41,490.4	62,583.9	48,677.5	2,953.7	35,929.2	143,334.8	35,966.1	9,030.2
7209	72	flat-rolled iron or nonalloy steel products, 600 mm (23.6 in.) or more wid	KGM	2019.0	327.2	291.9	287,659,312.0	287,659.3	257,561.5	27,976.9	16,866.0	84,809.5	1,756.1	6,955.5	75,900.2	42,869.7	427.6
7225	72	flat-rolled alloy steel (other than stainless) products, 600 mm (23.6 in.) or	KGM	2019.0	386.0	278.9	278,485,672.0	278,485.7	215,751.4	7,146.9	23,372.2	116,037.8	2,922.7	2,770.9	50,090.8	10,175.0	3,235.1
7211	72	flat-rolled iron or nonalloy steel products, less than 600 mm (23.6 in.) wid	KGM	2019.0	136.7	132.5	124,689,690.0	124,689.7	120,653.7	3,907.6	763.3	17,913.4	0.0	86,846.9	9,260.1	1,807.7	154.6
7213	72	bars and rods of iron or nonalloy steel, hot-rolled, in irregularly wound cc	KGM	2019.0	122.0	108.9	110,211,314.0	110,211.3	98,974.0	11,456.9	5,928.7	45,505.2	63.0	78.4	17,219.1	18,331.2	391.4
7227	72	bars and rods of alloy steel (other than stainless), hot-rolled, in irregularly	KGM	2019.0	87.6	86.5	76,659,082.0	76,659.1	75,677.6	6,525.8	1,530.1	51,866.2	0.0	46.0	6,765.5	8,944.0	0.0
7215	72	bars and rods of iron or nonalloy steel nesoi	KGM	2019.0	82.6	55.7	47,874,532.0	47,874.5	31,860.8	4,416.6	1,425.3	8,851.9	443.5	6,087.9	7,941.5	2,223.0	471.1
7217	72	wire of iron or nonalloy steel	KGM	2019.0	56.2	44.9	38,806,708.0	38,806.7	30,689.4	15,870.0	877.5	8,435.0	244.9	276.0	4,824.2	100.8	61.0
7216	72	angles, shapes and sections of iron or nonalloy steel	KGM	2019.0	82.0	34.9	59,583,504.0	59,583.5	25,942.4	3,513.8	769.7	5,021.6	1,123.4	8,490.2	2,370.4	3,574.4	1,078.9
7212	72	flat-rolled iron or nonalloy steel products, less than 600 mm (23.6 in.) wid	KGM	2019.0	41.6	30.8	29,306,727.0	29,306.7	23,126.2	2,655.3	1,101.9	10,770.3	26.6	3,256.9	2,629.2	2,666.6	19.4
7226	72	flat-rolled alloy steel (other than stainless) products, less than 600 mm (2	KGM	2019.0	59.1	35.0	32,580,866.0	32,580.9	21,447.5	629.7	712.3	17,540.0	122.4	421.3	1,699.0	320.1	2.8
7205	72	granules and powders, of pig iron, spiegeleisen, iron or steel	TNE	2019.0	29.3	15.1	20,223.0	20,223.0	10,088.0	1,243.0	526.0	1,105.0	687.0	66.0	3,614.0	436.0	2,411.0
7229	72	wire of alloy steel (other than stainless)	KGM	2019.0	20.4	17.2	12,217,997.0	12,218.0	10,079.7	5,732.2	1,302.7	1,711.1	15.4	30.8	1,165.8	121.7	0.0
7214	72	bars and rods of iron or nonalloy steel nesoi, not further worked than for	KGM	2019.0	16.9	11.5	14,506,292.0	14,506.3	9,611.3	1,794.2	755.8	1,670.4	549.0	1,442.5	1,967.7	1,103.8	327.7
7218	72	stainless steel in ingots, other primary forms and semifinished products	TNE	2019.0	17.6	17.6	9,015.0	9,015.0	9,015.0	456.0	4,466.0	165.0	0.0	3.0	1,336.0	2,581.0	8.0
7207	72	semifinished products of iron or nonalloy steel	TNE	2019.0	11.9	6.5	15,483.0	15,483.0	8,625.0	0.0	54.0	52.0	0.0	20.0	532.0	7,967.0	0.0
7202	72	ferroalloys	KGM	2019.0	106.8	99.7	10,581,794.0	10,581.8	7,500.7	3,056.7	1,262.4	562.2	0.0	588.5	347.7	1,679.3	4.1
7228	72	bars and rods nesoi, angles, shapes and sections of alloy steel (other thar	KGM	2019.0	11.6	7.4	4,493,198.0	4,493.2	2,801.5	788.0	63.5	759.4	17.5	220.4	507.0	240.0	205.8
7223	72	wire of stainless steel	KGM	2019.0	18.1	11.7	2,813,353.0	2,813.4	1,899.4	85.9	7.7	1,583.8	10.7	79.2	87.0	44.9	0.3
7224	72	alloy steel (other than stainless) in ingots, other primary forms and semifi	TNE	2019.0	2.3	1.7	1,562.0	1,562.0	1,028.0	497.0	183.0	32.0	0.0	0.0	122.0	194.0	0.0
7206	72	iron and nonalloy steel in ingots or other primary forms (excluding iron o	TNE	2019.0	1.1	1.1	1,015.0	1,015.0	990.0	0.0	131.0	725.0	0.0	0.0	0.0	134.0	0.0
7219	72	flat-rolled stainless steel products, 600 mm (23.6 in.) or more wide	KGM	2019.0	10.1	2.8	2,928,756.0	2,928.8	957.6	385.7	87.7	17.3	166.3	30.4	61.2	195.8	13.2
7220	72	flat-rolled stainless steel products, less than 600 mm (23.6 in.) wide	KGM	2019.0	2.9	2.1	974,738.0	974.7	620.1	89.0	10.2	367.6	0.0	1.4	144.5	7.5	0.0
7222	72	bars and rods of stainless steel nesoi; angles, shapes and sections of stair	KGM	2019.0	4.0	2.2	1,025,858.0	1,025.9	466.1	50.0	13.5	23.6	21.3	72.2	58.1	163.2	64.1
7203	72	spongy ferrous products from direct reduction of ore and products in lum	TNE	2019.0	0.0	0.0	11.0	11.0	11.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.0
7201	72	pig iron and spiegeleisen in pigs, blocks or other primary forms	TNE	2019.0	0.0	0.0	23.0	23.0	8.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0
7221	72	bars and rods of stainless steel, hot-rolled, in irregularly wound coils	KGM	2019.0	0.2	0.0	90,000.0	90.0	4.0	0.0	0.0	1.7	0.0	0.0	2.3	0.0	0.0

Figure 6-4: Interactive Spreadsheet Tool to Explore Statscan Trade Data

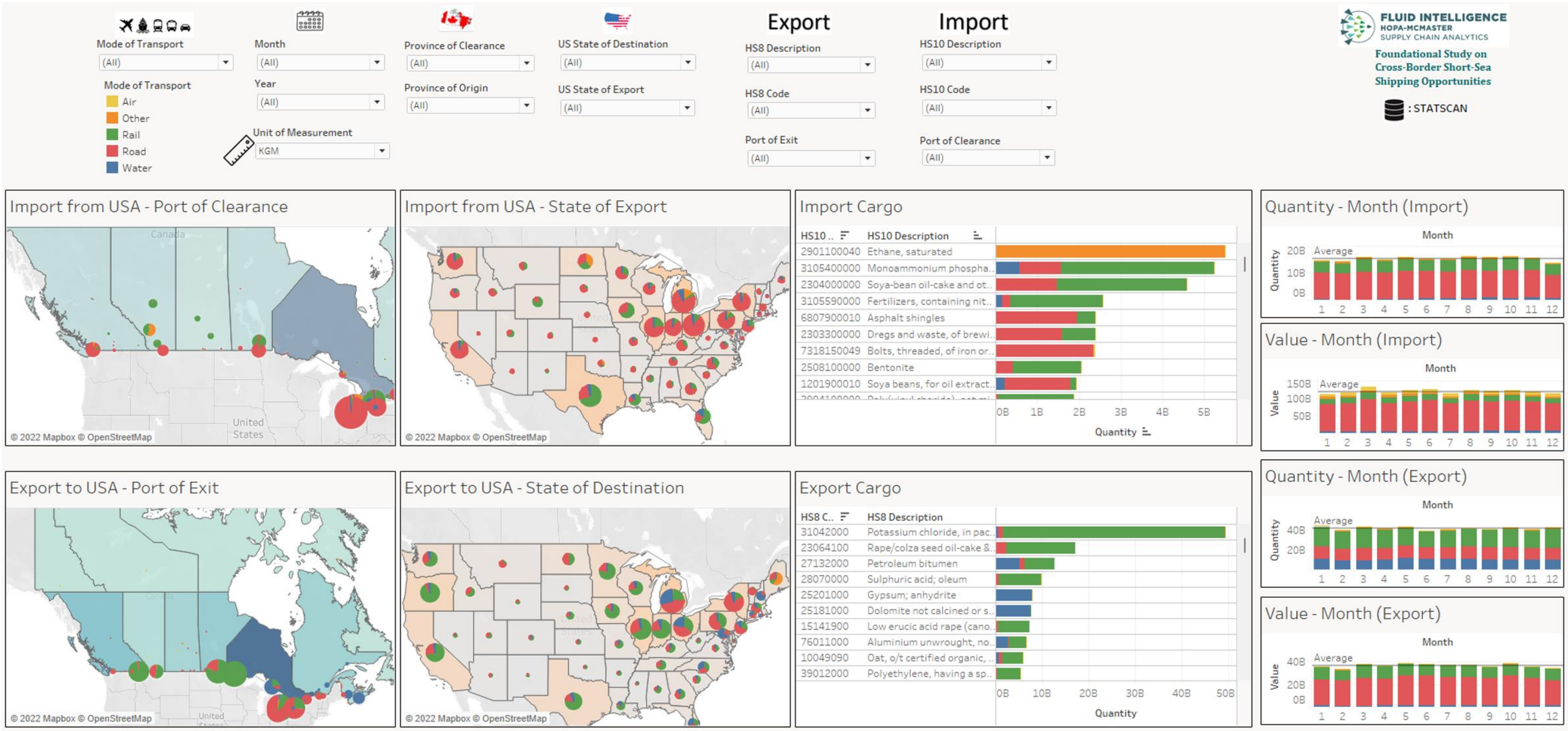


Figure 6-5: Conceptualization of a Statscan trade data Dashboard

6.5 Appendix E: Mapped County-Level Cross-Border Tonnage Outflows and Inflows in the Great Lakes Region

Here is a set of two maps, based on the 2019 CVS that show the association of particular counties in cross-border trucking movements. Both maps are expressed in tonnes and both summarize flows associated with the Great Lakes region. On the US side, counties that are part of a Great Lakes state are included in the tabulation. On the Canadian side it is essentially Ontario and Quebec counties (census divisions) that are included. Flows that are not internal to the Great Lakes region are omitted from the analysis. So, the tonnage associated with a truck trip from Toronto to Texas is not included in the tabulation. The tonnage totals are across all commodity types.

In Figure 6-6, tonnage flows from the Great Lakes states to Ontario/Quebec are shown. For US counties, cross-border tonnage outflows are depicted and for Canadian census divisions, the corresponding tonnage inflows are shown. The US outflow totals balance with the Canadian inflow totals. The flow is reversed for Figure 6-7 which focuses on tonnage flows departing from Canada and arriving in the US, within the region. Note that the two maps show an exponential scale for the mapped classes, with each successive class getting “wider” in terms of tonnes. Also, consider that these maps show aggregate cross-border totals per county and do not show any of the specific connections between individual pairings of counties on either side of the border.

For both maps, there are a lot of counties on both sides of the border that contribute to the totals but relatively few counties that are associated with very large weekly tonnage flows. US county tonnage totals are generally lower on a per county basis as many dispersed US counties contribute to the trucking flows to and from Canada. The differences between the maps are not stark but there does seem to be a pattern that tonnages are a bit more diversified away from the main metropolitan centres for exports than for imports. Figure 6-6 shows more US counties with larger totals for export tonnage into Canada and Figure 6-7 shows a similar pattern for Canadian counties associated with flows into the US. Corridors extending between Montreal and Chicago are evident on both maps with southern Ontario being highly prominent as an anchor of this corridor.

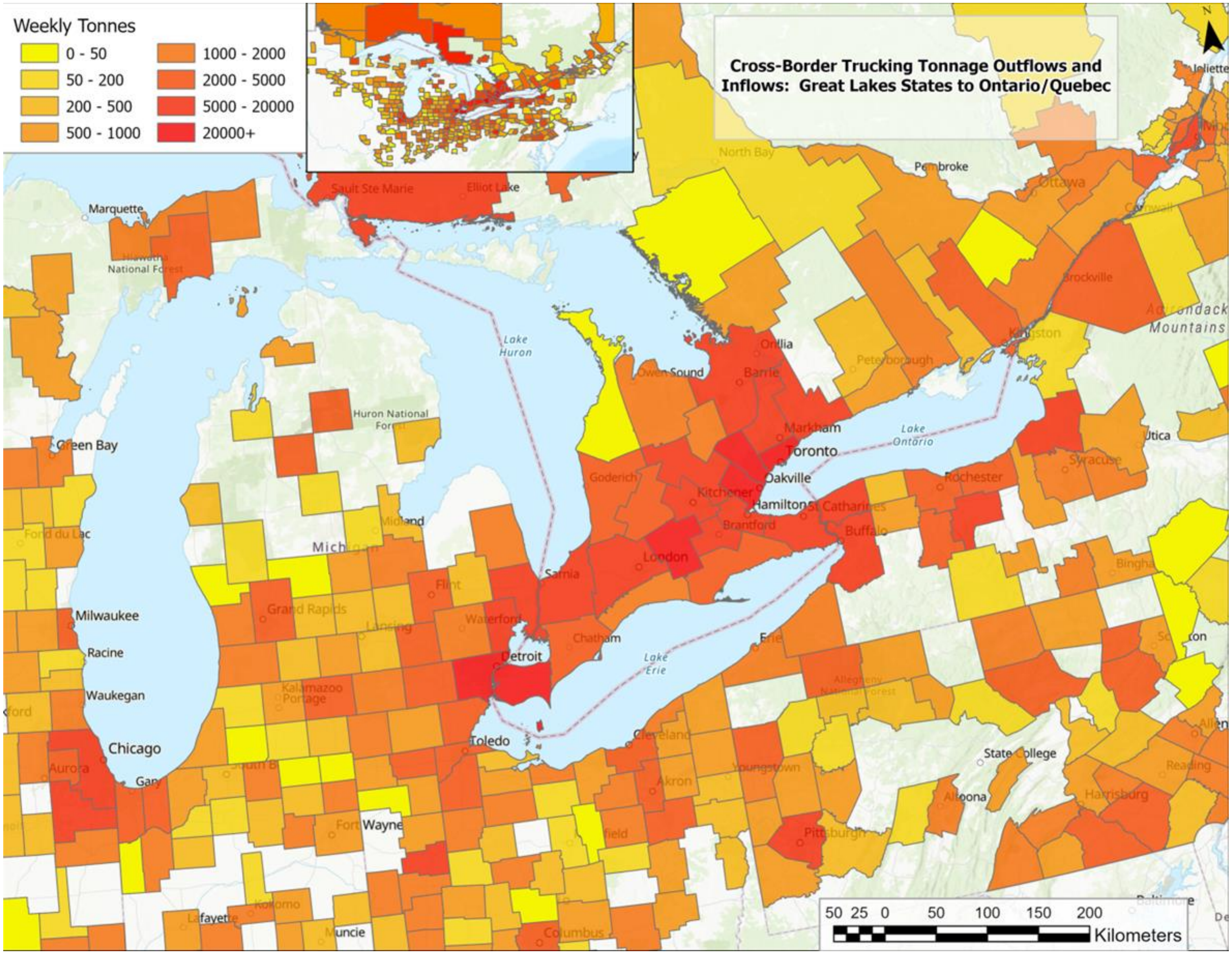


Figure 6-6: County Level Great Lakes Truck Tonnage Flows Crossing from the US to Canada

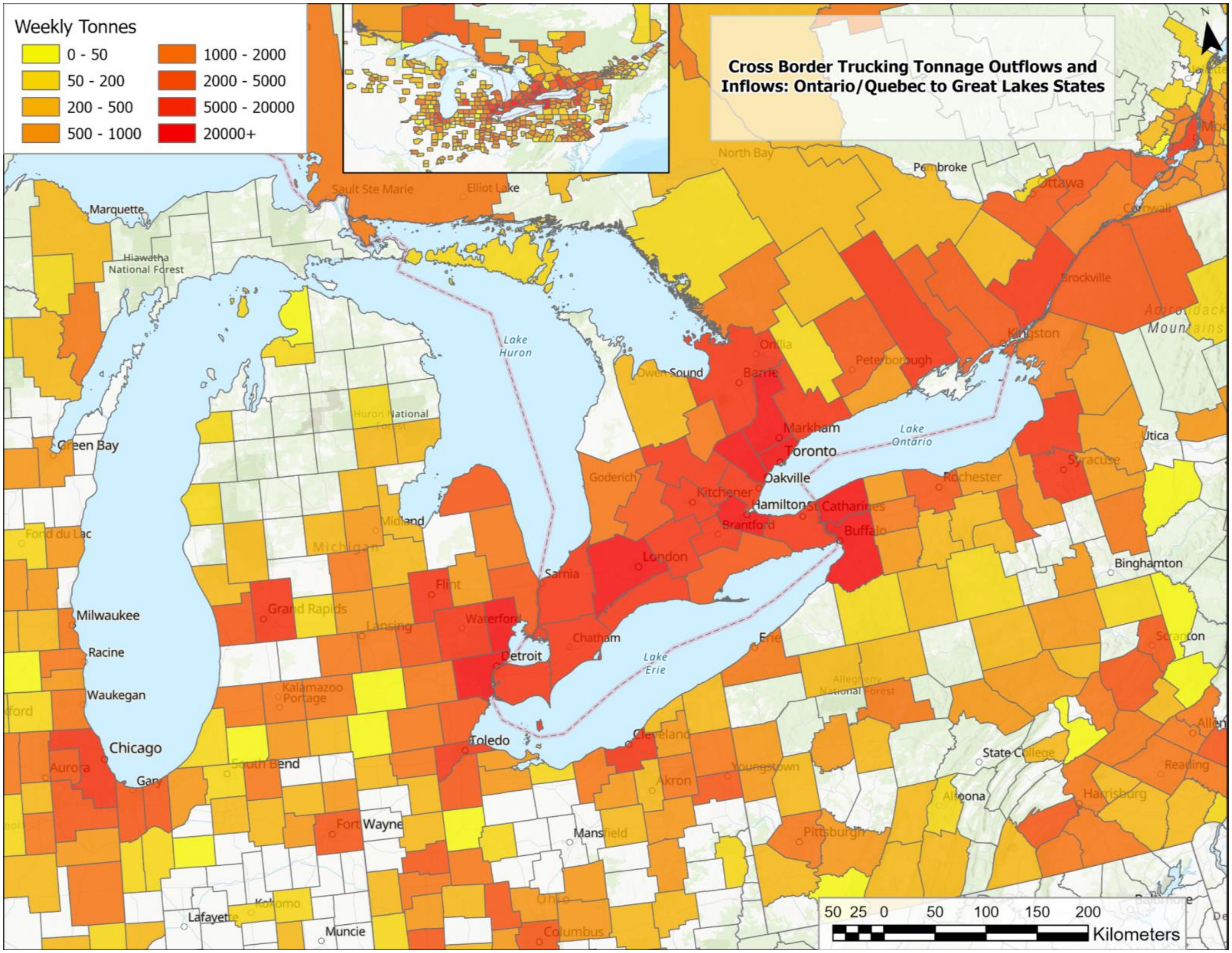


Figure 6-7: County Level Great Lakes Truck Tonnage Flows Crossing from Canada to the US

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