Assessing Shipping Risk in Canada

March 2022

About Us

Clear Seas Centre for Responsible Marine Shipping (Clear Seas) is an independent Canadian not-for-profit research centre that provides impartial and fact-based information about marine shipping in Canada.

Clear Seas' work focuses on identifying and sharing best practices for safe and sustainable marine shipping in Canada, encompassing the human, environmental and economic impacts of the shipping industry.

All Clear Seas research and publications are available at clearseas.org.

About this Report

Clear Seas Centre for Responsible Marine Shipping completed the **Assessing Shipping Risk to Canada** project to improve the understanding of marine incidents and accidents and the risks they present to marine shipping in Canadian and transboundary waters. This technical report conveys the background information, analytical methods and results of the analysis. This project builds on previous work published by Clear Seas, including the *Commercial Marine Shipping Accidents: Understanding the Risks in Canada* report (2016) and the *Maritime Commercial Incidents and Accidents* project (2021).

Board of Directors
Clear Seas Centre for Responsible Marine Shipping

Message from the Executive Director

Understanding historical incidents and accidents – through characterizing and contextualizing – is a vital component of managing the risk from shipping to people and the environment. While only one component of a successful risk management system, the calculation and communication of historical occurrence rates permits a system to be designed that learns from history.

Since its inception, Clear Seas has been focused on providing information on historical occurrences; Clear Seas' first report in 2016 in partnership with the Canadian Council of Academies titled *Commercial Marine Shipping Accidents: Understanding the Risks in Canada* provided a comprehensive overview on the topic. More recently, the *Maritime Commercial Incidents and Accidents* project released in 2021 has sought to make past data available in a more accessible, geospatial format. However, both projects highlighted a gap in understanding – that is, the ability to account for the volume of ship traffic and how it impacts the frequency of occurrences.

While the total number of occurrences in different regions is valuable information for risk management and planning, the number of occurrences needs to be given context by considering the volume of shipping in the region. This context provides a balanced picture of risk from individual vessel types in different regions. This report fills that gap by creating statistics on historical occurrence rates for the different regions in Canada based on the volume of traffic.

Government departments and others involved in planning for the type and placement of emergency response resources are increasingly focused on shipping risk analysis. In attempting to project past occurrences into future emergency response resource needs, such as the placement of emergency towing vessels, the normalization of historical occurrences provides an important perspective. This report supports these planning efforts by providing simplified, publicly accessible insights into historical shipping risks to facilitate a more nuanced dialogue about risk mitigation, grounded in the quantification of shipping risk in Canadian and transboundary waters.

Clear Seas is grateful for the assistance of Transport Canada through the provision of essential aggregated vessel traffic data for this analysis.

Table of Contents

Acronyms and Abbreviations

AIS	Automatic identification system
B.C.	British Columbia
EEZ	Exclusive Economic Zone
GIS	Geographic Information System
km	kilometre
MARSIS	Marine Safety Information System database
MCIA	Maritime Commercial Incidents and Accidents
MISLE	Marine Information for Safety and Law Enforcement database
TSBC	Transportation Safety Board of Canada
U.S.	United States
USCG	United States Coast Guard

List of Figures

List of Tables

Assessing Shipping Risk to Canada

1.0 Introduction

Clear Seas completed the *Assessing Shipping Risk to Canada* project to characterize the risks related to marine shipping in Canadian and transboundary waters. This report provides an overview of the data sources applied in the analyses, the methodology used to determine the rate of vessels involved in marine occurrences, and a description of the analytical results. The dataset of vessels involved in marine occurrences applied in this project was developed for Clear Seas' Marine Incidents and Accidents Dashboard. A detailed overview of this dataset and the dashboard can be found in the Maritime Commercial Incidents and Accidents (MCIA) report.

1.1 Purpose

The purpose of this project is to contextualize the number of vessels involved in marine occurrences that have occurred in, or around, Canadian waters. Vessel traffic data for regions within the study area were integrated with the geospatial dataset of vessels involved in marine occurrences to determine the rate of vessels involved in marine occurrences for different types of vessels across regions. The results of this project can help inform the conversation around shipping risk in Canada and add important context to the number of reported marine incidents and accidents.

1.2 Scope of Assessment

This project aims to better understand the risks of marine shipping in and around Canadian waters, including transboundary waters. The geographic extent of the project was defined using the same study area as for the MCIA project, which includes all waters within Canada's Exclusive Economic Zone (EEZ), territorial seas and internal waters, as well as inland waterways where commercial shipping traffic occurs. In addition to Canadian waters, the EEZs of the U.S. coastal states adjacent to Canada, including Maine, Washington, and Southeastern Alaska are included, as well as the U.S. regions of the Great Lakes. Marine occurrence records and vessel traffic statistics from January 2015 to December 2018 were gathered for this study.

After applying the same study area as the MCIA project, summarized vessel traffic data was obtained from Transport Canada in a spatial grid format, which was overlayed onto the study area. Traffic information was gathered for all the 50 km by 50 km grid cells that were partially or fully encompassed within the study area (Figure 1).

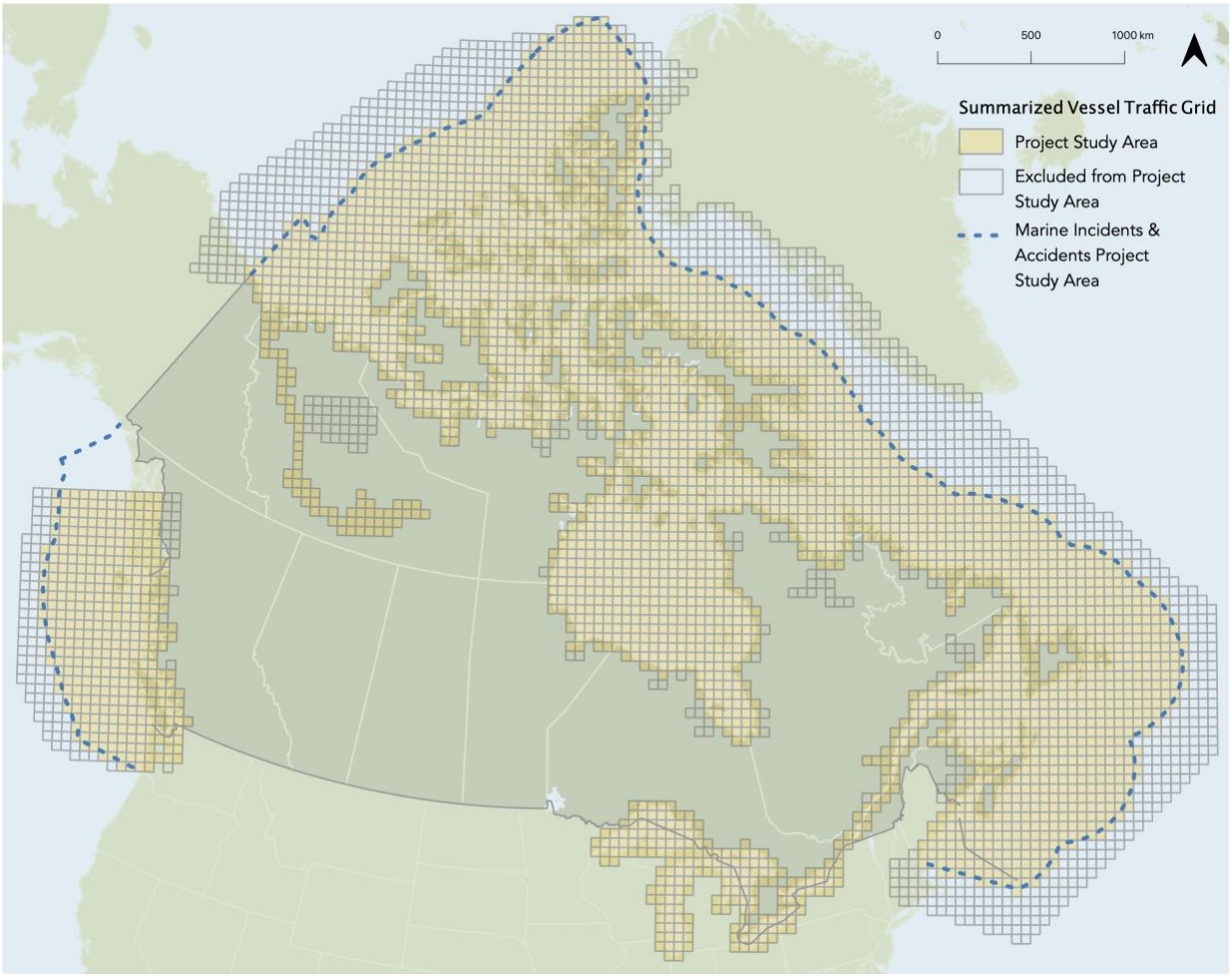

Figure 1. Vessel traffic statistics obtained from a 50 km by 50 km grid that falls within the project's study area boundary

The source of marine occurrence data for this project was the Marine Incidents and Accidents Dashboard dataset developed by Clear Seas in 2021. This spatial dataset includes marine occurrence records from the Marine Safety Information System (MARSIS) and Marine Information for Safety and Law Enforcement (MISLE) databases, maintained by the Transportation Safety Board of Canada (TSBC) and the U.S. Coast Guard (USCG), respectively. Each record in the dataset is a report of a vessel involved in a marine occurrence, therefore, there may be multiple records for the same marine occurrence if more than one vessel was involved. For more information on how this dataset was developed, see the MCIA report.

Vessel traffic information for this project was obtained from Transport Canada, which provided satellite automatic identification system (AIS) data obtained from exactEarth (now Spire Global) and Maerospace (Orbcomm), as well as terrestrial AIS data obtained from the Canadian Coast Guard. The vessel attribute information that was linked to the AIS data was gathered from a variety of sources (e.g., MarineTraffic, MyShipTracking, Industry Canada, and others). The AIS data were processed and summarized by Transport Canada into a spatial grid format, where the number of nautical miles sailed was calculated

for each vessel type for each 50 km by 50 km grid cell. The vessel traffic data received from Transport Canada did not contain identifying characteristics of any vessels and was summarized by vessel attributes such as the vessel type, sub-type, and size (gross tonnage).

For this project, vessel traffic and marine occurrences involving only commercial shipping vessels, ferries, and cruise ships are included. The types of commercial shipping vessels include various types of solid and liquid cargo ships and tugs. Fishing vessels (both commercial and non-commercial), government vessels, pleasure craft, and other types of vessels are not included. Ferries and cruise ships were included as a reference point for ship types that the wider public may find more accessible. Incidents involving small passenger vessels, like harbour passenger ferries, tour boats and non-ocean-going cruise ships, are excluded.

2.0 Methodology

2.1 Defining the Timeframe, Study Area, and Study Area Regions

The timeframe of this study begins in January 2015 and ends December 2018. This four-year time period was chosen because it was the longest temporal overlap between the marine occurrence and vessel traffic datasets. Marine occurrences are relatively rare, so four years of data were selected in order to reduce inaccuracies produced by year-to-year variations in calculating the occurrence rates.

The study area for this project (Figure 1) includes all the vessel traffic grid cells that fall partially or entirely within the MCIA study area boundary (for a description of how the MCIA study area was created, see the MCIA report). The Marine Incidents and Accidents Dashboard dataset includes reports of vessels involved in marine occurrences that are located within the MCIA study area boundary. The 50 km by 50 km grid cells closely approximate the MCIA study area, however, because some of the vessel traffic grid cells cross the MCIA study area boundary and fall partially inside and partially outside the MCIA study area some small variations in vessel traffic figures included in the analysis may exist. Though this is a limitation on the study, its impact on occurrence rates is insignificant.

To compare the occurrence rates of different areas around Canada, the study area was split into five different regions: Pacific, Western Arctic, Eastern Arctic, Great Lakes, and Atlantic (Figure 2). These regions mimic the study area regions defined in the MCIA project, except for the Northern region that has been split into the Western Arctic region and Eastern Arctic region for this project. The Western Arctic and Eastern Arctic regions provide greater insight into shipping risk in remote areas that have less vessel traffic. Because the amount of traffic and types of marine occurrences are much different in the Arctic regions compared to other regions in Canada, the rates of vessels involved in marine occurrences of the Western Arctic region and Eastern Arctic region will be compared against each other, and not against other study area regions.

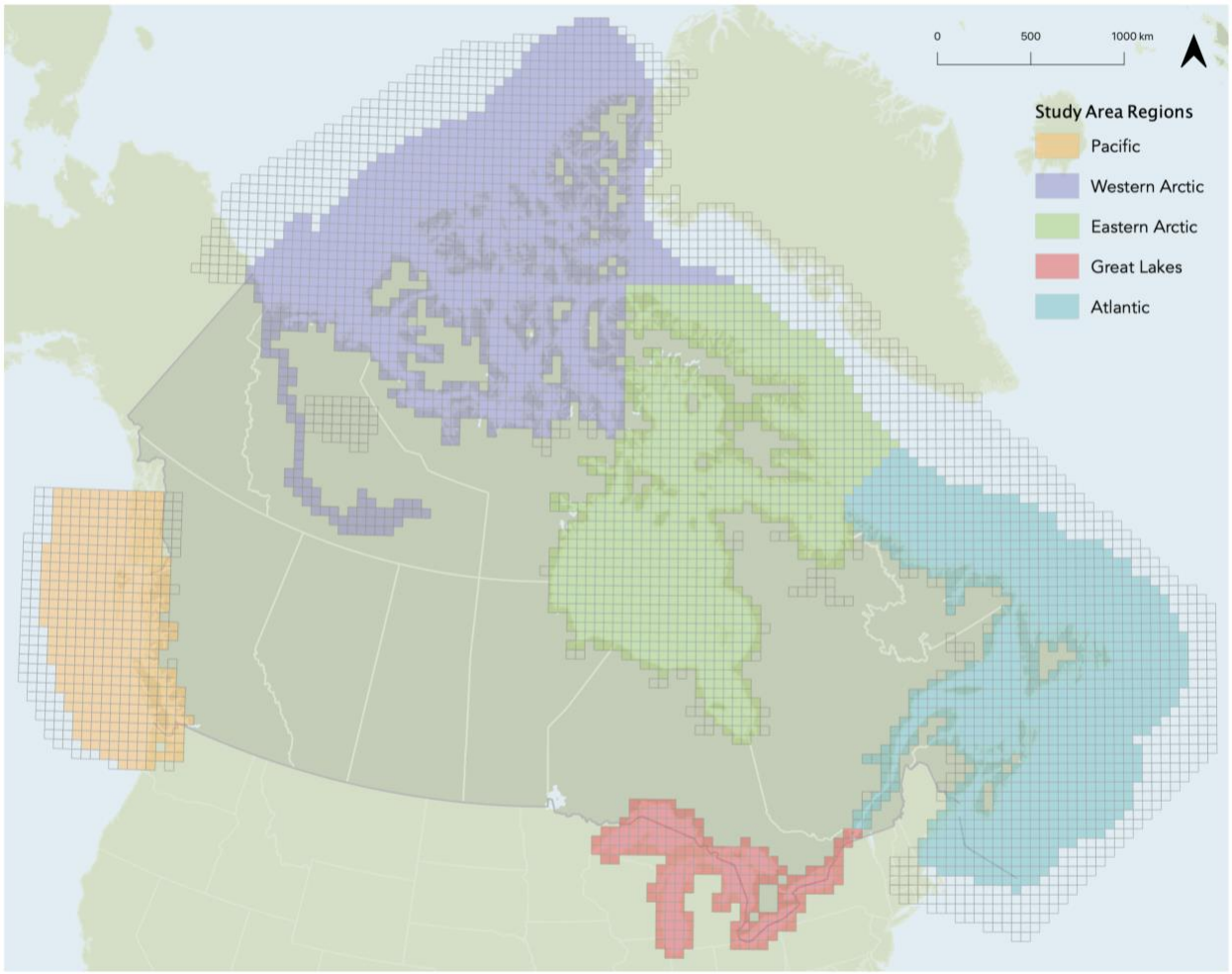

Figure 2. Study area regions

In addition to the primary study area regions, two sub-regions of interest for this project were identified: the Salish Sea sub-region and the St. Lawrence sub-region. Both of these areas see high levels of vessel traffic and are important transboundary marine shipping corridors in Canada.

The Salish Sea sub-region falls within the Pacific region and encompasses waters in both U.S. and Canada (Figure 3). This sub-region extends west to the opening of the Strait of Juan de Fuca, south to include Puget Sound, east to the Fraser River, and north to include the Strait of Georgia. There are several major ports in the Salish Sea, including the Port of Vancouver and the Port of Tacoma.

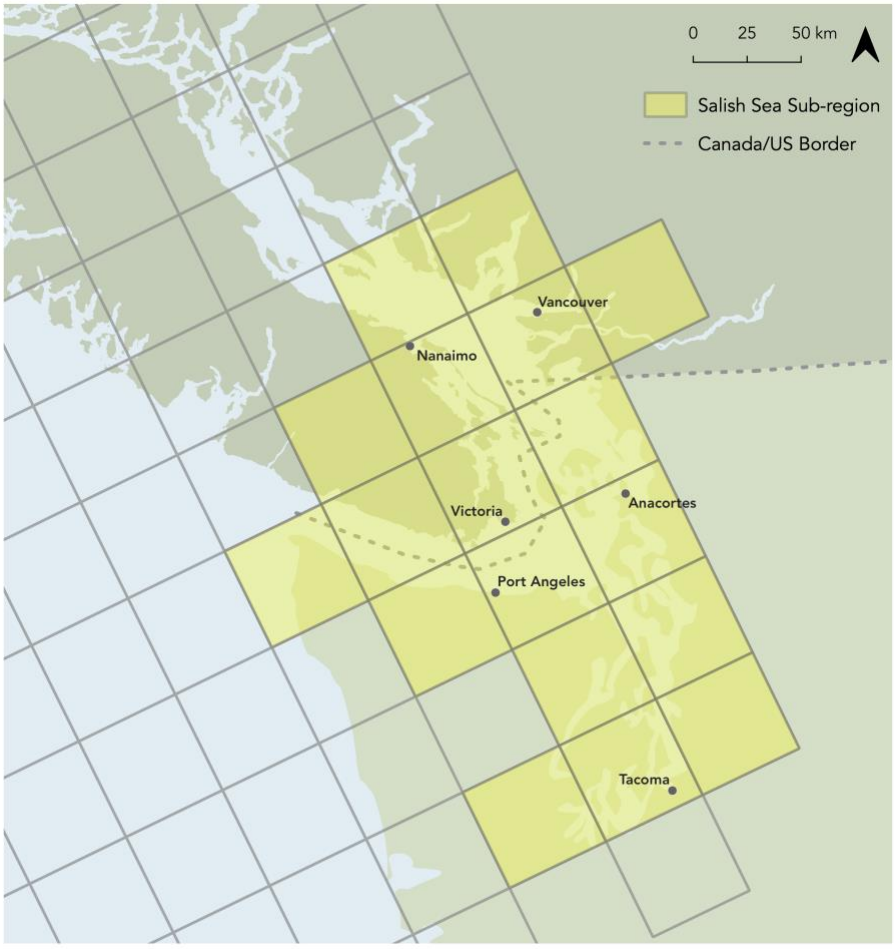

Figure 3. Area included in the Salish Sea sub-region

The St. Lawrence sub-region falls within the Atlantic region and encompasses areas of the St. Lawrence and Saguenay rivers (Figure 4). This sub-region begins at the Port of Montreal and extends downriver to Les Escoumins, including the Saguenay River to the west. There are several ports in this sub-region, including the Port of Montreal, the Port of Trois-Rivieres, and the Port of Quebec.

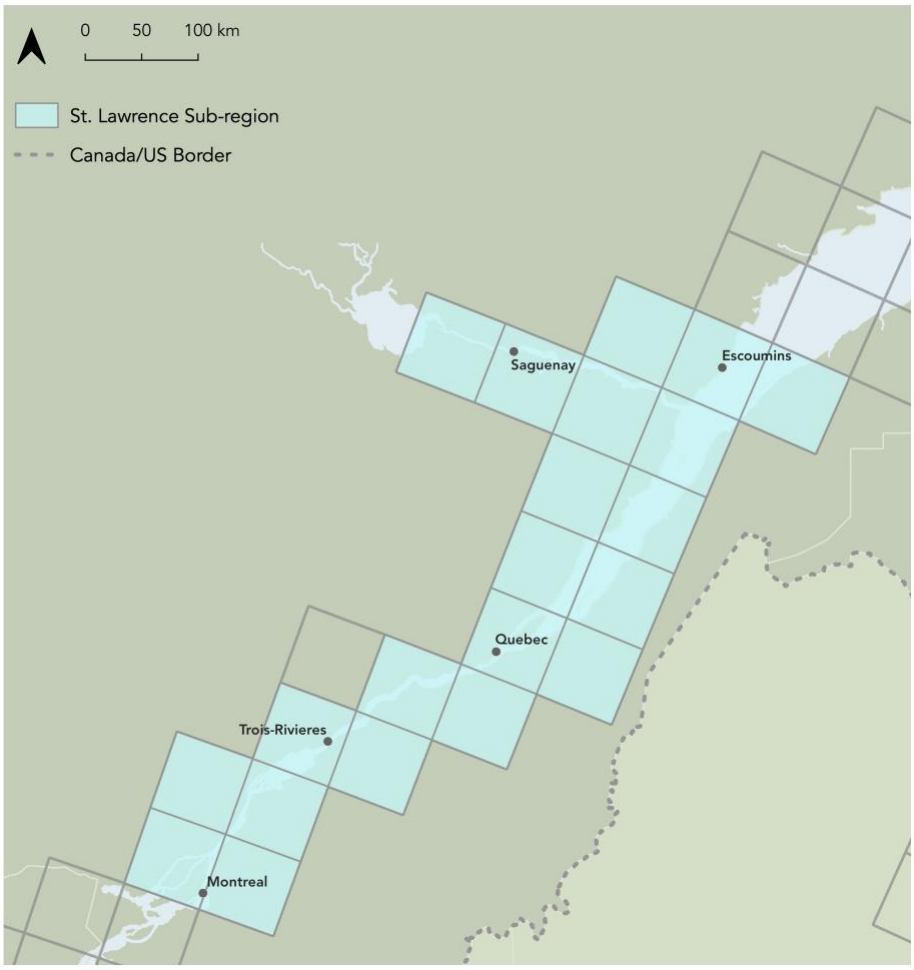

Figure 4. Area included in the St. Lawrence sub-region

2.2 Defining Marine Occurrences

The processes and policies on reporting marine incidents and accidents vary around the world, including between Canada and the United States. The Marine Incidents and Accidents Dashboard dataset includes marine occurrence records from the TSBC's MARSIS database, and the USCG's MISLE database. To integrate data from both sources into one cohesive dataset of marine occurrences, the definitions and classifications of marine occurrences had to be aligned. Table 1 shows how the types of marine occurrences were aligned into standardized categories, and how Clear Seas classified incidents and accidents for the purpose of this study. For more information on how marine occurrences are reported and defined, and how the dataset of vessels involved in marine occurrences was created, see the MCIA report.

Table 1. Data Alignment of Marine Incident and Accident Categories

Clear Seas Incident or Accident	Clear Seas Occurrence Categories	TSBC Occurrence Categories	USCG Occurrence Categories
Accident	Sank	Sank	Sinking
Accident	Capsize	Capsizes	Capsize
Accident	Explosion/fire	Explosion Fire	Explosion Fire – initial
Accident	Collision	Collision	Collision
Accident	Grounding	Grounding	Grounding
Accident	Allision	Striking	Allision
Incident	Flood	–	Flooding – initial Flooding – progressive
Incident	Sustains damage render unseaworthy/unfit for purpose	Sustains damage render unseaworthy/unfit for purpose	–
Incident	Total failure of any system	Total failure of any machinery or technical system	Loss of electrical power Loss/reduction of vessel propulsion/steering Material failure/malfunction
Incident	Cargo shift/damage/loss	Cargo shift/cargo loss	Cargo/fuel transfer/shift Damage to cargo Loss of stability
Incident	Fouling	Fouls underwater object	Fouling
Incident	Risk of occurrence (e.g., capsizing, collision, grounding, sinking, striking)	Risk of capsizing Risk of collision (near collision) Risk of grounding Risk of sinking Risk of striking (near allision)	Set adrift Vessel yaw/pitch/roll/heel Wave(s) strikes/impacts
Incident	Bottom contact	Bottom contact	–
Incident	Other	Dangerous goods released Intentional beaching/grounding/ anchoring to avoid occurrence	Discharge/release – pollution Vessel maneuver Abandonment

In the context of this project, and the MCIA project for which the Marine Incidents and Accidents Dashboard dataset was developed, Clear Seas used the following terms to describe marine incidents and accidents:

- **Marine occurrence**: Refers to any marine incident, accident, event, or casualty that has been recorded by the TSBC or USCG.
- **Marine accident**: Refers to any marine occurrence that presents a more serious risk of damage to the ship and/or the environment and is based on the TSBC classification of accidents.

- **Serious marine accident**: Refers to a marine occurrence with serious impacts, particularly in terms of damage to the ship, damage to the environment, or other damage. For this project, serious marine accidents are classified separately from marine accidents. The following criteria were used to define a serious marine accident:
    - A marine occurrence (i.e., incident or accident) that resulted in a TSBC or U.S. National Transportation Safety Board investigation.
    - A marine casualty identified as a serious marine accident in the USCG MISLE database extract.
    - A marine occurrence with an IMO Classification of "Serious Incident" or "Very Serious Incident" according to the USCG reports, or an IMO Class Level of "Very Serious Marine Casualty" according to the MARSIS database.
- **Marine incident**: Refers to any marine occurrence that is not an accident or serious accident. Incidents are perceived to be less severe than accidents.

For this project, people-related incidents and accidents, such as injury, loss of life, or instances where a person has gone overboard a vessel, are out of scope, since this work is not intended to analyze passenger and crew safety.

2.3 Defining Vessel Types

Aligning the vessel types was an important step in determining accurate rates of vessels involved in marine occurrences for this project, as the Marine Incidents and Accidents Dashboard dataset and the summarized AIS vessel traffic data categorize ships differently. During the data quality review process, some misreported vessel types were noted among the TSBC and USCG records. For this project, any records where the vessel type appeared to be misclassified were manually verified and corrected as necessary. Table 2 below shows how vessel types from each database were reclassified into standardized Clear Seas vessel categories.

Table 2. Reclassifying the reported vessel types into aligned Clear Seas categories

Aligned Clear Seas Vessel Categories	TSBC		USCG		Transport Canada Traffic Attribute Data	
	Vessel Categories	Vessel Sub-Categories	Vessel Categories	Vessel Sub-Categories	Vessel Categories	Vessel Sub-Categories
Cargo – Bulk Carrier	Cargo – solid	Bulk carrier	Bulk carrier	General Ore carrier	Dry bulk	All vessel sub-types
Cargo – Container Ship		Container ship	General dry cargo ship	Container ship	Container	All vessel sub-types
Cargo – Vehicle Carrier		Ro-ro cargo	Ro-ro cargo ship	Vehicle carrier	Cargo	Vehicles carrier
Cargo – Other		General cargo Refrigerated cargo	General dry cargo ship	General Heavy load carrier	Cargo	Cargo Cargo – hazard A Cargo – hazard C Deck cargo ship General cargo Heavy load carrier Livestock carrier Merchant general Merchant livestock Merchant ship Other/unknown Timber carrier
		Ro-ro cargo	Ro-ro cargo ship	General Ro-ro/ container	Ferry/ro-ro	Inland ro-ro cargo ship Merchant ro-ro Ro-ro cargo

Aligned Clear Seas Vessel Categories	TSBC		USCG		Transport Canada Traffic Attribute Data	
	Vessel Categories	Vessel Sub-Categories	Vessel Categories	Vessel Sub-Categories	Vessel Categories	Vessel Sub-Categories
Cargo – Tanker	Cargo – liquid	Product tanker Chemical tanker Crude tanker Combination carrier Liquefied gas carrier Chemical/ product tanker	Tank ship	Chemical tank ship General Petroleum oil tank ship	Tanker	All vessel sub-types
	Tanker – chemical/ ore/oil/crude	N/A				
	Tanker – other	N/A				
Ferry	Ferry	(>= 300 GT) Combination Other Passenger Passenger/train Passenger/vehicle	Passenger ship	(>= 300 GT) Ferry General	Ferry/ro-ro	(>= 250 GT) Merchant ferry Other/unknown Rail/vehicles carrier Ro-ro/passenger ship
	Passenger	(>= 300 GT) Passenger only Passenger cargo				
Cruise	Passenger	(>= 10,000 GT) Passenger only Passenger – cargo	Passenger ship	(>= 10,000 GT) Ocean cruise vessel	Passenger	(>= 10,000 GT) Merchant passenger Passenger ship
Tug	Tug	N/A	Towing vessel	Articulated tug and barge (tug) General Harbor/ship assist (tug) Integrated tug and barge (tug) Pushing ahead (towboat) Towing behind (tug)	Tugs/Port	Articulated pusher tug Pusher tug Towing vessel Tug Tug harbour Tug ocean

2.4 Gathering and Aligning Data

In this project, the Marine Incidents and Accidents Dashboard dataset was used to determine the number of vessels involved in marine occurrences from 2015-2018 inclusive. The dataset was filtered to exclude barges, as they do not carry AIS transponders and vessel traffic statistics were not available. Using a Geographic Information System (GIS), the dataset was displayed spatially to determine how many vessels involved in marine occurrences were reported in each region. Reports of vessels involved in marine occurrences that fell outside of the vessel traffic grid layer were excluded from the dataset. For each vessel type in each study area region and sub-region, the total numbers of marine incidents, accidents, and serious accidents were calculated.

The summarized vessel traffic data obtained from Transport Canada provided vessel traffic metrics for all vessel types in this project. Because vessels are classified differently by different organizations, the vessel traffic data was reclassified to align with the vessels included in the MCIA project and exclude any traffic data from vessels not included in the MCIA project. Table 2 shows how the summarized vessel traffic data was reclassified to fit the standardized Clear Seas vessel types applied to this project. In some instances, the vessel categories could not be perfectly aligned. For example, the Marine Incidents and Accidents Dashboard dataset only includes ferries that are greater than or equal to 300 gross tonnes. The gross tonnage ranges for the summarized vessel traffic data are defined in different intervals, so traffic statistics for ferry vessels greater or equal to 250 gross tonnes were included.

After completing the reclassification of vessel types, the number of nautical miles sailed in 2015-2018 was determined for each grid cell in the spatial layer, and then the cells were grouped together by region and sub-region to find the total number of nautical miles sailed for each area of interest. The results of this work show the total number of nautical miles sailed by each vessel type in each region and sub-region.

Marine occurrence rates were calculated by dividing the number of marine incidents, marine accidents (excluding serious marine accidents), and serious marine accidents, by the total number of nautical miles sailed for the vessel type in the region. The results of these calculations were then multiplied by 1,000 to show the rate of vessels involved in occurrences per 1,000 nautical miles sailed, displayed as a percentage.

2.5 Limitations

This project is constrained by certain limitations.

First, all the project limitations listed in the MCIA report are also applicable to this project. Examples of some of these limitations include incorrectly located marine occurrences, incorrectly categorized vessel information, mislabeled and conflicting records of the same vessel or occurrence, and others.

In addition, limitations specific to the methodology of this project include:

- Only vessels that are involved in commercial marine shipping and some passenger vessels are included in this project. Although marine occurrences involving barges were included in the Marine Incidents and Accidents Dashboard dataset, barges were not included in this project because vessel traffic statistics were not available. The results of this project cannot be used to understand the risks of shipping from all types of vessel traffic.

- The 50 km grid cells providing traffic data are only an approximation of the study areas.

- The alignment of vessel types used to categorize the vessel traffic data and marine occurrence data is not always accurate. The research team made efforts to verify and correct any inaccuracies in the dataset, but there may still be issues with how the vessels were reclassified into different categories. In some cases, the types of vessels included in the vessel traffic data could not align perfectly with the types of vessels included in the Marine Incidents and Accidents Dashboard dataset, because of how range of gross tonnage was defined.

- Unreported marine occurrences were not factored into this project.

3.0 Results

The graphs in this section show the regional comparisons of the rates of vessels involved in marine occurrences per 1,000 nautical miles sailed (Figures 5-11). For each region and vessel type, the tables included in this section show the calculated rates of vessels involved in marine occurrences (Table 3), the number of reported marine occurrences (Table 4), and the total number of nautical miles sailed (Table 5). Most graphs employ a scale to be able to show a marine occurrences rate of up to 10%, while the graphs for the Arctic regions are able to show a marine occurrences rate of up to 20% to allow for differences in traffic and occurrences.

Figure 5 shows the rates of vessels involved in marine occurrences per 1,000 nautical miles sailed for all regions in the study area. Ferries are shown to experience the highest rate of marine occurrences, while tugs show the highest rates of marine accidents and serious marine accidents. Vehicle carriers and cruise ships show the lowest rates of vessels involved in marine occurrences. Overall, the rate of vessels involved in marine occurrences per 1,000 nautical miles sailed is less than 3% for all types of vessels and the rate of occurrence of accidents is less than 0.5%.

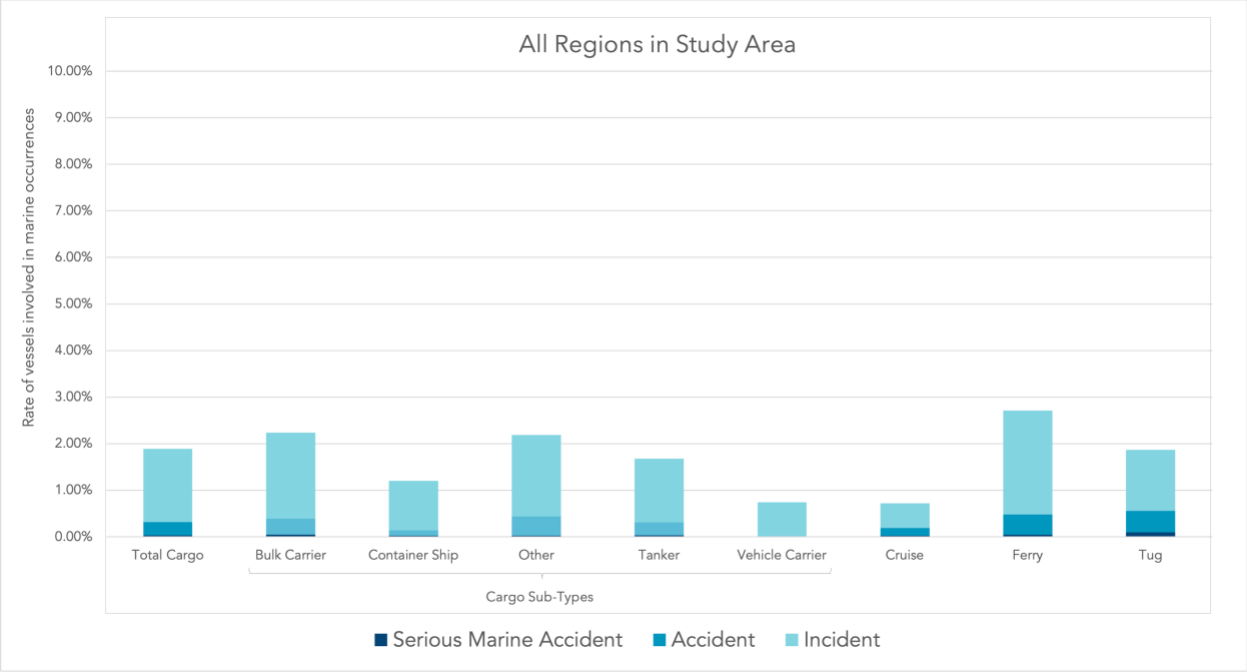

Figure 5. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the entire study area.

Figure 6 shows the rates of vessels involved in marine occurrences for the Pacific region and the Atlantic region. In comparing the two regions, the rates of vessels involved in marine occurrences is similar – ferries experience the greatest rates of occurrence and cruise ships the lowest in both regions. Tugs experience the highest rates of serious marine accidents in both regions.

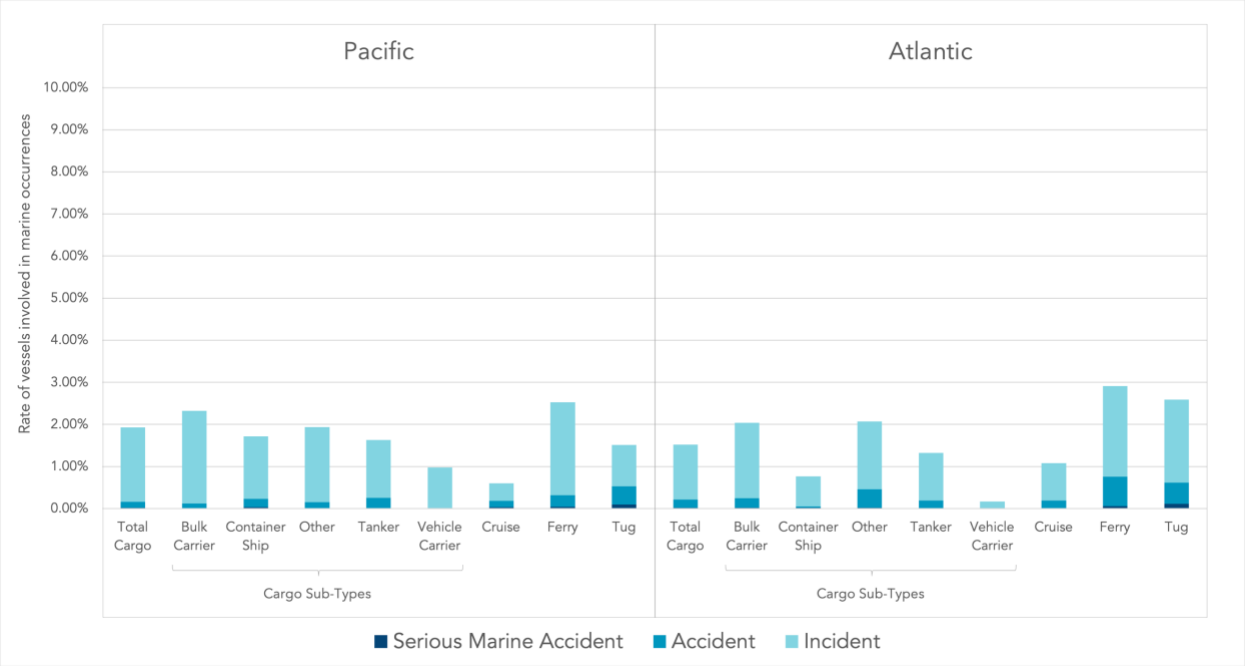

Figure 6. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Pacific and Atlantic regions.

Comparing the Pacific region with the Salish Sea sub-region, Figure 7 shows the Salish Sea sub-region experiences higher rates of vessels involved in marine occurrences for cargo ships and cruise ships. Ferries and tugs remain relatively unchanged because their activity is primarily confined to the Salish Sea sub-region. The increase in occurrence rates for cargo and cruise ships is because an increased number of occurrences occurring at berth or anchorage.

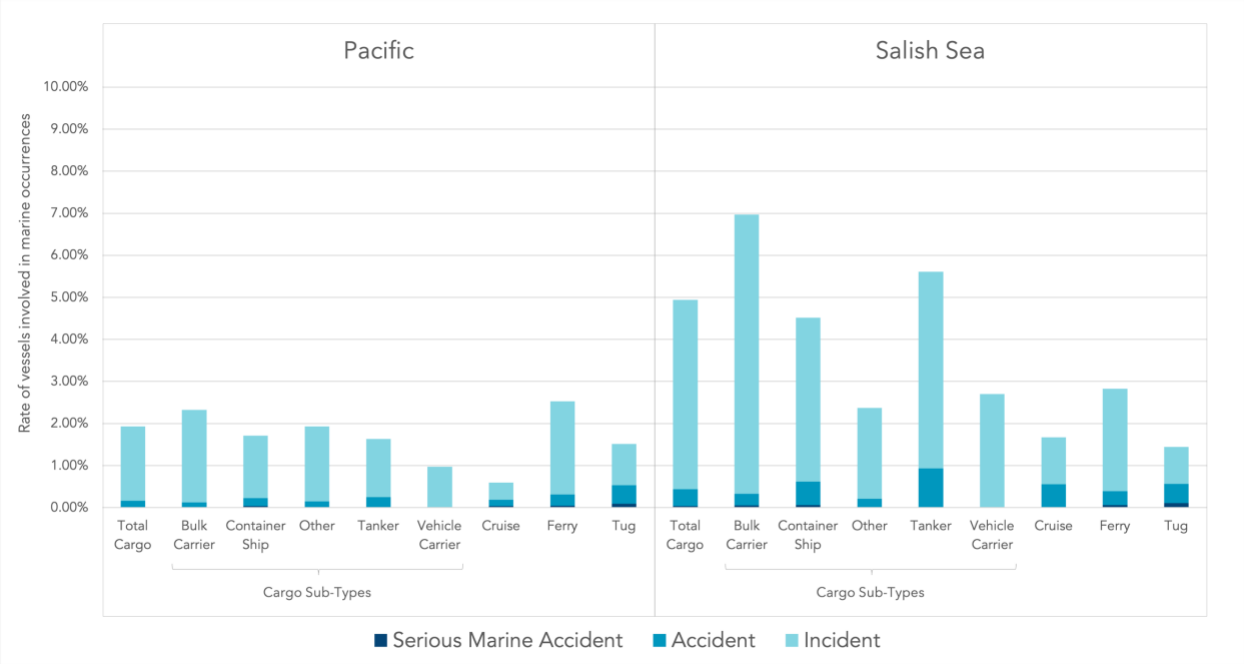

Figure 7. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Pacific region and Salish Sea sub-region.

A similar increase in occurrence rates is observed when the St. Lawrence sub-region is compared to the Atlantic region (Figure 8). However, the St. Lawrence sub-region sees higher rates of marine occurrences for all vessel types. There is very little traffic by vehicle carriers in the St. Lawrence sub-region. In both the Atlantic region and St. Lawrence sub-region, tugs experience the highest rates of serious marine accidents. Container ships see the lowest rates of marine occurrences for any sub-type of cargo vessels in both regions, as well.

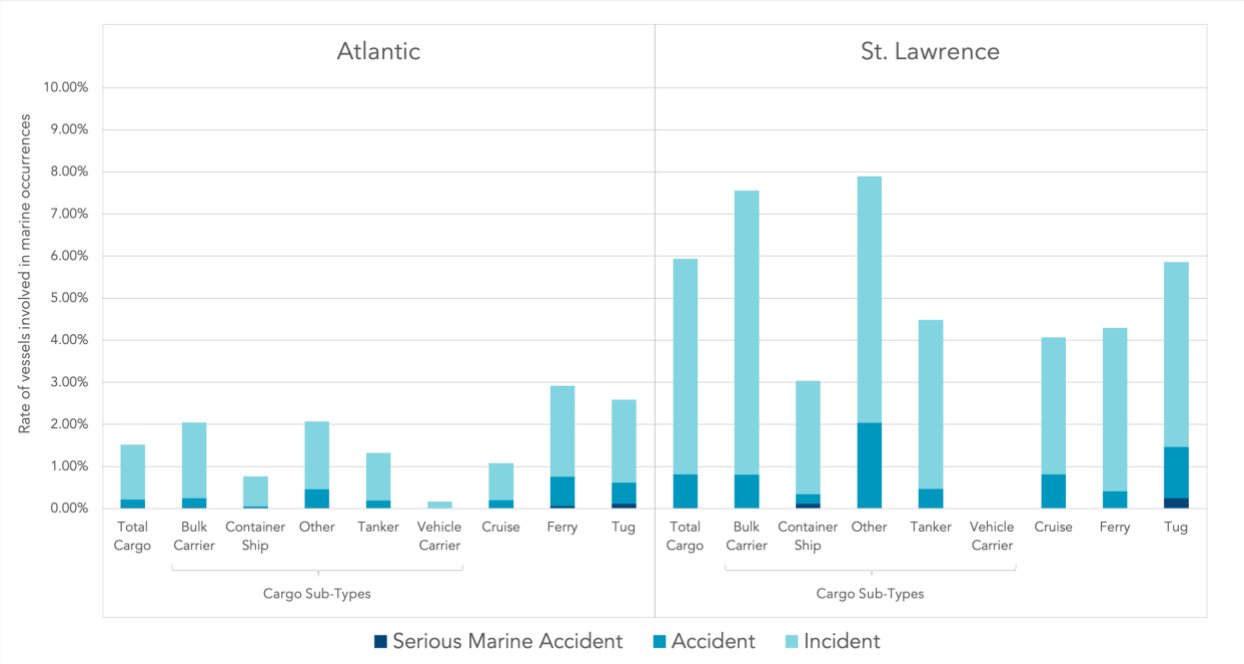

Figure 8. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Atlantic region and St. Lawrence sub-region.

In Figure 9, the St. Lawrence sub-region is shown to have generally higher rates of vessels involved in marine occurrences than the Great Lakes region. Tankers in the Great Lakes region experience the highest rates of serious marine accidents, while in the St. Lawrence sub-region, there are no reports of tankers involved in serious marine accidents during the study's timeframe (2015-2018). Bulk carriers and other cargo vessels experience the highest rates of marine occurrences in the St. Lawrence sub-region, while ferries experience the highest rates of marine occurrences in the Great Lakes region. No traffic data was recorded for vehicle carriers in the Great Lakes region, and minimal traffic was recorded for vehicle carriers in the St. Lawrence sub-region.

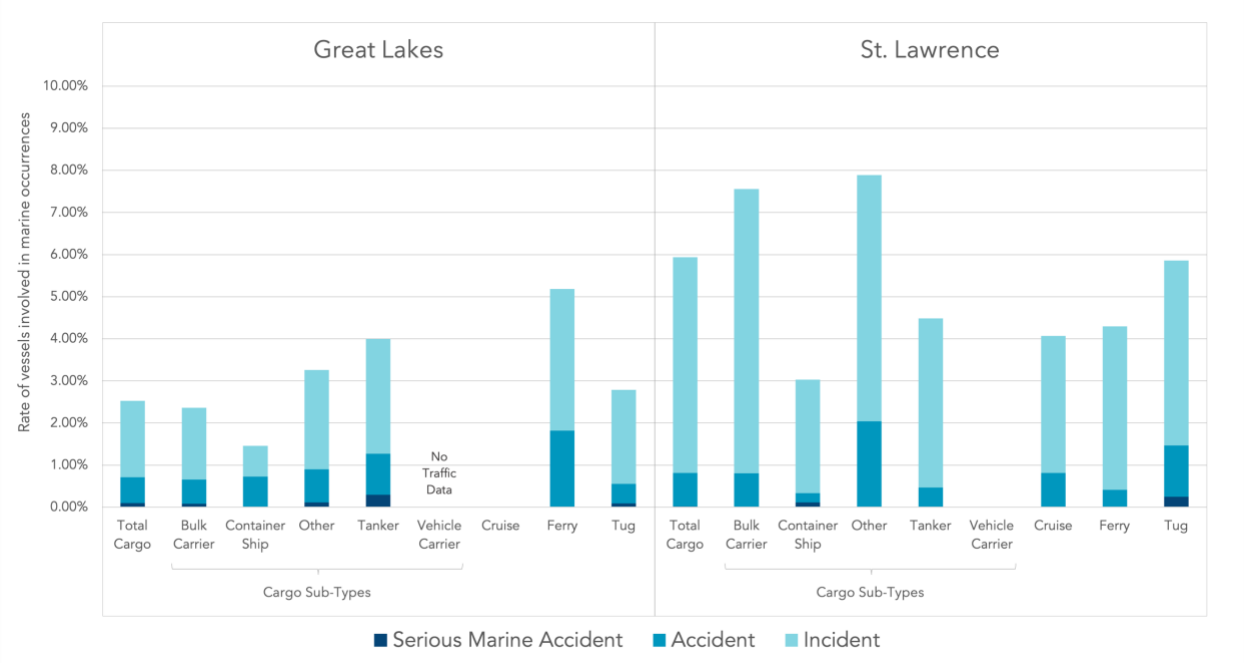

Figure 9. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Great Lakes region and St. Lawrence sub-region.

In comparing the Salish Sea and the St. Lawrence sub-regions (Figure 10), both show higher rates of marine occurrences compared to other regions. Cargo vessels experience the highest rates of marine occurrences, while tugs experience the highest rates of serious marine accidents. In the St. Lawrence, container ships experience the lowest rates of marine occurrences, while in the Salish Sea, tugs experience the lowest rates of marine occurrences.

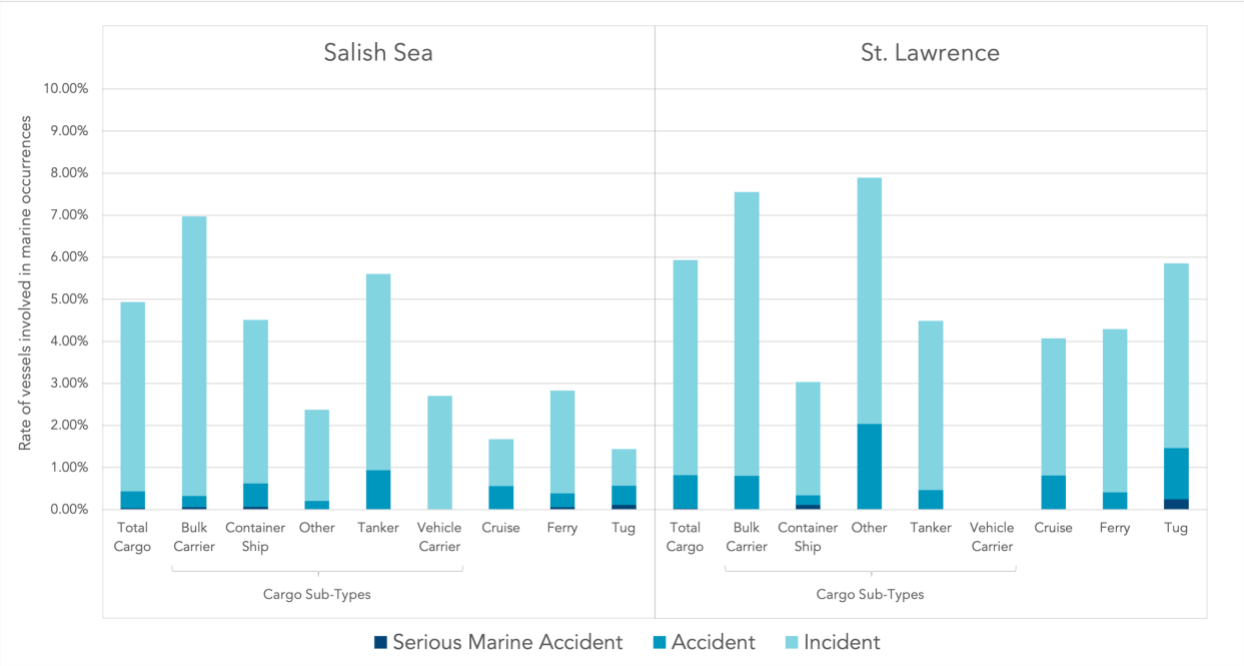

Figure 10. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Salish Sea and St. Lawrence sub-regions.

In the Arctic regions, shown in Figure 11, vessel traffic is much lower than the other study area regions. Therefore, the rates of vessels involved in marine occurrences are more heavily influenced by a few marine occurrence reports. In the Western Arctic region, tugs see drastically higher rates of vessels involved in marine incidents and accidents than any other vessel type in any region. The reports of tugs involved in marine occurrences in this region primarily occur along the Mackenzie River, where tug and barge traffic is prevalent. In the Eastern Arctic, tankers experience the highest occurrence rates compared to other types of vessels. In both of the regions, no vessel traffic was reported for vehicle carriers. There were no reports of vessels involved in serious marine accidents in these regions during the study's timeframe (2015-2018).

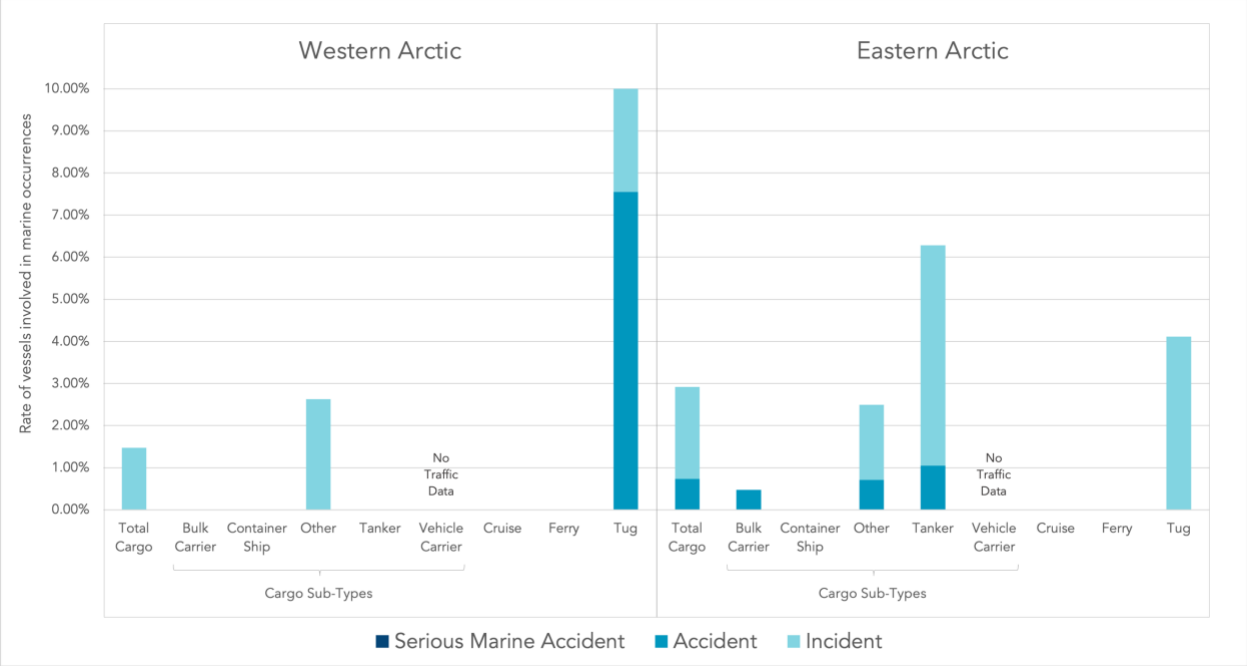

Figure 11. Rate of vessels involved in marine occurrences per 1,000 nautical miles sailed for the Western Arctic and Eastern Arctic.

Tables 3, 4, and 5 on the following pages contain detailed vessel occurrence rates, total number of occurrences, and total number of nautical miles sailed for all regions and vessel types, respectively.

Table 3. Rate of vessels involved in marine occurrences for all regions and vessel types.

Region/sub-region	Vessel Type	Rate of vessels involved in marine occurrences	Rate of vessels involved in marine incidents	Rate of vessels involved in marine accidents (non-serious)	Rate of vessels involved in serious marine accidents
Pacific	Cargo - Total	1.93%	1.77%	0.15%	0.02%
Pacific	Cargo - Bulk Carrier	2.32%	2.20%	0.11%	0.01%
Pacific	Cargo - Container Ship	1.71%	1.48%	0.19%	0.04%
Pacific	Cargo - Other	1.93%	1.79%	0.15%	0.00%
Pacific	Cargo - Tanker	1.63%	1.38%	0.25%	0.00%
Pacific	Cargo - Vehicle Carrier	0.97%	0.97%	0.00%	0.00%
Pacific	Cruise	0.60%	0.41%	0.15%	0.04%
Pacific	Ferry	2.53%	2.21%	0.27%	0.04%
Pacific	Tug	1.51%	0.98%	0.43%	0.09%
Salish Sea	Cargo - Total	4.94%	4.50%	0.40%	0.04%
Salish Sea	Cargo - Bulk Carrier	6.97%	6.64%	0.27%	0.05%
Salish Sea	Cargo - Container Ship	4.52%	3.90%	0.56%	0.06%
Salish Sea	Cargo - Other	2.37%	2.17%	0.21%	0.00%
Salish Sea	Cargo - Tanker	5.61%	4.67%	0.93%	0.00%
Salish Sea	Cargo - Vehicle Carrier	2.70%	2.70%	0.00%	0.00%
Salish Sea	Cruise	1.67%	1.11%	0.56%	0.00%
Salish Sea	Ferry	2.83%	2.44%	0.33%	0.06%
Salish Sea	Tug	1.44%	0.88%	0.46%	0.11%
Great Lakes	Cargo - Total	2.52%	1.81%	0.62%	0.10%
Great Lakes	Cargo - Bulk Carrier	2.36%	1.71%	0.57%	0.08%
Great Lakes	Cargo - Container Ship	1.45%	0.73%	0.73%	0.00%
Great Lakes	Cargo - Other	3.26%	2.36%	0.79%	0.11%
Great Lakes	Cargo - Tanker	3.99%	2.73%	0.97%	0.29%
Great Lakes	Cargo - Vehicle Carrier	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic
Great Lakes	Cruise	0.00%	0.00%	0.00%	0.00%
Great Lakes	Ferry	5.19%	3.37%	1.82%	0.00%
Great Lakes	Tug	2.78%	2.23%	0.46%	0.09%
St Lawrence	Cargo - Total	5.94%	5.12%	0.79%	0.02%
St Lawrence	Cargo - Bulk Carrier	7.56%	6.75%	0.80%	0.00%
St Lawrence	Cargo - Container Ship	3.03%	2.70%	0.22%	0.11%
St Lawrence	Cargo - Other	7.89%	5.85%	2.04%	0.00%
St Lawrence	Cargo - Tanker	4.49%	4.02%	0.46%	0.00%
St Lawrence	Cargo - Vehicle Carrier	0.00%	0.00%	0.00%	0.00%
St Lawrence	Cruise	4.07%	3.26%	0.81%	0.00%
St Lawrence	Ferry	4.30%	3.89%	0.41%	0.00%
St Lawrence	Tug	5.86%	4.39%	1.22%	0.24%
Atlantic	Cargo - Total	1.52%	1.31%	0.20%	0.02%

Region/sub-region	Vessel Type	Rate of vessels involved in marine occurrences	Rate of vessels involved in marine incidents	Rate of vessels involved in marine accidents (non-serious)	Rate of vessels involved in serious marine accidents
Atlantic	Cargo - Bulk Carrier	2.04%	1.79%	0.23%	0.02%
Atlantic	Cargo - Container Ship	0.76%	0.72%	0.03%	0.02%
Atlantic	Cargo - Other	2.07%	1.61%	0.44%	0.02%
Atlantic	Cargo - Tanker	1.33%	1.13%	0.18%	0.01%
Atlantic	Cargo - Vehicle Carrier	0.17%	0.17%	0.00%	0.00%
Atlantic	Cruise	1.08%	0.88%	0.20%	0.00%
Atlantic	Ferry	2.92%	2.16%	0.70%	0.06%
Atlantic	Tug	2.59%	1.97%	0.51%	0.11%
Western Arctic	Cargo - Total	1.47%	1.47%	0.00%	0.00%
Western Arctic	Cargo - Bulk Carrier	0.00%	0.00%	0.00%	0.00%
Western Arctic	Cargo - Container Ship	0.00%	0.00%	0.00%	0.00%
Western Arctic	Cargo - Other	2.63%	2.63%	0.00%	0.00%
Western Arctic	Cargo - Tanker	0.00%	0.00%	0.00%	0.00%
Western Arctic	Cargo - Vehicle Carrier	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic
Western Arctic	Cruise	0.00%	0.00%	0.00%	0.00%
Western Arctic	Ferry	0.00%	0.00%	0.00%	0.00%
Western Arctic	Tug	16.99%	9.44%	7.55%	0.00%
Eastern Arctic	Cargo - Total	2.92%	2.19%	0.73%	0.00%
Eastern Arctic	Cargo - Bulk Carrier	0.47%	0.00%	0.47%	0.00%
Eastern Arctic	Cargo - Container Ship	0.00%	0.00%	0.00%	0.00%
Eastern Arctic	Cargo - Other	2.50%	1.78%	0.71%	0.00%
Eastern Arctic	Cargo - Tanker	6.28%	5.24%	1.05%	0.00%
Eastern Arctic	Cargo - Vehicle Carrier	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic	No Vessel Traffic
Eastern Arctic	Cruise	0.00%	0.00%	0.00%	0.00%
Eastern Arctic	Ferry	0.00%	0.00%	0.00%	0.00%
Eastern Arctic	Tug	4.11%	4.11%	0.00%	0.00%

Table 4. Marine occurrences reported for all regions and vessel types in 2015-2018 (data source: Clear Seas' Marine Incidents and Accidents Dashboard dataset of vessels involved in marine occurrences).

Region/sub-region	Vessel type	Total reported occurrences	Reported incidents	Reported accidents (non-serious)	Reported serious marine accidents
Pacific	Cargo - Total	371	340	28	3
Pacific	Cargo - Bulk Carrier	189	179	9	1
Pacific	Cargo - Container Ship	90	78	10	2
Pacific	Cargo - Other	39	36	3	0
Pacific	Cargo - Tanker	39	33	6	0
Pacific	Cargo - Vehicle Carrier	14	14	0	0
Pacific	Cruise	16	11	4	1
Pacific	Ferry	225	197	24	4
Pacific	Tug	223	145	64	14
Salish Sea	Cargo - Total	272	248	22	2
Salish Sea	Cargo - Bulk Carrier	128	122	5	1
Salish Sea	Cargo - Container Ship	73	63	9	1
Salish Sea	Cargo - Other	23	21	2	0
Salish Sea	Cargo - Tanker	36	30	6	0
Salish Sea	Cargo - Vehicle Carrier	12	12	0	0
Salish Sea	Cruise	6	4	2	0
Salish Sea	Ferry	190	164	22	4
Salish Sea	Tug	133	81	42	10
Great Lakes	Cargo - Total	365	262	89	14
Great Lakes	Cargo - Bulk Carrier	293	212	71	10
Great Lakes	Cargo - Container Ship	2	1	1	0
Great Lakes	Cargo - Other	29	21	7	1
Great Lakes	Cargo - Tanker	41	28	10	3
Great Lakes	Cargo - Vehicle Carrier	0	0	0	0
Great Lakes	Cruise	0	0	0	0
Great Lakes	Ferry	20	13	7	0
Great Lakes	Tug	91	73	15	3
St Lawrence	Cargo - Total	284	245	38	1
St Lawrence	Cargo - Bulk Carrier	141	126	15	0
St Lawrence	Cargo - Container Ship	27	24	2	1
St Lawrence	Cargo - Other	58	43	15	0
St Lawrence	Cargo - Tanker	58	52	6	0
St Lawrence	Cargo - Vehicle Carrier	0	0	0	0
St Lawrence	Cruise	5	4	1	0
St Lawrence	Ferry	21	19	2	0
St Lawrence	Tug	24	18	5	1
Atlantic	Cargo - Total	449	385	59	5
Atlantic	Cargo - Bulk Carrier	189	166	21	2
Atlantic	Cargo - Container Ship	48	45	2	1
Atlantic	Cargo - Other	94	73	20	1
Atlantic	Cargo - Tanker	117	100	16	1
Atlantic	Cargo - Vehicle Carrier	1	1	0	0
Atlantic	Cruise	11	9	2	0
Atlantic	Ferry	100	74	24	2

Region/sub-region	Vessel type	Total reported occurrences	Reported incidents	Reported accidents (non-serious)	Reported serious marine accidents
Atlantic	Tug	46	35	9	2
Western Arctic	Cargo - Total	1	1	0	0
Western Arctic	Cargo - Bulk Carrier	0	0	0	0
Western Arctic	Cargo - Container Ship	0	0	0	0
Western Arctic	Cargo - Other	1	1	0	0
Western Arctic	Cargo - Tanker	0	0	0	0
Western Arctic	Cargo - Vehicle Carrier	0	0	0	0
Western Arctic	Cruise	0	0	0	0
Western Arctic	Ferry	0	0	0	0
Western Arctic	Tug	9	5	4	0
Eastern Arctic	Cargo - Total	20	15	5	0
Eastern Arctic	Cargo - Bulk Carrier	1	0	1	0
Eastern Arctic	Cargo - Container Ship	0	0	0	0
Eastern Arctic	Cargo - Other	7	5	2	0
Eastern Arctic	Cargo - Tanker	12	10	2	0
Eastern Arctic	Cargo - Vehicle Carrier	0	0	0	0
Eastern Arctic	Cruise	0	0	0	0
Eastern Arctic	Ferry	0	0	0	0
Eastern Arctic	Tug	2	2	0	0

Table 5. Number of nautical miles sailed for all regions and vessel types between 2015-2018 (data source: summarized and fused AIS data obtained from Transport Canada).

Region/sub-region	Vessel type	Nautical miles sailed (2015-2018)
Pacific	Cargo - Total	19,231,873
Pacific	Cargo - Bulk Carrier	8,135,515
Pacific	Cargo - Container Ship	5,253,208
Pacific	Cargo - Other	2,016,620
Pacific	Cargo - Tanker	2,389,577
Pacific	Cargo - Vehicle Carrier	1,436,953
Pacific	Cruise	2,678,442
Pacific	Ferry	8,908,667
Pacific	Tug	14,753,627
Salish Sea	Cargo - Total	5,507,832
Salish Sea	Cargo - Bulk Carrier	1,836,104
Salish Sea	Cargo - Container Ship	1,616,686
Salish Sea	Cargo - Other	968,738
Salish Sea	Cargo - Tanker	642,031
Salish Sea	Cargo - Vehicle Carrier	444,273
Salish Sea	Cruise	358,751
Salish Sea	Ferry	6,719,289
Salish Sea	Tug	9,223,321
Great Lakes	Cargo - Total	14,463,348
Great Lakes	Cargo - Bulk Carrier	12,409,773
Great Lakes	Cargo - Container Ship	137,496
Great Lakes	Cargo - Other	889,362
Great Lakes	Cargo - Tanker	1,026,716

Region/sub-region	Vessel type	Nautical miles sailed (2015-2018)
Great Lakes	Cargo - Vehicle Carrier	0
Great Lakes	Cruise	11,508
Great Lakes	Ferry	385,641
Great Lakes	Tug	3,267,558
St Lawrence	Cargo - Total	4,784,696
St Lawrence	Cargo - Bulk Carrier	1,865,674
St Lawrence	Cargo - Container Ship	890,223
St Lawrence	Cargo - Other	735,120
St Lawrence	Cargo - Tanker	1,293,124
St Lawrence	Cargo - Vehicle Carrier	556
St Lawrence	Cruise	122,863
St Lawrence	Ferry	488,825
St Lawrence	Tug	409,800
Atlantic	Cargo - Total	29,493,029
Atlantic	Cargo - Bulk Carrier	9,252,782
Atlantic	Cargo - Container Ship	6,277,818
Atlantic	Cargo - Other	4,548,193
Atlantic	Cargo - Tanker	8,819,339
Atlantic	Cargo - Vehicle Carrier	594,896
Atlantic	Cruise	1,022,009
Atlantic	Ferry	3,430,451
Atlantic	Tug	1,779,146
Western Arctic	Cargo - Total	68,062
Western Arctic	Cargo - Bulk Carrier	4,436
Western Arctic	Cargo - Container Ship	302
Western Arctic	Cargo - Other	38,056
Western Arctic	Cargo - Tanker	25,268
Western Arctic	Cargo - Vehicle Carrier	0
Western Arctic	Cruise	22,842
Western Arctic	Ferry	593
Western Arctic	Tug	52,986
Eastern Arctic	Cargo - Total	684,408
Eastern Arctic	Cargo - Bulk Carrier	212,328
Eastern Arctic	Cargo - Container Ship	863
Eastern Arctic	Cargo - Other	280,264
Eastern Arctic	Cargo - Tanker	190,954
Eastern Arctic	Cargo - Vehicle Carrier	0
Eastern Arctic	Cruise	17,430
Eastern Arctic	Ferry	3,310
Eastern Arctic	Tug	48,661

4.0 References

Clear Seas Centre for Responsible Marine Shipping. (2021). Marine Incidents and Accidents Dashboard – ArcGIS Online Experience. Retrieved from: https://experience.arcgis.com/experience/49bbdd14769646f69cc80cabcb5ac5d5

Clear Seas Centre for Responsible Marine Shipping. (2021). Maritime Commercial Incidents and Accidents. Retrieved from: https://clearseas.org/en/research_project/maritime-commercial-incidents-and-accidents.

Government of Canada, TSBC (2018, February). *Marine occurrence and vessel data from January 2004*. https://www.bst-tsb.gc.ca/eng/stats/marine/data-2.html

United States Coast Guard (n.d.). *Marine Casualty and Pollution Data for Researchers*. https://www.dco.uscg.mil/Our-Organization/Assistant-Commandant-for-Prevention-Policy-CG-5P/Inspections-Compliance-CG-5PC-/Office-of-Investigations-Casualty-Analysis/Marine-Casualty-and-Pollution-Data-for-Researchers/