

Evaluating Institutional Arrangements for Marine Shipping Management within the Northern
Marine Transportation Corridors Using Multiple Criteria Decision Analysis

By

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List of Abbreviations

AANDC- Aboriginal Affairs and Northern Development Canada
ABR- Arctic Bridge Route
AC- Arctic Council
AECO- Arctic Expedition Cruise Operations
AIS- Automatic Identification System
AMSA- Arctic Marine Shipping Assessment
APMs- Associated Protective Measures
ASPPR- Arctic Shipping Pollution Prevention Regulations
ATBA- Areas To Be Avoided
AWPPA- Arctic Waters Pollution Prevention Act
CanNor- Canadian Northern Economic Development Agency
CCG- Canadian Coast Guard
CHS- Canadian Hydrographic Service
CMAC- Canadian Marine Advisory Council
DFO- Department of Fisheries and Oceans Canada
DND- Department of National Defence
EBSAs- Ecologically and Biologically Sensitive Areas
ECCC- Environment and Climate Change Canada
ESD- Economic Sustainable Development
GHGs- Green House Gases
GIS- Geographic Information System
GOC- Government of Canada
GN- Government of Nunavut
HFO- Heavy Fuel Oil
HTOs- Hunters and Trappers Organizations
ICC- Inuit Circumpolar Council
IFA- Innuvialuit Final Agreement
IMO- International Maritime Organization
INAC- Indigenous and Northern Affairs Canada
ITK- Inuit Tapiriit Kanatami
LOMA- Large Ocean Management Area
MARPOL- International Convention on the Prevention of Pollution from Ships
MCDA- Multiple Criteria Decision Analysis
MPAs- Marine Protected Areas
MSP- Marine Spatial Planning
MSR- Minister's Special Representative
NLCA- Nunavut Land Claims Agreement
NGOs- Non-Governmental Organizations
NIRB- Nunavut Impact Review Board

NIS- Non-Indigenous Species
NMC- Nunavut Marine Council
NMTC- Northern Marine Transportation Corridors
NORDREG- Northern Canada Vessel Traffic Services Zone
NPC- Nunavut Planning Commission
NRC- National Research Council
NRCan- Natural Resource Canada
NRM- Natural Resource Management
NSR- Northern Sea Route
NSA- Nunavut Settlement Area
NTI- Nunavut Tunngavik Inc
NuPPAA- Nunavut Planning and Project Assessment Act
NWAB- Nunavut Wildlife Advisory Board
NWB- Nunavut Water Board
NWMB- Nunavut Wildlife Management Board
NWP- Northwest Passage
PSSAs- Particularly Sensitive Sea Areas
RIA- Regional Inuit Associations
RWO- Regional Wildlife Organizations
SOLAS- International Convention for the Safety of Life at Sea
TAC- Total Allowable Catch
TAH- Total Allowable Harvest
TC- Transport Canada
TSR- Transpolar Sea Route
TEK- Traditional Ecological Knowledge
UNCLOS- United Nations Convention on the Law of the Sea
VMS- Vessel Monitoring System
WWF- World Wildlife Fund

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Abstract

A promising policy framework called the ‘Low Impact Shipping Corridors’ (also referred to as the Northern Marine Transportation Corridors - NMTC) was developed for managing marine shipping activities in the Canadian Arctic. However, this initial design of corridors overlaps with sensitive cultural areas and also presents risks and challenges to the marine ecosystem and coastal communities. Consequently, it is necessary to identify an appropriate and acceptable form of institutional arrangement for maritime governance and decision-making within the corridors. This paper aims to evaluate institutional forms and to propose best practices by using Multiple Criteria Decision Analysis (MCDA). First, this paper analyzes the drivers, impacts and the current situation of marine shipping in the Arctic and then identifies the stakeholders, alternatives and criteria for evaluating different institutional forms. The selected institutional forms are co-management, co-governance and shared leadership, which have been applied to address Arctic related issues. Second, by using an MCDA matrix, the final result shows that co-management is the most appropriate arrangement for managing marine shipping activities within NMTC. This paper also demonstrates that MCDA can be used in evaluating forms of institutional arrangements and help decision makers select the appropriate one. Finally, discussion and some recommendations are presented for future applications of integrating these methodologies into the practical decision-making process for marine shipping management within NMTC.

Keywords: marine shipping; Arctic; Nunavut; Northern Marine Transportation Corridors (NMTC); co-management; co-governance; shared leadership; Multiple Criteria Decision Analysis (MCDA).

Chapter 1 INTRODUCTION

Driven by climate change and natural resources exploitation, the last decade has witnessed a substantial growth of marine shipping activities in the Arctic (Pizzolato, Howell & Dawson et al., 2016). Increasing shipping opportunities in the Arctic will not only generate economic benefits to industry and local communities, but also have socio-ecological impacts on the marine and coastal environment (Angell & Parkins, 2011; Buell, 2006; Kelley & Ljubicic, 2012). Recently, the Canadian government announced the development of “Low Impact Shipping Corridors” (also referred to as the Northern Marine Transportation Corridors - NMTC) to help govern maritime activities in the Canadian Arctic (TC, 2016). However, the corridors have not sufficiently integrated scientific knowledge, Indigenous Peoples’ experiences and values regarding to their land, and the corridors overlap with many socio-ecologically sensitive areas. Therefore, it is necessary to set up an integrated decision-making policy framework or mechanism for implementing maritime governance through the NMTC.

1.1 Arctic Shipping and Maritime governance

There are growing interests and opportunities for economic development in the Arctic region; one such interest or opportunity is in the sector of marine shipping (Flynn, 2013). Driven by factors like climate change and natural resources exploitation, and accounting for annual variability, the total vessel volume in the Arctic has increased by more than 75% over the past decade (Pizzolato et al., 2016).

Meanwhile, the visible economic benefits brought by marine shipping have attached risks. For example, there are potential discharges from normal shipping operations and accidents that present negative ecological impacts to the fragile Arctic environment (Kelley & Ljubicic, 2012). The increasing shipping activities will also disturb the living environment of wildlife and the

traditional life and culture of indigenous communities, especially for traditional hunting activities and food security (Angell & Parkins, 2011; Buell, 2006). On the other hand, the remote north presents challenges to shipping vessels: low temperatures, unpredictable weather and ice, incomplete sea charts and lack of supporting infrastructure all pose threats to marine navigation and safety (Boileau, Mak & Lever, 2010; Ghosh & Rubly, 2015; Stewart et al., 2010a). Thus, maritime governance, which is defined as a policy-making system to govern shipping activity and its consequences (van Leeuwen, 2015), is needed to mitigate shipping risks in the Arctic.

Shipping can not be managed by a single institution, since marine shipping activities involve passing through different jurisdictions and interacting with different natural and social environments (Young et al., 2007). Maritime governance thus involves a wide range of stakeholders, including international, national, regional, local, and Indigenous governments and agencies (Ritsema, Dawson & Macdougall et al., 2015). Currently, most shipping activities are managed under international and national laws and regulations. For example, from the perspective of international law and policy, the International Maritime Organization (IMO) has adopted the International Code for Ships Operating in Polar Waters (Polar Code) from January 1st, 2017 in order to improve the safety of shipping operations and mitigate negative impacts to the environment (IMO, 2016a). At the national level, the Arctic Shipping Pollution Prevention Regulations (ASPPR) aim to govern navigation in coastal waters north of latitude 60°N within Canadian waters (TC, 2010). Although some of these regulations have been customized for the north, many gaps have been identified in the actual maritime governance regime, such as no bans on Heavy Fuel Oil (HFO) (Weber, 2015), a lack of spill response and an inability to enforce these regulations (McGwin, 2015).

It is well recognized that broad public participation in the process of solving complicated issues can bring benefits to the decision-making process and to more stakeholders (Irvin & Stansbury, 2004). An integrated decision-making framework, with stakeholders' participation and contribution, especially the contribution from indigenous groups, is needed to improve the current maritime governance system up North.

1.2 Marine shipping activities and management in the Canadian Arctic

In the Canadian Arctic, retreating sea ice has increased access to remote areas which are rich in natural resources, spectacular landscapes and traditional culture (Prowse et al., 2009). Shipping activities are growing quickly in the Canadian Arctic (Johnston, A., Johnston, M. & Lemelin et al., 2012; Ritsema et al., 2015): community re-supply, resource exploitation and tourism are the most popular sectors (Kelley & Ljubicic, 2012; Pizzolato, Howell & Copland et al., 2014).

Increasing shipping activities result in an urgent need for new approaches to ocean, coastal and vessel management (Dawson, Johnston & Stewart., 2014).

In response to the need for improved Arctic shipping governance, the Government of Canada recently developed the “Low Impact Shipping Corridors” (NMTC) through the Oceans Protection Plan (TC, 2016). The framework is co-led by Canadian Coast Guard (CCG), Transport Canada (TC), and the Canadian Hydrographic Service (CHS). NMTC provides an important framework for maritime governance in the Canadian Arctic. It aims to minimize shipping risks, increase safety in the North as well as to bring development opportunities to communities within the Canadian Arctic (CCG, 2014). As designed, the five types of corridors are based on historical marine shipping data (see Figure 2 for more information). However, the design of these corridors overlaps with socially and ecologically significant areas. As a consequence, increasing shipping volume has affected the hunting activities and living

environment of Indigenous Peoples up North (ICC, 2008), and changed the behaviors of wildlife that Indigenous Peoples depend on (Burek, Gulland & O'Hara, 2008).

In addition to science data and knowledge, Traditional Ecological Knowledge (TEK) or Traditional Knowledge (TK) is also important in environmental planning and impact assessment. TEK or TK is defined as: knowledge and values, which have been acquired by Indigenous Peoples through experience, observation, from the land or from spiritual teachings, and handed down from one generation to another (GNWT, 2005). Integrating TEK into the Low Impact Shipping Corridors is important, particularly in Nunavut, since Inuit people have rich TEK reserves and high level of engagement with the environment. There are four institutions of public government in the form of co-management arrangements (see section 2.2.1 *Co-management* for details) established under the Nunavut Land Claims Agreement (NLCA, 1993). These institutions are the main instruments of resource and environment management in the Nunavut Settlement Area (NSA) and the main regulators of access to wildlife, water and other resources. However, they have tended to focus on issues such as wildlife management, water resources, environmental impacts and land use planning with little attention paid to marine shipping management. Therefore, it is necessary to set up an integrated institutional governance arrangement to support the sustainable development of NMTC, as well as a decision-making process for all related stakeholders participating in Arctic shipping management.

1.3 Multiple Criteria Decision Analysis (MCDA) for marine shipping

At the most rudimentary level, Multiple Criteria Decision Analysis (MCDA) is used to solve problems that involve a set of alternatives to be evaluated on the basis of incommensurate criteria according to multiple outcomes (Malczewski & Rinner, 2015). There are three key elements of any multicriteria decision problem: decision maker(s), alternatives, and criteria

(Zarghami and Szidarovszky, 2011). Arctic shipping management is a complex issue with multiple stakeholders and some conflicting interests. It is important to recognize stakeholders' rights and obligations as decision makers in this issue. Furthermore, alternatives in this study refer to different forms of institutional arrangement which have been applied in solving Arctic related issues. There are three forms identified in this study: Co-management, Co-governance and Shared Leadership, which can be regarded as three management alternatives of this issue. Finally, some criteria were selected from a literature review to compare these institutional forms from different perspectives, such as integrity, specificity, representativeness. Since the stakeholders, institutional forms and criteria are interrelated in a complex way, MCDA is a suitable comparative tool to address different forms of institutional arrangements for Arctic marine shipping management.

MCDA can be used in the following two ways: First, it can be applied to evaluating the impacts of the proposed shipping corridors and selecting the best locations with the minimum negative impacts on the Arctic socio-ecological environment. Second, MCDA can be used to analyze the management mechanisms or forms of institutional arrangements, approaches or frameworks for maritime governance in the Arctic. In this case, multiple criteria were used by decision makers to compare and choose the best form of institutional arrangement for a specific management issue, such as Arctic maritime governance. Specifically, in this paper, MCDA is used as a comparative tool for stakeholders to evaluate different forms of institutional arrangements for managing marine shipping activities through the NMTC.

1.4 Scope, purpose and objectives of this paper

The management problem highlighted here is: Appropriate institutional framework has not been developed yet to govern Arctic marine shipping activities. Although the Northern Marine

Transportation Corridors (NMTC) (herein after called NMTC or “Corridors”) is a promising maritime governance framework for the Canadian Arctic, it is important to develop an appropriate form of institutional framework or arrangement so that NMTC can help coordinate multiple interests from stakeholders and increase the overall effectiveness of the governance framework. The focus of this study is commercial shipping vessels, which are used for natural resources exploitation and community re-supply, and which are the major participants in the Corridors. However, there is some relevance to other types of vessels like fisheries vessels, cruise ships, Coast Guard ice breakers and research ships, because the design of the Corridors will affect their shipping patterns and behaviors – albeit to a lesser extent (Dawson, Porta & Mussels et al., 2016).

This paper begins with a detailed literature review of the current situation and expected future status of shipping activities in the Canadian Arctic. The review starts from analyzing the present conditions and opportunities for shipping in the Arctic, as well as the potential benefits and negative impacts brought by shipping activities. This paper will also introduce the current Canadian Arctic shipping policy framework: Northern Marine Transportation Corridors (NMTC) and explain its advantages and limitations.

The literature review proceeds to the major purpose of this paper, which is to provide a practical way to evaluate different forms of institutional arrangements for Arctic shipping governance. There are five objectives: (1) to identify *what* can be managed in marine shipping management; (2) to demonstrate *who* can manage marine shipping in the Canadian Arctic through a brief stakeholder analysis; (3) to analyze structural compositions within an institutional arrangement and to demonstrate *how* policymakers can make decisions for managing Arctic marine shipping; (4) to compare the institutional forms through MCDA by using a set of selected attributes and

criteria which focus on the structural factors; (5) to use an MCDA decision matrix as an example for evaluating and selecting the most appropriate institutional form for managing marine shipping activities in the Canadian Arctic.

This paper provides the foundation for a future NMTC stakeholder workshop to be held in Iqaluit in 2018. The stakeholders identified in this study could become the participants in the future NMTC workshop and even potential decision makers in NMTC. Also, the attributes and criteria selected in this study can be used by stakeholders to understand different forms of institutional arrangements and can also be used for helping decision makers to evaluate and select appropriate forms of institutional arrangement in general. Although all the data and results could change in actual practice, this study paves a way for future studies in maritime governance for the Canadian Arctic, and for the future development of the NMTC.

Chapter 2 LITERATURE REVIEW

2.1 Shipping in the Arctic

2.1.1 Increasing shipping activities in the Arctic

The most obvious sign of climate change is the rapid loss of summer sea ice in the Arctic Ocean (Huntington et al., 2012). According to the satellite data record since 1978, the fastest rate of August ice loss was exhibited in the year of 2012 (NSIDC, 2017). Recent observation results showed that the ice retreat rate in August in 2017, was faster than the 1981 to 2010 average rate of ice loss (NSIDC, 2017). As sea ice recedes in the Arctic, increasing access to natural resources and longer navigational seasons are attracting global commercial interests to explore feasible Arctic shipping routes (Buixadé Farré et al., 2014).

Climate change and the decline of Arctic sea ice have triggered global interests in new trade passages, expedition cruise tourism, natural resources exploitations and research activities in the Arctic (Corbett et al., 2010; Dawson et al., 2014; Dawson, Maher & Slocombe, 2007; Huntington, 2009; Johnston et al., 2012; Pizzolato et al., 2013; Stewart, Draper & Dawson, 2010 b). There has been a significant increase in shipping volume in the Arctic; accounting for annual variability, total vessel volume has increased by more than 75% over the past decade (Pizzolato et al., 2014).

Previous studies of Arctic shipping have focused predominantly on two routes: the Northern Sea Route (NSR), which extends along the Norwegian and Russian Arctic coasts, and the Northwest Passage (NWP), which passes through the Canadian Archipelago and North of Alaska (Buixadé Farré et al., 2014; Østreng et al., 2013; Solski, 2013). Other alternative shipping routes are the Transpolar Sea Route (TSR) and the Arctic Bridge Route (ABR) (see Figure 1). Marine shipping has become the dominant mode of commercial transportation, accounting for almost two thirds of world trade (Hoffmann & Kumar, 2002) and shipping through the Arctic can help shipping companies save time and energy compared to traditional shipping routes. According to different starting points and destinations, Arctic shipping activities can be classified into two types (Buixadé Farré et al., 2014). Transit shipping refers to transporting cargo between non-Arctic ports, including commercial shipping with container ships. Destinal shipping refers to activities with an origin or destination in the Arctic, which include fisheries, tourist cruises, scientific expeditions and resource extraction activities.

From the perspective of transit shipping, an obvious example is that passing through the NSR will shorten the trip distance between Northeast Asia and Europe by 40% (Liu & Kronbak, 2010). Some optimistic estimates point out that 15% to 25% of global traffic will pass through

the NSR by 2030 (Koranyi, 2013; Schmitt, 2014). However, although the most attractive economic lure is for commercial container shipping, the actual navigation environment in the Arctic will lower the economic benefits of transit shipping. Numerous scholars have noted many challenges of using Arctic shipping routes for container shipping (Beveridge et al., 2016; Buixadé Farré et al., 2014; Liu & Kronbak, 2010). Arctic shipping routes may be highly unpredictable due to the harsh environment, including variable sea ice extent and extreme weather (Howell & Yackel, 2004; Kubat, Collins & Timco, 2007; Pharand, 2007; Stewart et al., 2010a). This may threaten the just-in-time system and precise schedules that container ships rely on (Humpert & Raspotnik, 2012; Lasserre & Pelletier, 2011; Verny & Grigentin, 2009). Furthermore, the higher construction costs for ice-classed ships, special crew training and the extra need for ice breaker services will reduce economic efficiency of container shipping (Beveridge, Fournier & Têtu et al., 2016; Liu & Kronbak, 2010).

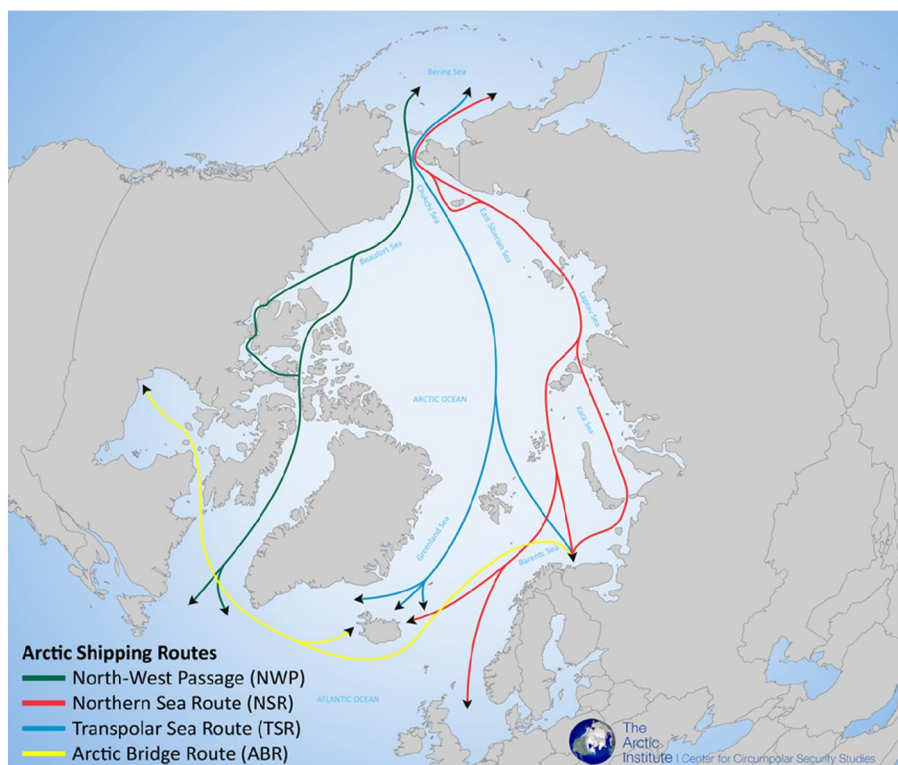


Figure 1. Primary Arctic Shipping Routes. (Source: Fleener, 2013)

Pizzolato et al., (2013) pointed out that four destinational vessel categories (government vessels and ice breakers, pleasure craft, passenger vessels, and bulk carriers) are the fastest growing types of vessels in the Arctic marine shipping. Unlike container ships, ships used for destinational shipping can better cope with variability of Arctic shipping routes. For example, bulk cargo ships are less sensitive to the schedules, and they can sail at a slower speed with greater fuel efficiency, lower fuel cost and lower emissions (Humpert & Raspotnik, 2012).

The Canadian Arctic has experienced significant reductions in sea ice over the past decade, while vessel traffic has more than doubled (Pew Charitable Trust, 2016). Other non-environmental factors have also likely contributed to the observed increase in Arctic shipping activity within the Canadian Arctic, such as tourism demand, community re-supply needs, and resource explorations (Pizzolato et al., 2013). The Canadian federal government has committed in principle to balancing Arctic development with concerns about national sovereignty and security, environmental protection and Inuit rights in the coming years (Pew Charitable Trust, 2016).

2.1.2 Risks related to shipping

Marine shipping is a risky activity. There are two types of key risks to consider in Arctic marine shipping. First, shipping activities have negative ecological impacts on the atmosphere and marine environment, as well as social disturbances to coastal communities (Angell & Parkins, 2011; Buell, 2006; Kelley & Ljubicic, 2012). Second, the harsh navigation environment of the Arctic also threatens marine shipping safety (Boileau et al. 2010; Ghosh & Rubly, 2015; Stewart et al., 2010a).

- Socio-ecological risks of marine shipping in the Arctic

Increasing shipping activities will bring harmful substances to the Arctic Ocean, which have negative impacts on the marine ecosystem (Douvere, 2008). The sources of negative impacts can be classified into two types: operational emissions and accidents.

As a part of normal operations, ships produce a range of substances that must eventually be eliminated from the ship (Douvere, 2008). Regular discharges present different risks for the marine ecosystem. These discharges include oil, ballast water, tank washings (oily water), oily sludge, sewage (black water), solid waste and Non-Indigenous Species (NIS) from ballast water (Arctis Knowledge Hub, 2010; Chan, Bailey & MacIsaac et al., 2013). Exhaust gases affect chemical atmospheric composition and regional air quality of the Arctic, while increasing CO₂ emissions aggravate climate change impacts regionally (Arctic Council, 2009; Eyring et al., 2010; Moore et al., 2012). Noise from shipping activities has affected underwater movements and the acoustic environment of large marine mammals like whales and dolphins, which depend on sound for critical life functions (Blair, Merchant & Parks et al., 2016). The growing vessel activities in the Arctic could increase the rate of collisions between ships and whales (Kaltenstein, 2012).

There are seven major types of ship-source accidents: loading/unloading incidents, fire/explosion, grounding, collision, severe weather conditions, structural damage, and unknown accidents (Chemical Pollution, 2016). Accident outcomes, such as toxic spills or oil spills, can damage the ships involved in the accidents and cause massive impacts to the marine ecosystem (Duarte, Drogue & Teixeira et al., 2013). The presence of sea ice affects oil weathering processes and the overall behavior of oil in Arctic waters, making clean-up work less effective (Board, M., Board, O.S. & National Research Council, 2014).

From the perspective of social impacts, prior studies have shown that, increasing Arctic shipping activities can cause a range of negative impacts on Indigenous Peoples and their communities (Angell & Parkins, 2011; Buell, 2006; Ritsema et al., 2015). Ships making passage through sea ice can accelerate ice break-up and cause delay in ice formation (Flynn, 2013), affecting the integrity of the sea ice platform on which numerous animal species and indigenous communities rely (Kelley & Ljubicic, 2012). Sea ice and on-ice travel routes provide Indigenous communities with important access to hunting places, fishing areas and other communities, which are vital to traditional culture (Aporta, 2011; Flynn, 2013; Hodgson, Calvesbert & Winterbottom, 2008; ICC, 2008). Increasing shipping activities present risks of disrupting traditional land-based economies and the subsequent loss of cultural traditions (Angell & Parkins, 2011).

- Risks that the environment poses to ships

The Arctic environment presents unique risks to the shipping industry. Harsh weather conditions, poor navigation charts and free-floating sea ice make marine navigation more difficult (Buixadé Farré, 2014; Ghosh & Rubly, 2015; Prowse et al., 2009). Furthermore, the remoteness of the Arctic and minimal supporting infrastructure for ships make emergency response, such as search and rescue services, consume more time with higher costs (Kelley & Ljubicic, 2012). These could result in adverse consequences, such as loss of valuable ships and cargo, as well as human lives (Flynn, 2013). Currently, there are relatively limited shipping activities occurring in the Arctic (Peters et al., 2011); as a consequence, negative impacts from ships and shipping accidents in the Arctic are rare compared to other parts of the world. However, it is important to analyze and mitigate the shipping risks beforehand through improved marine shipping management or, in other words, better maritime governance (Kum & Sahin, 2015).

2.1.3 Marine shipping management and maritime governance in the Arctic

The governance of shipping activities in the Arctic has been described as a “complicated mosaic” (VanderZwaag et al., 2008). The 1982 United Nations Convention on the Law of the Sea (UNCLOS) not only sets out the overall legal framework for ocean governance, but also describes a complex web of multiple jurisdictions for marine shipping activities. The term “marine shipping management” or “maritime governance” refers to complex connections among a range of actors, policies and practices that affect shipping activities (VanderZwaag et al., 2008). Actors and policies are involved with multiple levels of governance bodies, at international, national, regional and local levels. Governments and government officials are not the only actors with a role in shipping development and management; shipowners, cargo owners and insurers are also important actors in the scope of marine governance (Rothwell & VanderZwaag, 2006).

At the international level, as a specialized agency in the United Nations’ system, the International Maritime Organization (IMO) is responsible for governing the safety and security of global shipping activities as well as preventing marine pollution from ships. For the Arctic, IMO has developed the International Code for Ships Operating in Polar Waters (Polar Code), which entered into force on January 1st, 2017. The Polar Code aims to ensure safe shipping in polar waters by addressing design, construction, equipment, operations, training, search and rescue, and environmental protection issues (IMO, 2016a). Also, a broad range of international industry, labour and environmental Non-Governmental Organizations (NGOs) have played a critical role in shipping law-making and standard-setting processes (VanderZwaag et al., 2008).

As one of the five countries bordering the Arctic, Canada has implemented numerous federal acts to govern marine shipping activities in the Canadian Arctic. These include the Navigation

Protection Act (GOC, 1985), the Coasting Trade Act (GOC, 1992), the Marine Transportation Security Act (GOC, 1994), the Oceans Act (GOC, 1996), the Canada Shipping Act (TC, 2001a), the Marine Liability Act (TC, 2001b), and the Arctic Waters Pollution Prevention Regulations (TC, 2010). Several federal departments are responsible for enforcing these Acts, where the main responsible departments are Transport Canada (TC) and Fisheries and Oceans Canada (DFO).

Although there are not many territorial and local regulations for marine shipping management in the Arctic, the territorial governments and Indigenous communities still have some plans and recommendations for shipping activities. For example, subjected to the Nunavut Land Claims Agreement (NLCA, 2013), as one of the four co-management boards in Nunavut, the Nunavut Planning Commission (NPC) mentioned shipping risks and precautionary measures in their draft Nunavut Land Use Plan (see NPC, 2016). During the development process of this draft plan, indigenous people were consulted by NPC, and shared their traditional knowledge about marine shipping issues (NPC, 2014).

To summarize, governed by international regulations, federal laws and territorial agreements, the regulatory regime for Arctic shipping is extremely complex (Porta, Abou-Abssi & Mussells et al., 2017; VanderZwaag et al., 2008). Moreover, there are some limitations in this multi-level governance system. For example, the Polar Code didn't ban the use and carriage of Heavy Fuel Oil (HFO), which presents future risks to the marine ecosystem (Tedsen, Cavalieri & Kraemer, 2016). Besides, there are no indications that navigation standards and restrictions, such as sensitive areas and speed restrictions, could be adapted to all cases, especially to the special marine navigation environment in the Arctic (Tedson et al., 2016). An alternative option for marine shipping governance would be developing a comprehensive "Arctic Sea Lanes" as a

maritime shipping routing system, under the IMO's guidelines: *General Provisions on Ship's Routing* (IMO, 2015).

2.1.4 Marine shipping policy framework in Canada: Northern Marine Transportation Corridors (NMTC)

A promising initiative for maritime governance in the Canadian Arctic is the establishment of Low Impact Shipping Corridors or Northern Marine Transportation Corridors (NMTC) (here after referred to NMTC or "Corridors"), a collaborative initiative of Canadian Coast Guard (CCG) with Canadian Hydrographic Service (CHS) and Transport Canada (TC) (CCG, 2015). Corridors are shipping routes and/or areas within which key navigational information and response services, such as hydrography, icebreaking and aids to navigation would be more predictable (CCG, 2014). These corridors can minimize risks to vessels and the marine environment (Pizzolato et al., 2014; Porta et al., 2017). Figure 2 illustrates the preliminary developed Corridors. There are five types of corridors in the initiative: Primary corridors, Secondary corridors, Tertiary corridors, Private Interest and Proposed corridors.

The concept of the Corridors is to provide a pragmatic policy framework for future investments in the Canadian Arctic (CCG, 2014). Through the Corridors, not only can the Government of Canada regulate, prioritize and deploy its services for safe marine navigation, but also mariners, communities and other stakeholders can get benefits from enhanced marine navigation and economic development (CCG, 2015).

However, there are some limitations within the current Corridors. First, while it is impossible to exclude all sensitive areas from the Corridors, the current Corridors do not fully consider ecologically significant areas, sensitive areas of cultural significance or traditional marine areas used by northern communities (Porta et al., 2017). This limitation was identified as a knowledge

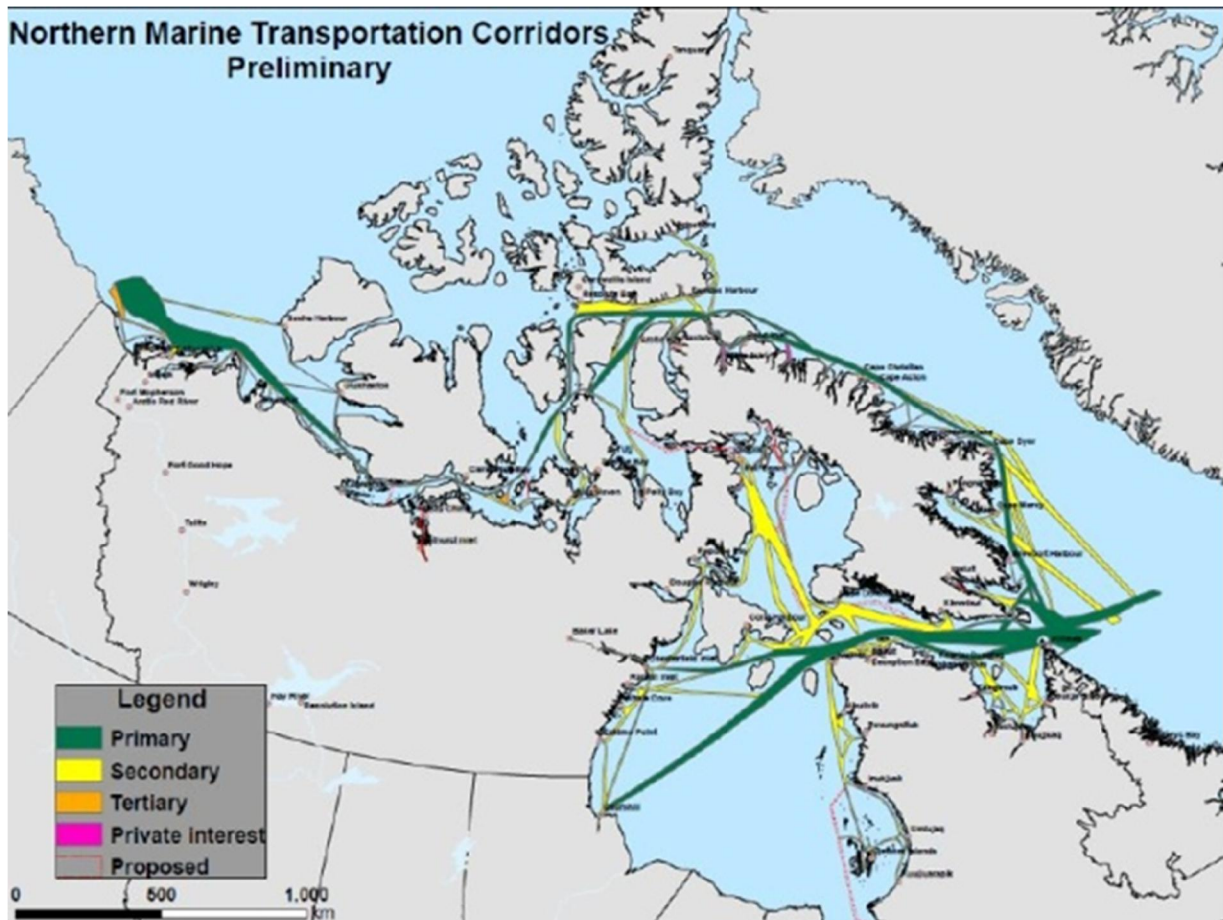


Figure 2. Current Northern Marine Transportation Corridors (Source: CCG, 2015)

gap in the Arctic Marine Shipping Assessment done by Arctic Council (AC, 2009). As discussed at an NMTC workshop held in 2015, additional information needs to be collected in order to re-prioritize the Corridors based on local community needs, environmental concerns, and other impacts (Dawson et al., 2016). Analysis published by the Pew Charitable Trust (2016) demonstrated that the potential development of the Corridors could involve integrating Traditional Ecological Knowledge (TEK) into the design and decision-making process (see Pew Charitable Trust, 2016). Thus, there is an urgent need to consider how the Corridors can integrate other types of information, data and knowledge, which are missing from previous studies. Second, although commercial shipping vessels are the major participants in the Corridors, fishing

vessels, cruise ships, Coast Guard ice breakers and research ships are the other fast-growing vessel categories in the Arctic (Pizzolato et al., 2013). Consequently, in addition to the current policy framework, it is important to create a supplementary framework to manage and support tourism vessels and fisheries through the NMTC initiative.

Establishing governance and management structures or approaches for the NMTC has been defined as an important step for the future development of this system (Dawson et al., 2016). An integrated decision-making framework aims to involve more stakeholders in the decision-making process, which can become a cost-effective and supportive institutional arrangement for the Corridors' future development (Porta et al., 2017). It is important to create a supplementary framework to support the Corridors to manage tourism and fisheries vessels. The NMTC presents a foundation for responsible and effective marine shipping governance in the Canadian Arctic and, with the supportive integrated decision-making framework, this policy will guide the future of maritime transportation in the region for the next century and beyond (Porta et al., 2017).

2.2 Institutional arrangements

Arctic issues have been emphasized and managed through different frameworks. There are three major forms of institutional arrangement mentioned both in the peer-reviewed literature and public government documents regarding Arctic management issues: (1) Co-management, (2) Co-governance and (3) Shared Leadership. For example, under the Nunavut Land Claims Agreement (NLCA, 1993), four co-management boards were established in Nunavut. These co-management boards address different issues related to wildlife, land use, water and environmental impacts. Similarly, in Quebec, the James Bay Cree "hunting leaders" have enjoyed the advantages brought by co-governance (Feit, 2005). As for shared leadership, the newly proposed "A New Shared

Arctic Leadership Model” is developed with support from the Indigenous and Northern Affairs Canada (INAC) (Simon, 2017). These three approaches share similar features but also have differences. Through a detailed literature review of each type of institutional arrangement and its best practices found in the literature, basic principles and successful criteria of each institutional form are introduced and prepared for further analysis.

2.2.1 Co-management

• Introduction

Resource management is too complex to be conducted effectively by a single agency (Berkes, 2009). Managing different kinds of resources, especially for common-pool resources (eg. fisheries, watersheds, wildlife and other resources), requires joint action of multiple parties (Berkes, 2009). In consideration of the limitations in unilateral management done by government, co-management systems evolved through experience of delegating power and authority from the powerful people (Pomeroy & Berkes, 1997). The concept of co-management can be interpreted as a joint partnership, in which stakeholders share the authority and responsibility of a specific management issue (Armitage, Berkes & Doubleday, 2007). In practical applications, co-management can be summarized as a power-sharing, institution-building and problem-solving process, or a governance based on trust (Berkes, 2009). One of the key contents of co-management is citizen or public participation in the decision-making process. There’s an increasing likelihood of successful management if public or stakeholders engage in more and more processes and activities under co-management (Armitage et al., 2007).

Depending on different initiators, co-management can be implemented through different approaches (Chuenpagdee & Jentoft, 2007): a top-down approach led by a powerful authority, or a bottom-up approach led by the “have-nots” (Arnstein, 1969). However, there are some

limitations that arise in both approaches. For example, in a top-down co-management, although the government and industry have the obligation to consult indigenous people (Promislow, 2013), indigenous people can only provide references and suggestions to the powerful people instead of having true impacts on the final decisions (Berkes, 2009). Meanwhile, most communities don't have enough resources, including legal support, financial support, natural resources and human resources, to conduct bottom-up co-management (Sen & Nielsen, 1996). In spite of these objective limitations, an ideal co-management approach should help user groups get involved in all stages of the co-management process, both the process and outcomes should demonstrate the characteristics of sustainability, transparency, equity, efficiency and effectiveness (Bradshaw, 2003; Kaplan & McCay, 2004; Sen & Nielsen, 1996).

- Examples and Best Practices

There is a growing literature on co-management processes and practices around the world, with a wide diversity of models and approaches, based on increasing recognition from political and legal bodies (Beem, 2007; Bown, Gray & Stead, 2013; Craig, 2002; Ferdous, 2015; Goetze, 2004; Nadasdy, 2003; Nielsen et al, 2004; Smith, 2011). Co-management had been used for issues of fisheries management (Beem, 2007; Nielsen et al, 2004), natural resources management (Eamer, 2004; Ferdous, 2015; Haider & Kabir, 2014) and Marine Protected Areas (Bown, Gray & Stead, 2013; Dodson, 2014; Smith, 2011) worldwide. In Canada, co-management has been applied to fisheries management (Berkes & Armitage, 2010; Pinkerton, 1989) and wildlife management (Dale, 2009; Dale & Armitage, 2011; Nadasdy, 2003; Osherenko, 1988). Also, co-management was used in an integrated management plan of the Beaufort Sea Large Ocean Management Area (LOMA) to encourage the participation of indigenous communities and other stakeholders (Berkes, F., Berkes, M., & Fast, 2007). Co-management usually exists as a formal

arrangement between local, regional (state, provincial or territorial), and federal departments, federal resource management systems, and other stakeholders such as indigenous people and industry representatives. For example, co-management in Canada has been considered in the context of regional governance agreements of comprehensive land-claim settlements such as James Bay and Northern Quebec Agreement, 1975, Inuvialuit Final Agreement (IFA), 1984, and Nunavut Land Claims Agreement, 1993 (Craig, 2002).

The co-management experience in Nunavut, Canada was selected as a best practice example for this form of institutional arrangement in this paper, because it aims to deal with multiple issues (eg. wildlife, water, land use) with the Inuit (see Craig, 2002; Dacks, 1994; Rodon, 1998). For decades, the Inuit of Nunavut had been negotiating a land-claim settlement with the federal Government of Canada. In 1993, they finally signed a Nunavut Land Claims Agreement (NLCA, 1993), which then implemented a co-management regime in the Nunavut territory (Rodon, 1998). This section reviews the literature of the co-management regime in Nunavut, including the legal basis, applications, outcomes, strengths and weaknesses.

The Nunavut Land Claims Agreement (1993) confirmed the Nunavut Settlement Area (NSA), and recognized and affirmed existing aboriginal and treaty rights (NLCA, 1993). Under the NLCA (1993), four co-management boards (Nunavut Wildlife Management Board (NWMB), Nunavut Planning Commission (NPC), Nunavut Impact Review Board (NIRB) and Nunavut Water Board (NWB)) were set up to protect the Inuit legal rights of traditional and current use of natural resources (see Section 5.2.1; Section 11.4.1; Section 12.2.1 and Section 13.2.1 in NLCA, 1993). These new institutions aim to manage the land, water, offshore and wildlife of the Nunavut Settlement Area (NSA) and realize an equal membership between the different levels of the Canadian government and the public (Craig, 2002).

This part will review the co-management of wildlife done by the Nunavut Wildlife Management Board (NWMB), since the management of wildlife resources has been one of the key elements in Nunavut land-claim negotiations (Rodon, 1998). Following the signing of the NCLA (1993), which provides a strong legal basis for wildlife co-management, NWMB was created as a public agency, which not only has powers of recommendations, but also of regulations (Dacks, 1994).

The co-management process with respect to wildlife can be described as a system of partnerships, in which the partners work cooperatively to assist the NWMB to make particular decisions, to conduct and commission research, and to provide approvals, advice, recommendations and information (NWMB, 2016). NWMB has a hierarchical structure with the responsible Minister at the top, followed by the NWMB decision board, representatives from related federal and regional government departments, three Regional Wildlife Organizations (RWOs), the Hunters and Trappers Organizations (HTOs), NGOs and general public at the bottom (Dacks, 1994; NWMB, 2016) (see Figure 3). The Board has the responsibility to make decisions on the different allocation to HTOs of Total Allowable Catch/Total Allowable Harvest (TAC/TAH) (see Section 5.6.16 and Section 5.7.3 in NLCA, 1993). This is a top-down co-management approach, where policy decisions are made at the top by federal government and allocation decisions are left to the lower levels of the management board and HTOs (Rodon, 1998). It is important to emphasize that co-management decision-making takes place solely within the NWMB, which means that the government is able to keep a certain level of control over the wildlife management in Nunavut (Rodon, 1998). The keys to success in such a process are communication and cooperation between partners.

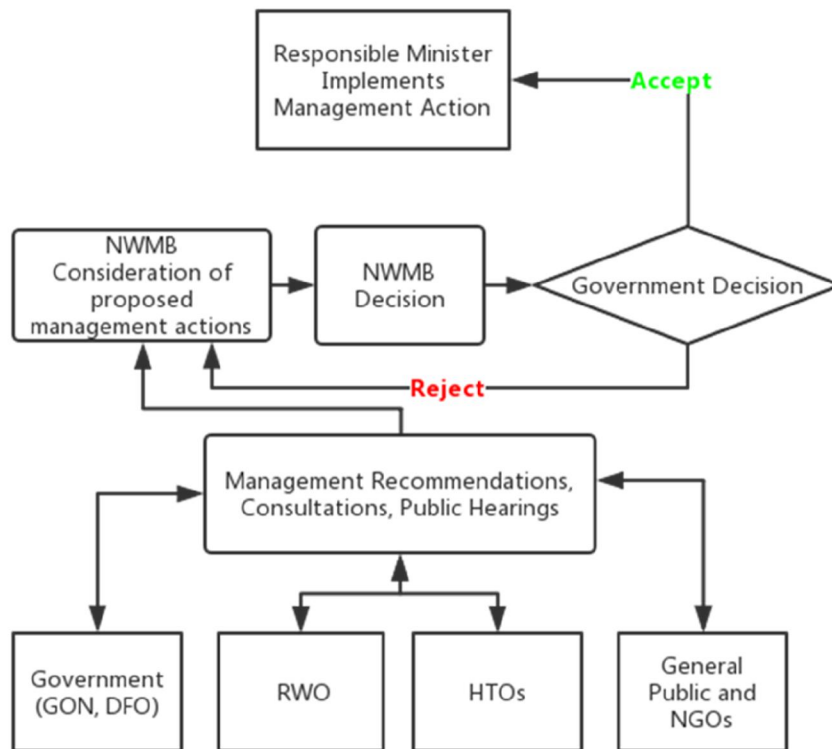


Figure 3 Simplified Co-management Decision Process (Source: NLCA, 1993; NWMB, 2016)

Compared to its predecessor, the Nunavut Wildlife Advisory Board (NWAB), adequate financial support has contributed to the success of NWMB (Rodon, 1998). According to this arrangement, the federal government had to fund a wildlife harvest study and a bowhead traditional knowledge study in Nunavut (see Section 5.4.4 and Section 5.5.2 in NLCA, 1993). Furthermore, the NWMB has also provided regional boards and HTOs with funding for necessary research (Rodon, 1998).

- Co-management for marine shipping

The other three Nunavut co-management boards have decision-making processes similar to the NWMB, but none of them are focusing on the management of shipping activities, which is becoming a major type of activity in Nunavut. Only the NPC has mentioned marine shipping in

its 2016 Draft Nunavut Land Use Plan (NPC, 2016). Empowered by the Nunavut Planning and Project Assessment Act (NuPPAA), NPC must contribute to the development and review of marine policy in the Arctic, of which shipping policy is an important component (GOC, 2015).

NPC has observed the increasing marine shipping activities in Nunavut and become concerned about the potential effects on wildlife and communities. As a consequence, NPC mentioned using Marine Spatial Planning (MSP) in developing marine corridors, such as setting up Marine Protected Areas (MPAs), Particularly Sensitive Sea Areas (PSSAs) or Areas To Be Avoided (ATBA) (NPC, 2016). Also, NPC touches on the Northern Marine Transportation Corridors (NMTC) initiative, pointing out its contribution to identifying locations of highest risk for marine safety (NPC, 2016). For better preparation, NPC had collected information about shipping activities from indigenous people by using maps during their community visits (NPC, 2014).

In conclusion, as a widely accepted and practical management approach, co-management has been applied to multiple management issues and areas in the world. Although co-management has been implemented in Canada for decades, most examples are related to natural resources management. Shipping co-management conducted by NPC still remains at the stage of information collection.

2.2.2 Co-governance

• Introduction

Co-governance is the second form of institutional arrangement described in this paper. Kooiman (2005) distinguished three modes of governance: hierarchical governance, self-governance and co-governance. To address a rapidly changing environment, there is an increasing need for decision-makers to create a collaborative governance structure that integrates ecological, physical and social sciences (Jacobson & Robertson, 2012). Co-governance is mainly about a

collaborative governance arrangement between state agencies and communities (Agrawal & Lemos, 2007). Co-governance signals an institutional arrangement where multiple stakeholders are involved in the formulation of policy, planning and delivery of services (Fenwick, Miller & McTavish, 2012). The co-governance bodies, as a result of negotiated decision-making arrangements, have different forms including statutory bodies, voluntary boards and other relationships (OAG, 2016).

It is important but not easy to distinguish the difference between co-management and co-governance since they share similar principles of multiple stakeholders' participation, and collaboration between state, civil society and markets (Frangoudes, Marugán-Pintos & Pascual-Fernández, 2008). Although there are no clear definitions of co-governance and co-management, in general, governance focuses on strategic matters, while management is concerned about operational responsibilities of stakeholders (OAG, 2016). To be specific, co-management is a collaborative process of decision-making and problem solving within a management board, while co-governance is a series of arrangements in which power and responsibility are shared between government and local stakeholders (Dodson, 2014), which can involve policy-setting and broader strategic planning.

Co-governance has been widely used in multiple issues and areas in the world (see Ackerman, 2004; Dodson, 2014; Feit, 2005; Frangoudes, Marugán-Pintos & Pascual-Fernández, 2008; Head & Ryan, 2004; OAG, 2016; Rogers & Hall, 2003). Initially, co-governance was used in political arenas to improve accountability and governance effectiveness (Ackerman, 2004). Later on, co-governance has been used in natural resources management and no-take marine reserve management in New Zealand and Australia (see Dodson, 2014; Head & Ryan, 2004; OAG, 2016). In Spain, co-governance is used for small shell-fish management (see Frangoudes et al.,

2008). In Canada, co-governance has been applied to the management of environment, water resource and wildlife (see Feit, 2005; van Tol Smit, de Loë & Plummer, 2015).

There are some attributes to a successful co-governance arrangement. Kernaghan (1993) has argued that collaborative partnerships are most likely to succeed when all significant stakeholders are included. A report done by the U.S.A. Office of Controller and Auditor-General (OAG, 2016) identified some principles for successful co-governance, including effective relationships, building structures and processes, transparent performance, clear purpose, roles and responsibilities, as well as financial sustainability. Conversely, the failed cases of co-governance showed the necessity of an appropriate legislative framework which can support partnership development during the decision-making process (Dodson, 2014).

- Best practice

People in Australia and New Zealand have taken actions, independently or in partnership with local and central government agencies, to conserve the environment for future generations and protect their economic, social and cultural well-being (OAG, 2016). The best co-governance practice identified in this paper is the Natural Resource Management (NRM) programme in Australia. This programme attempts to establish non-adversarial arrangements to address long-term environmental and natural resource management problems (Head & Ryan, 2004). The broad trend in NRM programmes is that governments have increasingly moved away from top-down regulations, towards adopting more collaborative and inclusive approaches to address the Economic Sustainable Development (ESD) challenges (Head & Ryan, 2004).

The major discussion paper on sustainable NRM released in 1999, advocated the “devolution of greater authority to and empowerment of regional communities” (AFFA, 1999). This paper

promoted the formation of regional government bodies with multiple stakeholders' participation (Head & Ryan, 2004). The stakeholders in NRM are diverse, including three levels of government, multiple industry sectoral leaders at national and regional levels, scientific and research experts, conservation and community organisations, indigenous interests, and the national and local media (Head & Ryan, 2003).

The NRM arrangements present a form of co-governance, which changed the role of government to framework-setter, co-funder and facilitator. This joint approach is crucially dependent on adequate government funding, relevant scientific research, the skills of participants, and NGOs' commitment to the processes (Head & Ryan, 2004).

Currently, marine shipping management lacks literature on co-governance. However, the growing literature in co-management has brought hope to the future development of co-governance. For example, Feit (2005) recognized that the successful experience of the wildlife co-management project in James Bay laid the ground work for a co-governance arrangement by increasing stakeholders' involvement in broad management issues. Also, Head and Ryan (2003) suggested that participatory co-governance would remain as a trend for solving Arctic related issues in the foreseeable future.

2.2.3 Shared Leadership

• Introduction

Traditionally, leadership research focused on individual leaders, whose work involves making strategic decisions, and then influencing and aligning the rest of the individuals in the organization to implement these decisions effectively (Northouse, 2015). However, a shift has occurred in the understanding of leadership: moving from a top-down leadership to a living, dynamic system of interconnected relationships among members. Shared leadership, as a new

model of leadership, recognizes that effectiveness of leadership does not depend on individual leaders but rather on interdependencies at different levels within the organization (Fletcher & Kaufer, 2003). Shared leadership offers a concept of leadership practice based on a group-level phenomenon, and it is a new approach intended to transform traditional organizational practices, structures and working relationships (Fletcher & Kaufer, 2003; Pearce & Sims, 2000).

Compared to the traditional leadership model, three new characteristics of a shared leadership mode have been identified (Fletcher, 2002). First, in a shared leadership mode, responsibilities are distributed to participants at all levels. Another key aspect is that instead of describing an individual leader as the social integrator, shared leadership bases social interaction on a group phenomenon and addresses the overall management environment and situation (Alvesson, 1992). Third, individuals involved in shared leadership will have mutual learning, greater shared understanding and actions that can contribute to positive outcomes (Fletcher, 2002).

Shared leadership is used in business management areas such as product development and team building (Cox, Pearce & Perry, 2003). There is a lack of literature about natural resource management or environmental management through shared leadership. Shared leadership was identified as a third form of institutional arrangement in this paper because in 2016, Indigenous and Northern Affairs Canada (INAC) supported the establishment of a “New Shared Arctic Leadership Model” project, a new initiative which explores using this institutional form (see Simon, 2017). This project is summarized as a best practice below.

- Best Practice

As the Government of Canada plans for the future of the Arctic region, it is important to ensure that many interests and users of the Arctic are considered, particularly for those that make the

Arctic their permanent home. In 2016, INAC appointed a Minister's Special Representative (MSR) responsible for leading a public engagement process for a New Shared Arctic Leadership Model (see Simon, 2017).

The purpose of this Shared Arctic Leadership Model is to enhance, not replace, legally-binding agreements or active consultations and negotiations between the federal government, Northern governments and Indigenous peoples (Simon, 2017). Once this is understood, conversations may turn to expectations of partnership with the Government of Canada. To achieve this purpose, territorial governments, Indigenous governments, NGOs, youth and women, industry associations, as well as researchers have engaged in this shared leadership model to seek ideas and advice (Simon, 2017). Also, in a shared leadership model, some principles of partnership were identified to conduct effective meetings and consultations with many leaders and representatives. These principles include understanding and honouring the intent of *Section 35 of the Constitution Act of 1982*, namely principles of equality, trust and mutual respect, flexible and adaptive policy and respecting indigenous knowledge (Simon, 2017).

There are two phases in this New Shared Arctic Leadership Model project. Part 1 was completed in 2016. Participants from different government levels, local communities, industries, and NGOs engaged in this initial phase (Simon, 2016). Major recommendations were made in the areas of education and language, research and indigenous knowledge, infrastructure development, energy, and conservation (Simon, 2017). Part 2 was completed in February 2017, with a theme of developing a new Arctic Policy Framework which aims to define the political and social geography of 'the Arctic' (Simon, 2017). The initial outcomes and advice of this Shared Arctic Leadership Model reflect the full range of discussion and meetings held between multiple participants. Major outcomes include principles of partnership for policy processes, action

commitment, funding and reviews for resources allocation (Simon, 2017). Such advice will support INAC's work towards a new Arctic Policy Framework with northern governments and Indigenous leaders. However, this New Shared Arctic Leadership Model project has some limitations such as reality that the objectives and suggestions are too vague. But this project is a new attempt to apply the shared leadership mode for addressing Arctic related issues. 2.3 Multiple Criteria Decision Analysis (MCDA)

Multiple Criteria Decision Analysis (MCDA) is the major framework used in this study to analyze different forms of institutional framework for Arctic marine shipping governance. This chapter introduces the definition and benefits of MCDA and MCDA's application in NMTC.

2.3.1 Definition

Multiple Criteria Decision Analysis (MCDA) refers to a suite of techniques in which multiple values reflecting different objectives are quantified and used to help decision makers evaluate alternative options and make decisions (Gregory, 2000). Belton and Stewart (2002) define MCDA as, "a way by which individuals or groups can use multiple criteria to make decisions from a collection of formal approaches". These general definitions illustrate three dimensions of MCDA, namely: (1) a formal approach, (2) the presence of multiple criteria, and (3) that decisions are made either by individuals or groups of individuals. Similarly, Malczewski and Rinner (2015) described that the three main elements of multicriteria decision problems were: decision makers (decision making agents), decision alternatives, and evaluation criteria. Based on those definitions and key elements, MCDA is usually used in helping decision makers to solve complex problems, which have a set of decision alternatives that are evaluated on the basis of conflicting and incommensurate criteria (Malczewski & Rinner, 2015).

MCDA is an umbrella approach that has been applied to a wide range of natural resource management situations (Mendoza & Martins, 2006). Forest management is one of the most popular applied areas of MCDA in natural resources management (see Kangas et al., 2010; Khadka & Vacik, 2012; Prabhu, Colfer & Dudley, 1999; Sheppard & Meitner, 2005), while others include: biodiversity conservation, wildlife management, and the selection of sites for networks of nature reserves (Mendoza & Martins, 2006). Applied with Geographic Information Systems (GIS), MCDA has been used for spatial planning and on-land corridor design (see Aissi, Chakhar & Mousseau, 2001; Malczewski & Rinner, 2015).

2.3.2 Necessity and Benefit of MCDA for Arctic shipping

Managing marine shipping in the Arctic is a complex issue. The changing environment in the Arctic presents risks to marine shipping activities, while the impacts engendered by shipping produce a variety of risks to the marine ecosystems and multiple stakeholders in the Arctic.

MCDA is appropriate for Arctic maritime governance, considering that managing this issue is a multi-disciplinary process involving a broad range of stakeholders (e.g. governments and local authorities, tourism enterprises, investors, insurance companies and scientists) with varying expertise and interests (Michailidou, Vlachokostas & Moussiopoulos, 2016). Studies have shown that MCDA can assist decision makers in efficiently evaluating management problems and generating ideas for the long-term strategic planning process of management, even under complex socio-economic and ecological conditions (Khadka & Vacik, 2012).

Maritime decision-making in the Arctic is typically a complex task, characterized by trade-offs¹ among stakeholders on socio-cultural, political, economic and environmental issues (Sheppard &

¹ A trade-off is choosing one option in favor of another, so that beneficial decisions can be made with less time and energy consumption.

Meitner, 2005). MCDA techniques can be used to help stakeholders establish consensus and help them to find mutually agreed compromises and management options (Khadka & Vacik, 2012). This can improve rationality and transparency of the decision-making processes in general, which are recognized as highly important features of policy-making process for some stakeholders (Kangas et al., 2010).

2.3.3 Applying MCDA in NMTC

Generally, the process of MCDA includes four steps: (1) structuring the problem and selecting criteria; (2) figuring out different weights for different criteria; (3) applying a weighting system to different alternative solutions; and (4) calculating and selecting the best offered solutions (Kitsiou, Coccossis & Karydis, 2002). There are two important ways to integrate MCDA into NMTC planning: selecting appropriate positions of the Corridors, and, selecting appropriate form of institutional arrangements for NMTC policy-making process. However, there is a lack of literature on both ways of using MCDA for marine shipping management in the Arctic.

Selecting Corridor positions usually implies several conflicting evaluation criteria and requires the participation of multiple stakeholders with different interests, so it is difficult to find a single solution that is best for all (Zhang & Armstrong, 2008). Therefore, selecting best positions with minimum negative impacts on stakeholders is the most evident application of MCDA. Although there's not much literature about designing marine shipping corridors using MCDA, examples of using MCDA for designing on-land corridors can illustrate this kind of application of MCDA. Aissi et al., (2012) evaluated land transportation corridors based on GIS using multiple criteria. The corridors are evaluated on two criteria: (1) a quantitative criterion measuring the length of the corridor, and (2) a qualitative criterion measuring the quality of the corridor with respect to the suitability for wildlife to cross its component polygons (Aissi et al., 2012).

Although MCDA has not been used for evaluating forms of institutional arrangement, there have been some examples contain similar ideas. Binder, Hinkel and Pahl-Wostl et al. (2013) compared 10 established frameworks for analyzing social-ecological systems using three major criteria. This is an example of using multiple criteria to evaluate different policies, to analyze different frameworks or to provide suggestions on choosing appropriate frameworks for different management issues.

By using NMTC as a case study, this paper aims to use MCDA for evaluating different forms of institutional arrangements or governance frameworks for maritime governance in the Arctic. The next chapter introduces the specific rules and procedures derived to collect, analyze and interpret data.

Chapter 3 METHODOLOGY

In order to evaluate different forms of institutional arrangements for implementing maritime governance through the NMTC, a series of reviews and analyses were performed. Firstly, a literature review was conducted to help shape the scope and objectives of this study. Secondly, three key elements in Multiple Criteria Decision Analysis (MCDA), namely decision makers, alternatives and criteria are drawn from the literature review and analyses of these three elements are also considered as major results of this study. Finally, in order to illustrate the results, an MCDA decision matrix was used as a comparative tool for decision makers to evaluate the three institutional alternatives. Overall, the purpose of this methodology is to identify whether MCDA is an appropriate comparative tool for evaluating different institutional forms for managing shipping activities in the NMTC and, if so, what needs to be done to implement it.

3.1 Literature review step

The preceding literature review provides a general review of the management issue and defines the scope and objectives of this study. The management issue of this paper is to identify a useful form of institutional arrangement for governing marine shipping activities within the NMTC using MCDA.

Marine shipping activities in this paper refer to the shipping activities that happen in the NMTC. Under this definition, commercial shipping vessels are the major objects in this study, while fishing vessels, cruise ships and research ships (including Coast Guard icebreakers) are secondary for the analysis.

The literature review provides a detailed review on the current and projected states of shipping activities in the Arctic, the risks related to the current and increasing shipping activities, the three candidate forms of institutional arrangements, and the comparative tool for this study: Multiple Criteria Decision Analysis. The review of the three institutional forms includes a description of different legal bases for indigenous people to get involved in the marine shipping decision-making process. This literature review attempts to identify the complexity of maritime governance, gaps in the selected forms of institutional arrangement, and *why* MCDA is appropriate for selecting the most appropriate forms of decision-making process for governing marine shipping activities within NMTC.

3.2 Key Elements of MCDA for Marine Shipping Management

As presented before, when using the MCDA to analyze marine shipping management, it is important to understand the three main elements in MCDA, namely decision makers, alternatives, and criteria, which are interconnected.

Before identifying decision makers in marine shipping management, the fundamental question is understanding *what* can be managed in shipping industry. A list of manageable factors in the shipping industry can be drawn from the preceding literature review of shipping risks and regulations. Managing one factor could result in multiple outcomes related to marine shipping activities. For example, reducing the speed of ships could delay the schedule of ships, while lowering the rate of ship-whale collisions. Those outcomes can affect multiple receptor groups of the marine shipping sector, such as the commercial shipping industry, marine life and community re-supply. Agents belonging to each receptor group can be seen as major stakeholders and potential decision makers in Arctic marine shipping management regime.

In regards to governing marine shipping activities within NMTC, decision maker refers to the question of *who* can manage shipping activities while their multiple interests reveal *what* can be managed in marine shipping management. Although decision makers are the key components in an MCDA, there's no clear definition for decision makers in the maritime governance regime. While maritime governance is involved with multiple stakeholders, it is appropriate to identify certain stakeholders as potential decision makers in an MCDA process for Arctic marine shipping. In order to identify different stakeholders in maritime governance and analyze their interests or demands in marine shipping activities, a simple stakeholder analysis was conducted as the second result of this study. All the stakeholders were assigned to four stakeholder groups including four governance levels: international, national, territorial and local (Beveridge, Fournier, & Pelot, 2015). Multiple stakeholders were identified from the literature review of Arctic marine shipping and their variety of interests were derived from their opinions, strategies or management regarding to shipping activities in the Arctic.

The alternative forms of institutional arrangements illustrate *how* stakeholders could manage things in marine shipping management. Three selected forms of institutional arrangements are the alternatives in this MCDA. They will be analyzed through a series of attributes and their corresponding criteria, based on their definitions, strengths and weaknesses.

The attributes in marine shipping management refer to the positive factors which can contribute to good governance outcomes. The criteria can be used by stakeholders and help them judge *how well* each alternative institutional form satisfies the attributes. These attributes and their corresponding criteria are drawn from the review of the three selected alternative institutional forms, their practices and successful principles. These attributes and criteria are important preparations to form the MCDA decision matrix for Arctic marine shipping management.

3.3 MCDA Decision Matrix

A matrix analysis was used to assess the three institutional forms that are candidates for Arctic marine shipping management. Using the matrix, the selected institutional forms were individually analyzed against a set of attributes and criteria derived from the literature review.

The two elements of MCDA, namely, alternatives and criteria are organized in a tabular format (see Table 1), while stakeholders will grade each alternative according to multiple criteria. The table is referred to as an MCDA decision matrix. The columns of the matrix represent the three alternative institutional arrangements forms (A_i). Each criterion (C_k) is listed under its related attribute and accounts for a row in the decision matrix. A_iC_k indicates the performance of the alternative A_i , when it is evaluated in terms of criterion C_k ($i = 1, 2, \dots, n$, and $k = 1, 2, \dots, m$) as shown in the table.

Table 1. MCDA Decision matrix (Adapted from Malczewski & Rinner, 2015)

		Institutional arrangements	Co-management	Co-governance	Shared Leadership
		Alternatives	Alternative 1 (A1)	Alternative 2 (A2)	Alternative 3 (A3)
Attributes	Criterion				
	Attribute 1	Criterion 1 (C1)	A1C1	A2C1	A3C1
Attribute 2	Criterion 2 (C2)	A1C2	A2C2	A3C2	
...	
Attribute n	Criterion k (Ck)	A1Ck	A2Ck	A3Ck	

Traditionally, an MCDA should include processes of value scaling (or standardization), criterion weighting and combination decision (Malczewski & Rinner, 2015). However, as a preliminary study in this area, instead of making actual decisions for NMTC, this paper aims to demonstrate the feasibility of applying MCDA in evaluating and selecting the most appropriate forms of institutional arrangement. Therefore, in this study, each criterion was weighted equally and the average rank for each criterion was calculated. However, in actual practice, different weights can be assigned to different attributes according to the priorities of stakeholders beforehand and results can be calculated through an optimal weighting scheme for more accurate results.

Different colors were assigned to illustrate the different levels of fulfillment of each criterion. Green, refers to a high fulfillment of the criteria, with the descriptions of complete, strong, adequate, specific, narrow, equal, etc. Yellow, refers to a medium fulfillment of the criteria, with the descriptions of medium, general, constant, etc. Red, refers to a low fulfillment of the criteria, with the descriptions of incomplete, weak, inadequate, broad, unequal, etc. To select the best practice, the simplest way is to count the colors. The approach with the biggest number of “greens” is the most appropriate alternative for the management problem.

In this study, the resulting MCDA decision matrix for Arctic marine shipping management presents an example of evaluating institutional forms for the future stakeholder workshop of NMTC, which will be held in Iqaluit, in 2019. The evaluation results are generated from the literature review and stakeholder analysis. In an actual application with the participation of multiple stakeholders, all these results may be changed.

In conclusion, the purposes of this methodology are identifying key elements in MCDA and offering an example for applying MCDA in evaluating different forms of institutional arrangements for Arctic marine shipping management.

Chapter 4 ANALYSIS

Marine shipping management has been identified as a complicated issue due to its multi-jurisdictional nature across international, supra-national and national levels (Roe, 2009). This paper has introduced a current marine shipping policy initiative, the Northern Marine Transportation Corridors (NMTC), as an adaptable policy framework for advancing marine shipping law and policy in the Canadian Arctic (Porta et al., 2017). In order to implement an effective decision-making process, it is important to consider the demands and interests of stakeholders, some of whom will potentially become decision makers in the decision-making process of Arctic marine shipping governance (Roe, 2009).

This chapter aims to illustrate application of Multiple Criteria Decision Analysis (MCDA) to evaluate the possible institutional arrangements for marine shipping management in the Canadian Arctic. The primary results include the three key elements in MCDA, namely decision makers, alternatives, and criteria. Based on an analysis of manageable factors in the shipping industry and potential receptor groups, a short list of multi-level stakeholders was prepared to

show major interests of each stakeholder and things that can be managed under the marine shipping management regime. Next, co-management, co-governance and shared leadership are the three selected alternative forms of institutional arrangements, showing *how* stakeholders could manage marine shipping. Finally, the MCDA decision matrix for Arctic shipping management uses selected criteria to explain *how well* each approach fulfills the attributes identified through the analysis of each institutional form's best practices.

4.1 Shipping activities and its receptors

Based on the literature review of multiple marine shipping regulations and policy frameworks, most regulations and policies address issues related to maritime security, marine safety or the marine ecosystems. More specifically, maritime security is concerned with the prevention of intentional damage to people and goods, while marine safety emphasizes the prevention of accidental damage or incidents in regular maritime operation (Ameri & Shewchuk, 2007). The marine ecosystem aspect includes protecting marine and coastal environments from ship-based pollution, as well as mitigating negative interactions among ships, wildlife and coastal communities.

4.1.1 Maritime security

Maritime security is concerned with the prevention of intentional damage related to concerns such as sovereignty, crimes and terrorism, resource security and security of seafarers (AMSSA, 2017). Affected by the retreating of sea ice, a longer shipping season and a broader shipping area are expected, bringing changes to shipping times, schedules and ships' positions (shipping lines and corridors).

Shipping times and shipping schedules are crucial to marine shipping in the Arctic, as they can have multiple impacts on marine service suppliers, local resource users and maritime governors.

First, the extended shipping time can increase the opportunities for annual re-supply of commodities to northern communities and increase the chance of natural resource exploitation and transportation (Parsons, Dinwoodie & Roe, 2011). Also, a longer shipping season may bring more ships to the Arctic, which can result in a high-level concurrence between shipping times and breeding and feeding times for marine mammals or other biota (Dawson et al., 2016). Also, changing shipping times and schedules of commercial shipping can overlap with the popular sailing times of cruise ships and adventure tourism activities, resulting in potential multiple-use conflicts. In order to increase maritime security, multiple levels of government have changed their service time in order to adapt to longer shipping seasons and have changed their service area to cover newly developed shipping routes.

Ship positions or locations and shipping lines or corridors are also important. Ships are able to access more areas in the Arctic, bringing more chances for community development and re-supply. However, the expanding shipping areas overlap with some marine areas used by local communities for significant socio-cultural traditions (AC, 2009). Ice-breakers may break the ice that indigenous people rely on heavily for traditional uses such as hunting, traveling and living (ICC, 2008). Importantly, it was identified by DFO that the location of the NMTC overlapped with some Ecologically and Biologically Sensitive Areas (EBSAs) (Dawson et al., 2016), which present risks to marine wildlife in the Arctic. To deal with these socio-ecological risks, the Canadian government is promoting the design of shipping corridors with low impacts (TC, 2016). Furthermore, the IMO and some coastal countries, including Canada, have developed mandatory routing and reporting schemes for ships operating in Arctic waters (Chircop, 2009). Mandatory Automatic Identification Systems (AIS) and Vessel Monitoring Systems (VMS) on

commercial ships and fishing vessels allow observers to monitor the types, positions, time and courses of ships in the Arctic (Eriksen, Høye & Meland, 2006).

4.1.2 Marine safety

Marine safety issues address the safety of regular operations of ships in or out of ports (Roe, 2009). Major considerations include ship design and classification, ship operation and crewing, types of shipping activities, as well as shipping accidents.

There are nine popular types of shipping activities in the Arctic, namely: Trans-Arctic Shipping; Inter-Modal Shipping; Community Re-Supply; Resources – Oil and Gas; Resources – Minerals; Resources – Fisheries; Resources – Other industrial developments; Tourism; Government Services and Research (Engler & Pelot, 2013). Each type of activity has different requirements for ship design and construction. Adapted within the framework of the International Convention for the Safety of Life at Sea (SOLAS), IMO has developed some maritime safety tools, which consist of a wide range of rules and standards for ship construction, equipping, operation and crewing (Chircop, 2009).

In addition to discharges from regular shipping operations, there is a high risk of shipping accidents in the Arctic due to its harsh marine navigation environment. The direct consequences of shipping accidents are the loss of ships, goods and crew lives, and often environmental consequences. Accidental discharge of pollutants from the ship will affect the living marine and coastal environment for local communities and wildlife. Toxic substances have negative impacts on fisheries resources as well. The degradation of the marine environment also affects the beauty of the landscape upon which cruise tourism depends. The Canadian Coast Guard (CCG) has developed pollution incident response capability, and the Northern Canada Vessel Traffic

Services Zone (NORDREG) to help prevent and respond to accidents. Also, the Polar Code and SOLAS include some terms to prevent and mitigate shipping accidents.

4.1.3 Marine ecosystem

Another important marine shipping issue is related to marine ecosystem protection. There are three sub-issues under this section: shipping pollution prevention, special maritime areas, and special mandatory or voluntary measures on ship type, size and speed.

Public interest in marine shipping pollution is mainly about protecting the marine environment from the harmful effects of all types of pollution, in particular, pollution associated with air, water and noise (Roe, 2009). Marine shipping activities have contributed significantly to Green House Gas (GHG) emissions, which aggravate climate change in the Arctic region (Eyring et al., 2010; Moore et al., 2012). Also, underwater noise generated by ships has become a major threat to marine mammals (Blair et al., 2016). Marine pollution also has negative impacts on fisheries and the tourism industry. There are some international policies that have been developed to address these issues, for example, the Polar Code includes terms about environmental protection measures (Porta et al., 2017). Canada's national regulations for Arctic shipping, the Arctic Waters Pollution Prevention Act (AWPPA), is recognized as a zero-discharge act in the Canadian Arctic and meets a higher standard than the Polar Code (TC, 2010). Marine pollution prevention acts require higher management standards for shipping companies and industry, and these acts protect the marine ecosystem in the Arctic but increase the cost of ships and the potential cost of resource exploitation and transportation.

There are some special areas that have been developed along international shipping routes with the main purpose of protecting marine environment and ecosystem. Under the United Nations Convention on the Law of the Sea (UNCLOS) and the International Convention on the

Prevention of Pollution from Ships (MARPOL), the IMO is empowered to designate special areas for vessel routes and discharges (Chircop, 2009; Porta et al., 2017). A major outcome is the designation of Particularly Sensitive Sea Areas (PSSAs) (IMO, 2016b). A PSSA is an area that needs special protection through actions by IMO because international shipping has the potential to negatively impact the environmental, socio-economic, or scientific value of that area (Porta et al., 2017). Special areas can be protected by ship routing measures, strict application of MARPOL discharge, and equipment requirements for ships. Other major types of special areas include Areas To Be Avoid (ATBA), no cruise traffic zones, and special areas for vessel discharges.

In order to support the management of special areas, IMO has adopted some Associated Protective Measures (APMs), and Transport Canada also has special mandatory or voluntary measures for ship type, size and speed (Chircop, 2009). For example, on the British Columbia coast, a voluntary Tanker Exclusion Zone has been in place since 1985 (TC, 2015), and there is also a size limit on tankers at Port Metro Vancouver (PMV, 2014). A ship speed requirement has been applied in the Gulf of St. Lawrence to reduce ship strikes with whales in the summer of 2017 (MacKinnon & Fraser, 2017).

In conclusion, major factors of marine shipping activities can be classified into three groups, namely: maritime security, marine safety and marine ecosystem. The management measures for each factor can implicate multiple receptors including local communities, marine and coastal wildlife, shipping companies and industry, fisheries, the resource industry, cruise tourism and multiple levels of governments (see Table 2). According to these identified receptors, a multi-level stakeholder group, their management targets and interests can be identified.

Table 2. Major Factors in Marine Shipping and the Receptor groups of Shipping Impacts

Receptors Factors Issues		Local community	Marine and coastal wildlife	Shipping companies and industry	Fisheries	Resource industry	Cruise tourism	Multiple levels of governments
		Maritime security ^a	Time and Schedules	Affect hunting time; travel time; annual re-supply time.	Overlap with breeding and feeding times for marine flora and fauna	Change shipping schedules	Affect fisheries season	Affect resource extraction and transportation time
Position or Location (Hydrographic mapping)	Disturbs on-ice routes and routes to other communities; changes in hunting areas.		Increases ship strikes and noise	Motivates commercial shipping services to use voluntary corridors	Overlaps with fisheries resource	Overlaps with regions rich in natural resources	Encourages cruise ships to use corridors occasionally	Sets up Low-Impact Shipping Corridors (GOC), mandatory routing and reporting schemes (IMO and coastal states)
Marine safety ^b	Accidents	Discharge pollutants accidentally and affect the living environment	Discharge pollutants accidentally and threaten marine ecosystems	Lose ship, goods and crew life	Discharge pollutants accidentally	Affect resource transportation schedule	Accidental discharge of pollutants affects the beauty of landscape	Set up pollution incident response and NORDREG (CCG);

^a Maritime security is concerned with the prevention of intentional damage, particularly for ensuring security for people and goods (AMSSA, 2017).

^b Marine safety refers to the safety of regular operation of ships and ports in the Arctic waters (Roe, 2009)

	Class/Design of ships	Affects ship types for re-supply	Protects marine organisms	Promotes safe operation in the Arctic water		Affects navigation and loading capacities of resource transportation		Set up Polar Code (IMO, 2016); SOLAS (1974); TC regulations
	Ship operation and crewing	Increase employment of coastal communities	Protect marine organisms through safe operations	Increase safety of ships and crew		Encourage marine safety of resource transportation		Set up Polar Code (IMO, 2016); SOLAS (1974)
	Types of shipping activities	Community Re-Supply	Scientific research	Trans-Arctic Shipping; Destinalional Shipping.	Fisheries	Resources exploitation of Oil, Gas and Minerals	Tourism	Voluntary Tanker Exclusion Zone in B.C. (TC)
Marine ecosystem	Pollution prevention	Prevents Green House Gases (GHGs) emission and ship-based pollution	Changes in life patterns of marine organisms due to under water noise	Requires higher management standards for shipping industry	Reduces pollution's threats on growth and life safety of fishes	Increases the cost of resource transportation	Protects and improves the quality of the landscape beauty	Sets up Polar code (IMO, 2016); AWPPA, zero discharge act (TC)
	Special areas	Set up areas of traditional use of local communities	Set up ATBA for reducing ship-whale strike; MPAs	Set up special requirement for shipping industry	Set up No-fishing zones	Add special requirements for resource exploitation	Set up No-cruise traffic areas	Design special areas for vessel discharges and PSSA (MARPOL, IMO)
	Special mandatory or voluntary measures: type, size and speed of ships	Protect coastal environment for local communities	Lower speed to reduce ship strike with whales	Increase shipping costs	Protect fisheries resources	Increase the cost of resource transportation	Affect cost, schedule and route planning	Limit tanker size (TC) and set up APMs (IMO)

4.2 Stakeholders and their interests

Adapted from Demeyer and Turbelboom (2014), stakeholders in a marine shipping management regime are groups or individuals who have impacts on marine shipping management and who directly/indirectly benefit or are negatively affected by management measures. Stakeholder involvement in the decision-making process has been regarded as an essential element in environmental and resource management (Young et al., 2013). Marine shipping management within NMTC is typically complex, uncertain, multi-scale and affects multiple actors and agencies. Therefore, the decision-making process should be flexible to a changing environment and be able to integrate diverse knowledge and values (Reed, 2008). To achieve this, stakeholder participation in such a decision-making process is needed and stakeholders are considered as decision makers in this MCDA study.

A stakeholder analysis is particularly important at the beginning of a stakeholder involvement process (Demeyer & Turbelboom, 2014). Once the stakeholder analysis is conducted, best practices of alternatives and criteria of attributes can be used by the selected stakeholders to evaluate different forms of institutional arrangement for managing marine shipping activities within NMTC. Stakeholder analysis is an approach and procedure for identifying the key stakeholders in an issue and assessing their respective interests in that issue (Grimble & Chan, 1995). The second major result of this paper is identifying stakeholders of marine shipping management in the Canadian Arctic. It is well recognized that, stakeholder participation in government decision-making process can generate many benefits (Irvin & Stansbury, 2004). Stakeholders are willing to support the governance regime when it is clear that their interests have been identified and taken into consideration (Beveridge et al., 2015). Also, stakeholders are

more likely to facilitate cooperation with other stakeholders based on their common interests and to build partnerships which can support the governance regime.

Based on literature review, 39 stakeholders were identified and classified into four groups according to their levels of governance: international, national/federal, territorial and local. Each group covers government institutions and stakeholders who have interests in local communities, shipping industry, marine wildlife, fisheries, natural resources and other receptors of Arctic marine shipping activities.

4.2.1 The International governance level

The International Maritime Organization (IMO), shipping classification societies and representatives of the international shipping industry focus on maritime transportation issues specifically. Their interests lie in marine security, maritime safety and marine ecosystems. As an intergovernmental forum for Arctic governments and peoples, the Arctic Council set Arctic security, safety and defence as their top priorities. As for marine shipping management, the Arctic Council has addressed ecological impacts caused by increasing shipping activities on the Arctic marine environment, as well as socio-economic impacts on coastal communities through their Arctic Marine Shipping Assessment (AMSA) (AC, 2009). International NGOs such as Greenpeace and World Wildlife Fund (WWF) focus on the ecological shipping risks to marine ecosystems. Furthermore, the Association of Arctic Expedition Cruise Operations (AECO), international commercial fisheries, and international research teams address the issues related to cruise tourism, commercial fisheries and scientific research, respectively.

4.2.2 The National or Federal governance level

The national/federal level stakeholder group includes many of the federal departments in Canada. First, from the perspective of marine shipping activities, Transport Canada (TC) has set

up a series of national regulations and policy frameworks emphasizing maritime security, marine safety and marine environment protection. The Canadian Hydrographic Service (CHS) has provided services in the marine shipping corridors. The Canadian Marine Advisory Council (CMAC) is TC's primary consultative body for marine matters. The Canadian Coast Guard (CCG) has provided marine safety services for search and rescue, marine shipping accidents and pollution response. The CCG also has ice-breakers for marine navigation services. Fisheries and Oceans Canada (DFO), Environment and Climate Change Canada (ECCC), and Parks Canada focus on marine ecosystem issues specifically. These three federal departments can set up Marine Protected Areas (MPAs) to protect Arctic ecosystems from negative impacts arising from increasing shipping activities. Indigenous and Northern Affairs Canada (INAC) whose predecessor is Aboriginal Affairs & Northern Development Canada (AANDC), and the Canadian Northern Economic Development Agency (CanNor) address the issues particularly related to the local and indigenous communities. Major concerns are about community re-supply, disturbance of traditional lifestyle, discharges from ships, community employment and economic development. Currently, the jurisdictional status of some Arctic waters remains controversial (VanderZwaag et al., 2008). The increasing shipping activities in the Arctic could give rise to future jurisdictional disputes as well as threats to national sovereignty. Therefore, the Department of National Defence (DND) may need to enhance their policies and strategies regarding the increasing marine shipping activities in the Canadian Arctic in order to protect navigational rights and Canadian sovereignty. Domestic commercial fisheries and the natural resources exploitation industry are searching for economic benefits partly relying on effective marine shipping. Research institutions like Oceans North Canada and the National Research

Council (NRC) focus on shipping route design and proposing mitigation options to reduce negative shipping impacts on the marine ecosystem.

4.2.3 The Territorial governance level

The most important stakeholder at the territorial level is the Government of Nunavut (GN) because the starting point and the main body of the planned NMTC corridors are under GN's jurisdiction. Based on the Nunavut Land Claims Agreement (NLCA, 1993), GN focuses on shipping activities and indigenous peoples' rights. To be specific, GN promotes increased shipping activities in the Arctic in order to benefit economic development of local communities in Nunavut. Potential economic benefits include increasing community re-supply, exploiting natural and social resources, and developing Arctic road and port projects in Nunavut.

Meanwhile, indigenous people and their living environment should be protected from the potential negative socio-ecological impacts brought by shipping activities. To achieve these targets, three of the four co-management institutions (see section 2.2.1 Co-management for details) established under the NLCA (1993) could address marine shipping or shipping-related issues. NWMB focuses on the disturbances between ships and marine organisms, while the NIRB emphasizes the overall socio-ecological impacts engendered by shipping activities. NPC had proposed a draft plan for marine shipping management in Nunavut, which includes shipping impacts evaluation, shipping corridors design, risks of marine shipping and overlapping areas between shipping routes and sensitive sea areas. Aside from the co-management bodies, the Nunavut Marine Council (NMC) is another collaborative body addressing marine issues in Nunavut. As for marine shipping management, the NMC focuses on ship construction, standards of ship operations, and environmental response.

4.2.4 The Local governance level

Stakeholders associated with the local level generally have a strong Inuit background. The Inuit Circumpolar Council (ICC) focuses on ecological impacts from ships and specializes in shipping route design, marine ecosystem protection, and cruise ship tourism development. ICC also commented on the broad social impacts brought by the shipping industry on coastal communities (see ICC, 2008). Inuit Tapiriit Kanatami (ITK), Hunters and Trappers Organizations (HTOs), Inuit local communities and Regional Inuit Associations (RIA) are primarily concerned about the social impacts brought by the increasing shipping activities on local communities and indigenous people. Nunavut Tunngavik Inc (NTI), as a local company focused on hydrographic mapping and survey activities, would also like to see meaningful engagement of indigenous people, especially on issues related to traditional hunting and fishing activities. There are also stakeholders from the local level that have interests in fisheries resources, with concerns about the potential changes to fishing areas and timing.

Based on the previous analysis about major factors in marine shipping and the receptor groups of shipping impacts, a single changed factor in marine shipping activities can have multiple impacts on different kinds of receptor groups. Similarly, these receptors can affect multiple groups of stakeholders related to marine shipping activities. Major players, or key stakeholders, in the marine shipping governance regime in the Canadian Arctic and their diverse interests are listed in this section (see Table 3). These stakeholders can contribute to the success of marine shipping management through NMTC, when their interests are taken into consideration in the decision-making process.

Table 3. Stakeholders of Shipping in the Canadian Arctic and their Interests

Governance level	Receptor group	Stakeholders	Management targets and interests
International	Governance Institution	International Maritime Organization (IMO)	<ul style="list-style-type: none"> • Marine security (ship construction and operations); • Maritime safety (goods and life); • Marine ecosystem (marine environment and shipping pollution).
		Arctic Council	<ul style="list-style-type: none"> • Security, Safety and Defence (political); • Marine environment (ecological impacts); • Social impacts of shipping; • Economic impacts of shipping industry.
	Local communities; Marine and coastal wildlife	World Wildlife Fund (WWF)	<ul style="list-style-type: none"> • Mitigate risks of oil spill; • Mitigate ship-wildlife collision; • Reduce underwater noise; • Pollution prevention and marine environment protection; • Reduce greenhouse gas emissions from ships.
		Greenpeace	<ul style="list-style-type: none"> • Shipping risks of oil spill; • Ship-wildlife collision.
		International research teams	<ul style="list-style-type: none"> • Time (research season); • Research vessel routes; • Marine and coastal ecosystem.
	Shipping industry	International Shipping industry	<ul style="list-style-type: none"> • Ship owners, operators and crew; • cargo owners; • chartering companies; • shipbuilders.
		Classification Societies	<ul style="list-style-type: none"> • Classification (marine security); • Ship-building.
	Fisheries	International commercial fisheries	<ul style="list-style-type: none"> • Time (fisheries season); • Fishing areas.
	Resource industry	International resource companies	<ul style="list-style-type: none"> • Natural resources exploitation time; • Natural resources exploitation sites; • Natural resources exploitation cost.
	Cruise tourism	Association of Arctic Expedition	<ul style="list-style-type: none"> • Cruise shipping lines/zones; • Sites that can be visited by cruise ships;

		Cruise Operations (AECO)	<ul style="list-style-type: none"> • Wildlife protection; • Mandate ship operational guidelines (safety, crew, environment protection etc.).
Federal or National	Governance Institution for marine shipping	Transport Canada (TC) & Canadian Marine Advisory Council (CMAC)	<p>Issues related to maritime security, marine safety; marine environment protection:</p> <ul style="list-style-type: none"> • Discharges: Arctic Shipping Pollution Prevention Regulations (ASPPR); • Position: Northern Marine Transportation Corridors (Low impact shipping corridors); • Speed (i.e. Area To Be Avoid); • Communication between ships and communities; • Time: for communities' supply/commercial shipping; • Other types of transportation (i.e. on-land transportation and over-ice routes, No ice-breaker zones, No-icebreaking zones); • Ship no-go zones; restricted-use zones.
		Canadian Hydrographic Service (CHS)	<ul style="list-style-type: none"> • Position: North Marine Transportation Corridors (Low impact shipping corridors); • Hydrography (sea charts).
		Canadian Coast Guard (CCG)	<p>Marine safety services:</p> <ul style="list-style-type: none"> • Search & Rescue; • Marine accident and pollution response; • Marine navigation.
		Department of National Defence (DND)	<ul style="list-style-type: none"> • Shipping safety control zones; • Maritime navigational rights; • Canadian sovereignty; • Shipping security.
	Governance institution for local communities	Canadian Northern Economic Development Agency (CanNor)	<ul style="list-style-type: none"> • Community re-supply; • Shipping affected place and time of traditional hunting activities, traditional and commercial fishing activities; • Community employment and revenue; • Discharges from shipping and communities' living environment.
		Indigenous and Northern Affairs Canada (INAC) ^c	

^c Indigenous and Northern Affairs Canada's predecessor is Aboriginal Affairs & Northern Development Canada (AANDC)

Federal or National	Governance institution for marine ecosystem (fisheries and wildlife)	Fisheries & Oceans Canada (DFO)	<ul style="list-style-type: none"> • The overlapping areas of shipping routes and important habitats; • Ballast water and non-indigenous species (NIS); • The change of shipping patterns due to the change of shipping environment and its impacts assessment; • Shipping safety control zones; • Impacts of the forecast shipping season.
		Environment and Climate Change Canada (ECCC)	<ul style="list-style-type: none"> • Sea ice forecast • Discharges/Emissions from ships; • The overlapped areas of shipping routes and important habitats; • Increased shipping for oil & gas exploration, development and cruise ships.
		Parks Canada	<ul style="list-style-type: none"> • Surveys of uncharted waters (safe navigation access); • Overlapped areas of shipping routes and establishment of national parks or Marine Protected Areas (MPAs).
	Governance institution for natural resources	Natural Resource Canada (NRCan)	<ul style="list-style-type: none"> • Natural resources exploration activities; • Prospect of a longer shipping season; • Construction of a deep-water port; • Possibility of fuel and cargo spills; • Disturbance of wildlife; • Underwater and airborne noise; • Destabilization of fast ice; • Efficient and effective shipping routes through the ice.
	Shipping industry	Domestic shipping industry	<ul style="list-style-type: none"> • Ship owners, operators and crew; • cargo owners; • chartering companies; • shipbuilders.
	Fisheries	Domestic commercial fisheries	<ul style="list-style-type: none"> • Time (fishing season); • Fishing areas.
	Natural resource industry	Domestic natural resource industry	<ul style="list-style-type: none"> • Time and schedule; • Types of ships; • Size of ships; • Cost of shipping.
	Marine ecosystem	Oceans North Canada ^d	<ul style="list-style-type: none"> • The Integrated Arctic Corridors Framework (low-impact shipping corridors);

^d Oceans North Canada is one of several networks that consider northern marine issues, others include MEOPAR, Clear Seas, ArcticNet etc.

	and local communities		<ul style="list-style-type: none"> • Maritime/Ocean governance; • Impacts of sea ice in shipping routes; • Protecting life; • Arctic standards for Oil Spill Prevention, Response, and Safety; • Areas to be avoided (ATBAs); • Vessel safety communication system; • Community involvement.
		National Research Council (NRC)	<ul style="list-style-type: none"> • Shipping time; • Shipping Routes.
		National marine research teams	<ul style="list-style-type: none"> • Time (research season); • Research shipping routes; • Marine and coastal ecosystem.
	Cruise tourism	Domestic cruise tourism interests	<ul style="list-style-type: none"> • Potential chances for developing cruise tourism
Territorial	Governance institution	Government of Nunavut	<ul style="list-style-type: none"> • Shipping and communities re-supply; • Road and Port Projects; • Shipping industry and revenue; • Indigenous peoples' right; • Socio-ecological impacts brought by marine shipping activities.
	Wildlife and fisheries	Nunavut Wildlife Management Board (NWMB)	<ul style="list-style-type: none"> • Time (important time for wildlife (i.e. migration, breeding, hunting); • Marine mammal-ship collision; • Habitat destruction by ice-breaking.
	Cruise tourism and resources	Nunavut Planning Commission (NPC)	<ul style="list-style-type: none"> • Noise (underwater noise); • Direct mortality of marine mammals; • Cumulative effects on ecosystem; • Oil spill; • Ice-breaking; • High risks for marine safety; • Northern Marine Transportation Corridors; • Ecological restrictions on marine shipping; • Shipping routes overlap and interrupt on-ice tracks.
	Shipping industry	Nunavut Marine Council (NMC)	<ul style="list-style-type: none"> • Infrastructure of marine shipping for community supply; • Potential year-round ice-breaking interfering with wildlife habitat, travel, harvesting, etc. • Effectiveness of oil spill clean-ups in ice-covered waters;

			<ul style="list-style-type: none"> • Development and enforcement of proper standards for ships operating in ice-covered waters, including trained operators with experience in Nunavut.
	Local communities	Nunavut Impact Review Board (NIRB)	<ul style="list-style-type: none"> • Review shipping activity proposals; • Analyze the potential socio-ecological impacts brought by shipping industry on local communities and marine environment.
Local	Fisheries	Inuit commercial fisheries	<ul style="list-style-type: none"> • Time (fishing seasons); • Fishing areas.
	Local communities and marine ecosystem (marine environment and wildlife)	Inuit Circumpolar Council (ICC)	<ul style="list-style-type: none"> • Mandatory vessel tracking and reporting system; • Protect reliance on marine mammals (Inuit food security); • Cruise ships; • Nuclear powered icebreaker has constant leaks; • Mandatory Polar Code.
Inuit Tapiriit Kanatami (ITK)		<ul style="list-style-type: none"> • Economic impacts; • Impacts on marine mammals; • Shipping routes overlap and interrupt on-ice tracks; • Impacts on traditional lifestyle; • Search and rescue and the Canadian Rangers. 	
Hunters and Trappers Organizations (HTOs)			
Inuit Communities			
Regional Inuit Associations (RIA)			
Local	Marine shipping	Nunavut Tunngavik Inc (NTI)	<ul style="list-style-type: none"> • Search and rescue/incidents; • Traditional activities: hunting and fishing; • Meaningful engagement of indigenous people; • Hydrographic mapping; • Mapping and survey activities.

4.3 Institutional arrangement alternatives

There are three forms of institutional arrangement identified in the preceding literature review.

The third major result of this study is to explain and compare the three alternatives from the perspectives of definitions, application areas, best practices, strengths and weaknesses. This analysis can help stakeholders get a deep understanding of each institutional form before doing an MCDA decision matrix.

4.3.1 Alternative 1: Co-management

Co-management is an institutional arrangement through which multiple stakeholders achieve an agreement covering a specific geographic region and make decisions affecting multiple actors (Osherenko, 1988). After decades of development, co-management has been applied in resource management of fisheries (see Beem, 2007; Nielsen et al., 2004), wildlife (see Dale & Armitage, 2011) and natural resources (see Ferdous, 2015), as well as establishment and management of Marine Protected Areas (MPAs) (see Dodson, 2014).

Strengths of co-management have been summarized by Goetze (2004): Co-management can increase input from local stakeholders and improve local control by integrating Traditional Ecological Knowledge (TEK). With sustainable conflict mitigation, improved resource management can be realized through co-management. However, there are also some weaknesses of co-management (Goetze, 2004): First, regional governments can be resistant to sharing power with local co-managers, so that the co-management body lacks decision-making authority. Second, stakeholders' multiple interests result in difficulties with building partnerships, while achieving consensus among these stakeholders will increase governance complexity and costs. There are also some difficulties integrating TEK and scientific knowledge.

The best practices of co-management identified in this study are the co-management boards in Nunavut for their successful experiences in dealing with comprehensive issues.

4.3.2 Alternative 2: Co-governance

Co-governance is an arrangement in which ultimate decision-making authority resides with a collaborative body, where power and responsibility are shared between government and local stakeholders (Dodson, 2014). The most popular application areas for co-governance include resource management (fisheries, wildlife and natural resources) and marine reserves management (see Dodson, 2014; Feit, 2005; OAG, 2016).

Co-governance arrangements can overcome the structural barriers to stakeholder collaboration by providing platforms for communication and equal participation (Jacobson & Robertson., 2012). Also, co-governance can integrate science knowledge and TEK and embrace multiple stakeholders' interests (Jacobson & Robertson., 2012). Federal governments, such as the UK, Australia and New Zealand have embraced co-governance arrangements in recognition that traditional institutional arrangements are not suitable for dealing with complex and wicked problems² (Fenwick et al., 2012; Ling, 2002). There are some institutional barriers in co-governance, such as weak accountability and reporting mechanisms (Fenwick et al., 2012), and limited resources exchange among stakeholders, making it difficult to maintain functional and adaptive partnerships (Jacobson & Robertson., 2012).

The best practice identified in this study for co-governance is the Natural Resource Management (NRM) programme in Australia (see Head & Ryan, 2004).

² Wicked issues/problems are generally seen as complex, open-ended, and intractable. Both the nature of the problem and the preferred solution are strongly contested (Head, 2008).

4.3.3 Alternative 3: Shared Leadership

Shared leadership is a property of a group where leadership functions are shared among group members (Drescher, Korsgaard & Wigand, 2014). Shared leadership offers a concept of leadership practice as a group-level phenomenon (Fletcher & Kaufer, 2003). Shared leadership is widely used in business for team-building as well as school education.

Shared leadership can promote effective group processes and outcomes: Group members gain experience from each other (Drescher et al., 2014) and achieve greater consensus, collaboration and coordination (Cox et al., 2003), higher intragroup trust and cohesion with less conflict (Bergman, J. Z., Rentsch & Bergman, S. M., 2012). The overall benefits are improved motivation and performance of group members (Drescher et al., 2014). However, the biggest barrier in shared leadership application is that the hierarchical leaders of the group are charged with creating less hierarchical organizations (Fletcher & Kaufer, 2003). This paradox could lead to a disappearance of the shared leadership principle during real management practice (Fletcher & Kaufer, 2003).

There's not much literature about the application of shared leadership in a governance regime. The best practice identified in this study is the New Shared Arctic Leadership Model project developed with the support from Indigenous and Northern Affairs Canada (INAC).

It is important to provide stakeholders a clear description of the three forms of institutional arrangements by presenting general definitions and pointing out their strengths and weaknesses (see Table 4) before evaluating them. Stakeholders can then evaluate these three alternatives based on their own experiences and the criteria provided in the section.

Table 4. A Comparison among Three Forms of Institutional Arrangements

	Co-management	Co-governance	Shared Leadership
Definition	Co-management is an institutional arrangement, whereby multiple stakeholders achieve an agreement covering a specific geographic region and make decisions affecting multiple actors.	Arrangements in which ultimate decision-making authority resides with a collaborative body, where power and responsibility are shared between government and local stakeholders.	A property of a group where leadership functions are distributed among group members. Shared leadership offers a concept of leadership practice as a group-level phenomenon.
Application areas	Resource management (fisheries, wildlife and natural resources); marine protected areas	Resource management (fisheries, wildlife and natural resources); marine reserves	Business area: team building and school education
Selected best practice	Four co-management boards in Nunavut, Canada	Natural Resource Management (NRM) programme, Australia	New Shared Arctic Leadership Model
Strengths	<ol style="list-style-type: none"> 1. Improve resource management; 2. Increase input from local stakeholders; 3. Sustainable conflict mitigation; 4. Integration of traditional local knowledge; 5. Increase local control. 	<ol style="list-style-type: none"> 1. Overcome the structural barriers to stakeholders' collaboration; 2. Integrate social and ecological knowledge; 3. Provide platforms for communication and equal participation among stakeholders; 4. Embrace diversity of perspectives and interests; 5. Good for dealing with complex and wicked issues. 	<ol style="list-style-type: none"> 1. Promote effective group process and outcomes; 2. Group members gain experience from each other; 3. Improve motivational implications and performance of group members; 4. Less conflict, greater consensus; 5. Higher intragroup trust and cohesion; 6. Greater collaboration and coordination.
Weaknesses	<ol style="list-style-type: none"> 1. Lack of decision-making authority for local co-managers; 2. Government resistant to share power with local co-managers; 3. Difficulties with building partnerships; 4. Increase governance complexity and costs; 5. Difficulties in integrating traditional ecological knowledge and scientific knowledge. 	<ol style="list-style-type: none"> 1. Institutional barriers make it difficult to maintain functional and adaptive partnerships; 2. Limited resources exchange among different stakeholders; 3. Weak accountability and reporting mechanisms within the co-governance scope. 	<ol style="list-style-type: none"> 1. Hierarchical leaders are charged with creating less hierarchical organizations; 2. Shared leadership principles "get disappeared" during practices.

Sources: Bergman et al., 2012; Controller and Auditor-General, 2016; Cox et al., 2003; Dodson, 2014; Drescher et al., 2014; Fenwick et al., 2012; Fletcher & Kaufer, 2003; Goetze, 2004; Jacobson & Robertson., 2012; Osherenko, 1988.

4.4 Attributes and criteria for institutional arrangements

Attributes are components that can contribute to the effectiveness of the institutional framework. The criteria can show *how well* each institutional form meets the requirements of the different attributes. The literature review identified several attributes and criteria to assess successful arrangements of co-management, co-governance and shared leadership (see Controller and Auditor-General, 2016; Goetze, 2004). In this section, some attributes and criteria drawn from the literature are described.

The following attributes and criteria are suggested to be subsequently applied in an MCDA decision matrix for stakeholders to use and evaluate different institutional arrangements: (1) integrity of decision-making procedures; (2) legal basis and jurisdiction; (3) specificity and clarity; (4) financial support for the institutional body; (5) degree of collaboration; (6) representativeness; (7) equality; (8) cost efficiency; (9) effectiveness; (10) uncertainty; (11) tightness, and (12) transparency. These 12 attributes and their 22 corresponding criteria serve to show the evaluation standards of the institutional arrangements in this study (see Table 5).

Attribute 1: Integrity of decision-making procedures

There are two criteria for evaluating the integrity of the decision-making procedures in different institutional arrangements. Criterion 1 considers the integrity of rules and regulations for the decision-making process. These rules include rules for proposal rating/ranking/selection, rules for necessary trade-offs and regulations for voting. As for Criterion 2, a complete decision-making framework should provide guidelines or principles for public participation. The arrangement that includes complete decision-making procedures will receive a high score (green) while incomplete ones will receive medium (yellow) or low (red) scores.

Table 5. Attributes and Criteria of Three Forms of Institutional Arrangement

Attributes	Criteria
Integrity of decision-making procedures	1. Does the institutional arrangement include complete rules/regulations for decision making procedures such as: <ul style="list-style-type: none"> ○ Proposal rating/ranking/selection; ○ Trade-offs; ○ Voting system/process. 2. Does the institutional arrangement have guidelines/principles for encouraging public participation in decision-making procedures?
Legal basis and jurisdiction	3. Which legislative level is this institutional arrangement based on? <ul style="list-style-type: none"> ○ Land Claims Agreement; ○ Federal regulations/laws/memorandums of understanding; ○ Official/Public documents of federal, territorial, local department. 4. Does this arrangement usually involve a single/multiple governance level. 5. Is this arrangement usually used in single/small/multiple/large jurisdiction(s).
Specificity and clarity	6. Is this institutional arrangement usually used for solving broad/comprehensive/specific/simple issues? 7. Does the arrangement have a clear/vague purpose/targets? 8. Do the stakeholders/decision makers participating in this arrangement have clear/vague roles and responsibilities?
Financial support for the institutional body	9. Does this institutional arrangement have adequate/inadequate financial support from government/organization/company? 10. Does this management/governance body have constant/intermittent financial support?
Degree of collaboration	11. Does this institutional arrangement take both economic and socio-ecological impacts into consideration during the decision-making process? 12. Does this arrangement consider both scientific knowledge and traditional ecological knowledge (TEK) in its knowledge co-production processes?
Representativeness	13. Are stakeholders in the management/governance board from all/some/part of/limited sectors related to the management issue. 14. Can this arrangement reflect all/most/some different interests of different stakeholders.
Equality	15. Do stakeholders in the decision-making process have equal/unequal power/voting rights/veto? 16. Is each stakeholder in this decision-making process impacted/benefiting equally?
Cost efficiency	17. Will this institutional arrangement consume large/medium/small amount of time and energy or, in other words, has a high/medium/low cost efficiency.
Effectiveness	18. Can the decisions made by the institutions contribute to the goals, targets and outcomes established in the arrangement?
Uncertainty	19. Do decisions made under this institutional form have a high/medium/low rate of uncertainty during implementation?

Tightness	20. Do the stakeholders/participants share a strong/weak or close/loose relationship in this management approach/framework?
Transparency	21. Can all the decision-makers/stakeholders access the information (material and evidence) for decision-making? 22. Is the decision-making process transparent to the public outside the management board?

Attribute 2: Legal basis and jurisdiction

Criterion 3 (legislative level), Criterion 4 (governance level) and Criterion 5 (jurisdictional area) are the three evaluating criteria under this attribute. First, an institutional arrangement will have a strong legal basis if it is established under a land claims agreement. Also, federal regulations, laws and memorandum of understanding documents are relatively strong legal support. Official or public documents published by related governmental departments can also provide legal basis to some extent. From the perspective of marine shipping management in the Arctic, an arrangement which involves multiple governance levels and multiple jurisdictions are more suitable. As a consequence, arrangements have applicable laws, diverse levels of government and multiple jurisdictions will receive high scores with green colors while incomplete laws, same government level and single jurisdiction will receive low scores with red colors.

Attribute 3: Specificity and clarity

Three criteria address different perspectives of this attribute: Criterion 6 (management issues), Criterion 7 (purpose and targets) and Criterion 8 (roles and responsibilities). First, since marine shipping is a complicated issue, any arrangement that is usually used for solving comprehensive issues is more suitable than those that are used for solving simple issues. An arrangement would also have better outcomes if it has a clear management purpose. Also, stakeholders participating

in the arrangement will have a better performance if their roles and responsibilities are clear.

Thus, institutional arrangements in which stakeholders have clear recognition of their roles and purpose will be assigned a green color. Also, arrangements which are used for solving comprehensive issues will receive higher scores.

Attribute 4: Financial support for the institutional body

The two relevant criteria here focus on the source (Criterion 9) and frequency (Criterion 10) of financial support for the institutional body. First, if the management or governance board has adequate funding from government departments, this arrangement's likelihood of success is high. In contrast, funding from organizations and companies is less reliable. Second, an institutional body would more likely achieve future success if it has guaranteed constant financial support on a regular basis. If the arrangement already has sufficient and constant financial support, it will get a higher score.

Attribute 5: Degree of Collaboration

There are two criteria under this category, namely Criterion 11 (impact) and Criterion 12 (knowledge). The first criterion focuses on the multiple impacts brought by shipping activities. A reasonable arrangement should consider both economic and socio-ecological impacts of their decisions. Meanwhile, the arrangement should support the knowledge co-production³ mainly of scientific knowledge and Traditional Ecological Knowledge (TEK). An arrangement that considers multiple impacts and different kinds of knowledge gets a high score with a green color.

³ Knowledge co-production refers to the collaborative process of bringing multiple knowledge sources, types and disciplines together to address a defined problem and build an integrated understanding of a specific problem (Dale & Armitage, 2011).

Attribute 6: Representativeness

This attribute refers to the representativeness of stakeholders in the decision-making process. There are two criteria addressing different aspects of representativeness: Criterion 13 (sector) and Criterion 14 (interest). An arrangement that has created opportunities for multiple stakeholders from diverse related sectors to participate as decision makers will get a high mark with a green color. Conversely, a limited range of stakeholders in an arrangement will result in a lower mark with a red color. Similarly, the management plan or governance policy should reflect most of the interests of different stakeholders. An arrangement that can reflect multiple interests will get a higher score; on the contrary, a lower score will be assigned when addressing limited interests.

Attribute 7: Equality

There are two criteria related to the attribute of equality, namely Criterion 15 (voting right) and Criterion 16 (benefit). The first refers to equality of power in the decision-making process. The most basic requirement for this criterion is equal voting rights among stakeholders at the same governance level. Compared to the rights of government decision makers, the more equal the rights that stakeholders in lower governance levels can get within the arrangement, the higher rank that the corresponding institutional form can get through evaluation. The voting equality of each institutional form can be assessed according to the regulations of stakeholders' rights distribution in the decision-making process. The other criterion suggests that stakeholders should be impacted and benefit fairly through the institutional arrangement. However, equally impacted doesn't mean each stakeholder can get exactly the same impacts and benefits. Rather, equally impacted means common responsibilities, and differentiated expenses and benefits. Specifically, stakeholders get common but differentiated benefits instead of getting the same kind of benefits.

For example, local communities allow industry developers to use their land and resources in order to get more jobs and income, while developers follow the sustainable development principles and respect the traditional culture of indigenous people. Stakeholders will assess this criterion based on their knowledge and experience, and evaluate how well their interests and benefits are considered equally through the institutional form.

Attributes 8: Cost efficiency

There is one criterion (Criterion 17) about an institutional arrangement's cost efficiency. High cost-efficiency means realizing a set outcome with less input. A successful arrangement should achieve its targets with a high cost efficiency while consuming small amount of time and energy. Therefore, arrangements that have high cost efficiency will receive a higher score with a green color.

Attribute 9: Effectiveness

Management effectiveness is defined in multiple ways, but all analysts have to deal with two fundamental questions (Skjærseth & Wettestad, 2002): *what* has been achieved and *how well* actual achievements meet the requirements of management targets? There is one criterion (Criterion 18) to help stakeholders evaluate the effectiveness of three forms of institutional arrangements. A better institutional form can help stakeholders to make decisions which have more significant and beneficial impacts on the management regime. The green color will be assigned to an arrangement with high effectiveness while a red color will be assigned to an arrangement with low effectiveness.

Attribute 10: Uncertainty

Criterion 19 is used for analyzing the level of uncertainty inside an institutional arrangement.

The governance or management plan made by decision makers through a successful institutional arrangement should be based on a high degree of consensus reached by stakeholders. If such decisions can be implemented with a low rate of uncertainty, the arrangement and will also receive a high mark with a green color in the decision matrix table.

Attribute 11: Tightness

Criterion 20 is used for analyzing the tightness of the relationship between stakeholders in the institutional arrangement. There is a greater likelihood of success of the arrangement if stakeholders can build a strong and close relationship between themselves. Thus, if stakeholders within the governance body have a close relationship, that kind of institutional arrangement will receive a higher score with a green color in the evaluation.

Attribute 12: Transparency

The last two criteria are used to analyze the transparency of different institution arrangements.

The first criterion (Criterion 21) focuses on sharing information, especially material and evidence sharing between decision makers. The more information that the arrangement allows stakeholders to access, the better outcomes will be achieved. Also, a good arrangement should be transparent to the public (Criterion 22). For example, the arrangement should allow public outsiders to attend decision-making meetings as observers or have public hearings for the proposed management plans. Arrangements that let both stakeholders and the public have access to the information for decision-making process will receive a higher rank with a green color, while lower transparency will result in a red color with a lower rank.

In conclusion, these 22 criteria can be used by stakeholders in the evaluation process for selecting a better institutional arrangement for managing marine shipping activities in the Arctic. Stakeholders can assign green, yellow and red colors to each form of institutional arrangement according to the criteria descriptions and their own experiences. The next sector provides an example of an MCDA decision matrix based on the previous literature review and the three institutional arrangements.

4.5 MCDA Decision Matrix for 3 Institutional Arrangements

The criteria developed in the preceding section can be used by stakeholders to evaluate different forms of institutional arrangements by assigning different colors to them. This paper proposed an example of complete decision matrix for Arctic marine shipping governance as the fifth result of this study (see Table 6). The opinions in this example are based on the evaluations of the three alternative institutional arrangements and information gleaned from the literature review, whereas in actual practice of the planned NMTC stakeholder workshop, the final results can be quite different due to stakeholders' personal experiences and informed perspectives. The results of each cell will be explained separately below. Each cell is uniquely labelled using the row and column identifiers for ease of reference.

The description for each cell in the MCDA decision matrix table provide the contact for the assessment and justifies the color choice, as follows. Different colors demonstrate different levels of fulfillment of each criterion. Green refers to a high level of fulfillment, while yellow refers to a medium level and red refers to a low level.

Table 6. MCDA Decision Matrix for 3 Institutional Arrangements (Green for high fulfillment of each criterion; yellow for medium fulfillment and red for low fulfillment.)

Attributes	Criterion	Institutional arrangements		
		Co-management Alternative 1 (A1)	Co-governance Alternative 2 (A2)	Shared Leadership Alternative 3 (A3)
Integrity of decision making procedures	Criterion 1 (C1)	A1C1	A2C1	A3C1
	Criterion 2 (C2)	A1C2	A2C2	A3C2
Legal basis and jurisdiction	Criterion 3 (C3)	A1C3	A2C3	A3C3
	Criterion 4 (C4)	A1C4	A2C4	A3C4
	Criterion 5 (C5)	A1C5	A2C5	A3C5
Specificity and clarity	Criterion 6 (C6)	A1C6	A2C6	A3C6
	Criterion 7 (C7)	A1C7	A2C7	A3C7
	Criterion 8 (C8)	A1C8	A2C8	A3C8
Financial support for the governing body	Criterion 9 (C9)	A1C9	A2C9	A3C9
	Criterion 10 (C10)	A1C10	A2C10	A3C10
Degree of Collaboration	Criterion 11 (C11)	A1C11	A2C11	A3C11
	Criterion 12 (C12)	A1C12	A2C12	A3C12
Representative	Criterion 13 (C13)	A1C13	A2C13	A3C13
	Criterion 14 (C14)	A1C14	A2C14	A3C14
Equality	Criterion 15 (C15)	A1C15	A2C15	A3C15
	Criterion 16 (C16)	A1C16	A2C16	A3C16
Cost Efficiency	Criterion 17 (C17)	A1C17	A2C17	A3C17
Effectiveness	Criterion 18 (C18)	A1C18	A2C18	A3C18
Uncertainty	Criterion 19 (C19)	A1C19	A2C19	A3C19
Tightness	Criterion 20 (C20)	A1C20	A2C20	A3C20
Transparency	Criterion 21 (C21)	A1C21	A2C21	A3C21
	Criterion 22 (C22)	A1C22	A2C22	A3C22

Cell A1C1: Co-management got a relatively high rating with a green color under Criterion 1 (integrity). Co-management boards usually have a clear decision-making process, specifying different rights and responsibilities for different levels of stakeholders. Integrated decision-making principles, rules and regulations can be found in a co-management arrangement easily and stakeholders are encouraged to participate in equitable voting systems. Co-management boards also encourage stakeholders to carry out necessary trade-offs for achieving consensus and making decisions.

Cell A2C1: Co-governance rated medium for integrity of decision-making rules with a yellow color. Co-governance arrangements have some principles for proposal rating and selection, but there's little chance for local stakeholders to have trade-offs and equal voting rights with government departments since the governing authority of the governance body is generally delegated from higher level government departments.

Cell A3C1: Shared leadership got the lowest rating (red) in regard to the integrity of rules for the decision-making process (Criterion 1). Because in a shared leadership model, stakeholders typically participate as contributors or advisors to the management plans instead of participating as decision makers. As a consequence, stakeholders don't need to rank or vote for the proposals under this arrangement and there are no rules for instructing stakeholders to make decisions within this arrangement.

Cell A1C2: Co-management arrangements have guidelines and principles for encouraging public participating in the decision-making processes, as a consequence, this form of arrangement got a high rating (green) under Criterion 2. Such co-management boards contain representatives from local communities and initial decisions are made at a lower level by members of the public (see

Figure 3: the decision-making process of NWMB for details), then progressively pass through higher level decision-makers. There is also some guidance for holding public hearings, community visits and workshops regularly. So, the overall rate of public participation in co-management arrangements' is high.

Cell A2C2: Co-governance arrangements are rated medium (yellow) for public participation guidelines (Criterion 2). In co-governance practices, decisions are made by the governance body and the members on governance boards are selected by both the government and communities. Although the governance board considers public opinions in the decision-making process, there are no guidelines for the public to participate directly in such a decision-making process.

Cell A3C2: Shared leadership is rated relatively high (green) for public participation (Criterion 2). For example, there are clear public partnership principles in the New Shared Arctic Leadership Model (Simon, 2017). Representatives from different government levels, community members, industry participants, NGOs and scientists can discuss directly with the Minister's Special Representative (MSR) within this arrangement.

The next criterion is related to legislation upon which different forms of institutional arrangements are based (Criterion 3). There are three legislative levels namely, Land Claim Agreement, federal regulations/laws/memorandums of understanding, and official/public documents of federal/territorial/local departments.

Cell A1C3: Co-management is rated at a high level with respect to the legislative criterion with a green color. Co-management arrangements in Canada established under land claims agreements are supported by the *Section 35 of the Constitution Act* or, in other words, have a "Duty to Consult" (Canada Act, 1982). Also, some federal departments and territorial governments have

developed a series of regulations and guidelines to promote and support co-management processes.

Cell A2C3: Co-governance arrangements also obtain a high level for legislative concerns (green). Co-governance arrangements have a strong legal basis from federal regulations or memorandums of understanding. Also, multiple levels of governments have some regulations and guidelines to support a cooperation among diverse stakeholders from multiple governance levels inside the governance body.

Cell A3C3: Conversely, the shared leadership arrangement has been rated as a lower legislative level (red). Shared leadership is seldom used in resource management or area governance; thus, it is hard to identify a related legislative basis within the current legal system. Although the New Shared Arctic Leadership Model is supported by the federal department INAC, currently, there's no supportive legislations from other federal departments, territorial governments or the land claims agreements.

Different levels of governance, such as federal, territorial/provincial or local level, have different political power and jurisdictions. Criterion 4 addresses the governance level involving in the particular form of institutional arrangement.

Cell A1C4: Co-management rated a green color with a high degree of multi-level governance institutions' involvement. Taking the Nunavut Wildlife Management Board (NWMB) for example, the decision board includes representatives from local, territorial, federal governments, NGOs, business sectors and other related organizations.

Cell A2C4: Similarly, co-governance was also rated with the green color because this form of institutional arrangement encourages cooperation among local, territorial, federal and even international institutions. The Australia co-governance board for natural resources management has combined local stakeholders and decision makers from multiple federal government departments together to balance their needs.

Cell A3C4: In contrast, shared leadership only rated in a yellow color for only including stakeholders from limited governance levels in the decision-making process. The proposed New Shared Arctic Leadership Model has engaged participants from the federal government, territorial government and local communities. There are diverse involvements of vertical government levels, however, the horizontal participation from different federal departments is limited. To be specific, ministers from INAC, ECCC and DFO engaged in this shared leadership model (Simon, 2016), while other important federal departments such as TC, NRCan and Parks Canada didn't participate in this developing process.

Criterion 5 focuses on different ranges of jurisdictional areas. The arrangement used in single or small jurisdictional area will rate red while an arrangement used for large management areas or multiple jurisdictions will be rated with green.

Cell A1C5: Co-management was rated very low with a red color according to this criterion. As noted earlier, co-management arrangements are widely used for resource management and managing Marine Protected Areas (MPAs). What these two applications have in common is a specific management area with multiple jurisdictions. Although management areas occur at different sizes in different co-management plans, nevertheless these areas are very specific with precise boundaries and functional divisions. However, from the perspective of marine shipping

management, this form of institutional arrangement is not suitable for managing shipping activities which cover large areas with multiple jurisdictions and multiple resources.

Cell A2C5: Co-governance was rated relatively high with a green color under the Criterion 5 for multiple jurisdictions. Co-governance arrangements have been developed for governing large areas covering multiple jurisdictions. In Australia, the co-governance arrangement for natural resources addresses this issue at a national scope. Thus, this form of institutional arrangement is suitable for marine shipping management from the perspectives of large areas and multiple resources management.

Cell A3C5: Having a high degree of fulfilling the criterion for multiple jurisdictions, shared leadership rated a green color. Shared leadership has been applied to address complicated issues in a relatively large area, namely the Canadian Arctic, which has diverse resources and covers multiple jurisdictions.

Cell A1C6, Cell A2C6 and Cell A3C6: Criterion 6 evaluates the specificity of management issues that different forms of institutional arrangements use in application. Co-management was rated as yellow under the criterion for specificity. Marine shipping management is a broad issue related to managing multiple resources and multiple jurisdictions. Co-management, however, has generally been applied to solve management issues which are specific, such as fisheries quota, wildlife hunting quota or MPAs with specific management targets. Co-governance got high rating with a green color since co-governance has been applied for solving comprehensive issues. Such issues address the governance of a relatively large area, which covers multiple jurisdictions with different resources. Co-governance is more applicable for maritime governance given its extensive range of applications. Shared leadership can also be used to address comprehensive

issues in a large area. However, shared leadership has very few applications in resource management. As a result, this form of institutional arrangement was only rated as a medium level with a yellow color.

Cell A1C7, A2C7 and A3C7: Criterion 7 is used for evaluating the clarity of management purposes. Co-management got a high grade with a green color for the criterion of specify. Co-management arrangements usually have very specific managing areas, purposes and targets. For example, fisheries co-management has specific management targets like quota and Total Allowable Catch (TAC). Co-governance ranked in a medium position with a yellow color. Co-governance arrangements usually have some general targets to reflect the common interests of multiple stakeholders. In contrast, the form of shared leadership as an institutional arrangement for management issues, was assigned a red color due to its very broad management purpose and vague management outcomes.

The clarity of stakeholders' roles and responsibilities are measured by Criterion 8. Arrangements setting clear roles and responsibilities for participating stakeholders will be rated with a green color while stakeholders' vague roles and general responsibilities will result in a red color.

Cell A1C8: Stakeholders on a co-management board have clear recognition of their roles and responsibilities as decision makers. Local level decision makers can make basic local decisions and then report them to the decision makers in upper levels. Although decision makers from the federal government level usually have the final approval right for decisions, but they can only reject decisions when the evidence is not enough to support decisions made by local level decision makers (NWMB, 2016). Therefore, co-management was assigned a green color for its clear descriptions for stakeholders' responsibilities.

Cell A2C8: Co-governance only got a medium ranking with a yellow color due to the fact that stakeholders' roles and authorities are not very clear and specific. Stakeholders' authorities are delegated from the upper level governance institutions whether they are decision makers, information collectors or reporters are decided by the overall governance arrangement.

Cell A3C8: Shared leadership got a red rating for participants' vague roles in an arrangement. Participants in the shared leadership model are supposed to participate as decision makers instead of only making contributions to the future management plan. However, in the Shared Arctic Leadership Model, stakeholders currently participate primarily as contributors who provided information and knowledge for federal government decision makers.

Cell A1C9, A2C9 and A3C9: Criterion 9 is used to illustrate different financial sources for institutional arrangements. Co-management arrangements got a green color for their adequate financial support from related government departments, multiple organizations (including NGOs) and different companies who have interests in the management areas. Co-governance was also rated as a good arrangement with a green color for its adequate funding. However, it seemed like shared leadership often does not have enough financial support due to its relatively limited range of stakeholders' participation. In the current stage, the Shared Arctic Leadership Model is funded by INAC. Territorial governments and industries got involved in the developing process only as participants not as funders. So, shared leadership was assigned with a medium yellow.

Cell A1C10, A2C10 and A3C10: Criterion 10 measures the continuity of funding. Co-management arrangements are routinely revised on a regular time period, so co-management got a green color for its steady financial support. Co-governance bodies can also get predictable

funding from federal departments and other sources; therefore, co-governance was rated in green. Co-management and co-governance plans and investments are made cyclically, and the funding duration was accepted by the stakeholders before the implementation. Shared leadership only got a medium rank with yellow for its program-based mode and unclear research duration. The second phase of the new Shared Arctic Leadership Model was completed in February 2017, the funding source for the next phase was not described in its final report.

Cell A1C11, A2C11 and A3C11: The three institutional arrangements were evaluated under a Criterion 11 for multiple impacts analysis. Co-management and co-governance got a high rate (green) because of their considerations of economic, social and ecological impacts in the decision-making process, while shared leadership only ranked as yellow due to its limited business participants and its limited consideration of the economic aspect.

Cell A1C12, A2C12 and A3C12: Criterion 12 addresses the knowledge co-production process within the decision-making process for a given institutional arrangement. Co-management and co-governance got high rank (green) for their integrated knowledge production process of both scientific and traditional knowledge. Similar, the current outcomes of the Shared Arctic Leadership Model showed traditional and scientific knowledge co-production on issues related to socio-economic well-being of indigenous people and ecological conservation of the Arctic environment. However, limited consideration has given to technological and economic aspects. Therefore, shared leadership only got a medium rate (yellow).

Cell A1C13, A2C13, and A3C13: Criterion 13 focuses on the representativeness of stakeholders in the decision-making process. Co-management was rated high with a green color for its integrated stakeholders of governments, NGOs, communities, scientists and industry

representatives into decision-making process. Co-governance boards get their authority from government, resulting in fewer representatives from industries and business areas. Therefore, co-governance only got a yellow color with medium rating. The current shared leadership arrangement has encouraged the public participation in the developing process. However, in the current stage, representatives from territorial governments, industrial companies and communities did not participate as decision makers. Consequently, shared leadership only got low rating with a red color.

Cell A1C14, A2C14 and A3C14: Co-management and co-governance were rated in green according to Criterion 14 for representation of different interests of multiple stakeholders. In order to reflect and balance their interests, stakeholders are encouraged by some principles within the arrangements to achieve consensus or trade-offs. Shared leadership was rated as medium yellow due to its emphasis on communities' interests but lack of reflecting some special business interests.

The next two criteria focus on the equality of the arrangements. Criterion 15 measures voting equality in the decision-making process. And Criterion 16 measures the equality of benefits and impacts that stakeholders can get from the arrangement.

Cell A1C15: The co-management arrangement was rated as green for equal voting rights. Stakeholders from the same level of governance institution, or marine-related sectors, usually have equal voting rights for making decisions or selecting decision packages through co-management. In some co-management plans, all the stakeholders participated as decision makers and have the same voting rights as federal representatives for selecting proposals.

Cell A2C15: In comparison, local stakeholders in a co-governance arrangement cannot get equal rights compared to the government departments since their authorities were delegated from upper-level government. Therefore, co-governance only got a yellow color with medium rank.

Cell A3C15: A shared leadership arrangement rated low under the criterion for equal voting. Local participants have made contributions to the comprehensive management plan in studied examples, but the arrangement didn't cover any principles for those stakeholders to vote for anything. Therefore, most stakeholders are not decision makers within the shared leadership mode, and they don't have equal voting rights in the decision-making process.

Cell A1C16: Co-management arrangements got high rank under this criterion for equally impacting and benefiting various stakeholders. Equality doesn't mean getting the same impact and benefit from the same issue but getting benefits on key interests and reaching compromises on other issues. The trade-offs and voting principles in the co-management approach support stakeholders to get relatively equal impacts and to benefit equally from the management plan.

Cell A2C16: Co-governance was rated as a medium rank with a yellow color. In a co-governance arrangement, the government usually sets up some priorities or major considerations in advance. These priorities aim to achieve the overall governance target, which may bring more benefits to key stakeholders regarding to key issues. In short, although a co-governance arrangement often tries to balance the interests of all stakeholders, there are some stakeholders which may need to make certain sacrifices without a balancing offset.

Cell A3C16: Shared leadership was only rated low with a red color. To date, developed under the supports from INAC, the Shared Arctic Leadership Model has placed more consideration on the

indigenous communities' side. Therefore, community members are supposed to get more benefits from this form of institutional arrangement.

Criterion 17 measures the cost efficiency of different forms of institutional arrangements. Cost efficiency is measured through the amount of consumed time and energy during the decision-making process.

Cell A1C17, Cell A2C17, and Cell A3C17: Co-management got a really low rate under the criterion of cost efficiency. Some co-management processes have taken a long time to achieve consensus among stakeholders or to balance their interests. Consensus and balances are critical to a co-management plan and cannot be avoided. Therefore, co-management arrangements have been criticized for their low cost-efficiency. However, once consensus has been reached by multiple stakeholders, the remaining decision-making process becomes more efficient. Co-governance was ranked as a medium cost efficiency. Since the government has set up some priorities beforehand, the stakeholders or decision makers can allocate more resources to targeted issues. This clear orientation helps the implementation to be carried out in an efficient way. Shared leadership ranked high with a green color for its higher cost efficiency. Although a shared leadership model usually has general targets for their projects, in the example, Minister's Special Representative (MSR) can choose the most efficient way for public participation or for addressing management issues.

Cell A1C18, A2C18 and A3C18: According to Criterion 18 (effectiveness), co-management and co-governance were rated very effective with green colors because their management plans usually have real and broad impacts on the management areas and resource users. Conversely, the shared leadership arrangement wasn't effective for solving management issues for lack of

experience in resource management related areas. Therefore, shared leadership was ranked as low effective with a red color.

Cell A1C19, A2C19 and A3C19: Criterion 19 measures the uncertainty in different arrangements. Co-management has the highest rate of uncertainty (red) compared to the other two arrangements. It is hard to achieve consensus among multiple stakeholders who have conflicting interests and strong say in the decision-making process. Co-governance performed better with a yellow color, since the government usually sets up priorities and provides orientation for governance body. Shared Arctic Leadership Model rated with the lowest level of uncertainty because instead of a manageable plan, the current outcomes are mainly suggestions. These suggestions have been accepted by participants so that the overall rate of uncertainty is low.

Relationships among different stakeholders are evaluated according to Criterion 20. An institutional form will be rated in a green color if stakeholders can develop or share a strong relationship among themselves.

Cell A1C20: Relationships in a co-management arrangement were rated as medium strong (yellow), since the stakeholders are usually representatives from independent organizations or departments. They were called to participate in the co-management process bringing their own interests and priorities. Therefore, stakeholders in co-management board are less strong in relationships and partnerships.

Cell A2C20: Representatives in a co-governance body have strong relationships among themselves. Decision makers in the co-governance board were selected and appointed by both the federal government and the community members and the work in the governance body is

full-time work for them. Decision makers form the governance board with consensus on the issues and targets and aim to achieve these targets. Therefore, co-governance was ranked in a relatively high position with a green color.

Cell A3C20: Shared leadership stakeholders got a medium strong (yellow) for relationships among each other. Most communities' members shared strong relationships built on their traditions, which contribute to total tightness of the institutional arrangements. However, the connections among federal departments, territorial governments and industrial representatives are not strong.

The last two criteria measure the transparency of an institutional form.

Cell A1C21, Cell A2C21 and Cell A3C21: Criterion 21 focuses on stakeholders' access to the needed information. Stakeholders in co-management and co-governance arrangements can access information used for decision-making process, so they were rated with high information transparency. However, the shared leadership model was rated with a red color because it didn't mention the way information is shared between participants and government leaders.

Cell A1C22, Cell A2C22 and Cell A3C22: Information transparency to the public is measured by Criterion 22. The co-management arrangement was ranked as high transparency for sharing information with public outsiders. The co-management boards, such as the Nunavut Planning Commission (NPC) usually have all kinds of online resources of information collection and decision-making process. Co-governance rated medium transparency (yellow) for the regular release of their reports and decisions. Shared leadership is rated as a relatively low transparency for its few materials and information that are open for the public, and the major reports do not help outsiders understand their arrangements.

In conclusion, the MCDA decision matrix provides an intuitive way to show the evaluation results for the three alternative forms of institutional arrangements based on the information and opinions derived from the literature review.

Chapter 5 DISCUSSION and RECOMMENDATIONS

The literature review provided background information on marine shipping and alternative forms of institutional arrangements within the Northern Marine Transportation Corridors (NMTC) initiative. Multiple Criteria Decision Analysis (MCDA) provided a logic framework and tool for evaluating different forms of institutional arrangements. In this section, the final results of the MCDA decision matrix for the three selected institutional arrangements are discussed. Next, the future application of this methodology is described. Finally, limitations of this study are presented, followed by some recommendations for both the evaluation process and the decision-making process.

5.1 Discussion of results

According to the decision matrix for the MCDA (Table 6), co-management received 15 green cells, 2 yellow cells and 3 red cells. Co-management was ranked at the highest level under most of the criteria, except for jurisdictional area size, practicality for solving comprehensive issues, cost efficiency, uncertainty and tightness.

The evaluation results of co-governance have a strong tendency for middle of the road outcomes. Co-governance didn't receive any red cells and received 11 green cells as well as 9 yellow cells for 20 criteria. The results illustrated that co-governance was as good as co-management under some criteria, while not superior in the remaining criteria.

The model of shared leadership only received 4 green cells under the criteria of public participation principles, cost efficiency and uncertainty. Another 8 aspects were ranked as yellow. The 8 low scores with red color appeared under the criteria for procedure integrity, legal basis, clear purpose, clear stakeholder roles, limited sectors, equality, effectiveness and transparency.

Table 7. Results Summary of MCDA Decision Matrix for 3 Institutional Arrangements

	Green (High)	Yellow (Medium)	Red (Low)
Co-management	15	2	3
Co-governance	11	9	0
Shared Leadership	4	8	8

According to the results, co-management seems to be the best form of institutional arrangement for managing marine shipping activities within the NMTC (Table 7). Osherenko (1988) pointed out that in a decision-making process, stakeholders preferred high engagement rates and complete decision-making rules. These characteristics can be found in co-management arrangements. Furthermore, the well-established institutional structure, rich research and practical experience of co-management in the Canadian Arctic can contribute to successful shipping co-management. However, the low cost-efficiency and large uncertainty of the implementation of co-management remain as problems to be solved in the future. Co-management has been widely recognized for integrating different stakeholders in decision-making processes, although reaching consensus among many stakeholders can increase management complexity and costs (Goetze, 2004). These contradictions can limit the overall effectiveness of co-management.

Co-governance has a medium cost-efficiency and medium rate of uncertainty. The governance authority is delegated from the upper-level government, and the government usually sets up general targets and orientations in advance (Dodson, 2014). Therefore, stakeholders participate in such decision-making process with pre-existing consensus on priorities. Furthermore, co-governance has been applied to solving comprehensive issues with multiple jurisdictions and multiple resources (Fenwick et al., 2012). The successful co-governance experiences can also help in developing the maritime governance plan for NMTC in the Canadian Arctic, since Arctic marine shipping management covers a wide range of areas and multiple resources related to shipping activities.

Shared leadership was rated as medium and low according to most of these criteria, because this form of arrangement lacked experience in resource and environmental management areas.

Although stakeholders in a shared leadership mode have cohesive relationships between themselves (Cox et al., 2003), the incomplete process can prevent stakeholders from making decisions in practice. The institutional form of shared leadership needs further development and more discussions for its future application in maritime governance. At its current stage of development, it seems that shared leadership is not applicable and suitable for solving marine shipping management issues within NMTC.

From the former analysis of the three forms of institutional arrangements, each of them has its own advantages and limitations. Through MCDA, all those advantages and limitations are reflected in the decision matrix results. Therefore, MCDA is a suitable comparative tool for stakeholders to evaluate and select appropriate institutional forms for management issues.

- Co-management is more suitable when:
 - The management problem is concrete and definite;
 - Legal basis is strong;
 - Financial support is adequate;
 - Management areas have clear boundaries;
 - Complete internal regulations can help all stakeholders' rights to speak and make decisions.

- Co-governance is better when:
 - Multiple levels of governance exist;
 - A large governance area exists whose impact extends beyond a single jurisdiction or single resource;
 - Stakeholders have strong relationships between themselves.

- Shared Leadership is more beneficial when:
 - A large management area exists whose impact extends beyond a single jurisdiction or single resource;
 - Members are closely linked and share the same status when making decisions;
 - Financial support is limited, or high cost-efficiency is required.

In conclusion, the MCDA decision matrix reflected that, based on current literature, co-management is the most appropriate form of institutional arrangement for marine shipping management within NMTC. In other applications, stakeholders can use this MCDA approach to choose appropriate institutional form for particular management issues, perhaps applying

different conceptualizations of the problem as well as a different set of criteria. In order to make better choices, stakeholders may need to understand the strengths and limits of different institutional arrangements before the evaluation.

5.2 Future application

The methodology of this study can be used in the future NMTC stakeholder workshop, which will be held in Iqaluit for developing maritime governance policies. The purpose of the workshop can be to identify stakeholders for the NMTC and select different institutional arrangements for maritime governance through NMTC.

By using the identified factors and receptors of Arctic marine shipping activities, the first session of the workshop will identify stakeholders related to maritime governance through the NMTC framework. The purpose of this session is to confirm *who* can make decisions for marine shipping through NMTC and *what* they want to manage. Next, based on their own experience, stakeholders can use selected criteria to evaluate different forms of institutional arrangements and select the most suitable form for managing marine shipping activities in NMTC. The purpose of this session is to show *how* stakeholders want to manage marine shipping activities.

Furthermore, in real applications, stakeholders always have some priorities among selected criteria. For example, some of the stakeholders may consider that the legal basis is essential to an arrangement, while others may think the financial support and cost efficiency are more crucial to the implementation of the management plan. Therefore, some preparations can be made before the institutional evaluation session. For example, stakeholders can reach a consensus on weights for each criterion beforehand and then, instead of different colors, scores can be assigned to

different alternatives. Thus, more accurate results can be delivered through a weighted calculation system.

5.3 Limitations of this study

This section will demonstrate the limitations of this research.

First, this research is exploratory and preliminary. The selected forms of institutional arrangement were deduced from previous practices and the literature review. This study may not consider enough of the stakeholders related to marine shipping activities, as only major stakeholders were identified in this study. However, there are likely some stakeholders that are not evident to researchers, but who have influence on the local area. These stakeholders can be confirmed with the further development of related research and consultation with existing stakeholders. As well, the selection of the attributes and criteria is not robust enough. These criteria were selected from the previous literature review, while in a real application, stakeholders may propose some other criteria based on their own management experience with maritime issues.

Also, this study doesn't have a complete MCDA analysis process. The traditional MCDA process should include a weighting system and weighted calculation. However, in this study, there were no weights assigned to criteria as they are all considered equal, while stakeholders may have some priorities for some criteria. Therefore, in the true practice, stakeholders can reach consensus on weights for criteria before they start rating each form of institutional arrangement.

Although this study has some limitations, it achieved its major purpose of demonstrating that MCDA is a useful tool for analyzing and selecting the best form of institutional arrangement for managing marine shipping activities in the Canadian Arctic. By using the example for an NMTC

workshop, this study will pave the way for future studies on stakeholder analysis and framework evaluations.

5.4 Recommendations

Following are some recommendations for evaluating and selecting appropriate forms of institutional arrangements for maritime governance within NMTC by using Multiple Criteria Decision Analysis. These recommendations address two aspects of the management problem: the evaluation process and the decision-making process.

First, as for the evaluation process, it may be better to allocate weights to different criteria and use weighted calculations to get precise results. These measures can help stakeholders achieve more convincing outcomes and prevent a polarization effect, which would partially benefit some of the stakeholders. Also, in future applications, resources and time can be invested in those attributes and criteria which have a relatively large proportion in the weighting system. This can increase the total cost efficiency of the institutional arrangements.

Second, in order to build up an effective decision-making process, it is important to understand *who* can manage marine shipping and *what* they want to manage in advance. In a decision-making process, different participants may generate different decisions due to their interests. Therefore, it is very important to identify stakeholders and their interests in advance, so that stakeholders' needs are fully considered during the decision-making process.

Third, previously reached consensus is critical to the decision-making process. Decision makers should promote more gradual consultations, open meetings, workshops or other patterns of public involvement activities to help stakeholders reach broad consensus before final decisions

are made. As for managing marine shipping within NMTC, these activities will help stakeholders select attributes and corresponding criteria for shipping policy making.

Fourth, it may be advantageous to combine the strengths of each institutional form into one arrangement and form the best institutional arrangement to manage marine shipping in the Arctic. For example, co-management could learn some lessons from the co-governance arrangement such as letting the federal government set up priorities in advance in order to achieve higher cost efficiency.

Fifth, during the decision-making process, stakeholders should adhere to principles of aboriginal consultation and accommodation, by following the instructions and guidelines provided by the federal government, for example, *the Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult - March 2011* (INAC, 2011). Decision makers for the NMTC should integrate those principles into the development and implementation of institutional arrangements.

Last but not least, incorporating both scientific knowledge and TEK into the decision-making process is important. Considering TEK during the development of the Arctic marine shipping policy framework can provide better understanding of Indigenous Peoples' relationship with marine and coastal areas. In order to achieve this target, decision makers should combine other effective methods to capture and communicate TEK as well as to develop knowledge co-production process for marine shipping activities, such as using recording equipment to collect data from interviews and using maps to better display the TEK collected from indigenous people.

Chapter 6 CONCLUSION

The anticipated increase of marine shipping activities in the Canadian Arctic has presented risks and challenges to both coastal and marine environments, resulting in the urgent need for developing a maritime governance policy framework for this area. Maritime management is a complex issue that bridges international, national, territorial and local levels of governance as well as different sectors, such as environment protection, business, resources extraction, and Indigenous Peoples' rights.

To deal with this complex management issue, the Canadian government proposed “Low Impact Shipping Corridors” or Northern Marine Transportation Corridors (NMTC), which is a promising initiative. Considering the limitations in the NMTC design, it is important to set up a decision-making policy framework, which can mitigate risks and maximize benefits for multiple stakeholders. Some institutional arrangements have already been implemented to address comprehensive issues. In this study, three forms of institutional arrangements were selected from a literature review as alternatives, namely co-management, co-governance and shared leadership.

This study acts as a starting point for managing marine shipping within NMTC and offers an example for evaluating forms of institutional arrangements using Multiple Criteria Decision Analysis (MCDA). This paper showed that MCDA can be used as an evaluating tool for institutional arrangements or policy frameworks. The results illustrated that, based on a literature review, co-management was more suitable for maritime governance in the Canadian Arctic. Meanwhile, some strengths of co-governance and shared leadership are worth learning by a co-management board to make up for their structural weaknesses. The methodology in this study can be applied at a future NMTC stakeholder workshop with certain adjustments and can contribute to the future development of NMTC.

Arctic maritime governance is an interdisciplinary issue, and a suitable form of institutional arrangement for decision-making processes can contribute to a successful governing practice. Therefore, maritime managers should understand and choose an appropriate way to develop a decision-making framework and integrate multiple stakeholders into the decision-making process. Managers should respect stakeholders' rights and balance their conflicting interests in order to generate more benefits for both governors and indigenous people, protecting the Arctic marine ecosystem as well as developing the maritime industry in a sustainable way.

REFERENCES

- Ackerman, J. (2004). Co-governance for accountability: beyond “exit” and “voice”. *World Development*, 32(3), 447-463.
- African Maritime Safety & Security Agency (AMSSA). (2017). *Risk Prevention and Maritime Security*. Retrieved from <http://www.amssa.net/intelligence/risk-prevention-and-maritime-security.aspx>
- Agrawal, A., & Lemos, M. C. (2007). A greener revolution in the making?: Environmental governance in the 21st century. *Environment: Science and Policy for Sustainable Development*, 49(5), 36-45.
- Agriculture Fisheries and Forestry Australia (AFFA). (1999). *Managing Natural Resources in Rural Australia for a Sustainable Future*. Canberra: Agriculture Fisheries and Forestry Australia
- Aissi, H., Chakhar, S., & Mousseau, V. (2012). GIS-based multicriteria evaluation approach for corridor siting. *Environment and Planning B: Planning and Design*, 39(2), 287-307.
- Alvesson, M. (1992). Leadership as social integrative action. A study of a computer consultancy company. *Organization Studies*, 13(2), 185-209.
- Ameri, M., & Shewchuk, M. (2007, October 17). *Maritime Security and Safety*. Retrieved from http://www.un.org/depts/los/convention_agreements/convention_25years/07unitar_doaos_2007.pdf
- Angell, A. C., & Parkins, J. R. (2011). Resource development and aboriginal culture in the Canadian north. *Polar Record*, 47(1), 67-79.
- Aporta, C. (2011). Shifting perspectives on shifting ice: documenting and representing Inuit use of the sea ice. *Canadian Geographer/Le Géographe canadien*, 55(1), 6-19.
- Arctic Council (AC). (2009). *Arctic Marine Shipping Assessment 2009*. Retrieved from https://www.pmel.noaa.gov/arctic-zone/detect/documents/AMSA_2009_Report_2nd_print.pdf
- Arctis Knowledge Hub. (2010). *Discharges from Ships in the Arctic*. Retrieved from <http://www.arctis-search.com/Discharges+from+Ships+in+the+Arctic>
- Armitage, D., Berkes, F., & Doubleday, N. (Eds.). (2007). *Adaptive co-management: collaboration, learning, and multi-level governance*. UBC Press.1-15.
- Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners*, 35(4), 216-224.

- Beem, B. (2007). Co-management from the top? The roles of policy entrepreneurs and distributive conflict in developing co-management arrangements. *Marine Policy*, 31(4), 540-549.
- Belton, V., & Stewart, T. (2002). *Multiple criteria decision analysis: an integrated approach*. Springer Science & Business Media.
- Bergman, J. Z., Rentsch, J. R., Small, E. E., Davenport, S. W., & Bergman, S. M. (2012). The shared leadership process in decision-making teams. *The Journal of social psychology*, 152(1), 17-42.
- Berkes, F. (2009). Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of environmental management*, 90(5), 1692-1702.
- Berkes, F., & Armitage, D. (2010). Co-management institutions, knowledge, and learning: Adapting to change in the Arctic. *Etudes/Inuit/Studies*, 34(1), 109-131.
- Berkes, F., Berkes, M. K., & Fast, H. (2007). Collaborative integrated management in Canada's north: The role of local and traditional knowledge and community-based monitoring. *Coastal management*, 35(1), 143-162.
- Beveridge, L., Fournier, M., & Pelot, R. (2015). Maritime Activities in the Canadian Arctic: A Tool for Visualizing Connections between Stakeholders. *Arctic Yearbook 2015*, 51.
- Beveridge, L., Fournier, M., Lasserre, F., Huang, L., & Têtu, P. L. (2016). Interest of Asian shipping companies in navigating the Arctic. *Polar Science*, 10(3), 404-414.
- Binder, C., Hinkel, J., Bots, P., & Pahl-Wostl, C. (2013). Comparison of frameworks for analyzing social-ecological systems. *Ecology and Society*, 18(4).
- Blair, H. B., Merchant, N. D., Friedlaender, A. S., Wiley, D. N., & Parks, S. E. (2016). Evidence for ship noise impacts on humpback whale foraging behaviour. *Biology letters*, 12(8), 20160005.
- Boileau, R., Mak, L., & Lever, D. (2010). Avoiding the next Titanic: Are we ready for a major maritime incident in the Arctic?. *Journal of Ocean Technology*, 5(4), 1-12.
- Board, M., Board, O. S., & National Research Council. (2014). *Responding to Oil Spills in the US Arctic Marine Environment*. National Academies Press.
- Bown, N., Gray, T. S., & Stead, S. M. (2013). *Contested forms of governance in marine protected areas: a study of co-management and adaptive co-management*. Routledge.
- Bradshaw, B. (2003). Questioning the credibility and capacity of community-based resource management. *The Canadian Geographer/Le Géographe canadien*, 47(2), 137-150.

- Buell, M. (2006). *Resource extraction development and well-being in the North: A scan of the unique challenges of development in Inuit communities*. Ottawa, ON: National Aboriginal Health Organization.
- Buixadé Farré, A., Stephenson, S. R., Chen, L., Czub, M., Dai, Y., Demchev, D., ... & Kivekäs, N. (2014). Commercial Arctic shipping through the Northeast Passage: routes, resources, governance, technology, and infrastructure. *Polar Geography*, 37(4), 298-324.
- Burek, K. A., Gulland, F., & O'Hara, T. M. (2008). Effects of climate change on Arctic marine mammal health. *Ecological Applications*, 18(sp2).
- Canada Act. (1982). Being Schedule B to the *Canada Act, 1982* (UK), c 11.
- Canadian Coast Guard (CCG). (2014). *Northern Marine Transportation Corridors Initiative, "Company of Master Mariners of Canada"*. Retrieved from <http://www.mastermariners.ca/maritimes/uploads/05marinecorridors.pdf>
- Canadian Coast Guard (CCG). (2015). *Northern Marine Transportation Corridors Initiative. Warming of the North: Challenges and Opportunities for Arctic Transportation, Supply Chain Management, and Economic Development*. Retrieved from https://umanitoba.ca/faculties/management/ti/media/docs/ALVARO__NMTC_Presentation.pdf
- Chan, F. T., Bailey, S. A., Wiley, C. J., & MacIsaac, H. J. (2013). Relative risk assessment for ballast-mediated invasions at Canadian Arctic ports. *Biological invasions*, 15(2), 295-308.
- Chemical Pollution in the Sea (Chemical Pollution). (2016). *Accidental pollution*. Retrieved from <http://www.chemical-pollution.com/en/sources-pollution/accidental-pollution.php>
- Chircop, A. (2009). The growth of international shipping in the Arctic: Is a regulatory review timely?. *The International Journal of Marine and Coastal Law*, 24(2), 355-380.
- Chuenpagdee, R., & Jentoft, S. (2007). Step zero for fisheries co-management: what precedes implementation. *Marine policy*, 31(6), 657-668.
- Controller and Auditor-General. (2016). *Principles for effectively co-governing natural resources*. Office of the Auditor-General New Zealand. Retrieved from <https://www.oag.govt.nz/2016/co-governance/docs/co-governance-amended.pdf>
- Corbett, J. J., Lack, D. A., Winebrake, J. J., Harder, S., Silberman, J. A., & Gold, M. (2010). Arctic shipping emissions inventories and future scenarios. *Atmospheric Chemistry and Physics*, 10(19), 9689-9704.
- Cox, J. F., Pearce, C. L., & Perry, M. L. (2003). Toward a model of shared leadership and distributed influence in the innovation process: How shared leadership can enhance new

- product development team dynamics and effectiveness. *Shared leadership: Reframing the hows and whys of leadership*, 48-76.
- Craig, D. (2002). Recognising indigenous rights through co-management regimes: Canadian and Australian experiences. *NZJ Env'tl. L.*, 6, 199.
- Dacks, G. (1994). *Nunavut: Aboriginal Self-Determination through Public Government*. Report Prepared for the Royal Commission on Aboriginal People. Retrieved from Canada Communication Group Publishing, Public Works, and Government Services Canada.
- Dale, A. T. (2009). *Inuit Qaujimagatuqangit and adaptive co-management: A case study of narwhal co-management in Arctic Bay, Nunavut* (Master Thesis). Waterloo, Canada.
- Dale, A., & Armitage, D. (2011). Marine mammal co-management in Canada's Arctic: Knowledge co-production for learning and adaptive capacity. *Marine Policy*, 35(4), 440-449.
- Dawson, J., Johnston, M. E., & Stewart, E. J. (2014). Governance of Arctic expedition cruise ships in a time of rapid environmental and economic change. *Ocean & Coastal Management*, 89, 88-99.
- Dawson, J., Maher, P. T., & Slocombe, S. D. (2007). Climate change, marine tourism, and sustainability in the Canadian Arctic: Contributions from systems and complexity approaches. *Tourism in Marine Environments*, 4(2-1), 69-83.
- Dawson, J., Porta, L., Okuribido-Malcolm, S., deHann, M., and Mussels, O. (2016). *Proceedings of the Northern Marine Transportation Corridors Workshop*, December 8, Vancouver, B.C., uO Research: Ottawa, ON.
- Demeyer, R., & Turkelboom, F. (2014). The ecosystem services stakeholder matrix. *OpenNESS manual: Stakeholder analysis for environmental decision-making at local level. EC FP7 Grant Agreement*, (308428).
- Dodson, G. (2014). Co-governance and local empowerment? Conservation partnership frameworks and marine protection at Mimiwhangata, New Zealand. *Society & Natural Resources*, 27(5), 521-539.
- Douvere, F. (2008). The importance of marine spatial planning in advancing ecosystem-based sea use management. *Marine policy*, 32(5), 762-771.
- Drescher, M. A., Korsgaard, M. A., Welppe, I. M., Picot, A., & Wigand, R. T. (2014). The dynamics of shared leadership: Building trust and enhancing performance. *Journal of Applied Psychology*, 99(5), 771.
- Duarte, H. D. O., Drogue, E. L., Araújo, M., & Teixeira, S. F. (2013). Quantitative ecological risk assessment of industrial accidents: the case of oil ship transportation in the coastal tropical area of northeastern Brazil. *Human and Ecological Risk Assessment: An International Journal*, 19(6), 1457-1476.

- Engler, C., & Pelot, R. (2013). *Analysis of Marine Traffic along Canada's Coasts Phase 2 – Part 1: Factors Influencing Arctic Traffic*. Maritime Activity and Risk Investigation Network (MARIN). Retrieved from Dalhousie University, Canada.
- Eriksen, T., Høye, G., Narheim, B., & Meland, B. J. (2006). Maritime traffic monitoring using a space-based AIS receiver. *Acta Astronautica*, 58(10), 537-549.
- Eyring, V., Isaksen, I. S., Berntsen, T., Collins, W. J., Corbett, J. J., Endresen, O., ... & Stevenson, D. S. (2010). Transport impacts on atmosphere and climate: Shipping. *Atmospheric Environment*, 44(37), 4735-4771.
- Feit, H. A. (2005). Re-cognizing co-management as co-governance: Visions and histories of conservation at James Bay. *Anthropologica*, 267-288.
- Ferdous, F. (2015). Co-management approach and its impacts on social, economic and ecological developments: Lessons from Lawachara National Park, Bangladesh. *Int. J. of Res. on Land-use Sust*, 2, 91-98.
- Fenwick, J., Miller, K. J., & McTavish, D. (2012). Co-governance or meta-bureaucracy? Perspectives of local governance'partnership'in England and Scotland. *Policy & Politics*, 40(3), 405-422.
- Fleener, C. L. (2013). *U.S. Arctic Policy, A Race for the Arctic Intelligence and National Security Implications*. Doctoral dissertation, American Military University. Retrieved from https://www.researchgate.net/publication/259694535_US_Arctic_Policy_A_Race_for_the_Arctic_Intelligence_and_National_Security_Implications
- Fletcher, J. (2002, August). The paradox of post-heroic leadership: Gender, power and the “New” organization. In *Academy of Management Conference, Organization and Management Theory Division, August* (pp. 9-14).
- Fletcher, J. K., & Kaufer, K. (2003). Shared leadership: Paradox and Possibility. *Shared leadership: Reframing the hows and whys of leadership*, 21-47.
- Flynn, A. (2013). *A Guide for Integrating Inuit Qaujimajatuqangit into Decision-making for Marine Shipping Development in Nunavut, Canada*. ((Unpublished Master Thesis). Dalhousie University, Canada.
- Frangoudes, K., Marugán-Pintos, B., & Pascual-Fernández, J. J. (2008). From open access to co-governance and conservation: The case of women shellfish collectors in Galicia (Spain). *Marine policy*, 32(2), 223-232.
- Ghosh, S., & Rubly, C. (2015). The emergence of Arctic shipping: issues, threats, costs, and risk-mitigating strategies of the Polar Code. *Australian Journal of Maritime & Ocean Affairs*, 7(3), 171-182.

- Government of Northwest Territories (GNWT). (2005). *Government of the northwest territories policy 53.03. Traditional knowledge*. Retrieved from http://www.enr.gov.nt.ca/sites/default/files/documents/53_03_traditional_knowledge_policy.pdf
- Goetze, T. C. (2004). *Sharing the Canadian experience with co-management: Ideas, examples and lessons for communities in developing areas*. International Development Research Centre, Canada.
- Government of Canada (GOC). (1985). *Navigation Protection Act R.S.C. 1985, c.N-22*. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/N-22/>
- Government of Canada (GOC). (1992). *Coasting Trade Act S.C. 1992, c. 31*. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/c-33.3/>
- Government of Canada (GOC). (1994). *Marine Transportation Security Act, S.C. 1994, c. 40*. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/M-0.8/>
- Government of Canada (GOC). (1996). *Oceans Act: S.C. 1996, c.31*. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/O-2.4/>
- Government of Canada (GOC). (2015). *Nunavut Planning and Project Assessment Act. S.C. 2013, c. 14, s. 2*. Retrieved from <http://laws-lois.justice.gc.ca/eng/acts/N-28.75/>
- Gregory, R. S. (2000). Valuing environmental policy options: a case study comparison of multiattribute and contingent valuation survey methods. *Land economics*, 151-173.
- Grimble, R., & Chan, M. K. (1995, May). Stakeholder analysis for natural resource management in developing countries. In *Natural resources forum* (Vol. 19, No. 2, pp. 113-124). Blackwell Publishing Ltd.
- Head, B. W. (2008). Wicked problems in public policy. *Public policy*, 3(2), 101.
- Head, B., & Ryan, N. (2003). Working with non-government organisations: a sustainable development perspective. *Asian Journal of Public Administration*, 25(1), 31-56.
- Head, B., & Ryan, N. (2004). Can co-governance work? Regional natural resource management in Queensland, Australia. *Society and Economy*, 26(2-3), 361-382.
- Hoffmann, J., & Kumar, S. (2002). Globalisation—the maritime nexus. *Handbook of Maritime Economics and Business, Part, 1*.
- Hodgson, J.R.F., Calvesbert, J.G., Winterbottom, M. (2008). *Arctic Shipping Impact Assessment: Scoping Study*. Prepared for Transport Canada. Retrieved from Marine Affairs Program, Dalhousie University.

- Howell, S. E., & Yackel, J. J. (2004). A vessel transit assessment of sea ice variability in the Western Arctic, 1969–2002: implications for ship navigation. *Canadian Journal of Remote Sensing*, 30(2), 205-215.
- Humpert, M., & Raspotnik, A. (2012). The future of Arctic shipping. *Port Technology International*, 55(11), 10-11.
- Huntington, H. P. (2009). A preliminary assessment of threats to arctic marine mammals and their conservation in the coming decades. *Marine Policy*, 33(1), 77-82.
- Huntington, H. P., Lyngø, A., Stotts, J., & Hartsig, A. (2012). Less ice, more talk: the benefits and burdens for Arctic communities of consultations concerning development activities. *CCLR*, 33.
- Inuit Circumpolar Council (ICC) (2008). *The sea ice is our highway: An Inuit perspective on transportation in the Arctic*. Retrieved from http://inuitcircumpolar.com/files/uploads/iccfiles/20080423_iccamsa_final_pdfprint.pdf.
- International Maritime Organization (IMO). (2015). *Ship's Routeing 2015 Edition*. Retrieved from <https://www.amnautical.com/products/ships-routeing-2015-edition#.VgFiwNwrKUK>
- International Maritime Organization (IMO). (2016a). *Shipping in polar waters: Adoption of an international code of safety for ships operating in polar waters (Polar Code)*. Retrieved from <http://www.imo.org/en/mediacentre/hottopics/polar/pages/default.aspx>
- International Maritime Organization (IMO). (2016b). *Particularly Sensitive Sea Areas*. Retrieved from www.imo.org/en/OurWorkEnvironment/PSSAs/Paes/Default.aspx.
- Indigenous and Northern Affairs Canada (INAC). (2011). *Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult - March 2011*. Retrieved from <http://www.aadnc-aandc.gc.ca/eng/1100100014664/1100100014675>
- Irvin, R. A., & Stansbury, J. (2004). Citizen participation in decision making: Is it worth the effort?. *Public administration review*, 64(1), 55-65.
- Jacobson, C., & Robertson, A. L. (2012). Landscape conservation cooperatives: Bridging entities to facilitate adaptive co-governance of social–ecological systems. *Human Dimensions of Wildlife*, 17(5), 333-343.
- Johnston, A., Johnston, M., Stewart, E., Dawson, J., & Lemelin, H. (2012). Perspectives of decision makers and regulators on climate change and adaptation in expedition cruise ship tourism in Nunavut.
- Kaltenstein, J. (2012). *Slow ships down to protect whales in the Arctic*. Retrieved from <http://www.foe.org/news/archives/2012-02-slow-ships-down-to-protect-whales-in-the-arctic>

- Kangas, A., Saarinen, N., Saarikoski, H., Leskinen, L. A., Hujala, T., & Tikkanen, J. (2010). Stakeholder perspectives about proper participation for Regional Forest Programmes in Finland. *Forest Policy and Economics*, 12(3), 213-222.
- Kaplan, I. M., & McCay, B. J. (2004). Cooperative research, co-management and the social dimension of fisheries science and management. *Marine Policy*, 28(3), 257-258.
- Kelley, K. E., & Ljubicic, G. J. (2012). Policies and practicalities of shipping in arctic waters: Inuit perspectives from Cape Dorset, Nunavut. *Polar Geography*, 35(1), 19-49.
- Kernaghan, K. (1993). Partnership and public administration. *Canadian Public Administration*, 36(1): 57-76
- Khadka, C., & Vacik, H. (2012). Use of multi-criteria analysis (MCA) for supporting community forest management. *iForest-Biogeosciences and Forestry*, 5(2), 60.
- Kitsiou, D., Coccossis, H., & Karydis, M. (2002). Multi-dimensional evaluation and ranking of coastal areas using GIS and multiple criteria choice methods. *Science of the total environment*, 284(1), 1-17.
- Kooiman, J. (2005). *Governing as Governance*. London: Sage.
- Koranyi, B. (2013). Ice levels, rule changes to boost Arctic northern sea route. *Reuters*, 29, 2013.
- Kubat, I., Collins, A., & Timco, G. (2007, June). Year-round shipping in the Canadian Arctic: Ice conditions and regulatory requirements. In *Proceeding of the 19th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC'07)* (pp. 446-456).
- Kum, S., & Sahin, B. (2015). A root cause analysis for Arctic Marine accidents from 1993 to 2011. *Safety science*, 74, 206-220.
- Lasserre, F., & Pelletier, S. (2011). Polar super seaways? Maritime transport in the Arctic: an analysis of shipowners' intentions. *Journal of Transport Geography*, 19(6), 1465-1473.
- Ling, T. (2002). Delivering joined-up government in the UK: dimensions, issues and problems. *Public administration*, 80(4), 615-642.
- Liu, M., & Kronbak, J. (2010). The potential economic viability of using the Northern Sea Route (NSR) as an alternative route between Asia and Europe. *Journal of Transport Geography*, 18(3), 434-444.
- MacKinnon, B.J., & Fraser, E. (2017). Ottawa to force ships to slow down to prevent whale deaths in Gulf of St. Lawrence. *CBC News*. Retrieved from <http://www.cbc.ca/news/canada/new-brunswick/whale-deaths-gulf-temporary-measures-fisheries-transport-1.4242512>

- Malczewski, J., & Rinner, C. (2015). Introduction to GIS-MCDA. In *Multicriteria Decision Analysis in Geographic Information Science* (pp. 23-54). Springer Berlin Heidelberg.
- McGwin, K. (2015). Full Polar Code in Place, But Gaps Remain. *The Arctic Journal*. Retrieved from <https://www.pacificenvironment.org/in-the-news/fill-polar-code-in-place-but-gaps-remain/>
- Mendoza, G. A., & Martins, H. (2006). Multi-criteria decision analysis in natural resource management: a critical review of methods and new modelling paradigms. *Forest ecology and management*, 230(1), 1-22.
- Michailidou, A. V., Vlachokostas, C., & Moussiopoulos, N. (2016). Interactions between climate change and the tourism sector: Multiple-criteria decision analysis to assess mitigation and adaptation options in tourism areas. *Tourism Management*, 55, 1-12.
- Moore, S. E., Reeves, R. R., Southall, B. L., Ragen, T. J., Suydam, R. S., & Clark, C. W. (2012). A new framework for assessing the effects of anthropogenic sound on marine mammals in a rapidly changing Arctic. *BioScience*, 62(3), 289-295.
- Nadasdy, P. (2003). Reevaluating the co-management success story. *Arctic*, 367-380.
- National Snow & Ice Data Center (NSIDC). (2017). *Arctic Sea Ice News & Analysis*. Retrieved from <http://nsidc.org/arcticseaicenews/>
- Nielsen, J. R., Degnbol, P., Viswanathan, K. K., Ahmed, M., Hara, M., & Abdullah, N. M. R. (2004). Fisheries co-management—an institutional innovation? Lessons from South East Asia and Southern Africa. *Marine Policy*, 28(2), 151-160.
- Northouse, P. G. (2015). *Leadership: Theory and practice*. Sage publications.
- Nunavut Land Claims Agreement (NLCA). (1993). *Agreement Between The Inuit of The Nunavut Settlement Area and Her Majesty The Queen In Right of Canada*. Government of Nunavut (GN). Retrieved from <http://www.gov.nu.ca/sites/default/files/files/013%20-%20Nunavut-Land-Claims-Agreement-English.pdf>
- Nunavut Planning Commission (NPC). (2014). *Spatial Data for Areas Identified During Community Meetings on the Draft Nunavut Land Use Plan (DNLUP)*. Retrieved from <http://www.nunavut.ca/en/downloads>
- Nunavut Planning Commission (NPC). (2016). *2016 Draft Nunavut Land Use Plan*. Retrieved from http://www.nunavut.ca/files/2016DNLUP/2016_Draft_Nunavut_Land_Use_Plan.pdf
- Nunavut Wildlife Management Board (NWMB). (2016). *NWMB Co-Management*. Retrieved from <https://www.nwmb.com/en/about-nwmb/co-management-partners>

- Office of the Controller and Auditor-General (OAG). (2016). *Principles for effectively co-governing natural resources*. Office of the Controller and Auditor-General, New Zealand.
- Osherenko, G. (1988). Wildlife management in the North American Arctic: The case for co-management. *Traditional knowledge and renewable resource management in northern regions*. M. Freeman and L. Carbyn (editors). University of Alberta Boreal Institute for Northern Studies, Edmonton, Alta, 92-104.
- Østreng, W., Eger, K. M., Fløistad, B., Jørgensen-Dahl, A., Lothe, L., Mejlænder-Larsen, M., & Wergeland, T. (2013). *Shipping in Arctic waters: a comparison of the Northeast, Northwest and trans polar passages*. Springer Science & Business Media.
- Parsons, J., Dinwoodie, J., & Roe, M. (2011). Northern opportunities: A strategic review of Canada's Arctic icebreaking services. *Marine policy*, 35(4), 549-556.
- Pearce, C. L., & Sims, H. P. (2000). Shared leadership: Toward a multi-level theory of leadership. In *Advances in interdisciplinary studies of work teams* (pp. 115-139). Emerald Group Publishing Limited.
- Peters, G. P., Nilssen, T. B., Lindholt, L., Eide, M. S., Glømsrød, S., Eide, L. I., & Fuglestedt, J. S. (2011). Future emissions from shipping and petroleum activities in the Arctic. *Atmospheric Chemistry and Physics*, 11(11), 5305-5320.
- Pew Charitable Trust. (2016). *The Integrated Arctic Corridors Framework Planning for responsible shipping in Canada's Arctic waters*. Retrieved from <http://www.pewtrusts.org/en/research-and-analysis/reports/2016/04/the-integrated-arctic-corridors-framework>
- Pharand, D. (2007). The Arctic waters and the Northwest Passage: A final revisit. *Ocean Development & International Law*, 38(1-2), 3-69.
- Pinkerton, E. (1989). Cooperative Management of Local Fisheries. Vancouver. *British Columbia: University of British Columbia*. Page 1-33.
- Pizzolato, L., Howell, S. E., Derksen, C., Dawson, J., & Copland, L. (2014). Changing sea ice conditions and marine transportation activity in Canadian Arctic waters between 1990 and 2012. *Climatic change*, 123(2), 161-173.
- Pizzolato, L., Howell, S. E., Dawson, J., Laliberté, F., & Copland, L. (2016). The influence of declining sea ice on shipping activity in the Canadian Arctic. *Geophysical Research Letters*, 43(23).
- Pomeroy, R. S., & Berkes, F. (1997). Two to tango: the role of government in fisheries co-management. *Marine policy*, 21(5), 465-480.

- Porta, L., Abou-Abssi, E., Dawson, J., & Mussells, O. (2017). Shipping Corridors as a Framework for Advancing Marine Law and Policy in the Canadian Arctic. *Ocean & Coastal LJ*, 22, 63.
- Port Metro Vancouver (PMV). (2014). *Frequently Asked Questions: Tanker Safety*. Vancouver (BC): PMV. Retrieved from <https://www.portvancouver.com/wp-content/uploads/2015/03/tanker-safety-and-navigation-faq.pdf>
- Prabhu, R., Colfer, C. J. P., & Dudley, R. G. (1999). *Guidelines for developing, testing and selecting criteria and indicators for sustainable forest management: a C&I developer's reference* (Vol. 1). CIFOR.
- Promislow, J. (2013). Irreconcilable: The Duty to Consult and Administrative Decision Makers. *Const. F.*, 22, 63.
- Prowse, T. D., Furgal, C., Chouinard, R., Melling, H., Milburn, D., & Smith, S. L. (2009). Implications of climate change for economic development in northern Canada: Energy, resource, and transportation sectors. *AMBIO: A Journal of the Human Environment*, 38(5), 272-281.
- Reed, M. S. (2008). Stakeholder participation for environmental management: a literature review. *Biological conservation*, 141(10), 2417-2431.
- Ritsema, R., Dawson, J., Jorgensen, M., & Macdougall, B. (2015). "Steering Our Own Ship?" An Assessment of Self-Determination and Self-Governance for Community Development in Nunavut. *Northern Review*, (41), 157.
- Rodon, T. (1998). Co-management and self-determination in Nunavut. *Polar Geography*, 22(2), 119-135.
- Roe, M. (2009). Multi-level and polycentric governance: effective policymaking for shipping. *Maritime Policy & Management*, 36(1), 39-56.
- Rogers, P., & Hall, A. W. (2003). *Effective water governance* (Vol. 7). Global water partnership.
- Rothwell, D. R., & VanderZwaag, D. L. (2006). The sea change towards principled ocean governance. *Towards Principled Oceans Governance: Australian and Canadian Approaches and Challenges*. Routledge, New York, 1-30.
- Schmitt, D. (2014). Arctic: the Challenges of Opening up the Northern Route. *Horizon, the EU Research & Innovation Magazine*. January, 31.
- Sen, S., & Nielsen, J. R. (1996). Fisheries co-management: a comparative analysis. *Marine policy*, 20(5), 405-418.

- Sheppard, S. R., & Meitner, M. (2005). Using multi-criteria analysis and visualisation for sustainable forest management planning with stakeholder groups. *Forest ecology and management*, 207(1), 171-187.
- Simon, M. (2016). *Interim report on the Shared Arctic Leadership Model*. Indigenous and Northern Affairs Canada (INAC). Retrieved from <https://www.aadnc-aandc.gc.ca/eng/1481656672979/1485800424490>
- Simon, M. (2017). *A new Shared Arctic Leadership Model*. Indigenous and Northern Affairs Canada (INAC). Retrieved from <https://www.aadnc-aandc.gc.ca/eng/1492708558500/1492709024236>
- Skjærseth, J. B., & Wettestad, J. (2002). Understanding the effectiveness of EU environmental policy: how can regime analysis contribute?. *Environmental Politics*, 11(3), 99-120.
- Smith, S. L. (2011). *An analysis of marine reserve co-management within the Caribbean: Factors influencing stakeholder participation*. University of Rhode Island.
- Solski, J. J. (2013). New developments in Russian regulation of navigation on the Northern sea route. *Arctic Review*, 4(1).
- Stewart, E. J., Tivy, A., Howell, S. E. L., Dawson, J., & Draper, D. (2010a). Cruise tourism and sea ice in Canada's Hudson Bay region. *Arctic*, 57-66.
- Stewart, E., Draper, D., & Dawson, J. (2010b). Monitoring patterns of cruise tourism across Arctic Canada. *Cruise tourism in polar regions: Promoting environmental and social sustainability*, 133-145.
- Tedsen, E., Cavalieri, S., & Kraemer, A. (2016). *Arctic Marine Governance*. Springer-Verlag Berlin An.
- Transport Canada (TC). (2001a). *Canada Shipping Act, 2001, c.26*. Retrieved from <http://www.tc.gc.ca/eng/acts-regulations/acts-2001c26.htm>
- Transport Canada (TC). (2001b). *Marine Liability Act, 2001, c.6*. Retrieved from <http://www.tc.gc.ca/eng/acts-regulations/acts-2001c6.htm>
- Transport Canada (TC). (2010). *Arctic Shipping Pollution Prevention Regulations (ASPPR)*. Retrieved from <https://www.tc.gc.ca/eng/marinesafety/debs-arctic-acts-regulations-asppr-421.htm>
- Transport Canada (TC). (2015). *Tanker Safety and Spill Prevention*. Retrieved from <http://www.tc.gc.ca/eng/marinesafety/menu-4100.htm>
- Transport Canada (TC). (2016). *Oceans Protection Plan*. Retrieved from <https://www.tc.gc.ca/media/documents/communications-eng/oceans-protection-plan.pdf>

- VanderZwaag, D., Chircop, A., Franckx, E., Kindred, H. M., McConnell, M., McDonald, A. H., ... & Spears, K. J. (2008). Governance of Arctic marine shipping. Retrieved from <http://library.arcticportal.org/391/1/AMSA-Shipping-Governance-Final-Report---Revised-November-2008.pdf>
- van Leeuwen, J. (2015). The regionalization of maritime governance: Towards a polycentric governance system for sustainable shipping in the European Union. *Ocean & Coastal Management, 117*, 23-31.
- van Tol Smit, E., de Loë, R., & Plummer, R. (2015). How knowledge is used in collaborative environmental governance: water classification in New Brunswick, Canada. *Journal of Environmental Planning and Management, 58*(3), 423-444.
- Verny, J., & Grigentin, C. (2009). Container shipping on the northern sea route. *International Journal of Production Economics, 122*(1), 107-117.
- Young, O. R., Osherenko, G., Ekstrom, J., Crowder, L. B., Ogden, J., Wilson, J. A., ... & Halpren, B. S. (2007). Solving the crisis in ocean governance: place-based management of marine ecosystems. *Environment: science and policy for sustainable development, 49*(4), 20-32.
- Young, J. C., Jordan, A., Searle, K. R., Butler, A., Chapman, D. S., Simmons, P., & Watt, A. D. (2013). Does stakeholder involvement really benefit biodiversity conservation?. *Biological Conservation, 158*, 359-370.
- Weber, B. (2015). *Polar Code still leaves significant gaps, experts say*. The Canadian Press. Retrieved from <http://www.cbc.ca/news/canada/north/polar-code-still-leaves-significant-gaps-experts-say-1.3073036>
- Zarghami, M., & Szidarovszky, F. (2011). *Multicriteria analysis: applications to water and environment management*. Springer Science & Business Media.
- Zhang, X., & Armstrong, M. P. (2008). Genetic algorithms and the corridor location problem: multiple objectives and alternative solutions. *Environment and Planning B: Planning and Design, 35*(1), 148-168.