

# Maritime Activities in the Canadian Arctic: A Tool for Visualizing Connections between Stakeholders

Leah Beveridge, Mélanie Fournier & Ronald Pelot

*The Canadian-German project PASSAGES (Protection and Advanced Surveillance System for the Arctic: Green, Efficient, Secure)<sup>1</sup> aims to: (1) determine the needs of Canadian stakeholders for better maritime situational awareness; and (2) design a maritime monitoring system adapted to Arctic conditions. Although the system could be deployed in the circumpolar region as a whole, the geographical zone of interest is the Northwest Passage within the Canadian Arctic archipelago. In its first phase, PASSAGES has created a database by collecting and cross-referencing contextual information and interacting with potential users of such a system (government agencies, shipping companies, communities etc.). Exploring the Canadian stakeholder network is a necessary part of understanding how operations are planned for and conducted. The sources of this information, however, remain fragmented and difficult to locate.*

*The objective here is to take a new approach to sharing stakeholder information through a visualization tool. The goal is to go beyond traditional bibliographies and indexes to provide a comprehensive account of the major stakeholders in the Canadian Arctic, including an evaluation of their scale(s) of operation, their interests, and interactions.*

## Introduction

Maritime activities in the Canadian Arctic have historically been minimal; aside from some offshore oil and gas exploration in the Beaufort Sea, uses have been limited to annual community resupply, minor commercial fishing, and significant local subsistence harvesting. As the climate continues to warm and the sea ice continues to diminish, it is expected that the level of activity by maritime vessels in the Canadian Arctic will also steadily grow. The majority of the growth will be destination traffic for natural resources projects and community resupply, and cruise tourism (AMSA 2009; Lasserre & Pelletier 2011). This change in traffic presents numerous opportunities for economic development both for Canada as well as internationally, such as new transportation routes and increasing cruise tourism. There are also numerous risks, though, most of which revolve around the immense potential environmental damage that could arise from an accident.

To fully understand the potential opportunities, risks, enablers, and barriers associated with developing Canada's maritime Arctic, it is important to gain an understanding of all those involved. Improved stakeholder consideration and integration for more effective governance of maritime

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activities is being promoted at several scales, but understanding the stakeholder environment and coordinating their efforts is no easy feat. The complexity of the interests for using the marine environment in the Arctic arises from the scope and diversity of stakeholders, ranging from international industries, through national government departments, down to local communities and economies.

A holistic view of the wide range of stakeholders involved in marine Arctic activities and the relationships among them appears to be lacking in the current body of literature on these topics. Most studies have focused solely on one or two groups of stakeholders, or one or two sets of interests; it is rare to see work that embraces the diversity of stakeholders and concerns. Furthermore, the reader often can become overwhelmed by the literature that does exist by the level of detail, and the sheer volume of information available makes it difficult to draw connections between stakeholders.

The purpose of this research is to investigate the stakeholders involved in maritime activities in the Canadian Arctic, and to document our findings in a user-friendly visualization tool. This research aims to shed light on all those who are involved in one way or another in maritime vessel-based activities in the Canadian Arctic. In addition, it aids in highlighting the major topics of interest at different operating scales, which will help to identify gaps and overlaps between stakeholders, and provides a platform for future collaboration between groups.

### **Why conduct a stakeholder analysis?**

When decisions about planning and development are made by groups in isolation from other stakeholders, the result is often a fragmented plan with numerous gaps and overlaps. By clearly considering, if not directly including relevant stakeholders in the governance process, conflicts can be avoided and the overall efficiency of the resulting policy can be improved. By identifying and integrating the interests of all stakeholders from the beginning, a better understanding of the social, economic, and environmental systems to be governed can be established and a balance between the interests can be found, thus reducing potential conflicts and maximizing the benefits for each stakeholder (VanderZwaag 1990; Douvere 2008; Halpern et al. 2008; Maes 2008; Pomeroy & Douvere 2008; Beaufort Sea Partnership 2009; Ehler & Douvere 2009; Jay 2009; Ritchie & Ellis 2010; Katsanevakis et al. 2011; Gopnik et al. 2012). Stakeholders are also more likely to support a governance regime when it is clear that their interests have been taken into account (Maes 2008; Jay 2009; Ritchie & Ellis 2010).

Demonstrating the common interests between stakeholders can also facilitate cooperation among themselves, as it is more evident where partnerships can be made (Grimble & Chan 1995; Douvere 2008; Pomeroy & Douvere 2008). It provides an opportunity for all stakeholders to gain a better understanding of the environment within which they work, and perhaps a better understanding of the perspectives and interests of others, allowing for greater transparency and potential for relationship-building (Helmick 2008; Reed 2008).

Arctic maritime activities, the risks, and the potential for development in the changing climate have been widely discussed in the literature, illustrating the extensive range of interests, concerns, and types of activities. Anthropologists and geographers have documented the role indigenous people have to play in developing their territories (Hovelsrud et al. 2012; Kelley & Ljubicic 2012; Flynn 2013); biologists have raised awareness about the risks to the Arctic environment from maritime

activities (Erbe & Farmer 2000; Huntington 2009; Reeves et al. 2012; Chan et al. 2013); engineers have studied technological and structural issues with cold-climate navigation (Frankenstein & Tuthill 2002; Liu, Lau & Williams 2006; Kennedy, Simoes Re & Veitch 2014); and lawyers have described the international and national legal aspects (Pharand 2007; Chircop 2012; Karim 2015). Each of these is an important piece, but putting them together to form a complete picture of the region is challenging.

Some reports have endeavoured to provide an overview of the situation. Many organizations, for example, have produced reports addressing aspects that must be considered when trying to develop marine Arctic activities, all providing a broad perspective of their respective topics (Chatham House 2012; Parsons 2012; Conference Board of Canada 2013; Johnston et al. 2013).

Most notably, however, is the *Arctic Marine Shipping Assessment* (AMSA) (Arctic Council 2009) by the Protection of the Arctic Marine Environment (PAME) working group of the Arctic Council. The AMSA report provides an overview of the aspects that need to be taken into consideration if and when maritime activities progress in the circumpolar Arctic. The working group incorporated the views of a range of stakeholders, and approached the document by ship type, including tankers, bulk carriers, offshore supply vessels, passenger ships, tug/barge combinations, fishing vessels, ferries, research vessels, and government and commercial icebreakers. The focus, however, is on shipping rather than on the stakeholders:

The AMSA is designed to be circumpolar in breadth and also to consider regional and local perspectives. The assessment's central focus is on ships: their uses of the Arctic Ocean, their potential impacts on humans and the Arctic marine environment and their marine infrastructure requirements (AMSA 2009: 2).

Furthermore, given the circumpolar approach, the level of detail on the stakeholders is not present.

The goal herein is not to replace the work of the PAME, or any other authors who have addressed the task of providing a holistic image of Arctic shipping, but rather to amalgamate the information in a way that provides the necessary level of detail without overwhelming the reader with text, while adding valuable information on interrelationships.

## **Why create a visualization tool?**

### ***Data exploration and data sharing***

There are many reasons for visualizing data. Beyond the practical aspects of aiding internal and external communications of a project, visualizations can also be used for sharing data and the products of data processing with groups that are unconnected to a given project. We discussed the use of visualization tools for sharing information with many of the stakeholders of Arctic shipping, all of whom provided their support. Many people do not have the time to sift through literature or the training to understand data and analyses. A visually appealing and easy-to-use tool can provide them the information they need in a timely manner. For example, in conversations with Canadian shipping companies it was mentioned that visualization tools would be particularly helpful for passing knowledge on to new employees.

The main goal of this research was to find a way to visualize and understand the governance of maritime activities by adapting pre-existing data visualization tools. Several projects are dedicated to studying the stakeholders and governance of the Arctic. Unfortunately, when the projects

terminate, the maintenance of the associated tools do as well. There are also a number of relevant indexes and bibliographies (e.g. The Arctic Governance Project, 2010),<sup>2</sup> but they are unclear and difficult to access; that is to say they are hard to find, they are not particularly user-friendly, and they do not provide any kind of analysis. These tools are nevertheless valuable to those who are knowledgeable on the given topic. However, they are not very useful to users who are not experts on the topic of interest.

### *Object of knowledge*

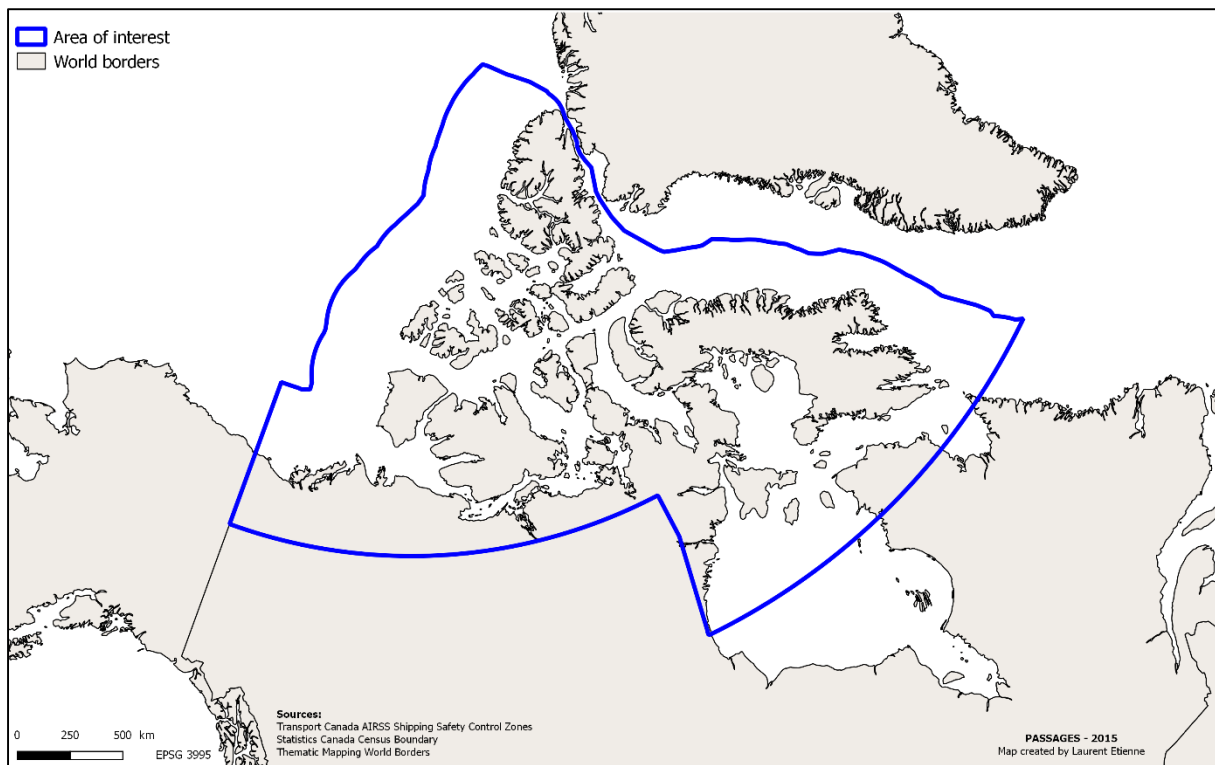
The type of representation we are discussing can be compared, to a certain extent with Geographic Information Systems (GIS). Many people want to use GIS or provide an online GIS platform, but most of the time the result is a simple map with stacked layers of information and relatively little added value. The added value lies where disciplines overlap and factors intersect; it is these aspects that make the Arctic so unique. Recognizing the required interdisciplinarity of marine activities, the aim was to incorporate the complexities of the system: the legal framework, issues related to Inuit traditional use and cultural connectivity to the marine environment, security and defence aspects, safety concerns, the unique climatic conditions, environmental considerations, natural resource development potential, and economic trends. By providing a visualization tool the user is able to consider all the possible links between the stakeholders in the Canadian Arctic as a result of common scale(s) of operations, shared interests, or working relationships. By making the tool interactive, the user is able to see only the information they are interested in, while still having access to the complete picture, thus simplifying the visualization to a user-friendly format. We aim to create a “mediating object of knowledge” (Kaplan, Fournier & Nuessli 2014); we want to provide a tool that is interactive and allows the user to play and explore the structured information.

### *Stakeholder analysis*

According to Grimble and Chan, a stakeholder analysis is “an approach and procedure for gaining an understanding of a system by means of identifying the key actors or stakeholders in the system, and assessing their respective interests in that system” (Grimble & Chan 1995). They also define a stakeholder as an individual, a community, a social group, or an institution that affects and/or is affected by the policies, decisions, and actions of the system. The system we are dealing with is that of maritime traffic in the Canadian Arctic, which is the geographic region described in the *Arctic Waters Pollution Prevention Act* (AWPPA 1985) as waters bound within the 60<sup>th</sup> parallel north, the 141<sup>st</sup> meridian west, the equidistance line between the islands of the Canadian Arctic and Greenland, and a line measured seaward from the nearest land a distance of 100 nautical miles (Figure 1). This definition was chosen because within this area, maritime vessel activities are governed by Arctic-specific Canadian regulations.

The stakeholder analysis was conducted in four steps: 1) general information on the present maritime vessel activities in the Canadian Arctic and the legal framework governing those activities was gathered; 2) stakeholders involved in the different aspects of the activities were spoken to directly; 3) the results were analyzed for commonalities and differences; and 4) a user-friendly tool for visualizing the results was designed and developed.

**Figure 1.** The study's area of interest: the Canadian Arctic marine waters defined by the *Arctic Waters Pollution Prevention Act*, 1985.



### *Methodology & results*

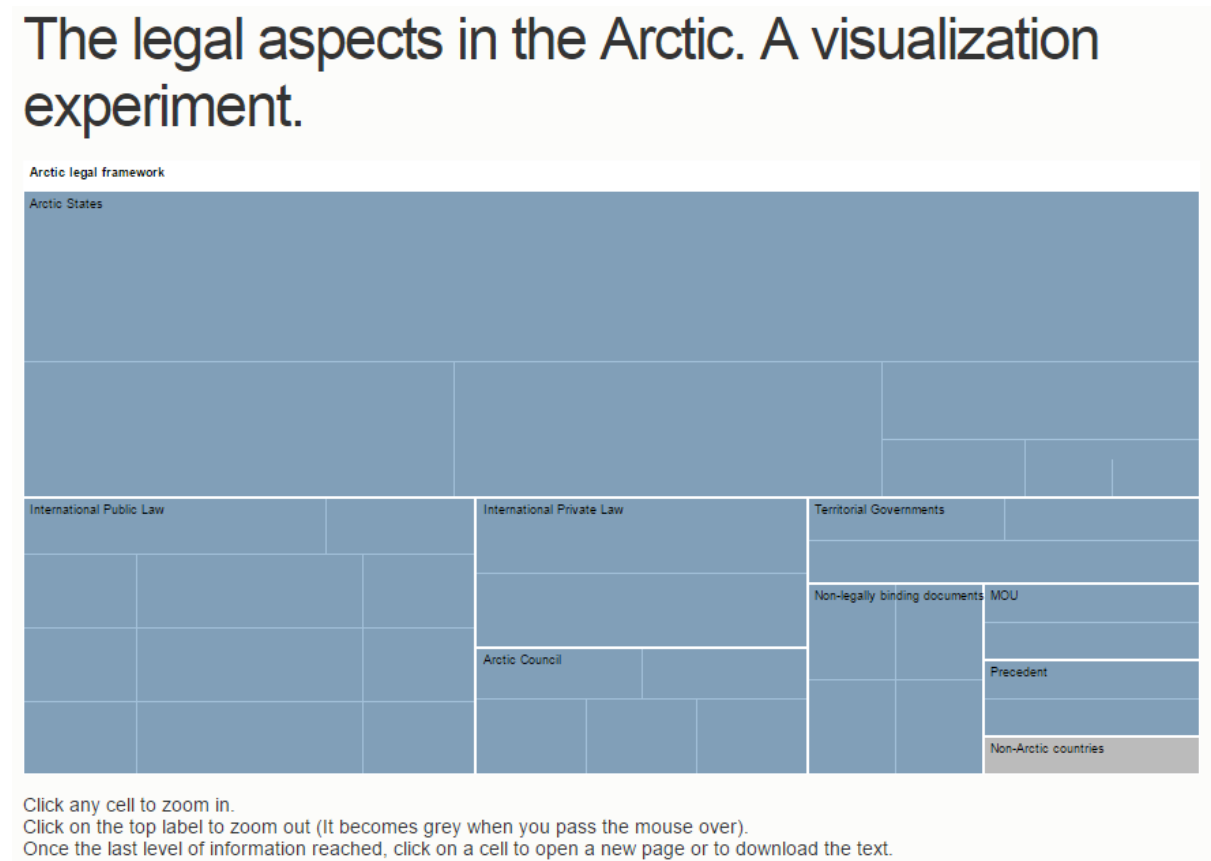
The first step towards analyzing the stakeholders of maritime vessel-based activities in the Canadian Arctic was to identify the stakeholders. Some were easily identified, such as the industries that deploy vessels. Others, such as the organizations that have sway over regulatory bodies were more difficult to isolate. In order to aid this process, an examination of the legal framework surrounding vessel activities in marine Arctic waters in Canada was conducted. To begin, the legal framework was divided into nine categories: international public law, international private law, non-legally binding documents, precedents, Memorandum of Understanding, territorial governments, Arctic Council, Arctic states and non-Arctic states. The last three categories have been sub-divided by territory and by country (see Figure 2 below).

Stakeholders were also identified through a review of the most up-to-date information, including reports, academic publications, news articles, and websites. Further information was gathered through participation in a number of industry- and academia-based conferences and forums, and the networking opportunities provided therein. These events included the Arctic Shipping Forums held in St. John's, Newfoundland and Helsinki, the MASS conference held in St. John's, and the Canadian Marine Advisory Committee - Prairie and Northern Region Meeting in Iqaluit.<sup>3</sup> In addition, formal and informal interviews were conducted to collect expert knowledge of the groups involved, as well as to better understand the interests of the stakeholders and their interactions.

Once the stakeholders, their inputs, and their roles were identified the data needed to be analyzed. Based on the information gathered during interviews and from the mandates provided on the official websites of stakeholders, we determined three criteria for our evaluation: a) the scale at which a stakeholder operates, b) their interests, and c) their interactions. Scale refers to the

geographic level at which the stakeholder focuses: international (including circumpolar), national (Canada-wide), local (limited to a specific region in the Canadian Arctic), or any combination of the three. These three scales reflect the governance regimes: international conventions, national legislation, and local regulations.

**Figure 2.** A screenshot of the tool for understanding the legal aspects relevant to shipping in the Arctic. The tool is available at [http://passages.ie.dal.ca/Legal\\_Aspects\\_Tool.html](http://passages.ie.dal.ca/Legal_Aspects_Tool.html). The user needs to enable the scripts into the browser used to run the tool.



The categories of interest were derived from the working groups of the Arctic Council. We decided to mirror the approach of this intergovernmental organization because of the Council's influential role in the governance of Arctic maritime activities, its work on the AMSA, and because of the support it receives from stakeholders. We determined five categories of interests:

1. *Climate & Environment*: pollution (spills, ejections, discharges, noise, light, invasive species); response; environmental protection; sustainable development; environmental hazards to and from ships; climate change.
2. *Economics*: business development; cost-efficiency; trade; financial gains; economic utilization of natural resources (petroleum, gas, minerals, fish); competitiveness; employment; income; sustainability.
3. *Safety, Security & Defence*: search and rescue; safety of navigation; maritime security; sustainability.
4. *Health & Social*: health; happiness; well-being; tensions and social problems; welfare.
5. *Inuit-Specific Aspects*: culture; language; traditional activities.

Safety, security & defence are grouped for our analysis because of the similarities in concerns within the three topics. Based on a presentation given by Major Pascal Sévigny of the Canadian Department of National Defence at the Warming of the North Conference<sup>4</sup>, they are viewed along a gradient rather than as three distinct areas of interest.

### ***From sources to structured data***

#### *Stakeholder segmentation*

We identified seventy-eight stakeholders; to simplify the analysis we decided to combine sets of stakeholders into stakeholder groups (SGs) (Table 1). The clusters were made according to four criteria: a) departments or working groups within the same authority (e.g., the Arctic Council includes its various working groups; and the Canadian Department of National Defence includes the Canadian Rangers, Defence Research and Development Canada, the Joint Rescue Coordination Centres, Joint Task Force North, and the National Search and Rescue Secretariat); b) characteristics; c) interests; and d) a combination of points b and c.

For example, the banks and the insurance market have been clustered, as they both play similar roles in determining whether a ship will be able to voyage in the Arctic. According to a stakeholder with considerable experience on this topic, in order for a ship to be built, a finance agreement must be established with a bank. Such agreements often require that the vessel has insurance, sometimes from a particular company known to have high standards, and require that the vessel remain in compliance with its insurance policy. As such, it was not seen as appropriate to include one and not the other, but it was unnecessary to separate the two.

After stakeholders were grouped, the number of distinct entities was reduced from 78 to 28. In three cases the decision was made not to group certain stakeholders. The first is the shipping industry. Although components of the shipping industry were combined (ship-owners, operators, etc.), the international and domestic shipping industries were left separated because different regulations apply depending on whether international or local transits are being conducted by foreign or domestic vessels. An example is the Canadian *Ballast Water Control and Management Regulations* (SOR/2011-237 2011): the regulations apply to all Canadian and foreign vessels conducting international transits, but do not apply to vessel operating exclusively in waters under Canadian jurisdiction.

Commercial fisheries were also left divided into Inuit and non-Inuit fisheries because their operations are quite different; Inuit fishers operate at the local level, whereas non-Inuit fishers are directed by international commercial interests. Another set of stakeholders that could have been grouped were those operating for tourism purposes: the cruise industry and adventure tourists. They were left separated because the cruise industry is highly regulated, whereas adventure tourists essentially operate on their own. The cruise industry was also left separated from international and domestic shipping because their purposes for operating in the Arctic, parts of the legal framework surrounding their activities, and the type of voyages they undertake are significantly different.

Finally, we decided to combine the territorial governments under one stakeholder group. This decision was made because, although their agendas may differ, their general mandate and role in the realm of shipping in the Canadian Arctic is the same. This is particularly true given the scale at which we are conducting this study.

Some stakeholders were consciously omitted from the analysis, such as the International Chamber of Shipping and the International Labour Organization. Although they do influence aspects of shipping, they were not considered to be central to the development of shipping in the Canadian Arctic specifically. The International Chamber of Shipping promotes the interests of shipowners and operators, and the International Labour Organization addresses workers' rights, but neither contributes to the demand for shipping in the Canadian Arctic that will drive changes in volumes of activities. In addition, many of these organizations collaborate with the IMO to develop guidelines and regulations for maritime activities. The decision was also made to exclude port authorities because there is a known lack of deepwater ports, places of refuge, marine salvage, and adequate port facilities in the Canadian Arctic, and the ports from which vessels voyaging to the Arctic originate are located outside the region, and outside the scope of our study.

**Table 1.** All identified stakeholders organized alphabetically by stakeholder group. For a complete list of all stakeholders and stakeholder groups, their scale(s) of operations, and their interests, see Appendix 1 on our website.<sup>5</sup>

<b>Stakeholder Group</b>	<b>Stakeholders Included in Group</b>
<b>Aboriginal Affairs &amp; Northern Development Canada (AANDC)</b>	Canadian Polar Commission
<b>Adventure tourists</b>	
<b>Arctic Council</b>	Arctic Contaminants Action Program (ACAP); Arctic Monitoring & Assessment Programme (AMAP); Conservation of Arctic Flora and Fauna (CAFF); Economic Council; Emergency Prevention, Preparedness & Response (EPPR); Protection of the Arctic Marine Environment (PAME); Sustainable Development Working Group (SDWG)
<b>Banks/Insurance market</b>	Underwriters, lawyers, P&I Clubs
<b>Canadian Northern Economic Development Agency (CanNor)</b>	
<b>Classification societies</b>	American Bureau of Shipping; Bureau Veritas; ClassNK; DNV GL; Korean Register; Lloyd's Register; RINA Services, SpA
<b>Cruise industry</b>	Association of Arctic Expedition Cruise Operations (AECO); ship owners, operators and crew
<b>Domestic shipping industry</b>	Ship owners, operators and crew; cargo owners; chartering companies; shipbuilders
<b>Environment Canada</b>	Canadian Ice Service
<b>Fisheries &amp; Oceans Canada (DFO)</b>	Canadian Coast Guard (CCG); Marine Communications & Traffic Services (MCTS); Canadian Hydrographic Service (CHS)
<b>Foreign Affairs Trade &amp; Development (FATD)</b>	
<b>Ice Navigators</b>	
<b>International Maritime Organization (IMO)</b>	Marine Environmental Protection Committee (MEPC); Maritime Safety Committee (MSC)
<b>International shipping industry</b>	Ship owners, operators and crew; cargo owners; chartering companies; shipbuilders
<b>Inuit commercial fisheries</b>	
<b>Inuit population</b>	Communities
<b>Mining industry</b>	
<b>National Defence (DND)</b>	Canadian Rangers; Defence Research & Development Canada (DRDC); Joint Rescue Coordination Centre (JRCC); Joint Task Force North (JTFN)
<b>Natural Resource Canada (NRCan)</b>	Geological Survey of Canada (GSC)



<b>Non-Government Organizations (NGOs)</b>	Greenpeace; Inuit Circumpolar Council (ICC); Inuit Tapiriit Kanatami (ITK); Oceans North; World Wildlife Fund (WWF)
<b>Non-Inuit commercial fisheries</b>	
<b>Northern population</b>	
<b>Oil &amp; Gas industry</b>	
<b>Parks Canada</b>	
<b>Public Safety Canada</b>	Canadian Border Service Agency (CBSA); Canadian Security Intelligence Service (CSIS); National Search & Rescue Secretariat (NSRS); Royal Canadian Mounted Police (RCMP)
<b>Research community/consultants</b>	Centres of Excellence; National Research Council (NRC); Research Institutes
<b>Territorial Governments</b>	Northwest Territories; Nunavut; Yukon
<b>Transport Canada</b>	Canadian Marine Advisory Council (CMAC); NASP; Marine Safety; Marine Security

### *Scale and interests*

The stakeholders were first analyzed by scale and interest separately. As one could expect, more stakeholders operate nationally than internationally or locally (71% versus 54% and 57% respectively) (Table 2). Of the 28 SGs, only seven operate at all scales: classification societies, DFO, DND, non-Inuit commercial fisheries, the cruise industry, NGOs, and the research community/consultants. We then analyzed the stakeholders based solely on interests, of which most were concerned with climate & environment (93%), safety, security & defence (89%), and economics (79%) (Figure 3). No stakeholder group is dedicated to only health and social aspects or Inuit interests. Nine are interested in all five topics.

**Table 2.** The distribution of stakeholder groups based on the scale(s) at which they operate.

<b>Scale</b>	<b>Number of stakeholder groups</b>	<b>Percent</b>
Includes international	15	54%
Includes national	20	71%
Includes local	16	57%
International only	3	11%
International and national only	4	15%
National only	6	22%
National and local only	4	11%
Local only	4	15%
International and local only	1	4%
International, national and local	7	26%

For the analysis, international and domestic shipping industries were classified as not having an interest in health & social aspects. Codes of conduct often require consideration of potential impacts on society, but it is our understanding that the main goals of the shipping industry are not

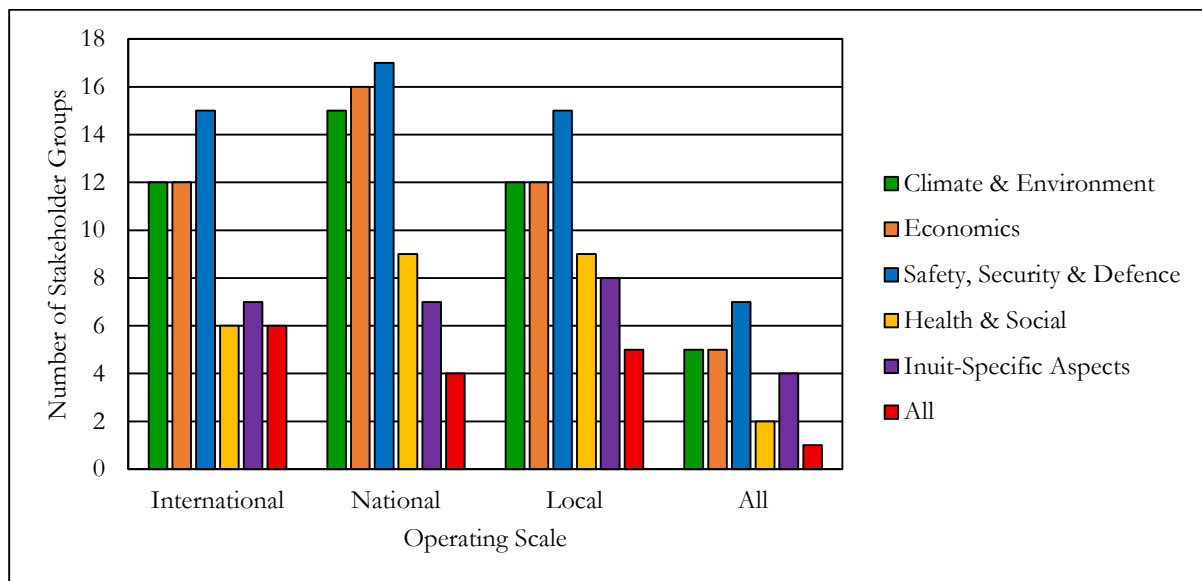
focused on improving the health and well-being of northern societies. Thus they were not considered to be interested in “health & social” within this study.

**Figure 3.** The number of stakeholder groups interested in a particular set of interests; those interested in all aspects are not included (9 groups). **C=Climate & Environment; E=Economics; S=Safety, Security & Defence; H=Health & Social; I=Inuit-Specific Aspects.** Each side of a square represents an interest, allowing up to four interests to be communicated. In some cases, an interest will be repeated, resulting less than four interests to be represented. Take the square with the number “7” for example: Starting on the left with Interest 1, we see the first interest is Climate & Environment; Interest 2 on the top of the square indicates the interest of Economics; the right side indicates Interest 3, which is Safety, Security & Defence; and Interest 4 represented by the bottom is also Safety, Security & Defence. This means that there are 7 stakeholder groups interested in climate & environment, economics, and safety, security & defence.

		INTEREST 2																			
		C					E				S			H		I					
INTEREST 1	C	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C		
		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	E		
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			INTEREST 4																		

The trend of more interest in climate & environment, safety, security & defence, and economics over health & social and Inuit interests was consistent when SGs were analyzed by both scale and interests (Figure 4). Of all the stakeholder groups, only one operates at all scales and is interested in all aspects of maritime, vessel-based activities, and that is the research community/consultants.

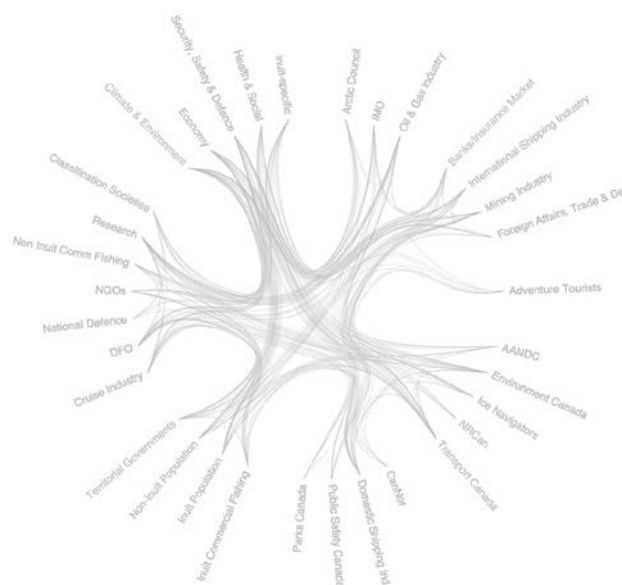
**Figure 4.** The distribution of stakeholder groups by operating scale and interests.



### From structured information to visualization

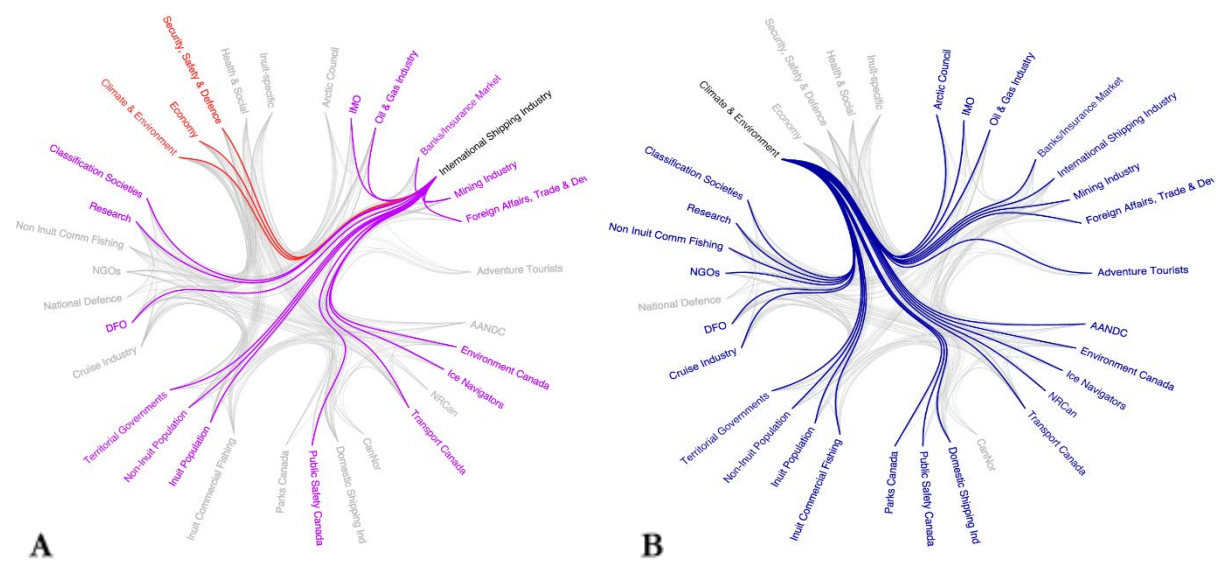
To begin we needed to find a platform upon which to develop the flexible and user-friendly tool. Mike Bostock<sup>6</sup> created D3.js, which is unlike classic visualization libraries in that it allows information to be communicated in much more powerful ways. The almost endless options for data representations make the library itself a tool. From the D3.js library we chose a visualization based upon hierarchical edge bundles (Holten 2006). The data are represented in a wheel format, which is composed of nodes and edges all coloured in light grey. The data are grouped into eight bundles: seven represent the stakeholders organized by the scale(s) at which they operate (see Table 2) and the eighth represents the interests. The nodes within each bundle are the stakeholder groups that operate at those particular scale(s), and each is linked to its interests (Figure 5).

**Figure 5.** The foundation of the visualization tool showing all connections between stakeholder groups, and between groups and their interests.



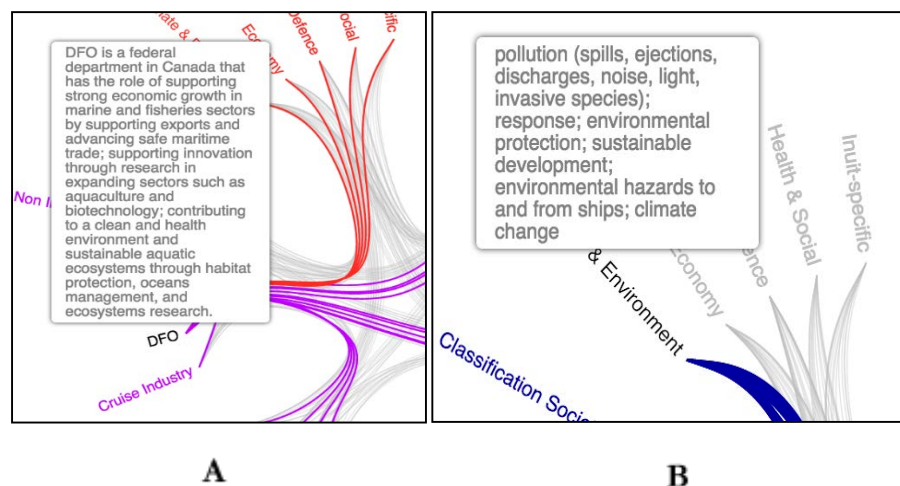
Each node (SG or interest) acts as both a source and target. When the user passes their cursor over either a stakeholder group or an interest (the source), it becomes highlighted in black. The colour of the edge (connecting line) and the target(s) will be different, though, depending on whether the selected source node is an interest or a SG. If the user passes their cursor over a SG, the edge(s) and the target node(s) become highlighted in red if it is an interest, or in purple if it is another SG (Figure 6a). In contrast, if the user passes their cursor over an interest, the edge(s) and the target node(s) will become highlighted in blue (Figure 6b).

**Figure 6.** (A) The visualization tool when a stakeholder group is selected: red indicates a link to an interest, and purple indicates a link to another stakeholder. (B) The tool when an interest is selected: all stakeholders with that interest are linked and highlighted in blue.



Furthermore, description windows were added for each SG and interest (Figure 7). They appear when the user clicks on a particular node. The descriptions are either taken directly from the official website of the SG (e.g., those of federal departments and agencies), or they have been written based on the literature. We took this approach because we wanted to provide more information to the user, but wanted to keep the visualization simple and easy to read and understand.

**Figure 7.** The pop-up description windows when clicking on (A) a stakeholder group or (B) an interest.



## Conclusions

With another three to four decades before substantial increases in maritime traffic are expected in the Canadian North, a unique opportunity has been presented: there is the time to conduct the integrative and collaborative work required to produce a governance regime that is inclusive and proactive. The need for this kind of approach has been documented in reports from numerous sources, and has been announced by leaders of organizations and states. The comprehensive, interactive visualization tool we have developed will facilitate future stakeholder-related work, be it more in-depth stakeholder analyses, consultations, engagement efforts, or planning processes.

As with all new tools, there are current limitations, but in this case those limitations are also the strengths of the work. The visualization tool is intended to be an evolving and ongoing collaborative tool, rather than a static end-product of a single research project. At this stage the list of stakeholders is not exhaustive; some have been intentionally omitted, others combined into groups for the purpose of simplifying the tool and the analysis. The limitation is that the visualization illustrates the interests and connections of stakeholders as identified by the stakeholders themselves. In other words, in order to improve the tool, stakeholder input is required. When a stakeholder chooses to participate, they not only provide data for the analysis but they become part of the project, thus initiating the desired stakeholder engagement and collaboration process. One example of this is the work we conducted with three domestic shipping companies that operate in the Eastern Canadian Arctic: we gathered information from them and presented it to delegates of the World Maritime University's ShipArc 2015 Conference, thus connecting two groups that may not necessarily interact on their own (our presentation is available at [http://passages.ie.dal.ca/PPT/BeveridgeFournier\\_ShipArc.pdf](http://passages.ie.dal.ca/PPT/BeveridgeFournier_ShipArc.pdf)).

The data have been gathered in an open-source format (D3.js for the interactive visualization, GitHub to share the code and data), so the users not only have online access to the representation, but they can also freely use the data and expand upon the tool (as long as the original developers' names are embedded within the code). For example, the scope of the analysis could be focused to study particular areas within the Canadian Arctic (e.g., the Beaufort Sea or Lancaster Sound), or the scope could be narrowed to study specific activities (e.g. search and rescue or fishing). The structure could also be broken down and the study segmented by the type of sailing routes, such as intra-Arctic, destination, or transit routes.

The AMSA report describes the governance of Arctic shipping activities as a "complicated mosaic" (AMSA 2009: 50), and it was our goal to provide a way to visualize this puzzle; a way to gain access to the complex web of stakeholders, their interactions, and the antagonisms of their activities and interests with a single click. The topic of Arctic shipping governance is not new, but documentation has often focused on the legal framework and only those players directly involved in writing and following the rules. There is so much more to the picture, though, and to begin to try to understand it, a more in depth analysis was required. Not only did we engage with numerous stakeholders from varying scales and arenas, we analyzed the information and translated it into a visualization tool to help decode the complexities of maritime Arctic activities in Canada. With further stakeholder support and collaboration, the work we have done can be expanded and improved.

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## Notes

1. The PASSAGES Project: <http://passages.ie.dal.ca>.
2. The Arctic Governance Project, Compendium is available at: <http://www.arcticgovernance.org/compendium.137742.en.html>.
3. Respectively: October 2014, February 2015 and May 2015.
4. Conference held in Ottawa in 2015: <http://umanitoba.ca/faculties/management/ti/warming-of-the-north-2015.html>.
5. See <http://passages.ie.dal.ca/Publications.html>.
6. The D3.js library is available at <http://d3js.org>.

## References

- Arctic Council. (2009). *Arctic Marine Shipping Assessment*.
- Arctic Waters Pollution Prevention Act, 1985 (R.S.C., 1985, c. A-12).
- Beaufort Sea Partnership. (2009). *Integrated Ocean Management Plan for the Beaufort Sea: 2009 and Beyond*.
- Canada Shipping Act, 2001, S.C. 2001, c. 26.
- Canadian Coast Guard. (2012). *Ice Navigation in Canadian Waters*. Ottawa: Department of Fisheries and Oceans.
- Canadian Hydrographic Service. (1999). *Marine Environmental Handbook - Arctic Northwest Passage*. Ottawa: Department of Fisheries and Oceans.
- Chan, F., Bailey, S., Wiley, C., & MacIsaac, H. (2013). Relative Risk Assessment for Ballast-mediated Invasions at Canadian Arctic Ports. *Biological Invasions*, 15: 295-308.
- Chatham House. (2012). *Arctic Opening: Opportunity and Risk in the High North*. Lloyd's of London.
- Chircop, A. (2012). Regulatory Challenges for International Arctic Navigation and Shipping in an Evolving Governance Environment. *Annual Meeting of the Comité Maritime International, 14-19 October 2012*. Beijing, China.
- Conference Board of Canada. (2013). *Changing Tides: Economic Development in Canada's Northern Marine Waters*.
- Douvere, F. (2008). The Importance of Marine Spatial Planning in Advancing Ecosystem-based Sea use Management. *Marine Policy*, 32: 762-771.
- Ehler, C., & Douvere, F. (2009). *Marine Spatial Planning: A Step-by-Step Approach toward Ecosystem-based Management*. Intergovernmental Oceanographic Commission.
- Erbe, C., & Farmer, D. (2000). Zones of impact around icebreakers affecting beluga whales in the Beaufort Sea. *Journal of Acoustic Soc. Am.*, 108: 1332-1340.
- Flynn, A. (2013). *A Guide for Integrating Inuit Qaujimaqatuqangit into Decision-making for Marine Shipping Development in Nunavut [graduate project]*. Halifax, NS: Dalhousie University.

- Frankenstein, S., & Tuthill, A. (2002). Ice adhesion to locks and dams: Past work; Future directions? *Journal of Cold Regions Engineering*, 16: 83-96.
- Gopnik, M., Fieseler, C., Cantral, L., McClellan, K., Pendleton, L., & Crowder, L. (2012). Coming to the table: Early stakeholder engagement in marine spatial planning. *Marine Policy*, 36: 1139-1149.
- Grimble, R., & Chan, M.-K. (1995). Stakeholder analysis for natural resource management in developing countries. *Natural Resources Forum*, 19(2): 113-124.
- Halpern, B., McLeod, K., Rosenberg, A., & Crowder, L. (2008). Managing for cumulative impacts in ecosystem-based management through ocean zoning. *Ocean & Coastal Management*, 51: 203-211.
- Helmick, J. (2008). Port and Maritime Security: A Research Perspective. *Journal of Transportation Security*, 1: 15-28.
- Holten, D. (2006). *Hierarchical Edge Bundles: Visualization of Advacency Relations in Hierarchical Data*. Retrieved from <http://www.cs.jhu.edu/~misha/ReadingSeminar/Papers/Holten06.pdf>.
- Hovelsrud, G., Poppel, B., van Oort, B., & Reist, J. (2011). Arctic Societies, Cultures, and People in a Changing Cryosphere. *Ambio*, 40(Suppl 1): 100-110.
- Huntington, H. (2009). A Preliminary Assessment of Threats to Arctic Marine Mammals and their Conservation in the Coming Decades. *Marine Policy*, 33: 77-82.
- IMO. (2010). *Guidelines for Ships Operating in Polar Waters*. London: International Maritime Organization.
- Jay, S. (2009). Marine Management and the Construction of Marine Spatial Planning. *TPR*, 81: 173-191.
- Johnston, M., Dawson, J., Steward, E., & De Souza, E. (2013). *Strategies for Managing Arctic Pleasure Craft Tourism: A Scoping Study*. Thunder Bay, Ontario: Transport Canada.
- Kaplan, R., Fournier, M., & Nuessli, M.-A. (2014). L'historien et l'algorithme. *Le temps des humanités digitales. La mutation des sciences humaines et sociales*, Fyp Editions.
- Karim, M. (2015). *Prevention of Pollution of the Marine Environment from Vessels: The Potential and Limits of the International Maritime Organization*. Springer International Publishing.
- Katsanevakis, S., Stelzenmuller, V., South, A., Sorensen, T., Jones, P., Kerr, S., Hofstede, R. (2011). Ecosystem-based Marine Spatial Management: Review of Concepts, Policies, Tools, and Critical Issues. *Ocean & Coastal Management*, 54: 807-820.
- Kelley, K., & Ljubicic, G. (2012). Policies and Practicalities of Shipping in Arctic Waters: Inuit Perspectives from Cape Dorset, Nunavut. *Polar Geography*, 35: 19-49.
- Kennedy, A., Simoes Re, A., & Veitch, B. (2014). Peak Ice Loads on a Lifeboat in Pack Ice Conditions. *Arctic Technology Conference, 10-12 February 2014*. Houston, Texas, USA.
- Lasserre, F. & Pelletier, S. (2011). Polar Super Seaways? Maritime Transport in the Arctic: An Analysis of Shipowners' Intentions. *Journal of Transport Geography*, 19: 1465-1473.
- Liu, J., Lau, M., & Williams, F. (2006). Mathematical Modeling of Ice-hull Interaction for Ship Maneuvering in Ice Simulations. *NRC Publications Archive*. Retrieved from <http://nparc.cisti-icist.nrc-cnrc.gc.ca/npsi/ctrl?action=rtdoc&an=8894995&lang=en>.
- Maes, F. (2008). The International Legal Framework for Marine Spatial Planning. *Marine Policy*, 32: 797-810.

- MARPOL 73/78. (1973/1978). International Convention for the Prevention of Pollution from Ships.
- Parsons, J. (2012). *Arctic Shipping Best Practices*. WWF-Canada.
- Pharand, D. (2007). The Arctic Waters and the Northwest Passage: A Final Revist. *Ocean Development and International Law*, 38: 3-69.
- Pomeroy, R., & Douvère, F. (2008). The Engagement of Stakeholders in the Marine Spatial Planning Process. *Marine Policy*, 32: 816-822.
- Reed, M. (2008). Stakeholder Participation for Environmental Management: A Literature Review. *Biological Conservation*, 141: 2417-2431.
- Reed, M., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Stringer, L. (2009). Who's In and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management. *Journal of Environmental Management*, 90: 1933-1949.
- Reeves, R., Rosa, C., George, J., Sheffield, G., & Moore, M. (2012). Implications of Arctic industrial Growth and Strategies to Mitigate Future Vessel and Fishing Gear Impacts on Bowhead Whales. *Marine Policy*, 36: 454-462.
- Ritchie, H., & Ellis, G. (2010). A System that Works for the Sea? Exploring Stakeholder Engagement in Marine Spatial Planning. *Journal of Environmental Planning and Management*, 53: 701-723.
- Sevigny, P. (2015, March 2). The Role of the Canadian Armed Forces in the North. Ottawa, Ontario, Canada: Canadian Joint Operations Command. Retrieved April 20, 2015, from [http://umanitoba.ca/faculties/management/ti/media/docs/U\\_du\\_Man\\_Sevigny.pdf](http://umanitoba.ca/faculties/management/ti/media/docs/U_du_Man_Sevigny.pdf).
- SOR/2011-237. (2011). Ballast Water Control and Management Regulations.
- UNCLOS. (1982). United Nations Convention on the Law of the Sea.
- VanderZwaag, D. (1990). On the Road to Kingdom Come. In Lamson, & VanderZwaag (Eds.), *The Challenge of Arctic Shipping* (pp. 219-244). Montreal & Kingston, Canada: McGill-Queen's University Press.