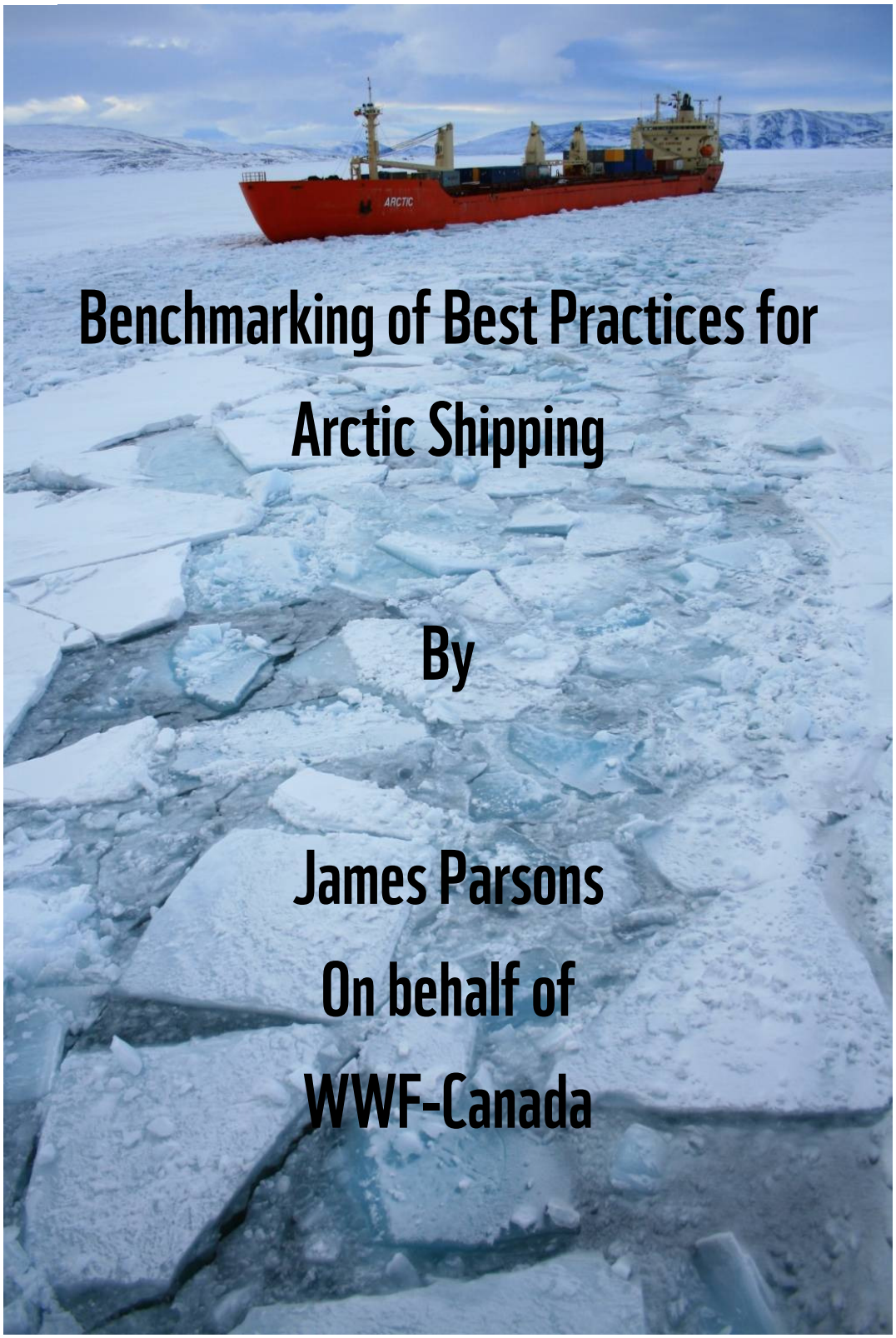

Benchmarking of Best Practices for Arctic Shipping

By

James Parsons

On behalf of

WWF-Canada

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FOREWORD

The Arctic is a vast northern ocean surrounded by the northern extremities of five Arctic coastal states[1]. Ice-covered for much of the year, the region supports a wide variety of fragile plant and animal ecosystems as well as a number of peoples with their differing traditions, cultures, economies, and political systems. These diverse habitats and cultures have been relatively stable in recent times, as the conditions that support them have seen relatively little change. Environmental conditions have been fairly constant and the region has received little interest from business and political circles to the South.

Several strong forces are converging on the Arctic, placing new stresses on the region and putting northern ecosystems and cultures at risk. Climate change is being dramatically felt in the Arctic, with temperatures warming at roughly twice the global average rate, resulting in changing habitats for plants, wildlife and people. Sea ice is disappearing so quickly that soon summers may be ice-free. Among other previously unimagined changes, a new frontier for shipping is opening in the polar region.

At the same time, rising fuel costs and other global trends have increased demand for new, shorter sea routes through the North. As the prices for oil and other scarce but important resources increase, the Arctic is seen as a new and vital source of these valuable commodities. Increased shipping, resource extraction and tourism will create new economic opportunities, along with environmental hazards.

The *Arctic Marine Shipping Assessment 2009 Report* shows that the current level of commercial shipping in many regions of the Arctic is low compared with other, more travelled routes. However, that may change in the years and decades to come, as open seas and commodity prices combine to promote development in the Arctic, with the necessary increase in shipping traffic to service those developments.

Any increase in development activity brings with it the potential for environmental impacts, and the shipping industry is no exception. Safety is of course a key concern in Arctic waters, where the conditions are harsh and the support infrastructure is relatively scarce, so that avoiding accidents and spills is of crucial importance. Environmental impacts of shipping include disruption of marine mammals and other wildlife, discharge of pollutants including greenhouse gases, emission of particulate matter, and the risk of introduction of invasive species through ballast water. Measures are needed to avoid or minimize these impacts, and they need to be reviewed and upgraded continually as new information emerges and new technologies are developed. And there is an ongoing role for the shipping industry to be engaged in planning and monitoring of shipping activities, in order to avoid

[1] United States, Russia, Norway, Denmark (Greenland) and Canada

impacts in sensitive areas, address cumulative impacts of multiple developments and engage in adaptive management and continual improvement.

Notwithstanding these impacts, it remains the case that it is not a question of *whether* there'll be increased Arctic shipping, but rather *how* that shipping will be undertaken – namely the measures, precautions, regulations and best practices that will be implemented in order to minimize the risks, avoid or mitigate the impacts and maximize the net benefits of development to the northern residents who rely on intact Arctic ecosystems.

In an effort to gain a better understanding of the potential for Arctic shipping to be carried out in an appropriate manner, WWF-Canada has commissioned an independent benchmark study of potential impacts of shipping in Arctic waters, and measures currently in place across the Arctic to address these impacts. This report provides the results of that benchmark study, which was carried out for WWF by Master Mariner Jim Parsons. Parsons brings 30 years' experience at sea, in academia, and as a consultant for global clients on various marine issues. He is Principal consultant at Global Marine Solutions, as well as Marine Institute director and lecturer at Memorial University of Newfoundland in St. John's. WWF is pleased to help raise and promote resolution of environmental issues related to shipping in the Arctic, but the views expressed in this report are those of the author, Jim Parsons.

The results from this report will help WWF to better understand potential environmental and social impacts of shipping on the Arctic environment, and to inform our efforts to engage the shipping industry, including the discussions underway at the International Maritime Organization to create a Polar Code for Arctic Shipping. At the same time, we hope that this study will be a stimulus to others in ongoing dialogue about best practices in Arctic shipping. We welcome comments on this report, either on our online blog at www.wwf.ca/arcticshipping or directly to us, at arcticshipping@wwfcanada.org

Lastly, we'd like to acknowledge Fednav Inc. for providing financial and other support for this project.

Martin von Mirbach
Director, Canadian Arctic Program

List of Acronyms

AIS – Automatic identification System
AMSA – Arctic Marine Shipping Assessment
AWPPA – Arctic Waters Pollution Prevention Act
BC – Black Carbon
CAD - Canadian
CO_2 - Carbon Dioxide
CH_4 - Methane
COSPAS-SARSAT – International Satellite System for Search and Rescue
CSR – Corporate Social Responsibility
ECA – Emission Control Areas
ECDIS – Electronic Chart Display and Information System
EEDI – Energy Efficiency Design Index
EEOI – Energy Efficiency Operational Indicator
EMS – Environmental Management System
ENC – Electronic Navigation Chart
EPIRB – Emergency Position Indicating Radio Beacon
ETD – Enhanced Target Detection
EEZ – Exclusive Economic Zones
FSICR – Finnish-Swedish Ice Class Rules
GBAS – Ground Based Augmentation System
GHG – Greenhouse Gases
GLONASS – Russian Global Navigation Satellite System
GMDSS – Global Maritime Distress and Safety System
GNSS - Global Navigation Satellite System
GPS – Global Positioning System
HFO- Heavy Fuel Oil
IACS – International Association of Classification Societies
ICT – Information and Communication Technology
IMO - International Maritime Organization
INS – Integrated Navigation System
ISM – International Safety Management Code
ISO – International Standards Organization
MARPOL – The International Convention for the Prevention of Pollution from Ships
MDO – Marine Diesel Oil
MODU – Mobile Offshore Drilling Unit
MOU – Memorandum of Understanding
MPA – Marine Protected Area
MSI – Maritime Safety Information
NAS – Navigation Assistance Service
NHS – Noxious Hazardous Substances
NO_x – Nitrogen oxides
N_2O – Nitrous Oxide
ODM – Overboard Discharge Monitor
OPRC – Oil Pollution Preparedness Response and Cooperation
PSSA – Particularly Sensitive Sea Area
PC – Polar Class
PM – Particulate Matter
PPU – Pilot's Portable Unit

RFI – Radio Frequency Interference
SAR – Search and Rescue
SART – Search and Rescue Transponder
SBAS – Satellite Based Augmentation System
SEEMP – Ship Energy Efficiency Management Plan
SMS – Safety Management System
SO_x – Sulphur Oxides
SOLAS – Safety of Life at Sea
SOPEP – Shipboard Oil Pollution Emergency Plan
STCW – International Convention on Standards of Training Certification and Watchkeeping for Seafarers
TBT - Tributyltin
TOS – Traffic Organization Service
UNCLOS – United Nations Convention on the Law of the Sea
US – United States
VDR – Voyage Data Recorder
VTMS – Vessel Traffic Management Services

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RESEARCH AIM

The ultimate aim of this research is to identify and bring forward those operating practices that maximize the benefits and minimize the harm to all stakeholders involved in Arctic shipping operations. The research will review publically available information to ascertain the impacts that shipping has had and may have on the Arctic environment and the local inhabitants who depend upon the environment to sustain their economic, social and cultural ways of living. While shipping can and does positively impact social and economic development in the Arctic, there are concerns over the negative potential impacts to traditional ways of living and the environment. Company website analysis, questionnaires and interviews with ship operators working in the Arctic were conducted to help triangulate the findings of the literature review and assist with the development of a roster of industry accepted "best practices" for Arctic operations. Four Arctic shipping operators from Canada, Finland and the United States were surveyed, and in some cases interviewed, and the websites of 29 shipping companies with operations in Arctic waters were analyzed. In attempting to understand the future potential impacts that shipping may have on the Arctic and the people who live there, it is hoped that a benchmark of best or proven operating practices will be developed, accepted and adopted by ship operators working in fragile and sensitive Arctic ecosystems. While the International Maritime Organization (IMO) currently has in place *Guidelines for Ships Operating in Polar Waters*, many maritime stakeholders feel that there is a need for a mandatory Polar Code which will help standardize the requirements and facilitate easier overall adoption for ship operators engaged in Arctic operations. This research aims to contribute to that end.

This report seeks to present an accurate circumpolar view of Arctic shipping practices and the ways in which they are affecting all peoples living in the Arctic and their environment. The research also aims to present an unbiased view of the ways in which Arctic nations, international organizations and the maritime community in general are addressing the concerns that shipping has on the Arctic and its peoples. Notwithstanding the above, the literature review highlights that not all Arctic nations appear to have the same regulations, guidelines and recommendations in place to deal with Arctic shipping. From a national regulatory perspective, a review of the literature highlights Canada being at the forefront with respect to controlling its Arctic shipping operations especially when it comes to pollution prevention. Russia has regulations in place concerning safety and environmental protection along the Northern Sea Route and the United States and Norway have strict regulations in place dealing with shipping in their respective Arctic waters.

INTRODUCTION

Climate change presages increasingly less sea ice and longer shipping seasons in the Arctic regions. The melting of Arctic sea ice appears to be happening much faster than originally calculated and there is much debate and uncertainty as to when the Arctic will actually experience ice-free summers (Cheek, 2011); it could be as early as 2015 (Leahy, 2008). While the media and some scientists anticipate that increased vessel traffic will occur, spurred by soaring fuel prices, between Asia-Europe via the Northern Sea Route (aka Northeast Passage) and central Arctic Ocean, and eventually between Asia-US East Coast via the more challenging Northwest Passage, ship owners appear less optimistic (Lasserre and Pelletier, 2011). However, retreating sea ice will provide the opportunity to increase the annual re-supply of goods to northern communities, expedite the development of natural resource projects (ibid), increase cruise ship and adventure tourism activity, and expand the fishing industry. Cruise ship activity is increasing and fishing fleets have already begun to follow the fish stocks that migrate northward as the ice edge retreats (National-Research-Council, 2005). Interest in the Arctic region, whether stemming from climate change or its abundance of natural resources, is high on the agenda of many nations and organizations (Arctic-Council, 2009; Brosnan et al., 2011; Kaltenstein, 2011). On a global scale, Arctic regions are rich in natural resources. In addition to the abundance of nickel, iron ore (Waldie, 2011), diamonds (Natural-Resources-Canada, 2008) and coal, the Arctic holds about 30% of the world's undiscovered gas and 13% of the world's undiscovered oil, which is found mostly offshore under less than 500 meters of water (Prime-Minister's-Office, 2010; Gautier et al., 2009). In terms of marine transportation, increased activity will likely result in new and increased business as a virtuous circle of business and economic activity appears to be moving northward (National-Research-Council, 2005).

The relative lack of shipping, the huge spatial separation and limited communication among Arctic villages, and the paucity of recorded empirical evidence make it difficult to determine with certainty and accuracy the effect that shipping is having on the Arctic environment and the people that live there. A review of the scientific literature clearly highlights the chasms of knowledge regarding the impacts of marine related activity in Arctic waters. Further research and consideration will need to be given in order to minimize the effects of shipping and offshore oil and gas development on marine inhabitants (Offshore-Oil-and-Gas-Research-Group, 2004; Richardson et al., 1995; Cosens and Dueck, 1993). In light of the available evidence, significantly more environmental research in the Arctic is warranted.

SECTION 1 - ENVIRONMENTAL IMPACTS

Wildlife

During the short Arctic summer many species of mammals (Henry, 2009), birds and fish migrate and congregate in Arctic regions in huge numbers to feed, mate, breed and raise their young (Glover et al., 2010; Arctic-Council., 2009; Arctic-Monitoring-and-Assessment-Programme, 2007; Mallory et al., 2006; Loeng, 2004). During these critical and sensitive periods, the presence of ships and their associated operations have the potential to impose additional stress on fragile and sensitive Arctic ecosystems (Chircop, 2007; Roginko and LaMourie, 1992) by way of noise and physical disturbance as well as the discharge, spill or release of oils, chemicals, engine exhaust, sewage, grey-water, garbage and other waste that may have immediate or subsequent negative effects (Arctic-Monitoring-and-Assessment-Programme, 2009). While the discharge of all waste, except untreated ship sewage, oil from underwater machinery components essential to the operation of the ship, or oil released in the event of an emergency, is prohibited in the Canadian Arctic north of 60 degrees north latitude (Department-of-Justice-Canada, 2012a), there are risks that it may occur accidently given the nature of ship operations and those working on board (Transport-Canada, 2010d). During migration periods there is also the potential of ship strikes with whales and seals, species that often aggregate in huge numbers in sometimes narrow migration corridors (Nuka-Research-and-Planning-Group, 2010). In addition to the impact on wildlife that migrate to the Arctic during the summer, year round shipping activity in the Arctic will also need to consider the effects it may have on wintering marine wildlife and nocturnal birds (Mallory et al., 2008). In light of the often harsh environmental conditions, freezing temperatures and limited or no daylight during winter months, limited human resources and limited environmental response equipment, it will be challenging to recover and mitigate the effects of pollutants that end up in Arctic waters (Congressional-Research-Service, 2011; Matishov et al., 2009; Stengel et al., 2006). The stranding of the M/V *Selendang Ayu* near Dutch Harbour, Alaska on 8 December 2008 is testimony to the challenges of responding to environmental disasters in remote Arctic regions (The-National-Academies-Press, 2009). Further, efforts to remove and clean up spilled oil with the use of chemical dispersants can have lethal effects on marine mammals, young fish and other biota (Offshore-Oil-and-Gas-Research-Group, 2004). While there is available scientific knowledge pertaining to the impacts of liquid hydrocarbon spills on marine life (ibid), the literature highlights the need for more thorough and extensive research especially in the Arctic. Oil may enter the environment from routine ship activities such as the loading, discharging, or transferring of oil; tank cleaning, bilge and ballast discharges (National-Research-Council, 2003). The greatest cause of environmental concern stemming from Arctic shipping activity is that of an accidental oil spill due to grounding, stranding, inclement weather, fire or collision (Arctic-Council, 2009; Arctic-Monitoring-And-Assessment-Programme, 2007; Stengel et al., 2006). While the Arctic is already known for its extreme weather and dearth

of meteorological capacity, retreating sea ice will likely influence a northerly shift of polar lows which will result in more unpredictable weather in high Arctic regions (Mauritzen and Kolstad, 2011). As Arctic shipping activity increases there will be greater potential for the release of oil, chemicals and other pollutants into the environment (Bruckner-Menchelli, 2012; Kaltenstein, 2011). During the summer of 2010, one cruise ship and two oil tankers ran aground in the Canadian Arctic (Bruckner-Menchelli, 2010). While there was no release of pollution to the sea in those cases, the potential exists.

Air Pollutants

Anthropogenic source contaminants amassing toxic concentrations result in the creation of pollutants having negative effects on people and the environment (Lentz et al., 1998). In the case of an inefficient ship engine, the incomplete combustion of marine fuel will result in the emission of pollution and other contaminants into the environment (Stengel et al., 2006). Research shows that the emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) along with short-lived pollutants, ozone pre-cursors and particulate matter (PM) from ships burning low grade residual fuel oil significantly contribute to climate change and negative health impacts (Corbett et al., 2010; Arctic-Council, 2009; Environmental-Protection-Agency, 2009; Stengel et al., 2006). However, the Arctic Council's 2009 Arctic Marine Shipping Assessment (AMSA) report notes that the impacts of emissions of nitrogen oxides (NO_x) and black carbon (BC) particulate matter in the Arctic are only beginning to be understood. On a global scale, there is limited research on particulate matter and its effect on air pollution in different sea areas (Mueller et al., 2011). The AMSA report highlights the correlation of increased shipping activity with increased NO_x and consequently increased levels of surface ozone negatively impacting plant growth and human health. The presence of black carbon on snow and ice in the Arctic helps expedite melting and consequently the retreat of sea ice, as black carbon reduces the albedo of snow and ice (Hadley and Kirchstetter, 2012; Shindell et al., 2012; Peters et al., 2011). In comparison to more gradual global effects on climate change, air quality and deteriorating health, emission increases in the Arctic may result in substantial local effects via climate feedback mechanisms (Lack et al., 2008). Globally, sulphur oxides (SO_x) and NO_x pollutants from ship emissions contribute to ocean acidification, affect regional climate and represent serious risks to human health (United-States-Environmental-Protection-Agency, 2010; Molnar and Koshure, 2009; OSPAR-Commission, 2009; Corbett et al., 2007; BP-Shipping, 2006; Stengel et al., 2006).

The International Convention for the Prevention of Pollution from Ships (MARPOL) consolidated edition 2011, Annex VI covers regulations for the prevention of air pollution from ship and as such deals with ozone-depleting substances: NO_x, SO_x, and volatile organic compounds (International-Maritime-Organization, 2011g). While SO_x can be controlled by limiting the sulphur content of the fuel oil used in the ship's main engine, NO_x and particulate emissions controls are directly connected to the combustion

machinery itself (American-Bureau-of-Shipping, n.d.-b). Annex VI allows for the establishment of emission control areas (ECA) for SO_x, NO_x, and particulate matter emissions. Emission control areas are areas that allow the adoption of special mandatory measures to prevent, reduce, and control air pollution from SO_x, NO_x, and particulate matter and its attendant adverse impacts on human health and the environment (International-Maritime-Organization, 2011g). Table 1 shows the ECAs currently in effect or adopted.

Table 1: Emission Control Areas

Annex VI: Prevention of air pollution by ships (Emission Control Areas)			
Special Areas	**Adopted**	**Date of Entry into Force**	**In Effect From**
Baltic Sea (SO_x)	26 Sept 1997	19 May 2005	19 May 2006
North Sea (SO_x)	22 July 2005	22 Nov 2006	22 Nov 2007
North American (SO_x, and NO_x and PM)	26 March 2010	1 August 2011	1 August 2012
United States Caribbean Sea ECA (SO_x, NO_x and PM)	26 July 2011	1 January 2013	1 January 2014

Note. From *Special Areas under MARPOL*, 2011. Retrieved from http://www.imo.org/OurWork/Environment/PollutionPrevention/SpecialAreasUnderMARPOL/Pages/Default.aspx

As with MARPOL Annexes I and V, Annex VI does not include the Arctic. Shown in Figure 1, the North American emission control area (ECA) will stop at 60° north latitude.

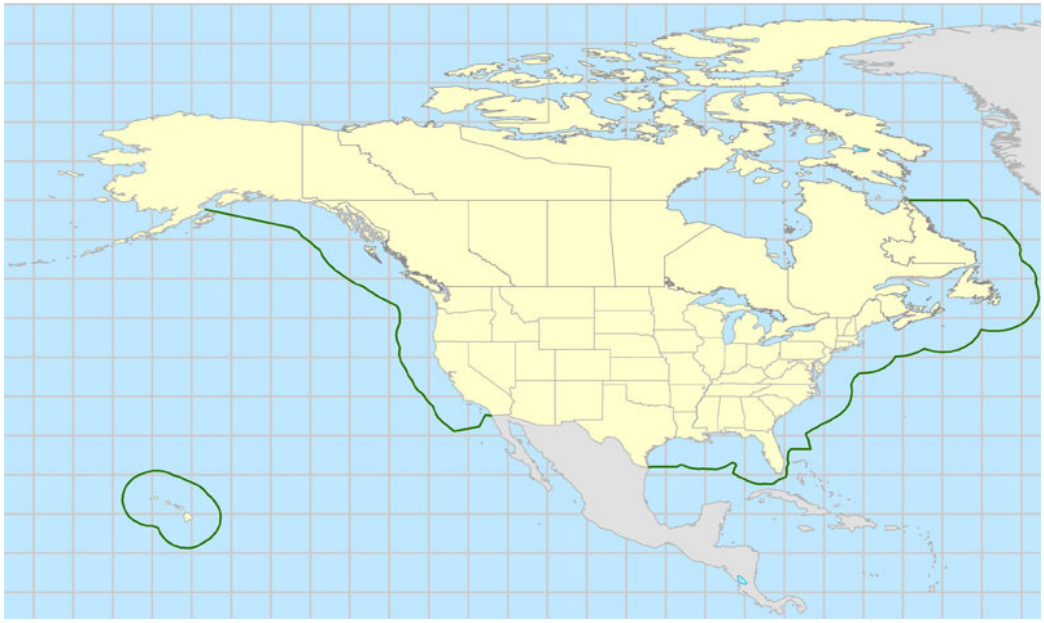

Figure 1: Area of the North American ECA. Retrieved from http://www.epa.gov/nonroad/marine/ci/420f10015.htm

Annex VI regulation 14 stipulates SO_x and PM requirements. Table 2 highlights the sulphur content of any fuel used on board ships both inside and outside of ECAs.

Table 2: Fuel Sulphur Content Limits

Date	General Sulphur Content Requirements (not exceeding % m/m)	Sulphur Content Requirements inside ECAs (not exceeding % m/m)
Prior to 1 July 2010		1.50
On and after 1 July 2010		1.00
Prior to 1 January 2012	4.5	
On and after 1 January 2012	3.5	
On and after 1 January 2015		0.10
On and after 1 January 2020	0.50	

Note. Adapted from *MARPOL Annex VI Regulation 14*

Annex VI regulation 13 provides for a three tiered level of NO_x emissions depending on the vessel's date of construction and rated engine speed. Table 3 notes the total weighted cycle emission limits at the various tiers. For vessel constructed prior to 1 January 2000, with a power output of more than 5000 kw and a per cylinder displacement of 90 litres or above, Tier I emission levels shall be adhered to provided that an approved method has been certified (International-Maritime-Organization, 2011g).

Table 3: Tier I, II and III NOx Emission Levels

Tier	Ship construction date on or after	Total weighted cycle emission limit (g/kWh) n = engine's rated speed (rpm)		
		n<130	n= 130 - 1999	n ≥ 2000
I	1 January 2000	17.0	$45.n^{-0.2}$ e.g., 720 rpm – 12.1	9.8
II	1 January 2011	14.4	$44.n^{-0.23}$ e.g., 720 rpm – 9.7	7.7
III	1 January 2016*	3.4	$9.n^{-0.2}$ e.g., 720 rpm – 2.4	2.0

Note. * Subject to a technical review to be concluded 2013 this date could be delayed, regulation 13.10. From *Nitrogen Oxides (NO_x) – Regulation 13.* Retrieved from http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Nitrogen-oxides-(NO_x)-%E2%80%93-Regulation-13.aspx

Ocean Pollutants

Relative to southern waters, less pollution is reported to occur in the Arctic. While the IMO and many maritime nations have enacted strict legislation to prevent or limit the regular discharge of oil, waste and litter into the world's oceans, it still occurs along trans-oceanic shipping routes (Arctic-Council., 2009; Stengel et al., 2006) and areas that are difficult to monitor and police. The deliberate release of illegal waste also occurs in areas that are relatively well monitored and policed. A recent case in Baltimore, USA notes two shipping corporations pleading guilty to the illegal discharge of oil and plastic into the sea (Cacnio, 2012). An environmental crime case in Honolulu notes the dumping of oily waste and the falsification of the vessel's oil record book (Marine-Log, 2012b). Another conviction in California notes the falsifying of a vessel's oil record book and tampering with pollution control equipment (Marine-Link.com, 2012). In many Arctic Ocean nations, oil may be legally released via operational underwater equipment such as propeller shaft bearings and in the event of an emergency. Globally, several thousand barrels of oil are released annually into the oceans from stern tube leakage (Etkin, *n.d.*). Ships operating in rough sea conditions and ice-covered waters are more prone to the operational release of oil from propeller shaft bearings (Thordon, 2011). Unlike the south, in the Arctic there is a paucity of infrastructure and shore side reception facilities available for ships to properly dispose of bilge water, garbage and other waste. In light of the above and unforeseen logistical challenges delaying planned ship operations, accumulated waste can overload on board stowage capacity and consequently lead to accidental or illegal release into the environment (Arctic-Council., 2009). While on board incineration can help mitigate waste accumulation (National-Research-Council, 2003), it may also contribute to localized air pollution (Canadian-

Council-of-Ministers-of-the-Environment, 1992). In addition to the negative impacts that an accidental oil spill may have in the fragile Arctic environment there are the potential negative impacts stemming from the operational or accidental discharge of bilge water, ballast water, sewage, grey water, food waste, and garbage. Hull fouling and associated anti-fouling coatings are also of environmental concern (Antarctic-and-Southern-Ocean-Coalition et al., 2011; Molnar and Koshure, 2009; Minchin, 2006; Stengel et al., 2006). Following is a closer look at each of those noted above.

Oil

In helping to prevent and mitigate oil pollution in the world's oceans, the IMO has set up Special Areas. Special areas described in Annexes I and V of MARPOL consolidated edition 2011, dealing with the discharge of oil and garbage respectively, include Antarctica but do not include the Arctic. According to MARPOL, special areas are sea areas that, owing to recognized technical reasons in relation to the area's oceanographical and ecological condition and to the particular character of its traffic, allow the adoption of special mandatory methods for the prevention of sea pollution by oil or garbage (International-Maritime-Organization, 2011g). Excluding Antarctica, MARPOL Annex I allows control of operational discharge of oil from ships of 400 gross tonnage and above under the following conditions both outside and in special areas:

1. The ship is proceeding en route;
2. The oily mixture is processed through oil filtering equipment designed to ensure that the mixture of any oily mixture discharged into the sea after passing through the system has an oil content not exceeding 15 ppm. For a ship 10,000 gross tonnage and above, the oil filtering equipment will also need to be provided with an alarm arrangement to indicate when the 15 ppm level cannot be maintained and it will also need to be provided with arrangements to ensure that any discharge of oily mixtures is automatically stopped when the oil content of the effluent exceeds 15 ppm;
    2.1 Within special areas a ship of 400 gross tonnage and above will need to adhere to the oil filtering equipment requirements of a ship 10,000 gross tonnage and above;
3. The content of the effluent without dilution does not exceed 15 ppm;
4. The oil mixture does not originate from cargo pump-room bilges on oil tankers; and
5. The oily mixture, in the case of oil tankers, is not mixed with oil cargo residues.

With respect to the discharge of oil or oily mixtures, outside of special areas, from the cargo area of an oil tanker, MARPOL Annex I allows for the control of operational discharges of oil under the following conditions:

1. The tanker is not within a special area;
2. The tanker is more than 50 nautical miles from the nearest land;
3. The tanker is proceeding en route;
4. The instantaneous rate of discharge of oil content does not exceed 30 litres per nautical mile;

5. The total quantity of oil discharged into the sea does not exceed 1/15,000 or 1/30,000 of the total quantity of the particular cargo of which the residue formed a part. The 1/15,000 requirement applies to tankers delivered on or before 31 December 1979; and
6. The tanker has in operation an oil discharge monitoring and control system and slop tank arrangements. The system shall, *inter alia,* provide a continuous record of the discharge, identify date and time, be kept for three years, come into operation when there is any discharge of effluent into the sea and shall ensure that any discharge of oily mixture is automatically stopped when the instantaneous rate of discharge of oil exceeds that permitted above. Total slop tank capacity may range from 3% to 0.8% of the oil carrying capacity of the ship depending on cargo tank design and tank washing arrangements.

In light of the above, and barring any zero discharge tolerance regimes put in place by individual Arctic coastal nations (e.g. Canada), MARPOL allows for the controlled discharge of oil into Arctic waters. Canada has a MARPOL exemption for its Arctic waters. Consequently, the MARPOL discharge limits would contravene the Canadian Arctic Waters Pollution Prevention Act (AWPPA) and its pursuant regulations (Transport-Canada, 2012). Oil may only be discharged in the Canadian Arctic for the purposes of saving life or preventing the loss of a ship; damage from stranding, collision or foundering; or through the exhaust of an engine or through leakage from an underwater machinery component (Department-of-Justice-Canada, 2012b).

Complicating a united regime of environmental protection in the Arctic is the fact that not all Arctic nations agree to ratification of international agreements and instruments dealing with environmental protection. Adoption of measures by Arctic nations under a Memorandum of Understanding (MOU) and availing of a port state control program (Transport-Canada, 2010e), the use of flag state control, or agreement among Arctic Council nations may be viable approaches to expedite the often lengthily process of passing IMO conventions. IMO conventions are internationally agreed 'templates' that are used, and sometimes modified, by maritime states as a base for enacting their own national maritime legislation (Stopford, 2009). Table 4 shows the status as of 31 January 2012 of the Arctic nations that have ratified IMO conventions dealing with the environment protection. It is also important to note that although a nation may have ratified a convention by introducing and accepting it into its own domestic legislation, it will not come into force until this process has been carried out by the required numbers of states noted in the in the convention, usually two-thirds (International-Maritime-Organization, 2011f; Stopford, 2009). The process of making a maritime convention involves four steps and could take years. The four steps are consultation and drafting, adoption, signature, and ratification.

Table 4: Ratification of Environmental Protection Agreements and Instruments

Arctic States	MARPOL 73/78 Annex I/II	MARPOL 73/78 Annex III	MARPOL 73/78 Annex IV	MARPOL 73/78 Annex V	MARPOL 73/78 Protocol 1997 (Annex VI)	London Convention 1972	London Convention Protocol	Salvage 1989	OPRC Convention 1990	OPRC/NHS 2000	Anti-fouling 2001	Ballast Water 2004	Nairobi Wreck Removal 2007
Canada	x	x	x	x	x	x	x	x	x		x	x	
Denmark	x	x	x	x	x	x	x	x	x	x	x		
Finland	x	x	x	x	x	x		x	x		x		
Iceland	x	x		x		x	x	x	x		x		
Norway	x	x	x	x	x	x	x	x	x		x	x	
Russian Federation	x	x	x	x	x	x		x	x				
Sweden	x	x	x	x	x	x	x	x	x	x	x	x	
United States	x	x		x	x	x		x	x				

Note. Adapted from AMSA 2009 report.

As of August 2012, the ballast water and wreck removal conventions were not yet in force.

MARPOL Annex II covers regulations for the control of pollution by noxious liquid substances in bulk. Annex III covers regulations for the prevention of pollution by harmful substances carried by sea in packaged form while Annex IV covers regulations for the prevention of pollution by sewage from ships. The London Convention 1972 and Protocol 1996 deal with the prevention of marine pollution by dumping of waste and other matter. The 1996 Protocol modernizes the 1972 Convention. The OPRC Convention 1990 deals with oil pollution preparedness, response and cooperation. OPRC/NHS 2000 deals with preparedness, response and co-ordination to pollution incidents by hazardous and noxious substances.

Bilge Water

The bilge water of ships may contain an emulsion of grease, hydraulic oil, lube oil, marine gas oil, marine diesel fuel, intermediate fuel oil, residual fuel oil, and degreasers. Accidental release of bilge water from a ship can have harmful effects on the Arctic environment. While the lighter petroleum components of bilge water are likely to evaporate faster than the heavier oily components, they can be more toxic than the persistent heavier components (Haggarty et al., 2003; National-Research-Council, 2003; Pitt, 2002). However, heavier

oils are more likely to impact waterfowl, fur-bearing mammals and seabed dwellers. While the mortal effects of persistent heavy oil on waterfowl and fur-bearing mammals is often visibly verifiable, further research with respect to an environmental risk management approach is needed to understand sub-lethal and long term impacts of acute and chronic exposure to petroleum compounds in Arctic ecosystems (Olsen et al., 2011; Nuka-Research-and-Planning-Group, 2010).

Ballast Water

With respect to ballast water and invasive species, which has been minimally studied in the Arctic (Arctic-Council, 2009), the discharge of a ship's ballast water that would likely take place during simultaneous loading of cargo in the Arctic can act as a conduit for the introduction of invasive aquatic species impacting both the environment and human health (Transport-Canada, 2010a; Gollasch and Nentwig, 2007; Niimi, 2004). Currently, the frigid temperature of Arctic waters may not be conducive to the survival of most invasive aquatic species that may be entrained in the warmer ballast water loaded on ships in more temperate or southerly latitudes (Environmental-Protection-Agency, 2008). However, these water temperature differences may decrease in light of climate change in the Arctic (Proshutinsky et al., 2011; CBC-News, 2010) causing ballast water to become a more significant concern in the future. Further, in the event of a leak between a cargo oil tank(s) and a ballast water tank(s), it is possible for ballast water to contain oil. Also, the use of chlorine based treatment systems, which may lead to possible chlorine residues (Haggarty et al., 2003), to sterilize ballast water of unwanted life forms is another environmental issue (Johannessen et al., 2007). Of further concern is the effect of fresh water ballast being discharged into salt water ecosystems, as some invasive species are salinity tolerant and spend parts of their lives in salt and freshwater (Transport-Canada, 2010b). On the 13th February 2004 the IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments. While the convention is not yet in force, but anticipated to happen in 2013 (Spears, 2011), the maritime community is preparing for it (American-Bureau-of-Shipping, *n.d.-a*). Under the convention, provisions will be made through the control and management of ships' ballast water and sediments to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens (International-Maritime-Organization, 2011a). Depending on size and age, vessels will be required to meet ballast water exchange standards or ballast water performance standards under certain criteria and deadlines. With regards to treatment regimes, ballast water systems may include the use of one or more of mechanical, physical disinfection and chemical treatment technologies (Marine-Log, 2012a). With regards to exchange methods, vessels are required to do so with an efficiency of at least 95% volumetric exchange and can do so using sequential, flow-through or dilution methods (American-Bureau-of-Shipping, *n.d.-a*). While various ballast water exchange programmes have been in effect for several years in various parts of the world, under the Convention ballast will have to be exchanged, whenever possible, at least 200 nautical miles from the nearest land and in water at least 200 metres depth, taking into account IMO guidelines concerning vessel stability

and safety. When this is not possible, ballast water should be exchanged as far as possible from the nearest land, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres depth (International-Maritime-Organization, 2011a). With respect to Arctic navigation, adhering to these requirements may be challenging during inclement weather conditions.

Sewage

The discharge of untreated sewage and the illegal release of food waste in Arctic waters may pose additional concerns for wildlife and those that depend on wildlife as part of their diet. Enteric pathogens found in sewage may be associated with waterborne disease. The effects of microbial infections can range from acute respiratory, skin, ear and gastrointestinal disorders to extreme liver disorders (Environmental-Protection-Agency, 2008; National-Research-Council, 1993). The environmental effects of organic content and pharmaceuticals found in sewage are a cause for concern (Johannessen et al., 2007). In the case of treated sewage and depending on the means of treatment, the disposal of concentrated sludge and the build-up of chlorine residues which are toxic to the environment are additional environmental concerns (Haggarty et al., 2003). MARPOL Annex IV(International-Maritime-Organization, 2011g) defines sewage as:

1. Drainage and other waste from any form of toilets and urinals;
2. Drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises;
3. Drainage from spaces containing living animals; or
4. Other waste waters when mixed with the drainages defined above.

Annex IV allows for the discharge of sewage under prescribed conditions with respect to distance from nearest land, approved sewage treatment plants, vessel speed and composition of the effluent.

Grey Water

Grey water consists of wastewater from sinks, showers, and galleys. It is not usually treated, unless mixed with sewage or treated directly with chlorine, and may contain organics, petroleum hydrocarbons, oils, greases, metals, suspended solids, nutrients, coliform bacteria, pharmaceuticals and personal-care products (Johannessen et al., 2007). When treated with chlorine there is the potential for toxic chlorine residues to be released into the sea. Of major concern regarding grey-water disposal is doing so in close proximity to shellfish beds, shorelines or within protected bays with low tidal exchanges (ibid). Currently, none of the MARPOL annexes set out regulations for the prevention of pollution from grey water. However, some countries including the United States are imposing restrictions on the discharge of grey water in some of its ports (Det-Norske-Veritas, 2010). In the case of the Canadian Arctic, while the discharge of grey water is not explicitly permitted, Transport Canada does not appear to enforce the prevention of grey water release.

Garbage

Garbage consists of all kinds of victual, domestic and operational waste generated during the normal operation of the ship. Subject to the provisions of regulations 4, 5 and 6 of MARPOL Annex V (International-Maritime-Organization, 2011g), outside of special areas (the Arctic is not a special area and is therefore subjected to):

1. The disposal into the sea of all plastics, including but not limited to synthetic ropes, plastic garbage bags and incinerator ashes from plastic products which may contain toxic or heavy metal residues, is prohibited;
2. The disposal into the sea of the following garbage shall be made as far as practicable from the nearest land but in any case is prohibited if the distance from nearest land is less than:
    a. 25 nautical miles for dunnage, lining and packing material which will float;
    b. 12 nautical miles for food waste and all other garbage including paper products, rags, glass, metal, bottles, crockery and similar refuse. In the event of being passed through a comminuter or grinder, disposal of these items may be permitted outside of 3 nautical miles from nearest land if capable of passing through a screen with openings no greater than 25mm.

Inside special areas, only the disposal of food waste is permitted as long as it is not less than 12 nautical miles from nearest land or 3 nautical miles in the case of the Wider Caribbean Region if comminuted or ground and capable of passing through a screen with openings no greater than 25mm. While the discharge of shipboard garbage and solid waste from ships is regulated and not permitted in the waters of Arctic nations such as Canada, it can impact the marine environment. Illegal dumping of garbage and solid wastes may occur from ships with limited waste storage capacity and in areas where policing of regulations may be difficult (Johannessen et al., 2007; Transport-Canada, 2007). While the disposal of garbage such as plastic is banned at sea under MARPOL Annex V, such substances can be blown into the ocean if not properly contained on board a ship. Plastics pose a significant threat to marine life and can remain in the environment for years (International-Maritime-Organization, 2011h). Birds feeding on the surface of the sea are vulnerable to the ingestion of floating plastic mistaken for food. Marine species dwelling below the sea surface may mistake submerged plastic for food while feeding. Plastics affect hundreds of marine species ranging from mammals to plankton and often result in mortality (Fisheries-and-Oceans-Canada, 2012).

Hull Fouling

While banned or being phased out in various parts of the world, antifouling paints used as biocides on the underwater portion of a ship's hull to prevent the attachment and growth of unwanted aquatic life may still contain the common organotin compound tributyltin (TBT) (OSPAR-Commission, 2009;

Johannessen et al., 2007). TBT has serious effects throughout the food webs of marine ecosystems (Haggarty et al., 2003). While copper- based antifouling paints are now being substituted for TBT-based paints, these may lead to the bioaccumulation of copper in aquatic biota resulting in increased mortality, lower reproductive success and other negative impacts (ibid). In 2001, the IMO successfully adopted the *International Convention on the Control of Harmful Anti-fouling Systems on Ships*. The convention entered into force in 2008. Under the convention, as of 1 January 2008 all ships subject to the convention would either not bear such compounds on their hulls or bear a coating forming a barrier to prevent the leaching of the compounds into the sea (International-Maritime-Organization, 2011e). However, Transport Canada notes the abrasive effects of ice on the hull coatings of ships operating in ice infested waters (Transport-Canada, 2010c), which can lead to unintentional release of chemical compounds in the Arctic.

Noise

Anthropogenic sources of noise from ships operating in Arctic waters can have undesired effects on marine mammals and fish (Marine-Mammal-Commission, 2007; Offshore-Oil-and-Gas-Research-Group, 2004). The low-frequency noise from commercial ships has been demonstrated to mask the communication signals of some large marine mammals, compromise their communication space and cause chronic stress (Rolland et al., 2012; Clark et al., 2009). The effects of noise on wildlife may range from the interruption of vocalizing (McCarthy et al., 2011), feeding and mating, the abandonment of certain habitats, to death (Risch et al., 2012; Molnar and Koshure, 2009; Popper and Hastings, 2009; Weilgart, 2007).

Deck Cargo

Deck cargo lost overboard from ships in stormy seas as a result of incorrect loading or incorrect or insufficient lashing can pose serious hazards to ships, people and the environment (American-Institute-of-Marine-Underwriters, n.d.). In the case of the 20 ton container of tetraethylene glycol diheptanoate that washed ashore on Bering Island in 2003, local residents were poisoned and there was bird and seal mortality (Arctic-Council, 2009). In light of anticipated worsening of Arctic sea conditions associated with less sea ice, more intense weather systems, and consequently more freezing spray and ice accumulation on deck, the loss of deck cargo into the Arctic Ocean may increase.

SECTION 2- HUMAN IMPACTS

According to IMO Secretary-General Koji Sekimizu, maritime transportation is cost-effective, environmentally sound and an essential part of any economy (2012). This is also very true for the Arctic where safe, secure and environmentally responsible shipping does occur. The AMSA 2009 report notes that from a human element perspective, Arctic marine shipping will have local, regional, and broad reaching impacts, both positive and negative, on indigenous Arctic communities. While the human element of Arctic marine shipping is purported to be broad reaching and extensive, there is little recorded empirical evidence identifying the impacts of shipping on Arctic residents (Arctic-Council, 2009). Undoubtedly, the natural progression of societies and warming of the Arctic will alter the contemporary ways of living in remote, isolated and sparsely populated Arctic communities. While traditional ways of living are still important to the indigenous people of the Arctic (ibid), there appears to be a growing dependence on the need for goods and services that are shipped in from the south. Maritime transport itself, being safe, secure and the least expensive form of transportation on the planet will play an increasing role in fulfilling the growing demands of Arctic residents. Marine transport will also allow for the exploitation of natural resources and large scale economic development in an otherwise relatively inaccessible region. In addition to the direct economic benefits of maritime transportation, future growth in safe and environmentally responsible shipping in the Arctic will require further supporting infrastructure, services and resources which are currently scarce or non-existent in places. The provision of ancillary supporting services will provide potential for further economic benefit for Arctic residents. However, in order to minimize environmental and human impacts while simultaneously maximizing potential benefits, Arctic shipping operations would be best served by involving the local residents during the early stages of the operation and throughout (ibid). Currently, the greatest benefit to Arctic residents would appear to come from the intra-Arctic or destination shipping which allows for relatively efficient and effective annual re-supply of many Arctic communities. At present, transit traffic through the Arctic from Europe to Asia for example is not perceived to be of much benefit to those living in the Arctic.

In many cases the existence and survival of industrial activity in the Arctic is dependent on safe and reliable maritime transportation (Prime-Minister's-Office, 2010). Economic development, whether direct or indirect, from mining, oil and gas, fishing, shipping and tourism will undoubtedly create potential for new wealth in the Arctic (Arctic-Monitoring-and-Assessment-Programme, 2007). Employment statistics indicate that 30-40% of the work force at Canadian diamond mines in the Arctic is made up of indigenous people (Natural-Resources-Canada, 2008). The Red Dog zinc-lead mine located in Northwest Alaska is one of the world's largest producers of zinc concentrate. With a payroll of USD $52 million in 2009, Red Dog provides 550 full-time jobs and significant seasonal summer employment for the local and regional economy. Nearly 57% of the mine's workforce is made up of shareholders from the local region (Red-Dog-Mine, 2009). However, this new wealth may be of

less benefit to those who adhere to traditional lifestyles (Hagen et al., 2001). In the case of the largest mining project ever undertaken in the Canadian north, the Baffinland iron ore mining project at Mary River is expected to triple Nunavut's annual gross domestic product growth rate, provide nearly CAD $5 billion in tax revenue and royalties to the territory, create over 5,000 direct jobs, many more indirect positions and offer training opportunities in an area of the north where the majority of people live in social housing and earn less than CAN $10,000 annually (Waldie, 2011). However, as is often the case, the economic benefits will need to be juxtaposed against the environmental and social impacts. As would and should be expected, local residents of the Mary River, Baffinland mining project area have raised concerns over the impacts the project will have on the landscape, wildlife, and their subsistence way of living (ibid).

Notwithstanding the above, the negative impacts of shipping on Arctic residents may present themselves in acute and/or chronic forms. Section 1 focused on the present and future environmental impacts that shipping has brought about and may bring about in the Arctic with respect to wildlife, sea and air. Like most environments, negative impacts in the Arctic will subsequently affect those who depend on it for various reasons. With respect to chronic human impacts from Arctic shipping, air pollution and reduced albedo of snow and ice stemming from toxic ship emissions and black carbon respectively will not likely cause a sudden onset of lung disease or climate change; it will take time. However, the destruction of sea ice from vessel traffic and the resulting tracks of open water can have acute impacts on local inhabitants using the frozen sea ice during winter as a daily means of transport for various social, cultural, and economic reasons. Acute impacts can also compound to bring about chronic impacts. For example, the occasional transiting of a vessel through frozen sea ice may disrupt the use of sea ice as a means of transport for the local inhabitants in terms of a day(s). However, the constant plying of ships through sea ice may prevent adequate refreezing so as to allow safe transit over it. In consideration of the vital importance of hunting to the subsistence-based lifestyle common to many Arctic inhabitants, the acute disruption of hunting for a day or two would likely not have the same negative impact as the chronic disruption of hunting for the season.

Unlike Antarctica which is surrounded by water, the Arctic Ocean is surrounded by land belonging to Canada, Russia, United States of America, Norway, and Denmark via Greenland. While national boundaries for most of the Arctic Ocean are in place and acknowledged by Arctic nations, there are some boundary disputes and some sections of the central part of the Arctic Ocean that fall under international waters (Arctic-Council, 2009). Without certainty of ownership and responsibility for careful management and stewardship of the disputed sections of the Arctic Ocean, a shipping accident affecting the environment in a disputed area may not receive the appropriate response as nations may be reluctant to incur the cost of clean-up (Hagen et al., 2001), which will be significantly high due to the dearth of available resources and remoteness of the Arctic (International-Maritime-Organization, 2011j). Regardless of the initial location of an environmental incident, the

existence of Arctic Ocean currents such as the Beaufort Gyro could possibly cause the spread of pollution.

In addition to some of the environmentally related impacts affecting human life in the Arctic, shipping can also pose more direct social, cultural and economic impacts on Arctic residents. Arctic indigenous people are undergoing profound social and cultural change. While evolution and isolation has allowed the indigenous people of the Arctic to slowly adapt to genetic and cultural changes, the magnitude and sudden introduction of new stressors stemming from the current resurgence of business interest and activity in the Arctic has brought about the most significant impact on health. Consequently, an assessment of the impact that increased Arctic shipping activity will have on the local inhabitants and the environment is imperative (Prime-Minister's-Office, 2010).

SECTION 3 – INFORMATION AND COMMUNICATION TECHNOLOGY

While electronic navigation has certainly progressed in recent years, the literature identifies that many information gaps still exist with respect to helping ensure safe and environmentally sustainable shipping in harsh, remote, environmentally sensitive and ice-prone or -infested Arctic waters. Increased use of information and communication technology (ICT) systems on board and ashore will be pivotal to dissemination of real-time information to the Arctic mariner. ICT is one of the most powerful tools invented in the 20th century, the benefits of which can be seen in the power of the information super highway which brought about networking and connectivity to billions of people. While the world may be conceptualized as a global village, the same cannot be said about maritime commerce where technology has traditionally lagged behind in terms of wireless connectivity. Introduction of the space segment for communication between ship and shore has revolutionized the entire maritime trade spectrum. Safety at sea, pollution prevention, search and rescue (SAR) techniques, navigational warnings, distress and safety systems have all been transformed due to the coupling of navigation and communication equipment on board and internet access; the bandwidth and speed of which continually increases. Best use of ICT technology will continue to play an increasingly important role in helping ensure safe and environmentally sustainable marine transportation in Arctic waters.

Navigation in the Arctic poses some major challenges which are not present in sub-Arctic latitudes namely:

- Presence of sea ice, growlers and ice bergs;
- Limitations of gyro and magnetic compasses;
- Limitations of equipment used for electronic position fixing such as global positioning system (GPS);
- Limitations of on board communication equipment in high latitudes due to masking, poor elevation and shadow sectors of satellites;
- Extreme weather conditions causing icing and freezing spray which limits machinery and equipment reliability on board;
- Inadequate hydrographical surveys in parts of the Arctic; and
- Lack of geodetic information and inadequate electronic navigation chart (ENC) coverage.

Electronic navigation (e-navigation), availing of ICT technology, can help provide safe and environmentally sustainable shipping in Arctic regions (Weintrit, 2011). e-navigation is defined as “the harmonised collection, integration, exchange, presentation and analysis of maritime information on board and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment” (International-Association-of-Lighthouse-Authorities, 2010).

According to a report from the Correspondence Group on e-navigation to NAV 57 (2011), some of the core objectives of the e-navigation concept are to:

- Facilitate safe and secure navigation of vessels having regard to domain and situational awareness; and
- Facilitate communication, including data exchange, among ships and shore-based entities.

The Nautical Institute (2009) notes that with respect to environmental benefits e-navigation will:

- Reduce the risk of collisions and groundings and the associated spillages and pollution by improving navigation safety;
- Reduce emissions by using optimum routes and 'safe' speed in ice; and
- Enhance ability and capacity in responding and handling of emergencies such as oil spills.

'Safe' speed-in-ice transit will result in reducing noise pollution and collision interaction with animals (Arctic-Council, 2009)

A multi-national group of experts formed under the auspices of IMO's Maritime Safety Committee has identified five separate 'Service Areas' along with an extensive menu of information services known as the 'Maritime Services Portfolio' (Correspondence-Group-on-e-navigation-to-NAV57, 2011). Operations in Arctic, Antarctic and remote areas fall under one of the five areas in the context of e-navigation. The group of experts has developed a gap analysis in the realm of e-navigation and information technology in the maritime domain. Following is a list of proposed services, although not exhaustive, put forward by the group that would address the identified gaps and have a significant positive impact on navigation in Arctic waters:

- Ice information services;
- Weather routing;
- Real-time environmental observation;
- Search and rescue (SAR) services;
- Automatic updating of ENC's;
- Manoeuvring support;
- Digital information exchange with the pilot's portable unit (PPU);
- Automatic presentation of relevant maritime safety information (MSI);
- Traffic organization service (TOS);
- Navigation assistance service (NAS);
- Remote inspection of navigation equipment;
- Remote update of automatic identification system (AIS) voyage details; and
- Standardized and automated reporting (Pot and Moore, n.d.).

ICT will play an extremely important part in linking transport logistics and supply chain management in order to safely and effectively move cargo in, out and through the Arctic regions. ICT seamlessly integrates various stakeholders who may be dispersed in all parts of the world through the e-platform. The ICT component, as it pertains to the maritime applications may be split up into marine, land and space based segments for ease of resource allocation and administration.

The marine segment may be divided into two areas of operation on board a ship, floating craft or a mobile offshore drilling unit (MODU) namely:

- The electronic equipment used for navigation and communication; and
- Integrated marine automation systems (e.g. unmanned engine room, remote operation of machinery, ballast and cargo systems).

The IMO Guidelines for Ships Operating in Polar Waters sets out construction, equipment, operational and environmental provisions with special consideration for the risks of navigating in ice-covered waters. Throughout the guidelines, the Arctic is recognized as a significant area for international shipping that requires special attention to human factors such as training and operational procedures. Chapter XII of the guidelines deals with navigational equipment and the recommendations of the chapter are not to be considered in addition to the requirements of the International Convention for the Safety of Life at Sea (SOLAS) Chapter V which makes mandatory the carriage of a voyage data recorder (VDR) and AIS (International-Maritime-Organization, 2009). The range of equipment mentioned in Chapter XII of the guidelines include: compasses (gyro & magnetic); speed, distance and depth measuring devices; radar installations; electronic positioning and charting systems (ECDIS), GPS/GLONASS receivers; ice-routeing equipment; AIS; searchlights and vision enhanced equipment among others (International-Maritime-Organization, 2010a). The operational and technical limitations of compasses and electronic positioning equipment such as GPS are emphasized.

Modernization of on board equipment is bringing about increased use of electronics, computers, data processing and exchange of information back and forth between the ship and shore. The success of ICT is extremely crucial in dissemination of timely data concerning ice, weather, and navigational warnings to the navigator. This requires appropriate training and certification to handle on board navigation and communication equipment, interpret vital data contained in shore-based ice reports, meteorological reports, navigational warnings and safety bulletins.

E-navigation is expected to be flexible enough to accommodate the existing bridge equipment as well as additional new equipment in the future. The performance standards of existing equipment such as ECDIS, RADAR, integrated navigation systems (INS), AIS and global navigation satellite systems (GNSS) are being widely used in developing the e-navigation concept. GNSS is being increasingly recognised as the primary electronic position finding system for e-navigation. GNSS 1, the first generation system is a combination of existing, United States controlled, Global positioning system (GPS) and, Russian controlled, global navigation satellite system (GLONASS) with satellite based augmentation system (SBAS) or ground based augmentation system (GBAS).The second generation of GNSS (GNSS2) will comprise a fully functional GALILEO satellite navigation system operated by the European Union. Navigation satellite systems are also being developed by China, Japan and India which should provide easy accessibility of electronic navigation system to the mariner in the future. The on board receivers should be integrated by the manufacturers to accommodate all systems and provide multi-tasking functionality in the future. This will greatly help position fixing

using GLONASS satellites if GPS satellites are not available particularly in high latitude Arctic navigation. The GPS system is a 6-plane constellation with an orbital inclination of 55° whereas the GLONASS has an orbital inclination of 64.8°. This has significant impact on operations at high latitudes.

The creation of 'Green' shipping corridors in the Arctic is another benefit of e-navigation. The power of information and communication technology should be totally exploited in achieving data connectivity between and among ship and shore stations. Such connectivity would allow for vessel traffic management services (VTMS) monitoring of ice infested routes, dissemination of ice information to the mariner, recommending appropriate routes, positioning and movement of maritime assets such as ice breakers to assist ships, monitoring of IMO 'areas to be avoided', search and rescue coordination, ecological sensitive areas, and oil spill response and mitigation measures.

IMO's e-navigation strategy appears to be well positioned and suited for the Arctic. Notwithstanding the above, over-reliance by vessel navigators, and other users, on electronic equipment relying on relatively weak satellite signals for vital ship operations may not be in line with best practices. The weak signal strength and high frequency band widths transmitted from high orbiting satellite based positioning systems are easy targets for malicious intentional interference such as jamming and spoofing (GPS World, 2012). These systems are also vulnerable to unintentional interference such as radio frequency interference (RFI) and ionospheric interference, and human error in terms of lack of knowledge and training.

SECTION 4 – OBSERVATIONS OF BEST PRACTICE BASED ON RESULTS OF WEBSITE ANALYSIS AND QUESTIONNAIRES

With respect to a methodological approach, a website search was conducted to look for shipping companies informing that they were involved in Arctic operations. Annex A provides full details of the website search. The website search of Arctic shipping companies helped with the creation of a two-part questionnaire aimed at identifying "best practices" currently in place with Arctic shipping operators. The questionnaire was administered electronically. Copies of the survey are available upon request. Subsequently, a number of companies, identified from the website search and representing a pan-Arctic sample of operators, were contacted by email to inquire if they were interested in taking part in the online questionnaire. Coast Guard vessels, naval ships and cruise ships were excluded from this research.

There are many definitions of the term "best practice." Taking a project management perspective, Kerzner (2010) defines "best practice" and compares it to "proven practice." He defines best practice as originating with an idea that there are more efficient and effective ways of achieving or delivering an outcome with fewer problems and unforeseen complications. This idea is then repeatedly put to practice in large numbers of cases and subsequently proven to be the most efficient and effective way of achieving or delivering the desired outcome. However, Kerzner goes on to note that once the "best practice" is proven to be effective it becomes integrated into the standard way of doing business and should therefore be referred to as a "proven practice." In light of the fact that there are relatively few Arctic ship operating companies, the use of the term "best practice" may be most appropriate.

An analysis of company websites, see Annex A , cannot be used for generalization of the policies implemented by all shipping companies operating in harsh, remote, environmentally sensitive and ice-prone or -infested Arctic waters. However, it does give an indication of the promotion of such policies and best practices through an official marketing tool. It is also necessary to fully appreciate and understand that while a company may have a very large and diverse fleet of vessels, only some of these vessels may be operating in the Arctic on a year-round, summer or seasonal basis. Notwithstanding the above, corporate wide environmental, safety and corporate social responsibility policies are normally expected to be holistic and cover the entire fleet regardless of the area of operation; components of such policies may be more direct and area specific.

It is evident from the website analysis that many of the shipping companies presently operating in the Arctic take environmental and social concerns seriously and are at the sharp edge of the wedge in working to protect fragile Arctic ecosystems and helping the indigenous peoples of the Arctic maximize the many benefits of shipping. For some experienced Arctic shipping companies a "Guide of Best Practices" may help with the broadening and or strengthening of already high operating standards. This is true since the analysis of some company websites indicate that while not forced to by national or international regulations, they are already operating voluntarily to high safety, environmental and corporate social responsibility (CSR) standards. Lucidly, novice entrants to Arctic shipping would be prudent to hearken the advice and assimilate the best practices of those experienced operators presently leading the way forward in Arctic shipping operations. The identification of environmentally sustainable initiatives and corporate social responsibilities, through the analysis of company websites, also helped forge the development of a research questionnaire. This questionnaire was sent to selected Arctic shipping operators to help further identify and triangulate best practices. Below is a summary of Part 1 of the questionnaire consisting of closed questions and following is a summary of Part 2 of the questionnaire consisting of open questions.

Summary of Part 1:

- All companies taking part in the research reported they were involved in cargo transport consisting of oil and oil products, dry bulk, general cargo and containerized cargo. The additional provision of tug and barge services, and ice breaking and ice support services were also noted. Companies were involved in year-round, autumn and summer operations. Those involved in year-round operations used vessels having 1AS or higher ice class notation while companies involved in autumn or summer operations used vessels of 1C to 1A ice class notation.

- While all companies were compliant with IMO regulations and, where applicable, accepted industry standards such as OCIMF, this was not the case with voluntary standards such as ISO 14000/14001. All companies did however report some form of connection with environmental industry associations such as Green Marine or were recipients of Green Awards. While some companies reported having both a safety and quality policy and an environmental management plan others reported having one or the other. Half of the companies responded they publish in some format the results of environmental action plans.

- In measuring the environmental impact of fleet operations, all companies reported they conduct regular inspections on board and record environmental incidents such as oil spills and near misses. While the majority of companies reported they conducted risk assessments, especially for environmental risk, half reported the establishment of environmental-related key performance indicators and one company reported they measured emissions and wastes from vessels' operations.

- In staying updated and following all environmental legislation and regulations, all companies reported they attended appropriate conference and seminars and that they were members of industry associations. The majority of companies also E-register to related maritime bodies to receive all newly published regulations and participate in international regulatory bodies. Consulting regulator websites and contracting with information providers for future and changing legislation were also noted by participants.

- All companies reported that the role of company personnel, both ship and shore based, with respect to environmental policy and management plans included following the company safety and quality policy where applicable. The majority of companies reported that ship and shore personnel receive environmental awareness training, regular safety training and familiarization, and report non-compliance with company's environmental policy and or environmental regulations to the company.

- The majority of companies reported they involve other stakeholders, such as charterers, contractors and sub-contractors in their environmental policy action plan. This involvement ranged from informing suppliers of ecological purchasing policies, sensitizing contractors to environmental requirements, inviting coast guard and other authorities to joint environmental response rehearsals, maintaining open dialogue with charterers and by participating in community outreach sessions where the effects of vessel operations are discussed.

- Regarding ship operations and practices that companies apply in helping the environment:
    - all reported they keep their vessels and equipment well maintained
    - the majority of companies reported they:
        - practice fuel management and energy efficiency through careful engine performance, adherence to ECA limits for SO_x, NO_x and PM; and
        - do not release bilge water or garbage in Arctic waters and that bilge system oil filtering equipment is fitted with high level alarms and automatic stopping devices.
    - half of the companies reported the use of:
        - IMO-approved antifouling hull coatings;
        - using low sulphur intermediate fuel oil;
        - adherence to Tier I and Tier II NO_x emission limits;
        - ballast water exchange;
        - no discharge of sewage or related sludge in Arctic waters; and
        - using biodegradable lubricating oil in propeller shaft bearings.
    - some companies reported:

- slow speed steaming in Arctic marine protected arrears (MPAs) and particularly sensitive sea areas (PSSAs);
- having a ship energy efficiency management plan (SEEMP) and an energy efficiency operational indicator (EEOI);
- mapping of factors affecting propulsion resistance and fuel efficiency;
- using low sulphur marine gas oil or marine gas oil;
- following a programme for the minimization of harmful emissions into the atmosphere close to ports;
- using on board ballast water treatment facilities;
- no discharging of grey water into Arctic waters;
- using water lubricated propeller shaft bearings; and
- regular hull and propeller cleaning.

- Regarding waste management practices, all companies reported they operate on board domestic waste management programs, recycle batteries, and manage cargo residues and waste oil. The majority of companies reported recycling paper, glass and aluminum. Half of the companies reported they manage ballast water and hull cleaning and use a biological sewage treatment plant on board. One company reported the use of an on board incinerator for waste.

- Regarding ship design and ship building, half of the companies reported the use of a waste water filtration system and keeping an inventory of hazardous materials. Some companies reported having ballast water management technology suited for cold climates, vessels fitted with dedicated holding and decanting tanks and extra storage capacity for sewage treated water and grey water. One company noted that clean ballast from segregated ballast tanks is circulated through and overboard discharge monitor (ODM) and verified to be oil free before being discharged overboard.

- Half of the companies reported they cooperate in or support research on environmental conservation and or protection of the Arctic. Such activities include bio-fouling research, air emission testing and direct involvement with environmental NGOs.

- Regarding company policies associated with environmental protection all companies reported maintaining adequate pollution liability insurance. The majority of companies reported they liaise with a designated community official(s) in Arctic communities. Half of the companies reported participation in environmentally focused industry groups and one company reported having on board wildlife monitoring protocol.

- Table 5 shows the response from a set of general statements dealing with mandatory regulations, training and the relative impact of shipping on air emissions.

Table 5: Opinion Results (reported in percentage of respondents)

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree	Undecided
A new Polar Code could lead to over-regulation in the shipping market.	0	25	50	25	0
A Polar Code should be mandatory.	0	25	25	25	25
Compliance with MARPOL regulations satisfies necessary environmental protection in Arctic waters.	0	25	50	0	25
Compliance with SOLAS regulations satisfies necessary vessel requirements for safe Arctic navigation.	0	50	0	25	25
Compliance with STCW regulations satisfies officer training necessary for safe Arctic navigation.	0	75	25	0	0
Ice navigation training courses should be standardized.	0	0	75	25	0
Ice navigator qualification schemes should be standardized.	0	0	50	50	0
Per ton mile of cargo moved, air emissions created by shipping are less compared to those created by land transport.	0	0	25	75	0

Statement	Strongly Disagree	Disagree	Agree	Strongly Agree	Undecided
There needs to be less regulation of ship generated air emissions.	0	50	25	25	0
There needs to be more regulation of land transport generated air emissions.	0	0	25	0	75
All new vessels intended for Arctic operations should be built to IACS Polar Class designation.	50	25	0	0	25

Summary of Part 2:

- Regarding processes in place for addressing environmental incidents and consequential improvements to operational results, companies reported strictly adhering to national and international regulatory regimes and safety management systems (SMS). One company reported the changing of ballast water on domestic voyages as an example of evolving environmental stewardship.

- Regarding the intentional limitation of black carbon emissions when operating in or near ice covered waters, companies reported adhering strictly to the operational and maintenance requirements of respective power plants, and in doing so achieved optimum engine performance consequently helping to limit emissions.

- Companies reported the use of heavy fuel oil (HFO) in accordance with engine maker's requirements when at sea but that marine diesel oil (MDO) was used in auxiliaries during port or at anchor operations.

- While no company reported having a policy in place to limit vessel noise and prevent vessel strikes with mammals and nocturnal sea birds, companies reported avoiding, where safe navigation allowed, identified sensitive areas and reducing speed.

- Regarding preventing or limiting the potential for invasive species, companies reported adhering to both mandatory and voluntary ballast water exchange programs.

- While companies reported they presently had no standards for infrastructure and shore side operations for the protection of Arctic communities and sensitive areas, they did note that after beach operations

are completed, sites are cleared of debris and waste originating from operations and it is brought to municipal landfills.

- Regarding training provided to officers when navigating in Arctic ice-covered waters, companies reported that officers received both external and in-house ice navigator training. On board training of junior officers by long serving and experienced Arctic navigators was also reported. Knowledge of and adherence to regulatory reporting systems and official publications was also reported.

- Regarding training, policy and procedures provided to officers and crew with respect to personal safety and emergencies when working in cold temperatures and Arctic ice-covered waters, companies reported having policies and procedures in place on board individual vessels. It was also stressed that vessels are manned by long serving officers and crew that originate from cold climate regions and who are experienced and well versed with working in harsh Arctic conditions. On board drills are conducted while working in the Arctic and cold weather training is provided on board every six months.

- Regarding environmental awareness, garbage and waste management training provide to officers and crew, companies reported providing environmental system training and making ship staff aware of waste management policies. Vessels operate with zero tolerance for waste disposal and on board signage and waste receptacles are provided for separating waste into appropriate categories. Where approved by local authorities, domestic garbage is brought to municipal landfills.

- Regarding the manning of vessels when working in Arctic regions, companies reported placing an extra master, ice navigator, local ice pilot, officers and crew on board when the conditions merited such actions.

- Regarding vessel operating manuals, safety management codes and risk identification for vessel operations in Arctic waters, companies reported having these in place. Winter operation risk assessments are carried out and ship specific winterization procedures and instructions have been developed. Safety management systems are evolving and the identification of new risks are recorded in the risk register and dealt with accordingly.

- Only one company reported that the shipboard oil pollution emergency plan (SOPEP) is designed and approved for all waters and regions in which the vessel operates.

- Regarding vessel safety and measures in place to help prevent vessel icing from sea-spray, companies reported having written winterization procedures in place. It was also reported that the experience of long serving officers and crew was very important in helping prevent vessel icing from sea-spray. Officers are never pressured to put expediency ahead of safety and seek refuge or delay sailing if freezing spray

conditions could be a threat to the vessel's stability. Strict attention is paid to weather conditions and forecasts and the vessel's stability is monitored regularly. Weather routing services are also availed of.

- Regarding the use of ice information technology and fitting vessels with additional navigation and communication equipment, companies reported a range of extra equipment beyond the mandatory requirements. Vessels are equipped with an Ice-Nav system incorporating advanced marine radar (VMR), enhanced target detection (ETD) radar and satellite communications for acquiring ice charts. Vessels are fitted with internet, weather fax, electronic chart viewer and satellite compass.

SECTION 5 – RATIONALE TOWARD AN INTERNATIONAL MANDATORY POLAR CODE

Currently there are no mandatory, internationally accepted rules written specifically to govern ship operations in Arctic waters. What is in place are IMO Guidelines for Ships Operating in Polar Waters. As noted earlier, these guidelines set out provisions for construction, equipment, operational and environmental protection and damage control with special consideration for the risks of navigating in ice-covered waters. Throughout the Guidelines, the Arctic is recognized as a significant area for international shipping that requires special attention to crew training and operational procedures. With respect to regulations, there are various flag states regulations in place belonging to individual Arctic nations aiming to control shipping operations within their own Arctic jurisdictions. A plethora of flag states regulations will be more difficult to adhere to than one unified international regulation. A legally binding Polar Code needs to be considered (Arctic-Council, 2009) A code which should identify and unify the commonalities of what it takes, and what is currently enforced by flag states, to safely operate in all Arctic nation waters.

Given that the stimulus for future shipping in the Arctic will come from global economic factors, as well as significant population growth in some parts of the circumpolar Arctic (Statistics-Canada, 2011; Bogoyavlenskiy and Siggner, 2004; Gorman and Paterson, 2004), international shipping interest, from non-Arctic nations, is most likely to increase. Resource exploitation and increasing re-supply needs will be key demand drivers for future maritime transportation in the Arctic. Valuable experience has been gained over decades of Arctic operations by shipping companies based in Arctic nations that have been involved in the re-supply and intra-Arctic shipping activities in their own Arctic regions. However, it would be reasonable to expect that operators from non-Arctic nations, with growing Arctic shipping interest in transit traffic or cabotage free shipping, will lack the required experience necessary for safe and environmentally responsible shipping in Arctic waters. Mining, oil and gas, and tourism operations will likely attract international operators with little or no Arctic experience and economies of scale will drive the size of future ships to be significantly larger than many of those currently operating safely in the Arctic. For the most part, the negative impacts that shipping can have on the environment are known. Fortunately however, there have been no major environmental accidents in the Arctic. This may be attributed to relatively low levels of vessel traffic and that most Arctic operations are being conducted by Arctic nations who have slowly and carefully developed a proven system of safe Arctic operations. Anticipating that this approach to Arctic shipping may change in the near future it seems sensible that strict mandatory regulations need to be put in place to help ensure that all future shipping operations are conducted in a safe and environmentally sustainable manner so that Arctic ecosystems are preserved to the benefit of all.

Many nations of the world are especially interested in the activities of the Arctic Council nations that border on the Arctic Ocean (Saran, 2012). Extraneous from the interest of resource extraction, re-supply and shorter shipping distances are the overall environmental interest connected with the Arctic. What happens in the Arctic will have repercussions on climate change elsewhere (Maslowski et al., 2012, Foreign-Affairs-and-International-Trade-Canada, 2010). Contemporary views suggest a connection between global climate change and environmental changes in the Arctic (International-Polar-Year, 2012). A recent scientific study suggests that diminishing Arctic sea ice may be impacting climate change in the Northern Hemisphere (Jaiser et al., 2012). There is much global interest in the changing conditions of the Arctic and therefore nations feel the need to sail there and study what is transpiring (CRI-English, 2012). The Arctic Ocean has been referred to as the barometer for global climate change (Cochran, 2008; Simon, 2004). Consequently, interest in the Arctic is gaining momentum.

While flag state regulations put in place by Arctic nations will regulate domestic ship operators working within their own Arctic regions, these regulations will not have the same control over foreign operators operating in Arctic waters where port state control resources may be absent or over tasked (International-Maritime-Organization, 2011b; VanderZwaag et al., 2008). Also, flag state regulations put in place by Arctic nation administrations will undoubtedly vary and thus cause confusion for shipping companies operating on the high seas and in various coastal regions belonging to different Arctic nations (Arctic-Council, 2009; Jensen, 2007). While flag state regulations of Arctic nations help ensure safe and environmentally responsible shipping in their respective Arctic waters, international maritime shipping regulations currently in place to help standardize the requirements for all ship operators appear to lack the necessary rigour to ensure safe and environmentally responsible operations in a harsh and fragile Arctic environment. Many IMO safety conventions have been written without the Arctic in mind (Arctic-Council., 2009) as they have global reach and impact all ship operators, many of whom have no intentions of working in Arctic waters. As noted by Jensen (2007), Arctic shipping is a marginal activity when looked at globally. Mandatory, broad reaching IMO treaties such as SOLAS, MARPOL, and the International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW) influence the global shipping community. Forcing ship operators to adhere to regulations dealing with Arctic operations, when they have no intention of operating there, would be viewed as an unnecessary expense and therefore would not be adopted by a sufficient number of IMO member states or global tonnage to enter into force. Lacking sufficient acceptance usually results in an IMO adopted measure becoming voluntary (International-Maritime-Organization, 2011d; Jensen, 2007), as is the case with the IMO *Guidelines for Ships Operating in Polar Waters*. Figure 2 delineates the maximum extent of these guidelines.

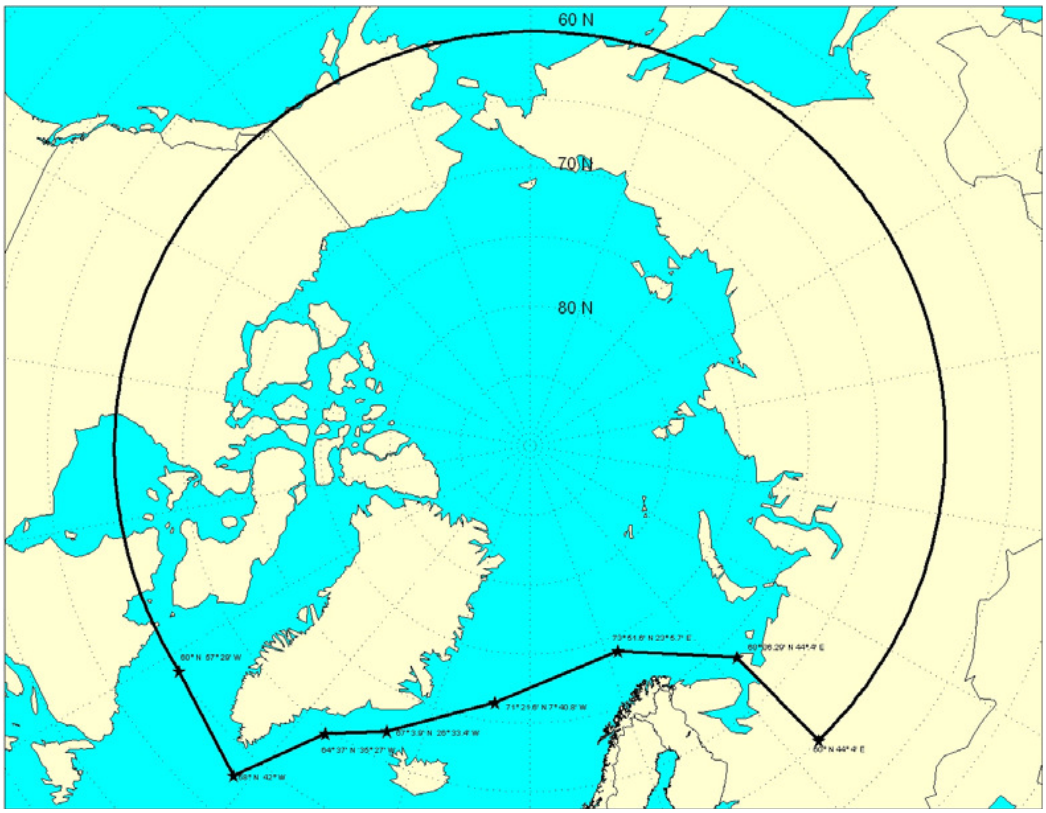

Figure 2: Maximum extent of Arctic waters application. From IMO guidelines for ships operating in polar waters, 2010. Guide section, p 9. Retrieved from http://www.imo.org/blast/blastDataHelper.asp?data_id=29985&filename=A1024(26).pdf

Having the backing of the IMO in supporting coastal state measures aimed at protecting the environment is deemed beneficial, as the international shipping community may be unwilling to accept measures that restrict freedom of navigation on the high seas (Roberts, 2007). With 170 member countries representing over 98% of world merchant shipping tonnage, the IMO has global impact over regulating international shipping (International-Maritime-Organization, 2011c). Consequently, the IMO has the ability to apply measures aimed at promoting safe and environmentally sustainable shipping in Polar regions (e.g. *Guidelines for Ships Operating in Polar Waters*). In addition, coastal states have the ability through the "Arctic Clause", Section 8, Article 234 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction, and control of marine pollution from vessels in ice-covered areas within their Arctic Exclusive Economic Zones (EEZs) (United-Nations, 2011; Fisheries-and-Oceans-Canada, 2010). For example, given that MARPOL Annex I: *Regulations for the Prevention of Pollution by Oil* excludes the Arctic as a special area (International-Maritime-Organization, 2002), Canada has enacted the *Arctic Waters Pollution Prevention Act* and its associated regulations to prevent, for the most part, the discharge of oil into Arctic waters (Department-of-Justice-Canada, 2012b).

In helping promote a mandatory code for ships operating in polar waters, the International Association of Classification Societies (IACS) has developed a set of Unified Requirements which address essential aspects of construction and power requirements for Polar class ships. These requirements are in addition to general classification society rules. Table 6 outlines the capabilities of the various IACS Polar class ships.

Table 6: Polar Class Descriptions

Polar Class	**General Description**
PC 1	Year-round operation in all ice-covered waters
PC 2	Year-round operation in moderate multi-year ice conditions
PC 3	Year-round operation in second-year ice which may include multi-year ice inclusions
PC 4	Year-round operation in thick first-year ice which may include old ice inclusions
PC 5	Year-round operation in medium first-year ice which may include old ice inclusions
PC 6	Summer/autumn operation in medium first-year ice which may include old ice inclusions
PC 7	Summer/autumn operation in thin first-year ice which may include old ice inclusions

Note. From *IMO Guidelines for Ships Operating in Polar Waters,* 2010. Retrieved from http://www.imo.org/blast/blastDataHelper.asp?data_id=29985&filename=A1024(26).pdf

With respect to the commonly referenced Finnish-Swedish ice class rules (FSICR) for winter navigation in sub-Arctic waters, IA Super and IA ice class vessels are comparable to PC 6 and PC 7 vessels respectively. In addition to vessel construction and power requirements, several of the IACS members have individually developed guidelines for Arctic shipping operations that focus on safety and environmentally sustainability.

Chapter IX of SOLAS 1974 deals with the management for the safe operation of ships. It does this via the ISM Code (International-Maritime-Organization, 2001). The objectives of the ISM Code are to (a) ensure safety at sea; (b) prevent human injury or loss of life; and (c) avoid damage to the environment, in particular to the marine environment and to property. More pointedly, the Code states that the safety management objectives of the company should:

1) Provide for safe practices in ship operation and a safe working environment;
2) Assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards; and
3) Continuously improve safety management skills of personnel ashore and aboard ships, including preparing for emergencies related both to safety and environmental protection.

In addition, the Code notes that the company must ensure they comply with mandatory rules and regulations and that all applicable codes, guidelines and standards recommended by appropriate bodies are taken into account (International-Maritime-Organization, 2010b). Pivotal to this research is a

requirement of the Code for the company to develop *inter alia* a safety and environmental-protection policy along with instructions and procedures to ensure safe operation of ships and protection of the environment. While the ISM Code is applicable to ships operating in Arctic waters, it does not provide details on the special requirements necessary for safe and environmentally sustainable shipping in the Arctic (Arctic-Council, 2009). While a ship operator may have a generic overall safety and environmental-protection policy in place, it may not be satisfactory for the specific demands required of operations in a harsh and environmentally sensitive Arctic environment. Specific, mandatory regulations will likely be required for novice and inexperienced Arctic ship operators. A mandatory Polar Code would help in this regard.

Training courses for ship officers working in Arctic waters are not standardized and the current IMO guidelines are vague with respect to training requirements for officers when working in Arctic waters. The IMO guidelines in their current voluntary non-binding form provide an important but limited contribution to safe navigation via the requirement for a qualified ice navigator. An ice navigator is defined in the guidelines as "any individual who, in addition to being qualified under the STCW Convention, is specially trained and otherwise qualified to direct movement of a ship in ice-covered waters" (International-Maritime-Organization, 2010a). Chapter XIV of the guidelines specifies that all ships operating in the Arctic ice-covered waters should carry at least one certified ice navigator. Navigation in the Arctic is unique compared to ship operations elsewhere (Snider, 2012). The unpredictable movement of sea ice, presence of multi-year sea ice, undetected growlers and remoteness of the area poses enormous challenges to surface navigation for most of the year. In recent decades, however, technological advances in ship design and the receding ice cover and thickness has resulted in the Arctic operational season getting longer.

Navigation in high latitudes demands extra skill on the part of the navigator keeping in mind the limitations of such equipment. It is critical for the mariner to be well versed in the basic principles of practical navigation and be prepared for such eventuality should the navigational equipment, which are aids-to-navigation at the best of times, fail to function normally. Knowledge of the special considerations to be applied when navigating in high latitudes is important due to:

- Rapidly changing weather conditions, low and ice-masked coast lines;
- Rapid convergence of meridians;
- Extreme refraction and false horizons;
- Low horizontal intensity of the earth's magnetic field;
- Chart projections, including non-triangulated charts and lack of detail;
- Loss of accuracy in plotting;
- Gyro compass limitations;
- Extended twilight;
- Majority of observations being low altitude;
- Decreasing importance of error in time;
- Front and back altitudes to offset refraction;
- Slow rate of change of altitude in relation to azimuth; and

- Maintaining track and estimated position; and determination of the most suitable heavenly bodies.

In light of the anticipated future growth in Arctic shipping, it would be prudent for the IMO to develop mandatory shipping regulations creating a standardized requirement regime for all Arctic shipping operators. While voluntary guidelines for ship operations in polar waters is a step in the right direction, inexperienced ship operators venturing into Arctic waters may not fully appreciate and act in accordance with the spirit of these voluntary guidelines. Further, if international regulations such as SOLAS, MARPOL, STCW and ISM are mandatory, and the intent of the Polar Code is to fill in the chasms of these regulations specific to the Arctic, it is argued that a Polar Code should be mandatory (Einemo, 2012). Mandatory regulations via a mandatory Polar Code are deemed essential to ensure safe and environmentally responsible shipping in Polar Regions.

CONCLUSION

The Arctic is a harsh, remote and environmentally sensitive region. Environmental protection of the Arctic is necessary as its health has significant implications on the rest of the planet. Increasing global interests in the Arctic from shipping, resource extraction and tourism are placing additional stress on its people and fragile ecosystems. While the remoteness of the Arctic can be of benefit in helping distance itself from the daily pollution of southern regions it can also be a hindrance in terms of environmental policing and law enforcement. In this respect it is critical that all users of the Arctic act as environmental stewards and have in place comprehensive environmental policies and plan to ensure environmental sustainability.

With respect to shipping operations currently on going in Arctic regions it appears that many operators are already carrying out their environmental stewardship duties and responsibilities. While there are numerous national and international regulations in place dealing with various aspects of Arctic shipping there are chasms in these regulations. Some operators appear to have recognized the gaps in these regulations aimed at protecting the Arctic and have gone above and beyond that required of them by regulators. While this may be the case with some operators there needs to be a means in place to ensure that all individuals and companies operating in the Arctic act as environmental stewards. A mandatory Polar Code would help to ensure such responsibility.

Areas for Further Research

There are constraints and limitations to all research work. While the above research provided insight on some of the contemporary issues associated with Arctic shipping operations, there are areas of importance in which there has been little or no scientific work conducted in Arctic environments. Following is a list of topics that require further research to be carried out in the Arctic. The list is by no means exhaustive:

- The impact of black carbon on the melting of sea ice;
- The climate effect from NO_x in high latitudes;
- The effect of a HFO ban;
- The inclusion of the Arctic in the North American ECA;
- The effect of hull fouling practices currently in use; and
- The socioeconomic effects of shipping on those living in the Arctic.

Recommendation of Best Practices for Inclusion in the Polar Code

The main aim of this research was to identify best practices currently in place by Arctic ship operators. It also aimed to identify possible new ways in which shipping operations in the Arctic could maximize benefits and reduce risks to all stakeholders. As there are varying degrees of limitations and constraints to most all practices, the following best practices have been broken down into what may be considered as mandatory and voluntary respectively.

Mandatory Best Practices:

- The importance of proper certification and training for officers and crew operating in Arctic waters cannot be over stressed. The IMO guidelines note the provision of at least one ice navigator on board. However, prudent shipping operators will likely ensure that all Arctic navigators receive formally recognized and appropriate ice navigation training. In addition, the rest of the crew on board need to undergo basic ice survival education and training in order to keep them appropriately informed of the special nature of operations which Arctic shipping demands.

- It would be beneficial to have an international system of standardized education and training in place for ice navigators. Appropriate training and certification for navigators in high latitudes including situational awareness and alternate means of position fixing by celestial, terrestrial, radar and sextant observations is important. In addition, ship drills practicing the loss of essential electronic bridge equipment should be conducted on a regular basis.

- Current bridge navigation equipment has limitations in high latitude navigation. It is important to be aware of these limitations and have additional arrangements in place as part of the standard bridge profile such as two gyro compasses, already required in most cases, a spare magnetic compass and integrated GPS receivers which can lock on to a GLONASS system if GPS satellites are unavailable due to low altitude and masking. The use of terrestrial based e-loran stations offering a relatively secure position fixing system using powerful signal strength and low frequency bandwidth, 100 KHz, are very reliable and virtually impossible to jam or spoof.

- Integrated marine automation systems are becoming commonplace as ships get bigger and more sophisticated requiring fewer officers and crew. Proliferation of modular systems will require the carriage of critical spare parts and expertise to set things right if automation does not work, thereby avoiding a complete shutdown of critical operations. Appropriate training in specific automation systems is a must and should be made mandatory for mariners sailing in Arctic waters where shore side repair and technical support may be non-existent.

- The number of companies offering communication systems and the increased use of satellite internet technology has brought the information super highway on board. High speed data, video links, emails, weather and ice reports can all be accessed relatively easily. This adds to the tremendous improvement in quality of telephony and facsimile broadcasts. Also, the entire global maritime distress and safety system (GMDSS) platform is based on a combination of satellite and terrestrial transceivers requiring robust and fail safe connectivity between ship and shore. SAR operations at sea could not have been possible without satellite based systems such as COSPAS-SARSAT, EPIRB, SART and INMARSAT technology. Safe navigation in the Arctic will not only require such equipment but provisions will have to be made to make them fail-safe. They will also have to be operated and possibly maintained by well-trained Arctic mariners.

- Measures need to be put in place to help avoid damaging interference with marine wildlife. These measures may include marine protected areas, ship speed limits, ship rerouting, diligent on board observation practices, environmental training for ship personnel, and better use of technology to help reduce noise for ships.

- Annex I of MARPOL, dealing with regulations for the prevention of pollution by oil, needs to include the Arctic as a special area in the same way that it is in Antarctica.

- Annex V of MARPOL, dealing with regulations for the prevention of pollution by garbage from ships, needs to include the Arctic as a special area in the same way that it is in Antarctica.

- Regulations are needed for the prevention of pollution from sewage and grey water.

- Companies operating in the Arctic need to have an environmental management policy and plan.

- As per Part A of the ISM Code all risks to ships, personnel and the environment need to be identified and assessed and appropriate safeguards need to be established.

- SOPEP's need to include dealing with emergencies in Arctic waters.

Voluntary Best Practices:

- 'Green' ship technology is an increasingly common topic with respect to maritime transportation in the Arctic (Arctic-Council, 2009). Increased

volumes of traffic in Arctic waters will pose additional stress on sensitive ecosystems if not managed properly. Best use of available and constantly evolving technology in ship construction, ship operation, maintenance and ship recycling supplemented with International Standards Organization (ISO) 14001 Environmental Management System (EMS) standards have been proposed by IMO and the IACS members to help structure the proposed 'Green' ship certification for ships (American-Bureau-of-Shipping, 2011; Lloyd's-Register, n.d.). Ships trading in the Arctic region could benefit from the best use of this environmentally sustainable concept.

- The concept of a 'Green Passport' being granted to a ship as conceptualized by IMO and Lloyds Register could be applied to Arctic shipping. The 'Green Passport' for a ship would accompany the ship throughout its working life and contain an inventory of all materials potentially hazardous to human health or the environment, used in the construction of the ship. The passport would be produced by the shipyard during construction and would be passed to the original, and any subsequent, purchaser of the ship. Any changes to original materials or equipment after the vessel leaves the shipyard are to be accurately recorded by the current owner. The final owner of the ship would deliver the passport to the recycling yard so as to help with safe and effective recycling of the ship (International-Maritime-Organization, 2011i). Having an inventory of the hazardous material contained on board a vessel would greatly assist with salvage or clean-up efforts that may occur as a result of grounding or stranding in Arctic waters. Implementation of an EMS certification for a ship as per ISO 14001 goes beyond the current International Management Code for the Safe Operation of Ships and for Pollution Prevention, otherwise known as the International Safety Management (ISM) Code and MARPOL stipulations and ensures an independently derived environmental standard, whose effective implementation is verified by means of survey and audit processes. It would also help with development of an environmental benchmark for environmentally conscious ship operators.

- The Arctic region is an extremely inhospitable and remote area for mainstream shipping. Lack of requisite infrastructure such as ports, ship repair facilities and navigational aids makes maritime transportation more challenging in the Arctic (Emmerson and Lahn, 2012). When it is determined that a port or ports are needed throughout the Arctic, the establishment of 'Green Ports' and point-to-point shipping will allow operators to establish infrastructure where it is needed most. As an example from the south, the port of Long Beach, California has initiated a Green Port policy which essentially looks at six elements to reduce the environmental impact and promote sustainable shipping based on community needs (Port-of-Long-Beach, n.d.). The green port policy elements and overall goals are:
    - Wildlife - protect, maintain or restore aquatic ecosystems and marine habitats;
    - Air - reduce harmful air emissions from port activities;

- Water - improve the quality of Long Beach Harbor waters;
- Soils/Sediments - remove, treat, or render suitable for beneficial reuse contaminated soils and sediments in the harbor district;
- Community engagement - interact with and educate the community regarding port operations and environmental programs; and
- Sustainability - implement sustainable practices in design and construction, operations, and administrative practices throughout the port.

- While adherence to ISO standards is not mandatory for shipping companies from a maritime regulatory perspective, some companies have applied for ISO certification. The ISO 14000 set of standards address environmental management, meaning what a company does to minimize harmful environmental effects and to continually improve its environmental performance. ISO 14001:2004 provides the requirements for an EMS. While the standard does not lay down levels of environmental performance, it does require a commitment to compliance with applicable environmental legislation and regulations, along with a commitment to continual improvement (International-Organization-for-Standardization, 2011).

The observation of secondary data available in public through the official websites reviewed enables the identification of certain patterns. Reporting on these patterns is a useful tool for understanding the current existence and promotion of environmental and CSR policies among Arctic shipping companies. The present analysis cannot be used for generalization of the policies implemented by all Arctic shipping companies. However, it does give an indication of the promotion of such policies and best practices through an official marketing tool, i.e. the company's website. The websites that provided a detailed description of their practices towards protection of the polar environment and of the communities in these regions can be used as a source of secondary data for the development of a ''Best Practices Guide" for Arctic shipping companies. Also, the analysis of the top-rated websites can be used for benchmarking and improvement of the applied practices by companies operating in the cargo transportation, seismic survey, ice-breaking and other shipping operations in the Arctic region. It is evident from the website analysis that many of the shipping companies presently operating in the Arctic take environmental and social concerns seriously and are at the sharp edge of the wedge in working to protect fragile Arctic ecosystems and helping the indigenous peoples of the Arctic maximize the many benefits of shipping. It would be prudent for novice entrants to Arctic shipping to hearken the advice and assimilate the "Best Practices" of those experienced operators presently leading the way forward in Arctic shipping operations.

Appendix 1 Two-part survey questionnaire

Part 1

QUESTIONNAIRE ON ENVIRONMENTAL BEST PRACTICES OF ARCTIC SHIPPING COMPANIES

WWF is the world's most experienced conservation organization, with a 30-year history of Arctic conservation. Having earned a coveted spot on the Arctic Council, WWF is recognized by governments, industries, and Indigenous communities as a key player in brokering agreements for the sustainable stewardship of Arctic lands and waters.

As part of our efforts to ensure a sustainable future for the Arctic, WWF is partnering with responsible industry leaders to demonstrate how shipping, fishing, oil and gas development, and mining can take place in the Arctic, benefit local communities while respecting and reinforcing the integrity of Arctic ecosystems already under siege from climate change.'

To help inform this work, WWF-Canada is currently commissioning research on the environmental policies and best practices applied by shipping companies operating in Arctic regions. To this end, WWF is requesting the participation of select shipping companies in interviews to share current sustainability practices. The goal of these interviews is to benchmark the identified policies, and distinguish from these best practices which can be promoted universally. The result of this research will be a roster of operational best practices aimed at the protection of the environment and the communities in the Arctic.

In light of the Arctic shipping industry's expected growth, cumulative impact and highly regulated nature, Arctic operators will benefit from the results of this research to stay ahead of the curve on best practices.
Absolute nondisclosure and strict confidentiality with respect to the identification of your company will be practiced and only the interviewer will have access to individual survey data. A synthesis of overall survey data will be published.

For any questions, please contact:
Capt. James Parsons, PhD
Global Marine Solutions
St. John's, Newfoundland, Canada

PART A. RESPONDENT'S DATA

1: Name, title and position in the company

Company's Name:	
Respondent's Name:	
Professional Title:	
Position:	
Date:	

PART B. COMPANY'S DATA

2. Please define the business sector for your organization: (for multiple responses tick ALL applicable boxes)

☐ Cargo transport (oil and oil products, dry bulk, general, container)

☐ Ferry and passenger services

☐ Ice breaking and ice support

☐ Seismic survey, marine and subsea survey

☐ Tug and barge services, towing

☐ Other (please specify) _____

3. Where are the company's headquarters based? (origin of organization)

☐ Canada

☐ Denmark

☐ Finland

☐ Norway

☐ Russia

☐ Sweden

☐ United States

☐ Other (please specify) _____

4. Arctic Fleet Profile: Type of vessel, number of V/Ls, Flag, ice class, region and season working in Arctic region.

Type of Vessel	No. of V/L's	Flag	Ice Class or Equivalent	Region of Operation	Season

PART C. ENVIRONMENTAL, SAFETY & QUALITY POLICIES & PRACTICES

5. The company is compliant with:

☐ ISM Code

☐ MARPOL

☐ ISO Environmental Management Standard 14000/14001

☐ Oil Companies International Marine Forum – Tanker Management and Self-Assessment

☐ A Classification Society Environmental Standard (please specify) _____

_____

☐ Other (please specify) _____

6. What is the main objective of the company's Safety & Quality policy?

_____

7. What is the main objective of the company's environmental management plan (environmental action plan) and how is it measured?

_____

8. How does the company measure the environmental impact of its fleet operation? (for multiple responses tick ALL applicable boxes)

☐ Conduct regular inspections on board its fleet

☐ Conduct risk assessments, especially for environmental risks

☐ Establish environmental-related key performance indicators

☐ Keep record of environmental incidents (oil spills, near misses)

☐ Measure emissions and wastes from vessels' operation

☐ Other (please specify) _____

9. How does the company manage to stay updated and follow all environmental legislations and regulations? (for multiple responses tick ALL applicable boxes)

☐ Attend conferences, seminars, etc.

☐ E-register to related maritime bodies to receive all newly published regulations

☐ Member of industry association

☐ Participate in international regulatory bodies

☐ Other (please specify) _____

10. What is the role of the company's outsourced (e.g. ship management/crewing) personnel (seagoing and shore-based) in the company's environmental policy and management plan? (for multiple responses tick ALL applicable boxes)

☐ Follow company's Safety & Quality policy

☐ Receive environmental awareness training

☐ Receive regular safety training and familiarisation

☐ Report non-compliance with company's environmental policy to the company

☐ Report non-compliance with environmental regulations to the company

☐ Other (please specify) _____

11. What is the role of the company's personnel (seagoing and shore-based) in the company's environmental policy and management plan? (for multiple responses tick ALL applicable boxes)

☐ Follow company's Safety & Quality policy

☐ Receive environmental awareness training

☐ Receive regular safety training and familiarisation

☐ Report non-compliance with company's environmental policy to the company

☐ Report non-compliance with environmental regulations to the company

☐ Other (please specify) _____

12. Does the company involve other stakeholders, such as charterers, contractors and sub-contractors in its environmental policy action plan? If yes, which stakeholders and how?_____

_____

13. Does the company publish the results of its environmental action plan? If yes, to whom and how often?_____

_____

14. With regard to ship operations, which practices does the company apply in helping the environment?
(for multiple responses tick ALL applicable boxes)

☐ Use of IMO-approved antifouling hull coatings

☐ Slow speed steaming in arctic marine protected areas (MPAs) and particularly sensitive sea areas (PSSAs)

☐ Operating to higher standards in MPAs and PSSAs

☐ Rerouting of vessels in MPAs and PSSAs

☐ Keep vessels and their equipment well-maintained

☐ Fuel management and energy efficiency through careful engine performance

☐ Ship energy efficiency management plan (SEEMP)

☐ Energy efficiency design index (EEDI)

☐ Energy efficiency operational indicator (EEOI)

☐ Mapping of factors affecting propulsion resistance and fuel efficiency

☐ Use low sulphur marine gas oil

☐ Use marine gas oil

☐ Use marine diesel oil

☐ Use low sulphur intermediate fuel oil

☐ Use of LNG

☐ Use of non-petroleum based fuels

☐ Follow a programme for the minimization of harmful emissions into the atmosphere close to the ports

☐ Adherence to ECA limits for SOx, NOx and particulate matter

☐ Use of scrubbers to limit SOx emissions

☐ Adherence to Tier I and Tier II NOx emission limits

☐ Control noise and vibration emissions

☐ Use of ballast water exchange

☐ Use of on board ballast water treatment facilities

☐ Testing of on board ballast water treatment facilities

☐ No bilge water is discharged in Arctic waters

☐ No sewage or related sludge is discharged in Arctic waters

☐ No grey water is discharged in Arctic waters

☐ No garbage is released in Arctic waters

☐ Bilge system oil filtering equipment fitted with high level alarms and automatic stopping devices on all ships

☐ Use water lubricated propeller shaft bearings

☐ Use biodegradable lubricating oil in propeller shaft bearings

☐ Use of monowing streamer diverting device

☐ Other (please specify) _____

15. Does the company follow GHG reporting conventions?

☐ Yes ☐ No

If yes, which conventions?

☐ The Carbon Disclosure Convention

☐ The Greenhouse Gas Protocol Corporate Standard's reporting guidelines

☐ Other (please specify) _____

16. With regard to waste management, which practices does the company apply? (for multiple responses tick ALL applicable boxes)

☐ Operate domestic waste management on board

☐ Recycle paper, glass and aluminum

☐ Recycle batteries

☐ Manage ballast water

☐ Manage hull cleaning

☐ Manage cargo residues

☐ Manage oil wastes

☐ Use biological sewage treatment plant on board

☐ Use of on board incinerators for waste

☐ Testing of on board waste management facilities (please specify) _____

☐ Other (please specify) _____

17. With regard to ship design and ship building, which practices does the company apply? (for multiple responses tick ALL applicable boxes)

☐ Ballast separated from cargo tanks

☐ Ballast water management technology suited for cold climates

☐ Waste water filtration system

☐ Vessels fitted with dedicated holding and decanting tanks

☐ Extra storage capacity for sewage treated water and grey water

☐ Use equipment to reduce noise and vibration emissions

☐ Inventory of hazardous materials

☐ Other (please specify) _____

18. Does the company co-operate in or support research on environmental conservation and or protection of the Arctic?

☐ Yes ☐ No

If yes, please provide with details (title of projects, funding and/or participation in research, on-going research, etc.)

_____

19. If applicable, what other policies does the company apply in terms of environmental protection? (for multiple responses tick ALL applicable boxes)

Provide financial aid for the conservation and restoration of biodiversity	☐ Yes	☐ No	☐ N/A
Provide financial aid for the support of natural reserves	☐ Yes	☐ No	☐ N/A
Rehabilitate infected and polluted areas	☐ Yes	☐ No	☐ N/A
Restore worksites and camp locations in the Arctic region	☐ Yes	☐ No	☐ N/A
Maintain adequate pollution liability insurance	☐ Yes	☐ No	☐ N/A
Liaise with a designated community official(s) in Arctic communities	☐ Yes	☐ No	☐ N/A
Participation in environmentally focused industry groups	☐ Yes	☐ No	☐ N/A
On board wildlife monitoring protocol	☐ Yes	☐ No	☐ N/A

Other (please specify)_____

PART D. ATTITUDES AND PERCEPTIONS TOWARDS ENVIRONMENTAL PROTECTION OF THE ARCTIC

20. What is your opinion about the following statements?

Statement	1: Strongly Disagree	2: Disagree	3: Agree	4: Strongly Agree	5: Undecided

Statement	1: Strongly Disagree	2: Disagree	3: Agree	4: Strongly Agree	5: Undecided
A new Polar Code could lead to over-regulation in the shipping market.					
A Polar Code should be mandatory.					
Compliance with MARPOL regulations satisfies necessary environmental protection in Arctic waters.					
Compliance with SOLAS regulations satisfies necessary vessel requirements for safe Arctic navigation.					
Compliance with STCW regulations satisfies officer training necessary for safe Arctic navigation.					
Ice Navigation training courses should be standardized.					
Ice navigator qualification schemes should be standardized.					
Per ton mile of cargo moved, air emissions created by shipping are less compared to those created by land transport.					
There needs to be less regulation of ship generated air emissions.					
There needs to be more regulation of					

Statement	1: Strongly Disagree	2: Disagree	3: Agree	4: Strongly Agree	5: Undecided
land transport generated air emissions.					
All new vessels intended for Arctic operations should be built to IACS Polar Class designation.					

Part 2

ADDITIONAL QUESTIONS CONCERNING ARCTIC OPERATIONS

1. **What process does your company have in place for addressing environmental incidents and what improvements, if any, have been made to operational practices as a result?**_____
_____

2. **Does your company limit black carbon emissions, especially when operating in or near ice covered waters? If so, how?**_____
_____

3. **Do your vessels use heavy fuel oil (HFO)? If yes, please comment on fuel specifics and why it is being used.**_____
_____

4. **Does your company limit vessel noise when operating in areas of congested birds, mammals, etc.? If so, how?**_____
_____

5. **Does your company prevent vessel strikes with mammals and nocturnal sea birds? If so, how?**_____
_____

6. **Does your company prevent or limit the potential for transfer of invasive species? If so, how?**_____
_____

7. **Does your company have standards regarding infrastructure and shore side operations for the protection of Arctic communities and**

sensitive areas? If so what are they?_____
_____

8. **With respect to navigating in Arctic ice-covered waters, what training is provided to officers and crew?**_____
_____

9. **With respect to personal safety when working in cold temperatures and Arctic ice-covered waters, what training, policy or procedures are provided to officers and crew?**_____
_____

10. **With respect to emergencies when working in cold temperatures and Arctic ice-covered waters, what training, policy or procedures are provided to officers and crew?**_____
_____

11. **What, if any, environmental awareness, garbage and waste management training is provided to officers and crew?** _____
_____

12. **Do vessels carry extra crew and officers when operating in the Arctic?**_____

13. **What crew/officer watch rotation system is used when operating in the Arctic?**
_____

14. **Does your company or ship manager employ Ice Navigators and how are they recruited?**_____
_____

15. **Do vessel operating manuals deal with operations in Arctic waters and if so to what level of detail?**_____
_____

16. **Does your company safety management system provide instructions and procedures to ensure safe operation of vessels and protection of the environment when operating in Arctic waters and if so to what level of detail?**_____

17. **In light of the objectives of Part A of the ISM Code, has your company assessed all identified risks to its ships, personnel and the environment when operating in Arctic waters?**_____
_____

18. **What appropriate safeguards have been established to deal with the identified risks from question 17?**_____
_____

19. **Does your company adhere to ISO 14001:2004? If so, to what level of detail does your Environmental Management System deal with operations in Arctic waters?**
_____

20. **Does your SOPEP deals with emergencies in Arctic ice-covered waters and if so to what level of detail?**_____

21. **What measures does your company have in place to help prevent vessel icing from sea-spray?**_____

22. **Does your company use ice information technology for vessel routing and if so what is used?**_____

23. **Are vessels fitted with additional navigation and communication equipment beyond the requirements of SOLAS for sea areas A3 and A4? If so, what is fitted?**

_____

24. **What do you identify as:**

i) **Best practices currently in place at your company**_____

ii) **Future best practices (i.e. vision for a sustainable industry by 2050)**_____

25. **How important is environmental protection to your company?**_____

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Information on Annex A

Annex A consists of a website analysis of 29 shipping companies informing of having operations in Arctic or remote northern waters.

ANNEX A

Website Analysis of Arctic Shipping Operators

Table of Contents:

1. Introduction

The objective of the following work is to examine the environmental and social impacts of shipping companies operating in the Arctic. Through a benchmarking procedure examining the implemented policies and applied practices of ship operators working in the Arctic- as available in public through the official websites of Arctic shipping companies, steps toward a set of ''Best Practices"[2] can be developed. Although the observation of secondary data and qualitative reporting cannot be used for generalization of the policies implemented by all Arctic shipping companies, the reader can achieve an indication of the advertising and promotion of such policies and best practices through one of the companies' important marketing tools, their official websites. Identifying best practices for Arctic shipping companies can help WWF promote the development of a mandatory Polar Code for shipping that incorporates these practices. Further, it is hoped that a ''Best Practices Guide" emerging from this research will help forge the development, acceptance and application of high operating standards for companies new to operating in fragile Arctic ecosystems. For some experienced Arctic shipping companies a "Best Practices Guide" may help with the broadening and or strengthening of already high operating standards. This is true since the analysis of some company websites indicate that while not forced to by national or international regulations, they are already operating voluntarily to high safety and environmental standards. However, it is beyond the scope of this research to confirm if the policies and practices noted on official company website are being adhered to. It is also important for the reader to note that while a company may have a very large and diverse fleet of vessels, all of these vessels may not be operating in Arctic, ice-covered waters. However, environmental, safety and corporate social responsibility policies are normally expected to cover the entire fleet regardless of the area of operation.

2. Methodology

For the needs of the research an inductive reasoning process[3] was used among a sample of Arctic shipping companies' publicly available information on implemented policies and best practices. The survey was conducted among Arctic shipping companies' websites with the basic aim of tracking down those published policy statements that show a special interest in environmental protection and, more broadly, corporate social responsibility[4](CSR). Through this method, along with the other methodological tools used, one can understand and isolate the main policies and practices of the shipping companies reviewed; thus benchmarking the best practices applied currently among shipping companies operating in the Arctic region.

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[2] ''Best practice" can be generally defined as a method, activity, strategy or practice that has consistently shown superior results compared to other means and is used as a benchmark. For further information about the definition of best practices, see Maire *et al.* (2005).

[3] "Induction is the process of inferring a general law or principle from the observation of particular instances" (Oxford English Dictionary in Vickers, 2011). In general, inductive reasoning (or induction) can be defined as reasoning from a specific case or cases and deriving a general rule; induction draws inferences from observations in order to generalize. For further information about the definition of inductive reasoning, see Rescher (1980).

[4] Corporate Social Responsibility is the private sector's way of integrating the economic, social, and environmental imperatives of their activities. CSR closely resembles the business pursuit of sustainable development and the triple bottom line. For further information about CSR, see Industry Canada (2011).

The websites survey took place during the first two weeks of January 2012. In total, 37 websites of Arctic shipping companies were examined. Shipping companies were selected based on their current Arctic shipping operations. Five cruise shipping companies were excluded from the sample, because of the nature of their operations and the special safety and cargo handling operations that are required for vessels carrying passengers[5]. Companies operating fishing vessel were also excluded due to the nature of their operation which is viewed to be different from merchant cargo vessels. Moreover, although Coastguards navigate the Arctic region, they were excluded because of their non-commercial operation in the Arctic region. Finally, one website of a company based in Germany was excluded from the sample, because of insufficient information provided on-line and that they are now no longer operating[6]. All examined companies run official websites, as presented in Annex A 1.

3. Sample characteristics

3.1 Origin of companies examined

Shipping companies whose websites were examined are based in Europe (44.8%), Canada (31.0%), Russia (20.7%) and United Arab Emirates (3.5%). More specifically, Table A1 depicts the country of companies' origin, based on the location of each company's headquarters.

Table A1

Country of origin	No. of companies	%
Canada	9	31.0
Russia	6	20.7
Denmark	3	10.3
Finland	3	10.3
Norway	3	10.3
The Netherlands	2	6.9
France	1	3.5
UK	1	3.5
UAE	1	3.5
	29	100

3.2 Operation of companies examined

Shipping companies whose websites were examined are mainly operating in fuel transportation (including crude oil, refined petroleum products and

[5] Referring to companies who operate only cruise ships, i.e. Polar Star Expeditions, Clipper Group, Hapag-Lloyd Cruises, Silversea Cruises and Hurtigruten.

[6] This is case of Beluga Shipping (http://www.beluga-group.com).

liquefied gas transportation services), as well as bulk, general cargo (timber, coal, steel) and container transportation. Also included were tug and barge services, ice-breaking and towing, seismic marine, ice and subsea support. It is important to note that apart from the shipping operation, there were companies who additionally offer consulting, design and engineering, field expeditions, training, crewing, ship management, ice model testing, ship building and development and other services. Table A2 depicts the various sectors and the numbers of companies operating in these sectors. Some companies operate in more than one sector.

Table A2

Operation sector	**No. of companies operating in sector**	**%**
Cargo transport (oil and oil products, dry bulk, general, fuel, containers)	17	48.6
Seismic survey, marine and subsea survey	5	14.3
Ice breaking and ice support	5	14.3
Tug and barge services, towing	5	14.3
Ferry and passenger services	3	8.5
	35*	100

* Refers to multiple responses, i.e. companies operating in multiple sectors.

Regions of operation for the examined websites of shipping companies include the Canadian Arctic and Labrador coast, Baltic states, Russian Arctic, Finland, Norway, Greenland, US Arctic, as well as Antarctic; 27.5% of the companies (8 from the 29) operate worldwide.

The companies whose websites were examined operate mainly tanker vessels (20.8%), general and dry bulk vessels (20.8%) and tugs, barges and tows (14.6%). Further, as Table A3 depicts, ice-breakers, seismic and subsea support vessels are operated in the Arctic region (10.4% for each vessel type category), while multipurpose and container vessels come last (with 8.4%).

Table A3

Type of vessels operated	**No. of companies operating vessel type**	**%**
Tankers (oil, chemicals, etc.)	10	20.8
General and dry bulk carriers	10	20.8
Tugs, barges, tows	7	14.6
Multipurpose and containers	4	8.4
Icebreakers	5	10.4
Seismic and subsea support vessels	5	10.4

Type of vessels operated	No. of companies operating vessel type	%
Others **	7	14.6
	48*	100

* Refers to multiple responses, i.e. companies operating a diversified fleet (different types of vessels).
** Others include: Ro-ro/ Lo-lo (2), Heavy lift (1), Timber carrier (1), Suppy vessel (1), Reefer (1), Passenger (1).

4. Results

The aim of the websites' survey was to examine the existence and range of the policy statements that reflect the companies' concern for and commitment to environmental protection of the Arctic marine environment. Moreover, the survey sought to examine what these companies state regarding the external human element associated with the impacts of shipping, and specifically CSR involving the communities of the regions in which their fleets operate.

The websites' survey focused on the following features, in order to analyze the existence and range of companies' policy statements:

a. The number of websites' pages including one or more environmental or CSR statements;
b. The number of environmental and CSR statements per website;
c. The quality content[7] of the company's published environmental and CSR statements; and
d. The publication of 'best practices', which can be used for benchmarking or as an example.

From the final sample used for the present analysis comprising 29 websites, three companies did not have any policy statement related to environmental protection or Corporate Social Responsibility on their website. These companies are based in Denmark, Finland and Russia, and operate bulk carriers, ice-breakers, and tankers, respectively. The three companies were excluded from the analysis of website pages and statements, as well as one company which shared the same policies with the umbrella Group it was a member of. For the needs of the descriptive analysis 25 websites were further examined.

4.1 Analysis of website pages

The first step of the analysis focused on examining the number of pages dedicated to the promotion of the companies' environmental and CSR policies. In total, 25 websites (100%) included at least one page with environmental policy statements, while 16 websites (64%) included at least one page with CSR statement.

[7] Content of companies' websites was analyzed in a qualitative way, without the use of software, in order to examine the topic, depth and breadth of published environmental and CSR policies and statements. See also Section 4.3 Content Analysis

The average number of pages per website including at least one environmental statement reached 3.80 pages in a sample of 25 websites. The maximum number of pages with environmental statements per website reached 12. The average number of pages per website including at least one CSR statement reached 1.69 pages in a sample of 25 websites. The maximum number of pages with CSR statements per website reached five.
The above data shows an indication of the space shared for the promotion of the companies' environmental and CSR policies. While the data cannot be used for generalization, it provides the public picture of selected Arctic shipping companies towards environmental and CSR issues and shows that the reporting of environmental policies is quite prevalent among those companies reviewed.

4.2 Analysis of statements

The analysis on the websites of the 25 shipping companies revealed that the average number of statements promoting the companies' environmental policy reached 4.76, with a maximum of 15 per website. Further, the analysis of the 16 websites with pages including CSR statements showed an average number of 2.06, with a maximum of five per website.

This data shows that there were cases of some companies who promoted their environmental policy in a greater scale than the average of 4.76 statements per website, some reaching even 15 statements per website. This can be indicative of the interest and effort of some companies to publicize their environmental policy, and may be also indicative of the concern that these companies show in environmental matters. In the same vein, the lower average number of CSR statements per website (2.06) may be interpreted to suggest that CSR is a field that fewer companies seek to promote in public through their official websites.

4.3 Content analysis

The quality of the content of companies' websites was analyzed based on the published environmental and CSR policies and related statements. Some examples are shown below Table A4. The companies who publish in their official website the highest number of policy statements related to environmental protection were mainly companies who operate dry cargo, general cargo vessels and tankers. Only one company of the top-rated in this category operates seismic vessels. Table A4 below presents the profile of the companies with the top-rated websites based on the number of published environmental and CSR policy statements.

Table A4

Company	Based in:	Operating vessels:	No. of environmental policy statements	No. of CSR policy statements
Norden A/S	Denmark	Dry cargo, tankers	15	3
Neste Oil Com	Finland	Tankers	12	5
Fednav Group	Canada	Dry cargo	12	1
OJSC MMC Norilsk Nickel	Russia	General cargo	12	5
Polarcus DMCC	UAE	Seismic	10	2
Groupe Desgagnés Inc.	Canada	General, dry bulk carriers, tankers	9	2
Fugro N.V.	The Netherlands	Seismic	4	3

Examples of published statements regarding environmental protection from shipping companies operating dry cargo, general cargo vessels and tankers, as well as seismic vessels include:

> *To Strive for Improvement and Remain a Winner Means… -Believing in the TOTAL QUALITY of everything we do, both collectively and individually; […] - Having THE HIGHEST STANDARDS of safety and environmental protection, work quality, and management process integrity; -Being involved in THE COMMUNITY and respecting people and the environment.*
> *Groupe Desgagnés Inc.*[8]

> *At Fednav, we understand that our business has an impact on the environment. […]. The Fednav Group is dedicated to the continuous improvement of our operational performance in order to reduce our environmental footprint. As leaders in the international shipping industry, Fednav conducts business in a thoughtful, responsible way, with a view to preventing pollution and safeguarding our natural environment.*

Fednav Group[9]

> *Environmental safety of operations and protecting the environment are among the main priorities of OJSC MMC Norilsk Nickel. The Group works to minimize environmental effects of its operations by phased reduction of such impact factors as emissions into the air, pollutant discharges and industrial waste generation, and by increasing waste recovery. The Group seeks to comply with the requirements of the environmental legislation and international agreements, provisions of ISO 14001:2004 international standard, as well as sectoral and corporate regulations applicable to environmental aspects and environmental protection activities of MMC Norilsk Nickel.*

[8] Available at: http://www.groupedesgagnes.com/en. Last accessed: January 4, 2012.

[9] Available at: http://www.fednav.com/anglais/environmental_policy/environmentpolicy.html. Last accessed: January 4, 2012.

OJSC MMC Norilsk Nickel[10]

Neste Oil's operations and products have an impact on society, the environment, and people. The company's goal is to reduce or eliminate negative impact, while generating added value and wellbeing for its stakeholders. […]
Neste Oil Com[11]

Most of NORDEN's activities take place at sea, which is where the Company imposes the greatest impact on the environment. NORDEN's climate initiatives are therefore emphasised on activities relating to the operations at sea. […] NORDEN wishes to help improve maritime safety and limit pollution from vessels. The continuous improvement of NORDEN's environmental performance is not only best for the environment, but also the best solution for NORDEN's customers, shareholders, employees and other stakeholders.
Norden A/S[12]

We have a goal to build an environmentally responsible company that we envision as being an inspiration and model for others. […] We are committed to being at the leading edge of maritime and technological innovation, and have set ourselves an ambitious environmental agenda that aims to minimize our environmental footprint through a combination of reduction, recycling and carbon offsetting.
Polarcus DMCC[13]

Examples of published statements regarding CSR from shipping companies operating dry cargo, general cargo vessels and tankers, as well as seismic vessels include:

The organisation is aware of its role in society, particularly in an international and multicultural environment, and understands the importance of paying constant attention to corporate social responsibility (CSR). Fugro strives to meet the expectations of all the stakeholders in the company by balancing regard for the environment, social awareness and financial results.
Fugro N.V.[14]

Publishing Social / CSR Reports, MMC Norilsk Nickel expects to develop and further expand constructive public dialogue regarding social responsibility of business, so as improve sustainability performance.
OJSC MMC Norilsk Nickel[15]

We care about the well-being and safety of others, and ensure that our operations have the minimum possible negative impact on the natural environment and the surrounding community. We are committed to promoting the quality of people's lives. […] We are socially responsible, environmentally sound, and economically viable. All our actions are safe for us, our neighbors, contractors, customers, and the

[10] Available at: http://www.nornik.ru/en/development/environmental_performance/. Last accessed January 10, 2012.

[11] Available at: http://www.nesteoil.com/default.asp?path=1,41,12079,12106,13532. Last accessed: January 10, 2012.

[12] Available at: http://www.ds-norden.com/profile/csr/carbondisclosureproject and http://www.ds-norden.com/profile/csr/environmentatsea. Last accessed: January 13, 2012.

[13] Available at: http://polarcus.com/ and http://polarcus.com/en-us/our-vision-values/our-vision-values.php. Last accessed: January 11, 2012.

[14] Available at: http://www.fugro.com/society/intro.asp. Last accessed: January 14, 2012.

[15] Available at: http://www.nornik.ru/en/development/development_strategy/social_report/. Last accessed: January 10, 2012.

environment. We act responsibly in society and respect human rights wherever we operate. We provide our customers with products that help tackle sustainability issues such as global climate change and improving local air quality.
Neste Oil Com[16]

Based on our core values, we strive on a voluntary basis to improve our corporate social efforts by integrating social, environmental, climate, health and safety concerns in our activities. We will establish appropriate reporting systems to help us meet our targets while at the same time focusing on continuous improvements. We will communicate openly with our stakeholders on these matters.
Norden A/S[17]

4.4 Best practices benchmarking

Fifteen companies of the total sample (15/28[18]: 53.5%) have published on their official websites details of their implemented practices for the protection of the environment and CSR. More specifically, the profile of the 14 companies whose websites include their self-reported environmental best practices is presented in Table A5.

Table A5

Company:	**Based in:**	**Operating vessels:**
CGG Veritas	France	Seismic
Far East Shipping Company (FESCO)	Russia	Ice-breakers, ro-ro, containers, ice-breaker cargo, bulk carriers, timber, supplier, general cargo
Fednav Group	Canada	Dry cargo
Groupe Desgagnés Inc.	Canada	General, dry bulk carriers, tankers
Jebsens Management A/S	Norway	Bulk carriers
Neste Oil Com	Finland	Tankers
Norden A/S	Denmark	Dry cargo, tankers
Nunavut Eastern Arctic Shipping Inc. (NEAS)	Canada	Ro-ro, Lo-lo, heavy lift, multipurpose- container
OJSC MMC Norilsk Nickel	Russia	General cargo
Polarcus DMCC	UAE	Seismic
Rosatomflot	Russia	(atomic) ice-breakers
Royal Arctic Line A/S	Denmark	Container, unit and settlement cargo vessels
Tschudi Arctic Transit A/S	Norway	Tanker, cargo vessels, tugs
WesternGeco (Schlumberger)	UK	Seismic

[16] Available at: http://www.nesteoil.com/default.asp?path=1,41,12079,12082,17611,12083 and http://www.nesteoil.com/default.asp?path=1,41,537,2455,2457,17092. Last accessed: January 10, 2012.

[17] Available at: http://www.ds-norden.com/profile/csr/environmentatsea. Last accessed: January 13, 2012.

[18] One company excluded because of sharing common website with the Group (i.e. Coastal Shipping Ltd, member of Woodward Group).

Table A6 synthesizes the analysis of company websites with respect to best practices regarding environmental protection. Three categories were created to help differentiate between what companies are required by law to adhere (Conventional), what companies are doing that is just beyond the legal requirement (Average), and what companies are doing that is far beyond that legally required (Leading). Notwithstanding the above, no guarantee can be made regarding the absolute appropriate placement of each of the components into one of the three categories. It is also possible that parts of some components may fall within two or three categories. A more detailed analysis is provided following Table A6.

Table A6

Policy Theme	Component	Company	Category
General management and certification	Environmental inspections at the facilities of the company and regular internal and external audits of the vessels as well as interviews with the vessel crew	OJSC MMC Norilsk Nickel; Norden A/S; Rosatomflot (partly); WesternGeco, member of Schlumberger (partly)	Leading
	Integrated environmental management and reporting system, as well as establishment of detailed standard operating procedures	OJSC MMC Norilsk Nickel; Norden A/S	Leading
	Establishment of a maritime safety service for control of the requirements of safety and pollution prevention during ship running and for the necessary assistance to the crew in order to ensure non-accident work	Rosatomflot	Leading
	Annual review of the environmental risks and liabilities and annual publication of related information	Neste Oil Com; CGGVeritas	Leading
	Establish a system for employees to report non-compliance with the company's environmental policy and notification about accidents and non-compliance with environmental regulations (e.g. development of a 'hotline' for reporting)	Norden A/S; Rosatomflot	Leading
	Attempt to obtain a commitment from charterers to ensure that cargo residues will be removed prior to the vessel leaving the berth	Fednav Group	Leading
	Environmental, quality, and safety inspection for time	Fednav Group	Leading

Policy Theme	Component	Company	Category
	chartered vessels		
	Enhanced environmental awareness and training level of the contractors and subcontractors	CGGVeritas	Leading
	E-register and monitoring of environmental regulations and legislations	OJSC MMC Norilsk Nickel	Average
	In-house performance indicators related to environmental protection, i.e. definition of quality, environmental and safety goals and objectives on a yearly basis and monitoring of achievement through a specified action plan	Fednav Group; Norden A/S; Rosatomflot	Average
	Communication and promotion of awareness, accountability, and environmental responsibility among various stakeholders	Fednav Group	Average
	Bridge team management, passage planning, training and use of latest electronic navigation technologies for minimization of risk of human errors	Fednav Group	Average
	Support of employees' environmental initiatives	Rosatomflot	Average
	Risk Assessments, including focus on identification and evaluation of environmental risk	Groupe Desgagnés Inc.; Fednav Group	Conventional
	Occupational Health & Safety Committees	Groupe Desgagnés Inc.	Conventional
	Compliance with, and exceeding where possible, all applicable standards, requirements, laws, rules and regulations	Fednav Group	Conventional
	Proven safety & quality management processes (implementation of ISM code, ISO Standardization, etc.)	Groupe Desgagnés Inc.; Jebsens Management S/A; FESCO	Conventional
Human resources training	Implementation of IMO Green Passport[19]	Polarcus DMCC	Leading
	Measurement of emissions, including solid, fluid, gaseous and acoustic, and certification of documentation and reporting	Polarcus DMCC	Leading
	Reporting of any oil spill or near incident to a main reporting	WesternGeco, member of	Leading

[19] Reducing environmental, occupational health and safety risks related to the vessel construction, management, operations and the eventual recycling at the end of the vessel's life, as well as the assignment of a designated environmental officer to provide guidance and support in maintaining this classification through the life-cycle of the vessel.

Policy Theme	Component	Company	Category
	and remedial action database	Schlumberger	
	Training of an emergency response team (specialized staff along with cleaning equipment) for crisis, emergency, and spill readiness	Groupe Desgagnés Inc. ; Rosatomflot	Leading
	Knowledge, experience and Best Practices sharing through Health and Safety technical papers and other means	WesternGeco, member of Schlumberger; CGG Veritas	Leading
	Training of crew on garbage management plan	Fednav Group	Average
	Enhanced environmental awareness and training level of the company staff	Groupe Desgagnés Inc.; Jebsens Management A/S; CGGVeritas	Average
	Advanced know-how for well- maintained equipment	Groupe Desgagnés Inc.; Jebsens Management A/S	Conventional
	Extensive training of shore and ship personnel on pollution prevention	Jebsens Management A/S	Conventional
	Regular exercises covering crisis management, communications during major accidents and pollution prevention exercises on board	Neste Oil Com; Jebsens Management A/S	Conventional
Ship operations	Detailed waste plan (including wastes such as batteries, used oil and filters, chemical solvents, paint, and flares, food waste, recyclables, and general trash)	WesternGeco, member of Schlumberger	Leading
	Ballast water control and management	Fednav Group	Leading
	Management of cargo residues	Fednav Group	Leading
	Sailing schedules prepared to maximize efficiencies and reduce unnecessary moves, thus reduce CO_2 emissions	NEAS	Leading
	Management of oil wastes	Fednav Group	Leading
	Recycling of batteries	WesternGeco, member of Schlumberger	Leading

Policy Theme	Component	Company	Category
	Use of biodegradable lubricating oil in the stern tube to limit pollution in the event of an accidental outflow of lubricating oil from propulsion equipment'	Fednav Group	Leading
	Use of environmental friendly anti-fouling hull coating	Fednav Group	Leading
	Use of biological sewage treatment plant on board	Fednav Group	Leading
	Port voluntary program for the minimization of harmful emissions into the atmosphere (e.g. within 20-mile water area of the port)	FESCO	Leading
	Spill prevention, waste handling and contaminated water control	Jebsens Management A/S	Leading
	Use of onboard incinerators for waste items not recommended for recycling	Fednav Group	Leading
	Use of monowing streamer diverting device	WesternGeco, member of Schlumberger	Leading
	Testing of flue gas scrubber systems to reduce sulfur emissions	Neste Oil Com	Leading
	Working proactively with industry associations and regulatory authorities to emphasize scientific analysis of the impact of noise emissions, with special regard to the marine fauna	WesternGeco, member of Schlumberger	Leading
	Reducing waste and pollution through recycling, conservation, education, and efficient use of resources	Fednav Group; CGGVeritas; WesternGeco, member of Schlumberger	Average
	Domestic waste management system on board	NEAS	Average
	Adoption of a basic speed of 13.5 knots at sea for the reduction in marine fuel consumption and CO_2 emissions	Neste Oil Com	Average
	Access to weather routing services with expert route recommendations to minimize the risks of accidents at sea	Fednav Group	Average
	Pollution prevention contingency plan and shipboard oil pollution emergency plan and garbage management plan	Jebsens Management A/S	Average
	Use of marine gas oil (especially for seismic vessels)	WesternGeco, member of Schlumberger	Average

Policy Theme	Component	Company	Category
	Emergency preparation and environmental demands including handling of oil vapour, ballast water and noise levels	Tschudi Arctic Transit A/S	Average
	Speed reduction measure to prevent shore erosion	Groupe Desgagnés Inc.	Average
	Well-maintained vessels and equipment	Groupe Desgagnés Inc., Jebsens Management A/S ; Norden A/S	Conventional
	Detailed guidelines on bunker fuels for the reduction in marine fuel consumption and CO_2 emissions	Neste Oil Com	Conventional
	Management of hull cleaning	Fednav Group	Conventional
	Bunkering operations under the watch of a responsible officer to prevent oil spill from tank overflow	Fednav Group	Conventional
	Reduction of air emissions through energy efficiency and use of cleaner marine fuels	Fednav Group ; WesternGeco, member of Schlumberger	Conventional
	Fuel management system, i.e. energy efficiency through careful management of engine performance	Royal Arctic Line A/S	Conventional
Ship design, ship building	Design of vessels in order to limit consequences of noise and vibration	Polarcus DMCC	Leading
	Mapping of factors affecting propulsion resistance and fuel efficiency followed by a climate action plan	Norden A/S	Leading
	Construction of vessels fitted with dedicated holding and decanting tanks, thus facilitating the proper management of hold washing residues	Fednav Group	Average
	Extra storage capacity for sewage treated water and grey water in newbuildings and modifications in existing vessels	Fednav Group	Average
	Wastewater filtration system	Groupe Desgagnés Inc	Average
	Construction of vessels according to certain standards (e.g. DNV's Clean Design)	Polarcus DMCC	Average
	Double-hulled tankers with ballasts separate from the cargo tanks and construction or modifications to the design of	Groupe Desgagnés Inc; Fednav Group	Conventional

Policy Theme	Component	Company	Category
	vessels		
Research and development	Partnership, investment and support of research and development of environmentally directed industry programs	Groupe Desgagnés Inc; Fednav Group; Royal Arctic Line A/S; Norden A/S; CGG Veritas	Average
Other themes	Provision of financial aid for the conservation and restoration of biodiversity, support of natural reserves, and rehabilitation of areas	OJSC MMC Norilsk Nickel	Leading
	Respect and protection of environmentally sensitive areas and zones where endangered species are present	CGG Veritas	Leading
	Development and maintenance of open and constructive relationships with environmental groups, regulatory agencies, customers, institutions, communities and employees in the countries of its activities	CGG Veritas	Leading
	Restoration of worksites and camp locations	CGG Veritas	Leading

Following is a more detailed and individual breakdown of the best practices noted on company websites:

- In the **general management and certification** field:
    - Implementation of the ISM (International Safety Management) Code for vessel operating safety and pollution prevention (Groupe Desgagnés Inc.) and proven safety and quality management processes embedded in the company's quality assurance system *"ensuring safe ship operations and pollution prevention, and in conformity with International Oorganization for Standardization (ISO) and the ISM Codes"* (Jebsens Management S/A);
    - ISO certification *"which shows that we meet or exceed all operational guiding principals"* (Groupe Desgagnés Inc.), and especially compliance of the environmental management system with ISO 14001:2004 (FESCO);
    - Having Occupational Health & Safety committees/representatives in all areas *"so that our employees have a continuous voice in health and safety"* (Groupe Desgagnés Inc.);
    - Risk assessments and "*practice and procedures in a day-to-day practice"* (Groupe Desgagnés Inc.);
    - Electronic register of legal and other requirements for the regular monitoring of environmental regulations and legislation (OJSC MMC Norilsk Nickel);
    - Development of a policy and management procedure to increase safety at sea and prevent loss of life and damage to the marine environment (Groupe Desgagnés Inc.);
    - Development of environmental management system (EMS) and introduction of integrated environmental reporting system *"for monitoring the accomplishment of the Group's environmental objectives"* (OJSC MMC Norilsk Nickel);
    - Establishment of in-house performance indicators and including protection of the environment as a critical factor in business decisions (Fednav Group);
    - Compliance with, and exceeding where possible, all applicable standards, requirements, laws, rules and regulations, as well as continual adoption, if not introduction, of industry best practices (Fednav Group);
    - Preventive identification and evaluation of environmental risk, along with the implementation of measures to eliminate or control that risk (Fednav Group);
    - Communication and promotion of awareness, accountability, and environmental responsibility among *"our employees, customers, partners, suppliers, as well as government, the public, and other stakeholders"* (Fednav Group[20]);

[20] Fednav Group was a founding member of Green Marine; "*a voluntary, bi-national programme aimed at strengthening the marine industry's environmental performance through various means—by promoting a process of continuous improvement, by building stronger relations with Great Lakes-St. Lawrence Waterway stakeholders, and by raising awareness of the industry's activities*". http://www.green-marine.org.

- Conducting of environmental inspections at the facilities of the company, including *"review of external requests and communications from state environmental authorities"* (OJSC MMC Norilsk Nickel);
- Conducting of regular internal[21] and external[22] audits of the vessels to review the vessel's condition, procedures and actions, and base conclusions on professional observations as well as interviews with the vessel management, junior officers, and other members of the crew (Norden A/S and partly, Rosatomflot and Westerngeco, member of Schlumberger);
- Production of annual review of the environmental risks and liabilities associated with company's operations (Neste Oil Com) and company's overall environmental performance, along with annual publication of related information (CGGVeritas);
- Definition of quality, environmental and safety goals and objectives on a yearly basis through the company's management review and monitoring of achievement through a specified action plan (Norden A/S and Rosatomflot);
- Establishment of a whistleblower system for employees to report non-compliance with the company's environmental policy (Norden A/S[23]) similar to implementation of procedures of notification about accidents and non-compliance with ISMC regulations (Rosatomflot);
- Development of a hotline for reporting any non-compliance with company's policy, and regular documentation (Norden A/S[24]);
- Establishment of detailed standard operating procedures –SOPs that *"ensure that the authorities' requirements and the policies of NORDEN are incorporated into the various work procedures and that documentation is being prepared on a regular basis."* (Norden A/S);
- Support of employees' environmental initiatives and implementation of the set scope of authority and communication between personnel on-shore, at sea and inside the divisions (Rosatomflot);
- Attempt to obtain a commitment from charterers to ensure that cargo residues will be removed prior to the vessel leaving the berth (Fednav Group);
- Environmental, quality, and safety inspection for time chartered vessels, *''with the scope to extend to maintenance and functioning of the sewage treatment plants on board time chartered vessels as well as to garbage management practices"* (Fednav Group);
- Establishment of a maritime safety service for control over observation of the requirements of safety and pollution prevention

[21] Internal auditing also implemented in Rosatomflot.
[22] In addition to NORDEN's own efforts, quality and safety of the vessels are regularly checked through a number of external inspections regimes (i.e. Port State Controls, Vetting Inspections, Classification surveys).
[23] Under NORDEN's whistle blowing scheme established in September 2011, *"SafeLine, reports may be made about suspected actual or potential violations of laws or other serious matters which may impact the NORDEN Group or significantly impact the life or health of individuals or the environment".*
[24] In addition to company's SafeLine scheme, NORDEN has established a hotline *"on which any member of the crew can contact the Company if they think that some of the conditions or actions on board are problematic and not in compliance with the rules or policies of NORDEN".*

during ship running and for the necessary assistance to the crew in order to ensure non-accident work (Rosatomflot[25]).

- In the **human resources training** field:
  - Advanced know-how for *"flawlessly"* maintained equipment (Groupe Desgagnés Inc. and Jebsens Management A/S);
  - Enhanced environmental awareness and training level of the company staff (OJSC MMC Norilsk Nickel), as well as of the contractors and subcontractors (CGGVeritas);
  - Training of an emergency response team that conducts regular exercises on crisis, emergency, and spill readiness; availability of specialized staff and cleaning equipment in the event of a spill (Groupe Desgagnés Inc. and Rosatomflot);
  - Extensive training of both shore and ship personnel on pollution prevention (Jebsens Management A/S);
  - Bridge team management, passage planning, training and use of latest electronic navigation technologies *"for minimization of risk of human errors"* (Fednav Group);
  - Training of crew on garbage management plan (Fednav Group);
  - Carrying exercises covering crisis management and communications during major accidents *"at least once a year"* (Neste Oil Com) and similar pollution prevention exercises on board *"carried out at least once a month"* (Jebsens Management A/S);
  - Implementation of IMO Green Passport: Reducing environmental, occupational health and safety risks related to the vessel construction, management, operations and the eventual recycling at the end of the vessel's life, as well as the assignment of a designated environmental officer to provide guidance and support in maintaining this classification through the life-cycle of the vessel (Polarcus DMCC);
  - Measurement of emissions, including solid, fluid, gaseous and acoustic, and certification of documentation and reporting (Polarcus DMCC[26]);
  - Prioritizing performance improvements and reporting of any oil spill or near incident to a main reporting and remedial action database (QUEST[27]) (Westerngeco, member of Schlumberger);
  - Knowledge, experience and Best Practices sharing; *"Schlumberger has a long-standing commitment to share best practices through HSE*

[25] Rosatomflot is a state-owned company. This service consists of five officers (i.e. Head of Service, Chief Navigator, two counselor captains and a leading specialist).

[26] Polarcus DMCC states that it *"is the first and only seismic company in our industry to receive the Det Norske Veritas 'Vessel Emissions Qualification Statement' for measuring emissions, awarded to the Company in Q2 2010."*

[27] Schlumberger *"captures its own performance data via QUEST, an online system that provides immediate consolidation of HSE information. Accessible by all employees, QUEST monitors reporting of HSE events and Risk Identification Reports (RIRs), facilitates investigations and records audits, manages remedial work plans (RWPs), shows improvement suggestions, posts recognitions, tracks HSE training, and facilitates HSE reports and data analysis".*

Technical Papers and other means" (Westerngeco, member of Schlumberger; Also applied by CGG Veritas).

- In the **ship operation** field:
  - Well-maintained vessels and equipment (Groupe Desgagnés Inc., Jebsens Management A/S and Norden A/S);
  - Voluntary speed reduction measure *"to prevent shore erosion"* (Groupe Desgagnés Inc.);
  - Domestic waste management system on board the ships, protecting the marine wildlife and maintain an aquatic ecosystems (NEAS);
  - Sailing schedules prepared to maximize efficiencies and reduce unnecessary moves, thus reduce CO_2 emissions (NEAS);
  - Reducing waste and pollution through recycling, conservation, education, and efficient use of resources (Fednav Group, CGGVeritas[28] and Westerngeco, member of Schlumberger);
  - Ballast water control and management (Fednav Group[29]);
  - Management of cargo residues (Fednav Group[30]);
  - Management of oil wastes in accordance with International, national, and local requirements for the prevention of oil pollution from ships and company's environmental management system (procedures relating to bilge water and waste oil management) (Fednav Group[31]);
  - Waste plan in place *"whereby all waste streams[32], including regulated waste such as batteries, used oil and filters, hazardous materials such as chemical solvents, paint, and flares, food waste, recyclables, and general trash (burnable and non-burnable), are identified"* (Westerngeco, member of Schlumberger);
  - Recycling of batteries (Westerngeco, member of Schlumberger[33]);
  - Bunkering operations are made under the constant watch of a responsible officer *"to prevent oil pollution from tank overflow during bunkering operations"* (Fednav Group);

[28] CGGVeritas implements *"waste management strategies that promote waste minimization (reduce, re-use and recycle) and pursue initiatives aimed at reducing atmospheric emissions".*

[29] Details about Fednav Group's policy on ballast water control and management available at its official website.

[30] Fednav Group's policy include the following: *''all deck and hold sweepings, as well as cleaning water containing cargo residues, be disposed of in strict compliance with all applicable international, national, and local requirements"* , *"vessels' crews will work with stevedores to: i) facilitate the removal of cargo residues from cargo holds, ii) sweep and collect cargo residues spilled on deck during loading and unloading operations", "use of only "eco-friendly" products in its hold cleaning operations"," cooperation with stevedores in their efforts to reduce dust emissions".* More details about Fednav Group's policy on cargo residues management available at its official website.

[31] Details about Fednav Group's policy on oily waste management available at its official website.

[32] WesternGeco, states that although *"International Maritime Organization regulations allow for discharge of some wastes at sea, such as food, wood, paper, and others; however, WesternGeco works to a zero discharge policy for such wastes".*

[33] WesternGeco developed the SLB150 lithium battery *" which increased battery changing intervals from 30 to more than 150 days, and combined with a specialized recycling process, allowed much better control of the disposal of depleted lithium batteries. Today, all vessels still using conventional cable depth controller technology send their depleted lithium cells to a recycling plant".*

- Use of biodegradable lubricating oil in the stern tube when technically feasible *"to limit pollution in the event of an accidental outflow of lubricating oil from propulsion equipment"* (Fednav Group);
- Access to weather routing services *"with constant updated data and expert route recommendations to minimize the risks of accidents at sea"* (Fednav Group);
- Reduction of air emissions through energy efficiency (reduction of fuel consumption) and use of cleaner marine fuels (to reduce sulphur dioxide and particulate matters emissions) (Fednav Group and Westerngeco, member of Schlumberger);
- Fuel management system, i.e. energy efficiency through careful management of the performance of engines *("a planned and preventive maintenance program to ensure that vessels are operated at an optimum level"*) (Fednav Group) and slow steaming (Royal Arctic Line A/S);
- Use of marine gas oil by seismic vessels, which although costs twice as much as the heavy fuel oil, offers considerable environmental advantages since heavy fuel oil used by some seismic contractors emits approximately 9% more GHG (Westerngeco, member of Schlumberger);
- Use of the *"WesternGeco Monowing streamer diverting device"*[34], which makes great contribution to energy efficient operations' (Westerngeco, member of Schlumberger);
- Use of environmental friendly anti-fouling hull coating *"to prevent underperformance of the vessel due to marine growth"* (Fednav Group);
- Management of hull cleaning; *"whenever hull fouling is discovered, hull cleaning is arranged at the earliest opportunity"* (Fednav Group);
- Use of biological sewage treatment plant on board (Fednav Group);
- Use of onboard incinerators for waste items not recommended for recycling (Fednav Group);
- Implementation and practice of relevant to pollution prevention contingency plan and shipboard oil pollution emergency plan and garbage management plan (Jebsens Management A/S);
- Spill prevention, waste handling and contaminated water control (Jebsens Management A/S);
- Emergency preparation and environmental demands including the handling of oil vapour, ballast water and noise levels; *"compliance with strict rules stating that the waters must be ice-free during lightering"* (Tschudi Arctic Transit A/S);
- Implementation of port voluntary program for the minimization of harmful emissions into the atmosphere *"within 20-mile water area of the port"* (FESCO)[35];

[34] WesternGeco states that *"based on this technology alone, company's vessels are 20 to 25% more fuel-efficient and emit 20 to 25% less GHG than other seismic contractors".*

[35] FESCO states that *"the environmental program of the Long Beach port, USA has been implemented since January 1, 2005 to the crew of the vessel "Igarka". The green flag of the Program goes to the companies, which vessels minimized harmful emissions into the atmosphere within 20-mile water area of the port during last year."*

- Adoption of a basic speed *''of 13.5 knots at sea and detailed guidelines on bunker fuels for the reduction in marine fuel consumption and CO_2 emissions"* (Neste Oil Com);
- Testing of flue gas scrubber systems *"in cooperation with a scrubber manufacturer to reduce sulfur emissions"* (Neste Oil Com);
- Working proactively with industry associations and regulatory authorities to emphasize scientific analysis of the impact of noise emissions, with special regard to the marine fauna[36] (Westerngeco[37], member of Schlumberger).

- In the **ship design, ship building** field:
  - Double-hulled tankers with ballasts separate from the cargo tanks and a wastewater filtration system (Groupe Desgagnés Inc.[38]);
  - Construction of vessels fitted with dedicated holding and decanting tanks, thus facilitating the proper management of hold washing residues (Fednav Group);
  - Modifications to the design of vessels (double bottom oil fuel tanks) *"to limit the risks of accidental spills that may occur when vessels collide or come in distress at sea"* (Fednav Group);
  - Extra storage capacity for sewage treated water and grey water in newbuildings (considering the length of voyages at sea and the increased number of no-discharge zones); modifications in existing vessels dedicated to this trade to increase the storage capacity (Fednav Group);
  - Mapping of factors affecting propulsion resistance and fuel efficiency followed by a *"climate action plan"* (Norden A/S[39]);
  - Implementation of a "Green by Design" policy, i.e. construction of seismic vessels *"according to DNV's CLEAN DESIGN[40] notation"* (Polarcus DMCC);
  - Limitation of the damaging consequences of noise and vibration *"by design of vessel with the distinctive ULSTEIN X-BOW® [41] that*

[36] WesternGeco shows special concern for the protection of marine mammals. A detailed description of the company's practices is included in Appendix 2.

[37] WesternGeco comments that *"non-governmental organizations have challenged the industry regarding the impact sound source arrays may have on marine fauna. […] In the Caspian Sea, there is concern for seals, in east Canada, the Bottlenose whale, in the Gulf of Mexico, whales and turtles, and in Norway, there is concern for fish. We have participated in the sperm whale seismic study research project in the Gulf of Mexico, consulted on proposed new regulations, and are contributing to the OGP/IAGC joint white paper that will attempt to identify the latest science on both sides of the argument."*

[38] *"When necessary, vessels are rated 1A for navigation through ice"* (Groupe Desgagnes Inc).

[39] NORDEN's *"climate action plan was initiated in 2007 and includes measures for implementation on owned vessels and newbuildings".*

[40] According to Polarcus' statement, *"the CLEAN-DESIGN notation recognizes that we have systems in place to control and limit operational emissions and discharges to air and water, along with recognizing our investment in defensive design elements such as a double hull."*

[41] A hull line design which offers high transit speed in adverse weather conditions, as well as enhanced fuel economics. Further information can be found in: http://www.ulsteingroup.com/. Present citation follows the examined company's website and shall not be used for commercial purposes.

provides for faster vessel transit speeds and smoother passage through water" (Polarcus DMCC).

- In **research and development, cooperation with third parties** field:
  - Partnership in research and development (Groupe Desgagnés Inc.[42]);
  - Investing in and supporting research and development of environmentally directed industry programs (Fednav Group, Royal Arctic Line A/S[43], Norden A/S[44] and CGG Veritas[45]).

- **Other** means:
  - Provision of financial aid for the conservation and restoration of biodiversity, support of natural reserves, and rehabilitation of areas (OJSC MMC Norilsk Nickel);
  - Respect and protection of environmentally sensitive areas and zones where endangered species are present (CGG Veritas);
  - Development and maintenance of open and constructive relationships with environmental groups, regulatory agencies, customers, institutions, communities and employees in the countries of its activities (CGG Veritas);
  - Restoration of worksites and camp locations to their original state *"as far as reasonably practical"* (CGG Veritas).

The two companies whose websites include CSR 'best practices' are OJSC MMC Norilsk Nickel (Russian company operating seismic vessels) and GC Rieber Shipping ASA (based in Norway, operating seismic and subsea support vessels); the last contains published best practices only related to CSR. More specifically, their CSR best practices are outlined below.

> *GC Rieber continuously work to make improvements on the areas of environmental work, anti-corruption, and CSR. To support this work the group has developed common guidelines for ethics and CSR. The guidelines cover general principles for commercial practice and personal conduct and are intended to form a foundation for the attitudes and key views we wish to be infused throughout GC Rieber's corporate culture. Furthermore GC Rieber became participant of the UN Global*

[42] Groupe Desgagnes Inc. is a partner of Environment Canada and Institut Maurice Lamontagne in a research project on water salinity, climatic data exchange, recommended navigation routes, ice conditions, vessel calibration based on environmental variables, and more.

[43] In relation to this policy, Royal Arctic Line A/S states that it *"closely monitors research and development that can reduce energy consumption and CO_2, SO_x and NO_x emissions through Danish Shipowners Association. Possibilities for minimizing CO_2 emissions on Royal Arctic Line ships are limited, as current measures for reducing CO_2 emissions by optimizing ship design, steel construction and materials are not practical in Arctic areas, due to maritime safety concerns for ships sailing in the Arctic Ocean. Royal Arctic Line does, however, follow developments in the area very closely and will put any improved technology into use to the extent possible".*

[44] NORDEN's *"has committed directly and indirectly to developing talent within the fields of shipping management, logistics and safety through foundation grants",* while sponsoring targets research and development in both propulsion resistance and fuel efficiency, *"e.g. in developing more efficient ship propellers under the EU-cosponsored CAPRICCIO project, which has resulted in the design of a highly advanced propeller type enabling fuel savings of more than 2%."*

[45] CGGVeritas is part of a Global Industry Research Initiative. CGGVeritas Research Initiatives focus on *" Passive Acoustic Monitoring (PAM) Field Trial in a Multi-Vessel Operation, Sound Source Verification (SSV) in Arctic Waters and Beaufort Sea".*

Compact initiative[46] *in 2010 .[…] By joining the initiative, GC Rieber is obliged to integrate the ten principles in its business strategy, promote the principles to partners and report on activities and improvements related to the ten principles.*

GC Rieber Shipping ASA[47]

Publishing Social/CSR Reports, MMC Norilsk Nickel expects to develop and further expand constructive public dialogue regarding social responsibility of business, so as improve sustainability performance. Norilsk Nickel's Social Report reflects the results for the period from 1 January to 31 December of the previous to reporting year for all the entities of the Group […]. Information and data in all areas covered by the Report are collected and consolidated using various tools, such as automated reporting systems, corporate reporting forms approved by management, etc. […]. In the Social Report for 2007 it was for the first time that indicators and information on economic and environmental performance, as well as on occupational health and product responsibility, personnel management, realisation of social programmes, and training cover all the key units of the Group, including international ones, which significantly increases transparency of the company and comparability of sustainable development data with IFRS data. […] In compiling Social/CSR Reports of the Company was guided by Russian and international best practices. […] The Company received a number of international and Russian awards for the high quality of Social/CSR Reports.

OJSC MMC Norilsk Nickel[48]

5. Conclusions

The observation of secondary data available in public through the official websites reviewed enables the identification of certain patterns. Reporting on these patterns is a useful tool for understanding the current existence and promotion of environmental and CSR policies among Arctic shipping companies. The present analysis cannot be used for generalization of the policies implemented by all Arctic shipping companies. However, it does give an indication of the promotion of such policies and best practices through an official marketing tool, i.e. the company's website. The websites that provided a detailed description of their practices towards protection of the polar environment and of the communities in these regions can be used as a source of secondary data for the development of a ''Best Practices Guide" for Arctic shipping companies. Also, the analysis of the top-rated websites can be used for benchmarking and improvement of the applied practices by companies operating in the cargo transportation, seismic survey, ice-breaking and other shipping operations in the Arctic region. It is evident from the website analysis that many of the shipping companies presently operating in the Arctic take environmental and social concerns seriously and are at the sharp edge of the wedge in working to protect fragile Arctic ecosystems and helping the indigenous peoples of the Arctic maximize the many benefits of shipping. It would be prudent for novice entrants to Arctic shipping to hearken the advice and assimilate the "Best Practices" of those experienced operators presently leading the way forward in Arctic shipping operations.

[46] As mentioned in the company's website, ''*this is currently the world's largest initiative for industrial corporate social responsibility with more than 5,000 businesses in 130 different countries. The UN's Global Compact has drawn up ten universal principles that encourage and demonstrate how businesses should take into account labor rights, human rights, protection of the environment and anti-corruption.*"

[47] Available at: http://www.rieber-shipping.no/?page=69&show=290. Last accessed: January 13, 2012.

[48] Available at: http://www.nornik.ru/en/development/development_strategy/social_report/. Last accessed: January 12, 2012.

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Annex A 1

List of companies' websites

Company's name	Official website
Aker Arctic Technology Inc. (AARC)	http://www.akerarctic.fi
CGG Veritas	http://www.cggveritas.com
Coastal Shipping Ltd (member of Woodward Group)	http://woodwards.nf.ca/coastalshipping.html
Far East Shipping Company (FESCO)	http://www.fesco.ru/
Fednav Group	http://www.fednav.com/anglais
Finstaship (now Arctia)	http://www.arctia.fi
Fugro N.V.	http://www.fugro.com/
GC Rieber Shipping ASA	http://www.rieber-shipping.no/
Groupe Desgagnés Inc.	http://www.groupeDesgagnés.com/
Groupe Ocean	http://www.groupocean.com/
Jebsens Management A/S	http://www.jebsens.com
McKeil Marine Limited	http://www.mckeil.com/
Murmansk Shipping Company	http://en.msco.ru/
Neste Oil Com	http://www.nesteoil.com/
Norden A/S	http://www.ds-norden.com
Nordic Bulk Carriers	http://www.nordicbulkcarriers.com/
NTCL- Northern Transportation Company Limited	http://www.ntcl.com
Nunavut Eastern Arctic Shipping Inc. (NEAS)	http://www.neas.ca/
OJSC MMC Norilsk Nickel	http://www.nornik.ru/en/
Petro-Nav (member of Groupe Desgagnés)	http://www.groupeDesgagnés.com/en/home/23.aspx
Polarcus DMCC	http://polarcus.com/
Rosatomflot (State owned)	http://www.rosatomflot.ru/
Royal Arctic Line A/S	http://www.ral.gl/
Russian Inspectors and Marine Surveyors Corporation (RIMSCO)	http://www.rimsco.ru/
Sovcomflot- Novoship	http://www.sovcomflot.ru/
Tschudi Arctic Transit A/S	http://www.tschudiarctictransit.com/
WesternGeco (member of Schlumberger)	http://www.slb.com/services/westerngeco.aspx
Wijnne Barends	http://www.wijnnebarends.com/
Woodward Group of Companies	http://woodwards.nf.ca

Annex A 2

WesternGeco's policy and Best Practices related to noise emissions and marine fauna

WesternGeco- Environmental Excellence in Marine Operations

Noise emissions and marine fauna

WesternGeco is familiar with the frameworks laid down by regulatory bodies such as the US Department of the Interior Minerals Management Service (MMS), the UK's Joint Nature Conservation Committee, the Australian Government Depart of Environment and Heritage, and the Canada-Nova Scotia Offshore Petroleum Board, and fully complies with prescribed mitigation measures. The following list identifies some of the prevention and mitigation measures available:

- Marine mammal observers – Depending on regulatory requirements, WesternGeco can either subcontract third party observers or ensure that WesternGeco personnel on the crew are correctly trained. An established training program is in place and approved by the MMS for the Gulf of Mexico. WesternGeco also has a documented observation reporting procedure that complies with existing regulatory requirements, and also allows the adoption of industry best practice where no local regulations exist.
- Soft start of marine sound source – A WesternGeco soft-start procedure complies with existing regulatory requirements and allows for adoption of industry best practice where no local regulations exist.
- A WesternGeco training program covering both general issues and marine mammal awareness supports the importance of environmental issues at all levels of the crew.
- WesternGeco can offer an integrated project design service. Part of this process optimizes the amplitude and bandwidth of acoustic energy, based on modeling using heritage data where available. This ensures that sound source array volumes meet geophysical objectives without dispersing excess energy
- By application of its quality management system, WesternGeco continuously improves practices and equipment reliability, thereby reducing rework and infill.
- Passive acoustic monitoring – In some regions of the world, passive acoustic monitoring (PAM) of marine fauna is required. WesternGeco has used this monitoring equipment since its first testing in 1998. In the past year alone, Schlumberger has used PAM in Australia, Canada, and the North Sea.
- By capitalizing on proprietary technology, WesternGeco can ensure that a survey area can be covered with the minimum number of traverses, thereby reducing source effort.

Available at:
http://www.slb.com/services/westerngeco/services/marine/ecomarine.aspx.
Last accessed: January 14, 2012.