Climate Change and Arctic Shipping Futures:

Community Perspectives on the State of Shipping and Emergency Preparedness in Canada’s Northwest Passage

By

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Abstract

Shipping trends in the Canadian Arctic are projected to continue along a rising trajectory due to a warming climate, loss in sea ice extent, and growing economic interests in the region. This is resulting in global interest in the region and potential for Arctic shipping routes, notably the Northwest Passage (NWP). As Arctic shipping traffic continues to rapidly grow in Canada, questions arise about the preparedness of both coastal communities and government in the event of a shipping accident, or a worst-case scenario shipping disaster. This thesis aims to integrate the perspectives of residents from Pond Inlet, Nunavut, a coastal community that sits along the entranceway/exit of the NWP and is at-risk of experiencing a shipping accident in the region. A review of literature and relevant grey literature (i.e. acts, agreements, reports) was undertaken to ground the study in current research and policy. A survey with a quantitative and qualitative approach was implemented to document the perspectives of Pond Inlet residents, verifying and identifying changes in shipping patterns in the region and exploring shipping futures around the community. This also entailed acquiring an understanding of how residents perceived shipping accidents, worst-case scenarios, and emergency preparedness for their community and the region. This study contributes to current understandings and research on the state of Arctic shipping and emergency preparedness from the perspectives of coastal communities in the region.

Declaration of Co-Authorship

This study was completed under the supervision of Dr. Jackie Dawson. Research ethics and approvals were completed in partnership with Selina Agyemang Duah. The study's planning, survey development, survey implementation, and verification of results were done in partnership with members of Ikaarvik: Michael Milton, Justin Milton, and Shelly Elverum. Data collection was undertaken by the primary author, Michael Milton, and Nathaniel Holloway. The chapters within this thesis were written by the primary author, with editing and input from Dr. Jackie Dawson.

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Chapter One: Introduction

1.1 Problem Statement

It is widely recognized that anthropogenic climate change is impacting the Arctic at disproportionately high rates compared to the global average (IPCC, 2023; Meredith, et al. 2019). This situation is leading to reduced sea ice extent and increases in shipping traffic, which further poses risks to ecosystems and for the wellbeing and livelihoods of Indigenous and non-Indigenous residents in Arctic communities (Dawson, et al. 2020; Lore, 2008; Byers, 2010; Bergstrom, et al. 2022; Nevalainen, et al. 2019). Local risks are further accentuated via accelerated commercial interest from state actors outside the Arctic region such as China, South Korea, and the European Union as these actors are developing new and advanced technologies to navigate Arctic conditions (Huebert, 2012; Holroyd, 2020; Raspotnik & Stepien, 2020; Afenyo, et al. 2022). Longer shipping seasons due to climate change and decreasing ice coverage, combined with technological innovations and international economic interest in the Arctic, are expected to continue to heighten shipping activity related to resource exploration, tourism, fishing, and trade in the near-term future. Ship-types that currently travel through the Canadian Arctic range from bulk carriers, general cargo, and tanker ships to passenger ships and government vessels (Kochanowicz, et al. 2020). Projected increases in shipping traffic in Arctic Canada have, in turn, increased the potential for emergencies or catastrophic events such as fuel, oil, or chemical spills, groundings, or other accidents or incidents (Afenyo, et al. 2019; Eide, et al. 2007; Nordam, et al. 2017; also see Aune, et al. 2018; Nicol, 2023).

In this study, the Clear Seas: Centre for Responsible Marine Shipping in Canada (2021) definitions of accidents and incidents have been adopted. Accidents are thus defined here as any marine occurrence (incident, accident, event, or casualty) that poses serious risk of damages to the vessel and the surrounding environment (Clear Seas, 2021, 11-12). Thus, an accident can include the material damages to a vessel, the disabling or stranding of a vessel, or the collision of vessels, and the subsequent risks to the environment (UNECE, 2019). An incident is defined here as any marine occurrence that is not considered an accident as it is considered to be less severe than an accident (Clear Seas, 2021). As this research project is focused on identifying and responding to worst-case scenarios, the term 'accident' will be used throughout, with only some reference to 'incidents.' The definition that has been adopted in this study to frame the analysis of accident response options is adapted from the United Nations (UN) definitions of disaster and emergency. These definitions label an emergency as an event that "can be responded to using the resources available at hand," whereas a disaster is labelled as an event that will "overwhelm the capacities of local responders and place demands on resources which are not available locally" (UN-SPIDER, *Emergency and Disaster Management*). According to Lopez-Carresi (2012), an emergency response is defined as the management and control of an emergency for the reduction of negative impacts to life, livelihoods, property, and infrastructure.

Anthropogenic marine disasters can be catastrophic in any part of the world, but the consequence of a shipping accident in the Arctic region is arguably worse than in less remote regions of the world due, in part, to limited infrastructure, distance from any major services provided in urban centers, and harsher environmental conditions (Pincus, 2015). Further complicating the situation are the challenges associated with investing in or building maritime infrastructure in the Arctic region, which include factors such as low tax base to support public sector economic investments, limited historic opportunities and/or willingness for public-private partnership investments, a perceived lack of need for investments based on current economic conditions and/or demographics, among others (Pincus, 2015; Mileski, et al. 2018).

The situation described above constitutes a 'wicked problem,' defined as a problem that is complex, uncompromising, and open-ended with often contradictory changing requirements that can open the door to additional problems (Mileski, et al. 2018). The overarching risks that are indeed continually exacerbated by worsening anthropogenic climate change further threaten human security in Arctic communities and also constitute an ongoing and potentially increasing threat to Canada's national security (Greaves, 2021; May, 2023). The increase in shipping traffic arising from climate change has the potential to pose national and local security risks for Arctic states as the Arctic is more accessible to state and non-state actors (Briggs, 2020), with the concept of security going beyond military affairs to include economic, ecological, and social aspects (Kullenberg, 2002).

Inuit communities have questioned if the benefits of increased Arctic shipping (i.e., including the employment and revenue benefits of cruise tourism for example) outweigh the costs of the risks (Kelley and Ljubicic, 2012; Dawson, et al. 2020; Stewart, et al. 2007). The importance of integrating local perspectives and Indigenous knowledge into both research and decision-making on shipping risks and governance has been highlighted in recent initiatives. These include through efforts by the Canadian Coast Guard through the Oceans Protection Plan, by local initiatives, such as by the Ikaarvik youth science organization, and by the academic community, such as through the Arctic Corridors and Northern Voices project, among others (DFO/CCG, 2020; Oceans North Canada, 2016; Munari, 2020; Goerlandt and Pelot, 2020; Dawson, et al. 2020; van Luijk, et al. 2021; Kikkert and Lackenbauer, 2019). Clearly, more information is needed as the risk of shipping accidents is rising due to a rising frequency of marine traffic as well as the increase in navigation hazards that are emerging in the Arctic considering ongoing climate change (i.e., warming and extreme events) and climate variability (Loughnane, et al. 1995), and the consequences of an accident in this region can be catastrophic.

There are organizations such as the International Maritime Organization (IMO) and the Arctic Council which are committed to establishing policy and agreements for Arctic development and transportation at the international level. A significant example of this are the outcomes of the *International Convention for the Prevention of Pollution from Ships* (MARPOL) (1973) which is considered the core international convention that covers marine shipping pollution from operational and accidental causes. At the national level, policy that governs Arctic shipping activities include the *Canada Shipping Act, 2001*, the *Arctic Waters Pollution Prevention Act, 1985,* the *Marine Liability Act, 2001,* and the *Marine Transportation Security Act, 1994,* among a range of additional acts and regulations. The *Northern Canada Vessel Traffic Services* (NORDREG) *Zone regulations* are an important component to this governance as domestic and international vessels operating within the NORDREG zone are monitored and required to follow an array of guidelines and standards (*Northern Canada Vessel Traffic Services Zone Regulations,* 2010). There are additional safety requirements and preventative measures that vessel operators must follow within Canadian Arctic waters under the *Arctic Shipping Safety and Pollution Prevention Regulations* (*Arctic Shipping Safety and Pollution Prevention Regulations,* 2017). On a more localized level, the Territory of Nunavut has an *Emergency Measures Act* (2007) that involves government institutions and municipal institutions to identify local risks and prepare emergency management programs based on those risks, while determining an emergency when an emergency event, such as a shipping accident near a community, occurs (NEM, 2021).

The capacities and resilience of the impacted coastal communities are critical for an effective emergency response and recovery, including the potential for search and rescue operations that may occur during an emergency response process (Mileski, et al. 2018). The community-based Canadian Rangers who operate alongside the Canadian military are one such example of Arctic community resilience and collaboration in the event of disasters or search and rescue operations (Lackenbauer and Kikkert, 2020). To respond directly to the above problem statement, this thesis-based research aims to answer the following key research questions:

1) How have community residents in Pond Inlet perceived the changes in shipping traffic and the associated risks?
2) What is the likelihood of shipping accidents and the feasibility of emergency response in and around the Northwest Passage (NWP) from community residents' perspectives?
3) What is the level of severity that shipping accidents can have on the community and its residents?
4) Which actions or approaches can improve emergency preparedness and Disaster Risk Reduction (DRR) outlooks to meet the growing accessibility in and around the NWP?

1.2 Research Aim and Objectives

This thesis-based research responds directly to the problem statement and key research questions outlined above and uses a hamlet that sits at the eastern entrance of the NWP as a case study community to analyze shipping disaster risk perceptions and perceptions of the level of readiness of the community (and community supports) to respond to / manage a shipping accident around the NWP. The research objectives are three-fold and include to:

1) Identify community perspectives on the observed changes in shipping around the NWP and coastal community;
2) Explore shipping risks, consequences, losses from worst-case scenarios, and prevention / preparedness from the perspectives of community residents;
3) Investigate community perspectives on historic shipping accident scenarios within the context of the NWP and coastal community.

1.3 Study Site

Pond Inlet, Nunavut, is located at the northern tip of Baffin Island and right at the eastern entrance to the NWP. Statistics Canada (2021) noted a population of 1555 in Pond Inlet, with 94% of residents identifying as Inuit. The community is unique in that ships must pass by or nearby to enter or exit the NWP at the eastern side. On the western side of the Passage there are multiple routeing options that do not require vessels to pass by a particular community and thus, Pond Inlet is in an opportune or precarious location depending on the extent to which shipping accidents can be successfully mitigated as a changing climate and changing world order continues to drive Arctic shipping demand. Pond Inlet is also near the Tallurutiup Imanga National Marine Conservation Area (NMCA), an ecologically sensitive area encompassing the Lancaster Sound that has seen extensive changes in shipping activity (see Figure 1.1). Being within the high Arctic, the community experiences the warming from climate change over twice the rate compared to global averages (Corell, et al. 2013). As a result of its location and a changing climate, Pond Inlet now experiences some of the highest rates of shipping traffic of any community in the Canadian Arctic (Carter, et al. 2018; Dawson, et al. 2018).

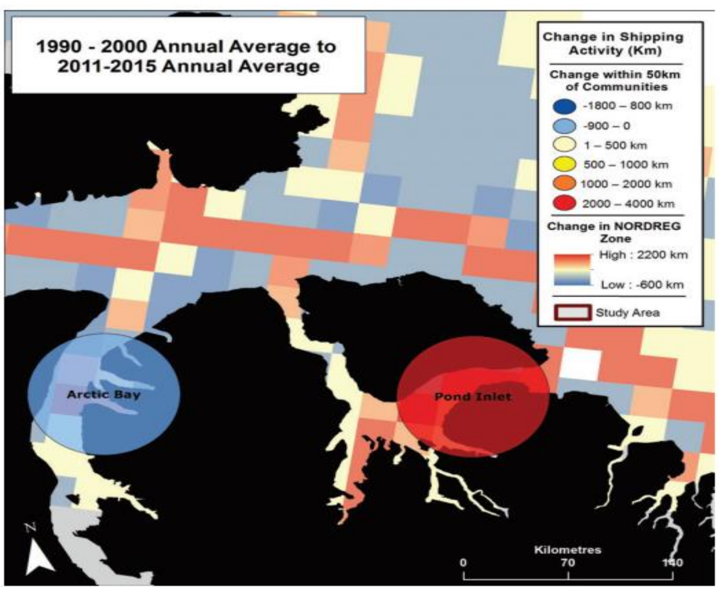

Figure 1.1: Increases in shipping activity (km) near Pond Inlet and Tallurutiup Imanga NMCA (Carter, et al. 2018).

1.4 Review of Literature

The following sub-sections contain five themes discussing current literature that is relevant to this research: 1) Disaster Preparedness Governance, 2) Climate Change and Arctic Shipping, 3)

Shipping Risks, Emergency Responses and Consequences of Inaction, 4) Human Dimensions of Shipping Accidents and Oil Spills, and 5) Community Perspectives and Indigenous Knowledge for Disaster Risk Reduction.

1.4.1 Disaster Preparedness Governance

Understanding the governance of shipping and potential emergency events in the Canadian Arctic is necessary to consider the policy tools that can act as protections to coastal communities and the environments, preventive or mitigative measures for shipping transits, and requirements or guidelines for emergency response capabilities. Aside from international agreements, for example, set by the International Maritime Organization (IMO) in the *International Convention for the Prevention of Pollution from Ships* (MARPOL) (1973) and the creation of the Arctic Council, there are currently tools within Canadian and territorial policy that provide limited protections to the marine space and coastal communities within the Canadian Arctic. With the Lancaster Sound and a critical section of the NWP being designated the Tallurutiup Imanga National Marine Conservation Area (NMCA), the *Canada National Marine Conservation Areas Act, 2002* becomes applicable to this study. This act promotes the protection of marine ecosystems through the adoption of the precautionary principle in the management and conservation of the marine space that falls under the act, with preventive measures being encouraged to reduce threats to the marine ecosystem (*Canada National Marine Conservation Areas Act,* 2002). The Government of Canada has shipping requirements that are exclusive to the Canadian Arctic waters, alongside the nation-wide shipping regulations that apply to vessels operating south of the Arctic territories. The *Canada Shipping Act, 2001* is recognized as the overall regime that encompasses vessel construction and crew requirements, safety requirements, pollution prevention and response, as well as emergency response arrangements in Canadian waters and Canada's Exclusive Economic Zone (CIRNAC, 2022; *Canada Shipping Act,* 2001). As a consolidation to this act, the *Vessel Pollution and Dangerous Chemicals Regulations* (2012) were enacted in 2012, requiring oil tankers of 150 gross tonnage or more to have an oil pollution emergency plan aboard which meets requirements set out in MARPOL and prohibits Canadian vessels from intentionally discharging oil and oily mixtures into Arctic waters.

Supplementary to the *Canada Shipping Act* regime*,* the *Marine Liability Act, 2001* demands that ship owners are responsible for the measures taken to ensure that pollution in Canadian waters from their ships is prevented or minimized, and the ship owners are liable for the costs of pollution events that originate from their ships which can cause a grave or imminent threat or direct damage to the marine environment. This act is based on the polluter pays principle, where the costs of pollution prevention, reduction, and control measures are the polluter's responsibility and obligation (Koivurova and Molenaar, 2010; CIRNAC, 2022). Ship owners must also have proof of insurance that satisfies the Civil Liability Convention, established at the International Convention on Civil Liability for Oil Pollution Damage in 1992, to enter or leave ports or offshore terminals in Canadian waters (*Marine Liability Act,* 2001*,* Article 55).

To address a broad range of pollution risks in the Canadian Arctic, the *Arctic Waters Pollution Prevention Act, 1985* outlines the obligations of the Canadian Parliament to ensure that Arctic waters are developed, exploited, and navigated "only in a manner that takes cognizance of Canada's responsibility for the welfare of the Inuit and other inhabitants of the Canadian Arctic and the preservation of the peculiar ecological balance that now exists in the water, ice, and land areas of the Canadian Arctic" (*Arctic Waters Pollution Prevention Act,* 1985*,* preamble). Regulations in the *Arctic Waters Pollution Prevention Act, 1985* and the *Canada Shipping Act, 2001* require foreign and Canadian ship owners operating in the Arctic to adhere to navigation periods in the shipping safety control zone, dependent on the ice strengthening and ice class of the vessels. Most vessels must also have an ice navigator on board who is trained and certified in navigating polar waters, while the ship operator is required to send a message to the Minister of Transport containing information on their vessel and route before entering the shipping safety control zone (*Arctic Shipping Safety and Pollution Prevention Regulations,* 2017). Under the *Canada Shipping Act, 2001,* the *Northern Canada Vessel Traffic Services* (NORDREG) *Zone regulations* (2010) require a sailing plan report to be provided by vessels before entering the NORDREG zone, when departing the NORDREG zone, and if a vessel has been stranded, has had a mechanical breakdown, or has been involved in a collision. The information required within this sailing plan report includes the vessel, date and time entering the zone, corresponding geographical position, the intended route, a description of the cargo, weather and ice conditions, as well as any defects or damages the vessel has (*Northern Canada Vessel Traffic Services Zone Regulations,* 2010). The NORDREG zone encompasses the Canadian territory within the Arctic circle, along with the Hudson Strait, Davis Strait, Hudson Bay and James Bay (DFO/CCG, 2024, 3-5). Other acts relevant to Arctic shipping risks and oversight include the *Marine Transportation Security Act, 1994,* the *Oceans Act, 1996,* the *Wrecked, Abandoned or Hazardous Vessels Act, 2019,* and Nunavut's *Emergency Measures Act* (2007).

1.4.2 Climate Change and Arctic Shipping

Ice-free summers are projected between mid to late century in the Arctic, making routes in the Arctic Ocean such as the NWP and the Transpolar Sea Route increasingly feasible, albeit risky, opportunities (Stevenson, et al. 2019). Mudryk, et al. (2021) consider these risks and opportunities when projecting sea ice changes through various scenarios of warming (1°C, 2°C, and 4°C above preindustrial values) using single model initial condition large ensemble of climate conditions and four classes of vessels: Polar Class 3 (typically icebreaking vessels), Polar

Class 7 (largely used for community resupply), Category C 1B (typically passenger ships or some resupply ships), and NIS or non-ice-strengthened vessels (such as yachts or pleasure craft). A strong dependence between levels of warming and the length of shipping seasons was evident, but important differences exist depending on the region and vessel classes. At 2°C, all shipping routes (Arctic Bridge, NWP Southern route, NWP Northern route, and the Beaufort region) were found to experience a navigation probability of 100% by around 2045, but the complete disappearance of multi-year ice is projected to be unlikely, even under 4°C. Mudryk et al. suggest that 2°C and 4°C of global warming are likely to provide profitable operating days for operators of Polar Class 7 vessels if the operators accept the elevated risk of mobile ice along with multi-year ice that accumulates within the NWP that is not captured by climate model simulations.

With the viability of Arctic shipping routes being constrained by significant ice variability as well as economic and regulatory considerations, Stephenson and Smith (2015) present future trans-Arctic shipping scenarios through 10 General Circulation Models from the World Climate Research Programme Coupled Model Intercomparison Project (CMIP5) archive based on representative concentrative pathways (RCPs) 4.5 and 8.5. To identify "optimal least-cost navigation routes," the Arctic Ice Regime Shipping Systems (AIRSS) from Transport Canada was integrated into the climate models while the chosen vessel classes for the scenarios were Polar Class 6 (PC6) and a NIS (Non-Ice Strengthened) open water vessel. Stephenson and Smith note that vessel class plays a more significant role in the projected routes and accessibility compared to accelerated climate forcing, with the route quantities in the 10-model average being around 401 to 447 for PC6 vessels and 176 to 197 for the NIS vessels in the RCP 8.5 scenario. The Northern Sea route is projected to remain the most reliably accessible space for shipping by mid-century, but the NWP and Transpolar Sea route will offer fuel savings and time with the trade-off of higher risks and minimal support infrastructure (Stephenson and Smith, 2015). However, profitability of navigating such routes is likely to be reduced due to the high costs of an ice classed vessel with adequate engine power and future Arctic regulation such as enhanced safety standards, bans on Heavy Fuel Oils (HFOs), and carbon pricing schemes (Cheaitou, et al. 2020; Ding, et al. 2020; Cheaitou, et al. 2022). Stephenson and Smith (2015) suggest that while the likelihood of the Arctic as a transit corridor increases with the increasing ice-free summer days occurring due to climate change, the likelihood of the region becoming a more feasible option compared to the Suez and Panama Canals is remote.

Similarly, Li and Lynch (2023) explore possible ramifications of the increasingly open Arctic Sea routes using the Coupled Model Intercomparison Project for 14 global climate models along with a scenario analysis of the Shared Socioeconomic Pathways and Risk Index Outcome values using the Polar Operational Limit Assessment Risk Indexing System (POLARIS) framework. The authors reaffirm the overall growing rates of shipping season length in relation to the higher emissions pathways, also noting that the differing scenario pathways can result in Arctic shipping regime shifts that are different in rate and extent. While the major shipping corridor is largely projected to be the Northeast Passage (Northern Sea route) in these scenarios, a few routes begin to divert to the NWP until the 2040s when the Central Arctic route begins gaining prominence. By mid-century, shipping routes are found to shift more toward the western Arctic (NWP) and the central Arctic (Transpolar Sea route), with this shift being especially pronounced under the higher emissions scenarios. Li and Lynch contend that it is extremely likely (>95%) that Arctic shipping navigation will expand beyond Russian administered waters by 2086 under a very high emissions scenario and by 2107 under a high emissions scenario. Risks are found to be much higher with pre-2045 shipping navigation throughout the Arctic routes due to the sea ice ridging and fast ice formation (also see Mussells, et al. 2017).

Afenyo, et al. (2019) contribute to a basis for understanding the economic landscape of Arctic shipping in relation to the risks, complexities, values, and concerns for emergency response and oil spill preparedness, while further identifying the economic and social impacts of Arctic shipping. Through a probabilistic-based model called the Socio-Economic Impact Model for the Arctic (SEMA), the authors estimate the social, economic, and biophysical impacts of a potential oil spill in the Arctic with hypothetical case studies and scenario analysis from global data, cost functions, and probabilities. The authors note that SEMA can capture both human and cultural elements for oil spill contingency planning along with the associated potential costs and vulnerabilities. The findings demonstrate that the type of vessel and type of oil involved in an accident are significant indicators for the total impact of an oil spill, whereas the recovery method and season are, to a lesser degree, indicators for the cost outcome (Afenyo, et al. 2019). Simulated oil spills via a multiperiod model in a worst-case scenario also demonstrated that socioeconomic impacts will continuously increase, and accelerate in following years, if there is no recovery intervention of the oil spill (Afenyo, et al. 2022).

1.4.3 Shipping Risks, Emergency Responses and Consequences of Inaction

Climate change risks within the Canadian Arctic are risks to national security, with these risks arising, in part, from a heightened access to the Arctic marine space (Greaves, 2021). As average temperatures rise at unprecedented rates in the Arctic, it is expected that decreased sea ice extent and thickness will create navigational opportunities for shipping transportation (i.e., movement of people) and shipping (i.e., movement of goods). Risks arise from, but are not limited to, the rising interests from global state and commercial actors such as China or the European Union, the human security of citizens living in Arctic communities, and the potential of high environmental and economic costs associated with an oil spill or a catastrophic shipping disaster in the Arctic (Huebert, 2012; Byers, 2010; Holroyd, 2020; Raspotnik & Stepien, 2020; Pincus, 2015).

Pincus (2015) addressed the case of a cruise liner, the *Crystal Serenity*, that departed from Alaska in 2016 to pass through the Bering Strait on its way to New York City. With the *Crystal Serenity* having approximately 2000 passengers and crew on board, questions were raised regarding the capacity and availability for an emergency response in the event of a severe incident in a region with scarce infrastructure and challenging conditions (also see Clark and Ford, 2017). Pincus (2015) noted that the Arctic Council's 2009 Arctic Marine Shipping Assessment indicated how investment and development in the region's infrastructure is being outpaced by Arctic marine tourism, creating the conditions for a wicked problem. With human activity within the Arctic increasing substantially and infrastructure development remaining stagnant, policymakers are left with a dilemma. Pincus suggested that policymakers must either commit significant investment in the Arctic to reduce the risk of a shipping disaster and risk that investment being perceived as a waste or delay the spending and face the likelihood of being perceived as having failed when a disaster occurs. The high cost and low probability character of disasters, notably in the Arctic, amplifies the complexity in decision-making processes for investment in long-term preparedness compared to shorter-term responses (Pincus, 2015), which can lead to extensive economic efficiency losses and financial burden that is passed onto future generations when a disaster does occur (Bechtel and Mannino, 2021).

Highlighting the complexities of an Arctic emergency response through a case study of a fictional Arctic voyage, Larsen, et al. (2016) address "what if" questions for planning for emergency management situations as Arctic shipping traffic increases along with the need for Search and Rescue and Oil Spill Response infrastructure in the North. For the case, the authors use a multi-purpose deck cargo carrier which they call *Oleum* with Ice Class 1A where icebreaker assistance is not needed during light ice conditions. This fictional ship was hauling a 750-tonne propane compressor module and 24 shipping containers consisting of equipment, parts, and chemicals. The main engines failed due to clogged filters in the Russian Kara Strait, leading the ship to drift into the rocky shores as the anchors were covered in solid ice, then causing the propane compressor and containers to detach and be released into the sea and shoreline. As a result, the chemicals stored in drums in a few of the containers were released into the sea, and the ship began leaking diesel fuel. Larsen, et al. note that the *Oleum* crew sent out distress signals at 09:45 when the engines initially failed, military helicopters arrived on scene at 14:30, then tugboats arrived at 16:45 with Oil Spill Response equipment. The authors suggested that the consequences of an accident such as this are far reaching, posing risks to drifting eggs and fish larvae, marine mammals, and sea birds, making post-accident environmental monitoring a critical feature after shipping accidents. Overall, the authors effectively present a fictional shipping accident with a large variety of complexities and challenges within these chains of events that require attention when considering environmental risks in Arctic navigation (Larsen, et al. 2016).

With the type of oil being a significant indicator of impact for an oil spill event (Afenyo, et al. 2019), it is important to consider fuel-types in Arctic shipping emergencies. Heavy Fuel Oil (HFO) is a lower cost fuel that poses the most significant threat to marine spaces in the event of an oil spill, being the most difficult to clean up while also releasing more harmful pollutants through its use compared to alternative fuels such as distillate fuels (van Luijk, et al. 2020). The IMO has recently approved a partial ban on HFOs in Arctic waters by 2024 (Cheaitou, et al. 2022; Afenyo, et al. 2022), then a complete ban by 2029 (Saul, 2021). Van Luijk, et al. (2020) used spatial analysis of ships using HFO when operating within the Canadian Arctic between 2010 and 2018, finding that 37% of total ships travelling through the Canadian Arctic during this timeframe were using HFO. The majority of the vessel types using HFO were general cargo, bulk carriers and oil tankers. While switching fuel types could have consequences via economic impacts to shipping companies and Arctic communities, a reduction in mining-related HFO-use could significantly reduce the overall HFO-use in the Canadian Arctic. Bulk carriers from mining companies were found to be a significant HFO contributor in the Canadian Arctic, with mining-related activities only expected to grow in the region (van Luijk, et al. 2020).

There are significant ecological threats, or threats to marine wildlife, in vulnerable marine ecosystems in any level of severity of oil spill events, both from the immediate release of the toxins and in the long-term (Halliday, et al. 2022; Pathmalal, et al. 2023; Afenyo, et al. 2019; Peterson, et al. 2003). Marine wildlife can be indirectly and directly harmed by oil spill events through contact, inhalation, ingestion, or absorption, contaminating birds and mammals with the toxic oils and hindering their abilities to fly, swim, dive, or float, often leading to their deaths (Chilvers, et al. 2021). Halliday, et al. (2022) suggest that a large oil spill event may especially cause irreversible harms to wildlife populations and ecosystem in the Tallurutiup Imanga NMCA. This risk is compounded onto the additional risks to wildlife from ships such as light and noise pollution, chemical pollution, ships striking wildlife, invasive species, and physical disturbances. To reduce such risks, Halliday, et al. propose some options: 1) excluding shipping traffic from vulnerable and important areas via "avoidance areas" or vessel routing, 2) slowing speeds of vessels through the region, and 3) developing a quota system that limits how many vessels can travel through the region. While these options can reduce the exposures of vessels to wildlife, they can also reduce the risks to the vessels from the hazardous navigation in the region and the risks to the health of community members from contaminated country foods (Chang, et al. 2014; Browne, et al. 2020; Pathmalal, et al. 2023).

The high-profile Exxon Valdez shipping disaster in 1989 provides an example of an Arctic shipping accident in Alaska where emergency response was limited while irreversible long-term impacts were substantial (Halliday, et al. 2022; Peterson, et al. 2003). The super oil tanker ran aground on Bligh Reef near Prince William Sound, Alaska, causing over 35,000 tonnes of oil to spill into the seas while the immediate emergency response took over two days before oil spill response equipment could finally be deployed (Barron, et al. 2020). When equipment arrived to contain the oil and contaminants, a windstorm hampered containment efforts and spread the oil spill well beyond the containment capabilities (Kelso and Kendziorek, 1991). Barron, et al. (2020) noted how the toxic effects of the oil caused the mortality of around 250,000 seabirds, 250 eagles, 2,800 sea otters, 22 killer whales, and billions of herring and salmon eggs. Impacts to the ecosystem beyond these estimates persisted as the oil that was spilled from this disaster continued to be bioavailable over a decade later, pointing to the significant and severe long-term impacts of an oil spill event (Peterson, et al. 2003). Most of the literature on the Exxon Valdez spill focuses on the ecological impacts as opposed to the psychological and social impacts to communities or groups and their members (Aguilera, et al. 2010). The Exxon Valdez case highlights the severity and extent of the consequences when there is a lack of preparedness and lack of a prompt response in the event of a worst-case scenario, leading to a disaster.

1.4.4 Human Dimensions of Shipping Accidents and Oil Spills

The human dimensions of Arctic shipping and shipping emergencies are crucial for understanding how and why a shipping accident occurs in the first place and what the consequences can be for surrounding communities, especially in terms of health risks. The focus within this section will be on the occupational risks and hazards of shipping operations (Oldenburg, et al. 2010; Salokannel, et al. 2018) as well as the physiological and psychological health risks from oil spill exposures (Ferguson, et al. 2020; Laffon, et al. 2016; Afshar-Mohajer, et al. 2019; Aguilera, et al. 2010; Liu, et al. 2016). These are especially important considerations when accounting for Indigenous communities whose traditional food systems are at risk of contamination from oil or chemical products (Jonasson, et al. 2019; Burek, et al. 2008).

It has been recognized that around 80 to 90% of shipping accidents have been due to human error, which has also been reflected in IMO statistics (Salokannel, et al. 2018; Oldenburg, et al. 2010). Salokannel, et al. (2018) suggest that the exposure to risks is significantly higher in the Arctic compared to regions south of the Arctic, while these risks are heightened by the lack of experience amongst seafarers within the region as it becomes increasingly accessible. In addition, the authors note that equipment such as magnetic compasses, Global Positioning Systems (GPS), radio coverage, satellite, among other technologies can be less reliable because of the remoteness and high latitudes. Then the harsh weather, cold, darkness, fog, and storms can be seriously demanding for crew members, with the remoteness of the Arctic routes causing challenges if a crew member gets ill or requires hospitalization. Thus, human resources are a critical determinant for the safe passage of an Arctic shipping route, and effective leadership is necessary to foster a professional environment and culture that engages and empowers crew members to participate in a safe work climate. Salokannel, et al. (2018) also advise that some level of uncertainty can allow for seeing new angles to risks or problems, and appropriate communication in a healthy work environment can prevent or mitigate shipping accidents.

It is generally acknowledged that disaster and accident rates in shipping have fallen (Oldenburg, et al. 2010; Council of Canadian Academies, 2016). The occupational risks to the crew members who are shipping in the remoteness of the Arctic is a further necessary consideration for shipping risks and requirements for an emergency response to a shipping accident, or in the event of a search and rescue. Oldenburg, et al. (2010) provided a review of expert opinion and a PubMed analysis on the occupational risks of seafaring, with categories in: disaster and accident rates, piracy, cardiovascular diseases at sea, work-related stress, environmental stressors, communicable diseases, and occupational cancers. For the relevancy to Arctic shipping accidents and emergencies, the categories of focus will be *disasters and accident rates* and *high load of work-related stress in seafaring.* The authors note that the major causes of mortality in shipping disasters have been a result of breakages and sinking from severe storms and heavy gales, cargo hold explosions, and collisions resulting from poor visibility, whereas inexperience, insufficient safety and risk awareness, and lack of personal protective equipment were the main causes of fatal workplace injuries. Shipping and seafaring were also found to be associated with special psychological and physical stressors compared to the general population, with fatigue, isolation, the multinational characterization of crews, and limited recreation opportunities being prominent themes contributing to the high load of work-related stressors (Oldenburg, et al. 2010).

Laffen, et al. (2016) explored all recent (until 2016) studies on the adverse health effects of oil spill exposure and the association between oil spill exposure and risks to human health, classifying the studies by human health, physical/physiological effects, and genotoxic, immunotoxin and endocrine toxicity. The studies identified within this review were based on only nine significant oil spills, including Exxon Valdez in the Arctic. The results on the mental health of the residents and cleanup workers (oil-exposed populations) who were impacted by oil spills showed higher scores of event-related psychological stress, depression, anxiety, and post-traumatic stress disorder. Factors such as low incomes, lacking social supports, and social disruption heightened the risks for adverse mental health effects in many coastal community residents, with changes in economic conditions and job losses being among the chronic long-term pressures and stressors. Based on the studies identified by Laffen, et al. (2016), physical and physiological effects of oil spill exposure generally entailed irritations in the eyes, throat, and skin, respiratory problems, neurological effects such as headaches, nausea, and dizziness, as well as trauma-related effects including backpain and injuries. These symptoms had a higher prevalence in populations exposed to the oil spill and were related to the intensity of exposure. The severity of these symptoms was also dependent on the level or prevalence of personal protective equipment used by the oil exposed populations involved in response and cleanup activities (also see Aguilera, et al. 2010). Regarding the genotoxicity, immunotoxicity, and endocrine toxicity category, Laffen, et al. (2016) noted higher rates of genotoxicity parameters and altercations in the levels of certain hormones, lymphocyte subsets, and cytokines in populations that were exposed to various oil spills.

While there are certainly many hazards to food security and health that are unique to shipping, the transportation and release of oil into the environment poses analogous challenges to Indigenous communities relying on both terrestrial and marine environments for country foods across Canada. Within this theme, Jonasson, et al. (2019) addresses the risks and impacts to the health equity for Indigenous communities with the push for oil pipelines and the rise of oil tanker traffic, with a focus on the Trans Mountain Pipeline expansion. The Trans Mountain Pipeline is estimated to result in a 7-fold increase in shipping traffic in Burrard Inlet, British Columbia, with the expansion of a petroleum storage facility and terminal. The authors note that the consumption of traditional foods is an essential part of Indigenous "cultural continuity" and the preservation of culture, community, nutrition, and self-determination, and this was the case for the community in the study area, Tsleil-Waututh First Nation. Being around Burrard Inlet, this community's traditional foods were historically marine species, including shellfish, salmon, and herring. These traditional foods are threatened by contamination from oil products transported by pipeline or vessel, while also being impacted by mercury and pesticides that bioaccumulate and bio-magnify. This leads to reduced traditional country food consumption, an increasing reliance on western diets that are higher in fats, sugar, and salt which can heighten risks for diabetes, as well as exposure risks that can cause a wide array of conditions including cancer (Jonasson, et al. 2019). In addition to the accumulation of evidence on the environmental and health consequences of oil spills, oil spills and the use of dispersants in the response has been found to lead to an increase in algal species that produce a toxin which causes shellfish poisoning (see Almeda, et al. 2018). Jonasson, et al. (2019) state how Indigenous social movements push the importance of upholding the rights in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) to promote health equity for sustainability for future generations, yet Canada's Environmental Impact Assessment for the Trans Mountain project has failed to consider climate change and health risks for severe spills.

1.4.5 Community Perspectives and Indigenous Knowledge for Disaster Risk Reduction

The recognition of the increasing shipping traffic and the heightening risks to ships in regions of scarce support infrastructure is resulting in the need for local stakeholder collaboration. Mileski, et al. (2018) stress cooperation and collaborative action among stakeholders as a critical mechanism to reducing risks and response planning in the event of an Arctic shipping accident in the face of rising economic interests, consumer travel (experience) interests, and security interests. This collaborative action includes local, national, and international stakeholders and rightsholders for creating plans and techniques for managing the risks that come with these rising interests and increasing shipping traffic which constitute a wicked problem. When addressing the mitigation for this wicked problem, the authors propose a model of cooperation among Arctic stakeholders. This first entails marine asset provisions for both public and private stakeholders that employ a collective decision-making process with the stakeholders. For shipping disaster risk management planning and mobilization, this model includes the designation of an experienced manager (or managers) to facilitate the process, and a plan that states stakeholder responsibilities and necessary actions for before, during, and after an accident takes place. This planning should also have an inventory of relevant assets and capabilities of both public and private stakeholders, along with appropriate safety procedures for the potential response and prevention of future shipping accidents. Training stakeholders, such as the response teams, will be necessary to ensure the response teams follow safety protocols during the response to an accident. The authors suggest that any incentive system that is used to encourage stakeholder participation is monitored by the Arctic Council to discourage corruption in the system. Furthering our understanding of maritime assets could assist in the prevention of shipping accidents and improve emergency response through the current asset data (Mileski, et al. 2018).

Tackling emergency management issues in Arctic shipping entails adopting climate change adaptation strategies and funding as environmental conditions allow for increasingly more shipping traffic and higher risks to communities. Ford, et al. (2015) discuss the challenges to adaptation in the Arctic through a review of previous studies from over the past decade on climate change adaptation, resilience, and vulnerability. Four “reasons for concern about adaptation” are outlined: 1) the limited window for action due to climate change, 2) adaptive capacity may not lead to adaptation, 3) adaptation strategies already in place are unsustainable (maladaptation), and finally, 4) community values and culture are often overlooked. The authors reiterate how climate models are projecting rapid and extreme warming, posing significant risks to human and biophysical systems while Arctic populations have been identified as highly vulnerable with limited adaptation opportunities. Most of the research was focused on Indigenous knowledge systems, with many of these Indigenous systems recognizing the Arctic environment as constantly being in a state of flux. Decisions for the Canadian Arctic are often made outside of the region; however, land settlement agreements have heightened northern communities' roles in decision-making for natural resource and land management which has positive implications for adaptation to future changes. The authors suggest that despite institutions inhibiting adaptation in some cases, institutions can also "act as pathways for knowledge development and learning" to improve and strengthen adaptive capacities. Having a history of cruise tourism, Greenland and Norway were provided as examples of well-developed multilevel governance structures that can manage new and future challenges in increased shipping traffic. In the Canadian Arctic, regulatory co-management efforts have taken place through strategies such as the integration of western science, traditional knowledge, and local needs in wildlife management stocks, but differing power relations compromise meaningful collaborative decision-making. Ford, et al. (2015) argue that root causes such as colonization and disempowerment are to be addressed to enhance adaptation opportunities.

Bridging the gap between the top-down scientific-centered approaches and the bottom-up (grassroots) Indigenous knowledge approaches can entail meeting in the middle or using and building on both scientific knowledge and Indigenous knowledge through participatory strategies to render more precise data and meaningful findings (Mercer, et al. 2010; Hadlos, et al. 2022; Pedersen, et al. 2020). Of course, these findings should not only be practical for the researcher, but the findings should also be beneficial and impactful for the community, or communities, in question. Mercer, et al. (2010) provide a framework for bridging Indigenous knowledge and scientific knowledge for disaster risk reduction research that goes beyond static community participation with a process that is ongoing and adaptive to adjust for environmental changes. The first step of this framework is for community engagement, requiring the community to judge their levels of vulnerability to certain hazards and to build trust and rapport between the research team and community. This requires addressing the unequal power relations between the research team and community, mitigating these unequal power relations from the start. The second step is the identification of vulnerability factors that are risks to the community, with the research team supporting the community in understanding the process of vulnerability that exacerbate hazards. Mercer, et al. advise that a local person who is familiar with the community and its cultural background would be necessary for the translation of certain concepts and language. The third step entails the identification of both Indigenous and scientific strategies from the past and present to reduce vulnerability and cope with certain hazards in a process of ‘guided discovery’ for ‘facts, relationships, and new truths.’ The fourth and final step of the framework is an analysis of the second and third steps of the framework for the development of an integrated strategy aimed at reducing vulnerability to hazards. Through the research team’s facilitation, the community analyses their levels of vulnerability, strategies that were identified to reduce vulnerability, and how the community will move forward with this information. While this is the ‘final step,’ continual evaluation and revision is necessary for the changing circumstances, and collaboration with relevant governmental and non-governmental organizations is advocated for the community to remain up-to-date with beneficial strategies and approaches (Mercer, et al. 2010).

“Cross-cultural knowledge” or “ScIQ” (science and Inuit Qaujimajatuqangit) weaves Western science and traditional Indigenous knowledge into collaborative research methods that can yield better results for the researchers and community (or communities) being worked with, also being referred to as “right-way science” (Pedersen, et al. 2020; McKemey, et al. 2022). In Northern Australia, McKemey, et al. (2022) explored the key requirements for “right-way science” through reflections on collaborative research that supported Indigenous cultural fire management, practices which were hindered by colonization as well as the changing land uses and policies. These requirements are: “building relationships and trust; formal research approval processes; co-development of research; acknowledging challenges; and ethical, productive and mutually beneficial research" (76). This collaborative research provided both qualitative and quantitative evidence on Indigenous cultural fire management, empowering Indigenous partners in answering questions most relevant and important to their communities that can be applied in the adaptive management of Indigenous Protected Areas in Australia (McKemey, et al. 2022). Similar approaches to collaborative research and co-development with Indigenous communities in Australia have been used for conservation translocations through Māori-led and co-led coastal restoration and revitalization initiatives that engaged local community members of all ages for the reintroduction or augmentation of threatened freshwater species (Rayne, et al. 2020). In this case, the authors integrated a "Two-Eyed Seeing" approach to their research that involved "decentring [their] western perspectives," or decolonizing, to co-develop the projects with the community holding the Indigenous knowledge (also see Gyapay, et al. 2022).

Cuerrier, et al. (2015) note that Indigenous knowledge, or Traditional Ecological Knowledge (TEK), systems can demonstrate the "harmonization of an Indigenous group's resistance and flexibility" of the variable environmental conditions and change through the past and present (see Turner and Spalding, 2013), accompanying Western science as a valid information source for climate change. In the context of northern Canada, Cuerrier, et al. (2015) studied and compared climate change perceptions in three Inuit communities in Nunavik, Quebec, focusing on vegetation changes and impacts to the community members' ways of life. This research entailed a qualitative and quantitative approach along with the high levels of trust and rapport between the researchers and communities which was developed over 15 years. The findings within the study showed consensus between the communities on increased shrub growth in the region, concerns over the deterioration of berry health and populations, new or changing distributions of various plant species, decreasing water levels, as well as changes in certain mammal populations and distribution (such as black bear and caribou). Sea ice conditions were also recognized as changing rapidly around Nunavik, with an earlier melt and ice forming later in the season (Cuerrier, et al. 2015). Many of the Arctic changes identified by Inuit communities in northern Canada, caused by the changing climatic conditions, have been altering and increasing northern communities' exposures to climatic risk and may have consequences for communities' adaptive capacities (Ford, et al. 2008; Ford, et al. 2013).

In an extensive study on policies and perspectives of Arctic shipping, Kelley and Ljubicic (2012) used collaborative and engaging methods with community members in Cape Dorset, Nunavut to understand Inuit characterizations of how the community uses the marine environment, the risks of shipping to this environment, and the monitoring of ship travel. The authors also reviewed relevant policies, acts, and agreements to identify areas of "apparent disconnect" between policy and community perspectives in an attempt to improve the future outlook for "shared benefits." The authors selected Cape Dorset as a case study to leverage previously established and collaborative research relationships with the community, while Cape Dorset has been subject to changing ice conditions and shipping practices. Methods ranging from participatory mapping, experiential trips to gain spatial and cultural context, and semi-directed interviews were employed with the community alongside a community guide that assisted in the community collaboration, translations, and minimizing potential misunderstandings or misinterpretations. The authors' findings indicated substantial disconnects between community perspectives of Arctic shipping and governmental policy. Arctic sea ice is significant for Inuit daily life, integral to the marine environment, and the ocean is used year-round by Inuit when the waters are open or frozen. For Arctic communities, sea ice is considered to be comparable to highways in southern Canada, but boating is also important depending on season and destination. According to Kelley and Ljubicic, the *Nunavut Land Claims Agreement* (NLCA) is the only agreement among the policies reviewed that recognizes the importance of sea ice for Inuit communities, whereas all other acts and agreements consider sea ice as a hazard to ships and focus on environmental concerns and safety. The authors stress that future policy-making and ongoing decision-making must ensure that “diverse perspectives and expertise” are acknowledged and incorporated, which entails governments enhancing cooperation with Inuit communities and considering Inuit knowledge alongside scientific knowledge.

Further studies on community perspectives of shipping in the Canadian Arctic have focused on changes in cruise tourism (Stewart, et al. 2015) and risks to local harvesting activities (van Luijk, et al. 2022). Stewart, et al. (2015) explored perspectives on the risks and opportunities of cruise tourism for communities in the Canadian Arctic, while documenting the future actions that arose from the authors’ findings in communities that are situated around the NWP: Pond Inlet, Gjoa Haven, and Ulukhaktok. The authors use the Cruise Tourism in Arctic Canada (C-TAC) systems framework that regards cruise tourism as an external “stimulus” that has potential to catalyse changes for communities, with changes manifesting as opportunities or challenges. The methods used for this study included a place-based approach in the three Arctic communities and semi-structured interviews on opportunities and risks identified by the sample individuals, with most participants having past or current experiences in tourism (as artists, guides, educators, etc.). The community-identified opportunities included showcasing Inuit culture and tradition, sharing local histories via guided walks, and the supplementary income for the community and community members. On the other hand, risks were classified by local-level economy, culture, environment, community, and regional level. Examples of the risks expressed by participants included the potential of minimal benefit for the local economies, inappropriate or insensitive behaviour by tourists, negative effects on marine wildlife, rising risks of marine pollution, lack of infrastructure to support vessels, and the lack of search and rescue capabilities in the event of a grounding or sinking. Among the future actions identified by participants, participants proposed monitoring and regulating all cruise ships that enter Nunavut waters as well as improving emergency preparedness and search and rescue capabilities (Stewart, et al. 2015).

Lastly, a study by van Luijk, et al. (2022) involved the engagement of 14 communities in the Canadian Arctic as part of the Arctic Corridors and Northern Voices (ACNV) project, in an effort to integrate Inuit perspectives into Arctic shipping corridors planning. The authors conducted workshops, participatory mapping, and interviews throughout each of the 14 communities, then used ArcGIS tools to create layered maps from the dataset which visualizes community activities and community travel routes during open water season and non-open water season. As a basic overview of the findings, the direct and indirect cascading risks of shipping on harvesting activities that were identified by participants included the severe degradation of the marine ecosystem and food chain via oil spills and groundings, contamination of the marine ecosystem from vessel operation, disruption of hunters' travel and safety, and the disturbance of marine wildlife. The authors further emphasized the need for Inuit perspectives to be included in shipping management frameworks for the Canadian Arctic, and that these frameworks ensure Inuit rights are respected and protected (van Luijk, et al. 2022).

1.5 Outline of the Thesis

This article-based thesis consists of four chapters: 1) the introduction, 2) the manuscript article that showcases the findings of this study, 3) additional findings not provided in the manuscript article, and 4) the discussion and conclusions. The first chapter of this thesis introduces the problem statement and the objectives of this study and provides an overview of the relevant literature for considerations surrounding the problem statement. The second chapter was designed as a publishable article manuscript that explains the study methods and findings, a discussion, and recommendations that respond directly to the problem statement. The third chapter includes the survey findings that were excluded from the article (second chapter). The fourth and final chapter provides a discussion of the research findings in consideration of other relevant literature, and also outlines key conclusions, contributions, limitations, and opportunities for future research.

This thesis-based research project is part of a larger study on Arctic mobilities and shipping that was funded by ArcticNet and through the Canada-Inuit Nunangat – United Kingdom (CINUK) Arctic Research program. All necessary approvals for this study have been received by the University of Ottawa Research Ethics Office and the Nunavut Research Institute. The approach to this community-based research is also in line with the *National Inuit Strategy on Research* (ITK, 2018), and supports a self-determined approach to science in Arctic Canada where there are four settled land claim areas and the ethical and legal imperative to ensure culturally respectful and inclusive research approaches.

1.6 Chapter One References

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Chapter Two: Journal Article

Title of Article

Arctic Shipping Futures: Community Perspectives of Emergency Risk and Preparedness around the Northwest Passage

Authors

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Abstract

Trends of increasing ship traffic due to climate change, changes in sea ice extent, and economic interests have resulted in a steady rise in ship traffic within the Canadian Arctic. This increase in ship traffic introduces rising risks to the region and higher probabilities of a shipping accident and disaster, challenging the emergency preparedness capacities of Arctic coastal communities and governments. The Northwest Passage (NWP) is of particular interest due to its rising popularity for its maritime shipping (movement of goods) and transportation (movement of people) potential, with opportunities for reduced transit times and unique tourism experiences. The coastal community of Pond Inlet, Nunavut, sits on the eastern entrance / exit of the NWP and is a community that firsthand experiences this rise in ship traffic. This study explores the perspectives of community residents within Pond Inlet on Arctic shipping trends and shipping futures around the community, along with community perspectives on emergency preparedness in the event of a shipping accident or worst-case scenario event. A survey was implemented with residents, and findings were categorized into four sections based on the survey question-types. The findings from this study reveal an observed increase in shipping and subsequent risks in the region. The findings also suggest that there is low confidence from residents in emergency response timing if a shipping accident occurred, along with high levels of devastation for the community and environment. Lastly, a process framework was developed to display themes from resident responses to the open-ended questions of the survey.

Keywords

Arctic, Shipping Accidents, Marine Disasters, Emergency Preparedness, Community-based research, Coastal Community Perspectives, Climate Change Adaptations

2.1 Introduction

Climate change and related reductions in sea ice extent in Arctic Canada (Stephenson and Smith, 2015; Cai, et al. 2021) has led to a significant increase in a range of shipping activities and maritime-based transportation opportunities (Stephenson, et al. 2018; Dawson, et al. 2018; Li and Lynch, 2023; Ford, et al. 2014; Mudryk, et al. 2021). Despite economic opportunities associated with increased Arctic shipping related to tourism, resource development, fisheries, and domestic and international maritime trade, there are also substantial costs that may outweigh the benefits if risks are not managed effectively (Khan, et al. 2020; Afenyo, et al. 2022; Dawson, et al. 2020a). The need for proper preparedness in anticipation of potential accidents and/or incidents that arise from anticipated growth in economic activities related to maritime shipping (movement of goods) and transportation (movement of people) within the Canadian Arctic is expected to increase with ongoing climate change (Afenyo, et al. 2022).

Among the stakeholders and rightsholders most impacted by the increase in shipping traffic are the northern communities and their residents within the Canadian Arctic. Climate change and the rise in ship traffic serve to highlight the coinciding risks and pressures that Inuit peoples are experiencing with respect to local and human security, self-determination, and Indigenous and national sovereignty, thus Arctic communities are feeling more than ever that they are on the "front lines" of a rapidly changing Arctic (van Luijk, et al. 2021). This situation also signals the need for Indigenous Knowledge, or Inuit Qaujimajatuqangit (IQ), to be integrated alongside the western sciences within studies, and also for community perspectives to be recognized in Arctic policy and Disaster Risk Reduction (DRR) developments (Kelley and Ljubicic, 2012; Balay-As et al. 2018; Ali, et al. 2021; Chang, et al. 2014; Pedersen, et al. 2020). The coastal communities in the Canadian Arctic that bear the brunt of the growing shipping risks could experience devastating consequences socially, physiologically, economically, and environmentally in the wake of a major shipping disaster (Barron, et al. 2020; Halliday, et al. 2022; Afenyo, et al, 2019; Nevalainen, et al. 2019; Peterson, et al. 2003). With the rising probabilities of a shipping accident occurring in this region, there is an urgent need for cooperation and collaborative action with all relevant stakeholders, especially local stakeholders and rightsholders, to ensure effective and efficient emergency response capabilities for maritime disasters (Mileski, et al. 2018).

Research focused directly on community perspectives of emergency preparedness in the Canadian Arctic is indeed very limited (Kelley and Ljubicic, 2012; Dawson, et al. 2020a; Bishop, et al, 2022) although some insight on the topic is garnered within the literature focused on Arctic shipping risks amid climate change impacts (Salokannel, et al. 2018; Halliday, et al. 2022; Ghosh and Rubly, 2015; Khan, et al. 2020; Afenyo, et al. 2022). As a result, this research was designed specifically to fill this knowledge gap on community perspectives on Arctic shipping risks and emergency preparedness. The work is geographically focused on Canada's Northwest Passage (NWP) due to the significance of the ecological sensitivity and biodiversity that is disturbed by the sharp rise in shipping traffic (Kochanowicz, et al. 2020; Halliday, et al. 2022; van Luijk, et al. 2020; Dawson, et al. 2020a; Kelley and Ljubicic, 2012) and also on the community of Pond Inlet, Nunavut, which is located at the eastern entrance of the NWP.

The specific objectives of the study were to: 1) compare current research to community perspectives of observed shipping futures around the Canadian Arctic, 2) explore how community residents perceive historic shipping accident scenarios within the context of the NWP, and 3) reveal what is perceived by community residents as shipping risks, consequences, losses from worst-case scenarios, and prevention / preparedness for the community. Beyond simply seeking community insight on observed shipping futures, exploratory scenarios allowed for historic shipping accidents to be placed in the Arctic community's context to learn about community perspectives on how these events and emergency responses are perceived via a scale, while also raising community awareness on such risks (van den Ende, et al. 2022). Lastly, open-ended questions into how community residents perceive potential shipping accidents, consequences, and prevention / preparedness was crucial to interpret how the shipping risks and emergency preparedness are considered or expressed by community members.

2.2 Methodology

2.2.1 Study Location

The case study for this project was Pond Inlet, Nunavut. Pond Inlet is a coastal community situated at the Northern edge of Baffin Island along the Lancaster Sound and the Tallurutiup Imanga NMCA (see Figure 2.1). According to the most recent Statistics Canada census (2021), Pond Inlet's population is 1555, with 94% of residents identifying as Inuit. The community also sits near the eastern entrance to the NWP, a passage with a disputed legal status that signals a gap in Canada's sovereignty (Greaves, 2021; Lackenbauer and Sergunin, 2022; Stewart and Dawson, 2011; Bert, 2012).

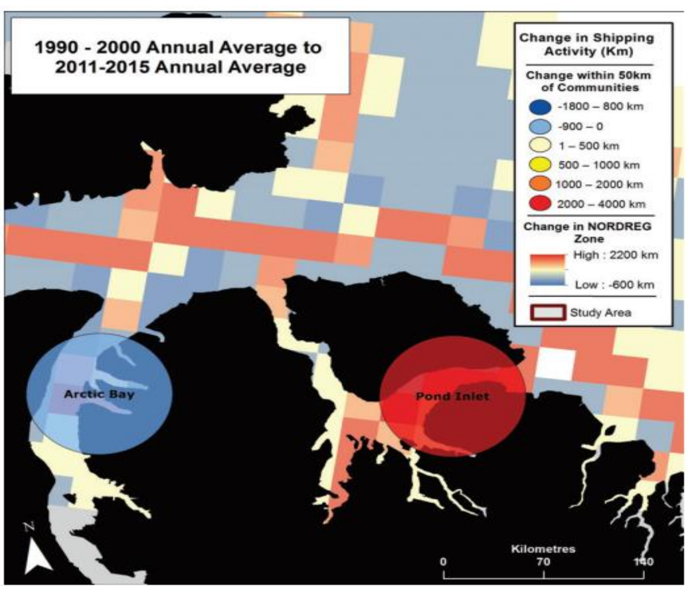

Figure 2.1: Increases in shipping activity (km) near Pond Inlet and Tallurutiup Imanga NMCA (Carter, et al. 2018).

2.2.2 Study Approach and Conceptual Framework

This research entailed a participatory approach and built on the existing relationships and rapport between Ikaarvik, a community organization in Pond Inlet, and University of Ottawa's Environment, Society, and Policy Group (ESPG), with the content, questions, and framing for this study being co-developed through collaboration with Ikaarvik. Ikaarvik was established by a group of youth in Pond Inlet to bridge the gap between Indigenous traditional knowledge and western science in research for meaningful and collaborative Indigenous engagement in the Arctic (Ikaarvik, n.d.). The Ikaarvik team was involved and engaged in the research process (Figure 2.2) in a co-managed partnership from the initial planning stages and implementation stages of the project (objectives and methods) to the completion of the project (outcomes). Pedersen, et al. (2020) provide an overview of Ikaarvik's mission and how researchers with disciplines based in western science can work effectively alongside the Arctic communities holding Indigenous knowledge, or Inuit Qaujimajatuqangit, to stimulate a beneficial relationship for all parties involved. The Ikaarvik team coined the concept of ScIQ to describe this balance or middle ground between IQ and western science.

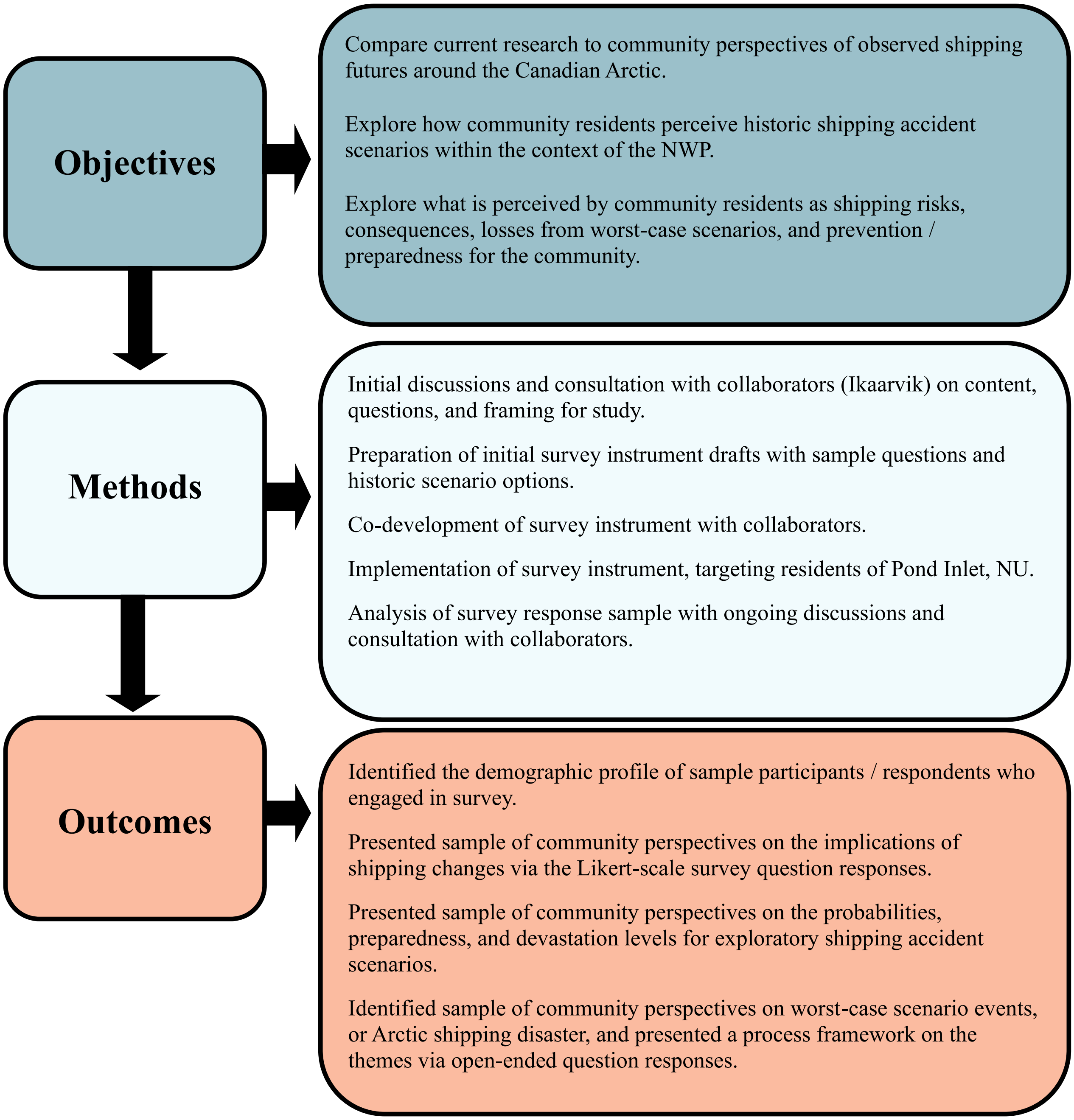

Figure 2.2: Overview of the study's objectives, methods, and outcomes.

This participatory approach is practical, collaborative, and empowering if executed appropriately by integrating community members as co-producers of the research process and outcomes (Duea, et al. 2022; Rayne, et al. 2020). The community-academic partnerships that are developed through collaboration and co-developing research can lead to higher quality data collection and a greater awareness of the challenges and uncertainties for the selected community, as well as possible solutions (Martin, et al. 2022). This partnership also benefits the researcher through community members' deep knowledge on the community context and the social networks for recruiting participants (Duea, et al. 2022). With Inuit being the "original Arctic scientists," Pedersen, et al. (2020) point out that Arctic communities hold an abundance of knowledge on northern elements (such as land, environment, animals, and northern life) that are critical for understanding the changing world.

2.2.3 Co-Development of Survey Instrument

Through a participatory approach, the survey was co-developed and implemented with Ikaarvik. Surveys are useful for gathering citizen perspectives as a basis for identifying community concerns about possible shipping risks and the feasibility and effectiveness of emergency responses in the region (van den Ende, et al. 2022). Initial themes for the survey were based on a review of literature encompassing Arctic shipping risks, climate change and shipping projections, and community-based perspectives. This survey was presented in a questionnaire format, and survey drafts were reviewed and discussed with the collaborators via virtual meetings on Microsoft Teams, with intentions for the initial drafts to be "torn apart" and redeveloped according to the knowledge and requests of the collaborators (see Glauser, 2020). The collaborators were involved in identifying the areas of focus for the survey, with the implementation being largely conducted online via Qualtrics. To allow for further accessibility and inclusion, participants also had the option to complete the survey in-person, assisted by the research team and collaborators. Surveys can typically lead to less trust building due to a lack of personal contact (van den Ende, et al. 2022), but this was mitigated through the collaborators' networks and their understandings of the best approaches on how the survey should be implemented within the community.

A foresight method for the participatory approach was employed within the survey to explore possible futures with community participants through exploratory scenarios (van den Ende, et al. 2022). Initially, approximately 10 historic shipping accidents that occurred along Canadian coasts were selected from the *Canadian Disaster Database* and the *Clear Seas Marine Incidents and Accidents Dashboard*. These scenarios were assessed and discussed with the collaborators from Ikaarvik, with four of the accidents ultimately being chosen as the scenarios to present to respondents. The details provided within these four scenarios were also deliberated until the questionnaire was finalized.

2.2.4 Survey Instrument

A qualitative and quantitative approach was used for this survey (see Annex 1 for a copy of the survey). The first section of the questionnaire sought basic demographic data, including verification on the respondents' age, length of time living in the community, if they identified with an Indigenous group (and which Indigenous group they identified with), as well as roles and experience levels in the community. The second section focused on ship-based transportation and the changes in sea-ice conditions for transportation. This section contained a range of statements surrounding the current state and projections of shipping and sea-ice conditions along with the risks that may arise from these conditions. A Likert Scale was used to identify the levels of agreement or disagreement with each statement on Arctic shipping and sea ice conditions. The benefits of the Likert Scale include the simplicity of the scale format and the ability to demonstrate the levels of intensity among statements (Babbie, 2016).

The final section focused on community perspectives of potential shipping accidents and the corresponding emergency preparedness. Within this section, respondents were asked open-ended questions where they would consider or imagine a potential shipping accident that may happen around their community and the Lancaster Sound (NWP), along with considerations for what feelings this evokes, what consequences can arise, and what needs to happen to reduce the probabilities of a shipping accident. Qualitative responses within this section were then categorized into themes, while these themes were inserted into a process framework.

The exploratory scenarios followed, with respondents being asked to consider the four historic scenarios in the context of their community with three questions that required the respondent to select a number along the scale that ranged from one to ten. From their perspective, the respondents were required to use this scale to provide the probability of such an event happening around their community, the speed of an emergency response, and the level of devastation, followed by an optional open-ended question.

2.2.5 Sampling Approach and Recruitment

Having a diverse array of perspectives from a wide range of community members was necessary to understand how Arctic shipping futures and emergency preparedness is perceived and to what extent these topics are considered at the community level (see Walsh, et al. 2019). The final questionnaire-based survey was implemented via purposeful and random sampling to reach a broad range of respondents. With the collaborators leading the recruiting for the questionnaire, the core strategies used to reach respondents included word-of-mouth and submitting posts on a Facebook page reserved for members of the community. Word-of-mouth strategies are often more effective and preferred in studies on smaller or rural communities (Friedman, et al. 2015; Farquhar, et al. 2015). Similarly, utilizing social media such as Facebook for recruitment, notably designated pages for a study or community, allows for a low-cost and easily accessible source for potential respondents to engage with the promoted study (Kayrouz, et al. 2016; Vos, et al. 2023).

The target sample size for this survey was 35 to 50 respondents. Respondents had to be over the age of 18 and a gift card to the local Co-op store was provided to respondents who attempted the questionnaire. Exclusions to the final sample included questionnaires that were incomplete and questionnaires that were completed by respondents who were not residents of Pond Inlet. Before exclusions to the sample were made, there were 54 responses. The final sample size after exclusions was 44 respondents from Pond Inlet. Pond Inlet's working age (15-64) and elderly (65+) population accounts for 980 residents (Statistics Canada, 2021), thus, this sample size represents around 4.5% of Pond Inlet's population (working age and elderly) at the time of the study.

2.2.6 Field Work and Survey Implementation

To initiate the first week of this survey, field work was undertaken by the primary author and a research assistant alongside the community collaborators in Pond Inlet, further allowing the primary author to gain in-person experience and context directly within the case study coastal community. This spatial, experiential, and cultural context gained from direct engagement within a community is valuable when interpreting results from responses provided by community members (Kelley and Ljubicic, 2012). It also allowed for the primary author to assist in the initial engagement and survey implementation efforts in-person alongside members of Ikaarvik. The survey spanned the month of November 2023 and closed when no further responses were being received.

2.3 Study Results

The results from the final sample of survey responses are distributed throughout the four sections below: 1) the demographic profile of participants, 2) the responses to the Likert Scale questions on the implications of shipping changes, 3) the scale-based responses to the exploratory scenarios, and 4) the qualitative findings that summarize varying perceptions on shipping accidents and emergency preparedness. These sections contain the findings from the survey and the associated themes that were identified from the community respondents.

2.3.1 Demographic Profile of Survey Participants

Within the total sample of 44 respondents, 93.2% (n=41) identified as Indigenous and 6.8% (n=3) as non-Indigenous. Of the 41 respondents who identified as Indigenous, 97.6% identified as Inuit (n=40), 4.9% as First Nations (n=2), and 2.4% as Métis (n=1). Males were the majority respondents at 61.4% (n=27) while 38.6% of respondents were female (n=17). The minimum age within the sample was 20 years and the maximum age reached was 71 years, while the average age of respondents was around 42 years. The majority of respondents lived in the community for 20 to 39 years (n=15, 34.1%) and 40 or more years (n=17, 38.6%). Languages spoken by respondents included Inuktitut (n=40, 90.9%), English (n=38, 86.4%), French (n=1, 2.3%), and sign language (n=1, 2.3%). Most respondents (72.7%) were employed (n=32), 22.7% were unemployed (n=10), and 4.5% were involved in voluntary work (n=2).

2.3.2 Community Perspectives on the Implications of Shipping Changes

The responses to the second section of the questionnaire are shown in Figure 2.3. The vast majority of respondents were in agreement that the increase in ship traffic can negatively affect the sea ice environment (95.5%, n=42), with 50% of respondents (n=22) selecting strongly agree and 45.5% (n=20) selecting agree. A majority of respondents (86.4%, n=38) were also in agreement on the rising risks of shipping accidents, such as fuel spills, corresponding with the increases in shipping traffic near Pond Inlet, with around 56% (n=25) selecting strongly agree. Many respondents agreed that a further increase in temperatures might lengthen the shipping season while also disrupting marine transportation routes (84.1%, n=37) and a majority (81.8%, n= 36) agreed that this increase in traffic can cause harm to local boaters. Approximately 81.8% of respondents (n=36) agreed that the increase in ship traffic due to climate change could present higher social and economic risks for the community and environment compared to the benefits from the increased ship traffic, which aligns with previous findings (Kelley and Ljubicic, 2012; Dawson, et al. 2020a). Climate change was perceived by the majority of respondents as contributing to an increase in shipping activities around Pond Inlet (81.8%, n=36), while 75% of respondents (n=33) agreed that this increase in shipping traffic affects their ability to access hunting locations, and 72.7% of respondents (n=32) agreed that the increase in ship traffic causes early breaking of sea ice which impacts safe travel. Approximately 68.2% of respondents (n=30) agreed that this increase in shipping activities will significantly reduce local accessibility for sea-based transportation, whereas 61.4% of respondents (n=27) agreed that the increase in ship traffic may provide new economic activities within the community. However, over half of respondents (54.5%, n=24) agreed that this increased shipping traffic affects their personal travel routes via sea-ice and around half of respondents (54.5%, n=24) also agreed that this increase in traffic can destroy smaller boats. In addition, respondents were asked how often they have considered or thought about the possibilities of a shipping accident in or around their community to identify levels of concern. According to the findings, 20.5% of respondents (n=9) selected regularly (5-10 times per year), 36.4% (n=16) selected occasionally (2-5 times per year), 36.4% (n=16) selected rarely (1 time per year or less), while 6.8% of respondents (n=3) selected never.

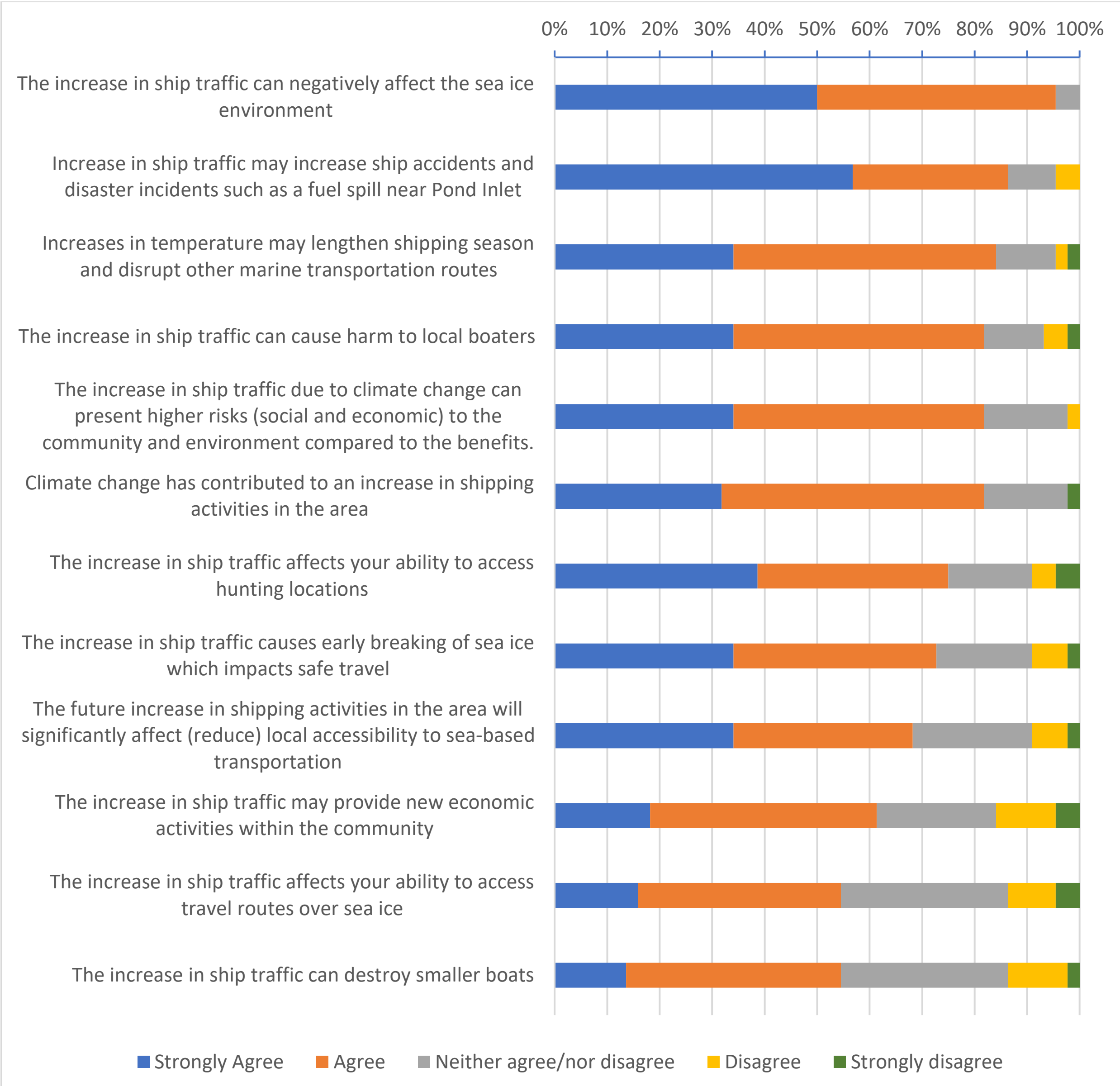

Figure 2.3: Percentage of respondents and their levels of agreement or disagreement to statements on climate change, Arctic shipping changes, and transportation.

2.3.3 Community Perspectives on Possible Shipping Accidents

Beyond understanding perceptions of the current trends in Arctic shipping, historic shipping accident scenarios being placed in the Arctic context may allow for an understanding of how community members in Pond Inlet perceive the levels of risk and preparedness around the NWP.

Four historic shipping accident scenarios were presented as part of the survey. They are detailed in Table 2.1 below and directly correspond to the figures within this section.

Table 2.1: Detailed overview of historic shipping scenarios used in the survey instrument. All scenarios were to be considered in the context of Pond Inlet and the NWP.

MV Marathassa oil spill	A bulk carrier called the MV Marathassa discharged over 2500 litres of bunker fuel into the Vancouver English Bay, with toxic oil spreading to the shorelines and having a significant negative impact on the water quality, wildlife (with at least 20 birds being affected), and surrounding environment. The oil spill was not noticed until a recreational boater spotted the oil in the water and reported the oil spill. It was after this that it was determined that there was oil coming from the MV Marathassa (Public Safety Canada, *Canadian Disaster Database*; Clear Seas, 2016; City of Vancouver, n.d.).
MV SKRIM receives ice damage	Off the shore of Newfoundland during the beginning of springtime (March), a bulk carrier from Panama called the MV SKRIM began leaking heavy oil after receiving ice damage from the icy conditions. The oil could be found in the ice near the ship and on the rocks on the shoreline of Newfoundland. With the amount of heavy oil leaking into the sea ice and marine space, it is clear that marine life would be impacted and the oil would increase sea ice melt around the impacted area by absorbing more heat from sunlight, but it would be unclear to what degree. There would be a chance that some fish may be unsafe to eat if they passed through the contaminated area (Public Safety Canada, *Canadian Disaster Database*).
Nathan E. Stewart accident and response	In a remote part of the Seaforth Channel in BC, a barge and tug called Nathan E. Stewart struck the bottom of a shallow part of the Channel after the operator fell asleep from fatigue, causing over 100,000 litres of diesel fuel and over 2000 litres of lubricants to be spilled into the channel near the Heiltsuk First Nation. 350 kilometres of shoreline were affected by the spill. There were two arial flights that confirmed that the diesel fuel and lubricants were spreading throughout the channel. A dive team was repairing the fuel tanks in an attempt to stop the leaking while a team of workers were attempting to pump out remaining fuel, but bad weather hindered the clean up and salvage efforts. It was over a month later that the tug was lifted out of the water and taken to shore. Despite the cleanup efforts, Heiltsuk First Nation fisheries were still closed due to environmental contamination concerns (Public Safety Canada, *Canadian Disaster Database*).
Vancouver Harbour collision	Around the Vancouver Harbour, there was a collision between two ships in fog, causing marine diesel oil to spill, contaminating the surrounding water with over a kilometre of shoreline affected. This incident killed 65 birds while over 200 birds were rescued with the clean-up efforts (Public Safety Canada, *Canadian Disaster Database*).

Respondents were required to consider each scenario as occurring around their community and the NWP in the future to determine the perceived likelihood of the four scenarios (see Figure 2.4). For each scenario, a moderate likelihood between 4 and 6 was selected by most respondents, and responses peaked around the likelihood of 5 while a smaller peak can be seen at the highest likelihood of the scale (10). The first scenario saw the highest peak at the likelihood of 5, selected by 14 respondents. This suggests that most respondents within the sample may consider the likelihood of a shipping accident event a possibility around their community, while 6 to 9 respondents may consider each of these scenarios to be extremely likely.

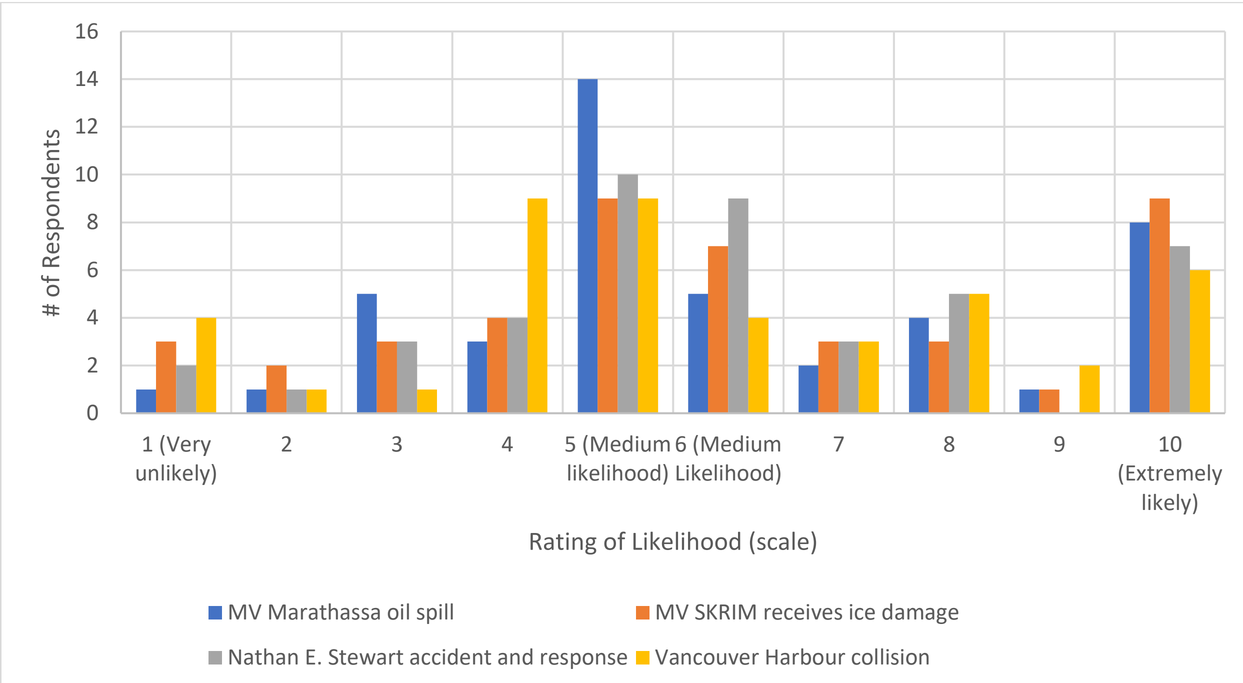

Figure 2.4: Rating of likelihood for four historic shipping accidents in the context of the region where respondents reside. Each colour represents the four scenarios briefly described in Table 2.1.

As shown in Figure 2.5, each scenario peaks at the lowest emergency response speed rating (1) with the majority of the responses, then a second smaller peak for each scenario occurs around the low-medium response speed selections (4 and 5). The highest response speed selections (9 and 10) for each scenario were selected by a maximum of 1 to 3 respondents, whereas the lowest response speed selections were selected by 11 to 17 respondents. Surprisingly, the responses were more distributed throughout the ratings for the scenario that contained additional details on the emergency response (Nathan E. Stewart accident and response) and the scenario that contained the least detail (Vancouver Harbour collision). Overall, respondents largely believed that an emergency response to the shipping accident scenarios would be slow to very slow.

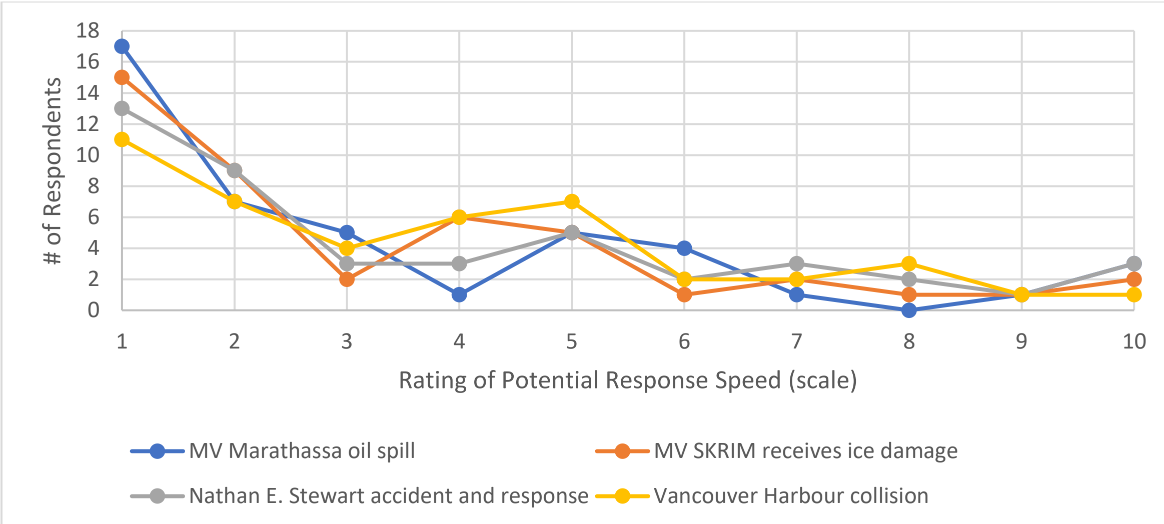

Figure 2.5: Rating of the potential response speed (from 1 – very slow, to 10 – very fast) for an emergency response in the context of the historic shipping scenario occurring in the region where the respondents reside. Each colour represents one of the four scenarios briefly described in Table 2.1.

Figure 2.6 shows that the vast majority of respondents in the sample perceived that a potential shipping accident would be devastating and extensive to the marine space and themselves for each of the four scenarios (rating of 10). While these findings were to be expected, they reaffirm the community-incurred levels of risk from pollution events in the marine space that can arise from heightened shipping or development activities.

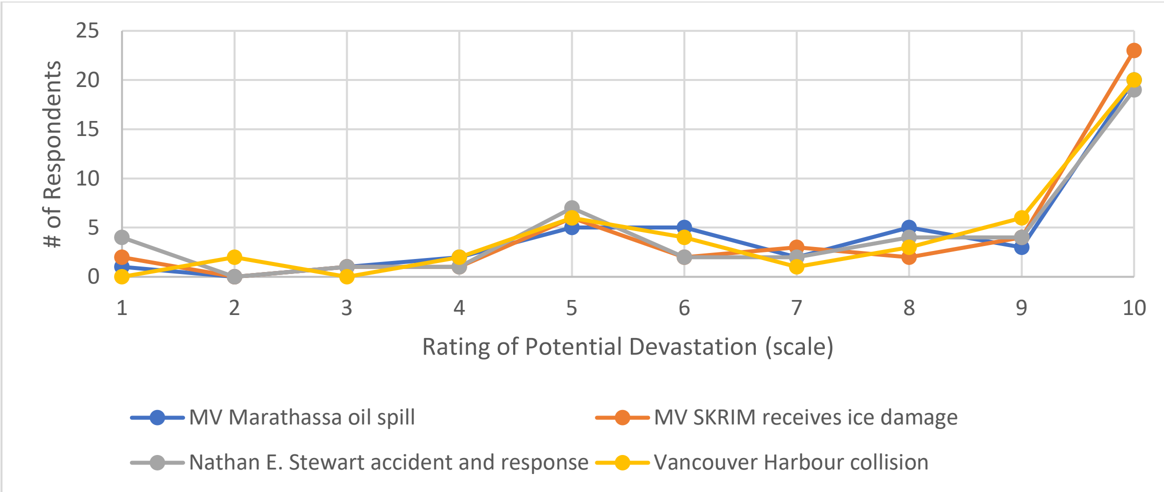

Figure 2.6: Rating of the potential scale of devastation (from 1 – limited/contained impact, to 10 – devastating/extensive impact) in the context of the historic shipping scenario occurring in the region where the respondents reside. Each colour represents one of the four scenarios briefly described in Table 2.1.

2.3.4 Community Perspectives of a Worst-Case Scenario Event

Respondents were asked to consider shipping accidents, worst-case scenarios, and emergency preparedness around their community. The responses to the open-ended questions and the subsequent themes are discussed in the classifications below. The themes identified within the responses to the open-ended questions are identified as elements within a process framework that visualizes Arctic shipping risk, potential for disaster, and opportunities for DRR (Figure 2.7). The themes that were identified from respondents include the vessel types, the types of accident event, the consequences of an event, "what is at stake" for community members in the event of a worst-case scenario shipping accident, and the areas of need for DRR. Lastly, respondents were asked for their perspectives on community and governmental preparedness for responding to an emergency from an Arctic shipping accident around Pond Inlet, and these findings are briefly summarized at the end of this section.

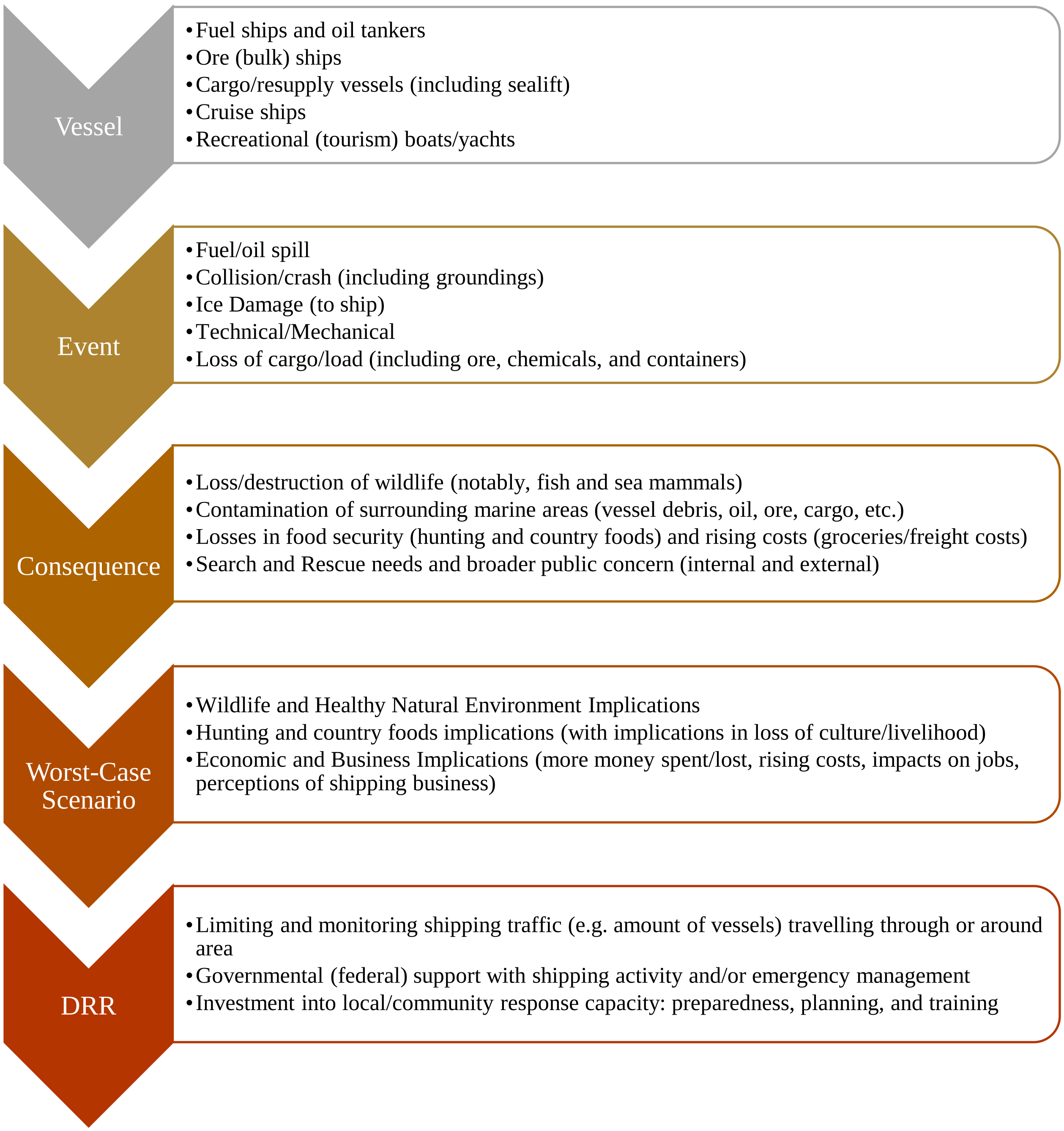

Figure 2.7: Process Framework containing themes from resident perspectives that conceptualizes the type of vessel, the event or occurrence of damage, and the consequences, which is then followed by what residents perceived as a worst-case scenario shipping accident (or disaster). The final theme presents opportunities for reducing the probabilities of a shipping disaster via the proposed Disaster Risk Reduction (DRR) objectives.

Vessel

When asked to consider a worst-case scenario shipping accident near Pond Inlet, respondents were first required to identify the type of vessel that they anticipate in this shipping accident. There were five themes of vessels identified. The most commonly identified vessels were cargo and resupply vessels, then fuel ships and oil tankers. General cargo vessels were found to be around 14% of the shipping traffic proportion around the Tallurutiup Imanga NMCA between 2010 and 2018, while tanker ships were found to be around 9% (Kochanowicz, et al. 2020). Ore and bulk ships, also known as bulk carriers, were the third-most common responses from the sample, which is likely due to the nearby Mary River Mine that operates along the north end of Baffin Island (Baffinland, n.d.). Cruise ships were also indicated by some respondents, with passenger ships (or cruise ships) making up around 21% of ship traffic in the Tallurutiup Imanga NMCA between 2010 and 2018 (Kochanowicz, et al. 2020). Recreational boats and yachts were least mentioned by respondents yet still relevant due to the growing tourism interests in the region (Kochanowicz, et al. 2020).

Event

There were five themes identified from the sample for shipping accident events that respondents envisioned. Unsurprisingly, fuel and oil spills were the most prominent event that was indicated by respondents. A couple respondents mentioned that the floating fuel hose connected from a refuel vessel to the community pipeline posed a concern and risk to the community via holes in the fuel line or contact with a smaller vessel. Collisions (or crashes) and groundings, as well as ice damage to the ship were both themes that were commonly mentioned by respondents. In one case, a respondent noted that there are risks of “groundings in uncharted areas” and “collisions or entrapments with ice,” while other respondents noted icebergs as a risk. A couple of respondents also noted the risks of groundings in shallow areas or an “unseen underwater hill or trench.” The least mentioned, yet mentioned nonetheless, was the loss of cargo such as ore, chemicals, or containers, as well as the possibilities of technical or mechanical problems. Specific cargo that was noted included lead, zinc, iron, oil, gasoline, and diesel.

Consequences

Finally, four themes were identified from the consequences of potential shipping accidents noted by respondents. These themes are largely interconnected, similar to the worst-case scenario discussion below. The loss and destruction of wildlife, especially sea mammals and fish, was particularly of concern for many respondents. Likewise, respondents noted the risk of contamination of the surrounding marine areas from pollutants such vessel debris, oil, ore, or other cargo. One respondent advised that “contaminated waters might not be safe for sea mammals [country foods] to eat and the ice might not form well,” and another respondent warned, “[an] oil spill would ruin the ocean where I hunt for seals and narwhals.” Another theme that was identified in the responses entailed the losses in food security via losses in hunting and country foods and the rising household costs for community members that result from a shipping accident and pollution event. The rising costs emanate from hunters and those normally relying on country foods being forced to supplement their losses with store-bought foods, leading to health concerns from an increased consumption of foods with higher fat, salt, and sugars (see Gyapay, et al. 2022; Jonasson, et al. 2019). There was broad concern over the safety of country foods after a shipping accident, emphasizing the importance of country foods. The last theme encompasses search and rescue needs in the event of a shipping accident as well as broader public concern after the shipping accident occurs. This relates to how the public internally (within community) and externally (beyond community) could react to the shipping accident event, and how the event would be viewed publicly. Some respondents suggested that there would be collaboration between communities and assistance from community members within Pond Inlet, but there could also be broader concern from other Arctic communities and communities beyond the Arctic. To highlight this, a respondent suggested, "I feel we as an Indigenous people would be held the most responsible and feel the most damage when in fact it would affect everyone." Another respondent advised, "our communities have limited response capabilities for either type of [impact]," referring to the potential significant loss of life and environmental disaster.

Worst-Case Scenario

Responses to what would be lost personally or at a community level in a worst-case scenario shipping accident, or shipping disaster, were classified into three themes of broader implications. Concerns for wildlife and the healthy natural environment were most prominently mentioned in the responses. Specific wildlife mentioned by respondents included fish, murres and mammals such as seals, narwhals, and polar bears, most of which are also local country foods. Implications to hunting and local foods were commonly mentioned alongside the mentions of wildlife. Several respondents suggested that they may lose everything and could go hungry from a loss of country foods, with some noting how this would increase spending on store-bought foods which would be more expensive for households. As a respondent stated when considering the potential loss of country food, "more money spent on food and less good nutritious food to eat." The potential for losing Inuit culture if a "bad enough" shipping accident occurred was also noted. For the third theme, there were found to be economic and business implications via rising costs, more money being spent, impacts to jobs, and the perceptions of shipping businesses if a shipping accident occurred. Basic needs such as heating, transportation, and health were mentioned as being at risk in a worst-case scenario, with a respondent warning that “human rights and freedoms [in Pond Inlet] will be compromised and limited.” When respondents were asked a follow-up question on how this would make them feel, there were four themes identified: anger and frustration; sadness, vulnerability, and depression; concern and worry; and distress and devastation.

Disaster Risk Reduction (DRR)

Lastly, DRR strategies from the respondents’ perspectives were identified through our question on what needs to happen to reduce probabilities or risks of severe damages from a shipping accident or disaster (see Figure 2.7). The most common theme was for limiting, reducing, and monitoring shipping traffic travelling through or around the Lancaster Sound. This finding aligns with previous recommendations for vessels travelling through the Tallurutiup Imanga NMCA (Halliday, et al. 2022). Investment into local response capacity, including preparedness, planning, and training, was another theme identified within this section. Some respondents proposed that education, planning, support, and infrastructure are needs for the community to ensure better emergency preparedness, with significant investment into these local capacity needs. With less mentions, governmental support with shipping activity and emergency management requirements was still found to be of importance, notably coming from the federal levels. A respondent emphasized that the Inuit and traditional knowledge from residents and Elders must be listened to, further noting, “need more consensus between parties at Inuit and federal level.” It was suggested that the Canadian Coast Guard should be more present when ships from the mines are operating, and for immediate communication and information-sharing between community members and the Royal Canadian Mounted Police (RCMP) in the event of a shipping accident.

Governmental Preparedness

When asked if respondents believed that the Government of Nunavut and Government of Canada would provide enough assistance to reduce risks caused by a shipping accident, 27.3% (n=12) selected no, 63.6% (n=28) selected unsure, and 9.1% (n=4) selected yes, which may speak to a lack of communication or awareness programs from governmental departments. Overall, respondents' opinions largely expressed that Pond Inlet is unprepared for an Arctic shipping emergency, while many were generally unsure of how prepared their community was. As one respondent stated, "over the years, federal government is not showing they have a plan," further expressing frustration over a lack of communication from the federal government. Others expressed optimism with how the community, especially hunters, would take action and collaborate with governmental departments if an Arctic shipping emergency happened. A respondent suggested that the community may be ready but would require more training and resources, also noting, "we are living so far up north it would take twice if not three or four times as long to get help from the rest of Canada if that were to happen."

2.4 Discussion

Encompassing the Lancaster Sound and the entranceway / exit for the NWP, the Tallurutiup Imanga NMCA has an estimated ecosystem service value of 37 billion CAD per year among Canada's natural capital assets (Mulrooney and Jones, 2023). The marine space is also habitat to biologically and culturally significant wildlife species that are more sensitive to disturbances from shipping compared to southern species, yet there is still a lack of data on shipping impacts in the Arctic to provide evidence-based plans for the mitigation of the risks (Halliday, et al. 2022). From 1990 to 2018, the vessel traffic in the Tallurutiup Imanga NMCA increased well over two-fold due to climate change and changes in sea ice, and the pace of the expected continued growth rate in shipping season length depends on a low, medium, or high emissions trajectory (Kochanowicz, et al. 2020; Dawson, et al. 2018; Li and Lynch, 2023). Indeed, the majority of respondents from Pond Inlet concurred with the current data on these connections between climate change and increased shipping. As emphasized, the increased probability of a shipping accident and emergency in the region follows the increase in ship traffic and lengthening shipping seasons. In concert with the potential for greater areal coverage and shoreline exposure from a warming climate and seasonal trends, these shipping trends in the Arctic broadens the environmental risks due to the heightened potential of oil spills or losses in cargo (Nordam, et al. 2017).

2.4.1 Indigenous Knowledge Systems and Arctic Shipping

Local and Indigenous knowledge systems are increasingly accepted and valued within the sciences and social sciences for data on the regional environments in which the communities reside (Cuerrier, et al. 2015; Rayne, et al. 2019; McKemey, et al. 2022; Balay-As, et al. 2018). At the same time, Hadlos et al. (2022) suggest that there has still been conflict and debate amongst ideologies within disaster scholarship regarding which knowledge systems are most effective for risk reduction. Yet, this has also allowed for a space that advances the integration of local and Indigenous knowledge systems while encouraging collaborative and meaningful research with the communities that hold these knowledge systems (Hadlos, et al. 2022; Pedersen, et al. 2020; Cuerrier, et al. 2015).

The necessity of community engagement and collaboration for co-managing emergency response preparedness and DRR strategies has been well established internationally (Cahyanto, et al. 2021; Nowell, et al. 2022; Pennington-Gray, et al. 2014; Khan and Eslamian, 2022), and for the Arctic region (Mileski, et al. 2018; Olsen, et al. 2019; Kirchner, 2019). However, much of the literature has been focused on natural disasters, compared to technological disasters such as shipping accidents which has had less of a spotlight. As suggested by Lauta, et al. (2018), if a ship travelling through the NWP such as the Crystal Serenity collided with an iceberg, the emergency response would occur in a "cold and hostile environment" with little to no resources and uncertainty over the responsibilities of parties. The findings from the sample in Pond Inlet maintains that this could indeed be the case if a shipping accident transpired. At the same time, over half of respondents from Pond Inlet considered an increase in shipping as a potential opportunity for new economic activities for the community, mirroring previous findings from Cape Dorset, Nunavut where an increase in goods and economic activity were considered positive outcomes of increased shipping in the Arctic (Kelley and Ljubicic, 2012). Despite this, respondents suggest that the risks of increasing shipping traffic may outweigh the benefits to the community and the environment, a notion that has been explored in previous studies (Kelley and Ljubicic, 2012; Dawson, et al. 2020a).

The findings from the responses to the scenarios were, to a degree, anticipated based on the remoteness of Pond Inlet, the lack of supporting or port infrastructure, and the cultural significance of the broader marine space and sea ice for the Inuit. The remoteness and infrastructure challenges in the Arctic pose a vulnerability for communities and national security, as an emergency response would prove logistically complex and challenging (Briggs, 2020). On the other hand, threats to Inuit food sovereignty and cultural practices that are constitutionally-protected become further at-risk from the rising risks of a shipping accident, increasing vulnerabilities in the Arctic population (Ford, et al. 2015; Kochanowicz, et al. 2021). Communities have been considered the "zero-order responders" when managing local hazards due to their embeddedness into the regional environments along with the historically accumulated local and Indigenous knowledge (Hadlos, et al. 2022). Hazards from human activities such as shipping, in the case of Pond Inlet and Arctic communities, abruptly challenges the accumulated knowledge and strategies developed by communities and their members. Indigenous knowledge systems in the Arctic recognize the region as being in a "constant state of flux" where uncertainty and unpredictability are necessary elements for local peoples, which is suggestive of the adaptive capacity of Inuit populations to natural hazards from climate change challenges despite the heightened vulnerability (Ford, et al. 2015). Thus, the warming from climate change paired with the hazard that shipping poses, as a respondent suggested, compounds and raises the unpredictability that Arctic communities already face.

2.4.2 Emergency Preparedness for Growing Artic Shipping Interests

Working with uncertainty, flexibility, and the need for improvisation, maintaining flexibility and resilience to respond to unpredictable events, have been noted as requirements in Arctic shipping safety and in the context of an emergency response to potential shipping accidents in the Arctic (Lauta, et al. 2018; Andreassen, et al. 2018; Salokannel, et al. 2018; Mileski, et al. 2018). Uncertainty and improvisation are elements that operators must also account for to operate in the region safely, alongside ensuring a safe and healthy workplace that allows operators to communicate effectively (Salokannel, et al. 2018). Yet, shipping accidents still happen and will require a response, an especially important consideration for remote communities. As a respondent from Pond Inlet expressed, "we're prepared enough to take action but not prepared enough to be the experts at this." Another respondent also offered, "I think the community would try to respond as soon as people hear about the accident." Responses indicate that improvisation will likely occur if a shipping accident happened around the community. However, these optimistic views were overshadowed by respondents who were either unsure or believing their community was underprepared or unprepared for a variety of reasons, which may highlight a lack of proper communications and engagement within communities. In a study by Kelley and

Ljubicic (2012), participants from Cape Dorset expressed concerns over ships releasing pollutants and contaminants into Arctic waters, while concerns were also expressed regarding the realistic emergency response and clean-up capabilities. Ritsema, et al. (2015) also found that interviewees from Pond Inlet were expressing concern over a "very under-resourced and severely understaffed" hamlet office, highlighting a gap in the need for an immediate emergency response from the community if a shipping accident were to happen. Respondents in Pond Inlet expressed similar sentiments when considering an emergency response to a shipping accident.

The Arctic Council has demonstrated progress in Arctic DRR through multi-lateral level cooperation with the establishment of a binding Arctic Search and Rescue Agreement in 2011 and the *Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic* in 2013 (Duda and Kelman, 2019). Mileski, et al. (2018) promote maintaining close multi-lateral collaboration, higher environmental standards and safety standards, improved preparedness, and effective management plans as precursors to sustainable economic activity in the Arctic Ocean. As a warming climate allows for the rising accessibility of ships to enter the Canadian Arctic waters, risk of accidents or disasters will clearly rise alongside the increasing traffic. These risks are multiplied in the Arctic when accounting for the rapidly changing and extreme weather, lack of physical or social infrastructures, vast distances between communities, and complex institutional landscapes (Lauta, et al. 2018).

Opportunities for DRR, emergency preparedness, response, and management in the Arctic have been proposed in the literature. Among those recommendations, the core necessities of community consultations and collaboration have been underlined as essential precursors as the communities within the Canadian Arctic remain at the "front lines" for a response (Kelley and Ljubicic, 2012; Duda and Kelman, 2019; van Luijk, et al. 2021; Dawson, et al. 2020a). These sentiments are reiterated and further stressed in this study. Prevention opportunities that were proposed by respondents from Pond Inlet that align with recommendations from a previous study include the limiting of vessels, or a quota system, through corridors that vessels are travelling, as well as speed limits for vessels passing through the region (Halliday, et al. 2022). The overlapping DRR themes identified from respondents in Pond Inlet also included governmental support and investment into local capacities. While governmental programs and personnel such as the Canadian Rangers exist in the Canadian Arctic, bolstering these existing capacities and increasing investment into local capacities to meet the current day risks will be critical for Canada's overall DRR and emergency preparedness systems in the Arctic (Pincus, 2015; Kelley and Ljubicic, 2012; Lauta, et al. 2018). What complicates the political will for investment into DRR and emergency preparedness in the Arctic is the low-probability and high-cost nature of disasters in the region, making long-term plans for preparedness unpopular (Pincus, 2015).

2.5 Conclusion

This study assessed community perspectives on the implications of increased Arctic shipping around Pond Inlet and the Northwest Passage, along with the risks of shipping accidents and the subsequent emergency responses. In collaboration with the community organization, Ikaarvik, a survey that integrated qualitative and quantitative approaches, was implemented with Pond Inlet as a case study for this interdisciplinary study on shipping risks and emergency response in the Canadian Arctic. The findings from this study indicate that there is near consensus among community members within the sample on the increase in shipping activities and seasons due to climate change and increases in temperature, as well as the risks that coincide with the increasing ship traffic (see Figure 2.3). Responses and speculation on the probabilities of shipping accidents based on the exploratory scenarios appears to be mixed (Figure 2.4), though, consensus is concentrated along the lower end of the spectrum for the emergency response speeds for all scenarios (Figure 2.5) and along the higher end of the spectrum for the level of potential devastation for all scenarios (Figure 2.6). For the qualitative section of the findings, responses were classified into themes that represented elements within a larger process framework that exhibits Arctic shipping risks, foreseen consequences and losses in a worst-case scenario event, and opportunities in DRR (See Figure 2.7). While a majority of community members within the sample were unsure and a quarter of community members were lacking confidence in an adequate governmental response to a shipping accident, opportunities for DRR to advance emergency response policy in the Arctic were presented by community members in Figure 2.7.

2.5.1 Future Studies

Future studies can expand on the baseline of studies on Arctic shipping emergencies through continuing engagement and consultations on emergency response options with a range of stakeholders and rightsholders: governmental and non-governmental, local communities, and relevant industries. Future studies can also allow for a longer implementation phase and to integrate open-ended interviews to supplement and follow-up on survey responses, allowing for a more holistic dataset. Assessing the current shipping-safety and pollution prevention plans alongside emergency response plans for each stakeholder-type will be important to determine levels of risk that is posed to Arctic marine spaces along the shipping corridors, especially around the NWP.

2.5.2 Study Limitations

With many respondents not having experienced an Arctic shipping accident near the community, imagining such an event may have been difficult. There were also a wide range of interdisciplinary questions on the survey that used a qualitative and quantitative approach, thus, individual topics or subjects within shipping and emergency preparedness may lack depth. The quality of responses could further be hindered if the questionnaires were rushed or where minimal effort was taken when providing responses. In addition, the lower sample size may not be representative of the broader population within Pond Inlet, and the shorter timeframe for the implementation of the survey may not have allowed for a fully diverse sample.

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Chapter Three: Additional Findings

This section discusses survey findings that were largely excluded from the article in Chapter Two to center the focus of the article on Arctic shipping futures, accidents, and emergency response. Topics covered in this chapter include the overview of community observations and experiences of shipping season lengths and insights into how this may impact the community. While there was mention of the findings on the levels of concern for shipping accidents within Chapter Two, these findings are presented in more depth within section 3.2 of this chapter.

3.1 Community Perspectives on Estimated Arctic Shipping Season Lengths

The purpose of this section is to incorporate insights from local knowledge into current shipping season length estimates, validating previous findings on shipping season lengths with local Indigenous knowledge via observed and experienced changes.

3.1.1 Methodology for Survey Questions on Arctic Shipping Season Lengths

Within the survey, respondents were asked to view figures (see Annex 1, questions 12 to 14) for resupply and cargo vessels with some ice-strengthening and yachts and local boats that are non-ice-strengthened and were provided a basic overview of the current shipping season lengths around Pond Inlet and the NWP for these vessel-types (see Figure 3.1). Grounded in findings from Mudryk, et al. (2021), respondents were asked if they considered the season lengths of 90 days for yachts and local boats with no ice strengthening and 110 days for resupply and cargo vessels with some ice strengthening to be correct or incorrect, based on their experience and observations. Respondents selected either yes (estimates are correct), no (estimates are incorrect), or unsure (neutral and do not know) based on their observations and experiences within the community. If no was selected, respondents had the option to comment on what they believed would be an appropriate estimate (in days).

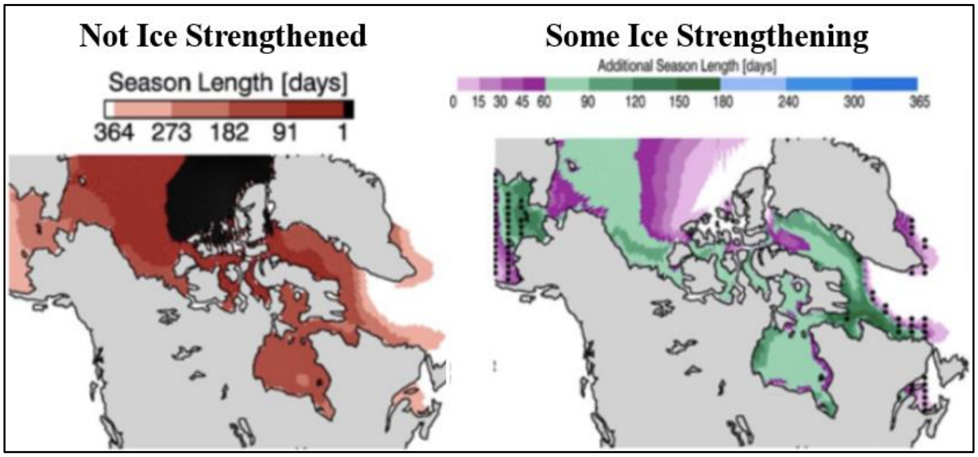

Figure 3.1: Current Arctic shipping season lengths identified by Mudryk, et al. (2021) for vessels that are not ice strengthened (left - local boats and yachts) and vessels with some ice strengthening (right - resupply and cargo).

Following up on the validation of the shipping season estimates, respondents were then provided with the current estimates on shipping season lengths under future global warming projections. Mudryk, et al. (2021) identified projections for yachts and locals boats with no ice strengthening to be around 120 days at +2°C by 2050 and to around 190 days at +4°C by 2080, while the projections for resupply and cargo vessels with some ice strengthening were around 200 days at +2°C by 2050 and up to 300 days at +4°C by 2080 (Figure 3.2). Based on their observations and experiences, respondents were asked to provide their opinions on how the outcomes of these projected futures may impact their community, whether good or bad. The responses were then allocated into positive, negative, and neutral classifications, depending on how the response was framed. In cases where individual responses had both positive and negative traits, these responses would be classified as such, while neutral was reserved for responses that did not present traits that leaned toward either positive or negative; these were excluded from this section.

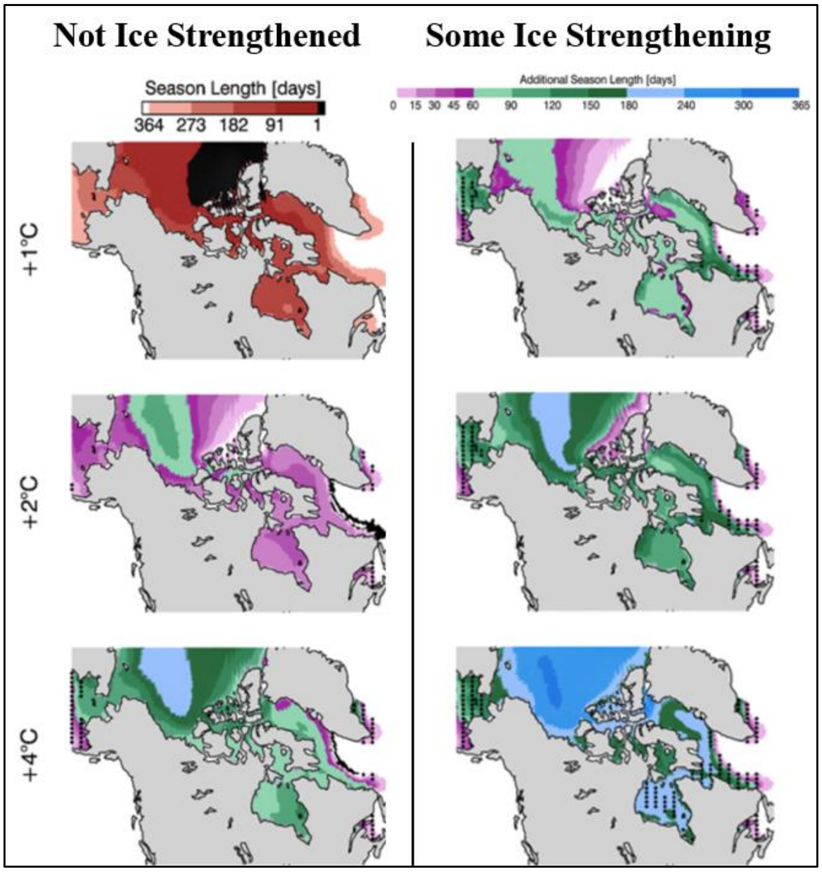

Figure 3.2: Changes in shipping seasons for vessels that are not ice strengthened (left - local boats and yachts) and vessels with some ice strengthening (right - resupply and cargo) under +1°C, +2°C, and +4°C of global warming, according to projections by Mudryk, et al. (2021).

3.1.2 Validating Estimated Shipping Season Lengths through Observations

With a sample size of 44, 64% (n=28) of respondents agreed with the current shipping season length estimates of 110 days for resupply and cargo vessels with some ice-strengthening, while 5% (n=2) disagreed with these estimates and 32% (n=14) were unsure (see Figure 3.3). Those who disagreed suggested a higher estimate of around 115 to 120 days (n=1), and a much lower estimate of 30 days (n=1). Furthermore, 55% (n=24) of respondents agreed with the current season length estimates of 90 days for yachts and local boats that are non-ice-strengthened, and

11% (n=5) disagreed with these estimates, with 34% (n=15) being unsure (Figure 3.3). Those who responded no had proposed estimates of 60 days (n=1), 90 days (n=1), and 120 days (n=2).

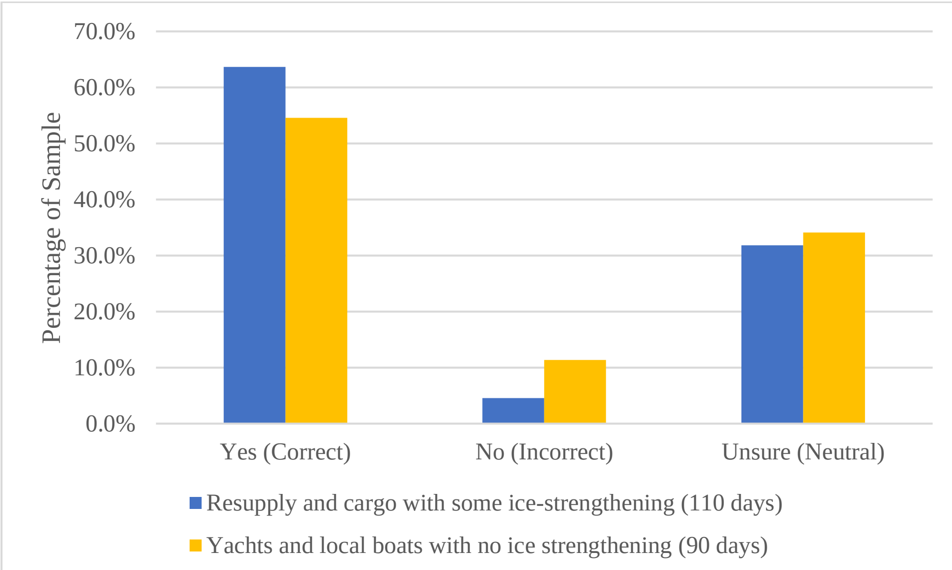

Figure 3.3: Percentage of respondents from the sample that identified current estimated shipping seasons lengths as correct, incorrect, or neutral based on their experience and observations. Shipping season lengths for resupply and cargo vessels with some ice-strengthening were estimated to be around 110 days, while the season lengths for yachts and local boats that are non-ice strengthened were estimated to be around 90 days.

3.1.3 Perspectives on Positives and Consequences of Longer Shipping Seasons

The following sub-sections below present the qualitative findings from the community respondents' opinions regarding the changes in shipping seasons under future scenarios of rising global temperature. Overall, the positive responses were largely overshadowed by the negative responses.

Yachts and Local Boats with No Ice Strengthening

For the futures surrounding yachts and local boats, the positive responses centered around the local economy and tourism. For example, cruise tourism was noted as being potentially beneficial for the local economy, while this can also be good for arts and crafts sales. Some respondents suggested that the increased open water seasons can potentially lead to local economic development and more opportunities for the community. There was also a couple of respondents who proposed that the community can adapt to the projected changes, and "everything flows better" if the operators of ships are careful and respectful within the region. On the other hand, the negative responses centered around potential accidents or disasters, consequences for the wildlife, and the implications for local hunters. There was mention of the heightened potential for accidents and disasters due to the higher traffic volume, with a respondent advising that safety should be a priority. The more widely mentioned concerns for the impacts were the consequences to wildlife, notably sea mammals, which intersects with the consequences for local hunting. One respondent noted that both bears and the Inuit need the ice and icebergs, while other respondents advised that these impacts could drive animals away and force hunters to venture further for the catch.

Resupply and Cargo Vessels with Some Ice Strengthening

For the futures surrounding resupply and cargo vessels, a longer shipping season for the resupply vessels was most prominently noted as a positive factor. This was especially found to be important by some respondents for when the community grows in population, while it was also proposed that this can bring more goods and lower prices for goods. However, one respondent noted that these positives will be dependent on ship management and ship designs that allow for less environmental impact. The negative responses for resupply and cargo vessels mirrored the negative responses described for yachts and local boats. Again, the potential for accidents were noted, along with the consequences for wildlife and local hunters. There was further emphasis placed on the consequences to traditional and cultural activities, such as ways of living and ways of hunting, by some respondents. One respondent even commented on the potential "loss of an authentic environment" from the projections, while another respondent advised that "with more vessels around, the sea mammals will go elsewhere which will make it much harder for hunters to hunt narwhal and seals."

3.2 Community Concern for Shipping Accidents

This section aims to identify a baseline understanding of how often community residents considered the potential for a shipping accident around their community. This section also draws on community reflections from the exploratory scenarios that were presented in Chapter Two (section 2.3.3).

3.2.1 Methodology for Questions on Shipping Accident Concerns and Reflections

The survey entailed a question seeking how often shipping accidents were personally considered by respondents. This involved identifying respondents' levels of concern via a Likert scale with frequencies of 1) never, 2) rarely (1 time per year or less), 3) occasionally (2-5 times per year), and 4) regularly (5-10 times per year). Within the same section of this survey, the exploratory scenarios described in Chapter Two followed. As optional follow-up questions to the quantitative questions in each historic scenario, respondents were asked to provide examples of impacts they considered and the impacts that concerned them. The responses to each scenario were summarized in point form, with each point being a general theme identified among the broader responses.

3.2.2 Level of Concern

The level of concern is shown below in Figure 3.4. With the sample size of 44, only 7% (n=3) of respondents never considered or thought about possible shipping accidents near or around their community. Interestingly, 36% (n=16) of respondents selected rarely (1 time per year or less) and 36% (n=16) of respondents selected occasionally (2-5 times per year), while 20% (n=9) selected regularly (5-10 times per year).

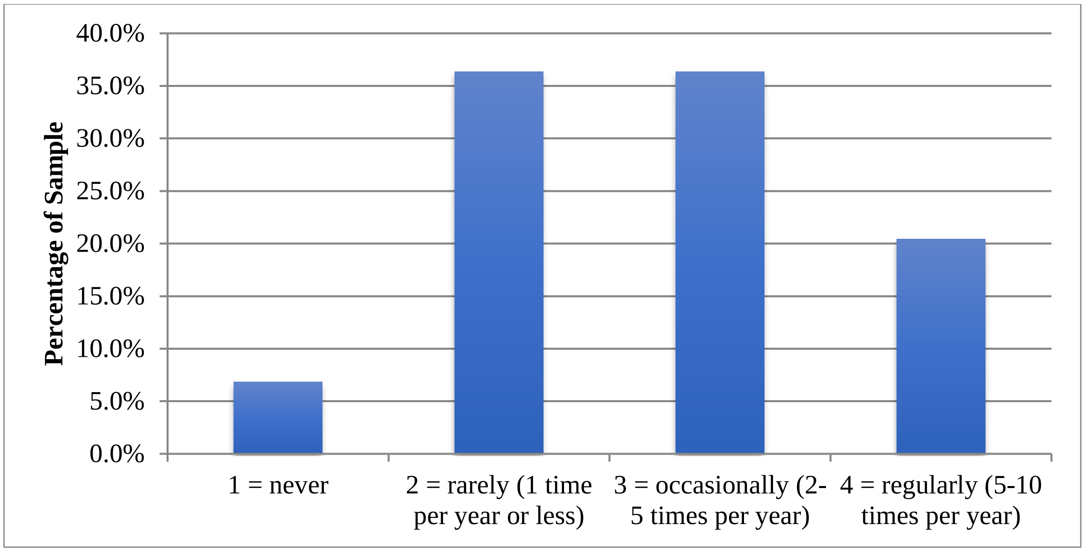

Figure 3.4: Level of concern for possible shipping accidents – how often respondents thought about possible shipping accidents near or around the community of Pond Inlet.

3.2.3 Community Reflections on Exploratory Scenarios

The following points briefly summarize the responses to the optional follow-up questions to each exploratory scenario described in Chapter Two (section 2.3.3). These summaries also reflect similar sentiments expressed in the process framework presented in Chapter Two (section 2.3.4), further emphasizing the concerns for community residents in the event of a shipping accident or disaster in the region.

MV Marathassa oil spill

- Fallout for wildlife due to injury, sickness, death, and movement away from impacted areas and habitats;
- Repercussions for local hunters and contamination of country foods and the food chain;
- Challenges for local access to land or sea travel.

MV SKRIM receives ice damage

- Fallout for wildlife due to injury, sickness, death, and movement away from impacted areas and habitats;
- Repercussions for local hunters and contamination of country foods and the food chain;
- Challenges for local access to land or sea travel;
- Devastation to Inuit culture, traditions, and ways of living.

Nathan E. Stewart accident and response

- Fallout for wildlife due to injury, sickness, death, and movement away from impacted areas and habitats;
- Repercussions for local hunters and contamination of country foods and the food chain;
- Devastation to Inuit culture, traditions, and ways of living;
- Needs for holistic emergency preparedness, effective clean-up, and the involvement of local and external teams;
- Emotional turmoil (stress, anxiety, fear).

Vancouver Harbour collision

- Fallout for wildlife due to injury, sickness, death, and movement away from impacted areas and habitats;
- Repercussions for local hunters and contamination of country foods and the food chain;
- Emotional turmoil (stress, anxiety, fear);
- Expectations for technological advances in shipping safety.

3.3 Chapter Three References

Mudryk, L., Dawson, J., Howell, S., Derksen, C., Zagon, T. & Brady, M. (2021). Impact of 1, 2 and 4°C of global warming on ship navigation in the Canadian Arctic. *Nature Climate Change.* 11. 673-679.

Chapter Four: Discussion and Conclusions

4.1 Discussion

The increased transits of ships throughout the Canadian Arctic and around the NWP will raise the uncertainty and challenges for policymakers and citizens when considering and expanding emergency preparedness in the region (Pincus, 2015). Throughout the analysis of literature, grey literature (including government policy), and survey findings for this thesis project, three themes materialized and form the basis for the recommendations that arise from this study. The following themes are representative of the cumulative guidance and insights from those within this study's sample of Pond Inlet residents, previous and current academic contributions, and the collection of grey literature from governmental and non-governmental sources.

4.1.1 Investment into Arctic Emergency Preparedness for the Northwest Passage

Inevitably, there will be both opportunities and costs that arise from the heightened global interests in the NWP and throughout the marine space within the Canadian Arctic, but determining whether the opportunities exceed the potential costs has yet to be seen. Focusing on Arctic shipping in the region, the event of a shipping accident and an oil spill can rapidly erode the opportunities as there are extensive costs associated with the remote emergency response, post-event monitoring and investigating, legal processes, economic losses as well as environmental and natural resource damages that diminish the ecosystem service values (Liu, and Wirtz, 2006; Depellegrin and Blazauskas, 2013; Afenyo, et al. 2022). These costs can be simply categorized by response, legal, social, economic, and natural resource (Afenyo, et al. 2022; Cohen, 1995), and measuring these costs to the fullest extent will require a multi-disciplinary effort. With the value of Tallurutiup Imanga NMCA and its ecosystem services being estimated as contributing around 37 billion CAD to Canada's natural capital (Mulrooney and

Jones, 2023), a shipping accident that causes a chemical or oil spill in the region will thus be devastating to Canada's natural capital assets. While not measured in monetary values in this study, the higher scores for the levels of devastation of the shipping scenarios (Figure 2.5 above) and the feelings that were described for a worst-case scenario event in the region may also provide some insight into the accumulating risks that a shipping accident could pose. So, it is in line with previous studies and the findings from this study that there must be significant investments and lobbying directly into emergency preparedness and DRR safeguards for the Canadian Arctic if the opportunities from the NWP and other Canadian Arctic passages are to be exploited (Lore, 2008; Larsen, et al. 2016; Pincus, 2015; Marchenko, et al. 2018; van Luijk, et al. 2022; Dawson, et al. 2016; Zhu, et al. 2023).

The costs mentioned above still fail to represent the full costs incurred by local communities and the Inuit residents whose livelihoods are at the front lines of the rapidly accumulating impacts from climate change in the Arctic and the subsequent increasing shipping traffic, highlighting the need for investment into local capacities (van Luijk, et al. 2021; Kelley and Ljubicic, 2012; Ford, et al. 2015). Local subsistence practices, in addition to safety and security, of Arctic communities have been threatened and disrupted by shipping activities despite also bringing economic benefits to the communities (Wang, 2023). Cruise shipping presents a peculiar high-risk example where community visits may present opportunities for some community residents, whereas the risks from cruise operators that deviate from safe shipping lanes places stress on community capacities if a cruise shipping accident were to occur and an emergency response was required (Stewart and Dawson, 2011; Marchenko, et al. 2018). Local capacity is critical in the initial emergency response where there may be immediate search and rescue needs and to identify the levels of damage from the shipping accident, determining the scale of emergency management operations. Minor accidents can rapidly evolve into worst-case scenario events where oil and/or other hazardous materials become trapped within and under sea ice, being carried beyond the initial disaster area and throughout sensitive ecosystems and habitats (Marchenko, et al. 2018; Larsen, et al. 2016). As outlined throughout this study, the contamination of the marine space and country foods in such an event could have detrimental consequences for the physical, physiological, and psychological health of nearby community residents via, for example, the loss of hunting grounds and travel routes and the bioaccumulation of contaminants in wildlife (Laffen, et al. 2016; Jonasson, et al. 2019). Regarding what would be lost in a worst-case scenario shipping accident, one community respondent from Pond Inlet suggested, "we would basically lose our way of life and [we would be] living in the worst-case scenario." Similar sentiments were shared among various respondents within the sample of the study, with losses in country foods and impacts to Inuit culture being significant concerns that were mentioned.

4.1.2 Co-Management of Emergency Preparedness and Planning

The Arctic environment around the NWP provides habitat to sensitive food webs that are currently impacted by the stressors caused by climate change, so major or cumulative pollution events from sources such as shipping activities and/or a shipping accident could trigger long-term and interconnected consequences to the surrounding ecosystem and local country foods (Huntington, et al. 2023). Further, these consequences pose significant risks to cultural identity for Indigenous community members, re-affirming the necessity for Canada's commitments to the UN *Declaration on the Rights of Indigenous Peoples* (UNDRIP) (Zhu, et al. 2023; Wang, 2023). In Canadian Arctic communities such as Pond Inlet, it is crucial to ensure that Inuit culture is a significant component in all decision-making matters that have potential or current consequences for the communities (Ritsema, et al. 2015). While the initial conceptualization and developments of the Low Impact Shipping Corridors in the region had undervalued Inuit and community perspectives, there have been recent efforts by the Canadian federal government to improve upon continued engagement with Inuit organizations and the Arctic communities for the corridors (Dawson, et al. 2020). Current and ensuing policy developments that are potential examples of this engagement include Canada's Oceans Protection Plan, Canada's Arctic and Northern Policy Framework, and Canada's Defence Policy (2017). However, the extent and depth of this engagement within these policy developments remains to be seen.

As suggested, co-development and co-management efforts with communities in the Canadian Arctic have been underway to varying degrees in Canada at policy and academic levels, which is critical for decision-making climates that are more inclusive of Indigenous peoples and local communities across Canada. Armitage, et al. (2009) proposed adaptive co-management as one tool to help achieve this objective, noting that "an adaptive co-management process can also help many such groups to articulate the full range of values and assumptions that will shape governance outcomes" (100). The values, expectations, and priorities of many groups at local, regional, and federal levels may not always "synchronize harmoniously" when engaging in dialogue on climate change adaptation and mitigation opportunities, making conflict an inevitability within the process (Turner and Spalding, 2013). Among the challenges within co-management processes, power relations will likely be the most prominent. Diminishing the dichotomy between grassroots and top-down groups is necessary for DRR and emergency preparedness through understandings of the historical and current vulnerabilities of everyday life, especially within Arctic coastal communities (Balay-As, et al. 2018).

Within the findings of this study, there were several responses indicating that the processes necessary for co-management of emergency management preparedness were limited to non-existent, which further implies an exclusion of the public. As discussed throughout, working with uncertainty in the case of an Arctic shipping accident will require improvisation (Lauta, et al.

2018; Andreassen, et al. 2018; Salokannel, et al. 2018; Mileski, et al. 2018), however, a lack of public confidence in the region where the hazard exists will require heightened engagement and co-development of emergency response plans alongside community residents. This is also demonstrated by the findings from the exploratory shipping accident scenarios where most community respondents suggested that the response speeds will be very slow, and the levels of devastation will be extensive. Thus, flexibility is a key element in the governance, or co-governance, structures and political mechanisms for emergency management and DRR within the Arctic, tailoring governance strategies to empower the coastal community for emergency response needs (Lauta, et al. 2018; Mileski, et al. 2018). Some respondents within the findings indicated that local hunters and community residents would be responders in the event of a shipping accident, challenging rigid governmental structures in traditional emergency management. The flexibility that is necessary for an emergency response in the context of an Arctic shipping accident can allow for testing and applying a diverse range of tools or measures to identify successes and shortcomings within the process, a condition for adaptive co-management (Armitage, et al. 2009).

4.1.3 Consolidating Inuit Sovereignty for Designated Arctic Shipping Routes

Despite the contemporary co-management efforts between the Canadian government and coastal communities, there is significant work needed in equitably recognizing and infusing the fundamental rights of the Inuit into Arctic shipping governance, in part, through addressing tensions and conflict between shipping rights and Inuit rights (Aporta, et al. 2018). An example of a conflict arises from the United Nations *Convention on the Law of the Sea* (UNCLOS) via Freedom of the seas and the right of transit passage, notably of foreign flagged vessels (UNCLOS, 1982, Article 38). The proposed Arctic shipping corridors are an opportunity to begin meeting minimum requirements to prevent or mitigate an Arctic shipping disaster, as those requisites according to Porta, et al. (2017) include basic infrastructure, emergency prevention and preparedness, vessel monitoring and management, and modern charting. The inclusion of Inuit partners into the Arctic corridors planning in a co-management effort, especially given that these communities are in favour of Arctic shipping corridors, will only strengthen Inuit and national sovereignty in the Arctic while likely improving emergency preparedness (Dawson, et al. 2020). This theme of "control" was also most prevalent within the DRR findings within this study's process framework (see Figure 2.7). However, international opposition from external nations, notably the US and European Union, continue to diplomatically protest Canada's policy tools that favour the adoption and enforcement of pollution prevention and control measures in ice-covered areas (UNCLOS, 1982, Article 234) which may limit freedom of the seas and the right of transit passage for foreign flagged vessels (UNCLOS, 1982 Article 38; Fahey, 2018; Zhang and Yang, 2023). The NORDREG zone is at the center of the debate where Canada's position on NORDREG is supported by Article 234 in UNCLOS, whereas opposing nations such as the US insist on prioritizing freedom of navigation over Article 234 (McDorman, 2019). This debate certainly accounts for national sovereignty and security interests for Canada but fails to account for or consider Inuit sovereignty and security.

As noted in Chapter One, the Arctic sea-ice is considered the "highway" for the Inuit and is important to the communities for Arctic marine travel, whether frozen or open (Kelley and Ljubicic, 2012). While ships operating in the Arctic are subject to the Polar Code and jurisdictional policy to reduce probabilities of an accident, the increasing ship traffic from national and international interests present rising risks of potential harm to Inuit traditional livelihoods and culture that are interconnected with the Arctic environment (Bergstrom, et al. 2022). These rising risks pose further concerns for wildlife conservation efforts and the accessibility of Inuit hunting grounds in the region (Halliday, et al. 2022). The process framework (Figure 2.7) demonstrates similar conclusions from the perspectives of residents in Pond Inlet, a community that is impacted by such shipping activities around the NWP. Thus, it could be argued that the Government of Canada should continue acting upon UNCLOS (1982, Article 234) and UNDRIP (2007) in favour of environmental protections and emergency preparedness efforts, such as Low Impact Shipping Corridors, which will entail policy that requires some level of control over designated Arctic shipping routes within the NORDREG zone that will impact freedom of navigation (Wang, 2023; Dawson, et al. 2020; Porta, et al. 2017; Bishop, et al. 2022).

4.1.4 Synthesizing Recommendations from Community and Academic Sources

This section aims to briefly summarize the key recommendations that are discussed throughout this study. Reiterating recommendations from previous research (Kelley and Ljubicic, 2012; Hadlos, et al. 2022; Dawson, et al. 2020; Bishop, et al. 2022; Carter, et al. 2019), there must be adequate engagement and consultations with communities and Indigenous peoples within the Canadian Arctic on existing and future shipping and emergency response policy that is relevant to the region. Within this process of engagement and consultations, there must be community campaigns to raise awareness on shipping-specific preparedness and emergency response plans for the region to raise confidence for community members. The next recommendation is to control and limit ship traffic in the region via tools such as quotas and speed limits, and existing legislation such as NORDREG and the *Canada Shipping Act, 2001.* This was proposed by community respondents and is likewise found in the literature (see Halliday, et al. 2022; Bishop, et al. 2022). The final recommendation is for heightened government intervention into Arctic shipping and emergency response plans, which entails the investment into local response capacities and preparedness for communities in the Canadian Arctic (see Kirchner, 2019; Bechtel and Mannino; 2021; Pincus, 2016). Russia has invested significantly into the governance of the Northern Sea route for building capacity, whereas Canada and the US have been lagging behind and are lacking capacity for the effective enforcement and response of their jurisdictions (Huntington, et al. 2023).

4.2 Conclusions

4.2.1 Contributions

This study presents a range of community perspectives from Pond Inlet on shipping futures and emergency preparedness around the community and the NWP. The findings within this study provide a baseline understanding of how community residents within Pond Inlet perceive shipping around their community and how they perceive potential shipping accidents or disasters in the Arctic. These findings also give insight into how community residents perceive the emergency preparedness for their community in the event of a shipping accident. Through the co-development and participatory approaches, this study contributes to the broader efforts for local and Inuit inclusion under UNDRIP on Arctic shipping issues and climate change adaptations (Wang, 2023; Zhu, et al. 2023; Dawson, et al. 2016; Huntington, et al. 2023; Dawson, et al 2020; Stewart, et al. 2015).

The survey tool along with its co-development and implementation are methodological contributions that can be built-upon and adapted for different coastal community contexts throughout the Arctic, further encouraging or fostering researcher-stakeholder engagement and collaboration. The participatory foresight methods that were used for this survey also achieved the goals of citizen participation outlined by van den Ende, et al. (2022): informing local climate policy via citizen input, stimulate learning and raising awareness on climate change impacts, and identifying knowledge and information that can support climate change adaptation.

4.2.2 Limitations of Study

The limitations for the survey and the broader study are discussed below.

The *Review of Literature* within Chapter One may not reflect the full depth of literature on the subject of Arctic shipping and emergency management in the Arctic due to sparce studies in the area and the rapidly developing nature of the subject.

The survey, while participatory, was also an experimental approach to engaging a coastal community on the topic of Arctic shipping futures and emergency preparedness. As such, the findings are not meant to be representative of the community's actual preparedness for a shipping accident, but instead are meant to inform about residents' perceptions related to local shipping futures, shipping accidents, and community preparedness for an emergency.

The findings from this survey rely on observed experiences and Indigenous knowledge, as well as, to a lesser degree, imagination. While some individuals within the sample have experience and/or knowledge relating to the shipping industry or emergency management issues (including search and rescue programs), respondents within the community may have lacked a full understanding on the topic due to not having experienced such an event. In addition, the quality of responses from residents could be hindered if questionnaires were rushed or if there was minimal effort when a response was provided.

Due to the interdisciplinary approach of this study and the survey, there may be a lack of depth into individual topics or subjects within Arctic shipping futures and emergency preparedness.

This is especially noticeable within the survey as questions crossed disciplinary lines, which has these benefits and trade-offs.

Finally, the shorter implementation period for the survey may have impacted the diversity of the sample, and the sample size itself (44 respondents) is not fully representative of the broader population of Pond Inlet. While the diversity of respondents was still broad, important perspectives may have been left out due to the shorter implementation period.

4.2.3 Future Research Needs

Future research can apply a similar qualitative and quantitative approach to the survey used in this study to coastal communities throughout the Arctic, using a longer implementation period to maximize community engagement and sample size. This approach could be supplemented with follow-up interviews that are open-ended for an improved and holistic dataset to identify perspectives that are more representative of the coastal community population. Further analysis of current shipping-safety, pollution prevention, and emergency response programs for each level of stakeholder and rightsholder will also be necessary to identify gaps and successes for managing the evolving risk levels to marine spaces throughout Arctic shipping corridors, especially the NWP (see Mileski, et al. 2018; Kikkert and Lackenbauer, 2019; Dalaklis and Drewniak, 2020; Afenyo, et al. 2019; Afenyo, et al. 2022; Ford and Clark, 2019). Additionally, future research can explore options to meet capacity building and emergency preparedness needs to respond to Canada's growing national security risks from climate change and the rising international interest in the NWP (see Huebert, 2012; Rothwell, 2017).

4.3 Chapter Four References

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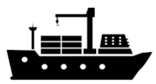
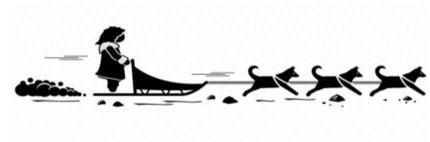
Annex

Annex 1: Survey instrument in questionnaire format that was used for data collection.

Climate Change and Transportation - Community Survey

About you

Background information

1**. How long have you lived in this community?** □ _Less than one year □ _1 – 4 years □ _5 – 9 years □ _10 – 19 years □ _20 – 39 years □ _40 or more years □ _Prefer not to answer □ _If you have lived in the community on and off over the years, and would like to provide more context, please explain: ________________________________

2**. Do you identify as an Indigenous person (Inuit, Métis, First Nation, or other)?** (check one)

□ _Yes □ _No □ _Prefer not to answer.

If yes, please select which Indigenous group(s) you identify with. (check all that apply, and use the text box to specify further if you like) □ _Inuit _______________________ □ _Métis _______________________ □ _First Nations _______________________ □ _Other _______________________

3. **Which languages do you speak?** (check all that apply) □ _Inuktitut □ _Inuinnaqtun □ _Inuvialuktun □ _English □ _French □ _Other language(s) (list): □ _Prefer not to answer.

4. Please indicate your gender

□ Male □ Female □ You don't have an option that applies to me. I identify as (please specify) ________ □ Prefer not to answer.

5. What year were you born? ______________

6. Are you a resident of this community? ☐ Yes ☐ No

If yes, how long have you lived here? Please indicate in years ____________

☐ Prefer not to answer

7. What is your highest level of education attained? Please check one box.

☐ No formal schooling

☐ Some Elementary school

☐ Completed Elementary school

☐ Secondary (High) school

☐ College, CEGEP or non-University

☐ University (bachelor's)

☐ Graduate/Professional

☐ Other

☐ Prefer not to answer

8. Employment status:

☐ Employed

☐ Unemployed

☐ Voluntary work

☐ Prefer not to answer

9. If employed, which industry do you work in? *Please check all that apply.*

☐ Information technology

☐ Defense (including Canadian Rangers)

☐ Search and Rescue (including emergency response activities)

☐ Energy

□ Mining

□ Fishery

□ Government

□ Non-Governmental Organization

□ Other, please specify ______________

10. Please indicate your role within the community. *Please check all that apply.*

□ Community member/resident

□ Elder

□ Community leader

□ Community council

□ Head of a local organisation

□ Other, please specify______

□ Prefer not to answer

Ship Based Transportation

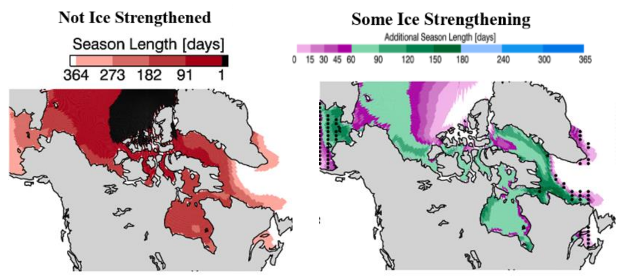
11. In your opinion, please indicate your level of agreement or disagreement to the following statements about climate change and shipping activities in your community by checking one box in each row.

Climate change/shipping activities	Strongly Disagree	Disagree	Neither agree/nor disagree	Agree	Strongly Agree
Climate change has contributed to an increase in shipping activities in the area.					
Increases in temperature may lengthen shipping season and					

disrupt other marine transportation routes.					
The future increase in shipping activities in the area will significantly affect (reduce) local accessibility to sea-based transportation.					
The increase in ship traffic may provide new economic activities within the community.					
The increase in ship traffic affects your ability to access travel routes over sea ice.					
The increase in ship traffic affects your ability to access hunting locations.					
The increase in ship traffic causes early breaking of sea ice which impacts safe travel.					
The increase in ship traffic can cause harm to local boaters.					
The increase in ship traffic can destroy smaller boats.					
Increase in ship traffic may increase ship accidents and disaster incidents such as a fuel spill near the community.					
The increase in ship traffic can negatively affect the sea ice environment.					
The increase in ship traffic due to climate change can present higher risks (social and economic) to the community and environment compared to the benefits.					

12. Looking at the figure below, shipping season lengths around Pond Inlet is currently about 3 months (90 days) for yachts and local boats that are non-ice strengthened (left) and over 3 months (110 days) for re-supply and cargo vessels with some ice strengthening (right). Based on your experience and observations, do you consider these season lengths to be correct?

a)



☐ Yes, 90 days is a typical season length estimate for yachts and local boats around Pond Inlet.

☐ Unsure, I do not know how long the season lengths are for yachts and local boats around Pond Inlet.

☐ No, 90 days is not a good season length estimate for yachts and local boats around Pond Inlet.

If you responded No, can you comment on what you believe the season length is for yachts/local boats around Pond Inlet ___________________ (in days).

b)

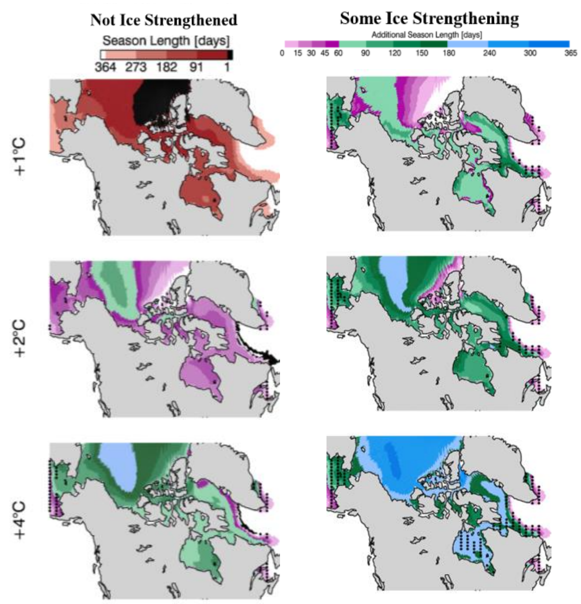
☐ Yes, 110 days is a typical season length estimate for re-supply and cargo vessels around Pond Inlet.

☐ Unsure, I don't know how long the season length is for re-supply and cargo vessels around Pond Inlet.

☐ No, 110 days is not a good season length estimate for re-supply and cargo vessels around Pond Inlet.

If you responded No, can you comment on what you believe the season length is for re-supply and cargo vessels around Pond Inlet___________________ (in days).

13. The future season length for yachts and local boats could increase to 120 days by +2°C by the year 2050, and to around 190 days by +4°C by the year 2080 (see figure – left panel). In your opinion, what are your thoughts about how this may impact your community? Good? Bad?



14. The future season length for re-supply and cargo vessels could increase to around 200 days at +2°C by the year 2050, and to 300 days at +4°C by the year 2080 (see figure above – right panel). In your opinion, what are your thoughts about how this may impact your community? Good? Bad?

Community perspectives on shipping disaster preparedness

15. When thinking about possible shipping accidents that could occur near-by your community, think about what type of accident that you think would be the worst-case-scenario. Please provide your opinions of the following:

    a) What type of vessel do you think about?

    b) What would happen?

    c) What would the consequences be?

16. We are interested in learning about the level of concern for possible shipping accidents and how often you think about this.

    How often have you considered or thought about possible shipping accidents near or around your community? 1= never, 2= rarely (1 time per year or less), 3= occasionally (2-5 times per year), 4= regularly (5-10 times per year), 5= very often (more than 10 times per year) ____

17. Please answer the following questions about a worst-case scenario shipping accident:

    a) What would you or your community lose if a worst-case-scenario shipping accident occurred near Pond Inlet?

    b) How would this make you feel?

18. What needs to happen to reduce the chances of severe damages caused by a shipping accident or disaster near Pond Inlet?

19. Please review (or listen to) the following real-life shipping scenarios that have occurred in other places across Canada and think about what it would mean for you and your community if the scenario were to occur near-by Pond Inlet.

SCENARIO 1

A bulk carrier called the MV Marathassa discharged over 2500 litres of bunker fuel into the Vancouver English Bay, with toxic oil spreading to the shorelines and having a significant negative impact on the water quality, wildlife (with at least 20 birds being affected), and surrounding environment. The oil spill was not noticed until a recreational boater spotted the oil in the water and reported the oil spill. It was after this that it was determined that there was oil coming from the MV Marathassa.

Sources for scenario: Canadian Disaster Database; Clear Seas, 2016; City of Vancouver

QUESTIONS

a. How likely do you think it is that something like this could happen around Pond Inlet? - Scale from 1 (unlikely) to 10 (extremely likely) ___

b. If something like this happened near Pond Inlet, how quick or slow do you think an emergency response to this could happen? – Scale from 1 (very slow) to 10 (very quick) ___

c. How bad would a scenario such as this be for yourself and the ocean you rely on? Examples can include wildlife, sea life, hunting, fishing. – Scale from 1 (limited/contained impact) to 10 (devastating/extensive) ___

d. Please list or give examples of impacts you think about or fear with this scenario (optional)

SCENARIO 2

Off the shore of Newfoundland during the beginning of springtime (March), a bulk carrier from Panama called the MV SKRIM began leaking heavy oil after receiving ice damage from the icy conditions. The oil could be found in the ice near the ship and on the rocks on the shoreline of Newfoundland. With the amount of heavy oil leaking into the sea ice and marine space, it is clear that marine life would be impacted and the oil would increase sea ice melt around the impacted area by absorbing more heat from sunlight, but it would be unclear to what degree. There would be a chance that some fish may be unsafe to eat if they passed through the contaminated area.

Source for scenario: Canadian Disaster Database

QUESTIONS

a. How likely do you think it is that something like this could happen around Pond Inlet? - Scale from 1 (unlikely) to 10 (extremely likely) ___

b. If something like this happened near Pond Inlet, how quick or slow do you think an emergency response to this could happen? – Scale from 1 (very slow) to 10 (very quick) ___

c. How bad would a scenario such as this be for yourself and the ocean you rely on? Examples can include wildlife, sea life, hunting, fishing. – Scale from 1 (limited/contained impact) to 10 (devastating/extensive) ___

d. Please list or give examples of impacts you think about or fear with this scenario (optional)

SCENARIO 3

In a remote part of the Seaforth Channel in BC, a barge and tug called Nathan E. Stewart struck the bottom of a shallow part of the Channel after the operator fell asleep from fatigue, causing over 100,000 litres of diesel fuel and over 2000 litres of lubricants to be spilled into the channel near the Heiltsuk First Nation. 350 kilometres of shoreline were affected by the spill.

There were two arial flights that confirmed that the diesel fuel and lubricants were spreading throughout the channel. A dive team was repairing the fuel tanks in an attempt to stop the leaking while a team of workers were attempting to pump out remaining fuel, but bad weather hindered the clean up and salvage efforts. It was over a month later that the tug was lifted out of the water and taken to shore. Despite the cleanup efforts, Heiltsuk First Nation fisheries were still closed due to environmental contamination concerns.

Sources for scenario: Canadian Disaster Database; Clear Seas, 2021; Heiltsuk Tribal Council - Investigation Report, 2017

QUESTIONS

a. How likely do you think it is that something like this could happen around Pond Inlet? - Scale from 1 (unlikely) to 10 (extremely likely) ___

b. If something like this happened near Pond Inlet, how quick or slow do you think an emergency response to this could happen? – Scale from 1 (very slow) to 10 (very quick) ___

c. How bad would a scenario such as this be for yourself and the ocean you rely on? Examples can include wildlife, sea life, hunting, fishing. – Scale from 1 (limited/contained impact) to 10 (devastating/extensive) ___

d. Please list or give examples of impacts you think about or fear with this scenario (optional)

SCENARIO 4

Around the Vancouver Harbour, there was a collision between two ships in fog, causing marine diesel oil to spill, contaminating the surrounding water with over a kilometre of shoreline affected. This incident killed 65 birds while over 200 birds were rescued with the clean-up efforts.

Source: Canadian Disaster Database

QUESTIONS

a. How likely do you think it is that something like this could happen around Pond Inlet? - Scale from 1 (unlikely) to 10 (extremely likely) ___

b. If something like this happened near Pond Inlet, how quick or slow do you think an emergency response to this could happen? – Scale from 1 (very slow) to 10 (very quick) ___

c. How bad would a scenario such as this be for yourself and the ocean you rely on? Examples can include wildlife, sea life, hunting, fishing. – Scale from 1 (limited/contained impact) to 10 (devastating/extensive) ___

d. Please list or give examples of impacts you think about or fear with this scenario (optional)

20. In your opinion, how prepared do you feel your community is to respond to an Arctic shipping emergency or disaster? (If unsure, please indicate).

21. Do you feel that there will be enough help from the Government of Nunavut and Government of Canada to be able to help lower the impacts caused by a shipping accident?

□ _Yes □ _No □ _Unsure

If you responded No, can you explain why you selected No? (Optional)