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August 15th, 2016

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Dear Mr. Savoy,

World Wildlife Fund Canada (WWF-Canada) appreciates the opportunity to submit expert reports in the Nunavut Land Use Plan (NLUP) process and thanks the Nunavut Planning Commission (NPC) for considering our submission.

We applaud the NPC for assigning Protected Area and Special Management Area statuses that prohibit incompatible uses for several marine areas in the 2016 draft, such as setback requirements of up to 5km around walrus haulouts, and seasonal shipping restrictions in two polynyas. However, we feel that additional sites warrant equivalent levels of protection to ensure effective land use planning of walrus haulouts and other marine areas in Nunavut.

Please find attached two expert reports commissioned by WWF-Canada:

- 1) A report outlining walrus haulouts in the Nunavut Settlement Area that includes and expands upon the R.E.A. Stewart et al. (2013) research from the Department of Fisheries and Oceans that was used to map the walrus haulouts in the 2016 draft of the NLUP. The location data for this database will also be shared with NPC to facilitate analysis, and shapefiles are available upon request. This report was compiled by Higdon Wildlife Consulting.
- 2) A report assessing the conflicting uses of marine environment in four areas of interests: Lancaster Sound, including Admiralty Inlet and Eclipse Sound; Foxe Basin; Chesterfield Inlet and adjacent areas of Hudson Bay; and Queen Maud Gulf and Coronation Gulf. The report presents an inventory of the significant ecological and cultural features in each region, assesses current and future marine operations, the risks and impacts resulting from industrial activities, and recommends mitigation measures. This report was compiled by Vard Marine Inc.

WWF-Canada will be the corresponding organization and the party present at future meetings to respond to questions and concerns surrounding these reports.

Sincerely,

Brandon Laforest
Senior Specialist
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Vard Marine Inc.

PROTECTION OF CRITICALLY SENSITIVE NUNAVUT MARINE HABITATS – FINAL REPORT

333-000-05

Rev 1

Date: 12 August 2016

Prepared for WWF-Canada



Report No.: 333-000-05
Title: Protection of Critically Sensitive Nunavut Marine Habitats
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SUMMARY OF REVISIONS

Rev	Date	Description	Prepared by	Checked by
0	20 Jul 16	Initial issue	MT	AK
1	12 Aug 16	Revision updating recommendations	MT	AK



EXECUTIVE SUMMARY

This study was performed to support to the WWF efforts in providing input to the Nunavut Land Use Plan (NLUP) - an important opportunity to help develop a key element of the policy and planning framework which will guide future activities in much of Canada's North. The study focuses on four areas of Nunavut. Specifically, Lancaster Sound, including Admiralty Inlet and Eclipse Sound; Foxe Basin; Chesterfield Inlet and adjacent areas of Hudson Bay; and Queen Maud Gulf and Coronation Gulf.

The project characterizes current and future marine operations by industry sector in each critical habitat area, including maps detailing the voyages taken by all vessels in each industry sector near each of the four regions of interest, which provides a basis for the assessment of risks and impacts in subsequent tasks. Impacts associated with operations (e.g., emissions, noise, ice disturbance) depend on cumulative traffic volumes, while probabilities of an incident or accident are linked to ship and voyage characteristics in other ways.

The project has developed an inventory of ecological, oceanic, socio-economic and cultural factors significant to each region. For the socio-economic and cultural aspects this covers data addressing historical sites, cultural sites, harvesting areas, and traditional place names. Oceanic data includes climate information, currents and bathymetry. For the ecological aspects information representing ecological features such as distribution of marine mammals, bird habitats, important fish habitats, and other relevant data is required.

An inventory of risks associated with marine operations has been developed, and risks evaluated for each area of interest and its particular environmental and marine traffic profile. The key risk areas identified include ship grounding, ship being beset by ice, capsize, loss of ship control, failure during sealift operations, cetacean strikes, and noise from ship operations.

Finally, the project presents recommendations for management options to mitigate or eliminate the impacts or risks associated with marine operations for each area of interest and its particular environmental and marine traffic profile. This report provides 6 main recommendations:

1. Inclusion of wildlife issues in voyage planning under new regulations: Related to the risk of cetacean strikes and environmental disruptions, as well as vessel generated noise.
2. Support and expand underwater acoustics research: Required to understand and address vessel noise issues.
3. Restriction of HFO in the Arctic: Reduction of the severity of consequences from vessel incidents such as grounding, ice damage, etc.
4. Additional investment in hydrographic data: Related to the risk of vessel incidents, especially grounding.
5. Additional investment in basic sealift support infrastructure: Mitigation of sealift risks
6. Review and refocus of Arctic Corridors Initiative: Mitigation of risks across a variety of areas.

ACRONYMS AND DEFINITIONS

AOPS	Arctic Offshore Patrol Vessel
CCG	Canadian Coast Guard
CHS	Canadian Hydrographic Services
DFO	Department of Fisheries and Oceans
ESA	Environmental Site Assessment
GIS	Geographic Information System
IMO	International Maritime Organization
NLUP	Nunavut Land Use Plan
NORDREG	CCG Northern Reporting System
NWP	Northwest Passage
POB	Persons on Board
TEK	Traditional Ecological Knowledge
Transit	Refers to the distance travelled by a vessel through a specific region or area, where the final destination is not within that region or area.
VARD	Vard Marine Inc.
Voyage	Refers to the entire distance travelled by a vessel between its port of origin and its destination, where the point of departure or final destination is within the region or area of interest.
WWF	World Wildlife Foundation

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1 INTRODUCTION

World Wildlife Fund (WWF) Canada is Canada's leading international conservation organization. A key focus of its 2015-2020 plan is to develop a healthy future for the Arctic.

WWF aims to work collaboratively with governments, industry, and other stakeholders to develop science-based approaches that can deliver lasting results. Providing input to the Nunavut Land Use Plan (NLUP)¹ is an important opportunity to help develop a key element of the policy and planning framework which will guide future activities in much of Canada's North.

As part of its work aimed at supporting the NLUP, WWF-Canada has commissioned Vard Marine Inc. (VARD) to study the vulnerability of critically significant marine habitats in Nunavut. VARD is a ship design and marine consultancy with considerable experience and expertise in Arctic issues. It is the designer of the new Canadian Coast Guard (CCG) polar icebreaker, and the Royal Canadian Navy's Arctic Offshore Patrol Ships (AOPS). VARD has supported Transport Canada throughout the development of the International Maritime Organization (IMO) Polar Code and on many other aspects of Arctic regulation and policy. It works with the transportation, resource extraction, cruise, and fishing sectors of the marine industry, among others, to provide safe, environmentally-friendly, and cost-effective solutions to a range of shipping issues. VARD has worked successfully with WWF-Canada on several previous projects.

The study has focused on four areas of Nunavut shown in Figure 31. The selected areas correspond approximately to:

- Lancaster Sound, including Admiralty Inlet and Eclipse Sound;
- Foxe Basin;
- Chesterfield Inlet and adjacent areas of Hudson Bay; and
- Queen Maud Gulf and Coronation Gulf.

¹ 2014 Draft Nunavut Land Use Plan, Nunavut Planning Commission, 2014

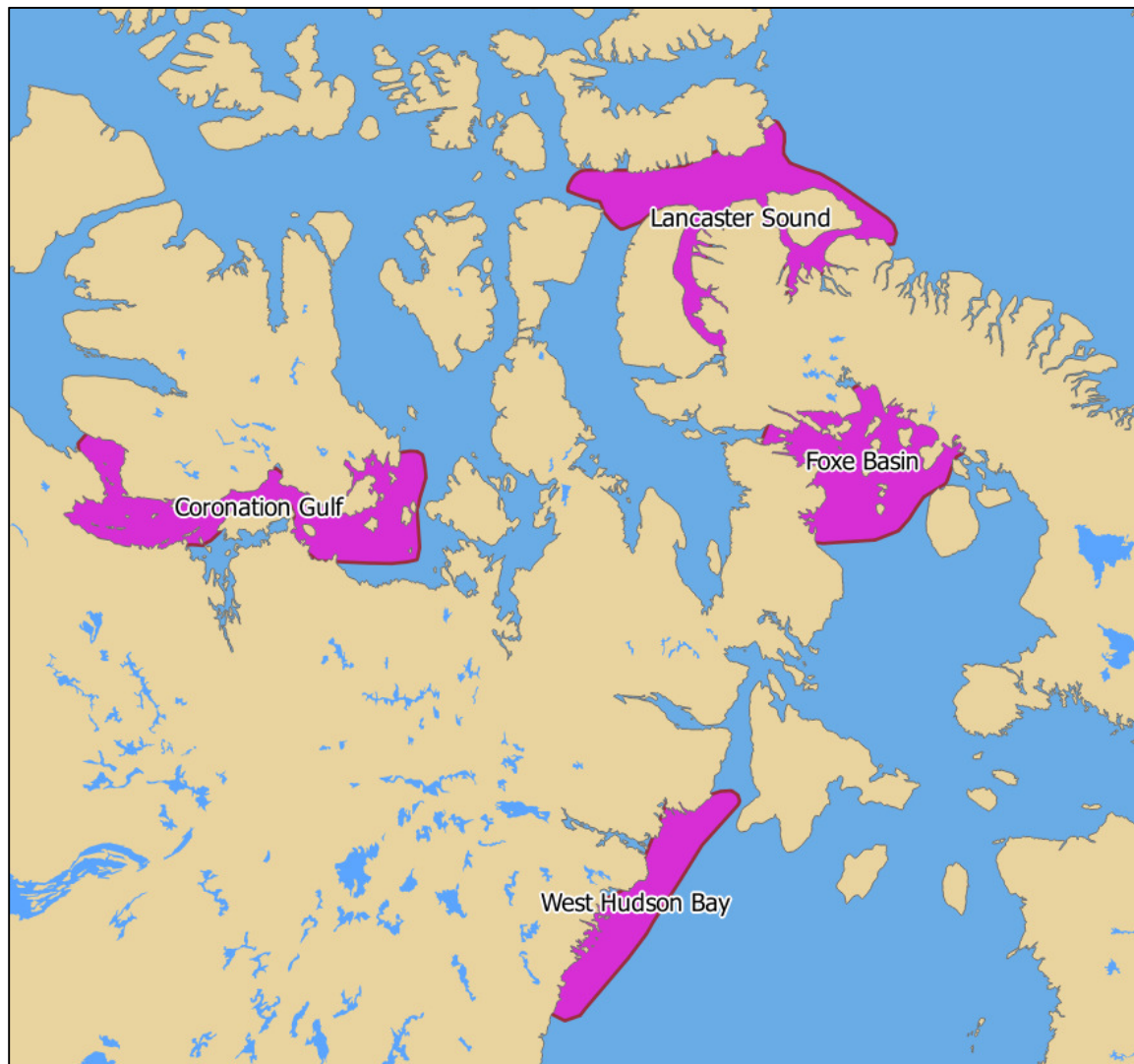


Figure 1: Study Regions and 2013 NORDREG marine traffic

Work on the project has covered four main tasks:

1. Characterization of marine operations – the types and patterns of shipping found in each area;
2. Development of an inventory of ecological, oceanic, socio-economic and cultural factors significant to each area;
3. Risk assessment of marine operations; and
4. The development of recommendations that could mitigate the higher risks identified.

This final report consolidates the work under each task, and provides a set of Appendices of supporting data.

2 CHARACTERIZATION OF MARINE OPERATIONS

The project has characterized current and future marine operations by industry sector in each critical habitat area. This includes maps detailing the voyages taken by all vessels in each industry sector near each of the four regions of interest. Detailed tables of voyages are provided for each region and include the total number of vessels passing through each area of interest and overall distance travelled, as well as the same metric for each industry sector and each main vessel type (e.g., tankers, general cargo ships, icebreakers).

This information provides a basis for the assessment of risks and impacts in Section 4 of the report. Impacts associated with operations (e.g., emissions, noise, ice disturbance) depend on cumulative traffic volumes, while probabilities of an incident or accident are linked to ship and voyage characteristics in other ways. The report itself provides an overview of the data, while more detailed information is provided at Appendix 1A.

2.1 TECHNICAL BACKGROUND

This study had been developed using vessel data and marine traffic data collected and processed by VARD. The data is stored in a variety of digital formats, and was combined within a Geographic Information System (GIS) to produce the maps and analyses used in the study. Different map layers representing information such as vessel movements, population centres, geographic areas of interest, geographic features, etc. are overlaid, which allows for statistical and qualitative assessment of how the data relate to each other.

A key data source for this is reports provided by the DFO/CCG Northern Canada Vessel Traffic Services Zone (NORDREG) reporting system. All vessels over 300 gross tons or carrying pollutants are required to report to NORDREG and many smaller vessels do so on a voluntary basis. The database is therefore reasonably comprehensive, though it does not capture all locally operated small craft. These small craft can be very important to many Arctic communities for fishing, hunting and food gathering, travel, or other purposes. Their collective impacts are however generally small and localized.



VARD's database of vessel traffic data and analysis of vessel traffic is being applied to the study, and includes a variety of characteristics for both individual voyages, industry sectors as a whole, and overall traffic across the areas of interest. The data includes supporting information for each voyage. Some data is calculated, some is transcribed from the input NORDREG reports, and some is based on or supplemented by estimates, assumptions, or research performed by VARD. The resulting particulars for each voyage include:

1. Dates of arrival in and departure from the NORDREG zone, days spent in the zone (which starts 200 nautical miles (nm) offshore), total distance travelled, and total distance travelled inside the NORDREG zone;
2. Vessel name, type, persons on board, and fuel type;
3. Likely cargo and notes from NORDREG report with cargo details, if available;
4. Industry sector associated with the vessel (based on the activity and route travelled, not necessarily the vessel type);
5. Vessel's port of origin, destination, and other ports visited during voyage, vector for arrival and departure from the NORDREG zone, whether the voyage is domestic or international, and remarks concerning Northwest Passage transit, if applicable; and
6. Availability of waste reception facilities at port of origin and destination.



2.2 OVERVIEW OF 2013 CANADIAN ARCTIC MARINE OPERATIONS

The 2013 data set was used for this project, as it represented the most recent and complete set readily available. There have been few significant changes in operations more recently; where these are known to have occurred this is noted in the report.

In 2013 a variety of vessels types entered the Canadian Arctic. While the fisheries fleet operates exclusively on the easternmost edge of the Canadian Arctic, other marine industry sectors operate throughout the region. Some noteworthy facts include:

- The sealift/resupply industry is meeting demand for supplies; however the cost gap between the profits associated with meeting expanded demand and financing new vessels to provide the service has been raised by sealift operators as a potential barrier to future growth.²
- In 2013, the Nordic Orion became the first ever bulk carrier to complete a delivery via a full transit of the Northwest Passage. The Northwest Passage is not however likely to become more than a niche shipping route in the foreseeable future. Most operators consider the navigational and logistical challenges too significant to make the route practical.
- Mine sites near Baker Lake continue to be productive and drive both local population growth and shipments of supplies to the region.
- The Baffinland Mary River mine was becoming operational in 2013, and has now (2015) completed its first full shipping season: over 900,000 metric tonnes of iron ore were shipped on 13 vessel voyages via the Milne Inlet Terminal.³
- No oil and gas activities are expected in the Canadian Arctic. All oil majors previously active in the region have exited the area for the foreseeable future due to low commodity prices, logistical challenges beyond their original expectations, and disappointing results from the limited number of sites tested in 2015.

Figure 2 shows a view of the Canadian Arctic and the regions most affected by the factors listed above. Figure 3 provides a general overview of marine traffic in the Canadian Arctic in 2013, the latest year for which full data is currently readily available.

² Comments from speakers at the 2014 Northern CMAC conference, May 15th, 2014.

³ Fednav Limited presentation, November 4, 2015.

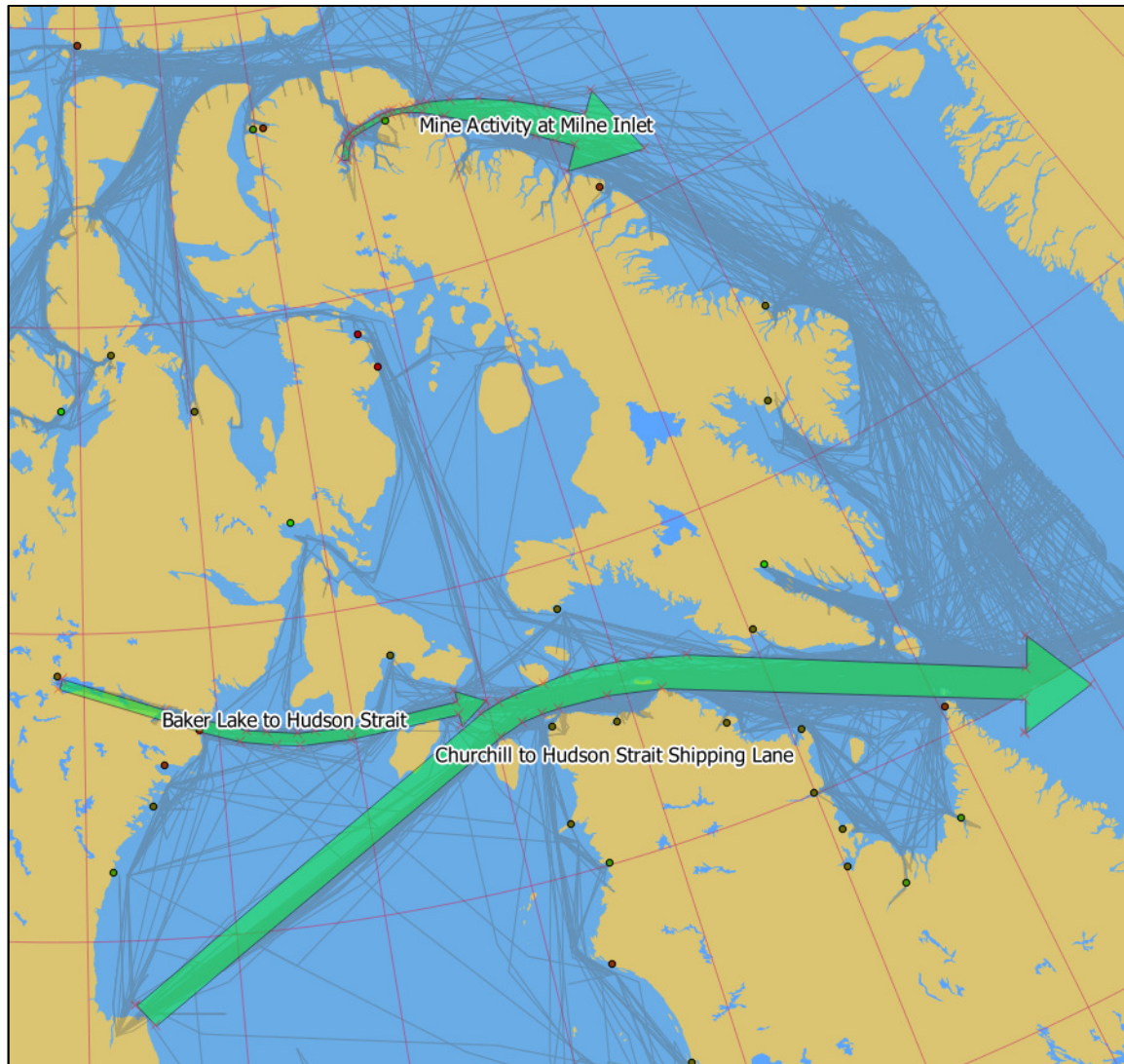


Figure 2: Regions most affected by marine operations in the Canadian Arctic

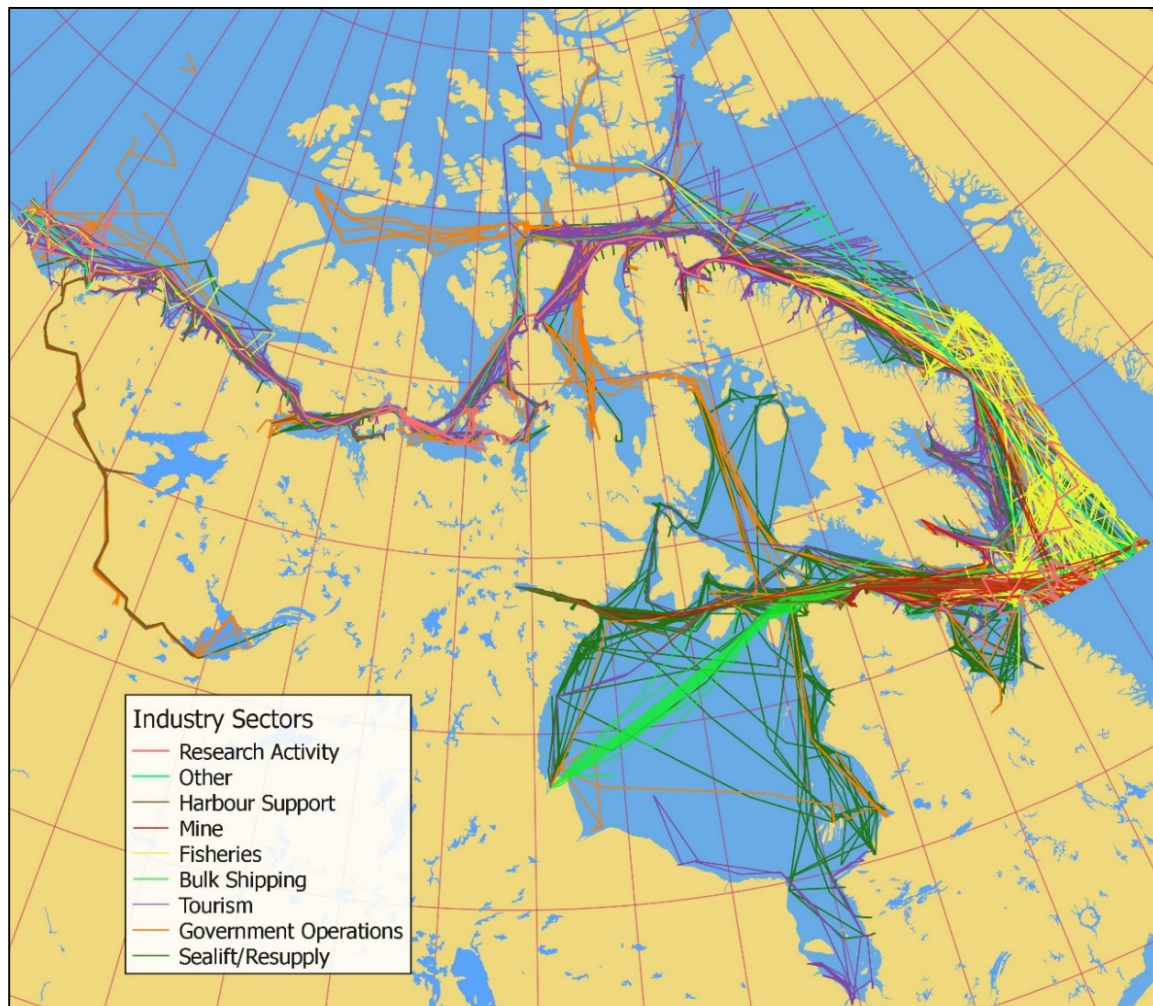


Figure 3: 2013 NORDREG marine traffic for 2013, classified by industry



Table 1 provides a detailed list of the voyages used to create the map in Figure 3. Note that for the purposes of this report, a “voyage” is a single sailing plan submitted to NORDREG. Most vessels will generally be assigned a single voyage for each discrete trip within the NORDREG zone, from entry to egress.

Table 1: Activity by Industry Sector in the Canadian Arctic, 2013

Industry Sector	Total Voyages	Total Distance (km)	Total Days in Arctic	Unique Vessels
Fishing	139	107,412	2,080	23
Mining and minerals extraction	16	32,148	338	9
Sealift and community resupply	74	367,400	2,017	29
Bulk shipping, primarily grain/Churchill	20	79,024	388	19
Government vessels, primarily CCG	20	132,610	719	12
Tourism and adventurers	45	142,494	1,179	36
Non-government research	10	13,726	146	5
Harbour assistance and management	15	33,871	176	6
Other voyages (including oil and gas)	9	4,534	30	5

The following table provides an alternative breakdown of this traffic, focusing on vessel types. A tanker (for example) may undertake community resupply or support a mining operation. In future, it may transport a natural resource out of the area, or potentially even be involved in transit traffic through the Northwest Passage. Knowledge of both the vessel types and the industry sectors or purposes they are serving is important to an understanding of their current impacts and the potential for future change.

Table 2: Activity by Vessel Type in the Canadian Arctic, 2013

Vessel Type	Total Voyages	Total Distance (km)	Total Days in Arctic	Unique Vessels
Fishing vessels	139	107,412	2,080	23
Adventure craft	24	63,667	931	24
Bulk carriers (grain shipments)	13	55,714	290	13
Passenger vessels	21	78,827	248	12
Tankers	28	123,050	647	11
CCG icebreakers	11	107,306	513	6
General cargo vessels	44	212,671	1,021	14
Research vessels	18	16,854	176	8
Bulk carriers	6	21,587	95	6
Tugs	37	102,683	876	21
CCG vessels (non-icebreakers)	5	22,044	179	4
Seismic survey ships	1	51	3	1
Non-CCG icebreakers	1	1,353	14	1
Totals	348	913,218	7,073	144



2.3 REGIONAL MARINE TRAFFIC

Each of the areas of interest has been identified within a GIS based map and corresponding shipping database. Current (based on a baseline of all traffic for 2013) marine traffic have been overlaid onto the map. The vessel traffic data has been identified by industry sector for Fisheries, Mining, Sealift, Bulk Shipping, Government Operations, Tourism, Research, Harbour Assistance, and Other types of traffic.

The following sections provide details of the types of vessels and industries served in each area of interest, as well as the distance travelled and total number of voyages and discrete vessels for each vessel and industry type. Please refer to Appendix 1A for a comprehensive data set for each area of interest.

2.3.1 VESSEL TRAFFIC IN CORONATION GULF

Marine traffic in the Coronation Gulf is primarily local community resupply, the bulk of which is provided by tug and barge. Most sealift traffic originates from Tuktoyaktuk, Northwest Territories, rather than the east coast or the St. Lawrence Seaway. There is also a relatively significant amount of tourist and adventurer traffic in the region, as many small vessels will begin their route in Alaska and travel through the Coronation Gulf as part of attempted Northwest Passage transits.

2.3.1.1 REGIONAL TRAFFIC SUMMARY

Figure 4 illustrates the traffic for 2013 in the Coronation Gulf based on the type of vessel. In 2013, the traffic was primarily resupply and tourism vessels.

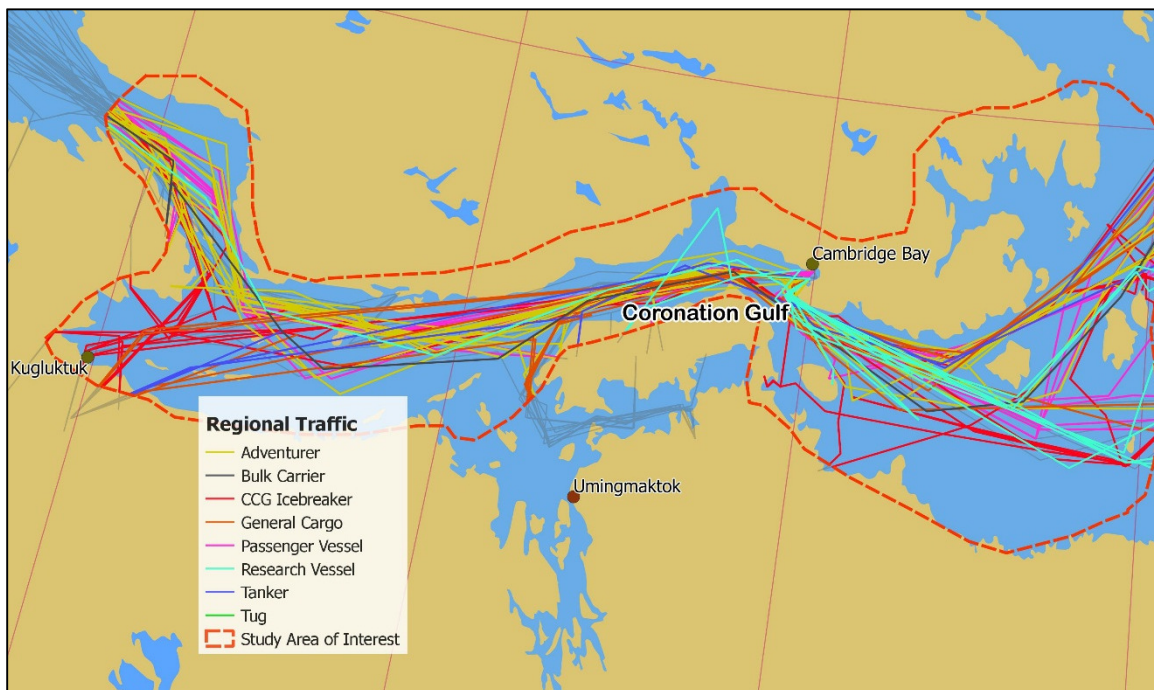


Figure 4: Regional Marine Traffic by Vessel Type in the Coronation Gulf, 2013

The following tables provide a complete list of all traffic in 2013, described in terms of the types of vessels present and the industries they serve. Note that the single bulk shipping vessel in the table was an unusual proof of concept voyage, specifically the Nordic Orion becoming the first bulk carrier to deliver cargo via a full transit of the Northwest Passage.

Table 3: Activity by Industry in the Coronation Gulf, 2013

Industry Sector	Total Voyages	Total Distance (km)	Unique Vessels
Fishing	0	0	0
Mining and minerals extraction	0	0	0
Sealift and community resupply	6	10,526	6
Bulk shipping, primarily grain/Churchill	1	858	1
Government vessels, primarily CCG	3	6,405	2
Tourism and adventurers	22	18,336	22
Non-government research	2	3,333	2
Harbour assistance and management	1	2,236	1
Other voyages (including oil and gas)	0	0	0

Table 4: Activity by Vessel Type in the Coronation Gulf, 2013

Vessel Type	Total Voyages	Total Distance (km)	Unique Vessels
Fishing vessels	0	0	0
Adventure craft	14	11,288	14
Bulk carriers (grain shipments)	0	0	0
Passenger vessels	8	7,048	8
Tankers	1	1,506	1
CCG icebreakers	3	6,405	2
General cargo vessels	3	4,013	3
Research vessels	2	3,333	2
Bulk carriers	1	858	1
Tugs	3	7,243	3
CCG vessels (non-icebreakers)	0	0	0
Seismic survey ships	0	0	0
Non-CCG icebreakers	0	0	0
Totals	35	41,693	34

2.3.1.2 REGIONAL FORECAST TO 2020

The forecast for the Coronation Gulf's marine activity is based on current trends as well as a limited number of individual projections and expected activities within the industries which affect marine traffic. The most important factors for the region are:

1. Community growth: The Nunavut communities of Kugluktuk and Cambridge Bay are experiencing a growth in population. Additional sealift operations could be expected for the region given that most community resupply operations are provided by tug and barge and typically sail from no further than the Beaufort Sea.
2. New tourist traffic crossing the Northwest Passage will need to travel through the region. The cruise ship *Crystal Serenity* is scheduled for a complete transit of the Northwest Passage in late summer/fall of 2016⁴ and a successful voyage could lead to opportunities for additional companies to schedule similar voyages.
3. The additional publicity a large cruise ship will generate may encourage more adventurers to attempt Northwest Passage crossings. Historically, over half these attempts have originated from Alaska, stopping in the Beaufort Sea for supplies, and typically even ultimately unsuccessful attempts are often able to progress as far as the Coronation Gulf.
4. A preliminary proof of concept voyage of a fully laden bulk carrier through the Northwest Passage has taken place as of 2013. Any further efforts to sail this route will necessarily pass through the region. However, as noted in Section 2.2 the Northwest Passage is unlikely to be used for shipping in the future due to the region's significant navigational and logistical challenges.
5. If completed by 2020, the Royal Canadian Navy base at Nanisivik, Nunavut, would serve as a seasonal base for a number of Arctic Offshore Patrol Ship (AOPS) Vessels, should they be in service in time. One or more of these vessels may sail to the region as part of an Arctic tour or patrol.
6. The Canadian High Arctic Research Station (CHARS) is currently being built in Cambridge Bay, and is expected to be open by 2017⁵. This new centre may influence the use of Cambridge Bay as an activity hub for the region, which may in turn affect the number of visits by government vessels as well as the level of resupply needed by the community.

⁴ Crystal Cruises Northwest Passage 2016 FAQ: <http://www.crystalcruises.com/ContentPage.aspx?ID=191>

⁵ Nunatsiaq Online, "Science, high-tech, guide Nunavut's Canadian High Arctic Research Station" http://www.nunatsiaqonline.ca/stories/article/65674science_technology_development_guide_CHARS/

7. There is a proposal for establishing a commercial Arctic Char fishery in Cambridge Bay, however the entirety of the suggested 53,500kg quota would be harvested at the inlet of regional rivers, either by the preferred method of installing weirs, or via gillnet. Neither method is likely to introduce new vessel traffic other than small craft at the harvest sites. Harvested fish will be field dressed and transported immediately to the processing plant via float plane.⁶

The following estimates for changes to traffic by industry sector are based on the above assumptions.

Table 5: Regional Shipping Forecast for the Coronation Gulf, 2020

Industry Sector	Forecast (Low)	Forecast (Baseline)	Forecast (High)
Fishing	N/A	N/A	N/A
Mining and minerals extraction	N/A	N/A	N/A
Sealift and community resupply	No change	2 to 4 additional annual voyages	6+ additional voyages
Bulk shipping ⁷	No voyages	1 new annual transit	2-3 annual transits
Government vessels, primarily CCG	1 additional voyage	2-3 additional voyages	4+ additional voyages
Tourism and adventurers	1 or 2 additional transits	4 or 6 additional transits	10+ additional transits
Non-government research	N/A	N/A	N/A
Harbour assistance	No change	No change	No change
Other voyages (including oil and gas)	N/A	N/A	N/A

2.3.2 VESSEL TRAFFIC IN FOXE BASIN

Marine traffic in Foxe Basin was exclusively sealift and CCG operations in 2013. Previous seasons with favourable ice conditions have seen a limited number of adventurers and other vessels transit through the area, however, most NWP transits use the northern route through Lancaster Sound.

2.3.2.1 REGIONAL TRAFFIC SUMMARY

Figure 5 shows the traffic for 2013 in Foxe Basin based on the type of vessel. In 2013, all traffic consisted of CCG icebreakers and general cargo ships and tankers performing sealift operations to communities in the region.

⁶ DFO, 2014. Integrated Fisheries Management Plan (Final Draft) Cambridge Bay Arctic Char Commercial Fishery, Nunavut Settlement Area.

⁷ Note that the new bulk shipping traffic represents an entirely new shipping pattern, as opposed to additional sailings being scheduled for known destinations and routes.

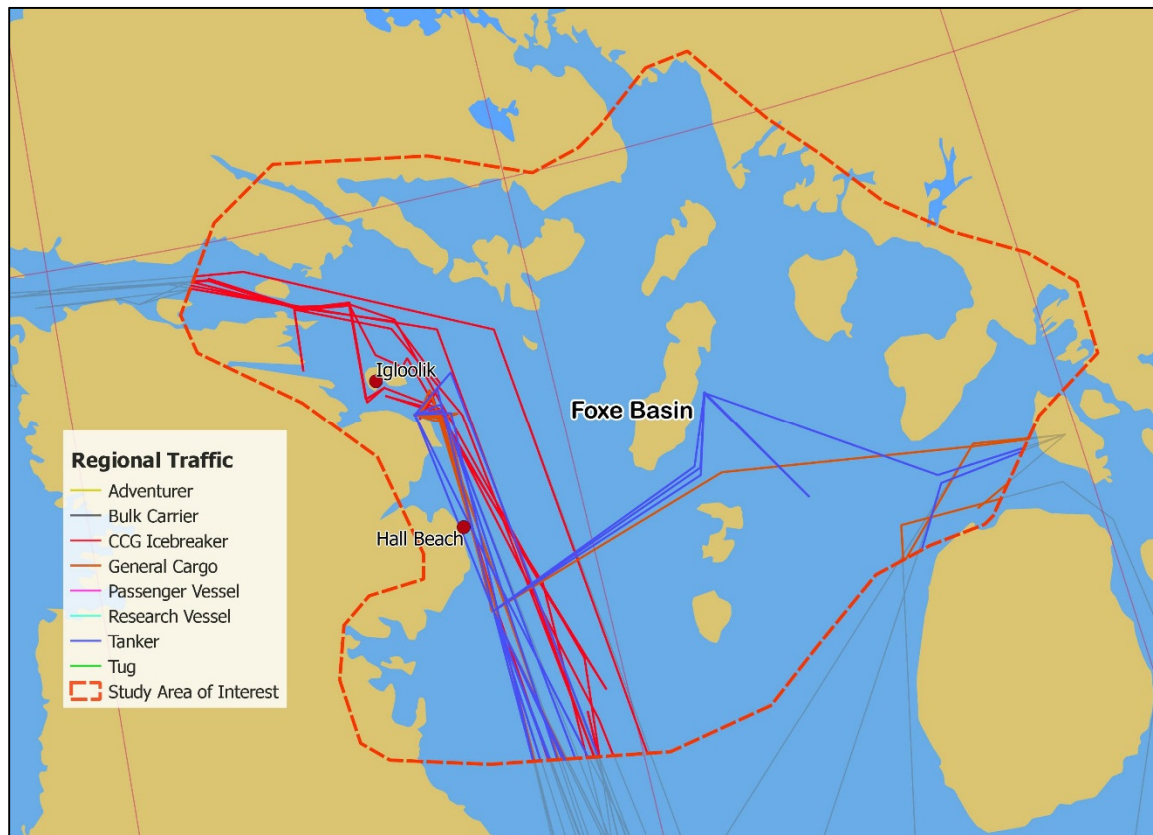


Figure 5: Regional Marine Traffic by Vessel Type in Foxe Basin, 2013

The following tables provide a complete list of all traffic in 2013, described in terms of the types of vessels present and the industries they serve.

Table 6: Activity by Industry in Foxe Basin, 2013

Industry Sector	Total Voyages	Total Distance (km)	Unique Vessels
Fishing	0	0	0
Mining and minerals extraction	0	0	0
Sealift and community resupply	8	3,419	7
Bulk shipping, primarily grain/Churchill	0	0	0
Government vessels, primarily CCG	4	2,668	4
Tourism and adventurers	0	0	0
Non-government research	0	0	0
Harbour assistance and management	0	0	0
Other voyages (including oil and gas)	0	0	0

Table 7: Activity by Vessel Type in Foxe Basin, 2013

Vessel Type	Total Voyages	Total Distance (km)	Unique Vessels
Fishing vessels	0	0	0
Adventure craft	0	0	0
Bulk carriers (grain shipments)	0	0	0
Passenger vessels	0	0	0
Tankers	5	2,215	4
CCG icebreakers	4	2,668	4
General cargo vessels	3	1,204	3
Research vessels	0	0	0
Bulk carriers	0	0	0
Tugs	0	0	0
CCG vessels (non-icebreakers)	0	0	0
Seismic survey ships	0	0	0
Non-CCG icebreakers	0	0	0
Totals	12	6,086	11

2.3.2.2 REGIONAL FORECAST

The forecast for the Foxe Basin's marine activity is based on current trends as well as a limited number of individual projections and expected activities within the industries which affect marine traffic. The most important factors for the region are:

1. Community growth: The Nunavut communities of Igloolik and Hall Beach are currently experiencing a decline in population. A minimal increase in demand for sealift services in the region, combined with challenging ice conditions and a lack of marine infrastructure, suggests that additional resupply sailings to the region are unlikely.
2. The Mary River mine development is not expected to use the southern access route (which would pass through Foxe Basin) before 2020, if at all.
3. New tourist traffic crossing the Northwest Passage may use the southern route through Foxe Basin as part of itineraries. The cruise ship Crystal Serenity's scheduled voyages in 2016⁸ may help spur interest in tourism.
4. Vessels transiting the Northwest Passage are more likely to use the Northern route through Lancaster Sound than the Southern route through Foxe Basin due to draft and other navigational considerations.

⁸ Crystal Cruises Northwest Passage 2016 FAQ: <http://www.crystalcruises.com/ContentPage.aspx?ID=191>

5. If completed by 2020, the Royal Canadian Navy base at Nanisivik would serve as a seasonal base for a number of AOPS Vessels, should they be in service in time. One of more of these vessels may sail to the region as part of an Arctic tour or patrol.

The following estimates for changes to traffic by industry sector are based on the above assumptions.

Table 8: Regional Shipping Forecast for the Foxe Basin, 2020

Industry Sector	Forecast (Low)	Forecast (Baseline)	Forecast (High)
Fishing	N/A	N/A	N/A
Mining and minerals extraction	N/A	N/A	N/A
Sealift and community resupply	No change	No change	No change
Bulk shipping	N/A	N/A	N/A
Government vessels, primarily CCG	No change	No change	1 or 2 additional transits
Tourism and adventurers	No change	1 or 2 additional transits	4 or 5 additional transits
Non-government research	N/A	N/A	N/A
Harbour assistance	N/A	N/A	N/A
Other voyages (including oil and gas)	N/A	N/A	N/A

2.3.3 VESSEL TRAFFIC IN WESTERN HUDSON'S BAY

Marine traffic in Western Hudson's Bay is primarily sealift operations resupplying local communities. Some traffic is there to support mining operations at Baker Lake. Both types of traffic generally arrive in the region from the Canadian East Coast or the St. Lawrence via the Hudson Strait, or occasionally from Churchill or Northern Ontario. Note that this sealift and mine support traffic is second only to bulk shipping of grain from Churchill in terms of the volume of traffic transiting through the Hudson Strait.

2.3.3.1 REGIONAL TRAFFIC SUMMARY

Figure 6 illustrates the traffic for 2013 around Western Hudson's Bay based on the type of vessel. In 2013, the marine traffic was almost entirely sealift and resupply operations in support of communities as well as mining operations near Baker Lake. Baker Lake is generally only accessible by tug and barge or by shuttle tanker, so resupply to the mine site is either directly by these types of vessels, or cargo is transferred to them by a larger vessel which will moor near Chesterfield Inlet. In 2013, there were mine supply trips made to Baker Lake by 3 different tugs and a shuttle tanker. In most cases their cargo was transferred on board near Chesterfield Inlet by two different tankers and a large general cargo vessel.

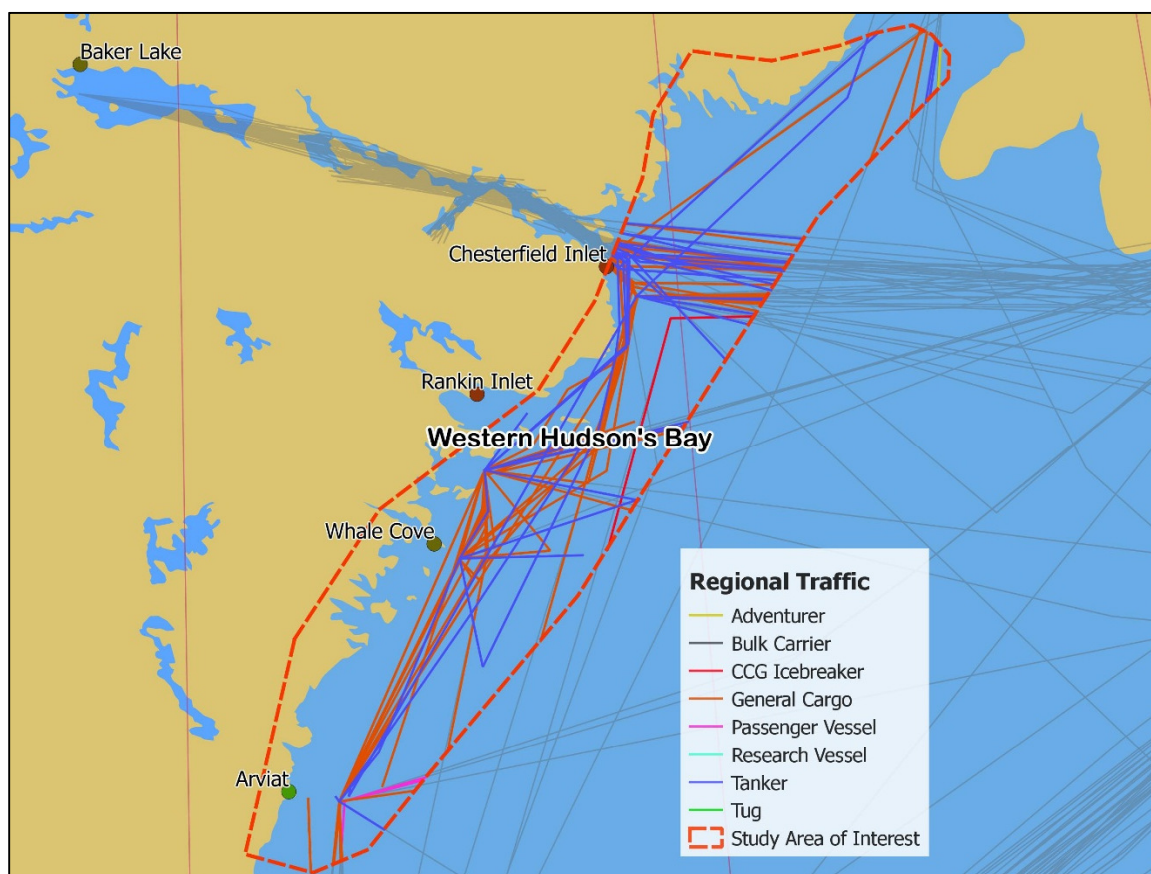


Figure 6: Regional Marine Traffic by Vessel Type in Western Hudson's Bay, 2013

The following tables provide a complete list of all traffic in 2013, described in terms of the types of vessels present and the industries they serve.

Table 9: Activity by Industry in Western Hudson's Bay, 2013

Industry Sector	Total Voyages	Total Distance (km)	Unique Vessels
Fishing	0	0	0
Mining and minerals extraction	10	4,781	7
Sealift and community resupply	16	6,282	10
Bulk shipping, primarily grain/Churchill	0	0	0
Government vessels, primarily CCG	1	161	1
Tourism and adventurers	2	135	2
Non-government research	0	0	0
Harbour assistance and management	0	0	0
Other voyages (including oil and gas)	0	0	0

Table 10: Activity by Vessel Type in Western Hudson's Bay, 2013

Vessel Type	Total Voyages	Total Distance (km)	Unique Vessels
Fishing vessels	0	0	0
Adventure craft	1	22	1
Bulk carriers (grain shipments)	0	0	0
Passenger vessels	1	113	1
Tankers	11	3,666	6
CCG icebreakers	1	161	1
General cargo vessels	12	6,846	8
Research vessels	0	0	0
Bulk carriers	0	0	0
Tugs	3	552	3
CCG vessels (non-icebreakers)	0	0	0
Seismic survey ships	0	0	0
Non-CCG icebreakers	0	0	0
Totals	29	11,359	20

2.3.3.2 REGIONAL FORECAST

The forecast for Western Hudson's Bay marine activity is based on current trends as well as a limited number of individual projections and expected activities within the industries which affect marine traffic. The most important factors for the region are:

1. Community growth: The Nunavut communities of Arviat, Whale Cove, and Baker Lake are experiencing population growth. Other Nunavut communities, Rankin Inlet and Chesterfield Inlet, are experiencing a decline in population, however, this decline is relatively small. The overall growth will likely increase demand for sealift services. Western Hudson's Bay is a relatively easy destination compared with other destinations in the Canadian Arctic; most resupply traffic bound for the region originates in the St. Lawrence or Newfoundland, and travels through the Hudson Strait, then directly to its destination. This route offers a longer navigation season than most other Arctic destinations, and presents few navigational issues. Adding additional sailings on this route would be much less logistically challenging than routes leading to most other Eastern arctic Communities.
2. The operators of the Meadowbank gold mine in the region expect the mine to remain fully operational beyond 2019.⁹ The Agnico Eagle Meliadine mine has also been granted

⁹ Baker Lake Meadowbank Mine Development: <http://www.bakerlake.ca/development.html>

permission to move from an exploration site to a complete gold mine operation¹⁰. Note that gold mines typically only require shipping support during their construction phase and for ongoing upkeep and supply of their worker camps. The mine's gold product is transported via aircraft, and the mine's byproducts are kept at the mine site. The forecast assumes that construction at Meliadine will be complete by 2020 and vessel traffic will be limited to sealift of fuel and supplies to the mine sites.

3. If completed by 2020, the Royal Canadian Navy base at Nanisivik would serve as a seasonal base for a number of AOPS Vessels, should they be in service in time. One of more of these vessels may sail to the region as part of an Arctic tour or patrol.
4. Transiting traffic is not a factor in the region, nor is the region seen as a significant tourism destination.

The following estimates for changes to traffic by industry sector are based on the above assumptions.

Table 11: Regional Shipping Forecast for Western Hudson's Bay, 2020

Industry Sector	Forecast (Low)	Forecast (Baseline)	Forecast (High)
Fishing	N/A	N/A	N/A
Mining and minerals extraction (construction and camp resupply)	3 or 4 additional voyages	5 or 6 additional voyages	6+ additional voyages
Sealift and community resupply	1 or 2 additional voyages	2 or 3 additional voyages	3+ additional voyages
Bulk shipping	N/A	N/A	N/A
Government vessels, primarily CCG	No change	No change	1 or 2 additional voyages
Tourism and adventurers	No change	No change	No change
Non-government research	N/A	N/A	N/A
Harbour assistance	N/A	N/A	N/A
Other voyages (including oil and	N/A	N/A	N/A

¹⁰ Nunatsiaq Online, October 14, 2014. Nunavut board gives green light to Meliadine gold mine. http://www.nunatsiaqonline.ca/stories/article/65674nunavut_board_gives_green_light_to_meliadine_gold_mine/



2.3.4 VESSEL TRAFFIC IN LANCASTER SOUND

Marine traffic near Lancaster Sound involves a wide range of industry sectors. The region is second only to the Hudson Strait as an access route to other areas of the Canadian North and in 2013 the region was used by sealift operations, tourist traffic, and government operations.

2.3.4.1 REGIONAL TRAFFIC SUMMARY

Figure 7 illustrates the traffic for 2013 in Lancaster Sound based on the type of vessel. In 2013, a variety of vessel types supporting a variety of industries travelled in the region. The most significant traffic was passenger vessels (both entering and exiting the interior of the Canadian Arctic as part of a Northwest Passage transit attempt, and larger cruise ships visiting the coasts around Lancaster Sound), tankers and general cargo vessels supporting the development of the Mary River mine, and Government icebreakers.

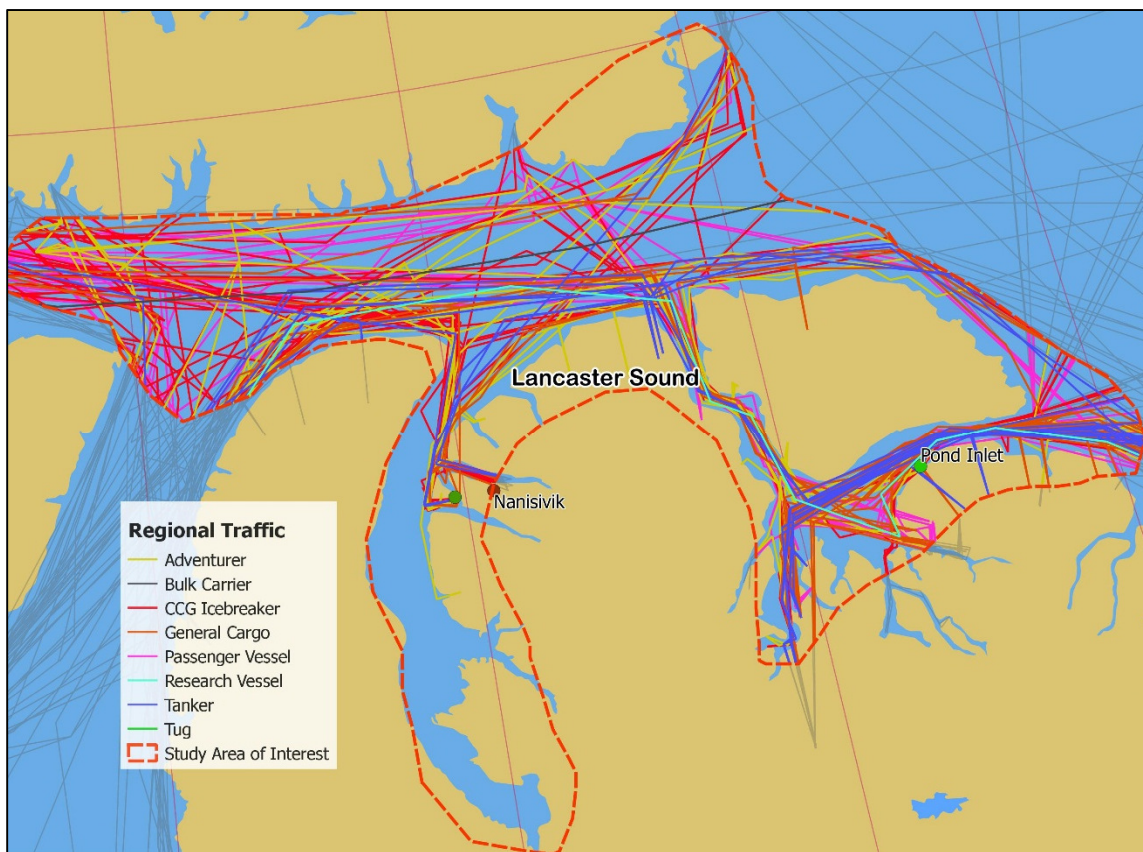


Figure 7: Regional Marine Traffic by Vessel Type in Lancaster Sound, 2013

The following tables provide a complete list of all traffic in 2013 described in terms of the types of vessels present and the industries they serve. Note that while some tankers and cargo ships sailed directly to Milne Inlet to supply the Mary River mine, others made multiple deliveries. In Table 12 below, the “Mining and minerals extraction” category refers to vessels serving the mine site exclusively.

Table 12: Activity by Industry in Lancaster Sound, 2013

Industry Sector	Total Voyages	Total Distance (km)	Unique Vessels
Fishing	0	0	0
Mining and minerals extraction	10	6,197	6
Sealift and community resupply	12	12,456	11
Bulk shipping	1	397	1
Government vessels, primarily CCG	7	15,387	5
Tourism and adventurers	27	25,014	25
Non-government research	1	606	1
Harbour assistance and management	0	0	0
Other voyages (including oil and gas)	0	0	0

Table 13: Activity by Vessel Type in Lancaster Sound, 2013

Vessel Type	Total Voyages	Total Distance (km)	Unique Vessels
Fishing vessels	0	0	0
Adventure craft	15	10,860	15
Bulk carriers (grain shipments)	0	0	0
Passenger vessels	12	14,154	10
Tankers	8	7,017	7
CCG icebreakers	6	15,139	4
General cargo vessels	14	11,637	10
Research vessels	1	606	1
Bulk carriers	1	397	1
Tugs	0	0	0
CCG vessels (non-icebreakers)	1	248	1
Seismic survey ships	0	0	0
Non-CCG icebreakers	0	0	0
Totals	58	60,057	49



2.3.4.2 REGIONAL FORECAST

The forecast for Lancaster Sound's marine activity is based on current trends as well as a limited number of individual projections and expected activities within the industries which affect marine traffic. The most important factors for the region are:

1. Community growth: The Nunavut communities of Arctic Bay and Pond Inlet are currently experiencing a growth in population. An increase in demand for sealift services in the region may occur to support these communities as they develop, primarily in support of the nearby Mary River mine.
2. The Mary River mine project continues to develop and is expected to be shipping ore through the region in significant quantities by 2020. As noted in Section 2.2, the Mary River mine has completed a full operational season and shipped over 900,000 metric tonnes on 13 vessels via the Milne Inlet terminal. It is reasonable to expect these numbers to increase as production at the site increases. For the "low" scenario it is assumed that production will not increase from this level, while all other scenarios include a significant increase in production.
3. The cruise ship Crystal Serenity is scheduled for a complete transit of the Northwest Passage in late summer/fall of 2016¹¹ and a successful voyage could lead to opportunities for additional companies to schedule similar voyages. The northern route through the region is generally preferred to the southern route through Foxe Basin.
4. A preliminary proof of concept voyage of a fully laden bulk carrier through the Northwest Passage has taken place as of 2013. Other attempts at a similar voyage would likely pass through the region. As noted elsewhere however, the Northwest Passage is unlikely to be used for shipping in the future due to the region's significant navigational and logistical challenges.
5. If completed by 2020, the Royal Canadian Navy base at Nanisivik would serve as a seasonal base for a number of AOPS Vessels, should they be in service in time. The base may also require harbour operations or towing operations.

The following estimates for changes to traffic by industry sector are based on the above assumptions. Note that in this table "bulk shipping" excludes the shipment of products from the Baffinland mine – Iron ore exports are included in the "Mining and minerals extraction" category.

¹¹ Crystal Cruises Northwest Passage 2016 FAQ: <http://www.crystalcruises.com/ContentPage.aspx?ID=191>

Table 14: Regional Shipping Forecast for Lancaster Sound, 2020

Industry Sector	Forecast (Low)	Forecast (Baseline)	Forecast (High)
Fishing	N/A	N/A	N/A
Mining and minerals extraction (both site supply and product export)	15 annual voyages	20-25 annual voyages	30+ annual voyages
Sealift and community resupply	No change	1 or 2 additional voyages	4 or 5 additional voyages
Bulk shipping	N/A	N/A	1 or 2 transits
Government vessels, primarily CCG	No change	4-6 additional voyages	10+ additional voyages
Tourism and adventurers	No change	1 or 2 additional transits	4 or 5 additional transits
Non-government research	N/A	N/A	N/A
Harbour assistance	N/A	1 or 2 additional voyages	4 or 5 additional voyages
Other voyages (including oil and gas)	N/A	N/A	N/A



3 INVENTORY OF ENVIRONMENTAL, BIOLOGICAL, AND SOCIO-ECONOMIC FACTORS

3.1 INTRODUCTION

This element of the project has developed an inventory of ecological, oceanic, socio-economic and cultural factors significant to each region. For the socio-economic and cultural aspects this covers data addressing historical sites, cultural sites, harvesting areas, and traditional place names. Oceanic data includes climate information, currents and bathymetry. For the ecological aspects information representing ecological features such as distribution of marine mammals, bird habitats, important fish habitats, and other relevant data is required.

The outputs from this task include a set of graphical and tabular presentations of various inventories, supported by commentary on sources and their comprehensiveness and reliability. In some cases information is region/area specific, while in others transportation and migration patterns make it more appropriate to provide broader overviews.

This information will provide a basis for the assessment of risks and impacts, and recommendations for mitigation measures in Section 4. The main report provides an overview of the data, while more detailed information is provided in a set of Appendices.

3.2 OVERVIEW OF COLLECTED DATA SOURCES

This report collects a variety of data sources for socio-economic, cultural, oceanographic, and ecological information:

Socio-Economic: Data has been collected describing transport, navigation, and supply infrastructure locations, population size and change trends, as well as macro-scale economic drivers in the shipping industries operating in the study's areas of interest.

Cultural: Data has been collected covering community consultations on sustainability and development, as well as locations of protected areas, sensitive areas, and traditional harvesting areas likely to intersect with vessel traffic.

Oceanographic: Data has been collected which provides a comprehensive view of bathymetry, sea ice conditions and seasonal forecasts, temperature and weather, and currents and tides for all the study's areas of interest.

Ecological: Data has been collected describing the estimated and observed ranges and populations for the entire range of species likely to be impacted by shipping, as well as discussion of cetaceans, pinnipeds, polar bears, seals, birds, fish, invertebrates and other sea based life.

Sections 3 - 5 of the report provide descriptions of key features of these data sources, including useful figures and tables of values and commentary on specific data sources of note. Section 6 provides complete reference details for each data source. Appendix 2 provides additional data sources for these inventories.



3.3 SOCIO-ECONOMIC AND CULTURAL DATA

The Canadian Arctic is home to a number of relatively remote communities. These communities are heavily dependent on marine traffic for their supply needs, which is generally only able to access the Arctic during a short window in the late summer and fall. During the winter season the Arctic is entirely ice covered. In many regions of the Arctic the ice coverage is dynamic, with numerous leads, cracks, polynyas, and other features occurring predictably each season. These features are favourable for a number of marine mammals including cetaceans and seals, who depend on the ice and winter access to the water beneath it.

The study's areas of interest experiences both transient ship traffic such as shipping from Churchill, sealift and coast guard vessels sailing to the interior of the Arctic, and occasional Northwest Passage transits, as well as traffic sailing to destinations within the former.

Many communities in the Arctic are currently experiencing modest population and economic growth. Supplies for these communities are exclusively imported via ship delivery during the summer and fall seasons, as well as by limited aircraft access at local airstrips. Facilities for both air and sea supply are basic – sea supply is typically via barge and beach landing, while air facilities are typically gravel runways suitable for smaller aircraft.

3.3.1 SOCIO-ECONOMIC DATA

Socio-economic data collected for the project includes metrics for population centres within the study areas and their growth/decline rates, as well as locations of airports, common marine infrastructure, and other key infrastructure.

3.3.1.1 CENSUS DATA AND POPULATION TRENDS

The previous two national Census submissions (2006 and 2011) have been used to estimate trends in population change for communities in the Canadian Arctic. The data suggests that most communities in the Coronation Gulf and Lancaster Sound regions are experiencing at least modest growth. Communities in the Foxe Basin all appear to be declining in population, while communities in Western Hudson Bay show a variety of trends. The following figure shows the percentage growth for many communities in the Canadian Arctic between 2006 and 2011. Data is also available that provides the relative rate of growth for these communities (a measure of the % population growth divided by the overall population size).



Figure 8: Population Change in the Canadian Arctic, 2006 to 2011

3.3.1.2 ECONOMIC DRIVERS

The key economic drivers in the study's areas of interest are as follows:

- Coronation Gulf: Tourism, some logistics support. Many traditional hunting and fishing activities in the region. Cambridge bay will be home to the new Canadian High Arctic Research Centre (CHARS) in 2017¹² which will support and expand Arctic research.
- Western Hudson Bay: Primarily mining are the nearby Agnico Eagle Meliadine and Baker Lake sites.
- Foxe Basin: There are few external economic drivers for the region. Most activity appears to be community focused and traditional in nature (as opposed to new development).

¹² http://www.nunatsiaqonline.ca/stories/article/65674science_technology_development_guide_CHARS/



- Lancaster Sound: Primarily mining and mineral extraction via the Mary River mine site, as well as a modest amount of tourism. The new naval facility in Nanisivik will have some effects on traffic during construction and operation after its opening in 2017.

As described in Section 2, the project has collected data describing:

- The production capacity and workforce size for the mining sector, as well as frequency and quantity of product exports by ship for applicable regions.
- The approximate number of community resupply visits from cargo ships and tankers for communities in each region.
- The frequency and passenger count for tourist vessels stopping at communities in each region.

3.3.1.3 NAVIGATION, ACCESS, AND LOCAL TRANSPORTATION

There are a number of local airports and small, sometimes seasonal airstrips throughout the study's areas of interest. Most serve as the sole access to the community when ship visits are not possible. Airports in the region are generally smaller, using packed gravel tarmacs. With few exceptions, all have less than 4000' of tarmac available and are generally limited to smaller prop driven aircraft. In addition to communities, mine sites also operate basic airstrips to move personnel to and from the site, as well as for exporting product in the case of gold mines.

There are few permanent navigation aids in the Canadian Arctic, with most vessel traffic relying on charts and satellite and radio systems. The entire region is covered by NAVTEX, however the only CCG Marine Communications and Traffic Services (MCTS) site in the Arctic is located in Iqaluit, which is not part of the study regions. There are also a limited number of shore lights near larger communities.

3.3.2 CULTURAL DATA

3.3.2.1 CULTURALLY SIGNIFICANT AND PROTECTED REGIONS

There are numerous Territorial and National parks within the boundaries of the study areas. The boundaries for all such areas have been collected as part of the work.

Background research and consultations in support of the Nunavut Land Use Plan (NLUP) offers many insights into local community priorities for important hunting, fishing, and gathering regions, as well as culturally significant regions, environmentally sensitive regions, and areas important to the logistics of local communities. The results of the NLUP have been parsed into individual comments, and have been correlated with their spatial references within a GIS. The following figure shows an example of NLUP data compared to the study's areas of interest, in this case, areas used for fishing compared with and vessel traffic thorough the region. Fishing is critically important to the sustainability and independence of Northern communities, and as a result is often at the center of local culture, community activity, and conservation requirements.

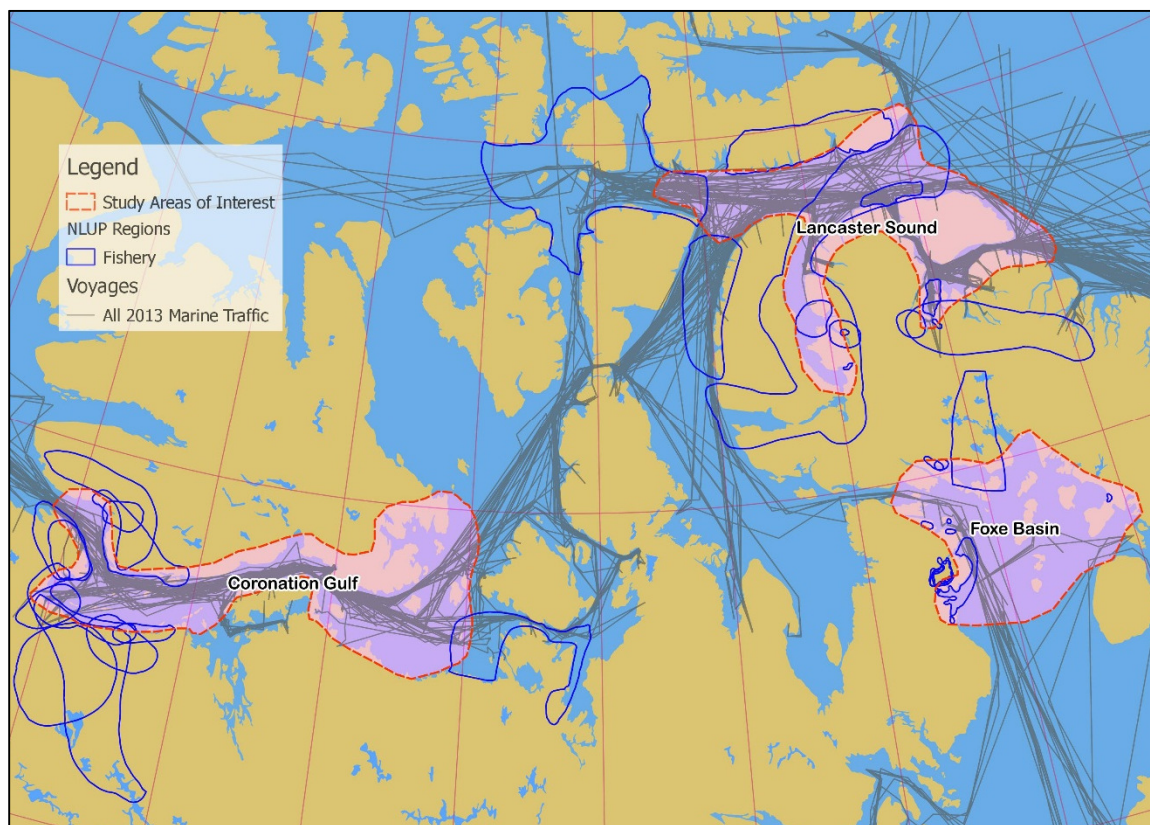


Figure 9: NLUP fisheries compared to vessel traffic for 2013

GIS Analysis of this type of information provides useful statistics such as the total number of vessels of a given type which are likely to transit through a fishing area over a season and the total distance travelled by such vessels within the fishing area. This will subsequently inform risk assessment for a given type of shipping activity compared to a particular region.

In addition to fisheries, VARD has processed the available NLUP data to create similar datasets describing local interest in marine mammals, polar bears, caribou, and seabirds. The following figure shows the distribution of marine mammal areas of concern or note throughout the study's areas of interest:

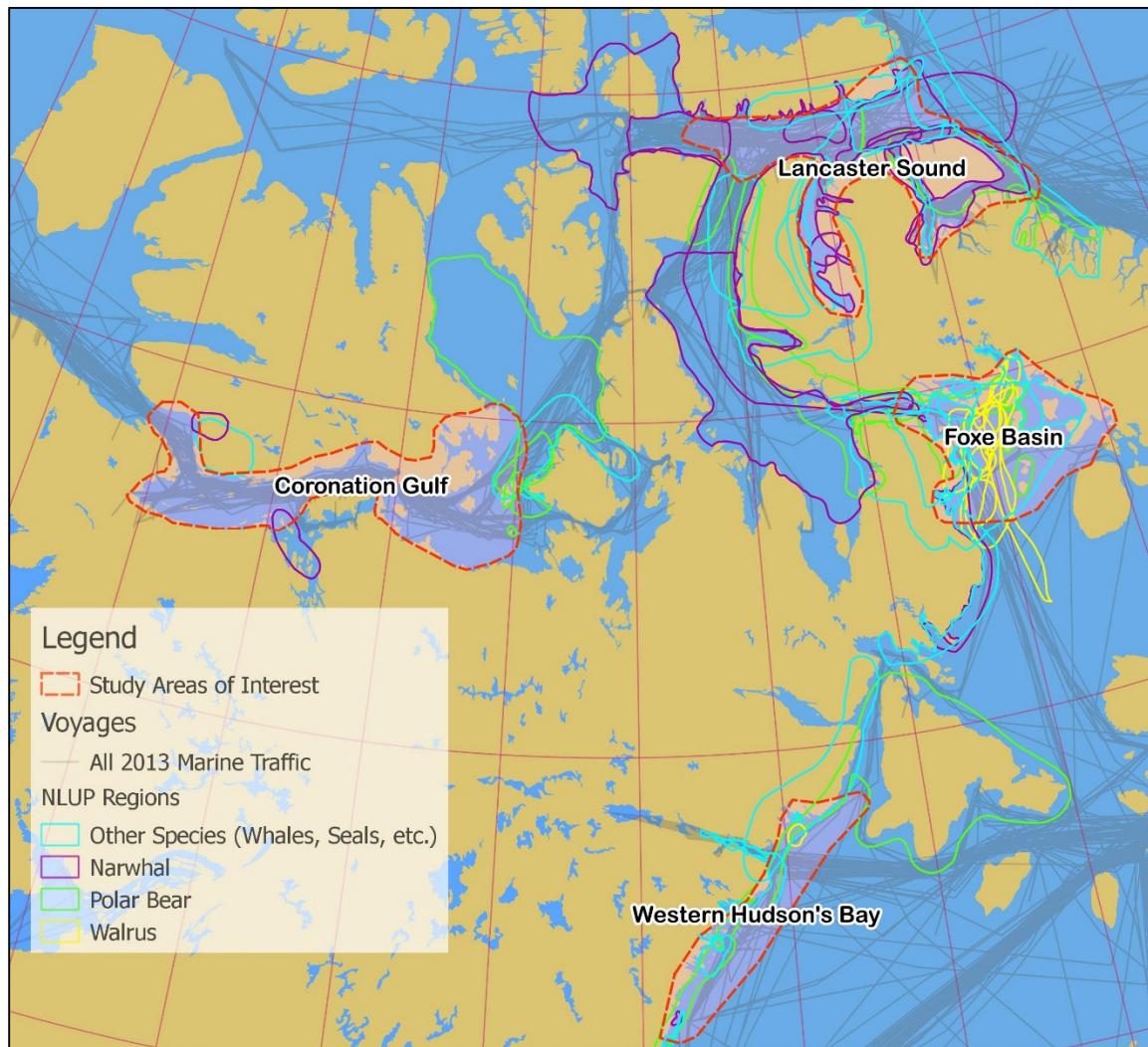


Figure 10: NLUP marine mammal areas of note compared to vessel traffic for 2013

3.4 OCEANOGRAPHIC DATA

The oceanographic data set includes GIS-ready data covering sea ice distribution, sea ice extent, sea surface temperature data, currents and tidal ranges, observed (land) temperature records, and bathymetry data.

3.4.1 SEA ICE DATA AND ICE CHARTS

Sea Ice data was obtained from the Canadian Ice Service (CIS), published online via the National Snow Ice Data Centre (NSIDC). The data is available as standard GIS shapefiles¹³. CIS data is divided into 5 regions; Eastern Arctic, Western Arctic, Hudson Bay, Canada's East Coast, and the Great Lakes. All the study's areas of interest are fully covered by the data set. The following figure shows an example of the data imported into a GIS. The figure shows the state of sea ice at the second week of June, 2013. Lighter shades of blue represent areas of lower ice concentration, and the legend within each region follows the SIGRID-3 ice egg code¹⁴.



Figure 11: Ice Conditions (Canadian Ice Service SIGRID-3 Ice Egg Coding) Around Lancaster Sound, Mid-June 2013

¹³ NOAA archive of past NSIDC ice charts: <ftp://sidacs.colorado.edu/pub/DATASETS/NOAA/G02171/>

¹⁴

https://nsidc.org/data/docs/noaa/g02171_CIS_seaice_regional/documents/CIS_SIGRID3_Implementation.pdf

Temporal coverage currently available to the project includes 2006 to early 2016 data. The overall data quality is very high, as the data provides detailed descriptions of ice conditions with a high level of confidence for all but the most difficult to remotely resolve types of ice. This information is used throughout the risk assessment work presented below.

3.4.1.1 SEA ICE BREAK-UP AND FREEZE-UP

The sea ice coverage in the Hudson Strait will vary from year to year, however the notional dates for freeze up and break up are available from the CIS¹⁵.

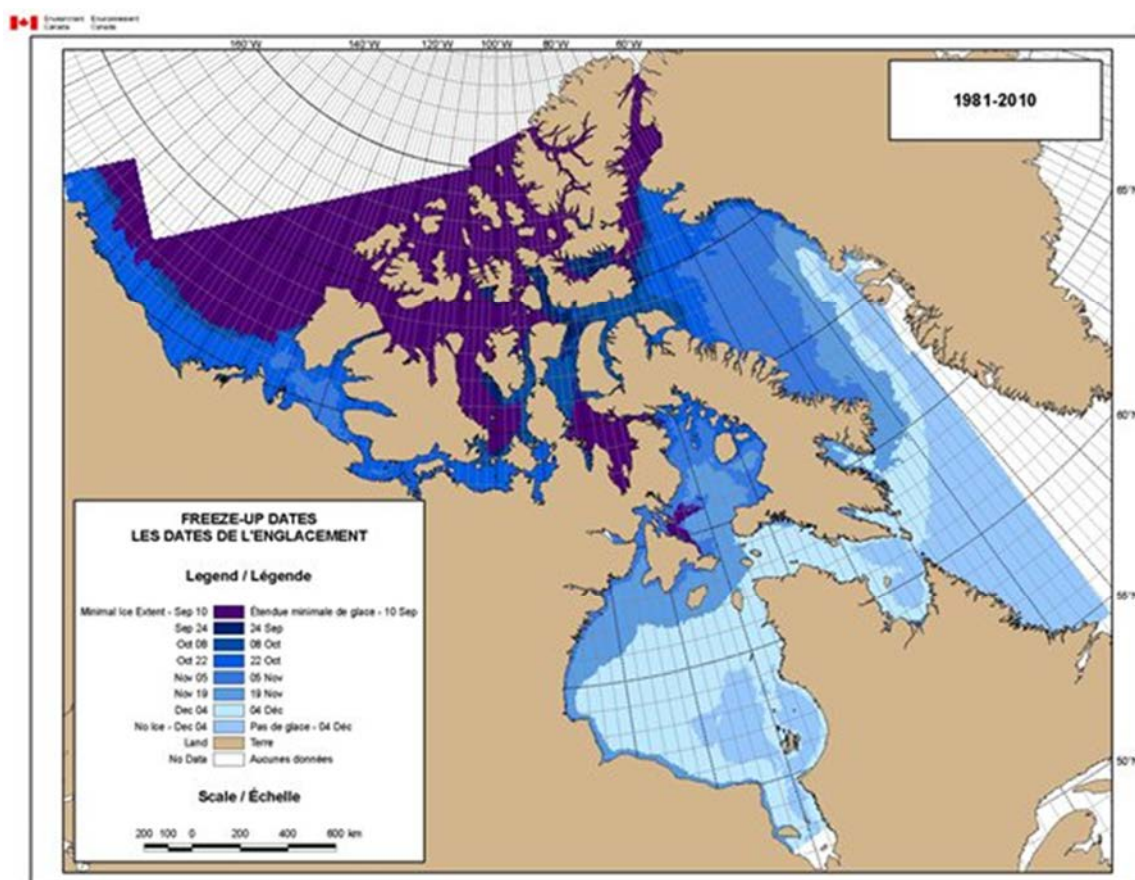


Figure 12: Notional Freeze-Up Dates

For the Coronation Gulf, freeze-up is typically in early to mid-October. Foxe Basin occurs earlier, typically early to mid-September. Western Hudson Bay typically occurs in early November near shore, and 1-2 weeks later away from shore where vessels would typically operate. The freeze-up date varies in Lancaster Sound, with sheltered regions such as Milne Inlet occurring in early to mid-October, and less sheltered regions following 1-2 weeks later.

¹⁵ Canadian Ice Service, Seasonal outlook: <http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=E568E9D7-1>

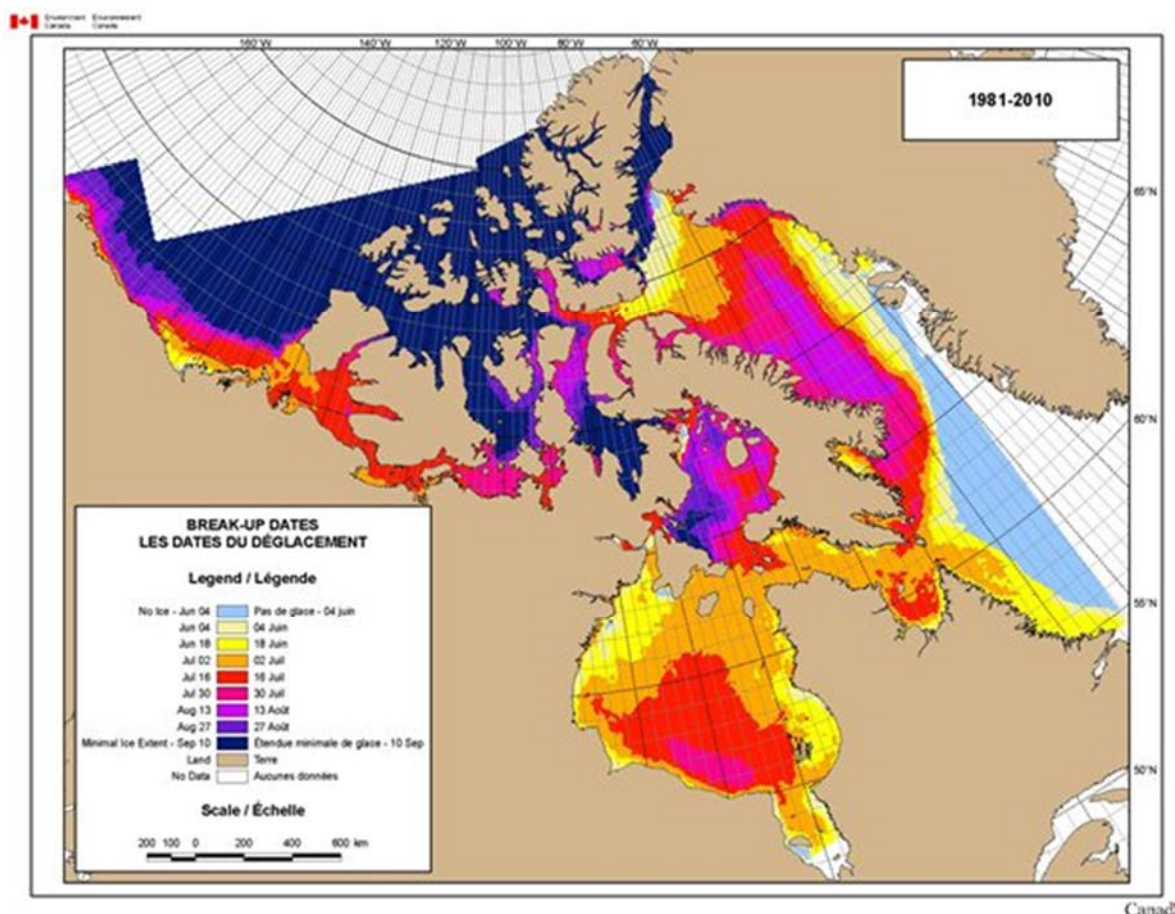


Figure 13: Notional Break-Up Dates

For the Coronation Gulf, break-up occurs throughout July. Most of Foxe Basin does not break up until mid to late July, and the more densely ice-covered parts of the region may not break-up until late August. Western Hudson Bay typically breaks up mid-June. The break-up date varies in Lancaster Sound, with different parts of the region typically breaking up throughout July.

3.4.1.2 SEA ICE EXTENT

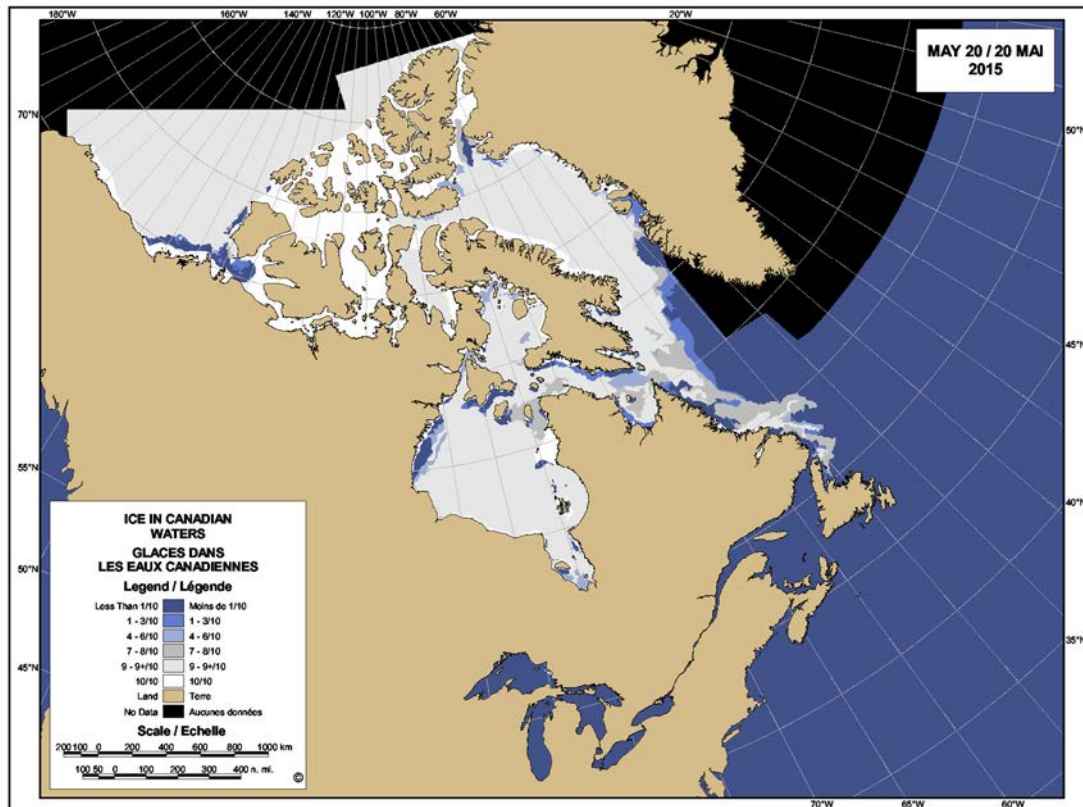
Sea ice extent data was obtained from Multi Sensor Analysed Sea Ice Extent (MASIE) data published by the NSIDC¹⁶. MASIE data is not as detailed as CIS data, however it provides a useful approximation (at a ~4km resolution) of the total area of the Arctic covered by ice (regardless of ice thickness, makeup, or age) for any given day.

An important aspect of ice cover is the existence of recurring polynyas; areas of low ice cover/concentration which re-occur from year to year through a combination of currents, bathymetry and other oceanographic phenomena. Figure 9, taken from May 2015 CIS data shows areas of low ice cover which are a very close match to a study on polynyas from more than 30

¹⁶ <http://nsidc.org/data/masie/>



years previously in Figure 10. Polynyas are areas of biological diversity and productivity, and very important to many species.



SOURCE: CIS DAILY AND REGIONAL ICE CHARTS / SOURCE: CARTES QUOTIDIENNES ET RÉGIONALES DES GLACES DU SCG

Figure 14: Polynyas, May 2015

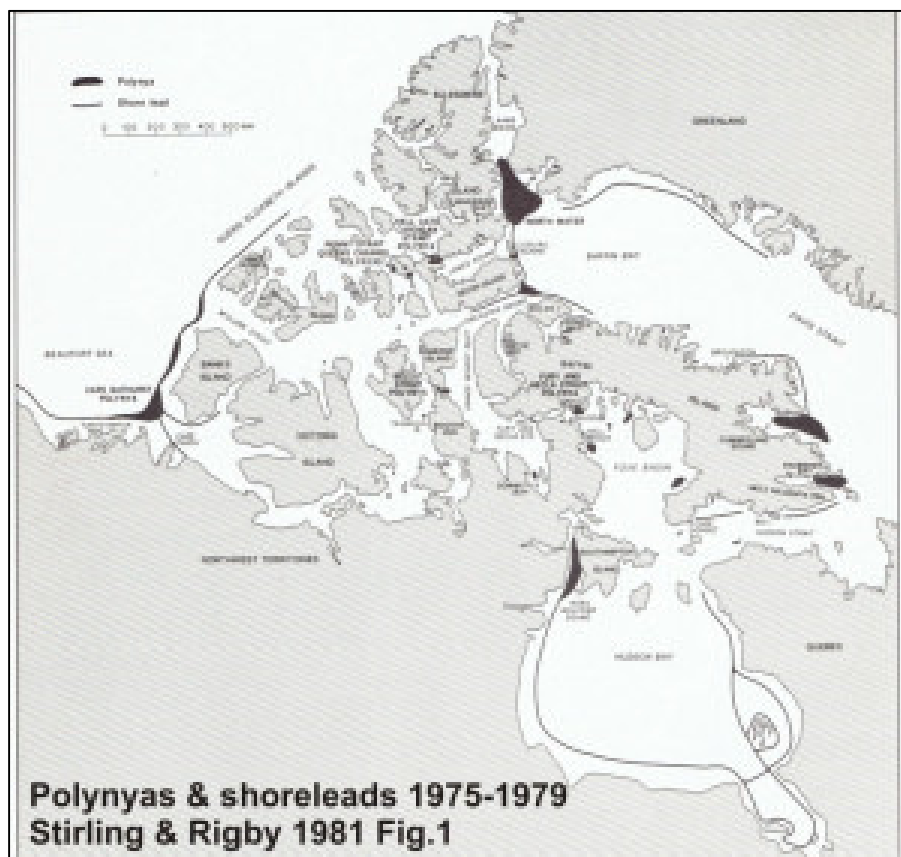


Figure 15: Historical Distribution of Polynyas

3.4.1.3 SEA ICE INDEX

The sea ice index is a monthly maximum sea ice extent calculation provided through the NSIDC¹⁷. This calculated value offers historical maximums back to 1979 by month of the year, as well as total mean extend for each month based on the entire temporal record.

3.4.2 TEMPERATURE DATA

3.4.2.1 SEA SURFACE TEMPERATURE

Sea surface temperature (SST) data is provided by NOAA¹⁸. Satellite instrumentation is used to calculate the temperature at sea surface level. The analysis uses an interpolation of local and satellite SST's as well as SST's simulated by sea-ice cover.

The NOAA SST data product is available at a number different resolutions and temporal frequencies. For the purposes of this project the data set used represents a one degree by one

¹⁷ <http://nsidc.org/data/g02135>

¹⁸ <http://www.esrl.noaa.gov/psd/data/gridded/data.noaa.oisst.v2.html>



degree grid, packaged into a mean temperature for incremental one week periods. NOAA also publishes monthly and long-term mean data should longer frequencies be required for a particular analysis or assessment.

Temporal coverage currently available to the project includes 1982 to January 2016, at both weekly and monthly resolutions. The overall data quality is good, as the NOAA satellite equipment used in collecting the data has been shown to correlate well with direct observations.

3.4.2.2 OBSERVED TEMPERATURE DATA

Mean temperatures and temperature fluctuations are important to marine operations in cold environments. Both will determine the operational requirements for vessels and equipment for virtually all marine activities. Directly observed temperature and meteorological data is available as a historical record for a number of stations inside the study areas of interest. Historical data is published by the NOAA National Climatic Data Centre¹⁹. Data current to 2016 is available for each of the study's areas of interest:

Coronation Gulf:

- Bathurst Inlet (65.85 N, 108.017 W)
- Cambridge Bay (69.108 N, 105.138 W)
- Cape Parry (70.167 N, 124.7 W)
- Cape Peel West (69.03 N, 107.82 W)
- Croker River (69.27 N, 119.22 W)
- Holman (70.763 N, 117.805 W)
- Keats Point (69.666 N, 121.666 W)
- Kugluktuk (67.82 N, 115.12 W)
- Paulatuk (69.35 N, 124.066 W)
- Sachs Harbour (72 N, 125.266 W)

Western Hudson Bay:

- Arviat (61.094 N, -94.07 W)
- Baker Lake (64.316 N, 96 W)
- Chesterfield Inlet (63.333 N, 90.716 W)
- Rankin Inlet (62.811 N, 92.115 W)
- Whale Cove Inlet (62.233 N, 92.6 W)

Foxe Basin:

- Hall Beach (68.783 N, 81.233 W)
- Igloolik (69.366 N, 81.816 W)
- Longstaff Bluff (68.88 N, 75.13 W)
- Rowley Island (69.07 N, 79.07 W)

Lancaster Sound:

¹⁹ NOAA interactive map of weather sites and data:

<http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=temp&layers=1>

- Arctic Bay (73 N, 85.033 W)
- Pond Inlet (72.7 N, 77.95 W)

This data includes daily observations for precipitation (both rain and snow) as well as maximum and minimum observed air temperatures for each site, and additional historical data is available for a number of additional sites within the project boundary if required, both through NOAA and Environment Canada²⁰. As an example, the following figure shows ongoing temperature trends for Rankin Inlet:

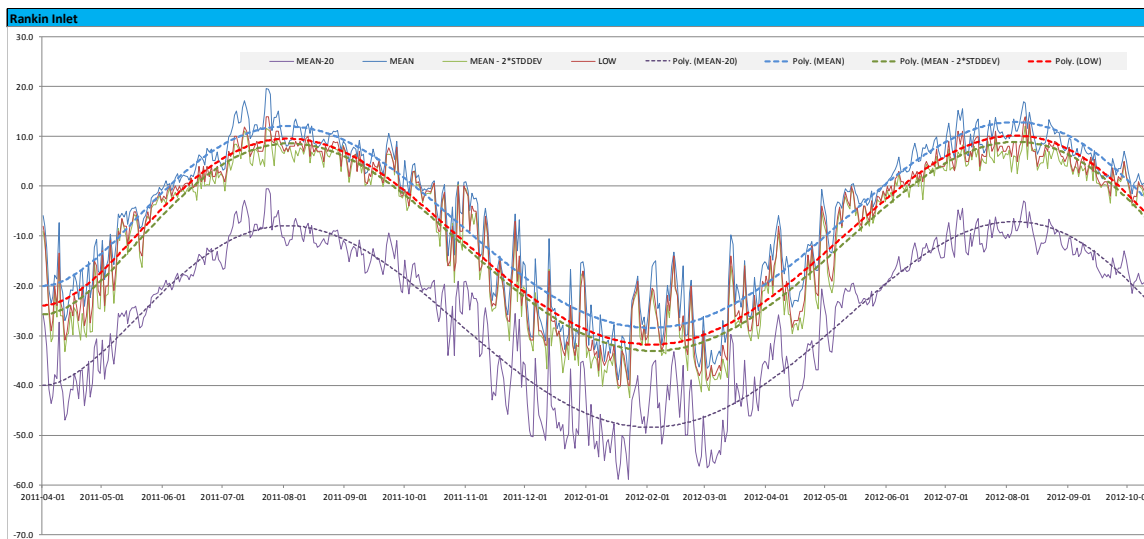


Figure 16: Observed air temperature at Rankin Inlet, April 2011 to December 2012

3.4.3 CURRENTS AND BATHYMETRY

3.4.3.1 CURRENTS

The flow and strength of currents is important to identifying how spills or operational discharges may be distributed in the marine environment.

Coronation Gulf: The region has a light current that runs west to east following the Western end of the Northwest Passage.

West Hudson Bay: The region has a light current that circulates counter-clockwise through the entirety of Hudson Bay.

Foxe Basin: There are moderate currents that flows from the Northernmost point of the Basin towards both the Southwest towards Hudson Bay, and also has light currents being fed by the Hudson Strait that circulate along the Eastern border of the basin.

²⁰https://weather.gc.ca/marine/weatherConditions-currentConditions_e.html?mapID=06&siteID=04201&stationID=WKW



Lancaster Sound: The region has a moderate current that flows along the North coast of Baffin Island towards the Atlantic Ocean.

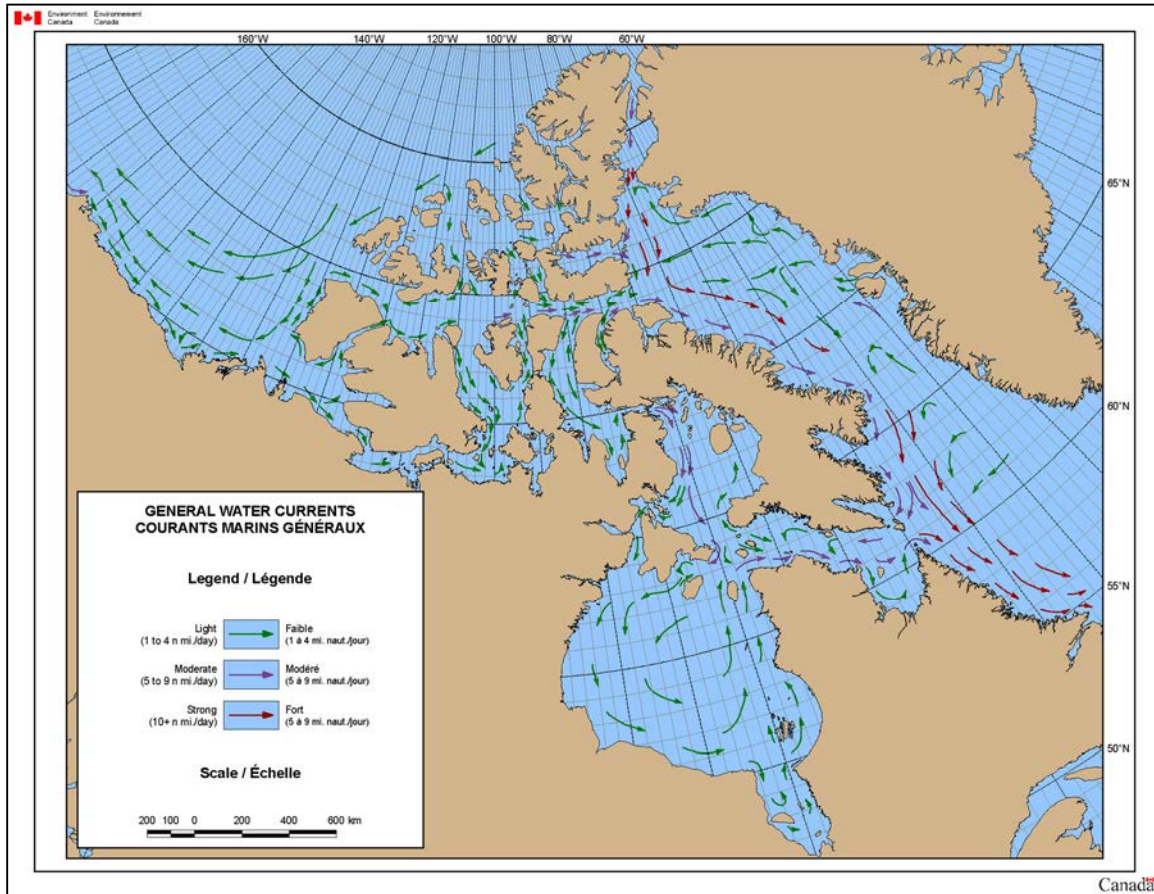


Figure 17: Currents throughout the Canadian Arctic²¹

3.4.3.2 TIDAL RANGES

Tidal ranges and speeds are important factors for sealift and resupply operations, as well as a variety of other marine activities. Tidal ranges for regions throughout the study's areas of interest are available from monitoring stations throughout the Canadian Arctic²². Most of the locations listed in Section 3.4.2.2 also have regular tidal data available. The following figure is an example of a current tide chart for Cambridge Bay:

²¹ <https://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=CD796E4C-1>

²² <http://tides.mobilegeographics.com/index.html>

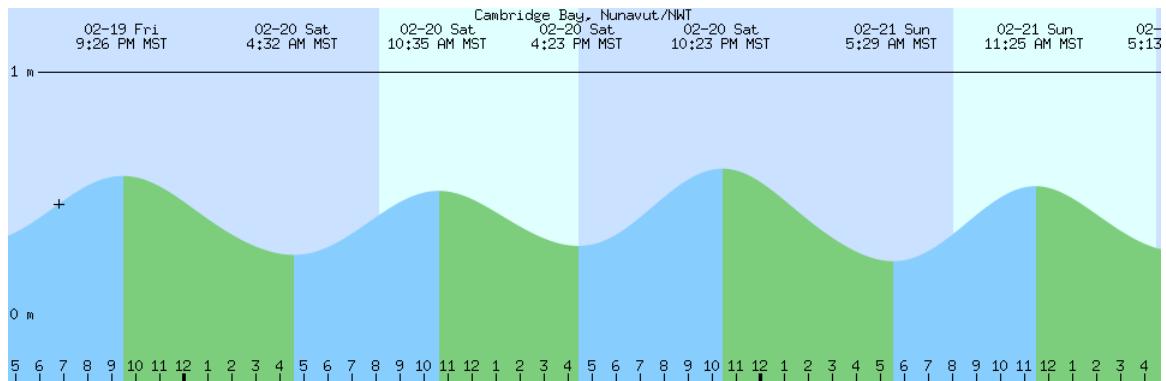


Figure 18: Tidal Ranges for Cambridge Bay, February 2016

3.4.3.3 BATHYMETRY DATA

Bathymetric data has been obtained from General Bathymetric Chart of the Oceans (GEBCO) published through the British Oceanographic Data Centre²³. Published in 2008, the data is available as a 30 arc-second grid of global elevations, providing a continuous elevation model for both ocean and land. The basis for the data set is a combination of ship soundings and interpolation between sounding points from satellite instrument gravity data.

This data set gives a general picture of bathymetry, but is not at a sufficiently high resolution to provide an accurate assessment of the risks of operating vessels near the coastline, or in channels and passages with restricted depths. For this, the amount of open source data available is very limited. The paper and electronic charts available for purchase are more detailed, but in many areas are also limited in terms of coverage and accuracy. Poor bathymetric data is a risk factor that is discussed in more detail in Section 4.

²³ https://www.bodc.ac.uk/data/online_delivery/gebco/gebco_08_grid/



3.5 ECOLOGICAL DATA

The Canadian Arctic is a unique ecosystem, comprising of a considerable diversity of species that live, breed, or migrate in the area. It includes important migration channels, feeding areas, haul-out sites, polynya, breeding colonies for different anadromous and migratory species.

The sea ice supports seals upon which the polar bear depend. Millions of geese and shorebirds feed and/or breed in the coastal saltmarshes, productive eelgrass beds provide food for multitudes of waterfowl on their way to and from breeding habitat in the Arctic Islands, and the rivers' estuaries provide vital habitat for anadromous fish and beluga whales.

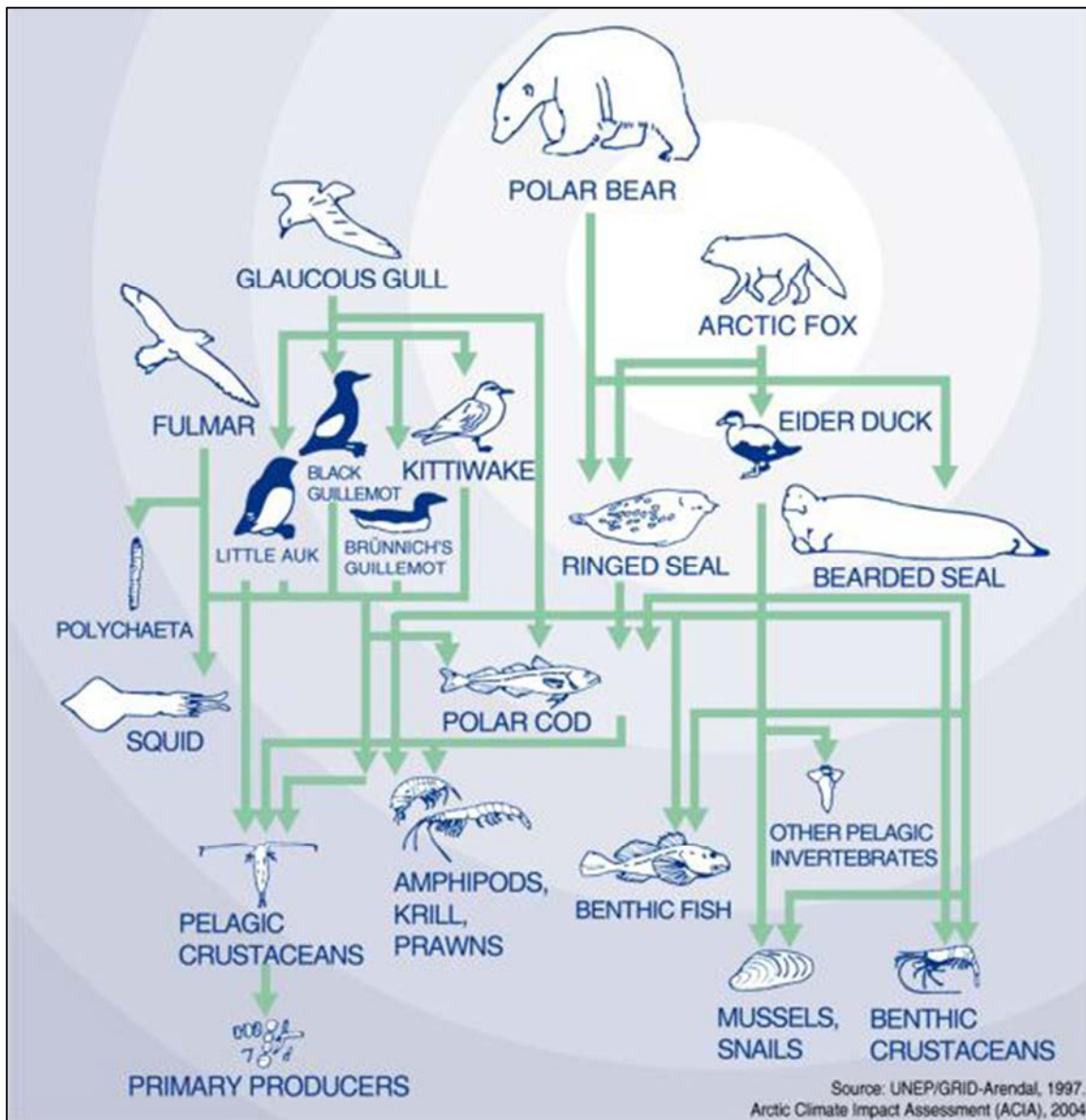


Figure 19. The Arctic food web.



Numerous sources of information are available for the spatial-temporal distribution of biodiversity in the Canadian Arctic. They are published in peer-review journals, as governmental reports, reports on Traditional Ecological Knowledge (TEK), or as internal report done by consultants for the industry (i.e., Nuami Stantec). Marine mammal, birds, fish and invertebrate experts working in the Canadian Arctic have been contacted to validate this list and ensure it covers the most pertinent and updated data for the four focal areas identified for this project:

1. Western Hudson Bay;
2. Northern Foxe Basin;
3. Lancaster Sound; and
4. Coronation Gulf.

Appendix 2 lists some of the most important ecological data sources to be considered in creating the inventory.

The species assumed more likely to be impacted by marine traffic are marine mammals, seabirds, and commercially important fishes, crustaceans, and benthic invertebrates. The four main species and categories identified by the Nunavut government as critically important for the communities are:

1. Caribou;
2. Polar Bear;
3. Walrus; and
4. Seabirds.

Each of these is discussed in sub-sections of the report below, and in a set of appendices which provide more detail. Additional information is provided for other key components of the Arctic ecosystems.

3.5.1 CARIBOU

Caribou are circumpolar in their distribution and occur all over the Arctic. In Canada, caribou are represented by 4 subspecies; Peary, Woodland, Grant's and Barren-ground (Figure 12). The latter is the most abundant in Nunavut. Barren-ground caribou generally occupy the tundra from the Yukon to Baffin Island (Jenkins 2011).

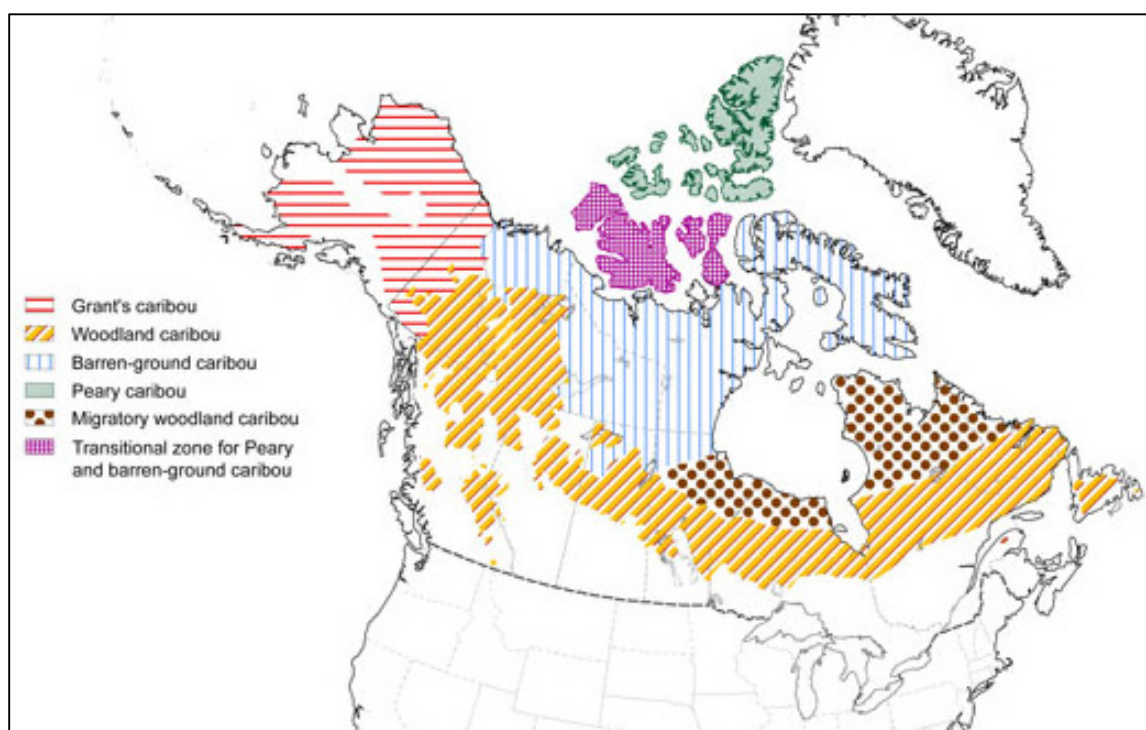


Figure 20. Distribution of the different subspecies of caribou in Arctic Canada. Source: Canadian Wildlife Federation (2016).

3.5.1.1 SPATIAL DISTRIBUTION

The Western Hudson Bay and Foxe Basin are important migratory areas for the woodland and barren-ground subspecies of caribou. In both areas, populations are declining, as it is also the case for the Lancaster Sound (barren-ground caribou). In the Coronation Gulf, caribou populations are mostly located on the south shore of the Gulf and migration occurs across the Gulf, towards north. The latest trends estimates suggest that they are either declining or stable at low abundance.

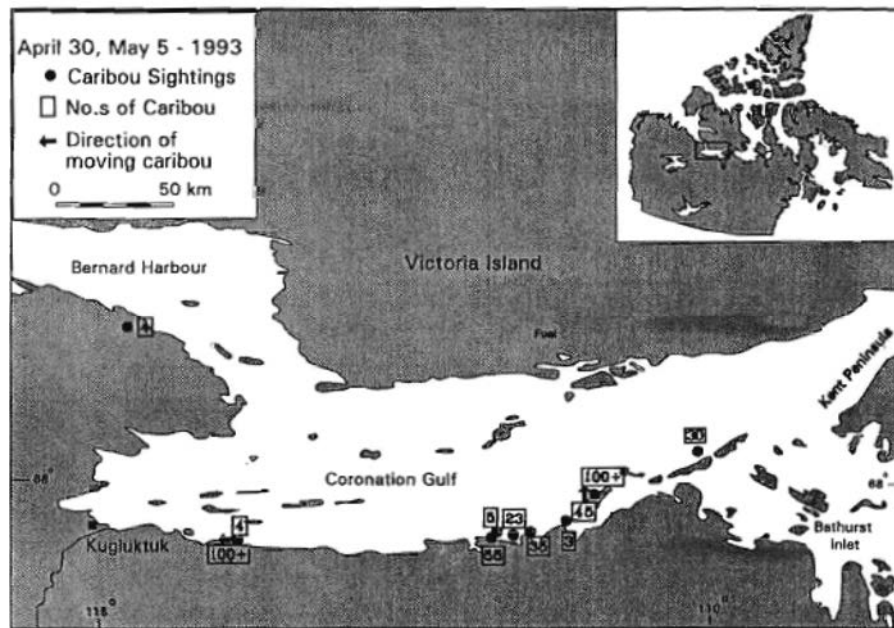


Figure 21: Observations of caribou on sea ice and direction of travel, Bernard Harbour, Coronation Gulf. From Gunn et al. 1997

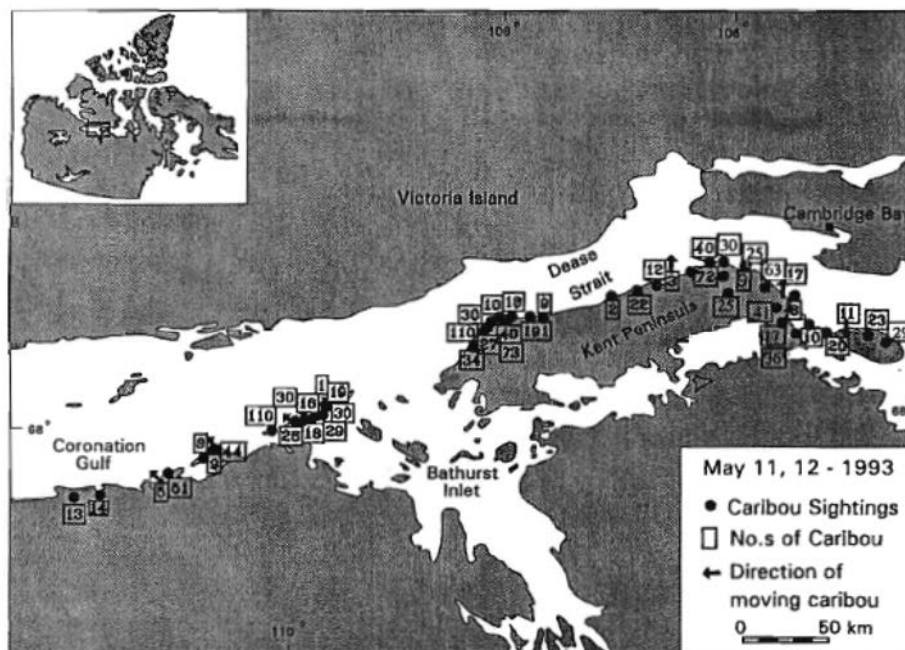


Figure 22: Observations Location and direction of caribou trails on sea ice, Coronation Gulf and Dease Strait. From Gunn et al. (1997)



Figure 23: Observations Ranges and recent trends of northern caribou populations in Canada. Source: Gunn et al. 2011

3.5.1.2 MIGRATIONS

Western Hudson Bay, the Northern Foxe Basin and to a lesser extent Lancaster Sound are known areas for caribou populations, however the Coronation Gulf area is one of the most important for migrations. In this area, caribou are known to cross the Gulf at different area from the mainland to Victoria Island.

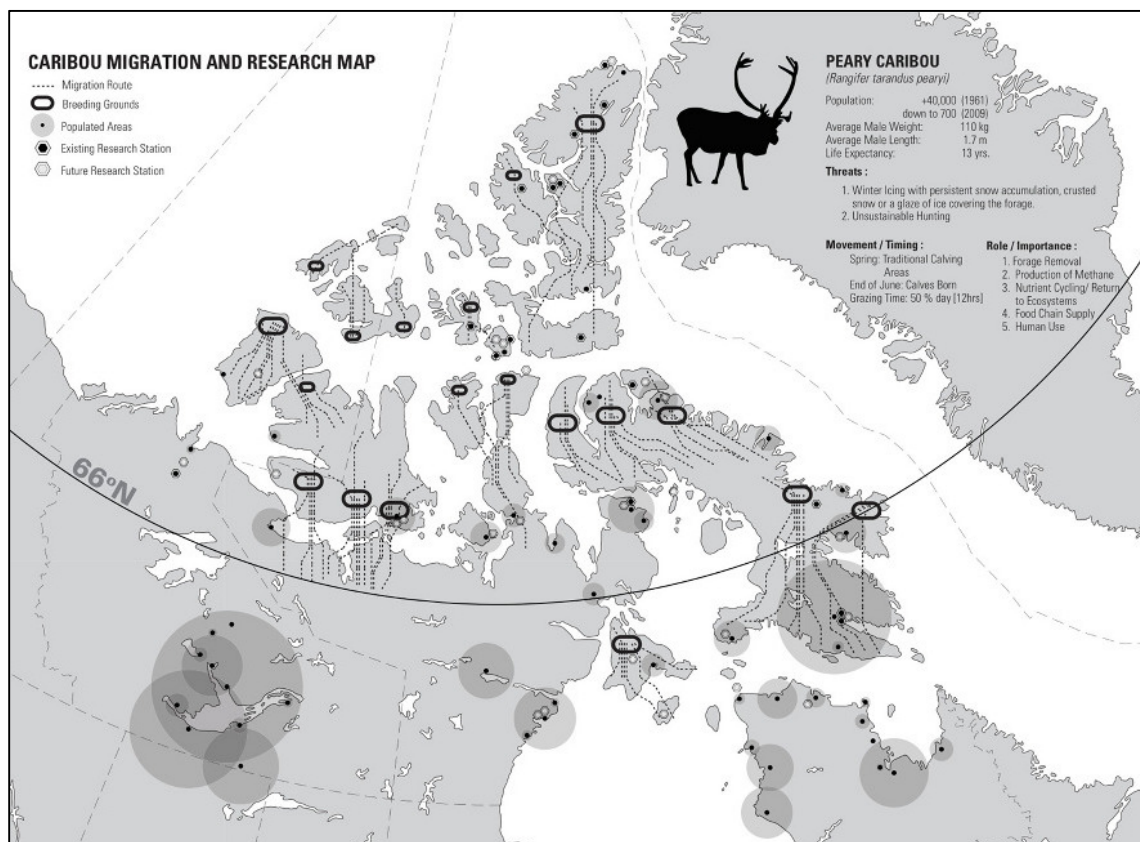


Figure 24: Observations Caribou migration map in the Nunavut area. Source: The Caribou Pivot Station project (2016)



3.5.2 POLAR BEAR

Polar bears are an iconic species in the Arctic, and have considerable economic and cultural importance to local communities. As such, there is extensive research into many aspects of their behavior, some examples of which are provided below and in more detail at Appendix 2B.

3.5.2.1 SPATIAL DISTRIBUTION

Polar bear are abundant all over Arctic Canada. In the four study areas, their populations are generally stable (Figure 25, Figure 26).

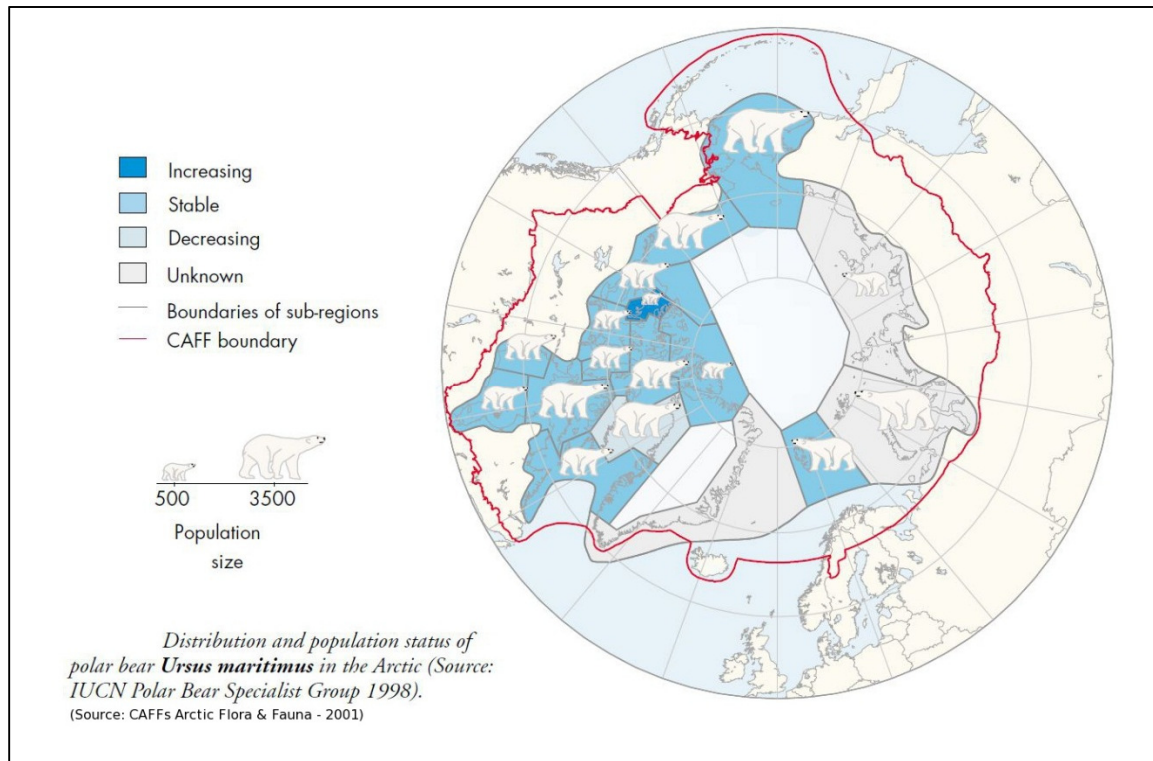


Figure 25. Distribution and population status of polar bear in the Arctic. Source: CAAF (2001).

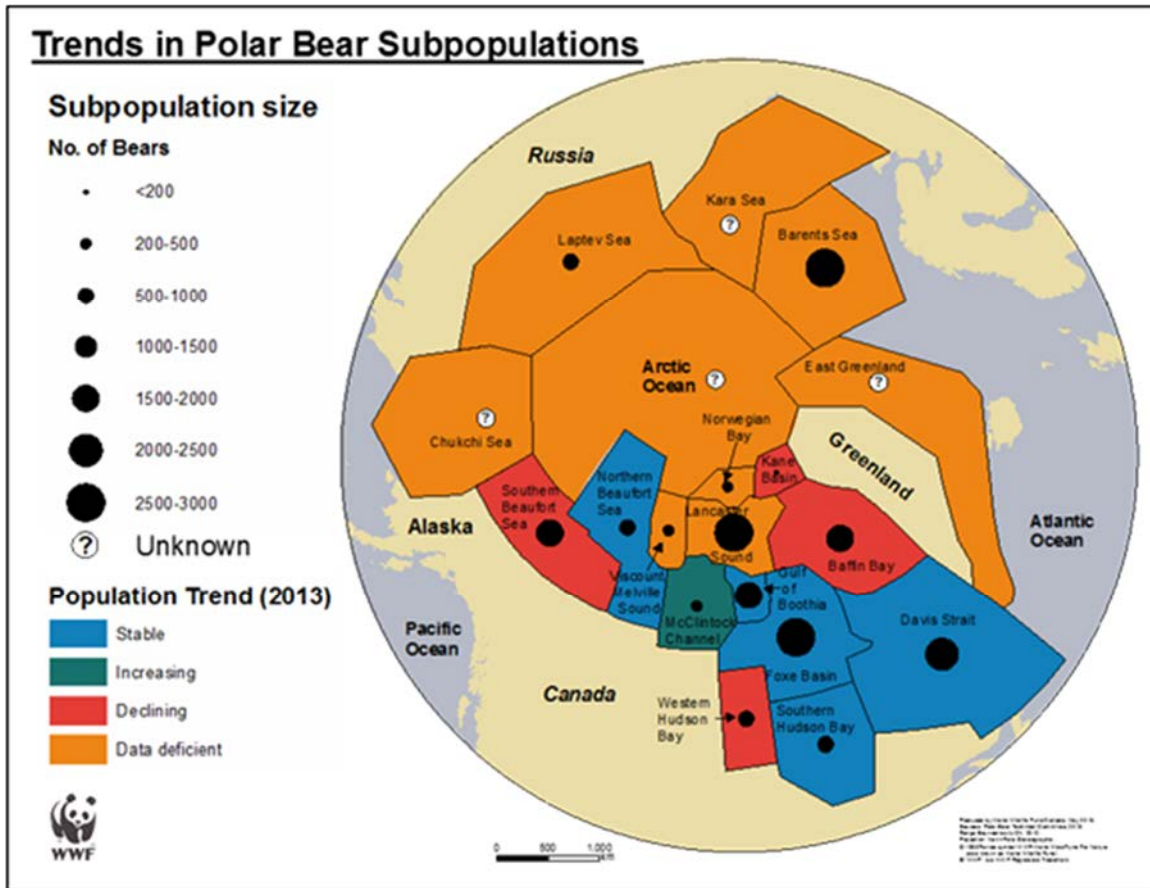


Figure 26. Polar bear distribution & subpopulations.

http://awsassets.wwf.ca/downloads/polar_bear_subpopulations_size_trend_2013_landscape_november_2013.pdf

At the more local level, Figure 27 provides an example of a collection of sightings in Foxe Basin.

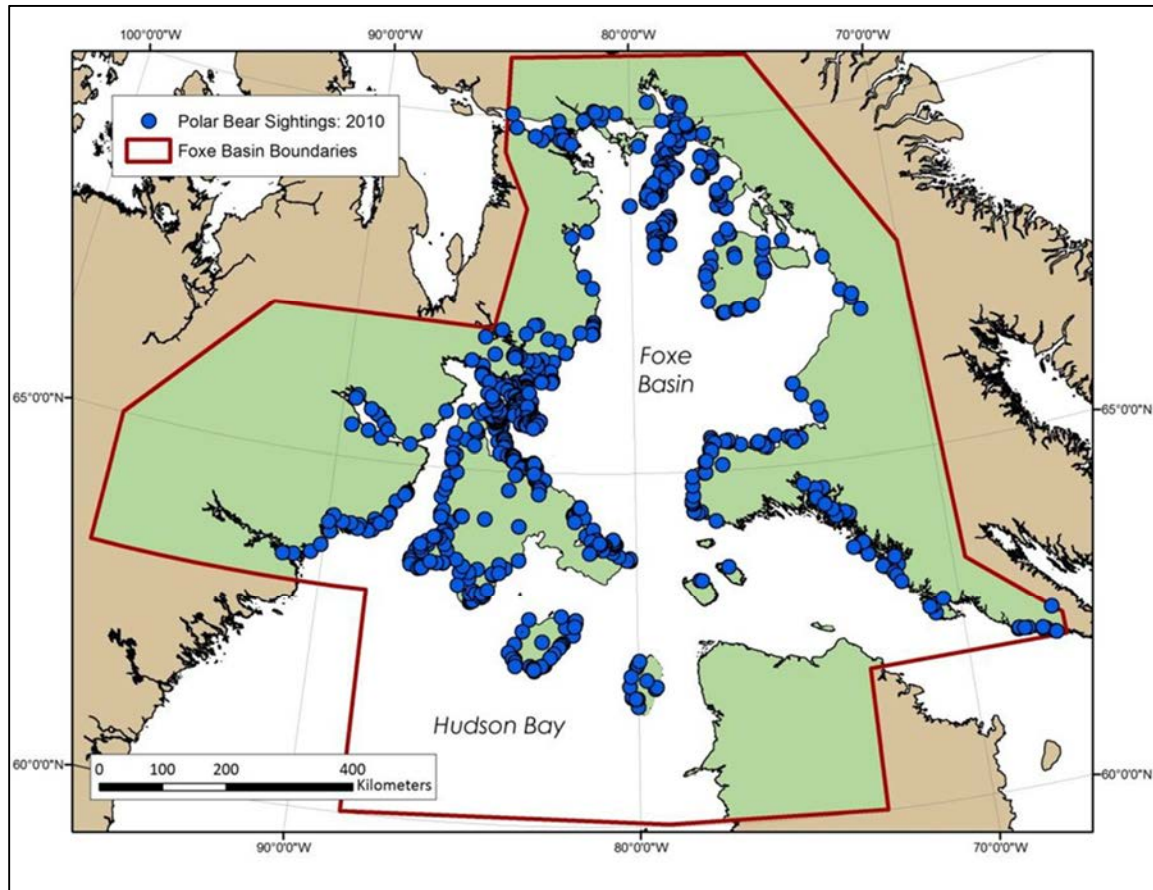


Figure 27. Polar bear sightings in the 2010 survey of the government of Nunavut.

3.5.2.2 MIGRATIONS

Data from satellite telemetry of tagged polar bears have shown that polar bears do not wander aimlessly, but rather their movement and distribution are determined by the way they use the sea ice habitat as a platform between feeding, mating, denning, and in some populations, summer retreat areas. They tend to move on drifting ice to remain in productive habitats (e.g., over the productive continental shelf; Durner *et al.* 2009), which often implies moving against the direction of drift of the sea ice to remain in the same general location (Vongraven and Peacock 2011).

An overview of polar bear migration patterns is provided in Figure 28, and a more local picture for one of the areas of interest is in Figure 29. Additional resources are illustrated and referenced in Appendix 2B.

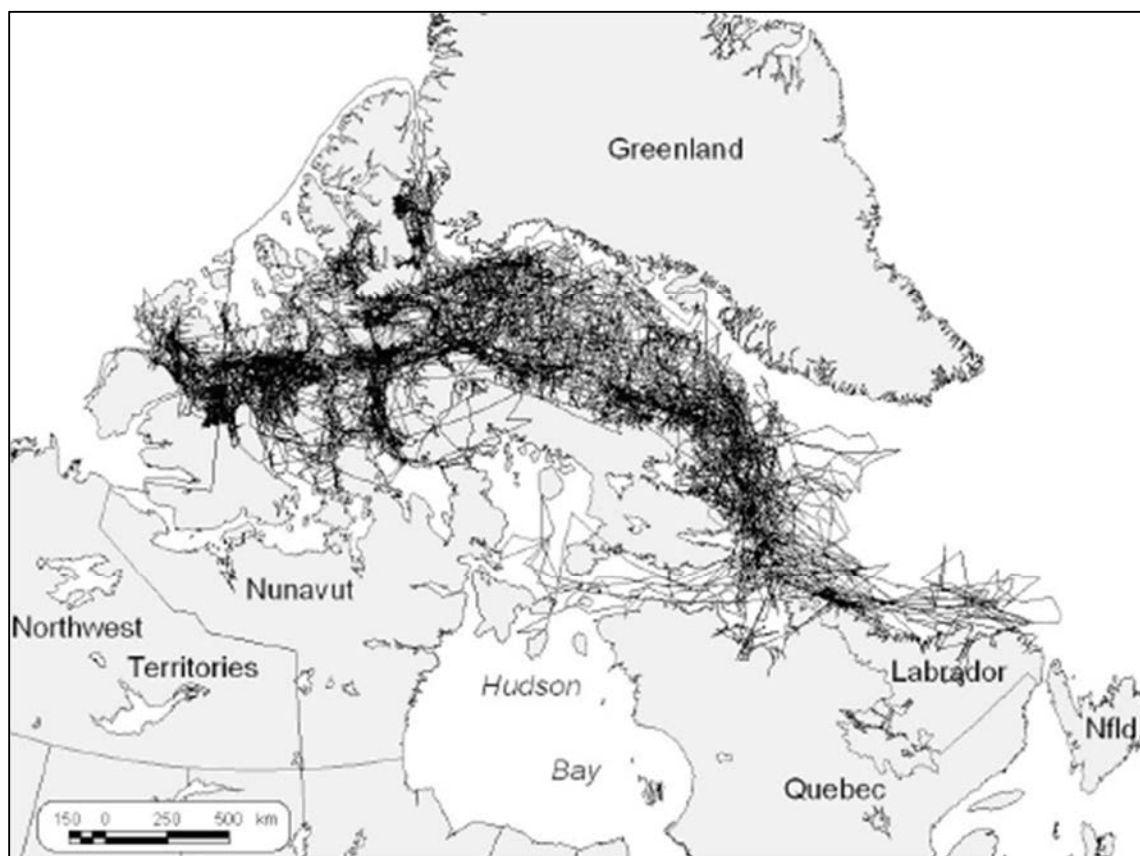


Figure 28 Movements of adult female polar bears. Source: Taylor *et al.* (2001).

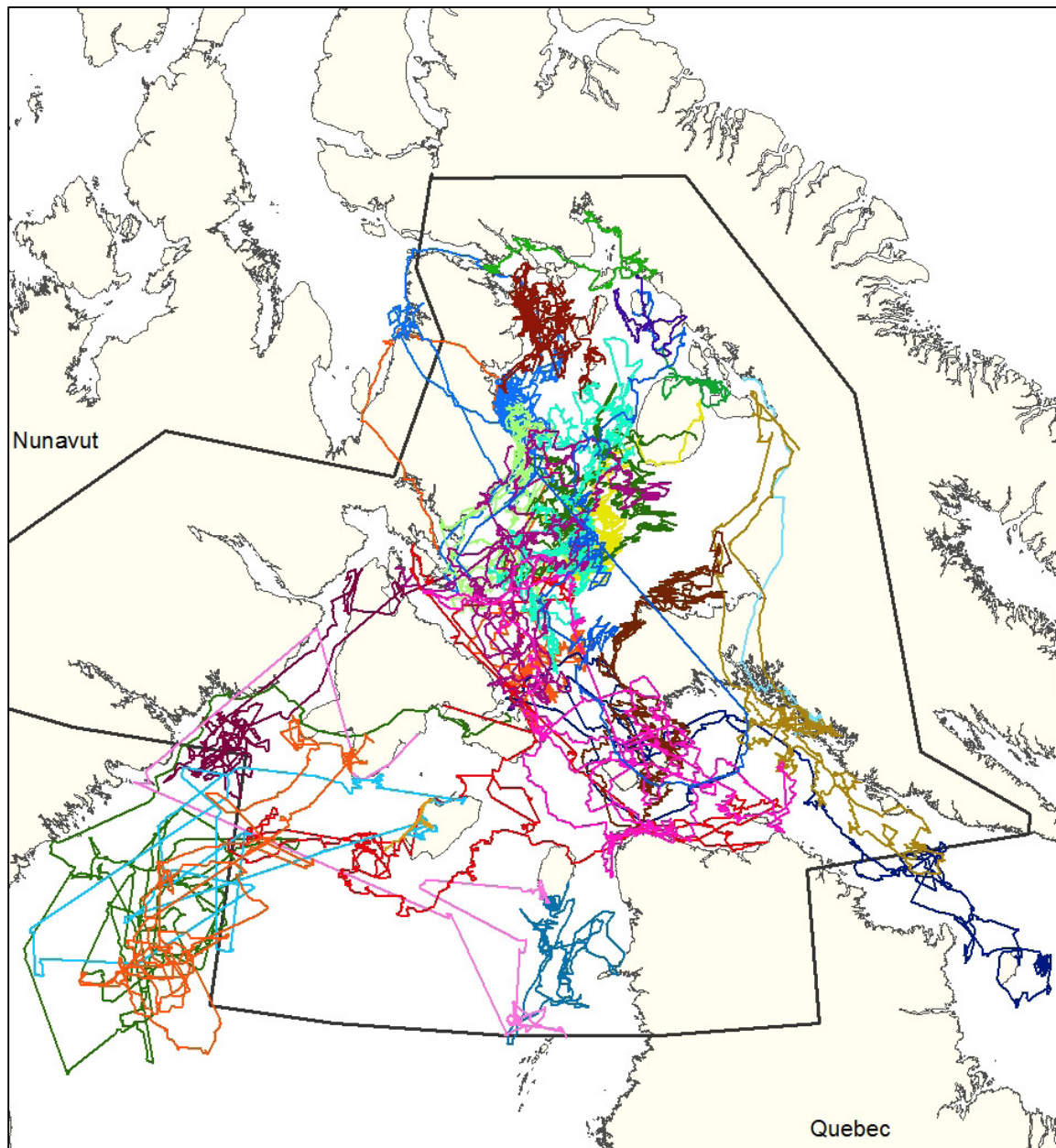


Figure 29. Annual movements of satellite collared female polar bears, Foxe Basin 2009-2010. Source: Sahanatien and Derocher (2010).



3.5.3 WALRUS

3.5.3.1 SPATIAL DISTRIBUTION

The Rowley Island area of the northern Foxe Basin is a preferred year-round walrus habitat providing haul-out sites, calving areas, and feeding grounds for this species. There is also an important haul-out site for walruses in the Lancaster Sound (Skjoldal *et al.* 2013).

In the Foxe Basin and Western Hudson Bay, there are important areas of occurrence for the species (Ghazal 2014). Inuit knowledge also identifies the Foxe Basin as well as the western Hudson Bay as important areas for walruses (Figure 30; Kowalchuk and Kuhn 2012). In Lancaster Sound, the same study identified the area as significant walrus haul-out (Figure 30 & Figure 32).

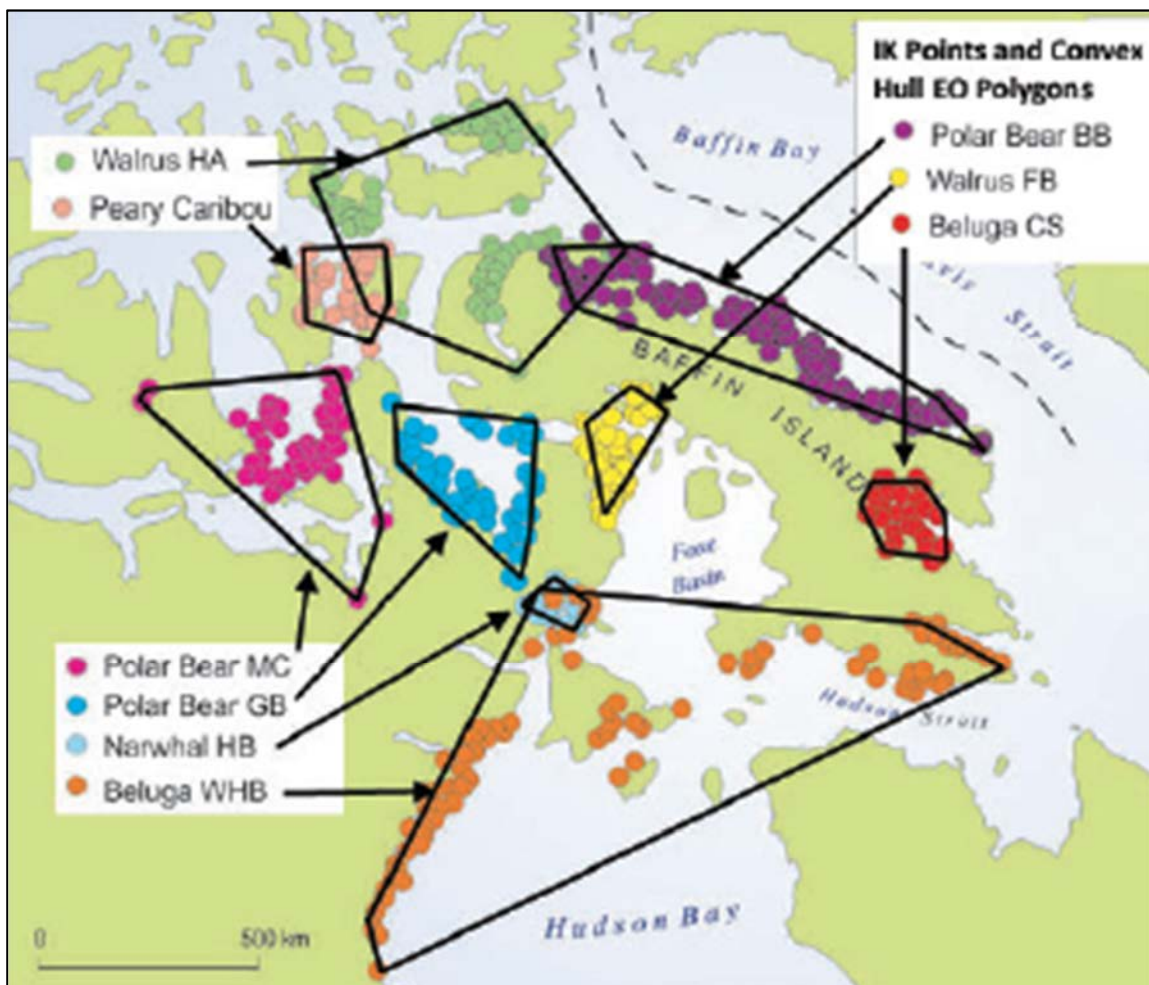


Figure 30. Inuit knowledge (IK) on the distribution of different mammal species in Nunavut. Source: Kowalchuk and Kuhn (2012)



Similar interviews in different coastal villages of the Northern Foxe Basin also shows that this is a major area of occupation for walrus (Figure 31).

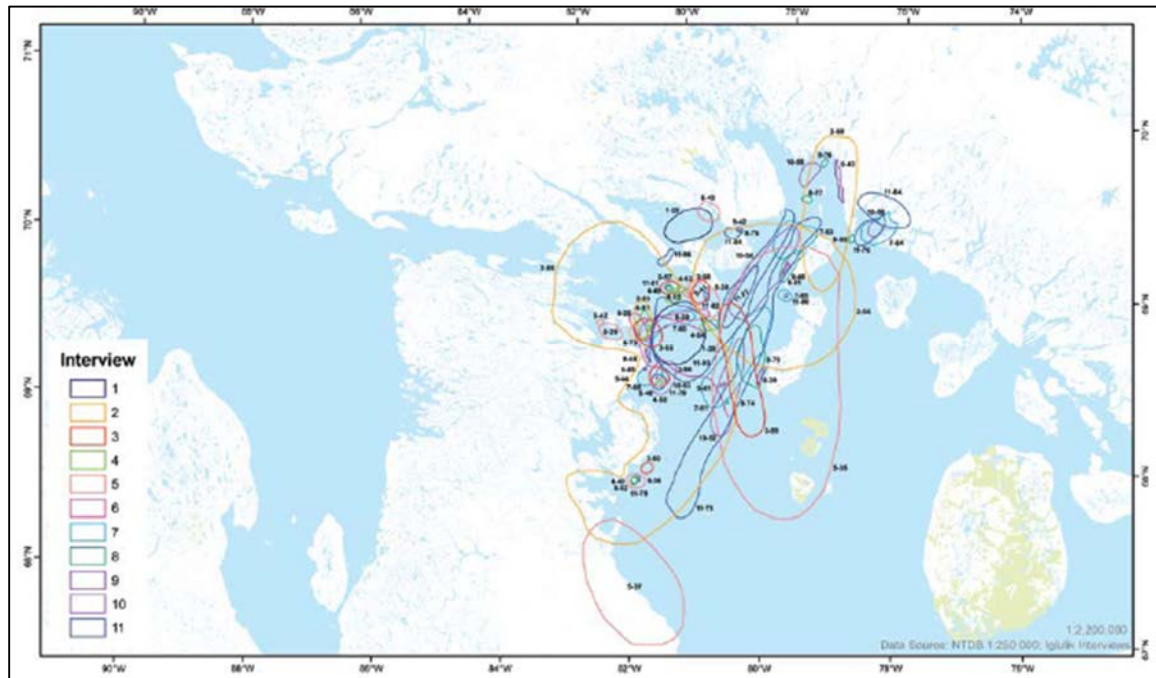


Figure 31. Walrus – Areas of Occupation. TEK from the interviews of the Iglulik Pilot Project (Source: NCRI 2008).

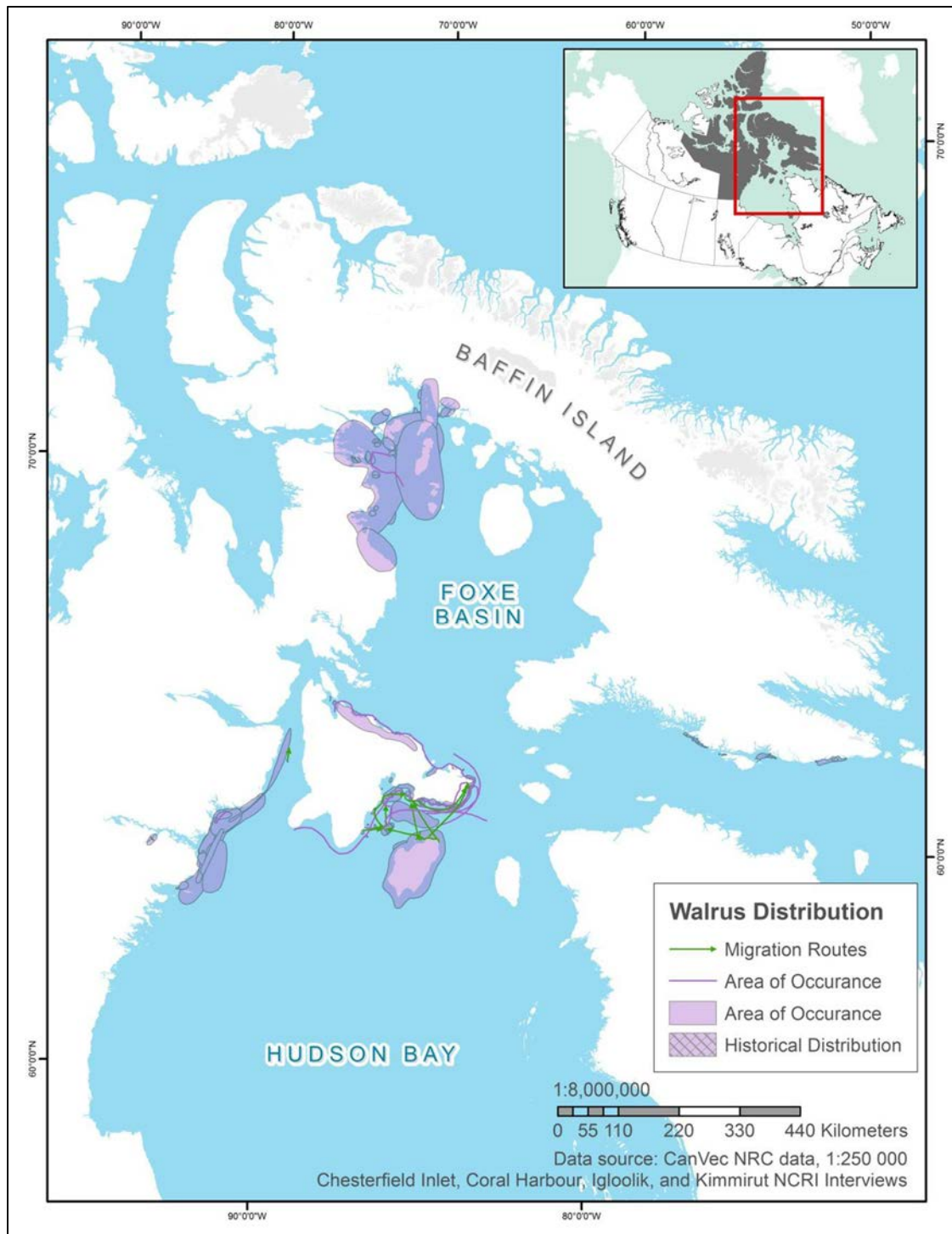


Figure 32. Walrus distribution in the Western Hudson Bay and Foxe Basin. From Ghazal (2014).

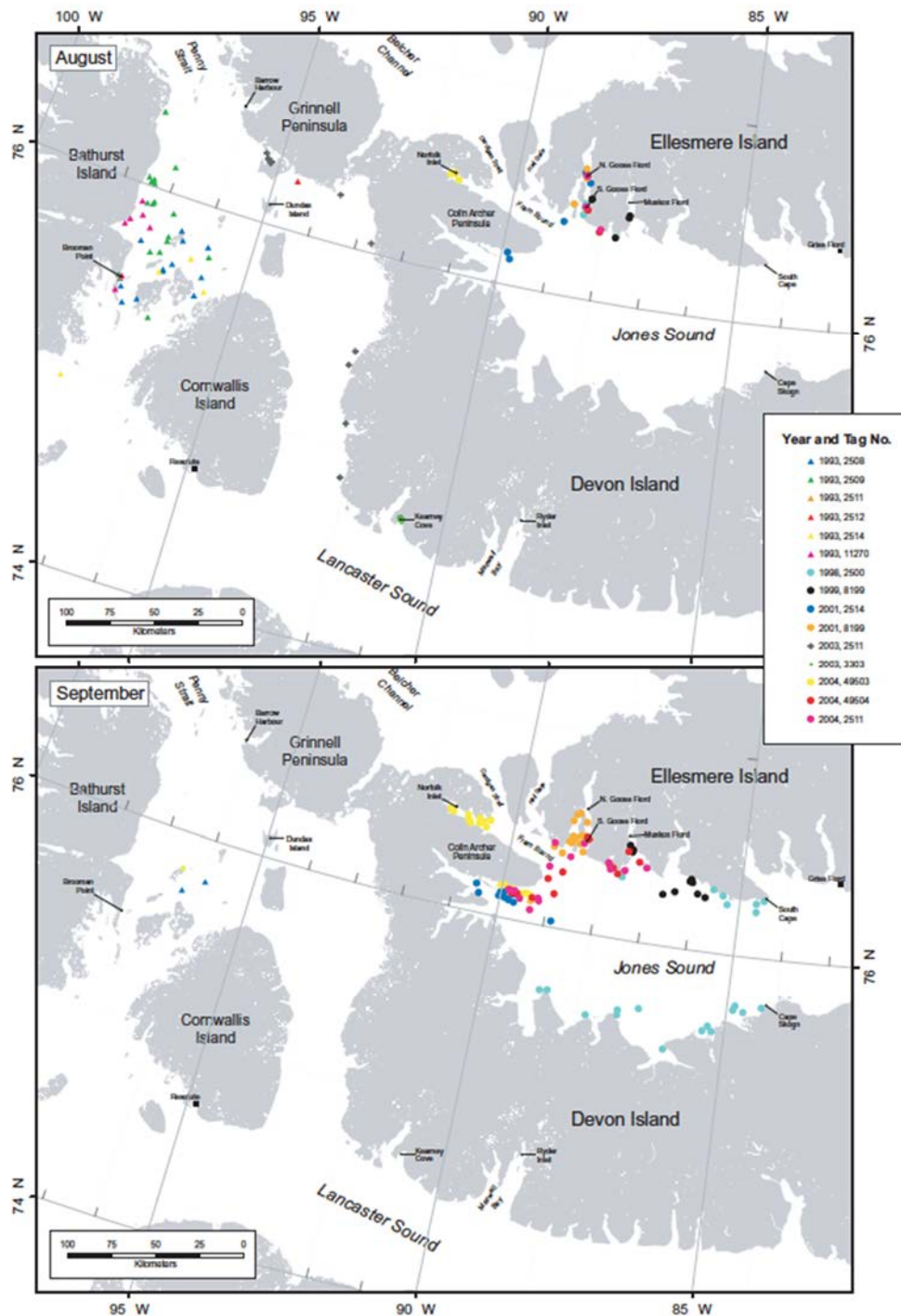


Figure 33. Satellite tags on walrus in Lancaster Sound in August and September 1993 and 1998 – 2004. Source Stewart (2008)).



3.5.3.2 MIGRATIONS

There is very little data on walrus migration patterns in any of the areas covered by the study. Based on data from Alaska, walrus appear to stay in the same general areas of occupation throughout the year, but this requires further study to confirm.

3.5.4 SEABIRDS

Seabirds play an important role in the Arctic ecosystem, as well as in local culture in Arctic communities.

3.5.4.1 SPATIAL DISTRIBUTION

Over one million seabirds and seaducks (e.g., thick-billed murre, black-legged kittiwake, northern fulmar, and black guillemot) use the Lancaster Sound area as a nesting, breeding, and feeding area (Skjoldal *et al.* 2013). In the Coronation Gulf, seabird colonies are found on small islands near the mouth of the Bathurst inlet where they feed (Skjoldal *et al.* 2013).

A high proportion of the global population of Ivory Gulls (*Pagophila eburnea*) winters in the Canadian Arctic, especially in the Lancaster Sound area, but a lower proportion breeds there. (Environment Canada, 2014). In Canada, the species breeds exclusively in Nunavut, where there is permanent drift ice and open water. The Ivory Gull is protected under the federal Species at Risk Act (SARA). The main threats the species is facing are illegal hunting of adults, industrial activities, natural predation, and most significantly changes in sea ice cover and extent. (Government of Canada 2016. Species at Risk Public Registry).

In the northern Foxe Basin, several areas have been identified during interviews as areas of high abundance for seabirds, an example of which is provided in Figure 35 from NCRI. Similar information is available for many other seabird species and areas, and further examples are included in Appendix 2B.

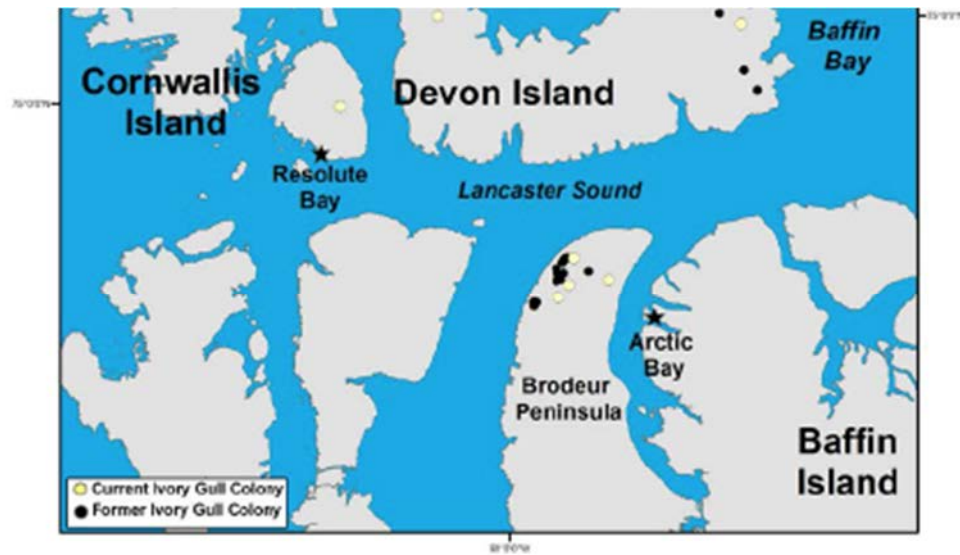


Figure 34. Nesting colonies of Ivory Gulls. Current colonies used at least once since 2002, former colonies last used before 2002. Adapted from Environment Canada (2014).

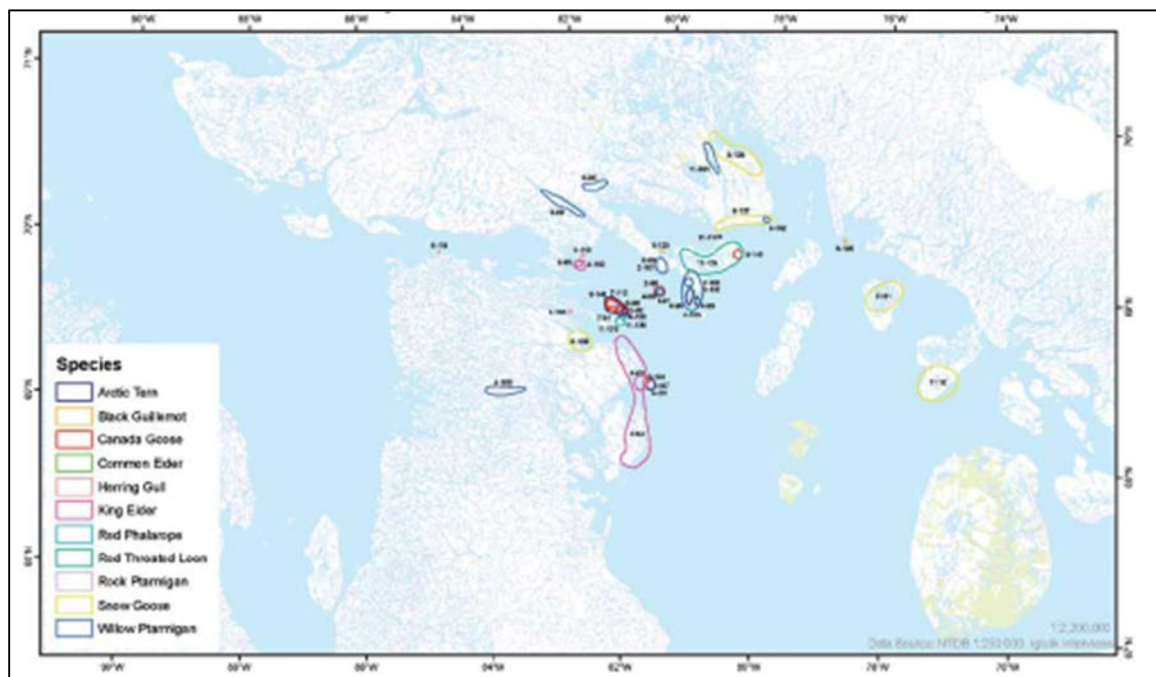


Figure 35 Birds - Areas of high abundance. Source: NCRI (2008).

3.5.4.2 MIGRATIONS

The Chantrey Inlet of the Coronation Gulf is also a key habitat for seabirds during their migration (Skjoldal *et al.* 2013).

Different areas of the Canadian Arctic are also important areas for different species of birds that are migrating to south during winter (Figure 36 & Figure 37).

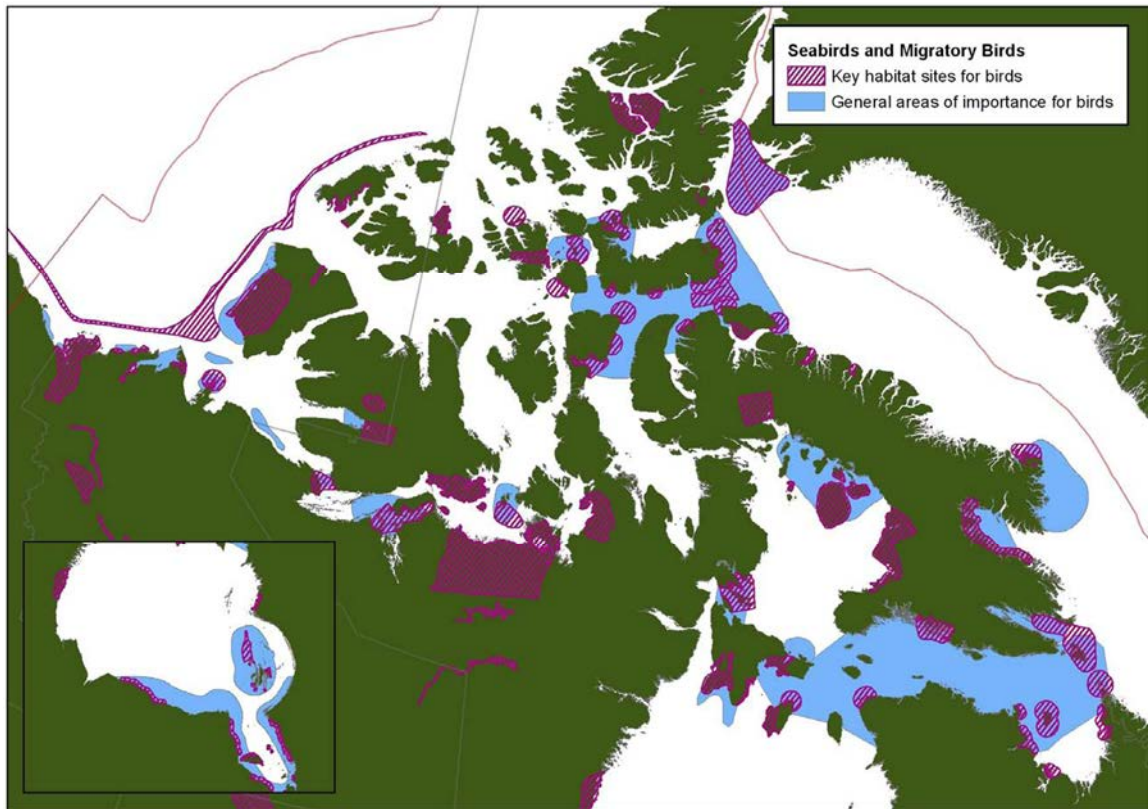


Figure 36. Seabird and migratory bird distribution in the Canadian Arctic. Source: Stephenson and Hartwig 2014

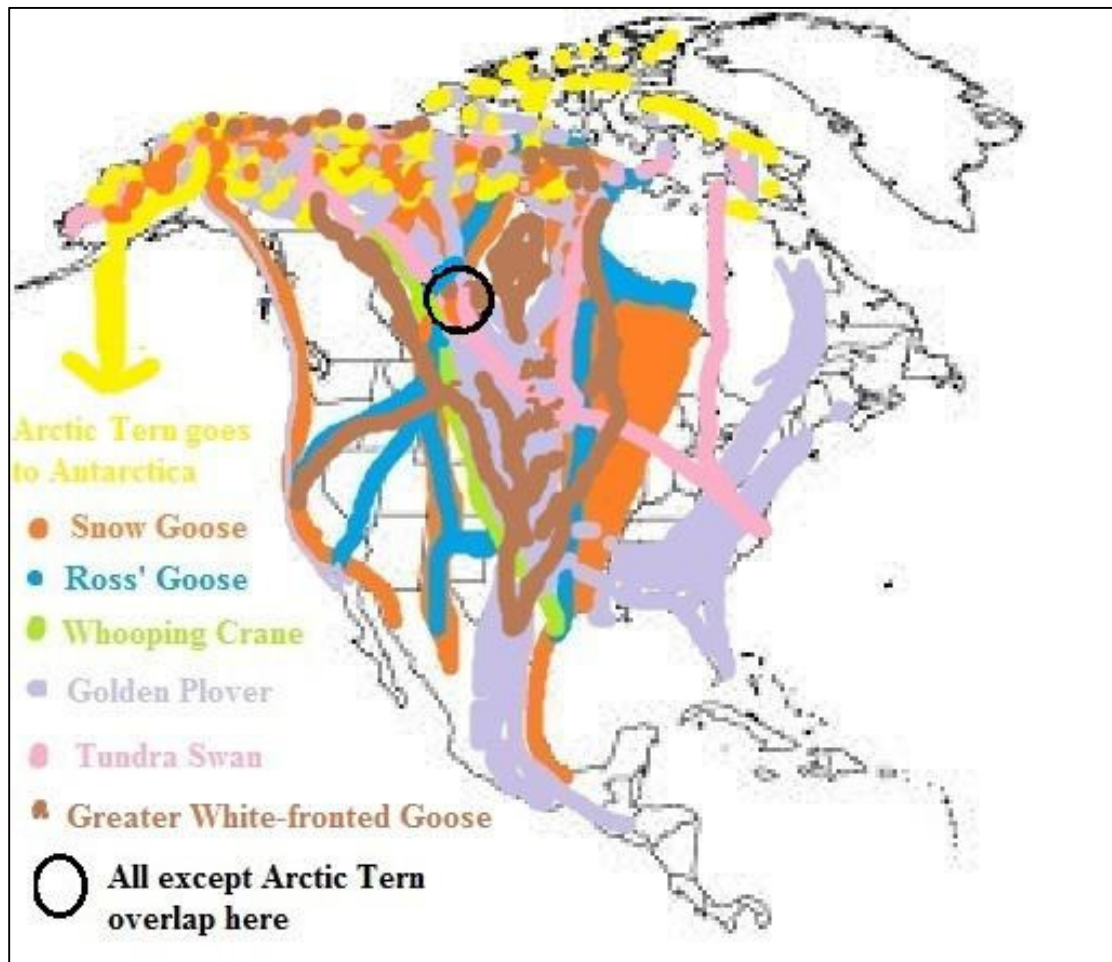


Figure 37. Migration routes for different bird species of the Canadian Arctic. Source: Travel Gumbo (2016).



3.5.5 OTHER MARINE MAMMALS

The Nunavut Coastal Resource Inventory identified the areas of high abundance for marine mammals as abundant in the northern Foxe Basin for different species (NCRI 2008; Figure 38). The main species of whales found in the study areas include bowhead, beluga, narwhal and killer whales.

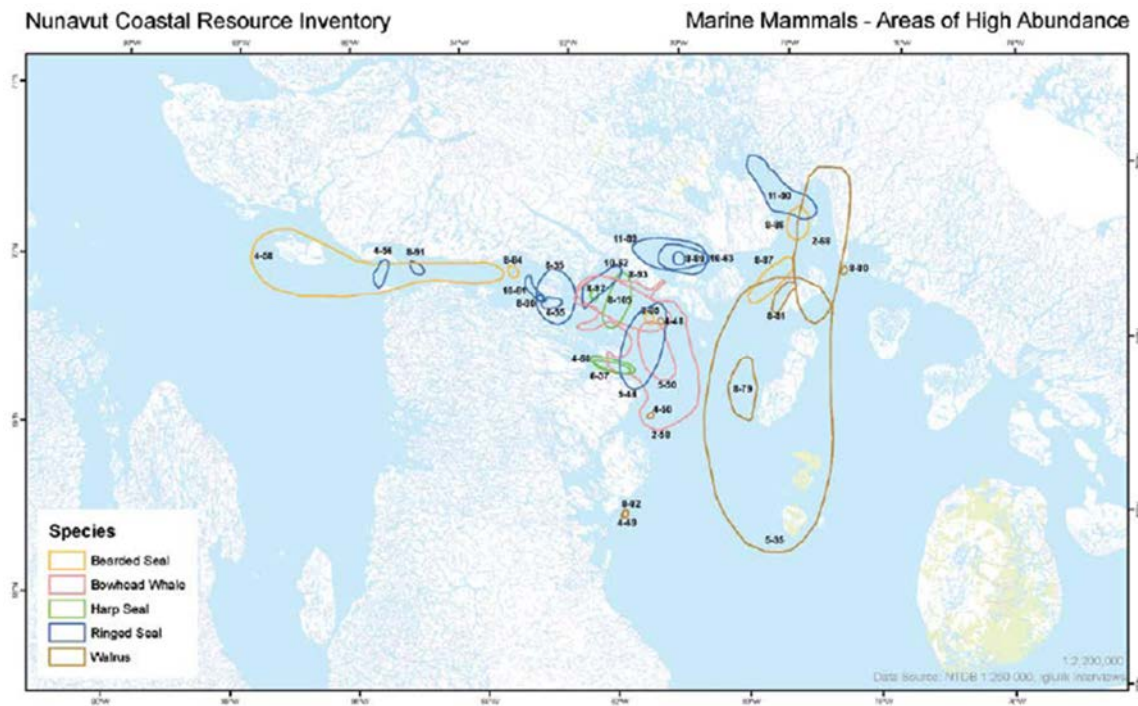


Figure 38. Marine mammal areas of high abundance from the Nunavut Coastal Resource Inventory (Government of Nunavut, 2008)

3.5.5.1 SEALS

A series of interviews of coastal communities for the Nunavut Coastal Resource Inventory (NCRI) Iglulik Pilot Project (NCRI 2008) indicates that the northern Foxe Basin is an important occupation area for different species of seals, for example ringed seals as shown in Figure 39.

In the Coronation Gulf, with depths of 100–200 m, and with the influence of the Burnside River, Bathurst Inlet is an important summer habitat for ringed seal, so is the Chantrey Inlet area. There is also a summer habitat in the Queen Maud Gulf, ringed seals are common throughout the year (Skjoldal *et al.* 2013).

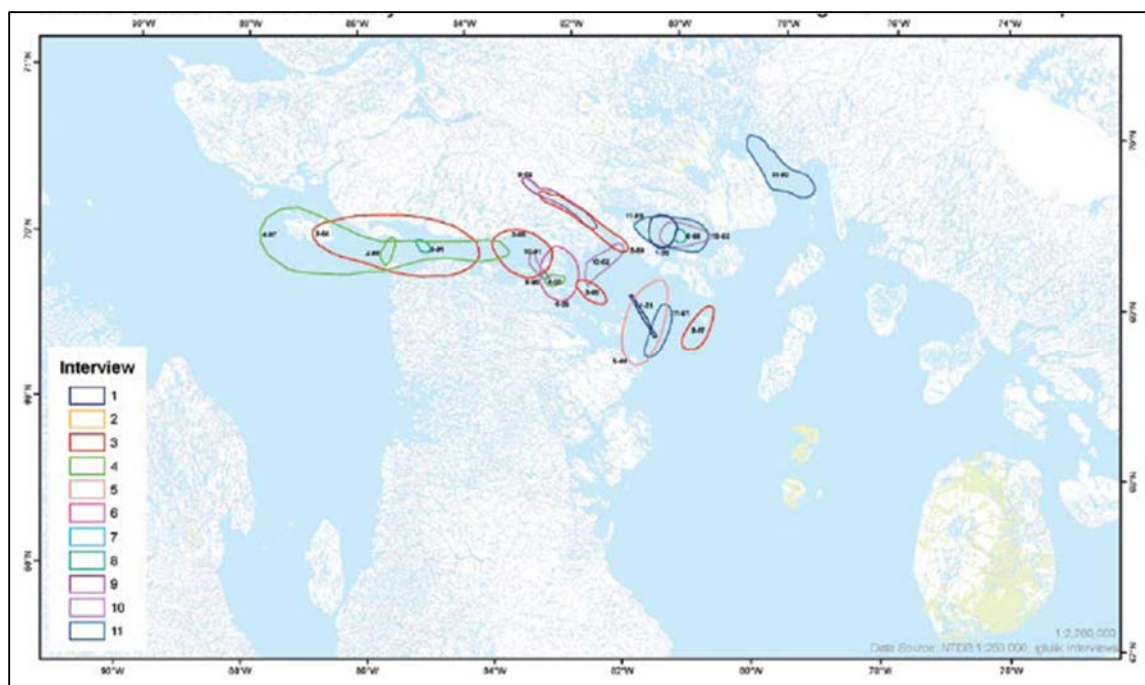


Figure 39. Ringed seal - Areas of occupation. Source: NCRI 2008



3.5.5.2 BOWHEAD WHALES

The northern Foxe Basin, especially in the Fury and Hecla Strait area features a large proportion of bowhead juveniles and calves, suggesting it is an important nursery area. TEK also indicates that the northern Foxe Basin is an important area for bowhead whales (Figure 40).

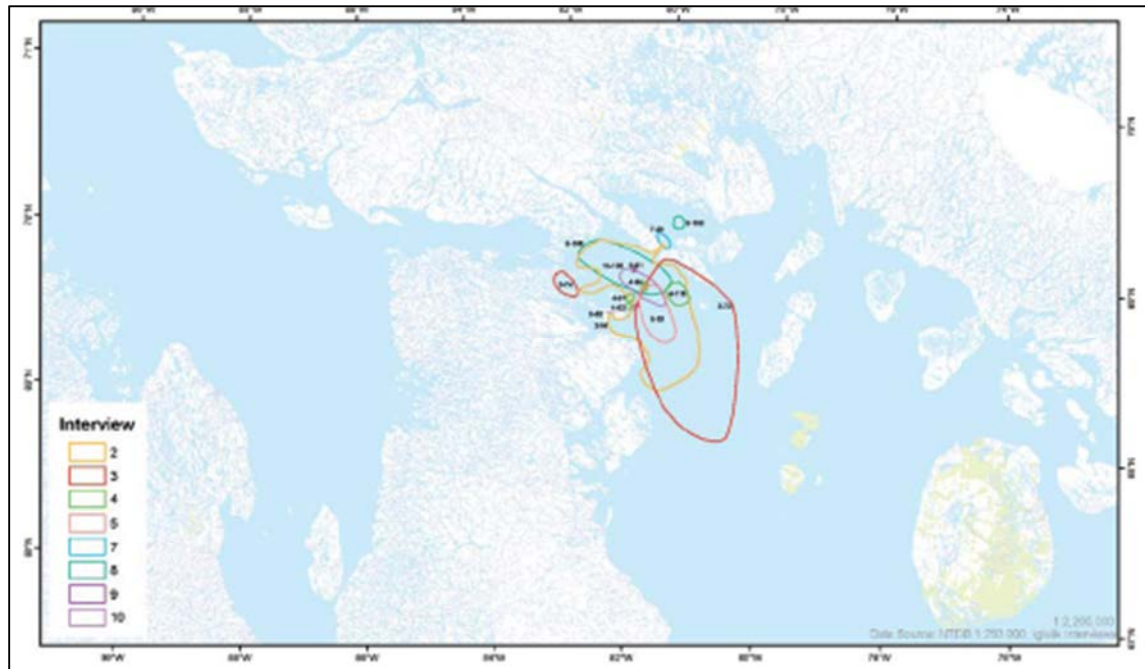


Figure 40. Bowhead whale – Areas of occupation. Source: NCRI (2008).

3.5.5.3 BELUGA

Belugas spend the summer in coastal and offshore areas. Their distribution is centred on certain river estuaries, which they visit shortly after ice break-up and where they moult (COSEWIC 2004). They frequent these areas occasionally throughout the summer months. In the autumn they begin migrating to other locations, including certain deep-water areas, where they may feed intensively (COSEWIC 2004). The four areas covered by this report represent important areas for different beluga populations. Western Hudson bay, Northern Foxe Basin and the western part of Coronation Gulf represent areas of extent for the “Western Hudson Bay”, “Cumberland Sound” and “Eastern Beaufort Sea” population, respectively, while the Northern Foxe Basin is also summer core area for the “Cumberland Sound” population (COSEWIC 2004).

The western Hudson Bay coastline is an important aggregation area for beluga. TEK based on interviews in the northern Foxe Basin indicate that the whole area is important for beluga occupation and migration. Beluga populations are found in the western Hudson Bay, northern Foxe Basin and Lancaster Sound at different times of the year (Figure 41).

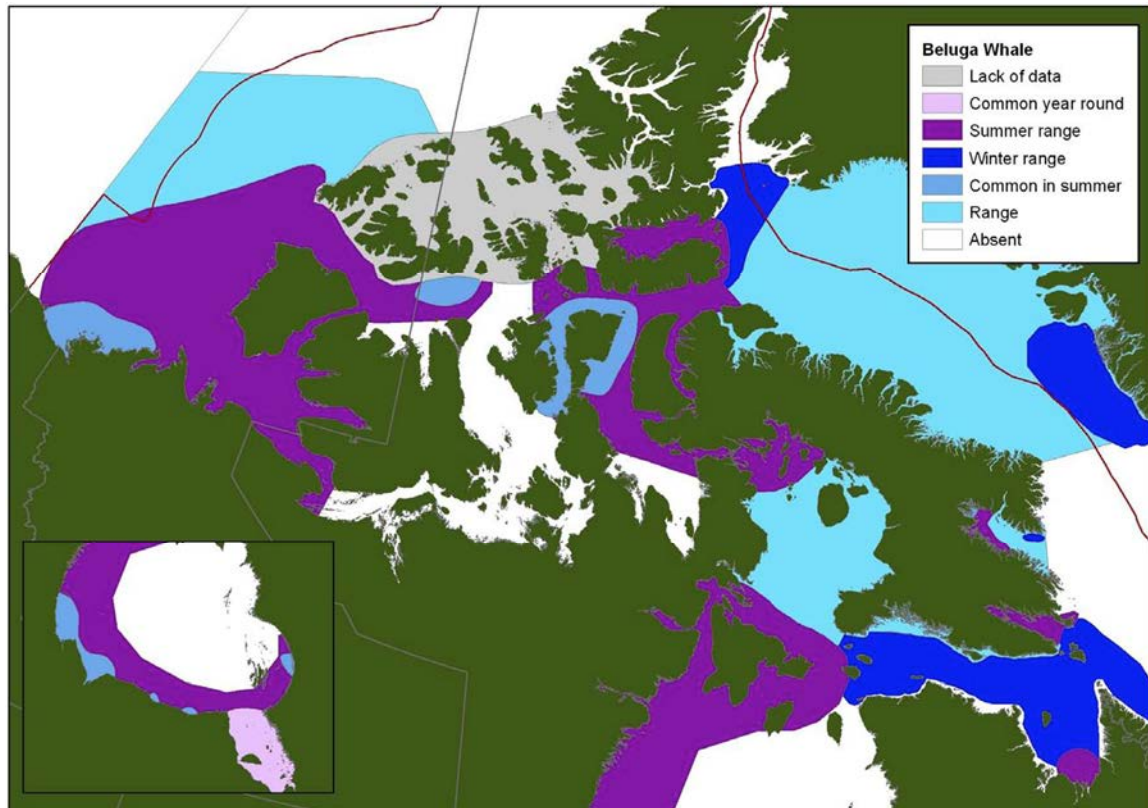


Figure 41. Beluga distribution and migrations. Source: Stephenson and Hartwig 2014



According to DFO, the Eastern Cumberland Sound, Clearwater Fjord and Crewel Bay support aggregations and fitness consequences for beluga populations but are not identified as critical habitats. They are part of the ESBA on Cumberland Sound. There is also research suggesting that the Lancaster area is an important area for beluga.²⁴

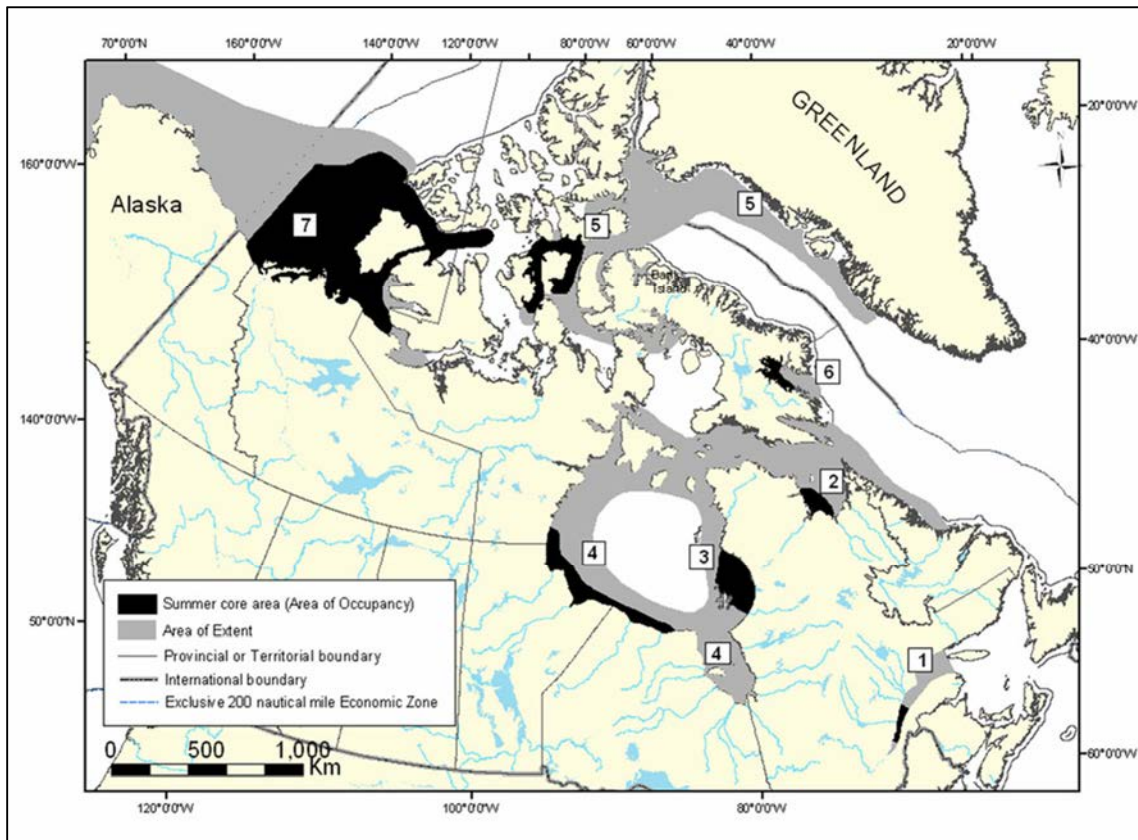


Figure 42. Location of the of Canadian Beluga Populations: (1) St. Lawrence Estuary population (2) Ungava Bay population (3) Eastern Hudson Bay population (4) Western Hudson Bay population (5) Eastern High Arctic – Baffin Bay population (6) Cumberland Sound population (7) Eastern Beaufort Sea population. From COSEWIC (2004)

²⁴ http://www.grida.no/graphicslib/detail/iron-mine-threatens-beluga-around-baffin-island_181f



3.5.5.4 NARWHAL

In the northern Foxe Basin, TEK indicates (from interviews of coastal communities) that there are some areas of occupation for narwhal (Figure 43). Milne Inlet and adjacent areas of Lancaster Sound are known to be a key area for narwhal during the breeding season, which became a focus for some of the environmental hearings into the Baffinland project.

The Baffinland project has undertaken narwhal monitoring programs, including ongoing monitoring of narwhal at Bruce Head (near Milne Inlet) by a team of marine biologists and Inuit observers.²⁵

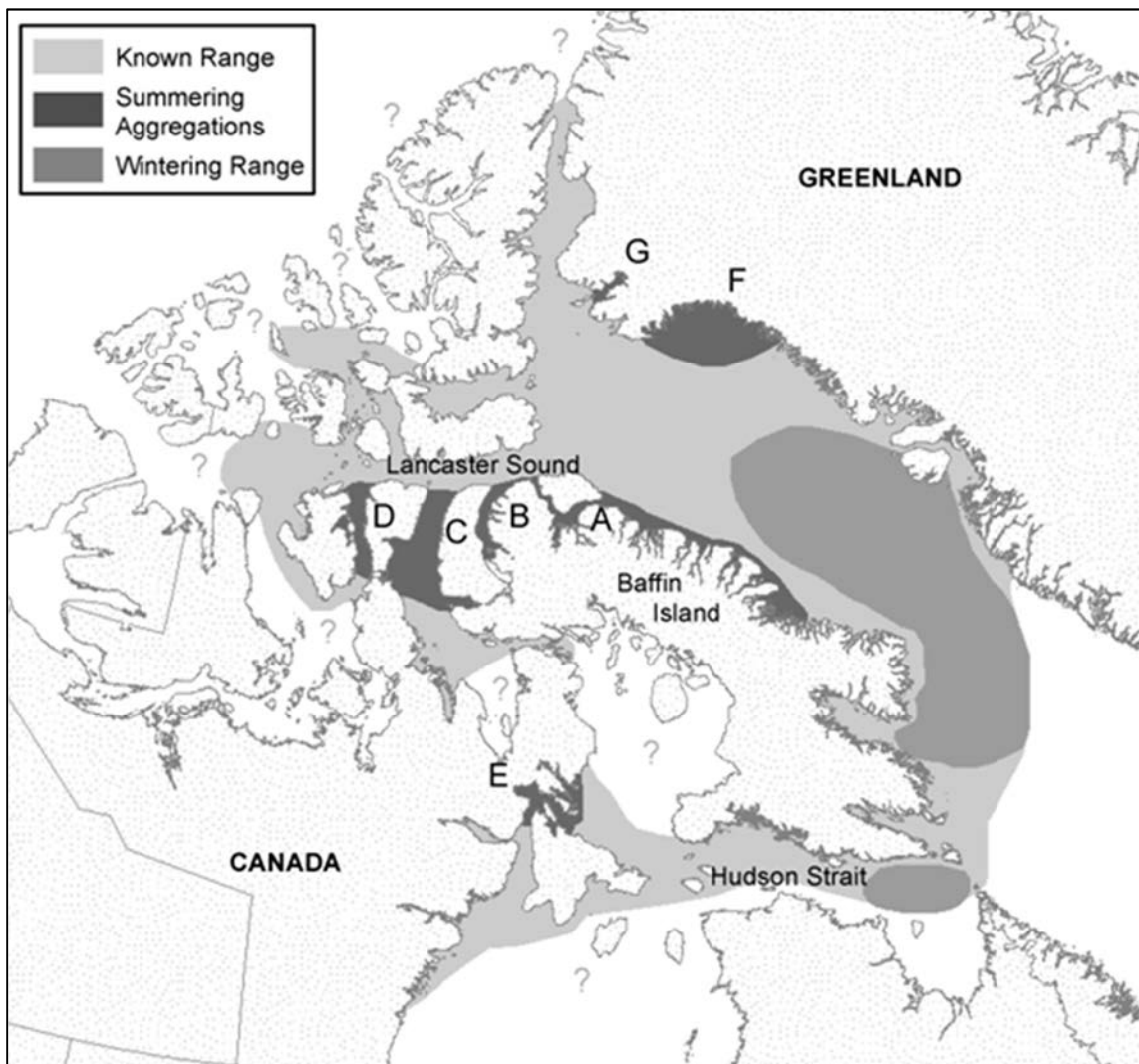


Figure 43. Narwhal - Areas of occupation, Northern Foxe Basin. Source: SARA.

²⁵ <http://www.baffinland.com/wp-content/uploads/2014/06/Narwhal-Study-For-Web-2014-Update.pdf>

Recent DFO surveys have also identified that Eclipse Sound and Admiralty Inlet could be important nursery sites for young Narwhal. Eclipse Sound is on the shipping route from the Baffinland mine, which presents a potential problem for local populations.²⁶



Figure 44. Narwhal calves in Admiralty Inlet. Source: DFO 2015.

²⁶ <https://www.newscientist.com/article/dn28729-elusive-narwhal-babies-spotted-gathering-at-canadian-nursery/>



3.5.5.5 KILLER WHALES

Killer whales are also seen in the Northern Foxe Basin. Recent observations suggest that changes in ice cover are allowing killer whales to extend their range in the Canadian Arctic (Hidden *et al.* 2009). Climate change models predict major reductions in sea ice with the subsequent expectation for changes in Killer whales' distribution and abundance. Hudson Bay and Foxe Basin appear to have been a significant sea ice choke point that opened up approximately 50 years ago allowing for an initial punctuated appearance of killer whales followed by a gradual advancing distribution within the entire Hudson Bay region.

Some studies suggest that the loss of ice is changing the distribution of killer whales in the Arctic. The following figures provide examples of observed ranges:

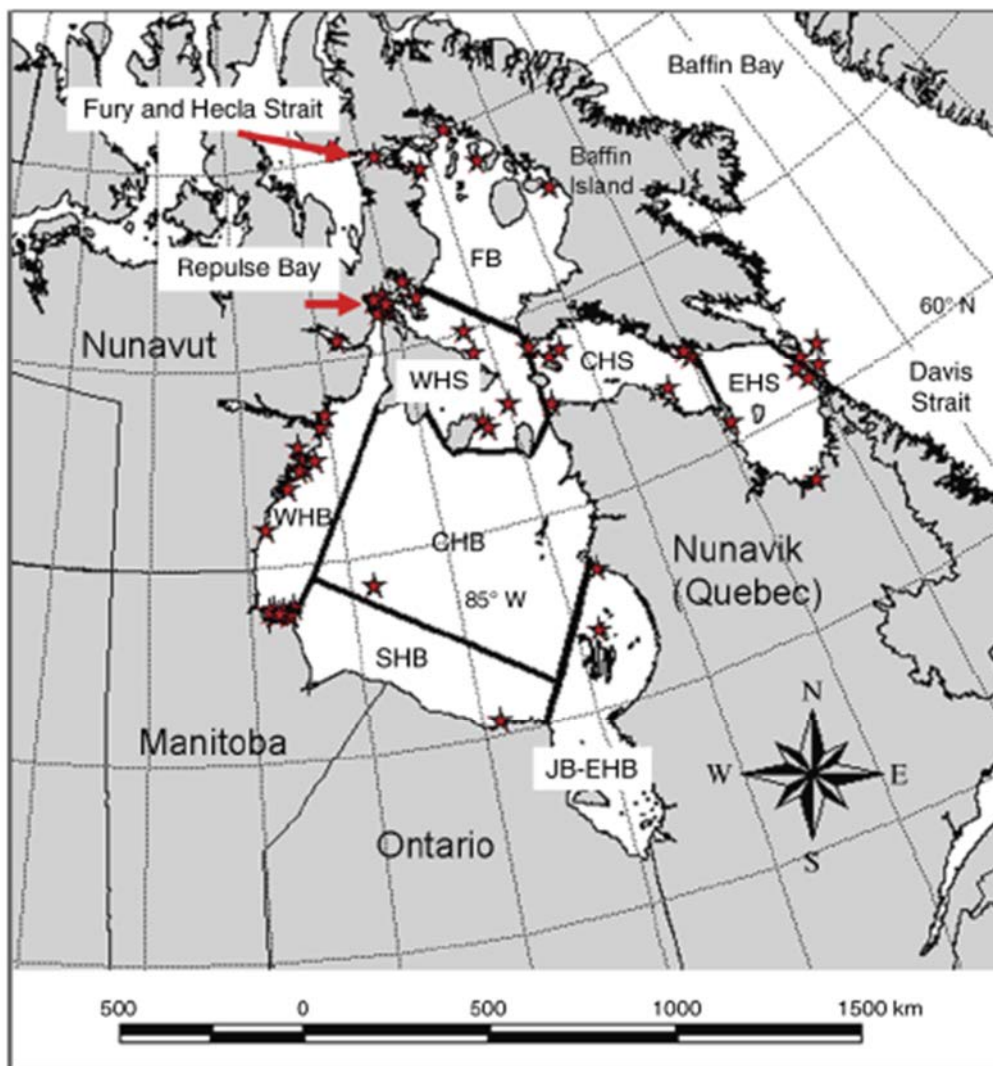


Figure 45. Locations of killer whale sightings in the Hudson Bay region in eastern Canada. Source: Higdon and Ferguson (2009).

In addition to ice cover, prey availability is also determining the abundance and distribution of killer whales. The main prey for killer whales is seals and therefore areas with high seal abundance should be listed as important for killer whales. Unfortunately there is little scientific data describing high seal abundance areas in the arctic, with the exception of the NCRI report which primarily covers the Northern Fox Basin.

In general, Western Hudson Bay, Northern Foxe Basin and Lancaster Sound all represent important occupancy areas for killer whales. (Higdon et al. 2012).

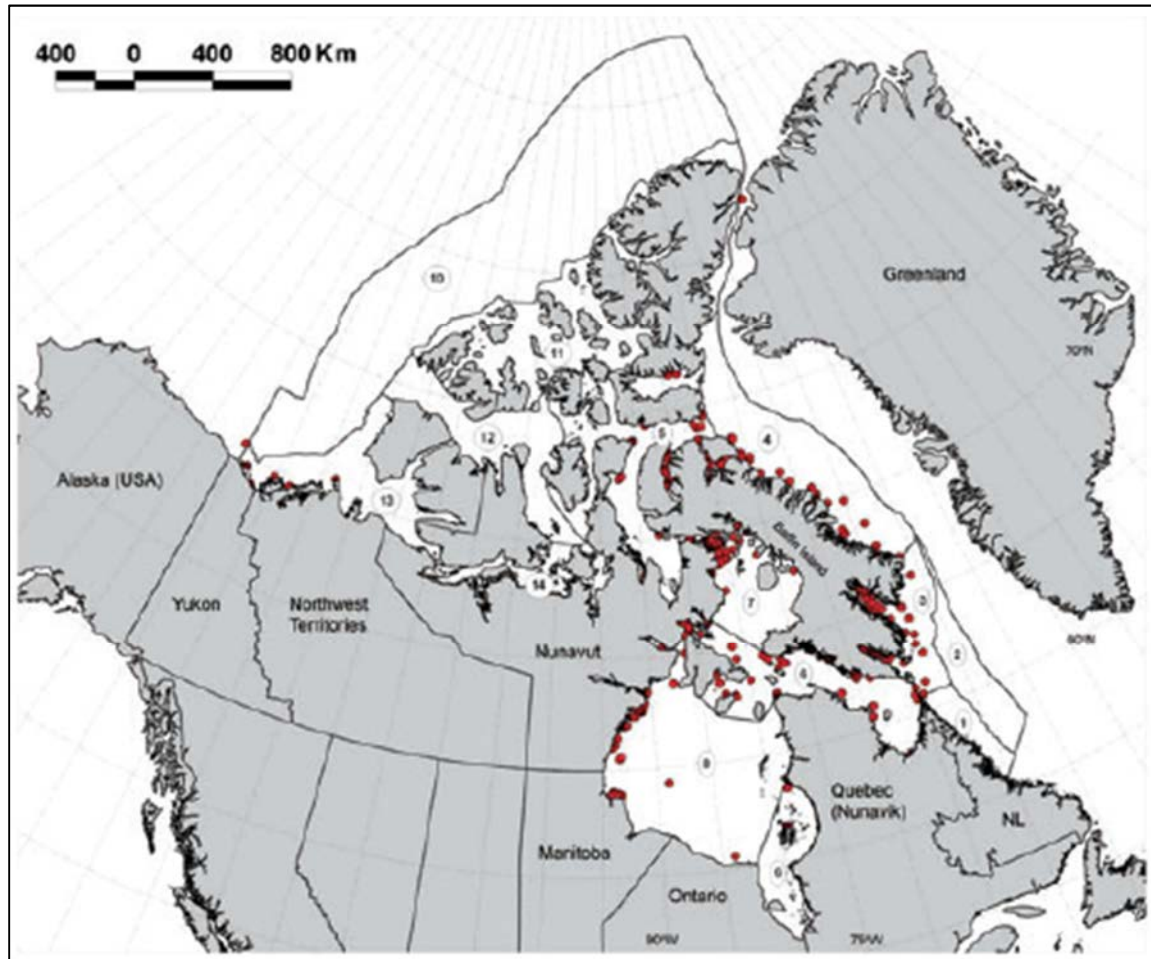


Figure 46. Canadian Arctic killer whale sightings locations. Source: Higdon et al. 2012.



3.5.5.6 MIGRATIONS

The northern Foxe Basin is a very important migration route for many species of marine mammals such as walrus, but also bowhead whales, narwhal, polar bear and ringed seal (NCRI 2008).

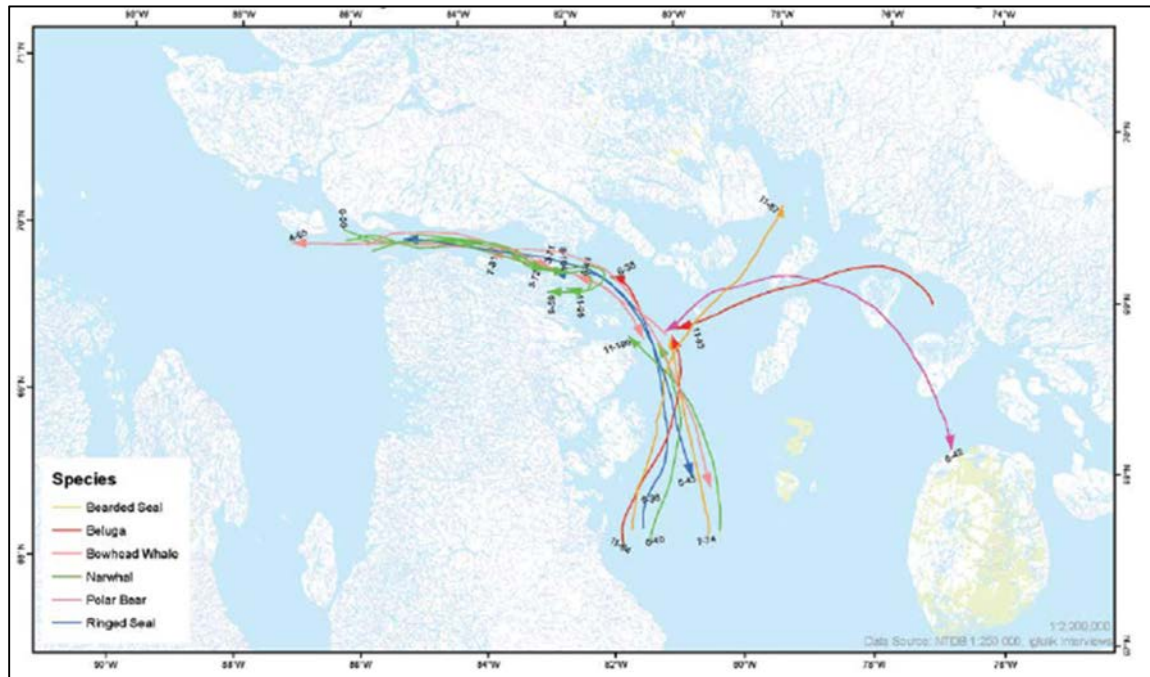


Figure 47. Marine mammal migration routes in the Northern Foxe Basin. Source: NCRI 2008.

Lancaster Sound is also known to be an important migration route for many whale species, including bowhead, beluga and narwhal.

3.5.6 FISH SPECIES

Several fish species are of socio-economic importance in one or more of the study areas of interest, notably Arctic Char and to a lesser extent Arctic Cod. Other species are of vital importance to the marine mammal and seabird populations.

Western Hudson Bay coastline is an important migration corridor and feeding area for Arctic char. In the Coronation Gulf, with depths of 100–200 m, and with the influence of the Burnside River, Bathurst Inlet is an important summer habitat for marine fish communities, particularly Arctic char. There is also an important marine feeding ground and migration corridor for Arctic char, in the Queen Maud Gulf (Skjoldal *et al.* 2013). In the northern Foxe Basin, several areas of occupation have been identified by coastal communities.

The Northern Foxe Basin is identified as an area of occupation for Arctic cod. In the Lancaster Sound, arctic cod (*Boreogadus saida*) is abundant in all stages of its life cycle (Skjoldal *et al.* 2013).

In the western Hudson Bay, dense kelp beds occur along the coastline and provide important habitat for many fish species (Skjoldal *et al.* 2013). Traditional ecological knowledge indicates that the northern Foxe Basin is also an area of high abundance and critical spawning areas for different species of fish, e.g. Figure 48.

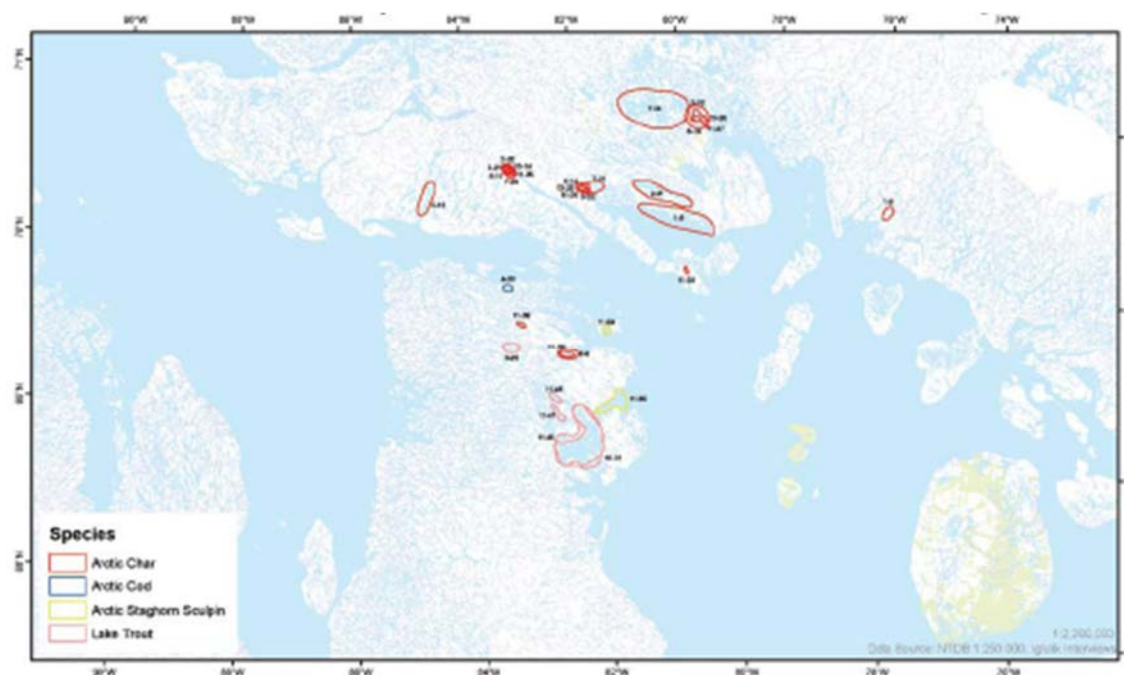


Figure 48. Fish – Areas of high abundance in Northern Foxe Basin. Source: NCRI (2008).



3.5.7 OTHER SPECIES

Invertebrates, plankton and marine plants are also vital components of the Arctic ecosystem. Knowledge of many of these species is quite limited, but some information is provided below and available in the reference sources cited.

The Lancaster Sound area is very productive, has a high export of sea-ice algae, and has high benthic diversity, production, and re-mineralization – likely to reflect the high quality food supply for the benthos (Skjoldal *et al.* 2013).

In the Coronation Gulf, based on the occurrence of a polynya around the Bathurst inlet, there may be productive benthic epifauna communities, however no data are currently available (Skjoldal *et al.* 2013). The northern Foxe Basin is also identified as an area of high abundance for benthic invertebrates such as clams. Other species are described in the official NCRI (2008) report.

The Igloolik Island part of northern Foxe Basin features the Fury and Hecla polynya and increased nutrients and productivity compared to other areas of the Canadian Arctic. This is also validated by TEK in the same area. In the Coronation Gulf, the relatively shallow (<100 m) waters along the coast of the Queen Maud Gulf are heavily influenced by freshwater inputs from four major rivers, the Armaq, Ellice, Perry and Simpson rivers. Nutrients from these rivers and those released from sediments lead to enhanced primary productivity in this area (Skjoldal *et al.* 2013).



4 RISK ASSESSMENT

4.1 INTRODUCTION

This section of the report presents an inventory of risks associated with marine operations, evaluated for each area of interest and its particular environmental and marine traffic profile. These evaluations are based on the data presented in Sections 2 and 3 and their associated appendices

Each risk in the inventory is explored as follows:

1. The hazard and its immediate and underlying causes are identified
2. The probability of occurrence, and potential immediate and long-term consequences are identified
3. Any current risk mitigation measures are listed, and potential mitigation strategies are identified, as applicable.

4.2 OVERVIEW OF RISK ASSESSMENT APPROACH

This report assesses a number of different risks posed by the intersection of ship traffic with the environment in the four areas of interest across the Canadian Arctic. In some cases, hazards are unique to the local environmental or socio-economic situation, and in other cases hazards are common to the shipping industry, but have different potential consequences or severities due to the location. Risk assessment combines the probability of occurrence of an event resulting from a hazard with the severity of its potential outcomes.

This assessment assumes that ships are complying with the relevant domestic and international legislation for the voyages they are undertaking. This includes the international SOLAS and MARPOL conventions (which as of January 1, 2107 include the new IMO Polar Code), the Canadian Arctic Shipping Pollution Prevention Regulations (ASPPR), and the Canada Shipping Act as appropriate. These requirements are intended to reduce the risks which they address to societally acceptable levels. Therefore any risk assessed as being unacceptably high is a result of one of the following possibilities:

1. Existing requirements do not address the risk;
2. Local factors significantly increase the probability of an occurrence;
3. Local factors significantly aggravate the consequences of an occurrence;
4. Local factors lead to different perceptions of acceptable levels of risk.

At the highest level, the risk assessment considers two categories for risk – disruptions to habitat and the social-economic environment, and risk posed by shipping activities and operations. These two categories naturally include a certain amount of overlap. Risk assessment is treated in a top-down fashion. Key hazards are identified at the highest level, underlying causes are listed, and potential outcomes or impacts are explored.

There are a large number of risks associated with any operation of ships. The project, as much as possible, has limited the scope of risks investigated to those assessed as being particularly important to the areas of interest the Canadian Arctic in general. This includes risks specific to

operations in the Canadian Arctic (such as sealift operations in remote communities, or the presence of specific species) as well as common risks whose outcomes or impact severities are different in the area of interest; for example, the additional difficulties associated with hydrocarbon cleanup in remote and ice infested waters.

A risk inventory has been developed summarizing nature of each hazard, potential causes, and potential outcomes. A more detailed assessment has been developed for a number of specific risks identified as being of particular importance, severity, or having a clear need for further study.

4.3 RISK ASSESSMENT

4.3.1 METHODOLOGY

The main tool that has been used in assessing risks is the matrix shown in Figure 49: Risk Evaluation Matrices. It considers the probability of the risk event occurring, and the potential severity of the consequences for all of health and safety, environmental impact, and economic impact.

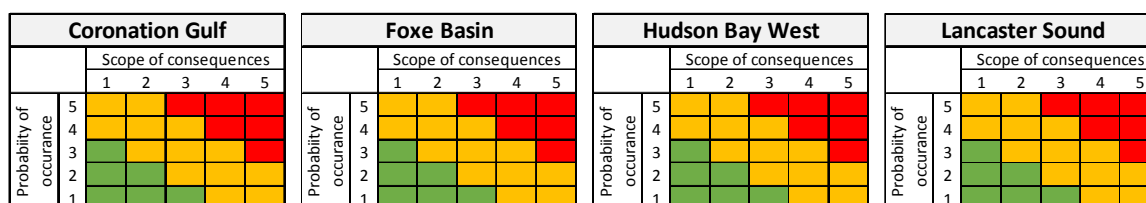


Figure 49: Risk Evaluation Matrices

The following tables describe the definitions used to evaluate and rate risk events:

Table 15: Risk Assessment, Probability of Occurrence

Probability of occurrence		Frequency (per ship voyage)
Remote	1	1/10000 or less
Unlikely	2	1/1000
Likely	3	1/100
Highly Likely	4	1/10
Near Certainty	5	1/1 and above

Table 16: Risk Assessment, Severity of Outcome

Scope of Consequences		Severity
Minimal or none	1	Consequences are limited in impact, with no known potential for long-term damage to business, persons, or the environment.
Marginal	2	Consequences have potential for immediate harm to persons, business, or the local environment.
Significant	3	Consequences present immediate, significant harm (such as injury or loss of life, temporary significant environmental disruptions) with some potential for longer term effects.
Critical	4	As above, except with high probability of lasting effects, such as reduced business potential, or lasting impact on population levels of important species.
Catastrophic	5	Unacceptable immediate impacts, and potentially irreparable long-term damage.

In the risk matrices, green results are low overall risk, and need no further action. Yellow are medium risk, and should be mitigated where it is technically and economically feasible to do so, taking into account the nature of the operation and the interests which it serves. Red are high risk, and should be considered to require additional mitigation measures, except in unusual circumstances such as emergency response.

The rating for severity is based on a semi-qualitative assessment of all possible consequences for a given risk. For example, an event which results in moderate consequences on almost every occurrence will generally be rated as more severe than an event with range of consequences, if the latter's more likely outcomes are of minimal impact.

4.3.1.1 REGIONAL INFLUENCES

As described in Section 2, each of the four areas of interest have a slightly different marine traffic profile:

A significant portion of Marine traffic in the Coronation Gulf is community resupply, the bulk of which is provided by tug and barge. There is also a relatively significant amount of tourist and adventurer traffic in the region, as many small vessels will begin their route in Alaska and travel through the Coronation Gulf as part of attempted Northwest Passage transits.

Marine traffic in Foxe Basin is almost exclusively sealift and CCG operations, with a limited number of adventurers and other vessels transiting through the area in seasons with favourable ice conditions.

Marine traffic in Western Hudson's Bay is primarily sealift operations resupplying local communities. Some traffic is there to support mining operations at Baker Lake.



Marine traffic near Lancaster Sound involves a wide range of industry sectors. The region is second only to the Hudson Strait as an access route to other areas of the Canadian North and in 2013 the region was used by sealift operations, tourist traffic, and government operations.

In order to account for the varying type and frequencies of marine traffic in each region, a separate assessment for each risk has been completed for each of the four regions.

4.3.2 RISK CATEGORIES

The risk analysis has been divided into 2 broad categories in an effort to clarify the difference between events which could occur as a result of marine traffic in the areas of interest, and events which are inherent to marine operations in general but have particular significance for the area of interest.

4.3.2.1 HABITAT, ECOSYSTEM, AND SOCIO-ECONOMIC DISRUPTIONS

This category generally includes events which occur as a direct result of a ship sailing in a given area or the effect that the type of marine operation has on the region. This includes risks such as:

1. Physical Impact – Direct physical impact between vessels and animals.
2. Environmental Disruptions – Immediate environmental disruptions such as operational noise, hydrocarbon or other discharges, waves/wakes, and the destruction of ice cover used as migration or hunting routes.
3. Ecological Disruptions – Longer-term issues such as the introduction of invasive species or permanent dislocation of animals from regular ranges or habitats.
4. Cultural Impact – Risks to local communities such as loss of culturally significant hunting resources, or tourism traffic in excess of local communities' capacities.

Noise emissions are a potential type of disruption due to the dependence of almost all marine mammals on sound for every functional aspect of their lifecycle. The real effects of noise on marine mammals are not well understood, which makes the assessment of risk problematic. Similarly, the cumulative effects of low levels of water- and airborne pollutants are not well known, particularly in Arctic areas.

Another less immediate but “new” type of risk is the rapid growth of recreational traffic (cruise ships and individuals) overwhelming local infrastructure. Growth of tourism traffic in the Arctic could present more opportunities for operators to lead larger parties on shore excursions. This introduces the risk that the communities being visited will not have sufficient infrastructure in terms of social, sanitation, resources (fuel, supplies), and health/response to accommodate such large groups. This could have consequences ranging from short-term inconvenience to the community to longer term problems of supply shortages, cultural disruptions, or excessive strain on limited infrastructure.

4.3.2.2 SHIPPING AND OPERATIONAL RISKS

Many of these risks are present for the shipping industry worldwide, however Arctic considerations such as harsh climate and remoteness increase the probability of certain events

and/or introduce additional consequences to their occurrence. Some are more specific to Arctic operations. Some examples in each of these categories include:

1. Increased probability: capsizes and grounding have increased probability due to topside icing and the lack of good charts and navigational aids respectively.
2. More severe consequence: any incident requiring emergency response has challenges in the Arctic due to remoteness and lack of infrastructure.
3. Arctic specific: Sealift and resupply operations may lead to spills or cargo loss occurring during transfer of fuels and other cargoes over the beach. Ice operations are particularly demanding in the Arctic

These and other risks have the potential to lead to a number of serious consequences with one of the key issues being pollutant spills, as they impact not only local wildlife, but could potentially damage communities, disrupt sustenance harvesting, and due to their immediate visibility and relatively well understood consequences could easily damage an operator's reputation and ability to do business in the region. While the risk of releasing pollutants via various incidents is present globally, the remoteness, lack of response infrastructure, harsh conditions, and relative fragility of the Arctic environment dramatically amplify the immediate and long term consequences of such an incident occurring.

4.3.3 RISK INVENTORY

The following table provides the risk inventory and summary assessment for each risk. For a complete list of all risks and detailed commentary on their evaluation, see Appendix 3A.

Table 17: Risk Inventory

Risks Across Areas of Interest													
ID	Hazard/event	Coronation Gulf			Foxe Basin			Western Hudson Bay			Lancaster Sound		
		Probability	Severity	Risk	Probability	Severity	Risk	Probability	Severity	Risk	Probability	Severity	Risk
1	Cetacean strike	2	3	MED	3	3	MED	3	3	MED	3	3	MED
2	Other species strikes	2	3	MED	2	3	MED	2	3	MED	2	3	MED
3	Disruption of fish stocks	2	3	MED	2	2	LOW	2	3	MED	2	3	MED
4	Icebreaking - ice environment change	1	2	LOW	1	2	LOW	3	2	MED	2	2	LOW

5	Wake wash disruptions (general)	2	1	LOW	2	1	LOW	3	2	MED	3	1	LOW
6	Wake wash disruption of shorelines	2	1	LOW	2	1	LOW	3	2	MED	3	1	LOW
7	Disruption of airspace (noise/bird strikes)	3	1	LOW	2	1	LOW	3	1	LOW	3	1	LOW
8	Noise Disruptions (sailing)	5	3	HIGH	5	3	HIGH	5	3	HIGH	5	3	HIGH
9	Noise Disruptions (icebreaking)	3	1	LOW	3	1	LOW	3	1	LOW	4	1	MED
10	Noise Disruptions (surveys)	1	2	LOW	1	2	LOW	1	2	LOW	1	2	LOW
11	Air Emissions (operational)	5	2	MED	5	1	MED	5	2	MED	5	2	MED
12	Pollutant Discharge (Operational)	4	2	MED	3	2	MED	4	2	MED	4	2	MED
13	Harmful Substance Discharge (Operational)	3	1	LOW	2	1	LOW	3	1	LOW	3	1	LOW
14	Introduction of invasive species	1	4	MED	1	4	MED	1	4	MED	1	4	MED
15	Socio-Economic disruption	2	2	LOW	2	2	LOW	2	2	LOW	2	2	LOW
16	Capsize	2	5	MED	2	5	MED	2	5	MED	2	5	MED
17	Ice Impact	3	2	MED	2	2	MED	2	2	MED	2	2	MED
18	Beset in ice	4	3	MED	4	4	HIGH	3	3	MED	3	3	MED
19	Ship collision	3	2	MED	2	1	LOW	3	2	MED	3	2	MED
20	Grounding	3	4	MED	3	4	MED	3	4	MED	2	4	MED
21	Equipment failure/pollution release	1	3	LOW	1	3	LOW	1	3	LOW	1	3	LOW
22	Loss of control	2	4	MED	2	4	MED	3	4	MED	2	4	MED

23	Sealift spill	3	4	MED	2	4	MED	3	4	MED	2	4	MED
24	Sealift cargo loss	3	2	MED	2	2	LOW	3	2	MED	2	2	LOW

4.3.4 KEY RISK ANALYSES

A set of the most significant risks has been identified for additional description and discussion below. A few risks are assessed as high in one or more of the areas under consideration. These are in need of additional risk mitigation measures. Others are towards the higher end of the medium risk part of the matrix, and so are priorities for consideration under the As Low as Reasonably Possible (ALARP) principle.

These are as follows:

1. Shipping incident: Grounding
2. Shipping incident: Ship beset by ice
3. Shipping incident: Capsize
4. Shipping incident: Failure during sealift operations
5. Cetacean strikes: Ice and ice-free seasons
6. Noise from operations: Ice and ice-free seasons
7. Loss of vessel control

Ice impact damage is considered to be of lower risk than these items. Recent experience in the Canadian Arctic suggests that the current regulatory regime, including access limits based on ice class and crew qualifications when operating in ice, has helped to limit the number of incidents to small number with marginal to significant consequences. This could change in the future through increases in traffic, a lack of experienced operators, and the “internationalization” of certain requirements under the Polar Code.

4.3.4.1 GROUNDING

There are a number of risk scenarios through which a vessel could be damaged or lost through grounding in any of the study’s areas of interest. Poor hydrographic information is a risk factor throughout the Canadian Arctic. In 2014, the challenging navigation requirements of Chesterfield Inlet in Western Hudson Bay combined with crew fatigue resulted in the MV Nanny grounding²⁷. Although no injuries or pollution events occurred, the incident does provide a current example of how the navigation challenges in the region can lead to accidents. The potential consequences of such an event include harm to crew, release of pollutants, damage to the ship or even loss of the ship. Additionally, an unsalvageable vessel could create a hazard to navigation, and any serious incident could cause significant harm to the operator’s reputation and ability to do business in the region. Remoteness and a lack of Search and Rescue (SAR) and environmental response infrastructure mean the consequences to both crew and the environment are amplified should an incident occur.

²⁷ <http://www.tsb.gc.ca/eng/rapports-reports/marine/2014/m14c0219/m14c0219.asp>

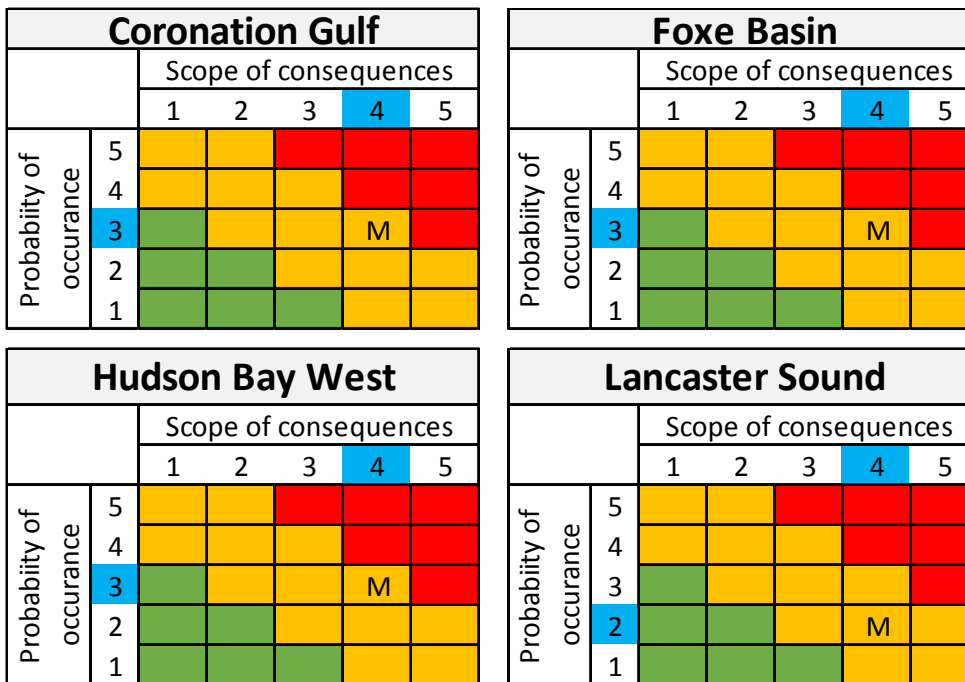


Figure 50: Risk Evaluation Matrices: Grounding

Note that the consequences are considered to be critical (rather than catastrophic) due to the fact that all of the recent recorded grounding incidents for the Canadian Arctic were resolved without loss of life or major pollutant releases, which suggests that while a serious spill or human impact is possible, in the majority of cases it is not the end consequence.

This risk is currently mitigated by a variety of regulatory requirements from Transport Canada and other regulatory agencies. The “Corridors” initiative by the Departments of Fisheries and Oceans and Transport may help to improve the availability of navigational information in most of the areas in the future.

4.3.4.2 SHIP BESET BY ICE

As listed in the risk matrix, there is a risk that vessels operating in any of the areas of interest could be beset by ice. This could lead to consequences ranging from delays in operations to poor conditions for crew. Incidents could escalate in the event that ice pressures overstress the hull, or ice draft carries the vessel aground. In these cases, there could be release of pollutants, a need to abandon ship, and total ship loss. However, these are much lower probability events.

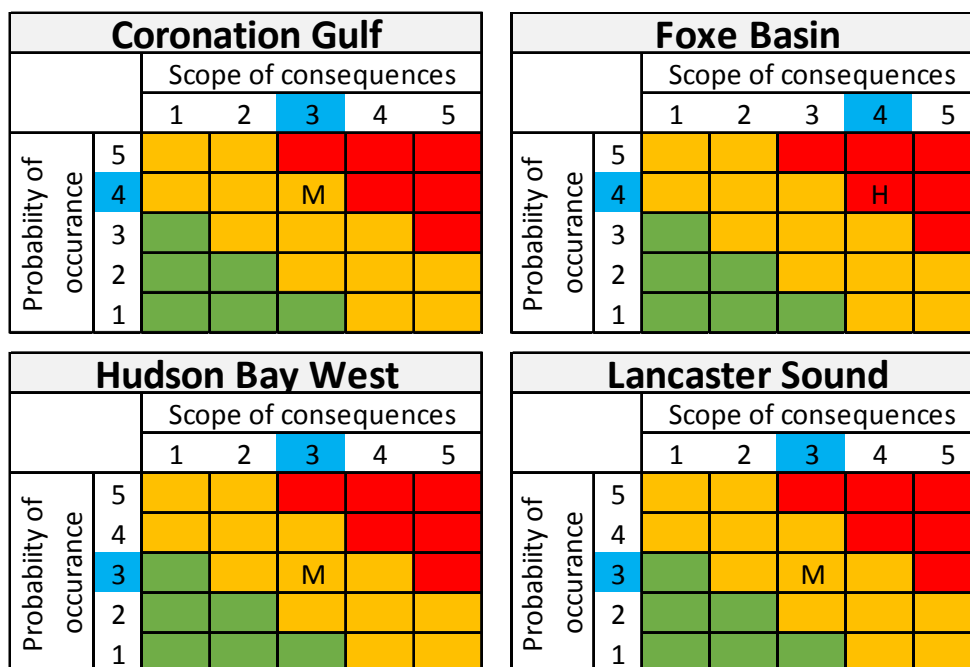


Figure 51: Risk Evaluation Matrices: Ship Beset by Ice

Note that the risk is deemed relatively high due to the high likelihood of occurrence (as evidenced by numerous reports of vessels becoming trapped, at least temporarily, in the ice) rather than the outcome severity, which has been tempered by the availability of CCG icebreakers or the use of capable, ice class reinforced vessels. Should traffic in the Canadian Arctic increase and begin to include less capable or more un-escorted “new” vessels, the risk level may increase as regards both probability and potential consequences. This is of particular concern to tourism traffic, where there is the potential for a larger, non-ice class vessel with numerous passengers to have difficulty in unanticipated ice conditions.

A contributing factor to this risk is the Canadian Coast Guard’s limited capacity to respond to this type of event. The CCGS Louis St. Laurent and other CCG icebreakers are now almost all being operated well beyond their designed service lives, and despite numerous refits will almost certainly become decreasingly available before any new vessels come into service. Even a fully renewed fleet would not necessarily be capable of responding promptly to all events, depending on where they occur and the ice conditions involved. Any operations in the areas of interest with the potential to encounter challenging ice conditions will need to be prepared to help themselves in the event of an emergency.

This risk is currently mitigated by regulatory operational requirements under the ASPPR. The forthcoming IMO Polar Code in principle extends the requirements for operators to take account of a wide range of hazards when planning for and conducting voyages. Newer operators without a record of Arctic experience may however incur additional risk if they do not have access to ice navigators, experience with Canadian Arctic ice conditions, or sound operating practices.

4.3.4.3 CAPSIZE

There is an enhanced risk of capsize in the Arctic, due to issues of icing on deck, as well as ship handling issues in extreme cold. This is a higher risk for smaller vessels such as fishing vessels, small workboats and passenger vessels, and other small craft. The consequences of such an event would almost certainly include harm to crew, release of pollutants, and potentially loss of the ship. Additionally, an unsalvageable vessel could create a hazard to navigation, and any serious incident could cause significant harm to the operator's reputation and ability to do business in the region. Due to the remoteness and lack of SAR and environmental response infrastructure in the region, the consequences to both crew and the environment are amplified should an incident occur.

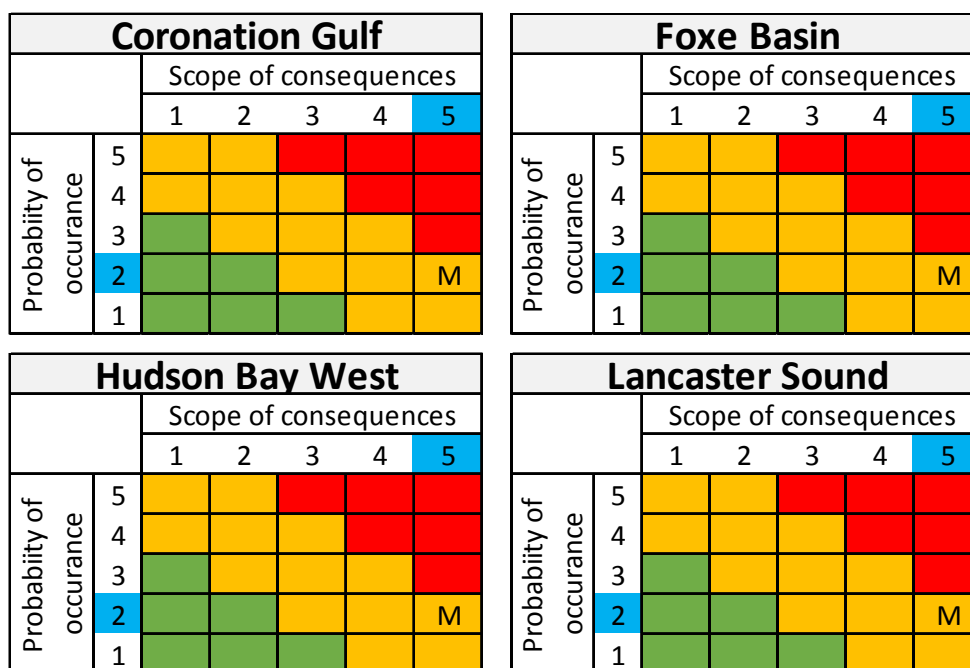


Figure 52: Risk Evaluation Matrices: Capsize

Capsize events very often end in loss of life, and are also likely to lead to some level of pollutant release after the loss of the ship

This risk is currently mitigated by a variety of regulatory (stability) requirements from Transport Canada, and SOLAS. The increasing volumes of small craft traffic in the North West Passage, and more adverse environmental conditions due to climate change may be increasing this risk

4.3.4.4 FAILURE DURING SEALIFT OPERATIONS

Sealift operations in the region are extremely challenging, due to the lack of ports and berths for vessels at most locations, coupled with often harsh environmental conditions. Most communities resupply from ships using cranes and barges for containerized cargo, and floating hoses for fuel supply. Both these methods are subject to a risk of spill or cargo loss given a variety of factors. Release of pollutants or loss of cargo would result in environmental damage, an adverse impact

on the community depending on the delivery, and potentially damage to the operator's reputation and ability to do business in the area. Additionally, communities and mine sites located inland of Western Hudson Bay often make use of ship to ship transfers of fuel and cargo near the shoreline. Chesterfield inlet is often used for these operations, as Baker Lake is inaccessible to deeper draft vessels.

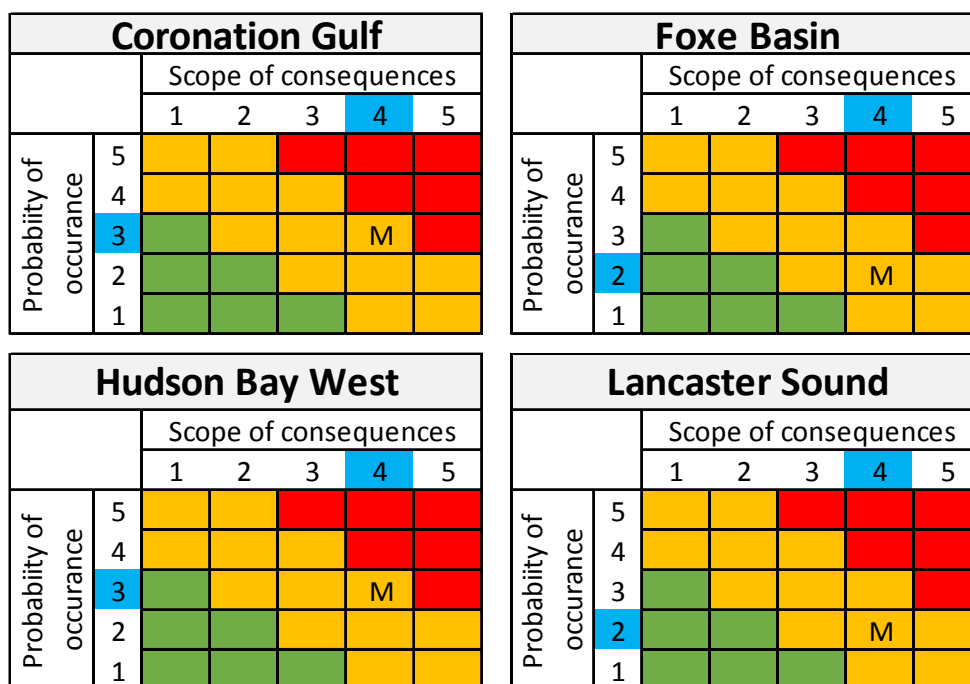


Figure 53: Risk Evaluation Matrices: Failure during Sealift Operations

Note that the vulnerable nature of the systems used coupled with difficult conditions is a primary reason for the high level of risk.

There is limited formal risk mitigation through regulation for many of these operations, which rely on experience and the application of best practices. For example, operators currently claim to follow the best practice of not attempting sealift operations in the presence of ice that is likely to interfere with the activity, particularly for fuel transfers. As the demand for sealift is likely to rapidly outpace the availability of supply in the next few years due to both the cost of acquiring or chartering new ships and the short season in which they operate, operators may choose to attempt to extend the season into less predictable conditions to meet demand.

4.3.4.5 CETACEAN STRIKES

Several species of cetaceans are found in the areas of interest throughout the year, including the winter season. Western Hudson Bay, Foxe Basin, and Lancaster Sound are all part of the known range for Narwhal, with Lancaster Sound and Foxe Basin also being key summer habitats. Northern Foxe Basin is believed to be an important Nursery Area for bowhead whales, and beluga are found throughout all four areas of interest at different times of the year. In addition, though risk of cetacean strike (or other marine mammal strike) exists year-round, the winter season and

the formation of Polynas presents a unique and important set of circumstances which considerably increases the risk of strike.

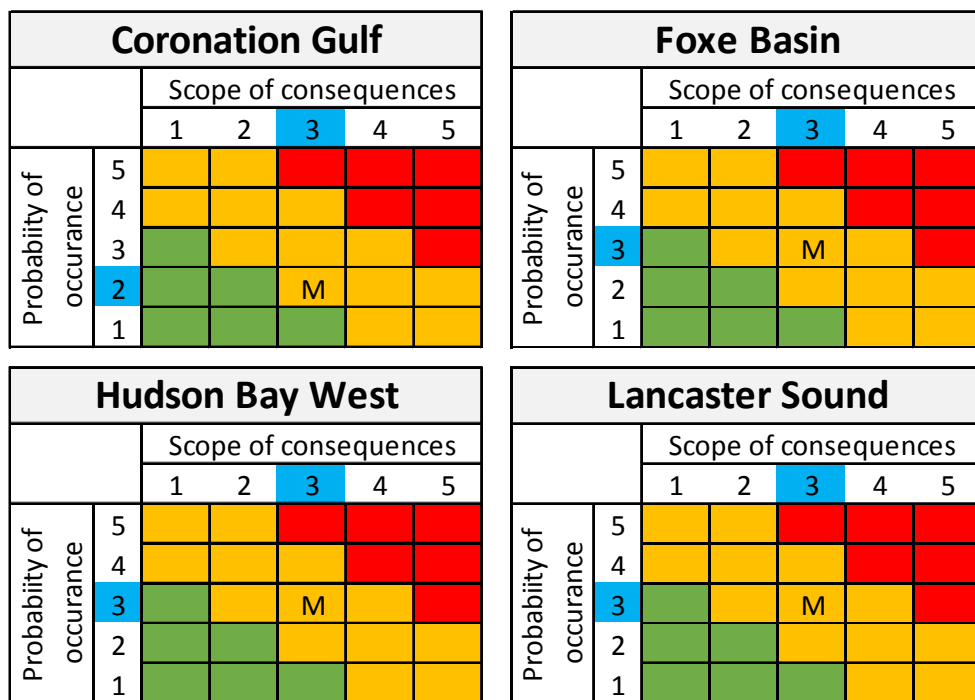


Figure 54: Risk Evaluation Matrices: Cetacean Strikes

During the winter season, several species remain almost exclusively in the polynas which form in predictable locations each year, as they are their main access to the surface, and serve as feeding and wintering grounds. Icebreaking vessels also naturally take advantage of these regions of open water during operations, leading to an inevitable intersection between vessel operations and population centres of cetacean species during the winter season. The following figure shows the intersection of observed ranges for cetacean species including narwhal, beluga, and other whales with traffic in the region.

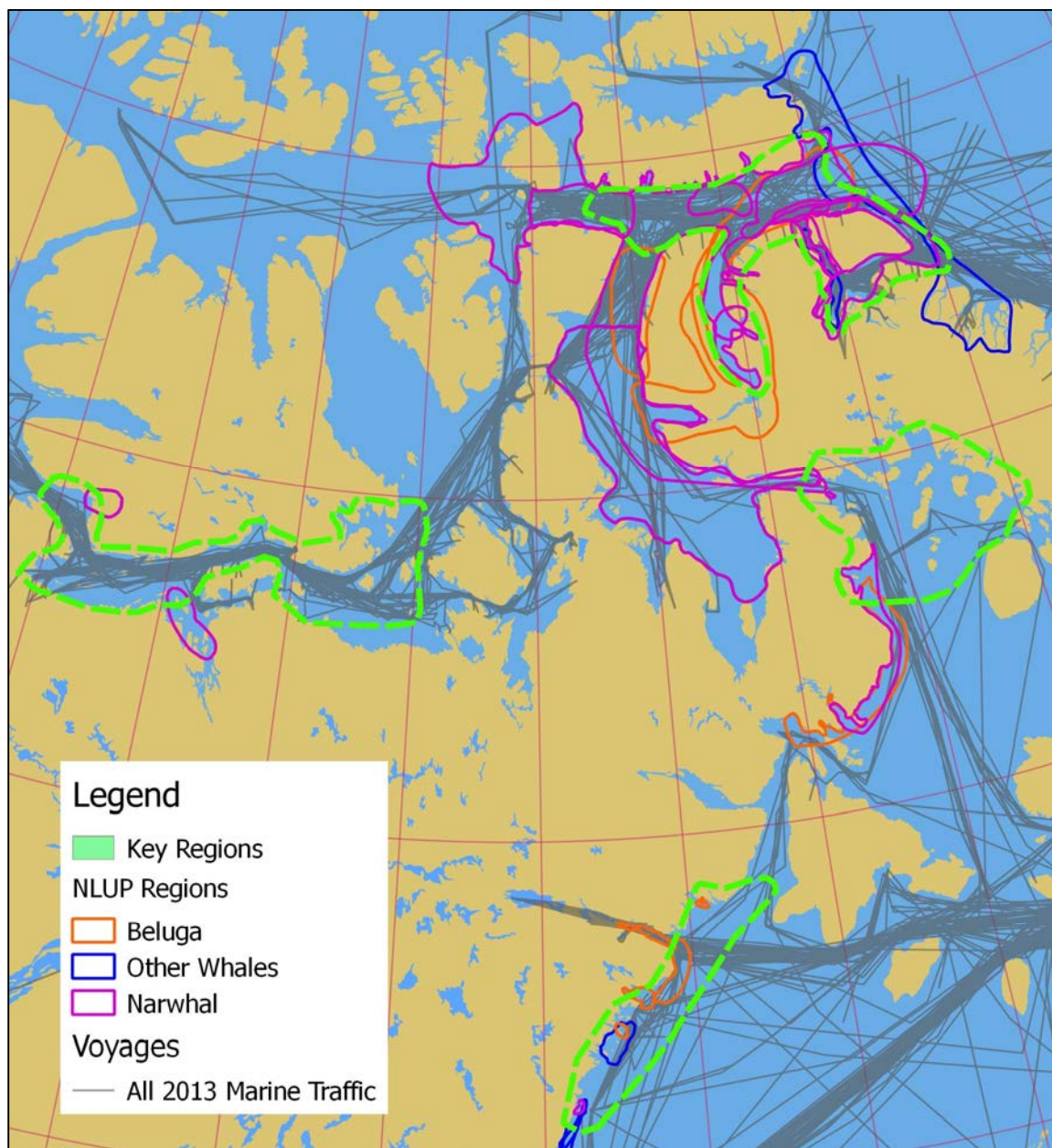


Figure 55: Observed Ranges for Beluga, Narwhal, other Whales in region

See Section 3.5 for a detailed summary of the seasonal and known ranges for cetaceans across all the areas of interest.

4.3.4.6 NOISE

The noise emitted from engines and vibrations from vessels can travel significant distances under water. Other operational noise sources such as sonars and seismic survey equipment can generate exceptionally high amplitude sounds. Cetaceans and other animals depend on transmission of sound for social interactions, navigation, feeding, etc. Increases in vessel traffic through habitats presents a variety of risks ranging from temporary disruptions to permanent hearing loss, which would likely lead to the death of the affected animal.

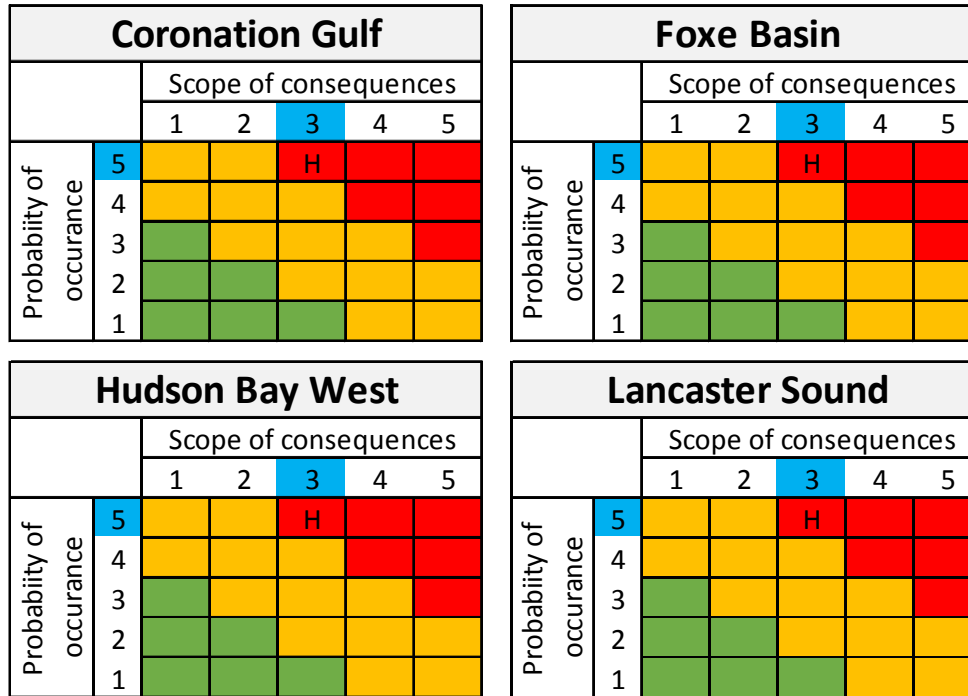


Figure 56: Risk Evaluation Matrices: Noise

Note that the lack of understanding of the longer term effects of noise is the main reason for assigning a high consequence level in most areas.

Local noise emissions from ships have been measured at almost 200 dB underwater, and icebreaking operations will necessarily increase the noise output; though it is possible that wildlife is desensitized to some degree by the ambient noise from ice movements themselves. Event based noise from equipment has been measured at higher still sound pressures across a range of frequencies. The following table characterizes sound levels for common commercial vessel activities:

Table 4.18: Sound Characteristics of Various Marine Sound Sources (Hildebrand 2005)²⁸

Source	Frequency Range	Sound Pressure	Total Energy
Commercial Shipping	5-100 Hz	150-195 dB	3.7×10^{12}
Seismic Airguns	5-150 Hz	< 259 dB	3.9×10^{13}
Naval Sonars (LF)	100-500 Hz	235 dB	2.6×10^{13}
Naval Sonars (MF)	2-10 kHz	235 dB	2.6×10^{13}
Fisheries Sonars	10-200 kHz	150-210 dB	Unknown
Research Sonars	3-100 kHz	< 235 dB	Unknown
Acoustic Deterrents	5-16 kHz	130-195 dB	Unknown

The main challenges with assessing and mitigating this type of risk stem from three main factors:

1. Uncertainty regarding the risk to marine mammals (and the marine ecosystem) from ship noise. Noise undoubtedly has a negative impact on the former, however a sound and verified baseline does not yet exist for accurately assessing level of exposure, characterization of the effect of different sound frequencies and amplitudes, as well as the cumulative effects of exposure, and the combination effects of exposure and other risk factors.
2. Inadequate monitoring and risk mitigation. There are few noise monitoring programs in place to collect useful data on the noise output of vessels and the exposure of marine mammal populations. There are also few established mitigation procedures in place which could be assessed for effectiveness should adequate data become available.
3. Lack of regulation. There are currently no regulations in Canadian waters concerned with management of noise output levels for commercial vessels.

The amount of noise from marine operations is related to the amount of traffic in a region, and to a lesser extent the type of vessel. The traffic patterns identified in Task 1 of the study suggest that all four areas of interest will be subject to non-trivial levels of traffic, and that Lancaster Sound (mining, tourism, other traffic types) and Western Hudson Bay (primarily sealift/resupply traffic) present the highest risk of regular exposure to underwater noise.

²⁸ Table 1 (Hildebrand 2005) Marine Mammal Commission, Marine Mammals and Noise, March 2007, pp6

4.3.4.7 LOSS OF VESSEL CONTROL

Navigation in the region is extremely challenging and often leaves little room for deviation from course, particularly in areas with narrow navigable channels such as Western Hudson Bay. There are a number of causes for a loss of vessel control which range from human error, to the effects of cold on ship's equipment, to ordinary mechanical problems. In the areas of the study, even a relatively brief loss of control could have serious consequences.

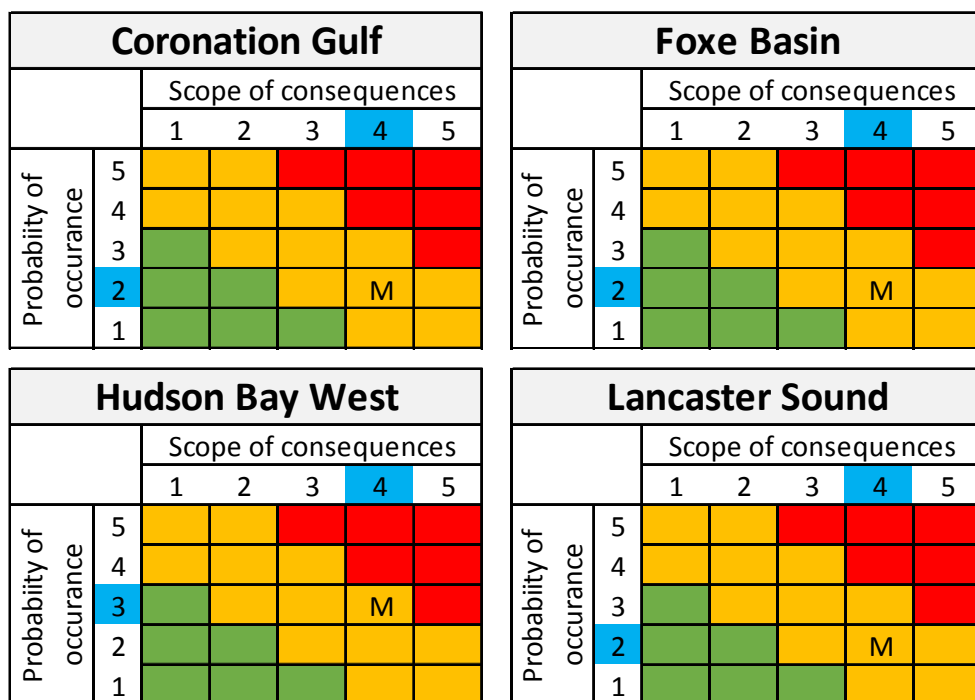


Figure 57: Risk Evaluation Matrices: Loss of Control of Vessel

As with other aspects of ship operations discussed above, there is currently limited formal risk mitigation beyond proper maintenance and inspection of the vessel, and competent operation of the same. Additional emergency response capabilities could be put in place in the future. Consequences of a loss of control could include grounding, blocking navigation in the region, collisions, or damage to shorelines or local infrastructure.



5 RECOMMENDATIONS

5.1 INTRODUCTION

Recommendations have been developed for management options to mitigate or eliminate the impacts or risks associated with marine operations for each area of interest and its particular environmental and marine traffic profile. These recommendations are based on the risk assessments presented in Section 4, and informed by the data provided in Sections 2 and 3.

5.2 CRITERIA FOR RECOMMENDATIONS

This report presents a number of recommendations for the study's areas of interest. Some describe direct actions that could be undertaken, others are meant to inform lobbying efforts, policy development, or the allocation of resources to research efforts. In all cases, the recommendations are meant to adhere to the following criteria:

1. The recommendation must be actionable: Recommendations require a party or parties to take action. They are more than the statement of a problem or risk; they outline a plan of action that can be followed to address the problem, mitigate the risk, or create a path to the improvement of a situation.
2. The recommendation must be achievable: Recommendations must provide a plan or action which can be reasonably implemented given adequate resources and political will.
3. The recommendation must be supportable: Recommendations must provide a plan or action which could realistically gain acceptance from the parties required to implement it, be it government, industry, or communities.
4. The recommendation must be sustainable: Recommendations must provide a plan or action which offers a long-term solution, rather than temporary or reactive measures to mitigate risks.
5. The recommendation must be cost effective: Recommendations must be reasonably affordable, or must be based on a compelling socio-economic case for the mitigation of risks identified in the course of the study.

Each recommendation also includes:

4. The ecological, environmental, and socio-economic factors the recommendation seeks to address in the applicable areas of interest.
5. References for any legislative authorities or other actors who could play a role in implementing the recommendation.
6. The relevant NLUP designations for recommendations that fall under the NPC's mandate.

Recommendations are derived from the risk assessments under Task 3. A single recommendation may contribute to mitigating one or more of the highest risks identified in this earlier task, and several recommendations may relate to a single risk. The relevance of each recommendation to risk mitigation is noted in the materials at Section 3.



5.3 RECOMMENDATIONS

6 main recommendations are presented below, each of which is derived from the study's risk assessment (Task 3):

1. Inclusion of wildlife issues in voyage planning under new regulations: Related to the risk of cetacean strikes and environmental disruptions, as well as vessel generated noise.
2. Support and expand underwater acoustics research: Required to understand and address vessel noise issues.
3. Restriction of HFO in the Arctic: Reduction of the severity of consequences from vessel incidents such as grounding, ice damage, etc.
4. Additional investment in hydrographic data: Related to the risk of vessel incidents, especially grounding.
5. Additional investment in basic sealift support infrastructure: Mitigation of sealift risks
6. Review and refocus of Arctic Corridors Initiative: Mitigation of risks across a variety of areas.

This set of recommendations addresses most but not all of the higher risk items for Task 3. In some cases, for example the reduction of capsizing risk for small vessels, effective risk mitigation measures would fall outside the scope of the NLUP and associated actions.



5.3.1 INCLUSION OF WILDLIFE ISSUES IN VOYAGE PLANS UNDER NEW REGULATIONS

Key Issues: Risks of marine mammal strikes, habitat disruption, and other ecological issues resulting from the operation of ships in marine habitats.

Applicable Areas: All areas.

Relevant Actors: Regulators (government and recognized organizations), ship operators.

NLUP Designations: Protected Area, Special Management Area.

The new International Maritime Organization (IMO) Polar Code, and its inclusion in Canadian legislation and regulations under the Canada Shipping Act (CSA) and Arctic Waters Pollution Prevention Act (AWPPA) require the development of a Polar Waters Operational Manual (PWOM) (Code Part 1 Chapter 2) and also of voyage plans for individual voyages (Code Part 1 Chapter 11). The general requirements for the PWOM do not include the need to address any environmental issues. The instructions for voyage plans do refer to the need to consider areas with high densities of marine mammals, but do not contain any real requirements. While a voyage plan itself can be reviewed by a Coastal or Port State inspector, the inspector cannot enforce anything beyond the requirements of the underlying Conventions and standards.

Including in the Canadian regulations more detail regarding consideration of data on all wildlife, and of procedures for actual avoidance of areas/seasons and species at higher risk would be a very valuable protective measure. This would reflect the best practices of a number of current operators, and ensure that these are mirrored by new operators and others.

There are critical wildlife habitats throughout the Arctic and the study's areas of interest. The following examples highlight some of these regions:

Western Hudson Bay

The shoreline (and during the cold season, ice edge) along Western Hudson Bay is a habitat and key migration route for a number of species including beluga, seals, and polar bears. Many of the activities are seasonal; however the available data does not allow for a detailed breakdown in any detail.

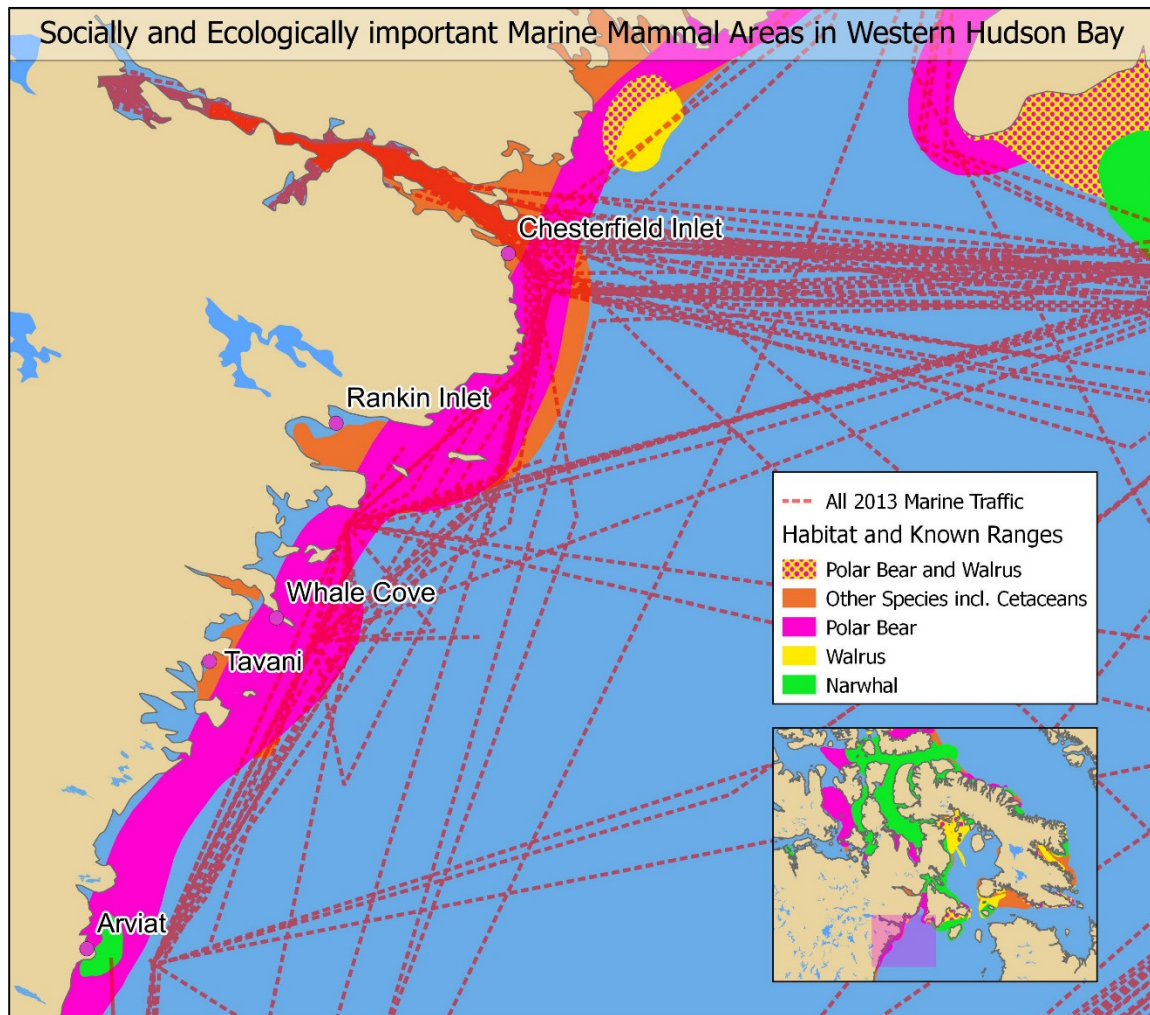


Figure 58: Traffic around Western Hudson Bay

The shipping season in this area is limited to early July through Late October. The following table lists the vessels which approached or sailed within 50 nautical miles of the shoreline in 2013. Note that the dates shown are for arriving in and exit from the Canadian Arctic rather than the Chesterfield Inlet area itself, so the local shipping season was somewhat shorter.

Table 5.1: Risk Assessment: 2013 Vessel Traffic near Western Hudson Bay

Ship Name	Ship Type	NORDREG Arrival Date	NORDREG Departure Date	Port of Origin
Alsternstern	Tanker	01-Jul	19-Jul	Saint-John, NB
Alsternstern	Tanker	04-Aug	25-Aug	Halifax, NS
Atlantic Beech	Tug	11-Jul	08-Nov	Becancour, QC
Atlantic Elm	Tug	12-Jul	17-Oct	Becancour, QC
Atlantic Teak	Tug	23-Jul	17-Aug	Becancour, QC
Camilla Desgagnes	General Cargo	06-Jul	12-Aug	Montreal, QC
Dorsch	Tanker	30-Jun	24-Aug	Lewisporte, NL
Dorsch	Tanker	09-Sep	23-Oct	Lewisporte, NL
Havelstern	Tanker	30-Jul	20-Aug	Halifax, NS
Havelstern	Tanker	09-Oct	24-Oct	Saint-John, NB
Mitiq	General Cargo	12-Jul	15-Aug	Montreal, QC
Nanny	Tanker	04-Jul	07-Sep	l'Anse aux Loups, NL
Nanny	Tanker	13-Sep	24-Oct	Lewisporte, NL
CCGS Pierre Radisson	CCG Icebreaker	07-Jul	10-Oct	Quebec City, QC
Qamutik	General Cargo	01-Oct	07-Nov	Montreal, QC
Camilla Desgagnes	General Cargo	16-Aug	21-Sep	Montreal, QC
Rosaire A. Desgagnes	General Cargo	03-Oct	29-Oct	Montreal, QC
Sedna Desgagnes	General Cargo	18-Jul	03-Aug	Becancour, QC
Sedna Desgagnes	General Cargo	17-Aug	31-Aug	Becancour, QC
Sedna Desgagnes	General Cargo	11-Sep	25-Sep	Becancour, QC
Sedna Desgagnes	General Cargo	10-Oct	01-Nov	Montreal, QC
Transsib Bridge	Tanker	07-Aug	25-Aug	Pascadoula, USA
Travestern	Tanker	29-Jun	27-Jul	Saint-John, NB
Travestern	Tanker	24-Sep	21-Oct	Lewisporte, NL
Umiavut	General Cargo	16-Aug	28-Sep	Montreal, QC
Zelada Desgagnes	General Cargo	27-Sep	11-Oct	Becancour, QC

The following table shows the distribution of arrival and departure dates. While some ships may arrive in late June or leave in early November, most voyages take place during the relatively short period between mid-July to mid-October. As a result, this region is a good candidate for studying the limiting of access (or implementation of mitigation measures as part of a sailing plan) on a seasonal basis, in order to separate the busiest periods of vessel activity from key migration periods and other species-sensitive times.

Table 5.2: Active Shipping Season Breakdown for Western Hudson Bay

Arrival Month	Total Vessels	Departure Month	Total Vessels
June	2	July	2
July	10	August	9
August	5	September	4
September	5	October	8
October	4	November	3

Foxe Basin

As with Western Hudson Bay, habitats for all of narwhal, beluga, polar bear, and walrus are found in Foxe Basin. Each of these species is likely to be present in the region depending on the nature of the ice coverage (or lack thereof) at different times of the year. As shown in the figure below, virtually all the species of interest have a range which includes the region. (Note that the ranges shown in the figure are based on the NLUP community findings, and can include terrestrial regions as part of the general nature of the data).

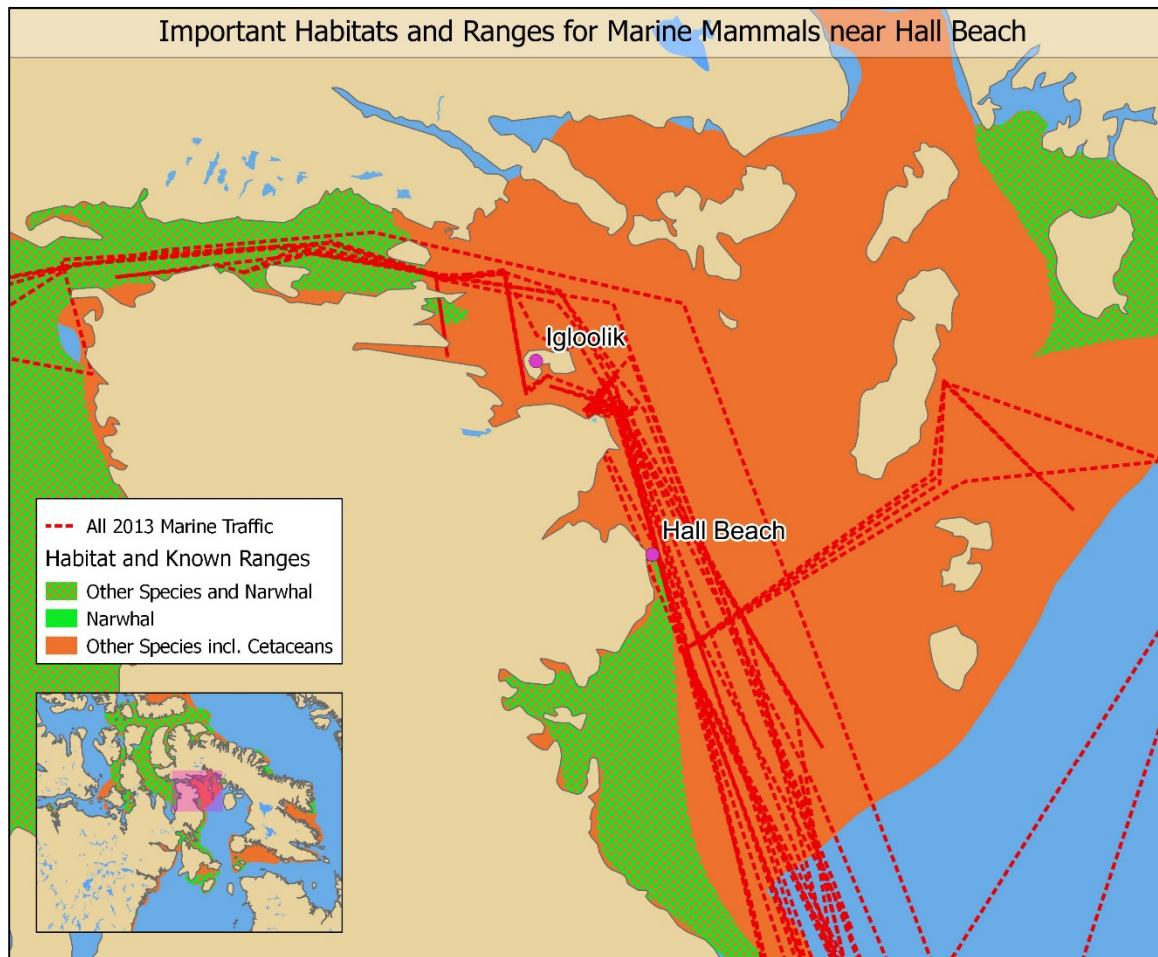


Figure 59: Cetacean habitats and minimal vessel traffic around Northwest Foxe Basin

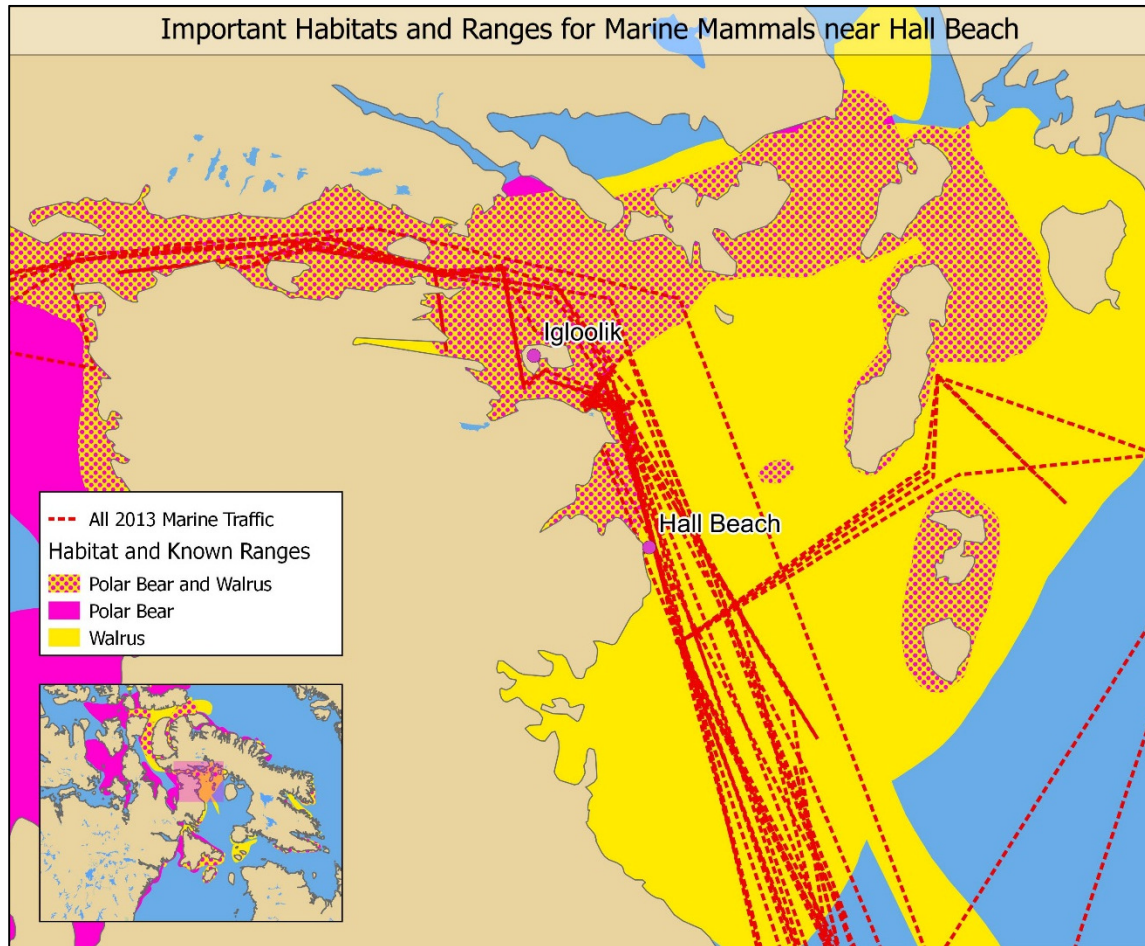


Figure 60: Polar bear and walrus habitats, minimal vessel traffic around Northwest Foxe Basin

The region typically has a relatively limited amount of vessel traffic compared to Western Hudson Bay, in most years consisting entirely of CCG vessels and sealift traffic. The combination of the abundance of sensitive habitats and the relatively low amount of vessel traffic make this a potential candidate region for pilot studies of mitigation measures for vessels, where new strategies could be tested with less logistical effort on the part of the ship operators.

Another important consideration is the potential interaction of vessels with the ice cover throughout the areas of interest. Caribou, walrus, polar bears, and other animals all depend on ice coverage as part of their habitat, and Northern communities' access to the ice (and the dependability of animals residing there) is essential to hunting and conservation efforts.

Figure 61 shows the distribution of caribou throughout the Canadian Arctic, and highlights the number of regions in which the range seasonally extends beyond land to ice coverage.

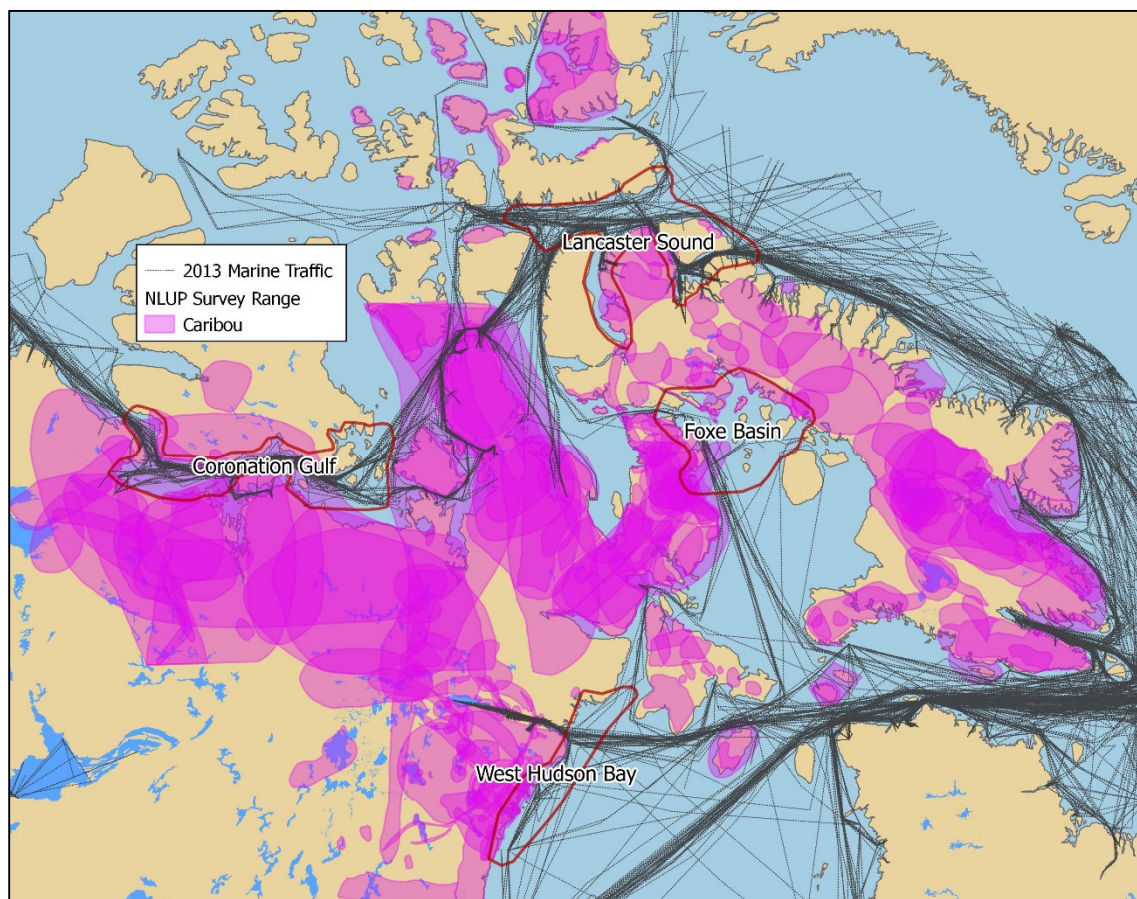


Figure 61: NLUP survey caribou ranges throughout the Arctic

While shipping activity in the Arctic does not currently extend year round, future activities which may involve icebreaking to extend the season will need to account for disruptions to migration paths and other animal activity on the ice sheet.

Recommendation Summary: Incorporate planning for appropriate mitigation measures when sailing in regions with sensitive species and habitat in the NLUP and as mandatory component of sailing plans under the Polar Code.

Specific mitigation measures could include:

- Barring access to certain areas during sensitive species breeding seasons;
- Applying speed limits during periods of high cetacean or pinniped activity;
- Establishing narrower navigation corridors in certain areas to limit the extent of disruption to wildlife. (See also Recommendation 7 – Corridors Initiative.)
- Ensuring future extensions to shipping seasons do not disrupt migration routes across the ice for land animals.



5.3.2 SUPPORT AND EXPAND UNDERWATER ACOUSTICS RESEARCH

Key Issues: Risks of marine mammal injury or mortality from acute events, and of general marine mammal habitat disruption from increasing overall noise levels.

Applicable Areas: All areas.

Relevant Actors: Vessel operators, industry and communities relying on vessel traffic (as partners, source of funding), scientific community members and SMEs currently or previously undertaking studies, Federal and regional government, NGOs.

NLUP Designations: Protected Area, Special Management Area.

The IMO has recognized (MEPC.1/Circ.833 7 April 2014) underwater noise as an undesirable product of shipping which can be mitigated.²⁹

Underwater sound generated by ship activity is an ongoing risk to marine mammal populations. Acute noise events present a risk of hearing damage, and ongoing noise is known to disrupt habitats, impede communication, and present numerous risks to marine mammal populations.

Quantification of the impacts of underwater noise on relatively untouched Arctic habitats will need to be supported by scientific data to gain acceptance of the need for mitigation by the marine industry. Additional support should be provided to current acoustic analysis projects³⁰, and an expansion of the scope of such projects (or the creation of new studies) into the Arctic environment should be implemented.

Researchers are currently studying the noise generated by a limited variety of oceangoing vessels, for example in work involving Port Metro Vancouver³¹, and defensible scientific approaches to sampling, processing, and analyzing noise from these vessels are already documented. Developing a baseline for noise generated by ships in the Arctic environment is a matter of making funding and scientific resources available to complete the work.

Several of the areas covered by this study currently have very low levels of shipping activity, and therefore some wildlife populations which are not habituated to shipping-related noise. These could be particularly valuable sites for further research. Northern Foxe Basin is an example area where high concentrations of marine mammals are present and where marine traffic is low (see Figure 59 and Figure 60 in the previous section above).

Recommendation Summary: Support current studies of ship generated underwater noise, and invest in new or expanded studies of the same in the Arctic Environment. Based on these studies, incorporate noise management and mitigation strategies into regulations for sailing in the Canadian Arctic.

²⁹ https://www.nrdc.org/sites/default/files/wat_14050501a.pdf

³⁰ <http://www.portvancouver.com/wp-content/uploads/2016/04/ECHO-Program-Underwater-Noise-Infographic-Footer-References.pdf>

³¹ <http://www.portvancouver.com/environment/water-land-wildlife/marine-mammals/>



5.3.3 RESTRICTION OF HEAVY FUEL IN THE ARCTIC

Key Issues: Consequences resulting from a heavy fuel oil spill (HFO and IFO) will be more severe in terms of toxicity and persistence than other ship fuel types.

Applicable Areas: All areas.

Relevant Actors: Regulatory bodies.

NLUP Designations: Protected Area, Special Management Area.

The potential impacts of a hydrocarbon spill are significantly greater for HFO fueled vessels than for those using other fuels. Air emissions from burning HFO cause more environmental damage than those with other fuels.

Replacing HFO with alternatives poses no technological barriers, though it will incur additional costs. Emission reduction can be achieved by various means. Spill risk reduction would require a ban on use and carriage, or an enhancement of segregation and protection requirements for fuel and cargo tanks. The IMO Polar Code does not impose any new requirements on burning HFO. While it does increase some tank segregation and protection measures, these are only for higher Polar Class vessels, which are arguably already at less risk of ice or grounding damage that penetrates the hull.

Some operations/operators have already chosen to avoid the use of heavy fuels as a risk mitigation measure; for example Crystal Cruise Lines. Petronav have also begun to phase out HFO from their newbuilds, and will be taking delivery of four dual-fuel LNG/MDO ships in the next 24 months, 3 of which are expected to sail on their Arctic service. While these ships may initially run on HFO, the long term plan is to switch to LNG³². For those involved in more locally competitive markets, a change to more expensive fuel is a major business risk and has to be based on regulation or customer policy/preference to be commercially viable.

All Canadian and US waters south of 60°N are already included in an Emission Control Area (ECA), which addresses the air emission component of the issue. Extending this ECA into the Arctic could be done quite easily. Spill risk mitigation would need more careful consideration.

Compliance with ECA requirements can be achieved by using engine exhaust scrubbers, which can still be used with HFO. Canada could require additional segregation for fuel tanks containing any HFO, or could preclude carriage on any route considered to have a higher probability of grounding or any operation with a higher probability of ice damage. In Task 3 of the project grounding probability was assessed to be lower in Lancaster Sound than in the other three areas considered, which would therefore have higher priority for HFO restrictions. For ice damage, navigational control system such as Canada's AIRSS and the Canadian implementation of the new Polar Code POLARIS system could consider HFO carriage as a factor affecting permissions to operate in certain ice conditions.

³² Desgagnes Group (Petronav) CMAC Prairie and Northern presentation, May 11 2016.



While the Canadian government has signaled an interest in investigating the issue, there has been no indication of having taken a firm position in favor of any real action³³. HFO has however been restricted elsewhere, with the MARPOL convention banning HFO use by vessels in the Southern Ocean around the Antarctic continent in 2011, and recently (April 2016³⁴) banning the carriage of HFO as ship ballast in those same regions.

Recommendation Summary: Consider measures to reduce or eliminate the use of heavy fuels by vessels operating in the Canadian (North American) Arctic.

5.3.4 ADDITIONAL INVESTMENT IN THE DEVELOPMENT OF HYDROGRAPHIC DATA

Key Issues: High risk of vessel grounding in some regions.

Applicable Areas: All areas, however Coronation Gulf, Foxe Basin, and Western Hudson Bay are the most urgently in need of improved hydrography. Western Hudson Bay's inland waterways such as Chesterfield Inlet towards Baker Lake are very narrow in places and have experienced vessel groundings in recent years.

Relevant Actors: Government, potential contributions by other parties (crowdsourcing, projects)

NLUP Designations: Protected Area, Special Management Area.

Poor hydrographic information is widely recognized as a risk factor for many Arctic operations. There is a risk of grounding or striking, which is aggravated if ice conditions require a deviation from a surveyed route. There are also few fixed or floating navigational aids to assist in following safe channels. Chesterfield inlet is a good example of challenging navigation requirements, where incidents have occurred with vessels that sail the region relatively frequently, such as the MV Nanny, which grounded in 2012³⁵ and 2014³⁶.

³³ Transport Canada CMAC Prairie and Northern presentation, May 11 2016.

³⁴ <http://www.imarest.org/themarineprofessional/item/2351-ngos-call-for-arctic-hfo-ban>

³⁵ <http://www.tsb.gc.ca/eng/rapports-reports/marine/2012/m12h0012/m12h0012.asp>

³⁶ <http://www.tsb.gc.ca/eng/rapports-reports/marine/2014/m14c0219/m14c0219.asp>

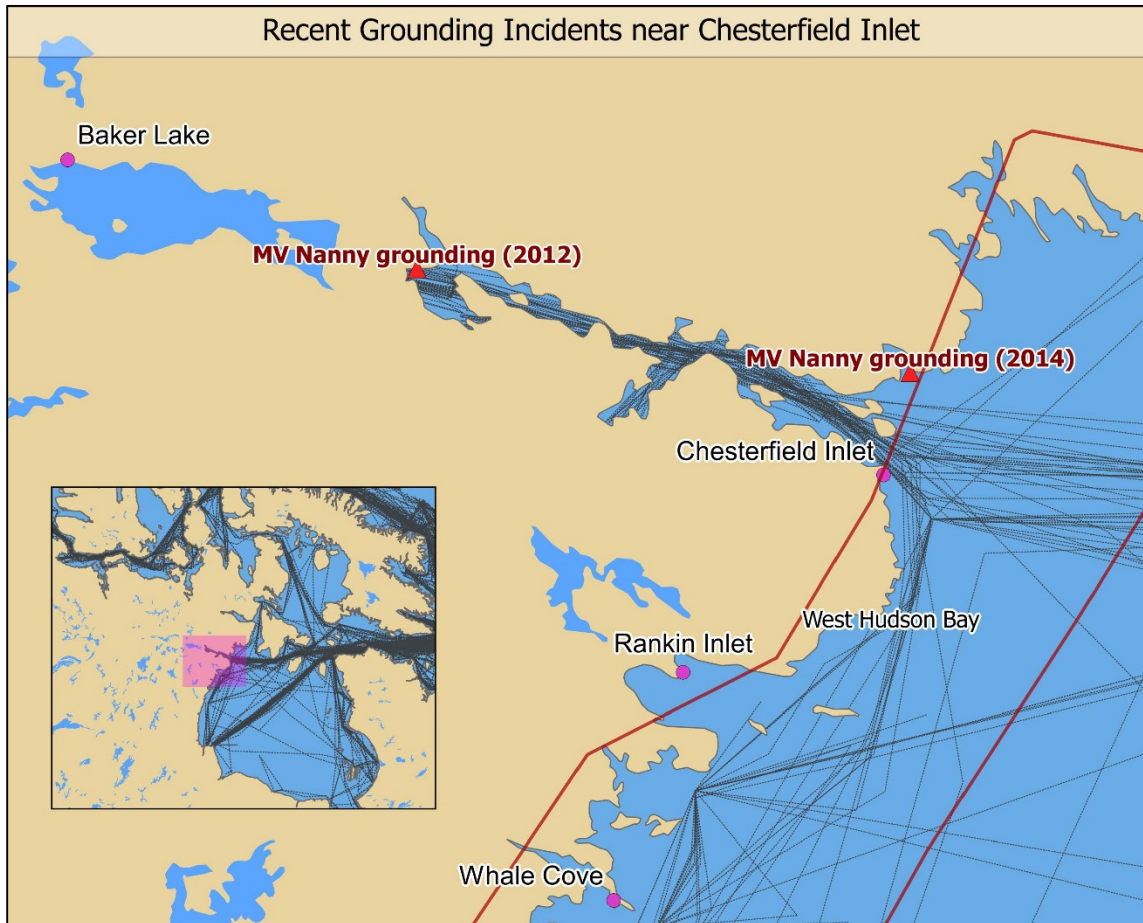


Figure 62: 2012 and 2014 Grounding Sites

The “Corridors” initiative (3.5.6 below) is intended to focus existing Canadian Hydrographic Services (CHS) and other Government of Canada resources in designated corridors, which cover some but not all parts of Coronation Gulf, Western Hudson Bay and Lancaster Sound. While these do cover many higher traffic areas, they do not capture all risks. Giving all priority to the corridors may mean that information available elsewhere becomes progressively lower quality.

It will therefore be advisable to ensure that there is some ability to continue work in other parts of the Arctic, and to supplement government activities where possible with other initiatives. Strict quality standards apply to formal charts, but records from other ships can offer useful supplementary information. CHS and other government websites could be used to provide access to these materials; with suitable cautions.

Recommendation Summary: Support and increase funding as necessary to CHS efforts to improve Arctic hydrography. Target high risk areas such as channels and poorly understood regions with shallow areas as a priority. Use other data to supplement official charts where resources are limited.



5.3.5 INVESTMENT IN BASIC SEALIFT SUPPORT INFRASTRUCTURE

Key Issues: Risk of spills and cargo loss during sealift operations can be exacerbated by a lack of even minimal infrastructure in many Arctic communities.

Applicable Areas: All areas.

Relevant Actors: Vessel operators, communities, and NGOs to support the position that investment is required and the potential consequences of a cargo loss merit the investment. Federal and territorial government.

NLUP Designations: Protected Area, Special Management Area.

Most Arctic communities are almost entirely dependent on sealift operations for resupply of their needs for fuel, food, supplies, and development/building materials. Sealift operations in the Arctic environment pose a risk of hydrocarbon spill, as well as other cargo loss. In many cases, the local marine environment requires the use of floating hoses, ship to ship fuel transfer, or ship to barge transfer for solid/containerized cargo. When operating seasons are short and operational flexibility is limited, vessels and communities may feel forced to undertake risky transfers to avoid losing deliveries altogether.



Figure 63: Unloading to Iqaluit from the Umiaviut via barge and heavy equipment

In most cases, there is little or no local infrastructure present to support sealift operations. The addition of even basic, targeted sealift infrastructure such as graded beaches for landing barges, mooring bollards, breakwaters for managing transfers, or seasonal deployment of navigation aids in regions with challenging hydrography and narrow navigable channels would serve to effectively mitigate many of the risks inherent in sealift operations. There is also a continuing need to ensure that supplies and training for clean-up operations are adequate.



Iqaluit is expected to receive significant investment in the near future, however most Arctic communities continue to depend on marginally acceptable systems for sealift³⁷.

While the logistics of building infrastructure in remote regions or seasonally deploying and collecting navigation aids are challenging, basic upgrades may still be cost effective in mitigating environmental risks and in improving service delivery.

The risk assessments under Task 3 identified Coronation Gulf and Western Hudson's Bay as the areas most at risk of sealift-related incidents, and therefore as having higher priorities for infrastructure investments. This was based primarily on the frequency of sealift operations and the relative challenge of marine navigation in these regions.

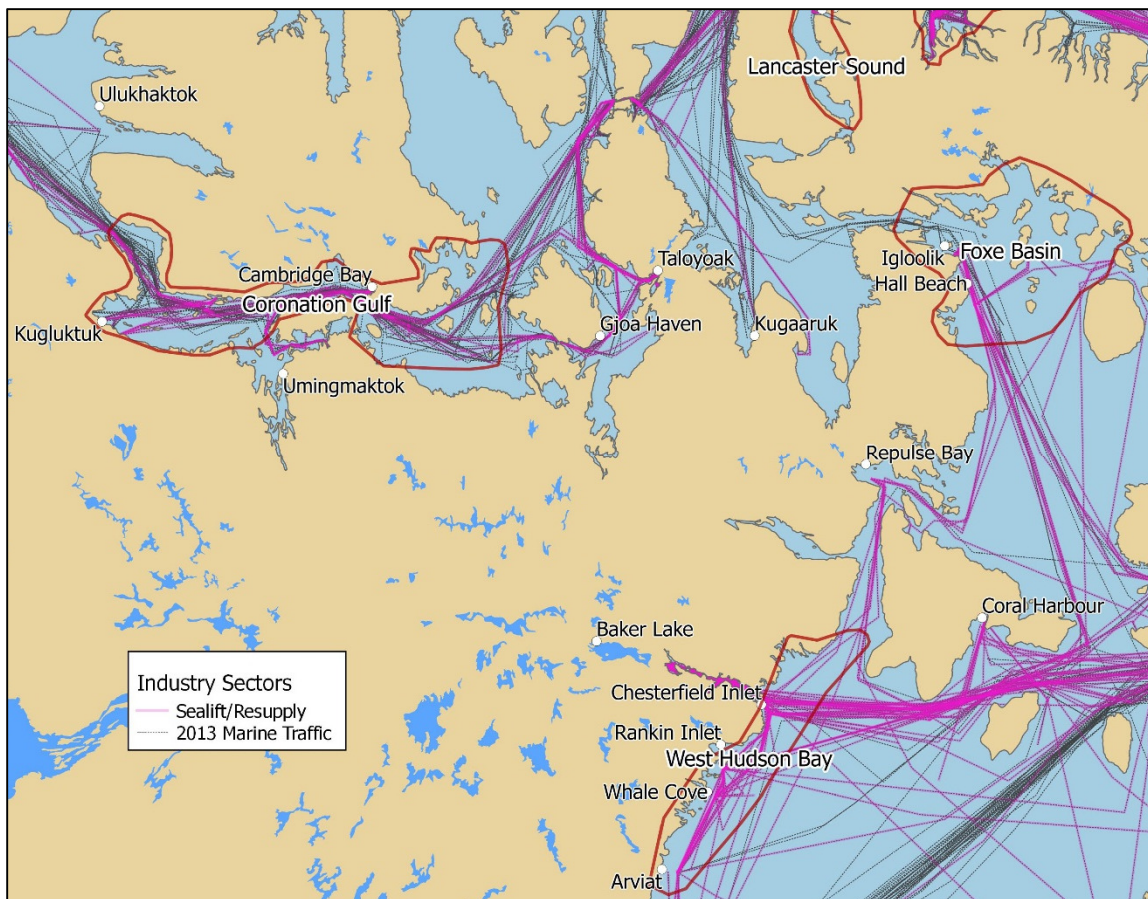


Figure 64: Sealift Traffic in 2013, with high traffic density in the Coronation Gulf and Western Hudson Bay

The Government of Nunavut and the local communities should work with the federal government to determine the most cost-effective investment strategies for the higher risk areas.

³⁷ http://www.nunatsiaqonline.ca/stories/article/65674a_plan_for_an_iqaluit_dock



Recommendation Summary: Invest in basic infrastructure such as graded beaches, breakwaters, or solid piers for remote communities to reduce the risk of cargo loss, spill, or inability to perform sealift. Investment should be based on incentivized/supported studies with sealift operators and the communities they serve to develop informed, experience-based options for cost effective improvements.

5.3.6 TIGHTENED FOCUS AND DEFINED LEADERSHIP OF CORRIDORS INITIATIVE

Key Issues: Continued growth of shipping in the Canadian Arctic will require targeted investment of the limited resources available to support infrastructure and navigation.

Applicable Areas: All areas.

Relevant Actors: Government.

NLUP Designations: Protected Area, Special Management Area.

The Canadian Government's Arctic Corridors Initiative presents a pragmatic starting point for determining how limited resources can be deployed to greatest effect.

However, there does not appear to be a common understanding of the objectives for the initiative amongst the stakeholders involved, including the importance of considering various types of risk holistically. Different government departments are conducting their own development activities, and appear to be both supporting different objectives for the initiative and reproducing much of each other's efforts.

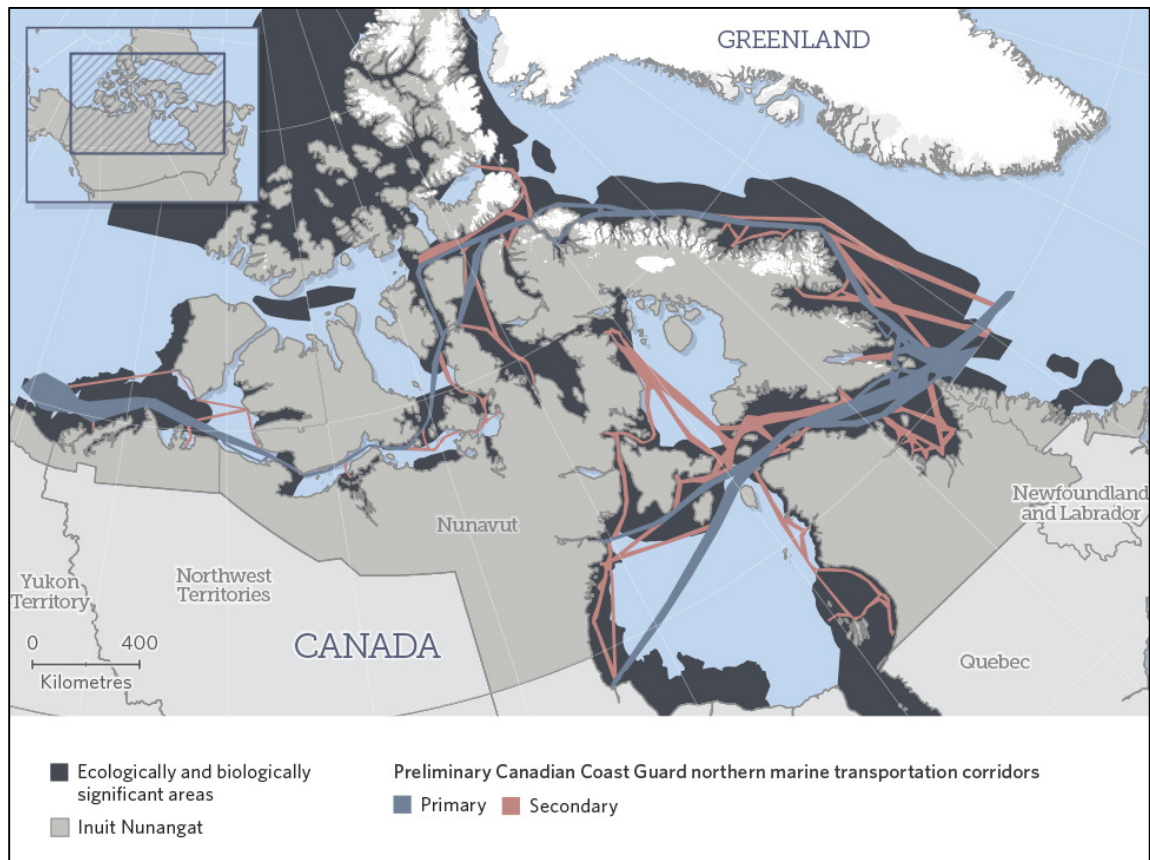


Figure 65: Overlay of Arctic Corridors with EBSAs (from Pew Trust)³⁸

As an example, there is little focus under the current work in avoiding areas of particular environmental sensitivity, or providing alternative routing which could help to achieve this. 3rd parties such as the PEW Charitable Trusts Oceans North have developed reports nothing the lack of a coherent vision for this initiative. Figure 65 shows the overlay of Ecologically and Biologically Sensitive Areas (EBSAs) with the corridors as currently envisaged – environmental sensitivity has not been a factor in defining corridors to date.

It would be beneficial to have the Corridors Initiative mandate extended to address economics, safety and environmental considerations, and to define clear responsibilities and targets.

Recommendation Summary: Review how roles and responsibilities have been allocated for the Arctic Corridors Initiative, and re-align the structure to improve the efficiency of both safety and environmental risk mitigation.

³⁸ <http://www.pewtrusts.org/en/research-and-analysis/reports/2016/04/the-integrated-arctic-corridors-framework>

APPENDIX 1A: DETAILED TRAFFIC DATA FOR STUDY REGIONS

The following tables provide a comprehensive listing of every voyage recorded for each area of interest in 2013:

Table 3: All NORDREG traffic in the Coronation Gulf, 2013

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes	NORDREG			Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Acalephe	812	Adventurer	TOUR	13	DIESEL		26-Jul	12-Sep	49	4,587	4,292	UNKNOWN	Greenland	Unknown	From Greenland Full East to West transit	5.0
Akademik Ioffe	562	Passenger Vessel	TOUR	15 3	DIESEL	617 MT propulsion diesel fuel on board on arrival in zone	27-Jul	09-Aug	14	3,499	2,919	UNKNOWN	St. John's, NL	Greenland		16.0
Alsternstern	1,506	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	01-Jul	19-Jul	19	4,948	4,389	NO	Saint-John, NB	Come-By-Chance, NL	665 CM propulsion diesel fuel on arrival in zone	15.6
Anna	1,268	Adventurer	TOUR	2	DIESEL		01-Jul	19-Sep	54	4,739	4,610	UNKNOWN	Nome, Alaska	Greenland	From Nome, Alaska Full West to East transit	5.0
Arktika	843	Adventurer	TOUR	4	N/A		24-Aug	18-Sep	26	5,628	1,803	UNKNOWN	Greenland	Alaska	From Greenland Full East to West transit	5.0
Bremen	762	Passenger Vessel	TOUR	24 1	IFO	392 CM propulsion diesel fuel on	10-Aug	23-Aug	14	4,194	4,194	UNKNOWN	Barrow, Alaska	Greenland	Full West to East transit	16.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						board on arrival in zone										
Camilla Desgagn?s	1,429	General Cargo	SUPPLY	27	HFO	General cargo	06-Jul	12-Aug	38	8,574	7,182	YES	Montreal, QC	Montreal, QC	434 MT propulsion diesel fuel on board on arrival in zone	14.5
Dodo's Delight	787	Adventurer	TOUR	5	N/A		18-Aug	25-Sep	39	6,061	3,996	UNKNOWN	Alaska	Greenland	Full West to East transit	5.0
Edgar Kotokak	447	Tug	SUPPLY	14	DIESEL	5 barges with general cargo + 1,869,162 liters of LSDL	01-Aug	03-Aug	3	5,357	5,236	NO	Tuktoyaktuk	Tuktoyaktuk	165 CM propulsion diesel fuel on arrival in zone	13.0
Empiricus	496	Adventurer	TOUR	3	N/A		11-Aug	25-Aug	15	1,640	1,640	NO	Alaska	Cambridge Bay	Stopped in Cambridge Bay for the winter West to East transit - Stopped in Cambridge Bay for the winter	5.0
Fairmont's Passion	513	Adventurer	TOUR	2	N/A		22-Jul	22-Aug	32	1,687	1,687	NO	Inuvik	Cambridge Bay	Vessel departed Inuvik on July 15 - Stopped in Cambridge Bay for the winter	5.0
Hanse Explorer	980	Passenger Vessel	TOUR	20	DIESEL	156 CM propulsion diesel fuel on	30-Aug	12-Sep	14	5,856	4,460	UNKNOWN	Greenland	Alaska waters	Full East to west transit	13.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						board on arrival in zone										
Hanseatic	1,107	Passenger Vessel	TOUR	26 7	HFO	443.6 CM propulsion diesel fuel on board on arrival in zone	20-Aug	05-Sep	17	5,826	5,395	UNKNOWN	Greenland	Point Barrow, Alaska	Full East to west transit	14.0
Henry Christoffersen	2,236	Tug	HARBO UR	14	DIESEL	1 Barge with heavy and construction equipment, 203 CM ULSD	08-Aug	03-Sep	27	8,037	7,944	NO	Mackenzie River	Mackenzie River	120 CM propulsion diesel fuel on arrival in zone	14.0
Isatis	798	Adventurer	TOUR	2	N/A		01-Aug	08-Sep	39	4,353	4,309	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
La Belle ?poque	935	Adventurer	TOUR	3	N/A		01-Aug	08-Sep	39	3,912	3,794	UNKNOWN	Greenland	Alaska	Full East to West transit	5.0
Lady M 2	851	Passenger Vessel	TOUR	14	N/A		06-Aug	04-Sep	30	6,120	4,686	UNKNOWN	Greenland	Alaska	Full East to West transit	20.0
Le Soleal	889	Passenger Vessel	TOUR	36 0	HFO	461 CM propulsion diesel fuel on board on arrival in zone	20-Aug	24-Aug	5	1,987	1,965	UNKNOWN	Savissivik, Greenland	Greenland		15.0
Libellule	846	Adventurer	TOUR	7	DIESEL	N/A	04-Aug	06-Sep	34	7,947	4,334	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
Louis S. St. Laurent (CCGS)	1,070	CCG Icebreaker	GOVT	46	DIESEL	N/A	22-Jul	09-Aug	19	10,316	5,101	YES	St. John's, NL	St. John's, NL	3,423 CM propulsion diesel	17.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
															fuel on arrival in zone Full East to West transit of the NW Passage and return	
Louis S. St. Laurent (CCGS)	986	CCG Icebreaker	GOVT	46	DIESEL	N/A	22-Jul	09-Aug	19	10,316	5,101	YES	St. John's, NL	St. John's, NL	3,423 CM propulsion diesel fuel on arrival in zone Full East to West transit of the NW Passage and return	17.0
Martin Bergman	2,568	Research Vessel	RESEAR CH	11	DIESEL	Science equipment	01-Jul	24-Sep	65	3,767	3,765	UNKNOWN	Cambridge Bay	Cambridge Bay	Vessel based in Cambridge Bay year round.- 16.5 CM propulsion diesel fuel on board	15.0
Michaela Rose	867	Passenger Vessel	TOUR	15	DIESEL		28-Aug	12-Sep	16	6,528	4,954	YES	Point Barrow, Alaska	Halifax, NS	Full West to East transit	15.0
Mitig	1,520	General Cargo	SUPPLY	22	HFO	General cargo + 417,801 KG dangerous cargo	12-Jul	15-Aug	35	7,242	6,537	YES	Montreal, QC	Montreal, QC	940 MT propulsion diesel fuel on board on arrival in zone	15.0
Nordic Orion	858	Bulk Carrier	SHIPPIN G	24	HFO	75,000 MT coal in bulk	17-Sep	24-Sep	8	7,147	3,856	UNKNOWN	Vancouver, BC	Europe	842 CM propulsion diesel fuel on arrival in	14.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
															zone Full West to east transit	
Octopus	1,030	Passenger Vessel	TOUR	63	DIESEL		05-Sep	21-Sep	17	7,555	6,538	UNKNOWN	Nome, Alaska	Greenland	Full West to East transit	18.0
Perd pas le Nord	772	Adventurer	TOUR	8	N/A		Unknown	05-Sep	40	4,699	3,028	UNKNOWN	Nuuk, Greenland	Alaska	Full East to West transit	5.0
Pisurayak Kootook	4,560	Tug	SUPPLY	13	DIESEL	3 barges with DEW line fuel, ships fuel and general cargo	29-Jul	08-Oct	72	12,314	12,271	UNKNOWN	Alaska	Alaska	55 CM propulsion diesel fuel on arrival in zone	12.0
Polar Bound	878	Adventurer	TOUR	2	DIESEL		22-Aug	19-Sep	29	3,913	3,913	UNKNOWN	Petersburg, Alaska	Greenland Waters	Full West to East transit	5.0
Polar Prince	765	Research Vessel	RESEARCH	18	DIESEL	1,484.2 CM propulsion diesel fuel on board on arrival in zone	23-Jul	14-Aug	23	6,562	4,757	NO	Cowichan, BC	Cartwright, NL	Ex: CCGS Sir Humphrey Gilbert - Escorting RV Discoverer Full West to east transit	13.0
Sir Wilfrid Laurier (CCGS)	4,349	CCG Icebreaker	GOVT	36	DIESEL	N/A	26-Jul	11-Oct	78	17,946	14,160	YES	Victoria, BC	Victoria, BC	730 CM propulsion diesel fuel on arrival in zone	15.3
Tara	787	Adventurer	TOUR	15	DIESEL	Master: Loic Vallette	18-Sep	10-Oct	23	5,397	5,346	UNKNOWN	Alaska	Greenland	28 CM propulsion diesel fuel on board on arrival in zone Full West to east transit	5.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
The Arctic Joule	507	Adventurer	TOUR	4	N/A	N/A	10-Jul	28-Aug	50	2,181	2,181	UNKNOWN	Inuvik	Cambridge Bay (CAM Main)	Departed from Inuvik and stopped in Cambridge Bay	2.0
Traversay III	1,048	Adventurer	TOUR	3	N/A	N/A	01-Jul	07-Sep	43	8,787	4,510	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
Zelada Desgagn?s	1,064	General Cargo	SUPPLY	21	HFO	General cargo + 232,658 KG dangerous cargo	01-Jul	08-Aug	39	8,432	7,510	YES	Montreal, QC	Montreal, QC	750 CM propulsion diesel fuel on board on arrival in zone	15.5

Table 4: All NORDREG traffic in Western Hudson Bay, 2013

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Alsternstern	726.9	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	Jul-13	Jul-13	19	4,948	4,389	NO	Saint-John, NB	Come-By-Chance, NL	665 CM propulsion diesel fuel on arrival in zone	15.6
Alsternstern	358.7	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	Jul-13	Jul-13	19	4,948	4,389	NO	Saint-John, NB	Come-By-Chance, NL	665 CM propulsion diesel fuel on arrival in zone	15.6
Anna Desgagnes	43.9	General Cargo	SUPPLY	31	IFO	General cargo + 125.75 MT dangerous cargo	Jun-13	Jul-13	35	5,865	5,015	YES	Sept-Iles, QC	Montreal, QC	1,339 MT propulsion diesel fuel on board on arrival in zone	15.5
Atlantic Beech	234.2	Tug	SUPPLY	8	DIESEL	General cargo	Jul-13	Nov-13	90	11,453	5,619	UNKNOWN	Becancour, QC	Saint-John, N.B.	100 CM propulsion diesel fuel on arrival in zone	13.0
Atlantic Elm	162.7	Tug	SUPPLY	8	DIESEL	Barge with general cargo + 2686.13 MT dangerous cargo	Jul-13	Oct-13	98	9,440	3,957	UNKNOWN	Becancour, QC	Saint-John, N.B.	138 CM propulsion diesel fuel on arrival in zone	10.0
Atlantic Teak	154.8	Tug	HARBOUR	7	DIESEL	2 barges with 6321 tons mining material + 5451 tons dangerous	Jul-13	Aug-13	26	4,343	4,019	UNKNOWN	Becancour, QC	Becancour, QC	93 CM propulsion diesel fuel on arrival in zone	12.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Camilla Desgagnes	928.1	General Cargo	SUPPLY	27	HFO	General cargo	Jul-13	Aug-13	38	8,574	7,182	YES	Montreal, QC	Montreal, QC	434 MT propulsion diesel fuel on board on arrival in zone	14.5
Dorsch	904.2	Tanker	SUPPLY	15	HFO	6,840 CM refined petroleum products	Jun-13	Aug-13	56	9,653	7,946	UNKNOWN	Lewisporte, NL	Lewisporte, NL		14.0
Dorsch	265.7	Tanker	SUPPLY	15	HFO	6,840 CM refined petroleum products	Jun-13	Aug-13	56	9,653	7,946	UNKNOWN	Lewisporte, NL	Lewisporte, NL		14.0
Explorer of Sweden	21.9	Adventurer	TOUR	8	DIESEL	0	Aug-13	Sep-13	29	6,119	3,629	UNKNOWN	Nuuk, Greenland	Halifax	From Nuuk, Greenland and then to Halifax, NS	5.0
Havelstern	165.8	Tanker	SUPPLY	19	HFO	19,345 CM Jet A-1	Jul-13	Jul-13	16	2,889	1,662	YES	Come-By-Chance, NL	Saint-John, NB	730 MT propulsion diesel fuel on arrival in zone	14.5
Havelstern	181	Tanker	SUPPLY	19	HFO	19,345 CM Jet A-1	Jul-13	Jul-13	16	2,889	1,662	YES	Come-By-Chance, NL	Saint-John, NB	730 MT propulsion diesel fuel on arrival in zone	14.5
Mitiq	1141.1	General Cargo	SUPPLY	22	HFO	General cargo + 417,801 KG dangerous cargo	Jul-13	Aug-13	35	7,242	6,537	YES	Montreal, QC	Montreal, QC	940 MT propulsion diesel fuel on board on arrival in zone	15.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Nanny	163.4	Tanker	SUPPLY	14	IFO	10,314 CM refined petroleum products	Jul-13	Sep-13	66	13,181	7,563	UNKNOWN	I'Anse aux Loups, NL	Lewisporte, NL		15.0
Nanny	390	Tanker	SUPPLY	14	IFO	10,314 CM refined petroleum products	Jul-13	Sep-13	66	13,181	7,563	UNKNOWN	I'Anse aux Loups, NL	Lewisporte, NL		15.0
Pierre Radisson (CCGS)	161.1	CCG Icebreaker	GOVT	39	DIESEL	N/A	Jul-13	Oct-13	96	20,891	20,411	YES	Quebec City, QC	Quebec City, QC	2,260 CM propulsion diesel fuel on arrival in zone	16.0
Qamutik	755.6	General Cargo	SUPPLY	22	HFO	General cargo + 433,028 KG dangerous cargo	Jul-13	Jul-13	22	2,665	1,779	YES	Montreal, QC	Montreal, QC	692 CM propulsion diesel fuel on board on arrival in zone	16.0
Rosaire A. Desgagnes	1522.5	General Cargo	SUPPLY	17	HFO	3,269 MT general cargo + 328 MT dangerous cargo	Jul-13	Jul-13	12	5,764	2,747	YES	Montreal, QC	Montreal, QC	796 MT propulsion diesel fuel on board on arrival in zone	15.0
Rosaire A. Desgagnes	817	General Cargo	SUPPLY	17	HFO	3,269 MT general cargo + 328 MT dangerous cargo	Jul-13	Jul-13	12	5,764	2,747	YES	Montreal, QC	Montreal, QC	796 MT propulsion diesel fuel on board on arrival in zone	15.0
Sedna Desgagnes	171.6	General Cargo	SUPPLY	22	HFO	General cargo	Jul-13	Aug-13	17	4,080	3,440	UNKNOWN	Becancour, QC	Becancour, QC	512 MT propulsion diesel	15.5

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
															fuel on board on arrival in zone	
Sedna Desgagnes	167.5	General Cargo	SUPPLY	22	HFO	General cargo	Jul-13	Aug-13	17	4,080	3,440	UNKNOWN	Becancour, QC	Becancour, QC	512 MT propulsion diesel fuel on board on arrival in zone	15.5
Sedna Desgagnes	165	General Cargo	SUPPLY	22	HFO	General cargo	Jul-13	Aug-13	17	4,080	3,440	UNKNOWN	Becancour, QC	Becancour, QC	512 MT propulsion diesel fuel on board on arrival in zone	15.5
Sedna Desgagnes	683.1	General Cargo	SUPPLY	22	HFO	General cargo	Jul-13	Aug-13	17	4,080	3,440	UNKNOWN	Becancour, QC	Becancour, QC	512 MT propulsion diesel	15.5
Silver Explorer	112.6	Passenger Vessel	TOUR	24 2	H/D	386 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Sep-13	21	7,088	6,003	UNKNOWN	Ittividleq, Greenland	Nuuk, Greenland	Ex: Prince Albert II	17.0
Transsib Bridge	166.6	Tanker	MINE	20	HFO	38,551 MT refined petroleum products	Aug-13	Aug-13	19	5,579	3,998	YES	Pascadoula, USA	St. John's, NL		15.0
Travestern	172.2	Tanker	SUPPLY	17	HFO	19,256 CM refined petroleum products	Jun-13	Jul-13	29	5,390	4,584	UNKNOWN	Saint-John, NB	Lewisporte, NL	750 CM propulsion diesel fuel on arrival in zone	15.0
Travestern	171.5	Tanker	SUPPLY	17	HFO	19,256 CM refined	Jun-13	Jul-13	29	5,390	4,584	UNKNOWN	Saint-John, NB	Lewisporte, NL	750 CM propulsion diesel	15.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						petroleum products									fuel on arrival in zone	
Umiavut	275.4	General Cargo	SUPPLY	23	HFO	General cargo + 26,384 KG dangerous cargo	Jul-13	Jul-13	30	5,961	5,138	YES	Montreal, QC	Montreal, QC	450 CM propulsion diesel fuel on board on arrival in zone	14.0
Zelada Desgagnes	174.8	General Cargo	SUPPLY	21	HFO	General cargo + 232,658 KG dangerous cargo	Jul-13	Aug-13	39	8,432	7,510	YES	Montreal, QC	Montreal, QC	750 CM propulsion diesel fuel on board on arrival in zone	15.5

Table 5: All NORDREG traffic in Foxe Basin, 2013

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Alsternstern	671	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	01-Jul	19-Jul	19	4,948	4,389	NO	Saint-John, NB	Come-By-Chance, NL	665 CM propulsion diesel fuel on arrival in zone 0	15.6
Des Groseilliers (CCGS)	288	CCG Icebreaker	GOVT	45	DIESEL	N/A	19-Jul	14-Oct	88	21,789	19,571	YES	Quebec City, QC	Quebec City, QC	1,400 CM propulsion diesel fuel on arrival in zone 0	16.0
Dorsch	789	Tanker	SUPPLY	15	HFO	6,840 CM refined petroleum products	30-Jun	24-Aug	56	9,653	7,946	UNKNOWN	Lewisporte, NL	Lewisporte, NL	0 0	14.0
Henry Larsen (CCGS)	1,395	CCG Icebreaker	GOVT	54	DIESEL	N/A	30-Jun	09-Jul	10	6,220	2,767	YES	St. John's, NL	St. John's, NL	0 0	16.5
Louis S. St. Laurent (CCGS)	309	CCG Icebreaker	GOVT	46	DIESEL	N/A	22-Jul	09-Aug	19	10,316	5,101	YES	St. John's, NL	St. John's, NL	3,423 CM propulsion diesel fuel on arrival in zone Full East to West transit of the NW Passage and return	17.0
Nanny	198	Tanker	SUPPLY	14	IFO	10,314 CM refined petroleum products	04-Jul	07-Sep	66	13,181	7,563	UNKNOWN	l'Anse aux Loups, NL	Lewisporte, NL	0 0	15.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Nanny	132	Tanker	SUPPLY	14	IFO	10,314 CM refined petroleum products	04-Jul	07-Sep	66	13,181	7,563	UNKNOWN	L'Anse aux Loups, NL	Lewisporte, NL	0 0	15.0
Pierre Radisson (CCGS)	675	CCG Icebreaker	GOVT	39	DIESEL	N/A	07-Jul	10-Oct	96	20,891	20,411	YES	Quebec City, QC	Quebec City, QC	2,260 CM propulsion diesel fuel on arrival in zone Partial East to West transit of the NW Passage as far as 117W in McClure Strait and return	16.0
Rosaire A. Desgagn?s	337	General Cargo	SUPPLY	17	HFO	3,269 MT general cargo + 328 MT dangerous cargo	20-Jul	31-Jul	12	5,764	2,747	YES	Montreal, QC	Montreal, QC	796 MT propulsion diesel fuel on board on arrival in zone 0	15.0
Travestern	425	Tanker	SUPPLY	17	HFO	19,256 CM refined petroleum products	29-Jun	27-Jul	29	5,390	4,584	UNKNOWN	Saint-John, NB	Lewisporte, NL	750 CM propulsion diesel fuel on arrival in zone 0	15.0
Umiavut	810	General Cargo	SUPPLY	23	HFO	General cargo + 26,384 KG dangerous cargo	01-Jul	30-Jul	30	5,961	5,138	YES	Montreal, QC	Montreal, QC	450 CM propulsion diesel fuel on board on arrival in zone 0	14.0
Zelada Desgagn?s	56	General Cargo	SUPPLY	21	HFO	General cargo + 232,658 KG	01-Jul	08-Aug	39	8,432	7,510	YES	Montreal, QC	Montreal, QC	750 CM propulsion diesel	15.5



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						dangerous cargo									fuel on board on arrival in zone 0	
Alsternstern	671	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	01-Jul	19-Jul	19	4,948	4,389	NO	Saint-John, NB	Come-By- Chance, NL	665 CM propulsion diesel fuel on arrival in zone 0	15.6
Des Groseilliers (CCGS)	288	CCG Icebreaker	GOVT	45	DIESEL	N/A	19-Jul	14-Oct	88	21,789	19,571	YES	Quebec City, QC	Quebec City, QC	1,400 CM propulsion diesel fuel on arrival in zone 0	16.0
Dorsch	789	Tanker	SUPPLY	15	HFO	6,840 CM refined petroleum products	30-Jun	24-Aug	56	9,653	7,946	UNKNOWN	Lewisporte, NL	Lewisporte, NL	0 0	14.0

Table 6: All NORDREG traffic in Lancaster Sound, 2013

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Acaphepe	926	Adventurer	TOUR	13	DIESEL	0	Jul-13	Sep-13	49	4,587	4,292	UNKNOWN	Greenland	Unknown	From Greenland Full East to West transit	5.0
Akademik Ioffe	1,955	Passenger Vessel	TOUR	153	DIESEL	617 MT propulsion diesel fuel on board on arrival in zone	Jul-13	Aug-13	14	3,499	2,919	UNKNOWN	St. John's, NL	Greenland		16.0
Alsternstern	1,185	Tanker	SUPPLY	15	HFO	19,615 CM ULSD	Jul-13	Jul-13	19	4,948	4,389	NO	Saint-John, NB	Come-By-Chance, NL	665 CM propulsion diesel fuel on arrival in zone	15.6
Amundsen (CCGS)	532	CCG Icebreaker	GOVT	79	DIESEL	N/A	Aug-13	Aug-13	16	5,973	3,385	UNKNOWN	Quebec City, QC	N/A		16.0
Amundsen (CCGS)	1,364	CCG Icebreaker	GOVT	79	DIESEL	N/A	Aug-13	Aug-13	16	5,973	3,385	UNKNOWN	Quebec City, QC	N/A		16.0
Anna	382	Adventurer	TOUR	2	DIESEL	0	Jul-28	Sep-13	54	4,739	4,610	UNKNOWN	Nome, Alaska	Greenland	From Nome, Alaska Full West to East transit	5.0
Anna Desgagnés	1,841	General Cargo	SUPPLY	31	IFO	General cargo + 125.75 MT dangerous cargo	Jun-13	Jul-13	35	5,865	5,015	YES	Sept-Iles, QC	Montreal, QC	1,339 MT propulsion diesel fuel on board on arrival in zone	15.5
Arctic Tern 1	1,158	Adventurer	TOUR	7	DIESEL	0	Unknown	Sep-13	16	1,208	1,208	UNKNOWN	Greenland	Greenland	From Greenland and back to Greenland	5.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Arctic Tern UK	1,301	Adventurer	TOUR	6	N/A	0	Aug-13	Sep-13	32	3,078	2,743	UNKNOWN	Kraulshavn, Greenland	Alaska	From Greenland	5.0
Arktika	348	Adventurer	TOUR	4	N/A	0	Aug-13	Sep-13	26	5,628	1,803	UNKNOWN	Greenland	Alaska	From Greenland Full East to West transit	5.0
Avataq	504	General Cargo	SUPPLY	22	IFO	General cargo + 157,742 KG dangerous cargo	Jul-13	Aug-13	33	5,745	4,432	YES	Contrecoeur, QC	Montreal, QC	425 CM propulsion diesel fuel on board on arrival in zone	14.0
Avataq	516	General Cargo	SUPPLY	22	IFO	General cargo + 157,742 KG dangerous cargo	Jul-13	Aug-13	33	5,745	4,432	YES	Contrecoeur, QC	Montreal, QC	425 CM propulsion diesel fuel on board on arrival in zone	14.0
Bremen	333	Passenger Vessel	TOUR	24 1	IFO	392 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Aug-13	14	4,194	4,194	UNKNOWN	Barrow, Alaska	Greenland	Full West to East transit	16.0
Camilla Desgagn?s	1,170	General Cargo	SUPPLY	27	HFO	General cargo	Jul-13	Aug-13	38	8,574	7,182	YES	Montreal, QC	Montreal, QC	434 MT propulsion diesel fuel on board on arrival in zone	14.5
Claude A. Desgagn?s	752	General Cargo	SUPPLY	20	IFO	3,818 MT general cargo + 242.4 MT dangerous cargo	Jun-13	Jul-13	25	4,268	4,167	YES	Montreal, QC	Montreal, QC	905 CM propulsion diesel fuel on board on arrival in zone	15.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Claude A. Desgagnés	504	General Cargo	SUPPLY	20	IFO	3,818 MT general cargo + 242.4 MT dangerous cargo	Jun-13	Jul-13	25	4,268	4,167	YES	Montreal, QC	Montreal, QC	905 CM propulsion diesel fuel on board on arrival in zone	15.0
Claude A. Desgagnés	508	General Cargo	SUPPLY	20	IFO	3,818 MT general cargo + 242.4 MT dangerous cargo	Jun-13	Jul-13	25	4,268	4,167	YES	Montreal, QC	Montreal, QC	905 CM propulsion diesel fuel on board on arrival in zone	15.0
Dax	457	Adventurer	TOUR	3	N/A	0	Aug-13	Unknown	30	2,068	1,166	NO	Upernavik, Greenland	Clyde River (Kangiqtugaapik)	Vessel loaded onboard MV Anna Desgagnés https://northwestpassage2013.wordpress.com/	5.0
Des Groseilliers (CCGS)	4,327	CCG Icebreaker	GOVT	45	DIESEL	N/A	Jul-13	Oct-13	88	21,789	19,571	YES	Quebec City, QC	Quebec City, QC	1,400 CM propulsion diesel fuel on arrival in zone	16.0
Dodo's Delight	775	Adventurer	TOUR	5	N/A	0	Aug-13	Sep-13	39	6,061	3,996	UNKNOWN	Alaska	Greenland	Full West to East transit	5.0
Hanse Explorer	847	Passenger Vessel	TOUR	20	DIESEL	156 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Sep-13	14	5,856	4,460	UNKNOWN	Greenland	Alaska waters	Full East to west transit	13.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Hanseatic	878	Passenger Vessel	TOUR	26 7	HFO	443.6 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Sep-13	17	5,826	5,395	UNKNOWN	Greenland	Point Barrow, Alaska	Full East to west transit	14.0
Havelstern	1,364	Tanker	SUPPLY	19	HFO	19,345 CM Jet A-1	Jul-13	Jul-13	16	2,889	1,662	YES	Come-By- Chance, NL	Saint-John, NB	730 MT propulsion diesel fuel on arrival in zone	14.5
Henry Larsen (CCGS)	5,568	CCG Icebreaker	GOVT	54	DIESEL	N/A	Jun-13	Jul-13	10	6,220	2,767	YES	St. John's, NL	St. John's, NL		16.5
HHL Mississippi	554	General Cargo	MINE	16	HFO	General cargo	Sep-13	Sep-13	12	5,548	4,330	YES	Montreal, QC	Montreal, QC	563 MT propulsion diesel fuel on board on arrival in zone	15.0
Hudson (CSS)	248	CCG Vessel	GOVT	40	DIESEL	N/A	Aug-13	Sep-13	21	5,636	4,251	YES	Halifax, NS	Halifax, NS		16.0
Isatis	530	Adventurer	TOUR	2	N/A	0	Aug-13	Sep-13	39	4,353	4,309	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
Jana Desgagn?s	536	Tanker	SUPPLY	17	IFO	8,294 CM ULSD; 1,318 CM gas; 800 CM Jet fuel - Total of 10,412 CM	Jun-13	Jul-13	24	1,730	1,611	YES	Montreal, QC	Quebec City, QC	385 CM propulsion diesel fuel on arrival in zone	12.5
Jana Desgagn?s	563	Tanker	SUPPLY	17	IFO	8,294 CM ULSD; 1,318 CM gas; 800 CM Jet fuel -	Jun-13	Jul-13	24	1,730	1,611	YES	Montreal, QC	Quebec City, QC	385 CM propulsion diesel	12.5



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						Total of 10,412 CM									fuel on arrival in zone	
La Belle ?poque	475	Adventurer	TOUR	3	N/A	0	Aug-13	Sep-13	39	3,912	3,794	UNKNOWN	Greenland	Alaska	Full East to West transit	5.0
Lady M 2	1,068	Passenger Vessel	TOUR	14	N/A	0	Aug-13	Sep-13	30	6,120	4,686	UNKNOWN	Greenland	Alaska	Full East to West transit	20.0
Le Boreal	548	Passenger Vessel	TOUR	36 0	HFO	N/A	Aug-13	Sep-13	5	2,857	2,718	UNKNOWN	Greenland	Greenland		15.0
Le Soleal	470	Passenger Vessel	TOUR	36 0	HFO	461 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Aug-13	5	1,987	1,965	UNKNOWN	Savissivik, Greenland	Greenland		15.0
Le Soleal	901	Passenger Vessel	TOUR	36 0	HFO	461 CM propulsion diesel fuel on board on arrival in zone	Aug-13	Aug-13	5	1,987	1,965	UNKNOWN	Savissivik, Greenland	Greenland		15.0
Libellule	563	Adventurer	TOUR	7	DIESEL	N/A	Aug-13	Sep-13	34	7,947	4,334	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
Louis S. St. Laurent (CCGS)	520	CCG Icebreaker	GOVT	46	DIESEL	N/A	Jul-13	Aug-13	19	10,316	5,101	YES	St. John's, NL	St. John's, NL	3,423 CM propulsion diesel fuel on arrival in zone Full East to West transit of the NW Passage and return	17.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Louis S. St. Laurent (CCGS)	2,829	CCG Icebreaker	GOVT	46	DIESEL	N/A	Jul-13	Aug-13	19	10,316	5,101	YES	St. John's, NL	St. John's, NL	3,423 CM propulsion diesel fuel on arrival in zone Full East to West transit of the NW Passage and return	17.0
Michaela Rose	794	Passenger Vessel	TOUR	15	DIESEL	0	Aug-13	Sep-13	16	6,528	4,954	YES	Point Barrow, Alaska	Halifax, NS	Full West to East transit	15.0
Mitiq	1,024	General Cargo	SUPPLY	22	HFO	General cargo + 417,801 KG dangerous cargo	Jul-13	Aug-13	35	7,242	6,537	YES	Montreal, QC	Montreal, QC	940 MT propulsion diesel fuel on board on arrival in zone	15.0
Nanny	1,221	Tanker	SUPPLY	14	IFO	10,314 CM refined petroleum products	Jul-13	Sep-13	66	13,181	7,563	UNKNOWN	l'Anse aux Loups, NL	Lewisporte, NL		15.0
National Geographic Explorer	2,255	Passenger Vessel	TOUR	24 3	IFO	279 MT propulsion diesel fuel on board on arrival in zone	Aug-13	Aug-13	21	7,178	7,178	UNKNOWN	Uummannaq, Greenland	Greenland		17.5
Nordic Orion	397	Bulk Carrier	SHIPPING	24	HFO	75,000 MT coal in bulk	Sep-13	Sep-13	8	7,147	3,856	UNKNOWN	Vancouver, BC	Europe	842 CM propulsion diesel fuel on arrival in zone Full West to east transit	14.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Octopus	1,211	Passenger Vessel	TOUR	63	DIESEL	0	Sep-13	Sep-13	17	7,555	6,538	UNKNOWN	Nome, Alaska	Greenland	Full West to East transit	18.0
OW Atlantic	801	Tanker	SUPPLY	11	HFO	4,620 MT refined petroleum products	Aug-13	Sep-13	11	3,070	2,539	UNKNOWN	Copengagen , Norway	Skagen, Norway	Bunkering CCG vessels	14.0
Perd pas le Nord	218	Adventurer	TOUR	8	N/A	0	Unkno wn	Sep-13	40	4,699	3,028	UNKNOWN	Nuuk, Greenland	Alaska	Full East to West transit	5.0
Polar Bound	642	Adventurer	TOUR	2	DIESEL	0	Aug-13	Sep-13	29	3,913	3,913	UNKNOWN	Petersburg, Alaska	Greenland Waters	Full West to East transit	5.0
Polar Prince	606	Research Vessel	RESEAR CH	18	DIESEL	1,484.2 CM propulsion diesel fuel on board on arrival in zone	Jul-13	Aug-13	23	6,562	4,757	NO	Cowichan, BC	Cartwright, NL	Ex: CCGS Sir Humphrey Gilbert - Escorting RV Discoverer Full West to east transit	13.0
Qamutik	695	General Cargo	SUPPLY	22	HFO	General cargo + 433,028 KG dangerous cargo	Jul-13	Jul-13	22	2,665	1,779	YES	Montreal, QC	Montreal, QC	692 CM propulsion diesel fuel on board on arrival in zone	16.0
Qamutik	492	General Cargo	SUPPLY	22	HFO	General cargo + 433,028 KG dangerous cargo	Jul-13	Jul-13	22	2,665	1,779	YES	Montreal, QC	Montreal, QC	692 CM propulsion diesel fuel on board on arrival in zone	16.0
Rosaire A. Desgagn?s	741	General Cargo	SUPPLY	17	HFO	3,269 MT general cargo + 328 MT	Jul-13	Jul-13	12	5,764	2,747	YES	Montreal, QC	Montreal, QC	796 MT propulsion diesel	15.0

Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
						dangerous cargo									fuel on board on arrival in zone	
Sarah Desgagn?s	1,020	Tanker	SUPPLY	19	HFO	4,797 MT Jet fuel, 1,488 MT gasoline, 8,599 diesel fuel	Jul-13	Aug-13	23	2,525	1,223	YES	Montreal, QC	Quebec City, QC		15.0
Sea Adventurer	2,893	Passenger Vessel	TOUR	18 7	H/D	280 CM propulsion diesel fuel on board on arrival in zone	Jun-13	Jul-13	4	2,224	1,567	UNKNOWN	Ilulissat, Greenland	Greenland	Ex: Clipper Adventurer - From and to Greenland	17.0
Tara	1,478	Adventurer	TOUR	15	DIESEL	Master: Loic Vallette	Sep-13	Oct-13	23	5,397	5,346	UNKNOWN	Alaska	Greenland	28 CM propulsion diesel fuel on board on arrival in zone Full West to east transit	5.0
Tooluka	658	Adventurer	TOUR	6	N/A	0	Unkno wn	Unknown	24	1,565	1,565	UNKNOWN	Nuuk, Greenland	Alaska	Turned around at east entrance of Bellot Strait	5.0
Traversay III	950	Adventurer	TOUR	3	N/A	N/A	Jul-27	Sep-13	43	8,787	4,510	UNKNOWN	Upernavik, Greenland	Alaska	Full East to West transit	5.0
Travestern	329	Tanker	SUPPLY	17	HFO	19,256 CM refined petroleum products	Jun-13	Jul-13	29	5,390	4,584	UNKNOWN	Saint-John, NB	Lewisporte, NL	750 CM propulsion diesel fuel on arrival in zone	15.0



Vessel	Distance in Region (km)	Ship Type	Industry	P O B	Fuel	Cargo Notes		NORDREG		Total Distance (km)	NORDREG Distance (km)	Waste Facilities @ Destination	Origin	Destination	Remarks	Avg. Speed
							Arrival	Leave	Days							
Umiavut	1,389	General Cargo	SUPPLY	23	HFO	General cargo + 26,384 KG dangerous cargo	Jul-13	Jul-13	30	5,961	5,138	YES	Montreal, QC	Montreal, QC	450 CM propulsion diesel fuel on board on arrival in zone	14.0
Zelada Desgagn?s	946	General Cargo	SUPPLY	21	HFO	General cargo + 232,658 KG dangerous cargo	Jul-13	Aug-13	39	8,432	7,510	YES	Montreal, QC	Montreal, QC	750 CM propulsion diesel fuel on board on arrival in zone	15.5



APPENDIX 2A: MAIN NUNAVUT ECOLOGICAL DATA SOURCES

ECOLOGICALLY AND BIOLOGICALLY SIGNIFICANT AREAS FROM THE DEPARTMENT OF FISHERIES AND OCEANS

The identification of EBSAs is an initiative developed by Fisheries and Oceans Canada (DFO) following Canada's Ocean Act (1996). It is considered a useful tool to call attention to areas that have particular ecological or biological significance, in order to facilitate a greater-than-usual degree of risk aversion in the management of activities. In 2011, a national Canadian Science Advisory Secretariat (CSAS) science advisory process was held in Winnipeg, Manitoba to provide science advice on the identification of EBSAs in the Canadian Arctic based on guidance developed by Fisheries and Oceans Canada. Three of the four study areas on which this report focuses on have been identified as an important area to be eventually protected. In their report, a team of experts identified the importance of the Western Hudson Bay, Lancaster Sound as EBSA zones 1.6, 2.6, respectively. The Coronation Gulf has also been partly identified with ESBAs around Lambert Channel, Bathurst Inlet, and Queen Maud Gulf (areas 3.1, 3.2 and 3.3, respectively). In 2014, a similar exercise was made in June 2009 in a regional science peer review meeting with science experts from DFO, Natural Resources Canada, Environment Canada, Parks Canada Agency and the Government of Nunavut to identify ESBAs in the Northern Foxe Basin study area (Paulic et al. 2014). Reasons for retaining these areas as EBSAs were:

In Western Hudson Bay:

- Presence of unique macrophytes (macro algae);
- Arctic Char migration corridor and feeding area;
- Beluga aggregation
- Fall migration area for Polar Bear.

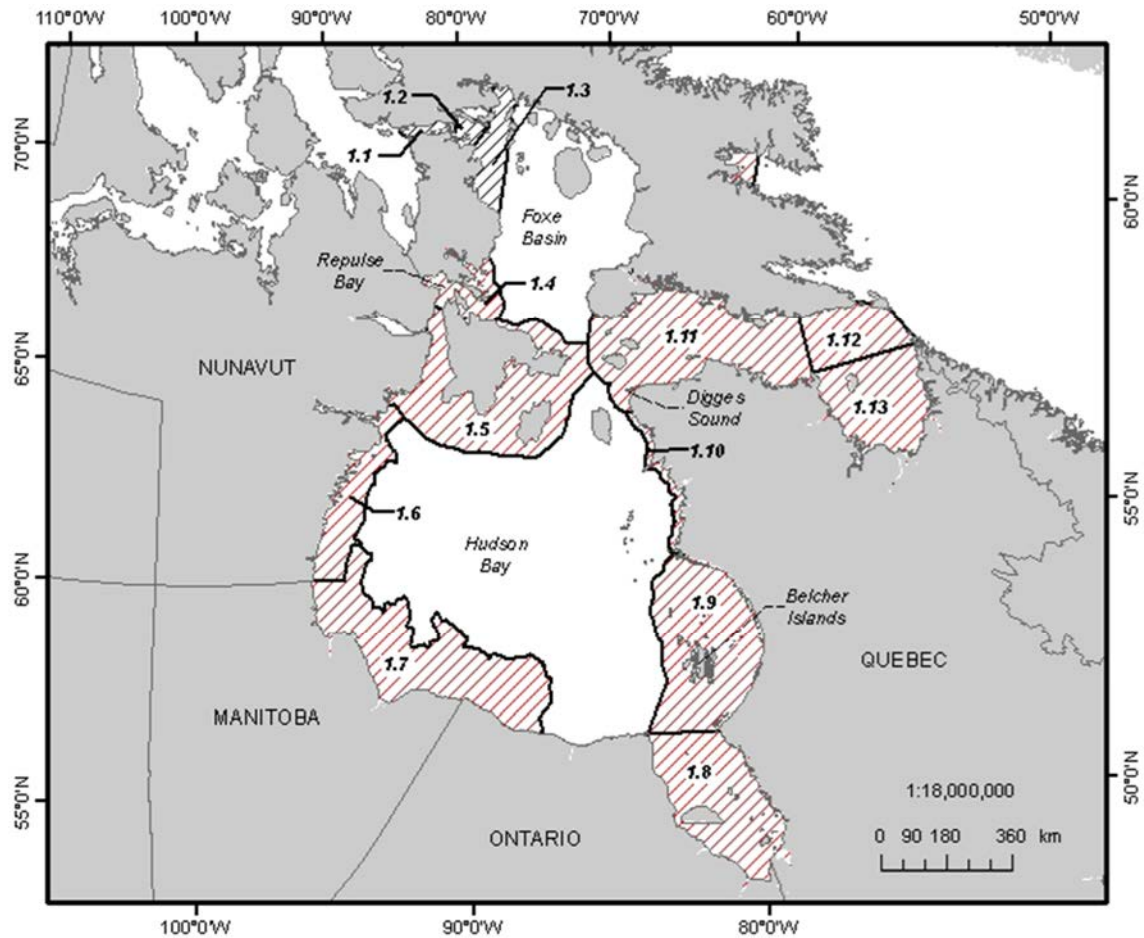


Figure 66. EBSAs identified within the Hudson Bay Complex biogeographic region, including the Western Hudson Bay area (1.6) and the Foxe Basin (1.1, 1.2, & 1.3). From CSAS (2011).

In the Northern Foxe Basin:

- High productivity at the sea ice edge;
- Important habitat for Walruses, Bowhead Whales Arctic Char and Polar Bears during critical periods of their life history;
- Recurring polynyas that serve as important nursery and feeding areas and as a migratory corridor for several species of marine mammals;
-

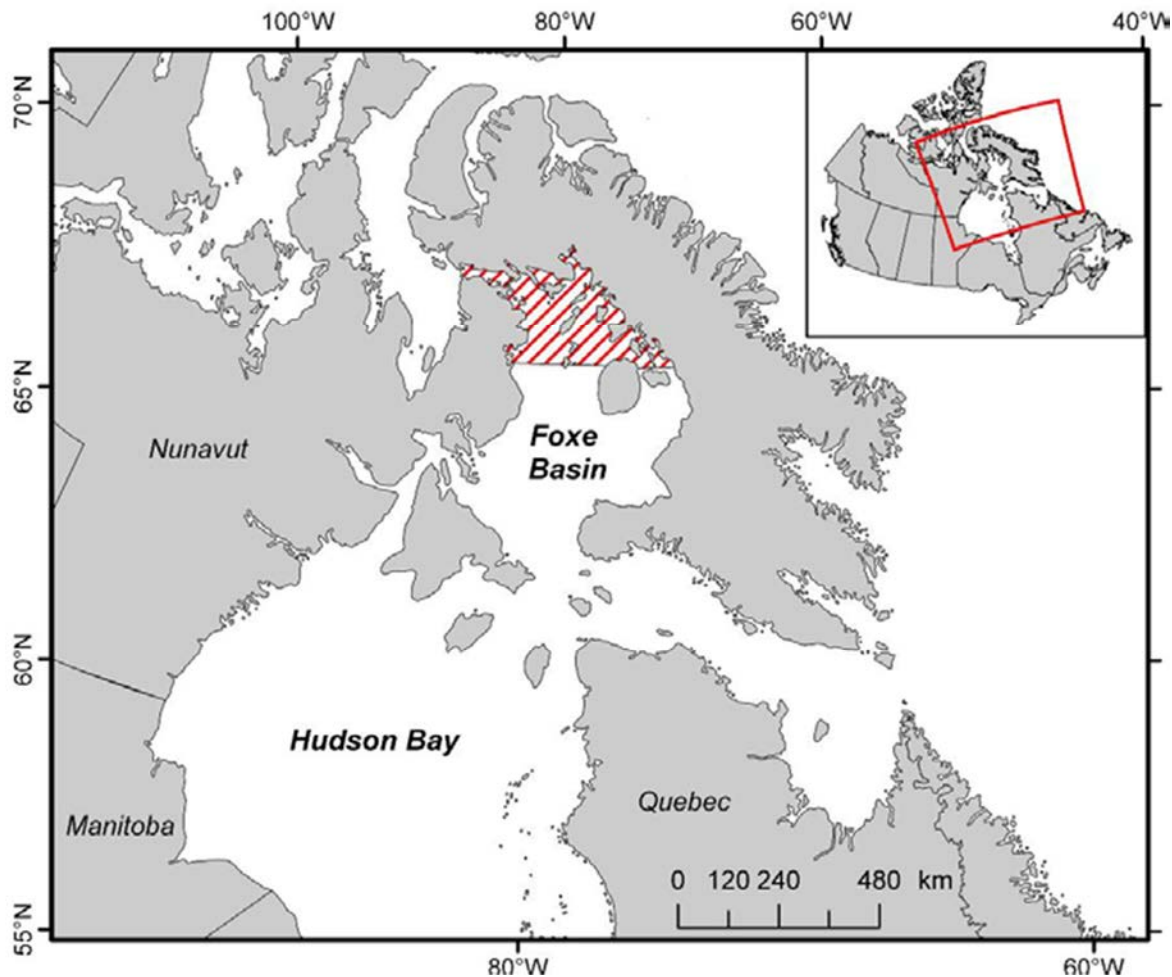


Figure 67. Identified ESBA of the Northern Foxe Basin (red diagonal lines) with southern boundary line set at 68°N, from Paulic *et al.* (2014)



In the Lancaster Sound:

- Polynya and associated ice-edges;
- Major migration corridor for marine mammals;
- High productivity;
- High export of sea-ice algae;
- High benthic diversity and production;
- Highest density of Polar Bears ;
- Over 1,000,000 seabirds and seaducks use this as a nesting and feeding area;
- Walrus haul-out sites;
- Polar Bear feeding area;
- Key foraging area for breeding Arctic seabirds and seaducks;
- High benthic re-mineralization;
- High quality food supply for benthos.

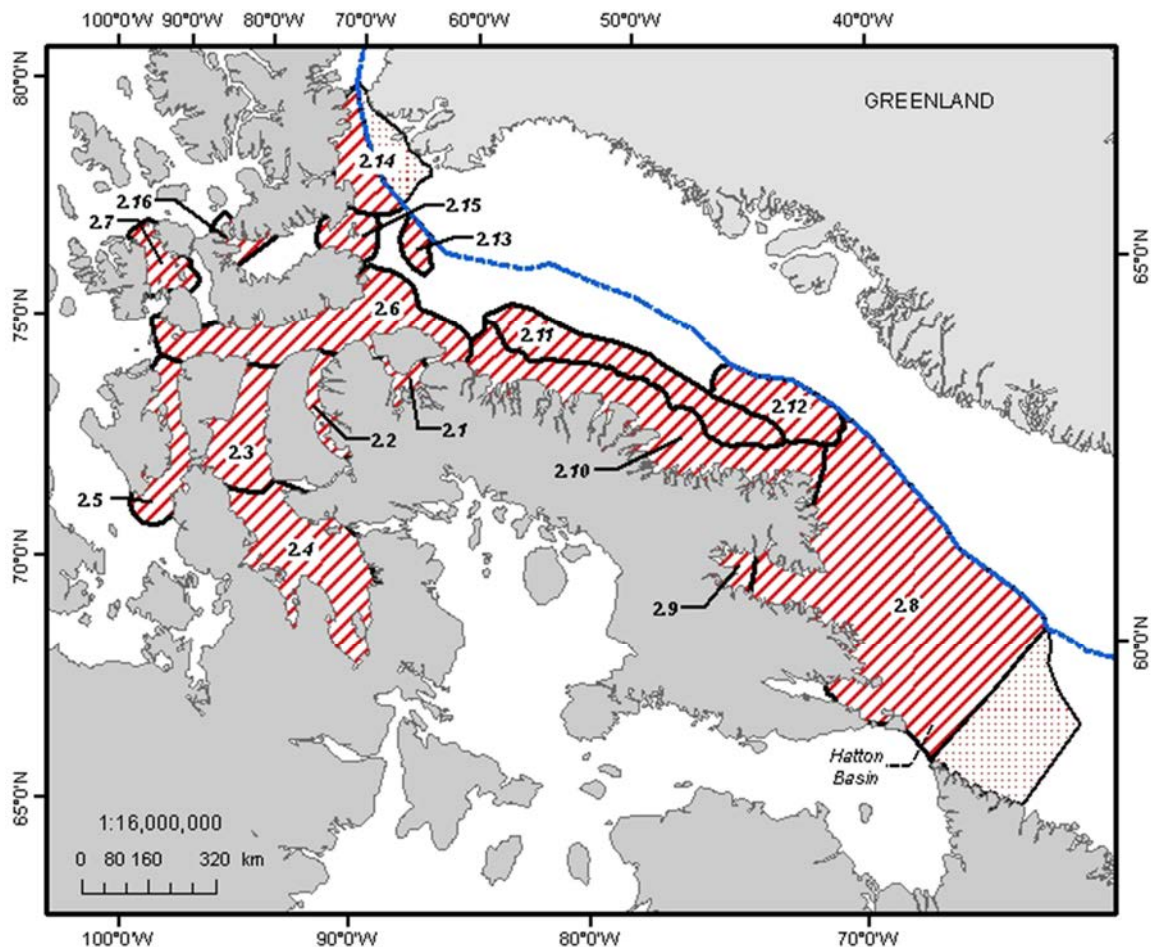


Figure 68. EBSAs identified within the Eastern Arctic biogeographic region. The Lancaster Sound ESBA is 2.6. Based on CSAS (2011).

In Coronation Gulf

- Presence of polynya and estuaries;
- Seabird migration, stinging and foraging area;
- Marine fish communities;
- Ringed Seal feeding area;
- Arctic Char migration corridor and feeding area;
- Possible productive benthic epifauna communities.

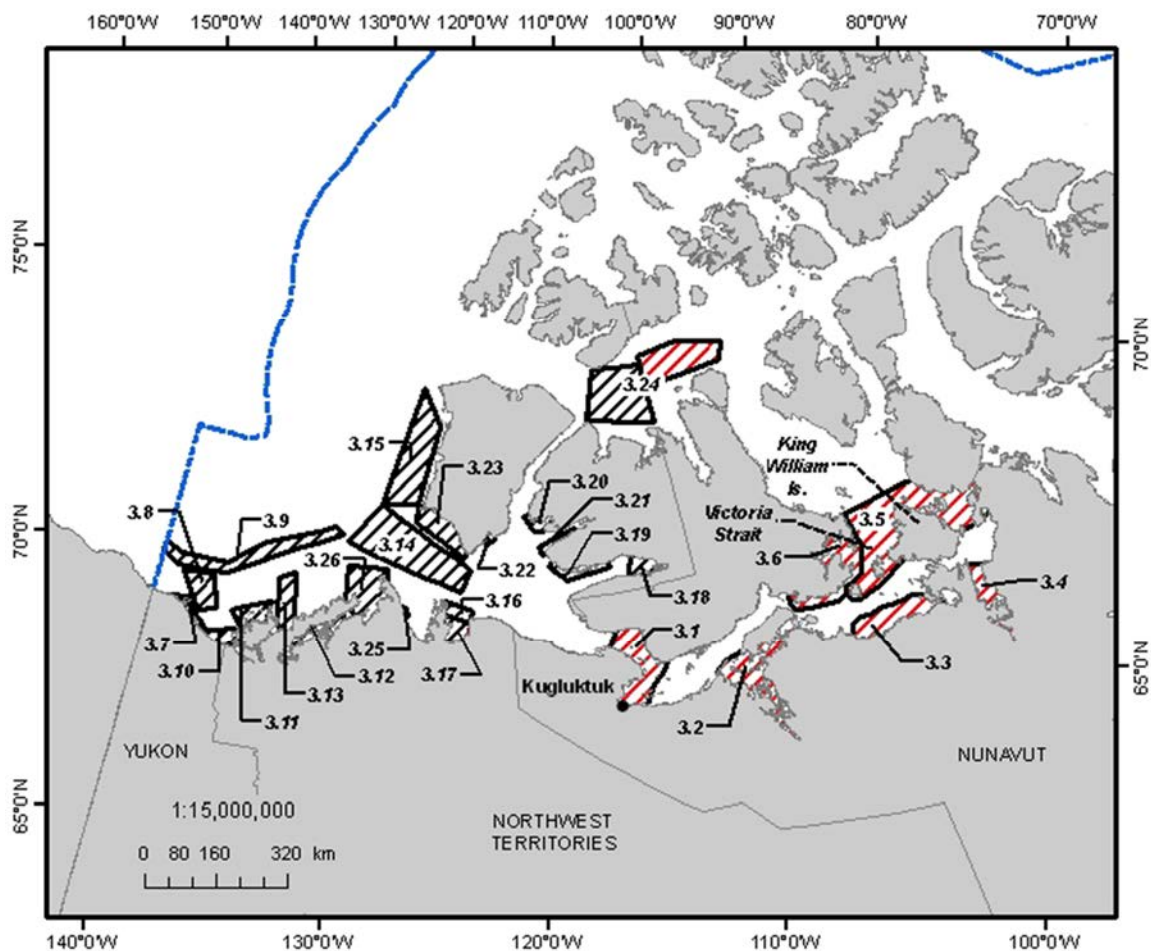


Figure 69. EBSAs identified within the Western Arctic biogeographic region, based on CSAS (2011). ESBA of particular interest for this study are zones 3.1, 3.2, and 3.3.

From these ESBA reports, several species distribution maps are available and are integrated in the analysis. An example for Walrus distribution in the Foxe Basin is given below. Investigation and data collection are underway to collect similar data for the four study areas.



AREAS OF HEIGHTENED ECOLOGICAL AND CULTURAL SIGNIFICANCES FROM THE ARCTIC COUNCIL

The Arctic Council's Arctic Monitoring and Assessment Programme (AMAP) and Conservation of Arctic Flora and Fauna (CAFF) working groups produced an important report in 2013. This report aims to identify areas of heightened ecological and cultural significance in light of changing climate conditions and increasing multiple marine use and, where appropriate, should encourage implementation of measures to protect these areas from the impacts of Arctic marine shipping, in coordination with all stakeholders and consistent with international law. A total of 15 areas are covered in the report, including the Canadian Arctic Archipelago and the Hudson Bay complex, where our four areas of interest are located.

Each area of heightened ecological and cultural significances are described in terms of ecological functions that makes them important. The Western Hudson Bay was selected as an important zone based on the fact that this is a migration corridor and feeding area for Arctic Char, and an autumn migration area for Polar Bear, and an aggregation area for Beluga.

The Northern Foxe Basin is a migratory corridor for Bowhead Whales, Narwhals, Belugas and Killer Whales. It is also a year-round habitat for Walruses including haul-out sites, calving areas and feeding grounds.

The Lancaster Sound area was highlighted for its Polar Cod aggregations, its major migratory route for Belugas, Bowhead Whales, Narwhals, its high density of Polar Bears (denning/feeding), and because it is a major foraging area for staging and breeding seabirds/seaducks, as well as an aggregation of Ivory Gulls.

The Coronation Gulf area (Bathurst Inlet, Queen Maud Gulf and Chantrey Inlet) was highlighted as important for its marine fish communities, its summer habitat for Ringed Seal, the presence of seabird colonies & feeding areas, the feeding ground and migration for Arctic Char, and a summer/feeding habitat for Ringed Seals.

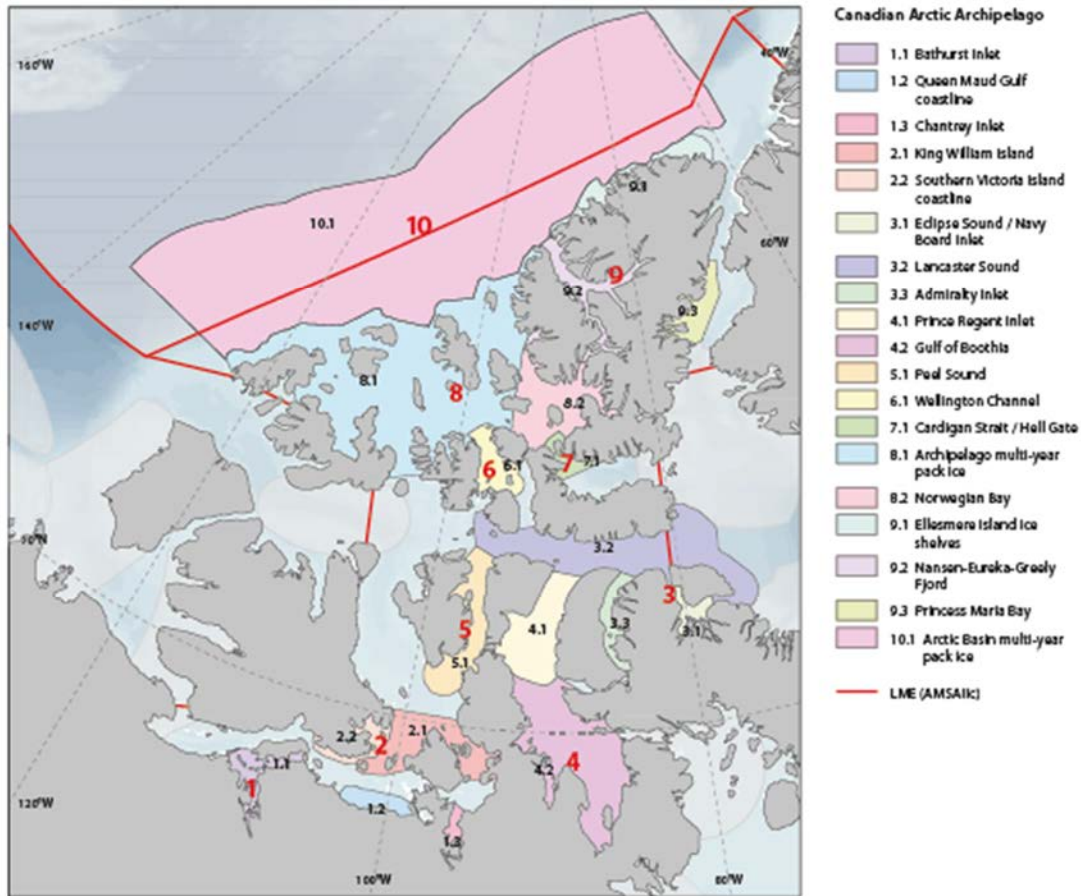


Figure 70. Areas of heightened ecological significance in the Canadian Arctic Archipelago LME. Figure A.14 from AMAP 2013.

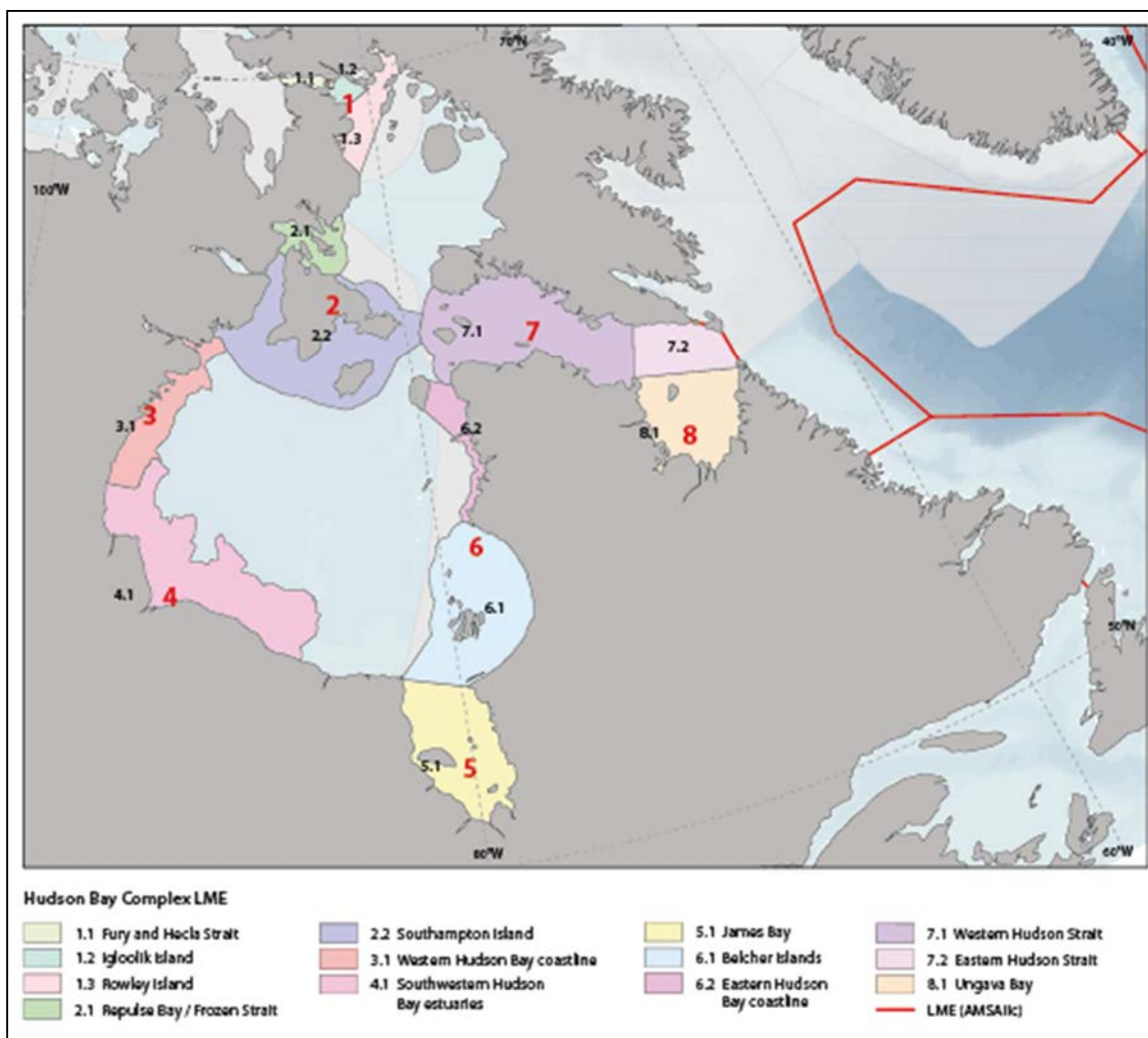


Figure 71. Areas of heightened ecological significance in the Hudson Bay complex LME. Figure A.15 from AMAP 2013.

NUNAVUT LAND USE PLAN

The Nunavut Land Use Plan is still at a “draft” stage, but is available online and already contains an important amount of information on ecological features of the different Nunavut ecosystems. This information is based on a consultation process deployed from 2007 to 2012 to identify areas of importance to the NPC goals of:

- Protecting and Sustaining the Environment;
- Encouraging Conservation Planning;
- Building Healthier Communities; and
- Encouraging Sustainable Economic Development.

Following the preparation of a draft Plan in 2012 and the consultation process, the Commission has learned a great deal about the priorities and values of residents, as well as those of the Government of Canada, the Government of Nunavut, Inuit organizations, other Nunavut Institutions of Public Government, industry, communities from neighbouring jurisdictions, and non-governmental organizations.

In 2012, a report was prepared for the Government of Nunavut by Nuami Stantec, representing an inventory of wildlife and habitat for different areas of Nunavut. The primary objectives of this study were to identify wildlife species important for ecological, social, cultural and economic reasons, review their current status, habitat needs, and challenges, and present potential solutions to those challenges (Beckett et al. 2012). Shapefiles, maps and complete information are available in the “Downloads” section of the Government of Nunavut (DNLUP spatial data)³⁹.



Figure 72. An example of integrated data from consultation process and Nunavut land use plan (From Beckett et al. 2012)

³⁹ Available at <http://www.nunavut.ca/en/downloads>



ZONES OF HIGH BIOLOGICAL IMPORTANCE (HBI)

In 2010, Stephenson and Hartwig published a report of the Arctic Marine Workshop organized by the Oceans Programs Division of Fisheries and Oceans Canada. This workshop was held to bring together expert knowledge about Arctic fauna, including marine mammals, fish, marine invertebrates, seabirds and polar bears, and their distribution in the marine environment. One of the major outcomes of this report is that it identifies areas of High Biological Importance (HBI) to wildlife. A total of 16 species or trophic groups are covered in this report for all the Canadian Arctic, and thus this represents an important source of information for this study.

SCIENTIFIC LITERATURE

A scientific literature review is underway trying to find scientific publications and projects focusing on wildlife using the marine environment of Nunavut. The search is focusing on our four study-areas, and is done with priority for the main species (Seabirds, Caribou, Polar Bear and Walrus), but is covering all species of marine mammals, fishes, benthic invertebrates, commercially important species (for fisheries), and plankton. Peer-reviewed papers, unpublished reports, projects, and other data sources (e.g., web databases), in English and in French, are covered. A few examples are given in the upcoming sections.

ONLINE DATABASES

Some data resources are also available on the web. The Nunavut Database is one of them, containing descriptions of 34,000 publications and research projects about Nunavut and the adjacent waters, the Canadian Arctic as a whole, and the circumpolar Arctic as a whole. The database was created for the [Nunavut Planning Commission](#) by the [Arctic Science and Technology Information System \(ASTIS\)](#). Recent updates to the Nunavut Database have been funded by the [Nunavut General Monitoring Plan \(NGMP\)](#). This database is available at <http://www.aina.ucalgary.ca/nunavut/>.

Another online database source is the Environment and Natural Resources database of the Government of Northwest Territories (<http://www.enr.gov.nt.ca/publications>). This database includes all research projects and publications done in the NWT area, and might cover information for our research areas.

NUNAVUT COASTAL RESOURCE INVENTORY BY THE GOVERNMENT OF NUNAVUT

The Nunavut Coastal Resource Inventory (NCRI) aims to conduct coastal resource inventories in the majority of Nunavut's communities. Such inventories are an information compendium on coastal resources and activities, gained principally from interviews with elders in each community. Coastal resources are defined as the animals and plants that live near the coast, on the beaches, on and around islands, above and below the surface of the ocean, above and below sea ice, and on the sea floor. Consequently, the extent of the survey varied by community, and "near the coast" can include species and activities up to 50 and sometimes 100 miles inland (mainly lakes and river systems) (Ghazal 2014).



Coastal inventories are a way of collecting diverse coastal information, which can be used to develop community fisheries development and other fishing-related activities. One of the goals of this initiative is to preserve traditional knowledge and preparing for rapid environmental changes, particularly climate-related changes (Ghazal 2014).

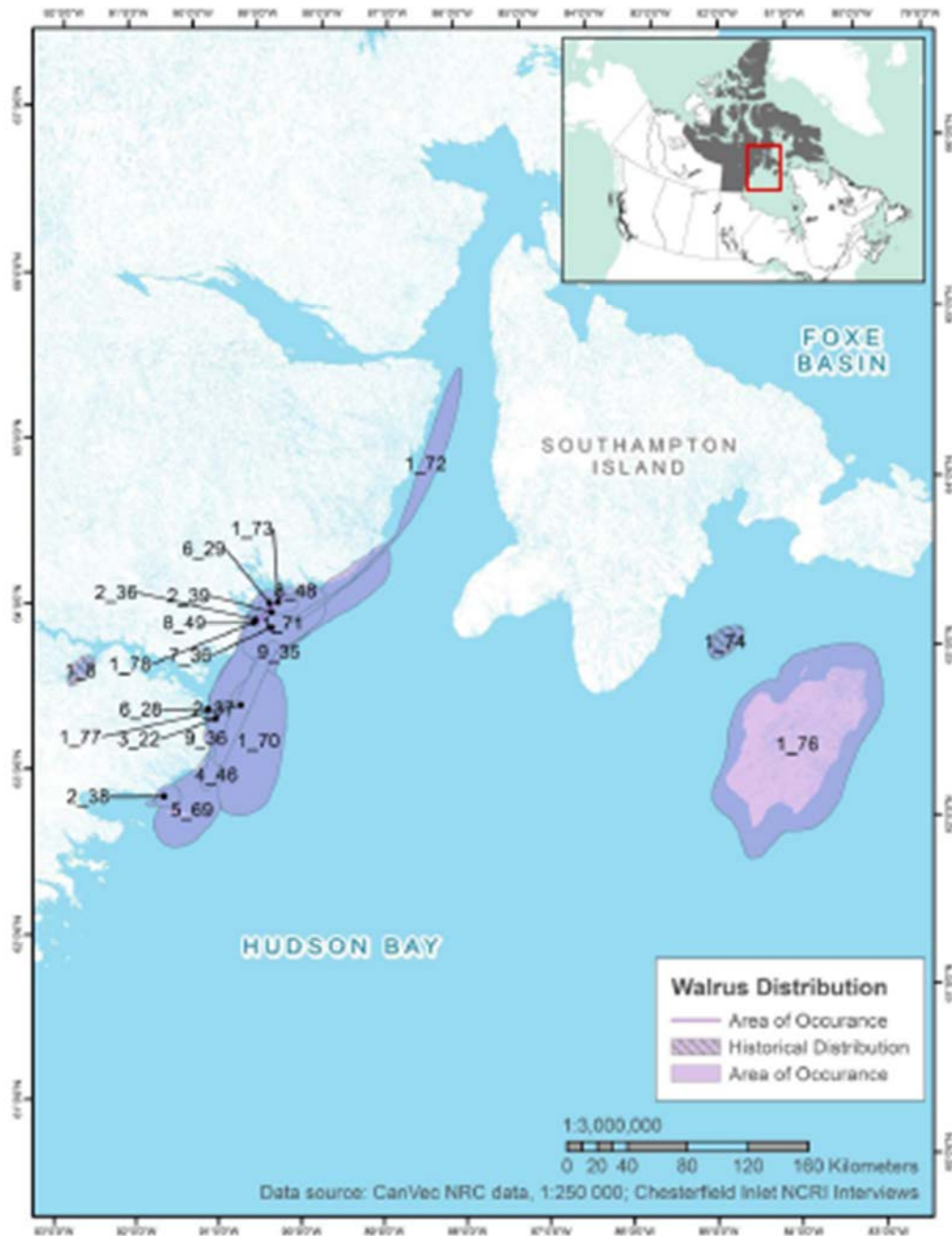


Figure 73. Chesterfield Inlet Walrus distribution. From Ghazal 2014.

APPENDIX 2B: DETAILED ECOLOGICAL DATA

This appendix provides additional information drawn from the References at Section 6 and the materials discussed in Appendix B to supplement the examples provided at Section 5 of the main report.

POLAR BEARS

POPULATIONS AND TRENDS

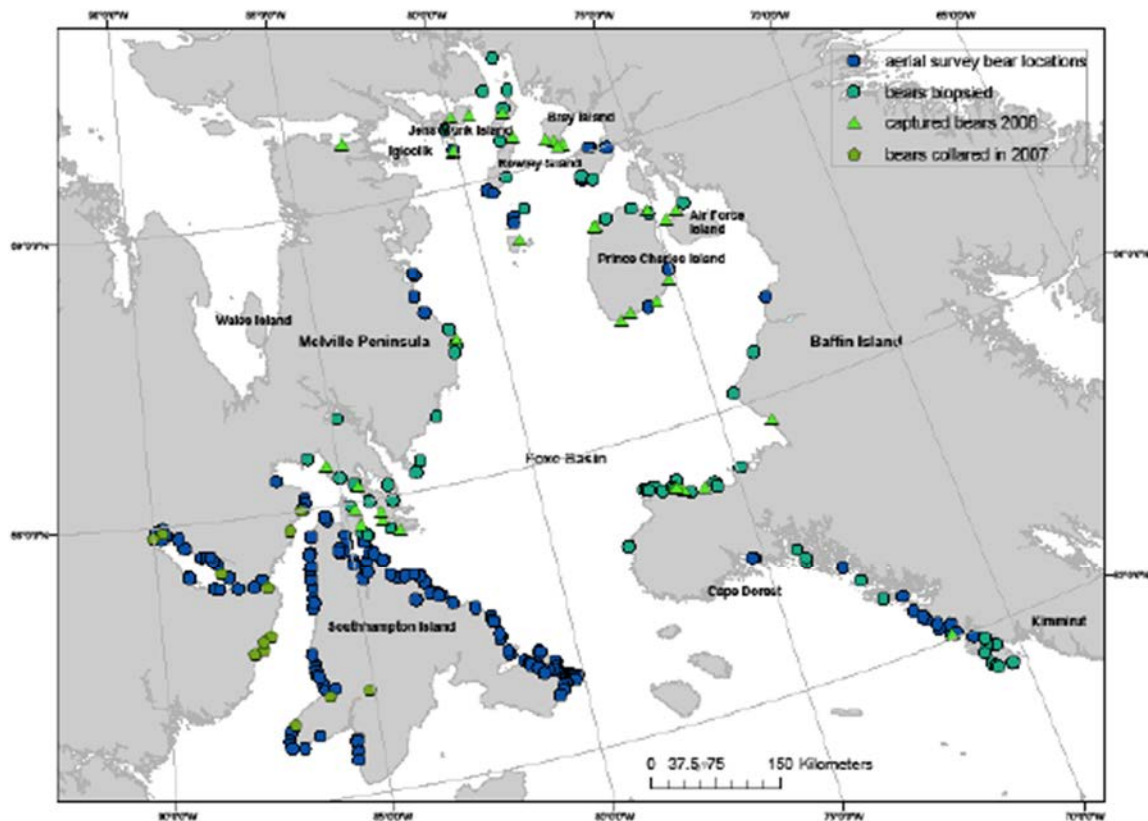


Figure 74. Locations of polar bears observed during aerial surveys, in addition to those captured, collared, in Foxe Basin in 2008. Source: Peacock *et al.* (2008)

The Lancaster Sound area contains the highest density of polar bear in the world (Skjoldal *et al.* 2013). Further south, interviews of coastal communities identified several areas of the northern Foxe Basin as important areas of occupations for polar bear (Figure 75).

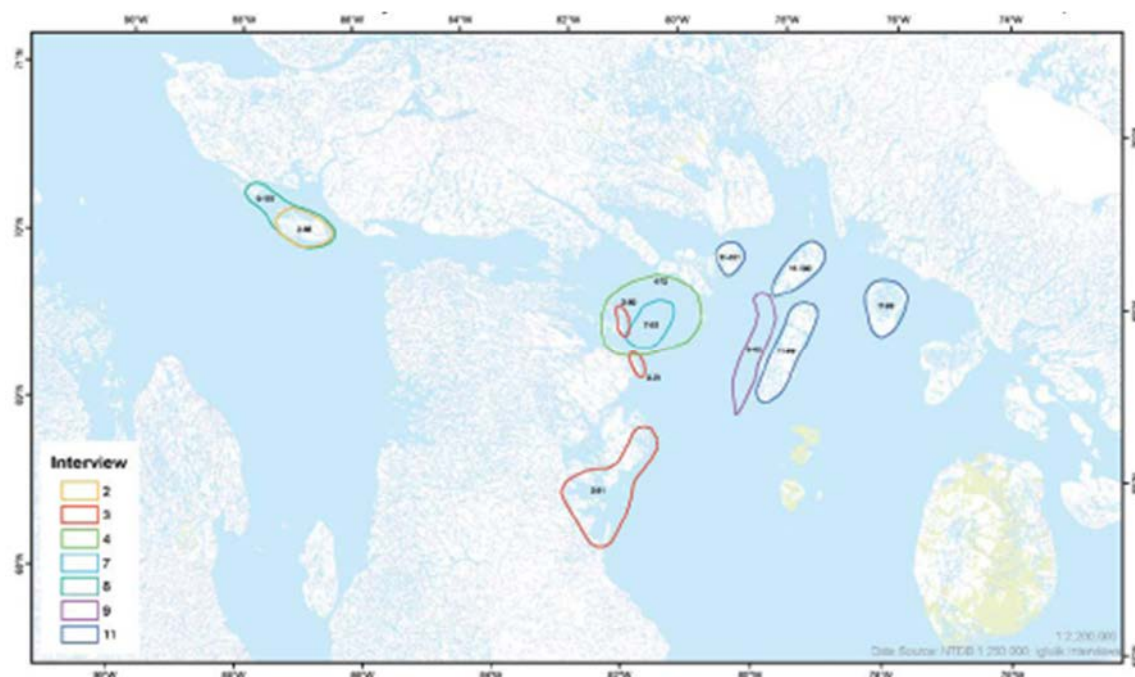


Figure 75. Areas of occupation by polar bear in the northern Foxe Basin based on TEK and interviews of coastal communities in Nunavut. Source: NCRI 2008.

In Lancaster Sound, polar bears concentrate in certain parts of the area during the late winter months (April and May; Schweinsburg et al. 1982). They occupy both southern and northern coasts of the Sound and can migrate through it (Figure 76).

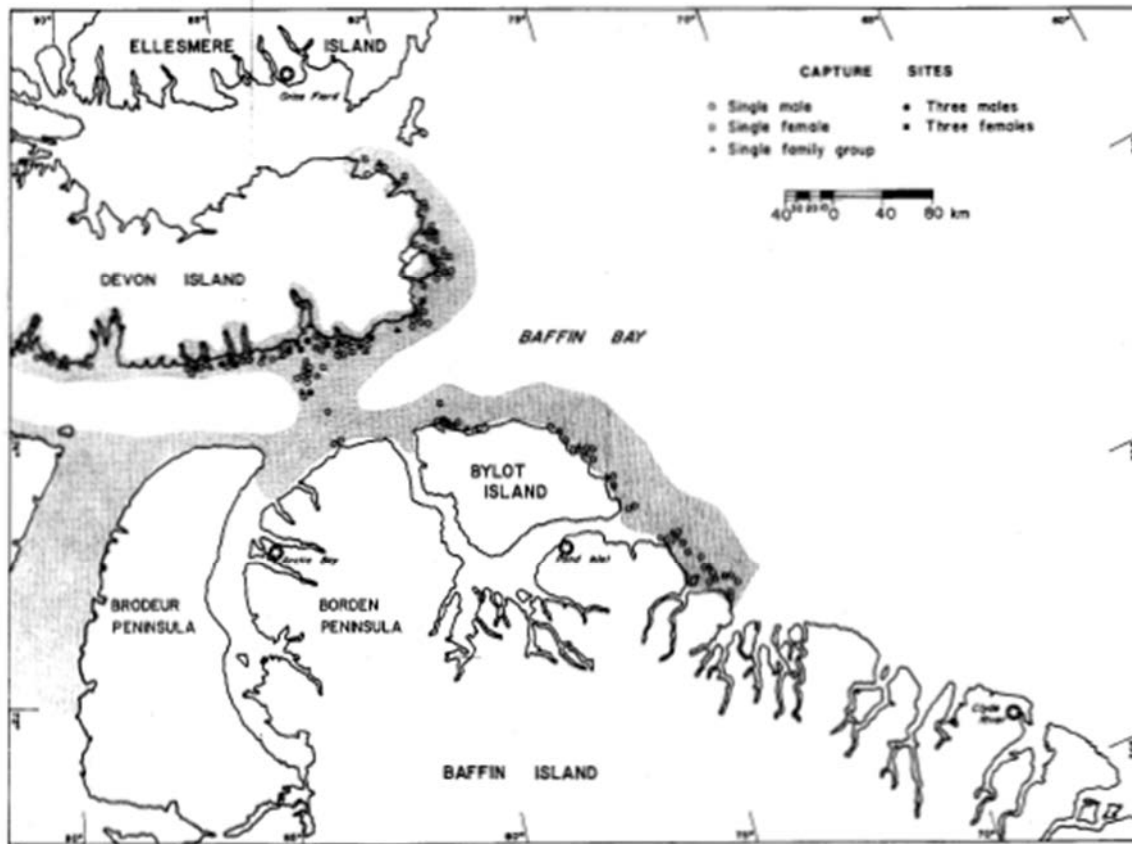


Figure 76. Capture locations and areas of concentrations of polar bears in late winter.
Source: Schweinsburg *et al.* (1992).

A map from the [U.S. Geological Survey](#) shows the projected changes in polar bear habitat from 2001 to 2010 and 2041 to 2050, indicating that the population is moving towards the eastern part of the Canadian Arctic (our Nunavut study areas) and up north (Figure 77).

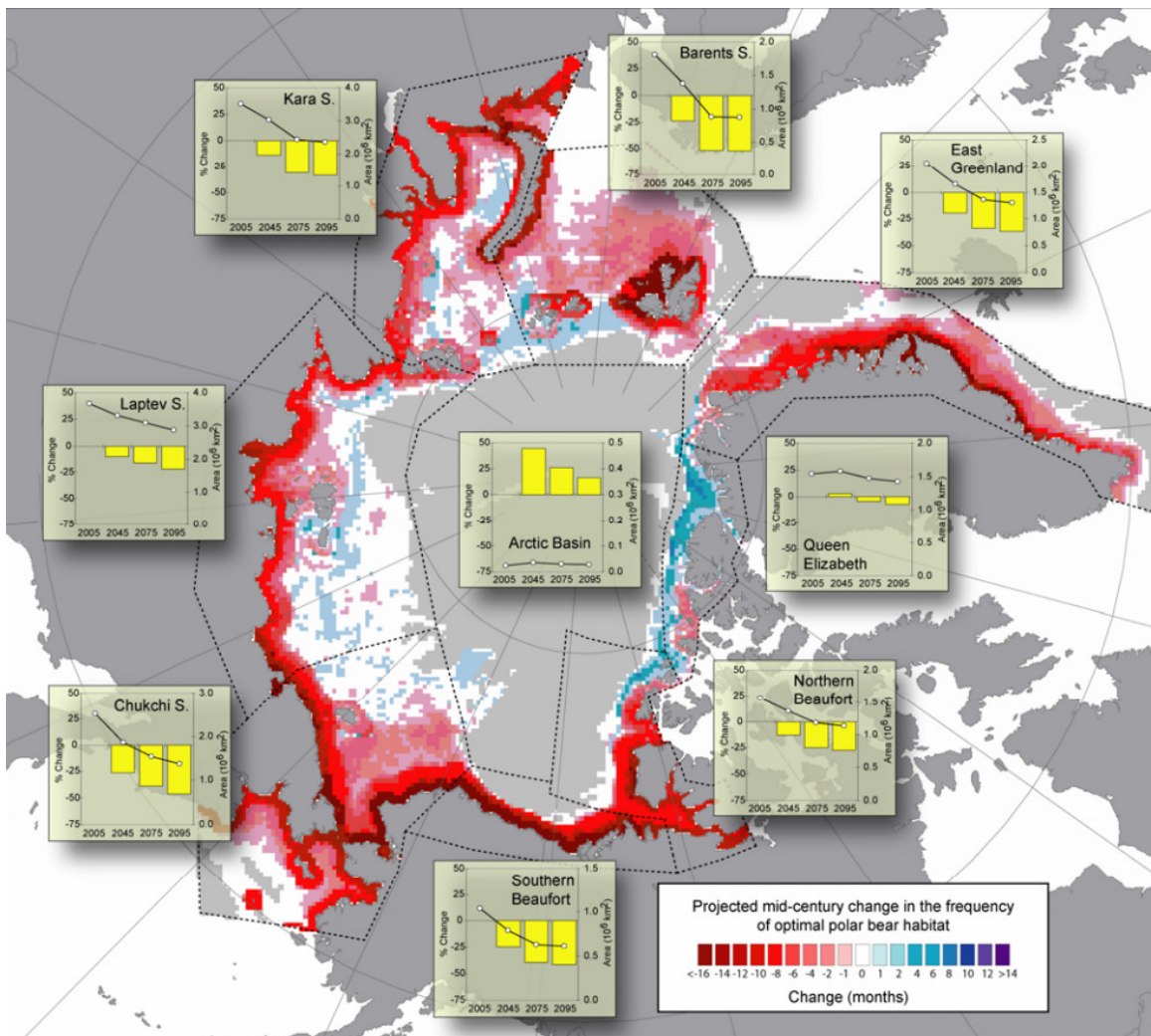


Figure 77. Projected changes in polar bear habitat from 2001 to 2010 and 2041 to 2050. Red areas indicate loss of optimal polar bear habitat; blue areas indicate gain. Source: U.S. Geological Survey (2016).



MIGRATION PATTERNS

Movement patterns of populations and individual bears within populations vary, but individual bears exhibit a high degree of seasonal fidelity to different areas within their home ranges (Vongraven and Peacock 2011). Generally, polar bears inhabiting or shore drift ice have much larger home ranges than bears inhabiting consolidated ice (Born *et al.* 1997, Ferguson *et al.* 2001).

The western Hudson Bay coastline is an important autumn migration area for polar bear (Skjoldal *et al.* 2013 & Figure 82; Taylor *et al.* 1990).

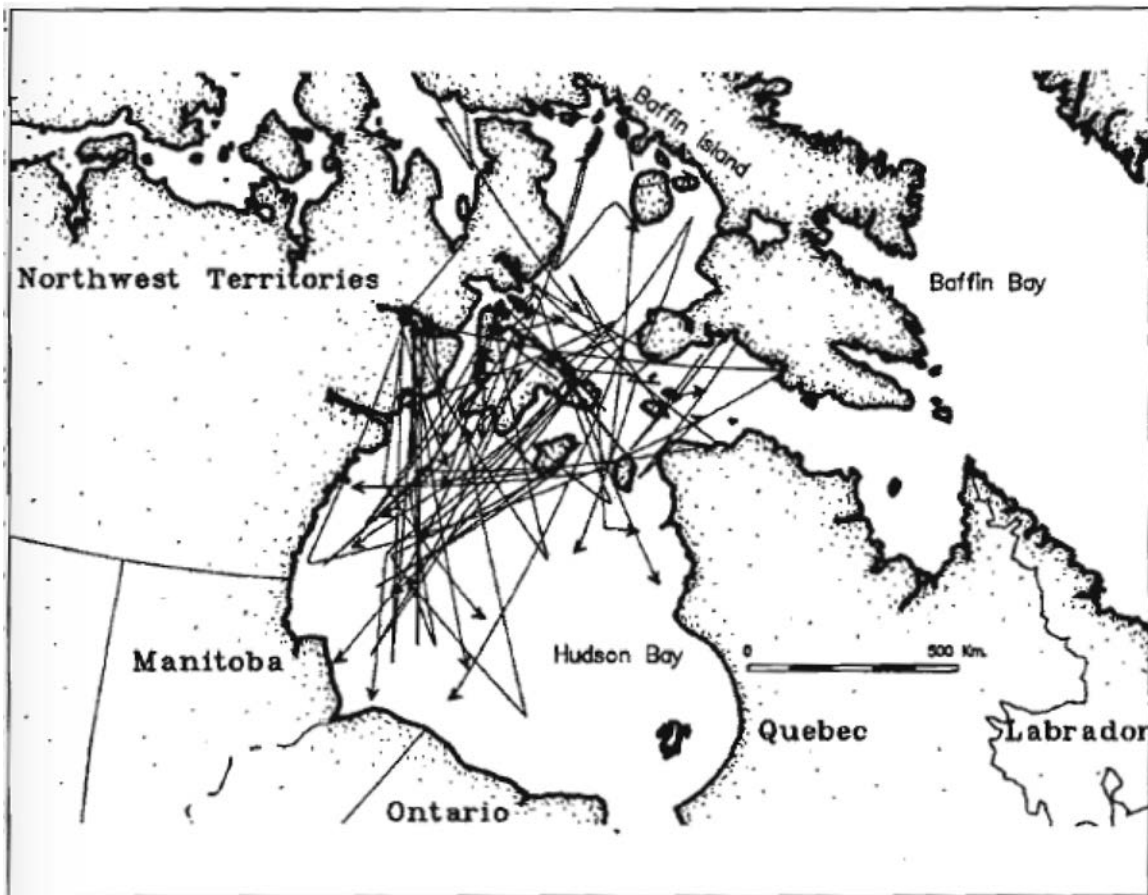


Figure 78. Movements of radio collared Polar Bears 1986-1988 Source: Taylor *et al.* 1990

A more recent survey shows similar migrations on the western side of the Hudson Bay (Figure 79), indicating that this is an important area for the species.

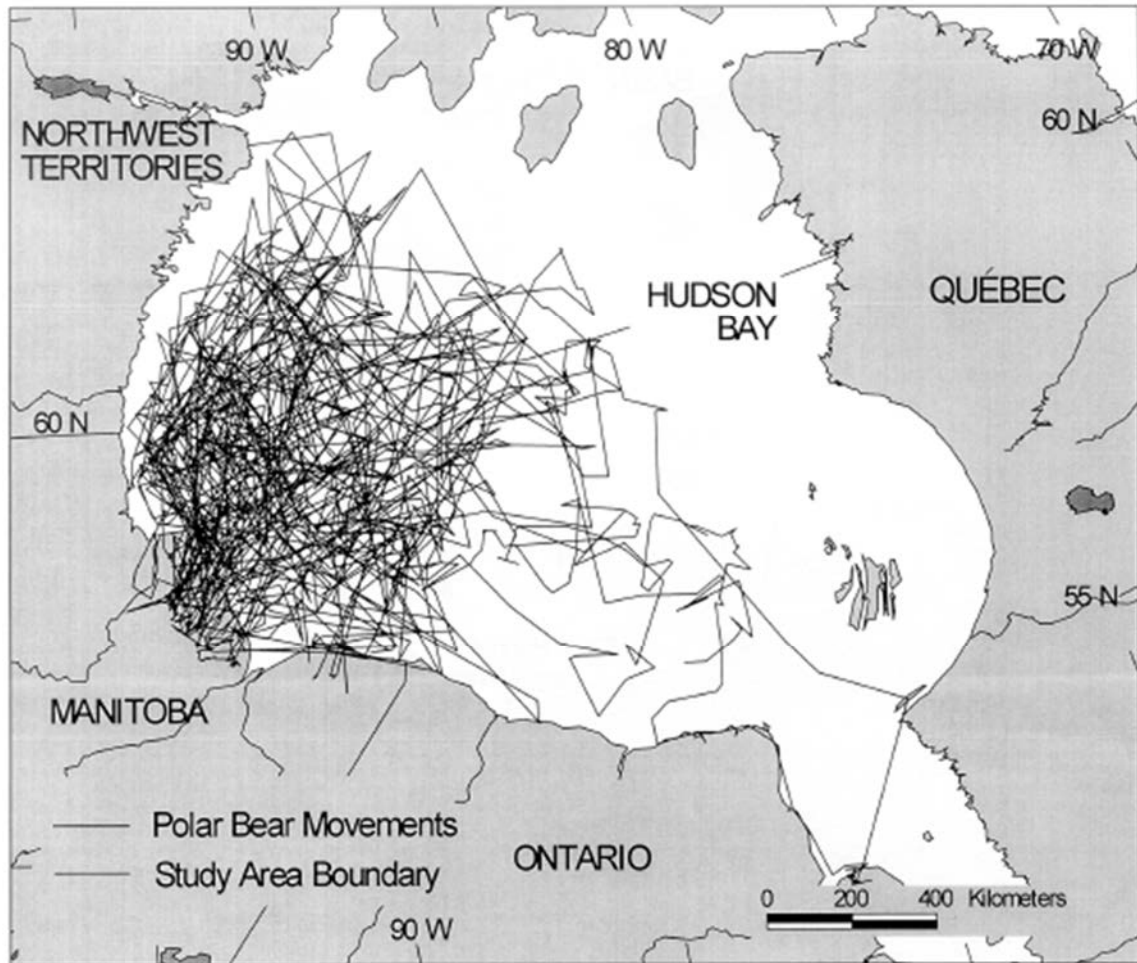


Figure 79. Movements of 41 adult female polar bears, 1991-98. Source: Stirling et al. (1999).

Polar Bears International have created a tool through which it is possible to track the migrations of satellite-collared polar bears as they travel across Hudson Bay. Although this mostly covers the southern part, in future records may provide useful information about their migration in the study area (Figure 80).



Figure 80. The “bear-tracker map” from Polar Bear International
<http://www.polarbearsinternational.org/about-polar-bears/tracking/bear-tracker>

The map displays the movement paths of 20 female and 4 adult polar bears in the Canadian Arctic. The bears are tracked across various islands and peninsulas, including Igloolik, Resolute, Prince Charles Island, Baffin Island, Cape Dorset, Southampton Island, and the Foxe Basin. The legend on the right identifies each bear by a unique color and line style, along with their sex and ID number. A scale bar at the bottom right indicates distances up to 100 kilometers. Latitude and longitude coordinates are marked along the map's edges.

Legend:

- Female with young 165.143 path
- Female with young 165.120 path
- Female with young 165.293 path
- Female with young 151.519 path
- Female with young 151.590 path
- Female with young 151.000 path
- Female with young 166.643 path
- Female with young 165.550 path
- Female with young 165.580 path
- Female with young 165.580 path
- Female with young 165.620 path
- Female with young 165.633 path
- Female with young 165.660 path
- Female with young 165.675 path
- Female with young 165.680 path
- Female with young 165.693 path
- Female with young 165.720 path
- Female with young 166.329 path
- Female with young 165.750 path
- Female with young 165.743 path
- Female with young 165.750 path
- Female with young 166.780 path
- Female with young 165.770 path
- Adult male 84581 path
- Adult male 84582 path
- Adult male 84583 path
- Adult male 84584 path

Figure 81. Point to point movements of Foxe Basin polar bears with satellite collars ($n = 23$ adult females) and ear tags ($n = 4$ males). Source: Peacock *et al.* (2008).



The movements of satellite-collared polar bears in the Foxe Basin have also been monitored in 2010 (Figure 81; Sahanatien and Derocher, 2010). This indicates that the whole area is an important migration passage for polar bears. In their report, authors have even more detailed maps about the movements of this species (see their figures 4-7).

Information on the movements of adult female polar bears monitored by satellite radio-collars, and mark-recapture data from past years, has shown that polar bears in the Lancaster Sound are occupying almost all the territory. This is also assumed that this subpopulation is distinct from the adjoining Viscount Melville Sound, M'Clintock Channel, Gulf of Boothia, Baffin Bay and Norwegian Bay subpopulations (Taylor *et al.* 2001).

The eastern part of Coronation Gulf also represents important migration areas for polar bear (Figure 82; Schweinsburg *et al.* 1981).

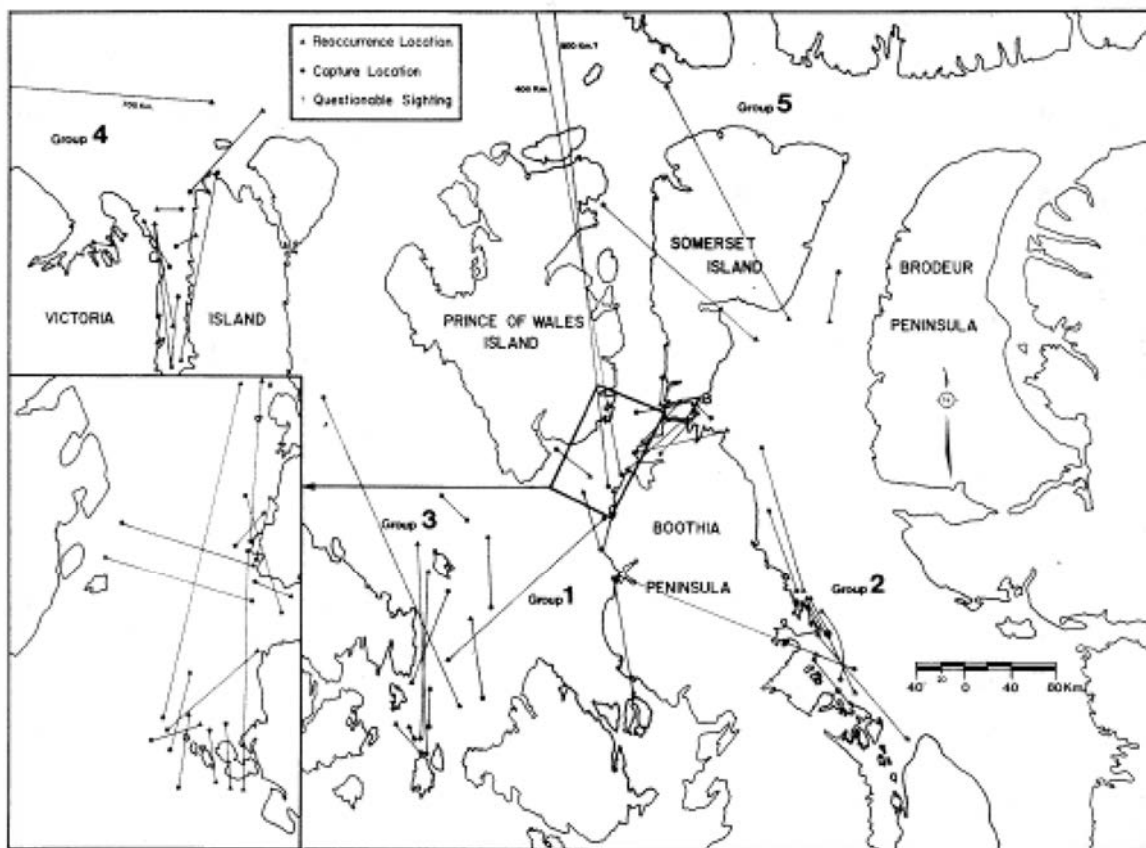


Figure 82. Groups of polar bears captured, sighted, or killed. Source: Schweinsburg *et al.* (1981).

SEABIRDS

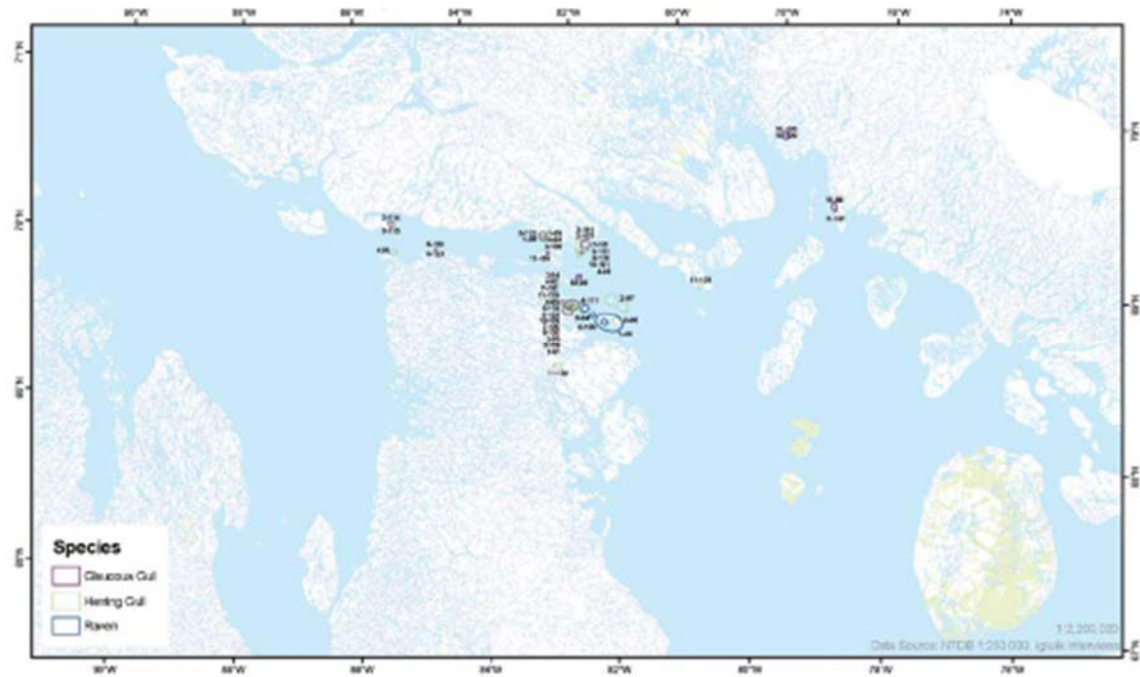


Figure 83. Glaucous gull, Herring gull, Raven - Areas of occupation. Source: NCRI (2008).

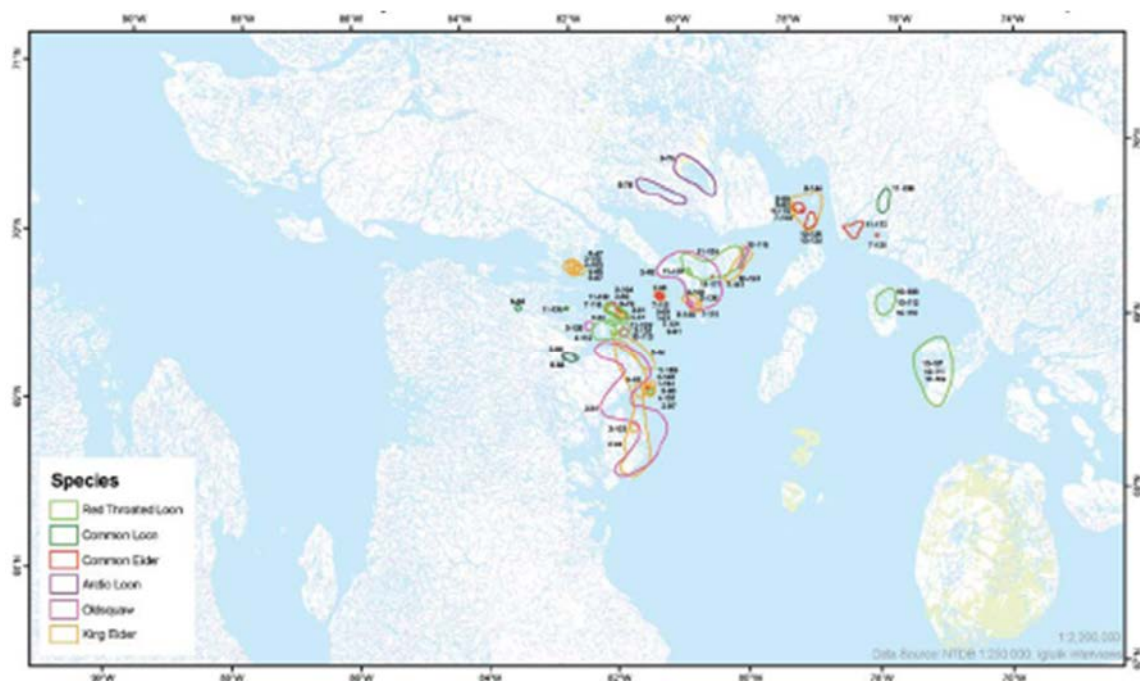


Figure 84. Ducks and loons - Areas of occupation. Source: NCRI (2008).

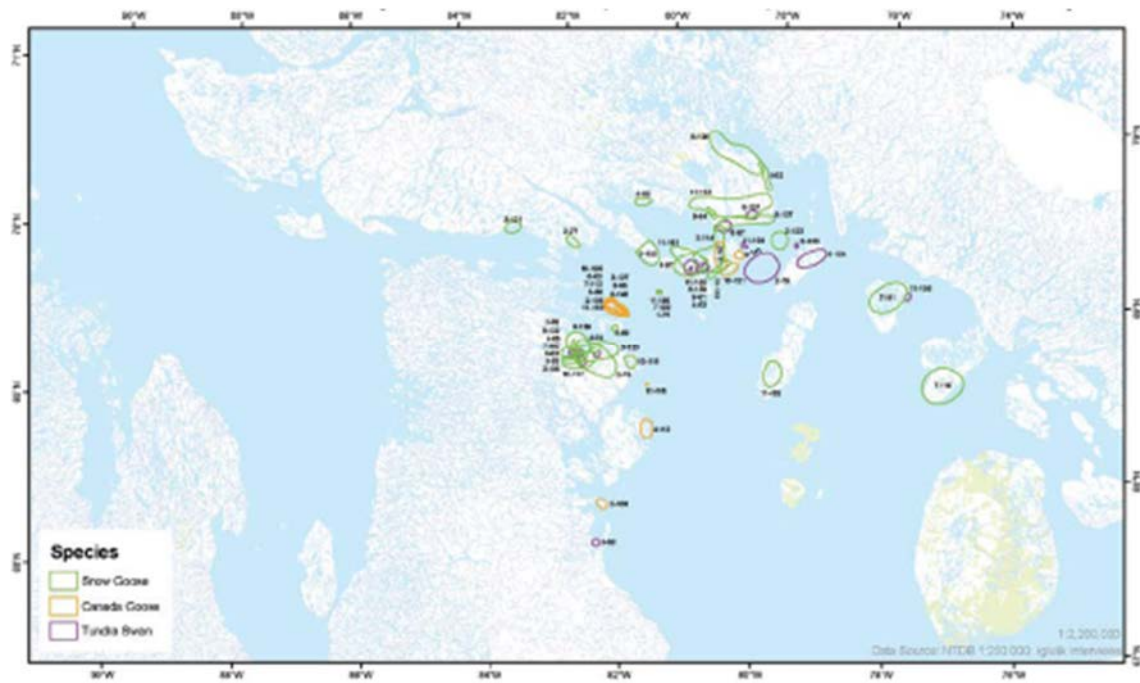


Figure 85. Snow goose, Canada goose, Tundra swan - Areas of occupation. Source: NCRI (2008).

MARINE MAMMALS

SEALS

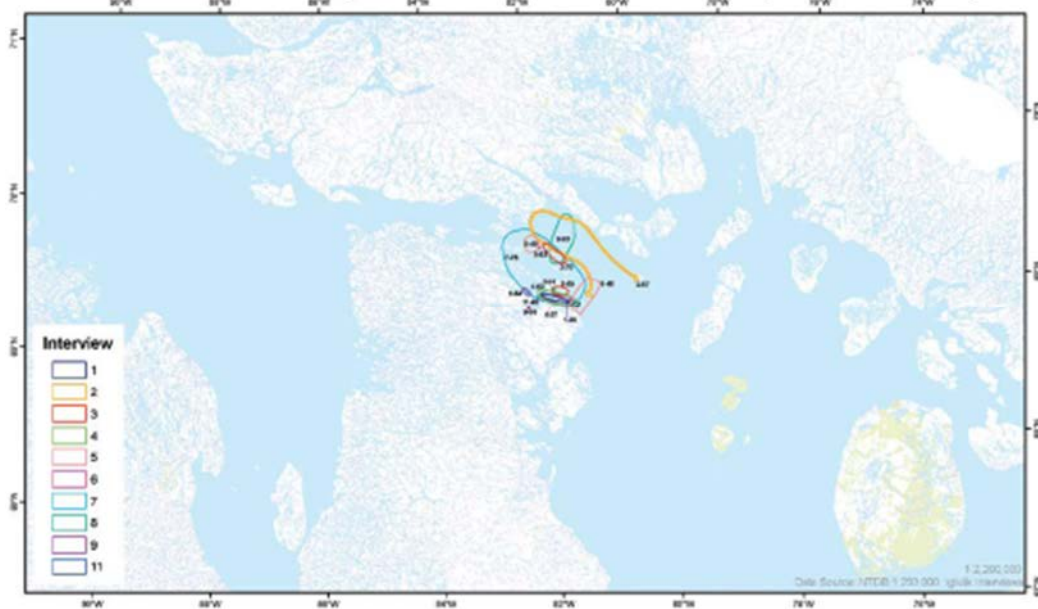


Figure 86. Harp seal – Areas of occupation . Source: NCRI 2008

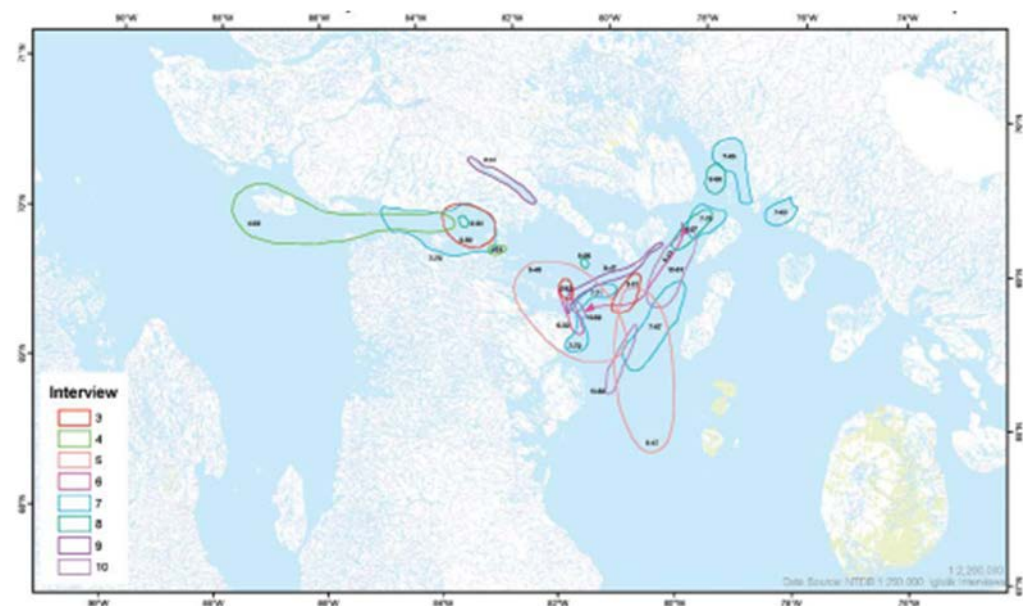


Figure 87. Bearded seal - Areas of occupation. Source: NCRI (2008).

WHALES

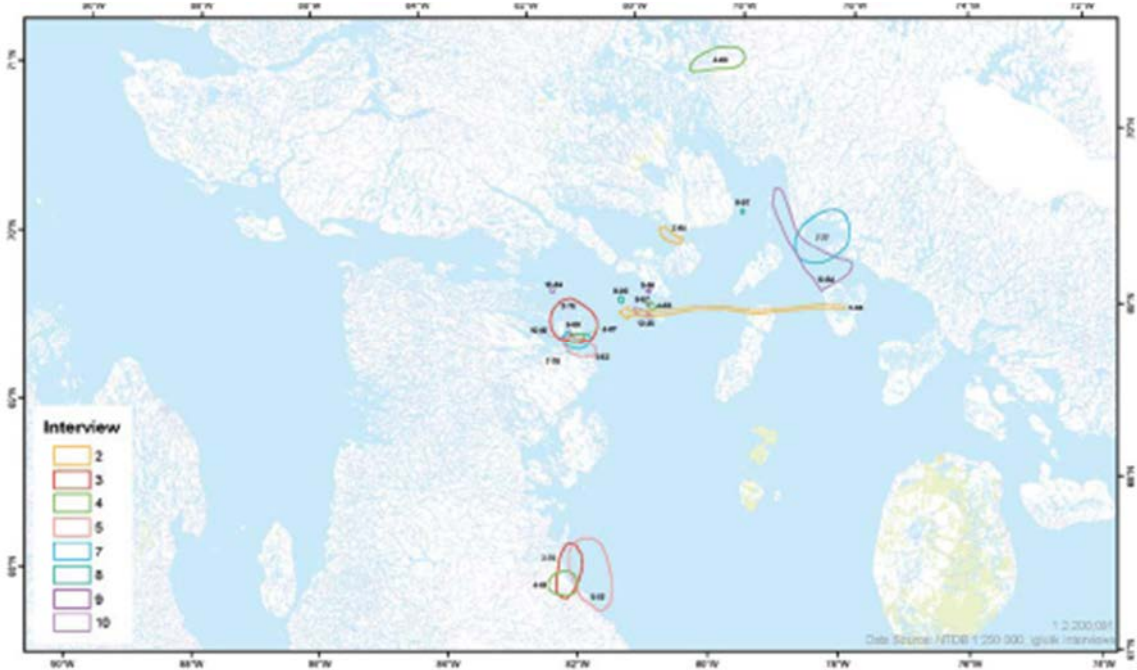


Figure 88. Beluga - Areas of occupation. Source: NCRI (2008).

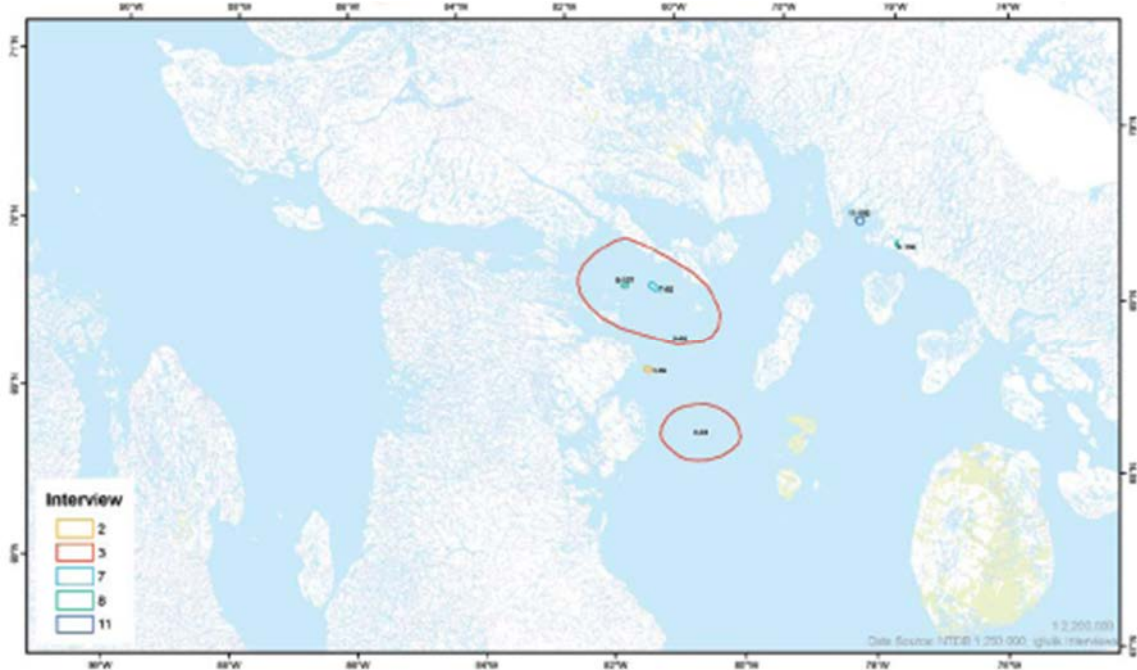


Figure 89. Killer whale – Areas of occupation. Source: NCRI (2008).

FISH

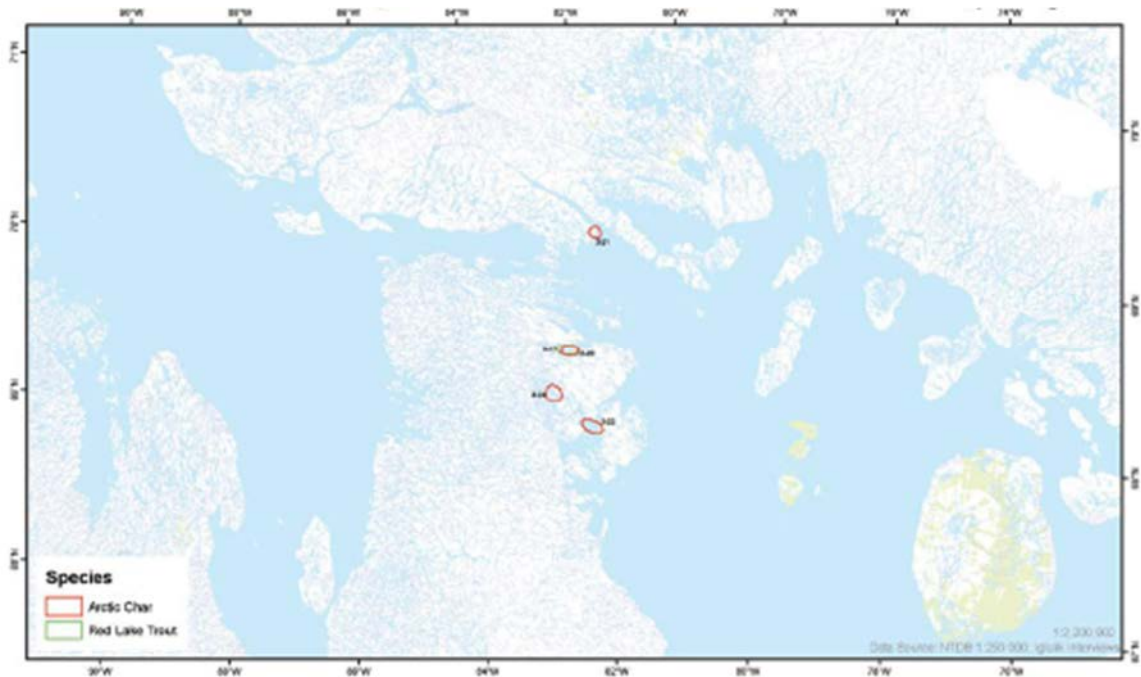


Figure 90. Fish - Spawning areas. Source: NCRI (2008).

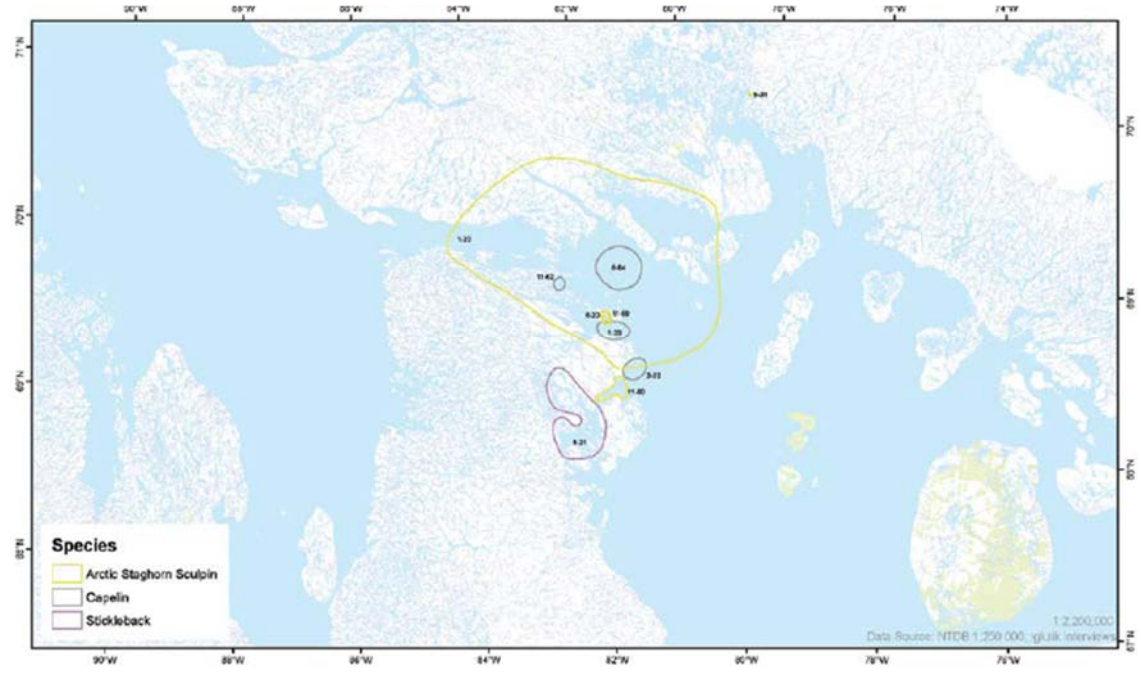


Figure 91. Sculpin, Capelin, Stickleback - Areas of occupation. Source: NCRI (2008).

ARCTIC CHAR

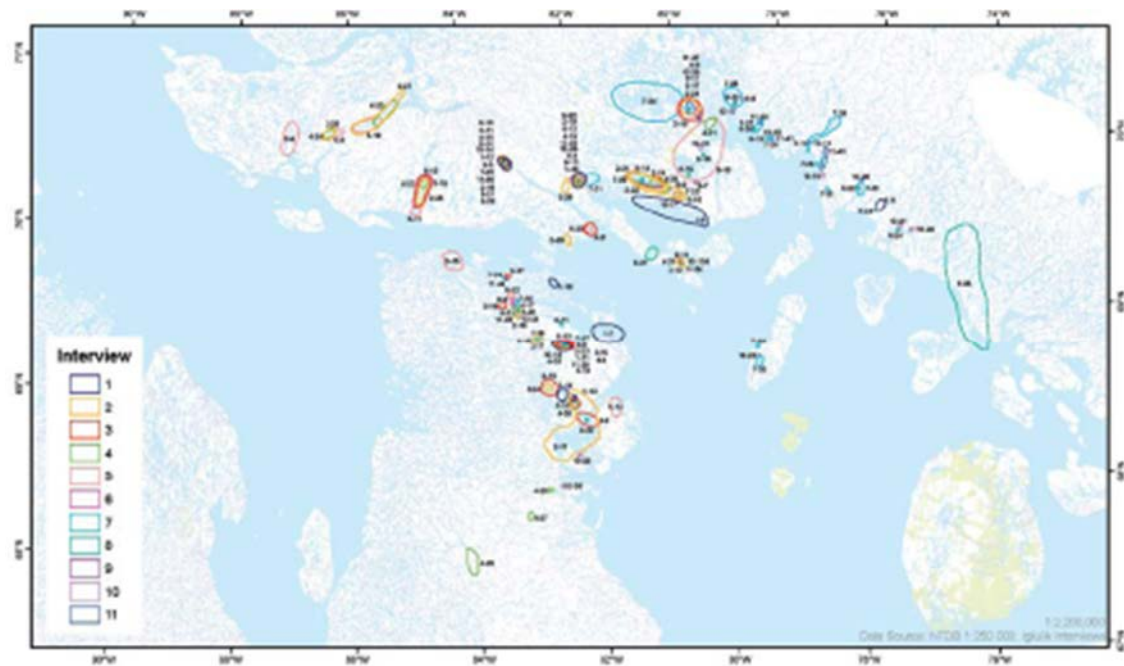


Figure 92. Arctic char - Areas of occupation. Source: NCRI (2008).

ARCTIC COD

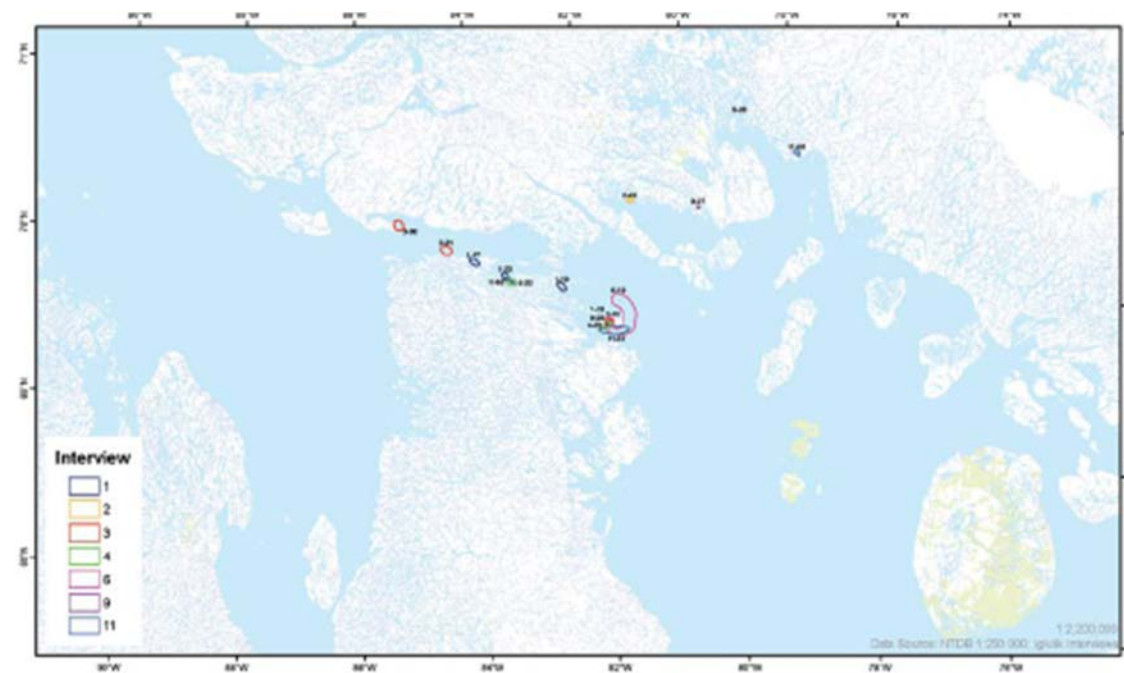


Figure 93. Arctic cod – Areas of occupation. Source: NCRI (2008).



OTHER SPECIES

Other species present in the study regions which may warrant additional consideration include Salmon, Greenland Halibut, and Greenland Shark.



APPENDIX 2C – INVENTORY REFERENCES

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APPENDIX 3A – RISK INVENTORY

RISK INVENTORY HEADINGS AND DETAILS

The following headings are used in the risk inventory:

- Risk: Identifying name or description for the risk.
- Coronation Gulf: Details specific to evaluation of the risk for this particular region.
- Foxe Basin: Details specific to evaluation of the risk for this particular region.
- Lancaster Sound: Details specific to evaluation of the risk for this particular region.
- Western Hudson Bay: Details specific to evaluation of the risk for this particular region.
- Oper. Risk: Risk inherent to operating a vessel.
- Event Risk: Risk inherent to a discrete event which could occur.
- Description or Cause: Description of the risk or the cause of the event
- Influence of Arctic: Factors contributing to the event or its severity specific to Arctic operations.
- Immediate Cause: Why the event occurs.
- Underlying Cause: Factors allowing the circumstances required for the event to exist.
- Current Mitigation: How the risk is currently mitigated, if applicable.
- Probability or Frequency: Generally speaking, how likely or often, as applicable, the event is likely to occur.
- Immediate Consequences or Effects: Immediate impact of the event.
- Potential Consequences or Effects: Long-term impact of the event
- Suggested Mitigation: How the risk could be mitigated beyond any current measures.

RISK INVENTORY

Risk	Coronation Gulf	Probability	Severity	Risk Rating	Foxe Basin	Probability	Severity	Risk Rating	Lancaster Sound	Probability	Severity	Risk Rating	Western Hudson Bay	Probability	Severity	Risk Rating	Oper. Risk	Event Risk	Description or Cause	Influence of Arctic	Immediate Cause	Underlying Cause	Current Mitigation	Probability or Frequency	Immediate Consequences or Effects	Potential Consequences or Effects	Suggested Mitigation
Habitat, ecosystem, and Social Disruption																											
Cetacean strike	Fewer whales in the region	2	3	MED	Key habitat for several species	3	3	MED	Key habitat for several species, large narwhal population.	3	3	MED	Large beluga population throughout region	3	3	MED		YES	Vessel in transit strikes a cetacean, causing injury or death	Numerous intersections between cetacean migratory and feeding grounds and shipping activities, particularly in Lancaster Sound and Foxe Basin.	Transit of waters used by cetacean species	Inadequate data on likely locations and seasonal habits of cetaceans available to mariners. Difficulty identifying animals in transit.	None	Unknown. Likely higher in the winter season.	Injury or death of animal	Lasting negative impact on animal populations already at risk (decrease in population trends), change in the distribution patterns (linked to a potential change in food availability)	Reduction of transit speed coupled with forward watchkeeping. Passive or active acoustic detection systems, acoustic deterrents, route planning.
Other species strikes		2	3	MED		2	3	MED		2	3	MED		2	3	MED		YES	Vessel strikes other animal on ice surface, causing injury or death.	Seals, walrus, polar bear, all use ice coverage for mobility	Transit through ice coverage used by species for mobility	Inadequate data on ranges and habits of animals using ice coverage.	None	Unknown. Likely higher in the winter season.	Injury or death of animal	Lasting negative impact on animal populations already at risk (decrease in population trends), change in the distribution patterns (linked to a potential change in food availability)	Reduction of transit speed coupled with forward watchkeeping. Passive or active acoustic detection systems, acoustic deterrents, route planning.
Disruption of fish stocks		2	3	MED	Little traffic in region	2	2	LOW		2	3	MED		2	3	MED	YES		Shipping patterns cause key species such as Arctic char to shift population centres	Unknown	Transit of waters where fish stocks exist	Inadequate data on fish stock locations (and relative effect of noise on fish)	None	Unknown	Risk of shortages for local sustenance fisheries	Potential for negative impact on sustenance food sourcing though fishing is unknown	Data collection to establish delineation of sensitive areas for shippers, and avoidance of sensitive areas
Icebreaking - ice environment change		1	2	LOW	Few icebreaking operations in region	1	2	LOW	Icebreaking operations around Milne inlet intersect with some species	2	2	LOW	Ice edge, especially inland, important for hunting, travel	3	2	MED	YES		Vessel icebreaking activities change the ice landscape	Ice coverage used for various reasons by numerous species	Icebreaking activity alters ice regime	Inadequate data on ice coverage usage by animals.	None	High (seasonal)	Interruption of floes used by land mammals, creating openings in the ice which will not be seasonally repeatable.	Unknown	Data collection to establish delineation of sensitive areas for shippers, and avoidance of sensitive areas
Wake wash disruptions (general)		2	1	LOW	Little traffic in region	2	1	LOW		3	1	LOW		3	2	MED	YES		Wake wash from ships passing causing rapid and localized changes in current patterns, leading to habitat disruption.	Unknown	Transit of habitat of Arctic Char and other important species	Inadequate data on fish and other lower animals potentially affected.	None	Unknown	Loss of habitat, fish more available to predators, dewatering that may expose fish larvae to air (death of fish larvae).	Changes in fitness of fish through displacement into areas of lower quality. Decrease in population trends for commercially important fish species, change in ecosystem balance, diffuse foodweb effects, change in food availability for predators (seabirds)	Coastal monitoring program in essential habitats for fish & seabird species.
Wake wash disruption of shorelines		2	1	LOW	Little traffic, not necessarily near shore.	2	1	LOW	Lots of traffic in and out of Milne inlet near shore.	3	1	LOW	Majority of traffic passes close to shore, especially in inlet channels	3	2	MED	YES		Vessel traffic in near shore areas disrupt shoreline environment.	Relatively fragile flora in Arctic	Transiting near shorelines introduces additional wash from ship wake to sensitive shorelines.	N/A	None	Low. Open water season only.	Shoreline erosion	Unknown	Transits at distance from shore (couples with avoiding habitat)
Visual disturbances		2	2	LOW	Little traffic, not necessarily near shore.	1	2	LOW		2	2	LOW		2	2	LOW			Presence of ship traffic is unfamiliar and disturbing to wildlife, causing displacement	Limited traffic, wildlife not used to presence of ships	Sailing in regions inhabited by wildlife	N/A	None	Unknown	Disturbance of nearby wildlife	Wildlife may be displaced or relocate to less disturbed regions, affecting population distributions and local/cultural issues.	Avoid particularly sensitive areas

Risk	Coronation Gulf	Probability	Severity	Risk Rating	Foxe Basin	Probability	Severity	Risk Rating	Lancaster Sound	Probability	Severity	Risk Rating	Western Hudson Bay	Probability	Severity	Risk Rating	Oper. Risk	Event Risk	Description or Cause	Influence of Arctic	Immediate Cause	Underlying Cause	Current Mitigation	Probability or Frequency	Immediate Consequences or Effects	Potential Consequences or Effects	Suggested Mitigation
Disruption of airspace		3	1	LOW	Little traffic in region	2	1	LOW		3	1	LOW		3	1	LOW	YES		Vessels transiting near sensitive avian habitats.	Unknown	Transit of waters adjacent to avian colonies	Poor understanding of preservation requirements. Many sensitive regions are located in areas of interest	None officially - a guideline from Environment Canada's Canadian Wildlife Services propose some mitigation measures.	Seasonal (lower risk during winter)	Change in behaviour and distribution of seabirds through the habitat.	habituation of seabirds to increased ship traffic, change in distribution of seabirds (avoidance of major shipping zones), increased flushing distance (distribution travelled to go hunting for prey)	Maintain a minimum distance of at least 300m from all areas occupied by seabirds (and colonies), travel parallel to the shore at a steady speed.
Noise Disruptions (sailing)		5	3	HIGH		5	3	HIGH	Large ships near key habitati	5	3	HIGH		5	3	HIGH	YES		Noise from transiting vessels, and increase in vessel traffic and range rapidly increases sonic inputs to environment.	N/A	Transit of waters used by species dependent on underwater sound transmission	Inadequate data on likely locations and seasonal habits of cetaceans available to mariners. Lack of data on noise outputs from ships.	None	Continuous	Hearing injury (may be lethal), disorientation amongst underwater wildlife, leading to disorientation, communication, navigation issues. Increased risk of collisions	Lasting negative impact on animal populations already at risk	Data collection to establish delineation of sensitive areas for shippers, and avoidance of sensitive areas
Noise Disruptions (icebreaking)		3	1	LOW		3	1	LOW	Icebreaking operations to extend shipping season year round.	4	1	MED		3	1	LOW	YES		Noise from icebreaking activities and an increase in icebreaking activities causes moderate increase to sonic inputs to environment.	Arctic sailing outside of short summer season requires icebreaking	Icebreaking activity in waters used by species dependent on underwater sound transmission	Inadequate data on likely locations and seasonal habits of cetaceans available to mariners. Lack of data on noise outputs from ships.	None	High (seasonal)	Hearing injury (may be lethal), disorientation amongst underwater wildlife, leading to disorientation, communication, navigation issues. Increased risk of collisions	Lasting negative impact on animal populations already at risk. Potential socio-economic impact to communities via displacement of sustenance and/or culturally significant wildlife.	Data collection to establish delineation of sensitive areas for shippers, and avoidance of sensitive areas
Noise Disruptions (surveys)	No O&G activities taking place in 2016	1	3	LOW	No O&G activities taking place in 2016	1	3	LOW	No O&G activities taking place in 2016	1	3	LOW	No O&G activities taking place in 2016	1	3	LOW	YES		Noise from seismic surveys causes moderate increase in acute sonic inputs to environment.	Appetite for O&G surveys in the area?	Surveys in waters used by species dependent on underwater sound transmission	Lack of data on noise outputs from ships and effect on various levels of ecosystem.	None	Low	Hearing injury (may be lethal), disorientation amongst underwater wildlife, leading to disorientation, communication, navigation issues. Increased risk of collisions. Potential kill-off of sensitive lower species.	Lasting negative impact on animal populations already at risk and/or food chains. Potential socio-economic impact to communities via displacement of sustenance and/or culturally significant wildlife.	Data collection to establish delineation of sensitive areas for shippers, and avoidance of sensitive areas
Air Emissions (operational)		5	2	MED	Less traffic in region	5	1	MED		5	2	MED		5	2	MED	YES		Vessel emissions negatively impact air quality in sensitive environment	Arctic is excluded from SECA zone for North America.	Burning of regular diesel or HFO	No regulations for air emissions in the Arctic, no incentives for operators to switch to low sulphur fuel (fuel cost) or alternate fuel type (retrofit cost)	None	Continuous	Health issues amongst sensitive avian populations	Lasting negative impact on animal populations already at risk	Adhere to SECA rules (no HFO)
Pollutant Discharge (Operational)		4	2	MED	Less traffic in region	3	2	MED		4	2	MED		4	2	MED	YES		Vessel emissions as a result of regular operations negatively impact water quality in sensitive environment	Vessel may not dump grey water, but may dump sewage.	Poor regulations	Inadequate regulations prohibiting discharge of sewage.	Restrictions on grey water discharge	Low	Potential local impact on sea populations, negative impact on community shorelines, sustenance fisheries.	Negative impact on animal populations already at risk. Potential socio-economic impact to communities via displacement of sustenance and/or culturally significant wildlife.	0 Discharge policy, subsidy for treatment facilities where feasible, onboard treatment and hold.
Harmful Substance Discharge (Operational)		3	1	LOW	Less traffic in region	2	1	LOW		3	1	LOW		3	1	LOW	YES		The introduction of harmful substances through regular operations (such as anti-fouling agents, coatings, etc) negatively impacts water quality in sensitive environment	navigation in ice may cause abrasion of coatings and agents	Use of common chemicals as part of normal operational practices	Lack of data of effect (and magnitude of impact) of common agents used on Arctic environment.	Some regulatory incentives for low-VOC coatings	Continuous	Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries.	Lasting negative impact on animal populations already at risk. Potential socio-economic impact to communities via displacement of sustenance and/or culturally significant wildlife.	Study of effects of coatings, etc.

Risk	Coronation Gulf	Probability	Severity	Risk Rating	Foxe Basin	Probability	Severity	Risk Rating	Lancaster Sound	Probability	Severity	Risk Rating	Western Hudson Bay	Probability	Severity	Risk Rating	Oper. Risk	Event Risk	Description or Cause	Influence of Arctic	Immediate Cause	Underlying Cause	Current Mitigation	Probability or Frequency	Immediate Consequences or Effects	Potential Consequences or Effects	Suggested Mitigation
Introduction of invasive species		1	4	MED		1	4	MED		1	4	MED		1	4	MED		YES	Ballast water discharge in Arctic ports releases new species into local ecosystem	Sensitive area with no prior exposure to invasive species	Risk of introduction of invasive species is inherent in any shipping operation.	No inspection regime for remote arctic ports.	IMO and TC ballast water regulations	Low	Competition for at risk or endangered species, disruption of low-diversity Arctic food chain	Negative impact on sustenance food sourcing though fishing, potential ecosystem-wide impact if key species is affected.	Zero discharge of ballast in sensitive areas
Socio-Economic disruption		2	2	LOW		2	2	LOW		2	2	LOW	Very little tourist traffic in region	2	2	LOW	YES		Rapid growth in tourism traffic in excess of local population centre's capacities	Small population centres with limited infrastructure and social resources can only support limited growth in visitor traffic	Rapid growth in tourist traffic exceeds the handling capacity of local marine and shore-side infrastructure	Poor planning for sustainable growth in industry.	Regulatory, required permits constrain growth. developments typically require community impact assessments	High	Risk of overwhelming limited local resources (hygiene, marine support, fuel supply, etc.) leaving insufficient resources for local community	Potential for long-term negative impact on communities if growth is not sustainable and tourism traffic drops. Potential for local health issues, resource shortages.	Advocacy for sustainable growth of tourism trade.
Shipping and Operational Incidents																											
Capsize		2	5	MED		2	5	MED		2	5	MED		2	5	MED			Ship capsizing releases pollutants	Extreme icing conditions change stability characteristics of ship	Vessel stability changes under large ice loads, which may not have been accounted for at design time, particularly for foreign flagged vessels sailing in the Arctic for the first time.	Ice navigation and safe practices (as well as ship capabilities) are never truly predictable, even for the most experienced operators). Adding an increase in traffic, some of which is from relatively inexperienced operators with less capable ships, increases the risk of an accident occurring.	Ice regime systems, zone-date systems, ice navigator requirements, vessel class requirements	Low	Risk of injury or loss of life to crew and passengers. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances.	Potential for injury or loss of life if SAR feasibility is limited due to remoteness and harsh conditions. Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for creation of hazard to navigation if vessel is lost and not salvagable.	
Ice Impact		3	2	MED	Little traffic in region	2	2	MED	Reasonably well understood area, ice management mitigations in and out of mine.	2	2	MED	Well understood shipping season, typically less severe ice conditions.	2	2	MED		YES	Impact event between ship and ice breaches vessel and allows release of pollutants	Unpredictability of ice conditions	Risk is inherent in ice infested waters	Ice navigation and safe practices (as well as ship capabilities) are never truly predictable, even for the most experienced operators). Adding an increase in traffic, some of which is from relatively inexperienced operators with less capable ships, increases the risk of an accident occurring.	Ice regime systems, zone-date systems, ice navigator requirements, vessel class requirements	Low-Med	Risk of injury or loss of life to crew and passengers. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances.	Potential for injury or loss of life if event is severe and SAR feasibility is limited due to remoteness and harsh conditions. Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for creation of hazard to navigation if vessel is lost and not salvagable.	

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Beset in ice		4	3	MED	The most remote and unpredictable of the regions considered, very difficult to access once ice is set.	4	4	HIGH	Reasonably well understood area, ice management mitigations in and out of mine.	3	3	MED	Well understood shipping season, typically less severe ice conditions.	3	3	MED		YES	Vessel beset by ice	Unpredictability of ice conditions	Risk is inherent in ice infested waters	Ice navigation and safe practices (as well as ship capabilities) are never truly predictable, even for the most experienced operators). Adding an increase in traffic, some of which is from relatively inexperienced operators with less capable ships, increases the risk of an accident occurring.	Ice regime systems, zone-date systems, ice navigator requirements, vessel class requirements	Low-Med	Potential for harm to crew if stranded for extended period of time. Potential for damage or loss of ship and release of harmful pollutants if ice pressures breach hull.	Potential for injury or loss of life if event is severe and SAR feasibility is limited due to remoteness and harsh conditions. Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for creation of hazard to navigation if vessel is lost and not salvagable.	Escorts for less capable and larger ships. Sailing with support, provision of support from salvage tug or equivalent closer to shipping routes.
Ship Collision	Traffic can be concentrated around Tuktoyaktuk.	3	2	MED	Relatively little traffic in the region	2	1	LOW	More, larger vessels operating in Milne inlet mean a higher overall risk	3	2	MED	More sealift operations near shore mean a higher overall level of risk.	3	2	MED		YES	Impact event between ship and other vessel damages ship and allows release of pollutant	Few navigational aids an well-understood navigation lanes (particularly for new operators)	Risk is inherent to operations in remote/low utilization regions, extreme cold can lower strength of steel and other structural components such as tank walls. Escort activities involve multiple ships operating very close together in unpredictable conditions.	Difficult navigation conditions at times (fog, wind, ice) could force small amount of traffic into localized areas trying to make progress. Escort activities necessarily require icebreakers to sail in close proximity to less capable ships.	General seafaring practices, ice escort practices	Low	Risk of injury or loss of life to crew and passengers. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances.	Potential for injury or loss of life if event is severe and SAR feasibility is limited due to remoteness and harsh conditions. Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for creation of hazard to navigation if vessel is lost and not salvagable.	
Grounding		3	4	MED	Poor hydrographic information, but less vessel traffic	3	4	MED	Somewhat better understanding of navigation in region, especially around port.	2	4	MED	Slightly higher probability of grounding in region due to narrow inland channels and shallow hydrography.	3	4	MED		YES	Grounding of vessel allows release of pollutant	Low use in region, less than complete bathymetry and charts.	Charts and bathymetric surveys of the region are not as developed as more southern regions. extreme cold can lower strength of steel and other structural components such as tank walls.	Low use of the Arctic to date (compared to other regions) means that supporting navigation aids and charts will need to play "catch up" quickly should traffic begin to increase quickly.	Sonar, repeatable navigation routes.	Low-Med	Risk of injury or loss of life to crew and passengers. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances.	Potential for injury or loss of life if SAR is required and feasibility is limited due to remoteness and harsh conditions. Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for creation of hazard to navigation if vessel is lost and not salvagable.	

Risk	Coronation Gulf	Probability	Severity	Risk Rating	Foxe Basin	Probability	Severity	Risk Rating	Lancaster Sound	Probability	Severity	Risk Rating	Western Hudson Bay	Probability	Severity	Risk Rating	Oper. Risk	Event Risk	Description or Cause	Influence of Arctic	Immediate Cause	Underlying Cause	Current Mitigation	Probability or Frequency	Immediate Consequences or Effects	Potential Consequences or Effects	Suggested Mitigation
Equipment failure/pollution release		1	3	LOW		1	3	LOW		1	3	LOW		1	3	LOW		YES	Failure of vessel equipment allows release of pollutant	Extreme cold temperatures, icing, ice clogging	The requirements for operating in the Arctic, particularly in ice, and also particularly on very cold days/seasons exceed the design capabilities of ship's systems, causing freezing, overloading, or other failure of ship's systems enabling release of pollutants.	Harsh conditions in the Arctic may not be fully appreciated by less experienced operators, and like ice, are not 100% predictable by new and experienced operators alike.	Class requirements, ice regime, zone date system.	Low-Med	Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries.	Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up.	
Loss of control		2	4	MED		2	4	MED		2	4	MED	Narrow channels and shallow draft increase risk during sealift voyages	3	4	MED		YES	A loss of ship control leaves the ship vulnerable to impact with rocks, shoals, or ice.	Conditions in the Arctic (winds, currents, dynamic ice) may lead to rapid escalation of situation. Remoteness of region will lead to delays in support or salvage.	Fire, power loss due to equipment malfunction or mechanical failure, operator error, damage to external propulsion components.	Risk of loss of control is inherent with ship operations.	None	Low-Med	Risk of injury or loss of life to crew and passengers. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances.	Consequences could escalate to similar to grounding/capsize events due to harsh conditions, coupled with no towing resources in the area. Closest support would need to steam from Churchill (at least 2-3 days) to arrive and tow. An escalated incident could have long term impact on environment, hazard to navigation if vessel is not salvagable.	Escorts for less capable and larger ships. Requirements for redundancy on ships. Sailing with support, provision of support from salvage tug or equivalent closer to shipping routes.
Sealift spill	Lots of tug and barge operations in the region, floating hose rarely used.	3	4	MED	Few annual operations in the region, with only Hall Beach	2	4	MED	Most operations are via the Mary River pier, which is a better controlled environment,	2	4	MED	Very high - sealift, and tanker to shuttle fuel transfers in the area	3	4	MED		YES	A failure of the systems used to supply shore facilities from a vessel via floating hose fails.	Challenging sealift/supply conditions. Demand for sealift services currently outpaces supply, leading to extension of the season into shoulder seasons. Limited or inadequate sealift infrastructure	Failure of hose, connections between hose and supply or reception facility, ice damage to equipment.	Lack of modern (even basic) infrastructure in many Arctic communities.	No deployment of floating hoses in ice infested waters (operational or regulatory?)	Low	Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries.	Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up.	Advocacy and lobbying for infrastructure investment for communities.
Sealift cargo loss		3	2	MED	As above	2	2	LOW	As above	2	2	LOW		3	2	MED		YES	A failure of the systems used to supply shore facilities from a vessel via cranes and barges fails.	Challenging sealift/supply conditions. Demand for sealift services currently outpaces supply, leading to extension of the season into shoulder seasons. Limited or inadequate sealift infrastructure	Barge or crane systems fail, due to stability problems, poorly graded landing areas, human error, etc.	Lack of modern (even basic) infrastructure in many Arctic communities.	Best practices for loading equipment to barges	Med	Risk of injury or loss of life to crew performing operations. Potential severe impact on sea populations, negative impact on community shorelines, sustenance fisheries due to release of pollutants or harmful substances if barged cargo is released.	Potential for lasting negative impact on animal populations already at risk, as well as local communities due to logistical challenges of staging adequate environmental response and clean-up. Potential for negative socio-economic impact on communities if event drives sealift supply down.	Advocacy and lobbying for infrastructure investment for communities.

Walrus haulouts in the eastern Canadian Arctic: a database to assist in land use planning initiatives

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Abstract

Terrestrial haulout sites (*uglit* in Inuktitut) are a critically important habitat for Atlantic walrus (*Odobenus rosmarus rosmarus*) in the eastern Canadian Arctic. Such sites are limited on the landscape and are used, to varying degrees, on an annual basis during the open-water season. Walrus are sensitive to disturbance at their haulout sites, and repeated disturbance can lead to haulout abandonment. Protecting these sites is therefore important, and the Nunavut Planning Commission (NPC) has recognized this in the Draft 2016 Nunavut Land Use Plan (NLUP), and these areas are assigned a Protected Area Land Use Designation that prohibits incompatible uses and includes setback requirements of up to 5 km. The walrus haulouts identified and mapped by the NPC (as site #41 in the NLUP) is incomplete however, and is limited to Foxe Basin only. The NPC walrus haulout database is therefore missing a significant number of sites throughout eastern Nunavut. Many additional walrus haulout sites are reported in the literature however, and they should be added to the NPC database. Having a comprehensive walrus haulout database will improve land use planning in Nunavut and assist with conservation efforts for the species. This report describes and summarizes efforts made on behalf of WWF-Canada to prepare a database of walrus haulout locations in eastern Canada (and West Greenland for shared stocks). This database should be considered as a starting point for additional work by NPC to refine haulout locations and ensure that buffers will effectively protect hauled out walrus from disturbance.

Introduction

Atlantic walrus (*Odobenus rosmarus rosmarus*) in the eastern Canadian Arctic require suitable areas to haul out (of the water) throughout the year. Sea ice is an important haulout substrate when it is available, but during the time of sea ice minima in late summer and early fall, terrestrial haulout sites (*uglit* in Inuktitut, singular *ugli*) become of critical importance to walrus.

Walrus are sensitive to disturbance at *uglit*, and human disturbances may cause them to stampede into the water, resulting in potential mortality through trampling, increased energy expenditures and stress levels, and impaired thermoregulation (Loughrey 1959; R.E.A. Stewart et al. (ed.) 1993). In some areas, hunting and noise disturbance has caused walrus to abandon *uglit* near communities in favour of less accessible islands and shores (Kopaq 1987; Born et al. 1995; Immaritok 1996; Kupaaq 1996; Paniaq 2005). Prolonged or repeated disturbances may cause walrus to abandon *uglit* (Salter 1979), and their ability to recolonize areas and to habituate to disturbances is largely unknown (COSEWIC 2006).

Protection of walrus haulouts from disturbance is an important conservation goal, particularly with increasing human use of Arctic waters and declining sea ice cover. The Nunavut Planning Commission (NPC) has recognized the importance of walrus haulouts in the Draft 2016 Nunavut Land Use Plan (NLUP), and these areas are assigned a Protected Area Land Use Designation that prohibits incompatible uses and includes setback requirements of up to 5 km (NPC 2016). The walrus haulouts identified and mapped by the NPC (as site #41 in the NLUP) are from R.E.A. Stewart et al. (2013) and are based on research from the Department of Fisheries and Oceans (DFO). This research was conducted only in northern Foxe Basin, however, and the NPC walrus haulout database is therefore missing a significant number of sites throughout eastern Nunavut. Walrus Island (site #76 in the NLUP) was identified by the community of Coral Harbour as a Community Areas of Interest, and these areas are also assigned a Protected Area Land Use Designation. This will also protect some important walrus

haulout sites in the Kivalliq Region. A large number of additional walrus haulout sites are reported in the literature however, and they should be added to the NPC database.

Having a comprehensive walrus haulout database will improve land use planning in Nunavut and assist with conservation efforts for the species. To that end, WWF-Canada commissioned Higdon Wildlife Consulting, Winnipeg, MB, to prepare a database of walrus haulout locations in eastern Canada.

Methods

Walrus population and stock designations

Each haulout site was assigned to a walrus population and stock (where applicable). Walrus populations and stocks were defined following D.B. Stewart et al. (2014). Those authors identified three populations in Canada - High Arctic, Central Arctic and Low Arctic. Higdon and Stewart (2016) revised these names to reflect their shared nature with Greenland, where applicable, and to place their locations in a circumpolar context:

- 1) Canadian High Arctic - Northwest Greenland (Canada, Greenland)
- 2) Canadian Central Arctic - West Greenland (Canada, Greenland)
- 3) Canadian Low Arctic (Canada)

The Canadian High Arctic - Northwest Greenland (CHA-NWG) population, shared by Canada and Greenland, was formerly referred to as the North Water (Baffin Bay-Eastern Canadian Arctic) population (Born et al. 1995). There are significant genetic differences between these walruses and animals in the Canadian Central Arctic - West Greenland (CCA-WG) population (Andersen and Born 2000; de March et al. 2002; Andersen et al. 2014; Shafer et al. 2014, 2015). Three management stocks have been tentatively identified within the CHA-NWG (Outridge et al. 2003; Stewart 2008; NAMMCO 2011): Penny Strait-Lancaster Sound (Canada), western Jones Sound (Canada), and Baffin Bay (Canada and West Greenland).

The Canadian Central Arctic - West Greenland (CCA-WG) walrus population has a wide range in the eastern Canadian Arctic and extends across Davis Strait to west Central Greenland (Richard and Campbell 1988; Born et al. 1995; Stewart 2002, 2008). Four management stocks have been tentatively identified within this population: Foxe Basin (Canada), north and west Hudson Bay (Canada), south and east Baffin (Canada) and West Greenland, and southern Hudson Strait-Ungava Bay-Labrador (Canada) (see D.B. Stewart et al. 2014).

No genetic analyses have been conducted on animals in the putative Canadian Low Arctic (CLA) population, but it is considered separate on the basis of geographical distributions (Born et al. 1995) and lead isotope ratios (Outridge and Stewart 1999; Outridge et al. 2003). No stocks are defined for this population.

The population and stock designations used in the database are summarized in Table 1. The distribution of these populations and stocks is shown in Figure 1 (from D.B. Stewart et al. 2014, and note overlap in putative stock areas for Nottingham and Salisbury islands in Hudson Strait - this potential overlap between the SEBI-WG and SHSUBL "stocks" is described as "Overlap" in the database).

Data sources

A spatial database of walrus haulout sites was compiled from a variety of sources, including peer-reviewed literature, technical reports, local knowledge, and consulting company reports. Sources that were relied on extensively included a comprehensive assessment of the status of Atlantic walrus populations (Born et al. 1995) and recent survey efforts conducted by DFO (R.E.A. Stewart et al. 2013, 2014a-c; Hammill et al. 2016) (NPC 2016 included one of these only - R.E.A. Stewart et al. 2013). Other haulout sites were added to the database, using a variety of sources including Traditional Ecological Knowledge (TEK) (e.g., Brody 1976a,b; Orr

and Rebizant 1987; Riewe 1976, 1992). Where possible, actual location data (i.e., reported latitude-longitude values) are reported. In many cases however, locations had to be estimated from published maps. These haulouts are given a lower score for spatial accuracy (see below). DFO has a Garmin Mapsource (.gdp) file of waypoint locations of walrus haulouts in the areas that they have surveyed (J. Blair Dunn, DFO, pers. comm.). This file would provide more accurate location information than used here, and permission could be requested from DFO to access those data.

Confidence and uncertainty

Haulout sites were assigned “confidence values” based on currency of information and accuracy of geography. Two columns are included in the database, one for haulout status and one for spatial accuracy.

For haulout status, three categories are included:

- 1) *Active* - currently used by walruses (i.e., published evidence of recent use [ca. last 10 years] or reported to be active by local harvesters)
- 2) *Uncertain* - no recent data to confirm or suggest current use
- 3) *Abandoned* - haulout previously reported to be abandoned and no recent data to refute (note: it is possible that walruses could re-colonize formerly abandoned haulouts, and these sites should therefore receive the same level of protection as currently used sites)

For spatial accuracy, three categories are included:

- 1) *High accuracy* - positional data (latitude-longitude, UTM coordinates, etc.)
- 2) *Moderate accuracy* - position estimated from map(s) with sufficient resolution to have reasonable certainty of accuracy within ca. 5 km
- 3) *Uncertain accuracy* - position estimated from map(s) with insufficient resolution to have reasonable certainty of accuracy within ca. 5 km (or landscape pattern adds uncertainty), from non-spatial sources, or for haulouts where different sources locate them differently or show different numbers of sites in particular locations. The location data provided may be accurate to within 5 km but this cannot be stated with certainty.

There is some level of subjectivity involved with spatial accuracy classes 2 and 3. Uncertainty and/or errors in some source reports also adds uncertainty here. For example, Born et al. (1995 - their Figure 10) identify six haulouts in Foxe Basin, all “historical haul-outs; present status unknown”. There is uncertainty with these locations however, as many are incorrectly labeled. A location near Tern Island is labeled as “Rowley Island”, and Rowley Island is labeled as “Spicer Island”. R.E.A. Stewart et al. (2013), which was used as the primary source for Foxe Basin, do not include either of these islands as haulouts, although Riewe (1992: 91,129) also refers to a haulout on Spicer Island (see Results and Discussion). The scale of the source maps also has an influence of perceived accuracy, as maps of smaller areas (e.g., Southampton and Coats Island area versus all of Hudson bay) allow more careful estimates of locations. When assigning locations from maps, the haulout was often placed on the coastline (using Google Maps), although in some cases they could actually be located on small offshore islands, which adds another layer of uncertainty.

In some cases, one source includes more haulout sites in a particular area (e.g., a small island) than another source does. This could represent multiple sites close together, or just variation in the mapping efforts. In cases like this, the haulout sites (i.e., point locations) that are shown in multiple sources receive higher confidence scores. All points are included in the database however. Some times the locations used by the animals may have shifted 100 to 3000 m away for various reasons (coastline erosion, etc.) over time (R.E.A. Stewart, DFO (retired), pers. comm.). All these factors lead to uncertainty in the database, and this should therefore be treated as a preliminary assessment and a “living document” that is updated as better data become available. Some data on haulout size (i.e., number of animals) are available in the literature, from both scientific (e.g., Fisher 1962; Mansfield and St. Aubin 1991; R.E.A. Stewart

et al. 2013, 2014a,c; Hammill et al. 2016) and traditional knowledge (e.g., Brody 1976a,b; Riewe 1976, 1992; Orr and Rebizant 1987) sources. No data on size are reported in the database however, since the NPC proposes equal protection for all known sites, regardless of size. The primary source is generally the one that mapped the location, or produced the highest quality map if several did, and not necessarily the first source to mention and/or map a site.

Maps

The database was created in Microsoft Excel and exported to ArcView 3.3 for processing and to produce haulout maps. Data were maintained as geographic (i.e., latitude-longitude, non-projected) but were projected to Lambert Conformal Conic - North America (LCC-NA) for the maps.

Results and Discussion

The database includes a total of 213 haulout location entries (198 in Canada - Figure 2), summarized by population and stock as follows, and detailed below:

- 1) Canadian High Arctic - Northwest Greenland population - 57 locations
 - a) Penny Strait-Lancaster Sound stock - 35 locations
 - b) West Jones Sound stock - 18 locations
 - c) Baffin Bay stock - 4 locations (all in Greenland)
- 2) Canadian Central Arctic - West Greenland population - 144 locations
 - a) Foxe Basin stock - 11 locations
 - b) North and West Hudson Bay stock - 55 locations
 - c) Southern Hudson Strait-Ungava Bay-Labrador stock - 9 locations
 - d) Area of overlap of Southern Hudson Strait-Ungava Bay-Labrador and South and east Baffin - West Greenland stocks - 11 locations
 - e) South and East Baffin - West Greenland stock - 58 locations (including 11 abandoned haulouts in West Greenland)
- 3) Canadian Low Arctic population (no stocks recognized) - 12 locations

Canadian High Arctic - Northwest Greenland population

The database for the CCA-NW population includes 57 location points in total (Figure 3), with most ($n = 35$) for the Penny Strait-Lancaster Sound (PS-LS) stock. The primary source for haulout locations in the PS-LS and West Jones Sound (WJS) stocks was Stewart et al. (2014a), which includes maps of haulouts surveyed in 1977 and 1998–2009. Those extensive efforts resulted in 24 terrestrial haulout sites currently or historically used in the PS-LS area, and 10 terrestrial haulout sites used in the WJS stock area. These data were augmented with other sources as available (e.g., Manning and Macpherson 1961; Brody 1976a, b; Riewe 1976, 1992; Davis et al. 1978; Koski and Davis 1979; Salter 1979; Born et al. 1995). The recent work by DFO in this area significantly expands on the available knowledge of haulout locations, as none of the haulouts between Maxwell Bay and Croker Bay that were mapped by Stewart et al. (2014a) were reported by Born et al. (1995) in their review.

Historic information summarized by Born et al. (1995) indicated that there are no *uglit* along the east coast of Ellesmere island north of Jones Sound, and aerial surveys of the Baffin Bay (BB) stock summer range (western Nares Strait) conducted in August of 1999, 2008, 2009 observed no walruses on land (Stewart et al. 2014b). There are historic (abandoned) haulouts in Northwest Greenland, however, and these ($n = 4$) are included in the database (from Born et al. (1995) and sources therein - Hayes 1867; Peary 1917; Freuchen 1921; Vibe 195) for additional context, despite not being directly relevant to Nunavut land use planning.

Haulout occupancy status was based on Stewart et al. (2014a), and all haulouts that were not included by Stewart et al. (2014a) ($n = 19$ including the four in Greenland) were classed as either Abandoned or Uncertain.

Stewart et al. (2014a) also note some details that are relevant to the NPC's proposed 5 km buffer around haulout sites. For example, they report that in Baad Fjord there are two sites only ca. 4 km apart on the same shoreline. Both places had not been occupied simultaneously during their surveys, so they considered these two sites as one site. A 5 km buffer placed around one of these two sites will not offer the same level of protection to both. Conversely, in Musk Ox Fjord, the two sites are about 5 km apart on opposite sides of the fjord and they have both been occupied at the same time. Stewart et al. (2014a) therefore included these as separate sites. These results make it clear that the buffers proposed by NPC need to be carefully considered in light of the spatial accuracy of the haulout locations mapped here.

Canadian Central Arctic - West Greenland population

R.E.A. Stewart et al. (2013) was considered as the authoritative source for walrus haulouts in Foxe Basin. Their map includes 10 Foxe Basin haulouts - six confirmed and four unconfirmed (defined here as "Uncertain") (Figure 4). Unconfirmed haulouts were surveyed in 2010-2011 but no walruses were observed. Some of these were historically used (e.g., North Ooglit Islands, Brody 1976a) and may still be active. COSEWIC (2006) notes that walruses were abundant at *uglit* along the east coast of Melville Peninsula until the 1940s or 1950s, and these *uglit* have not been reoccupied. No abandoned haulouts in this area are included in the database as no spatial data were found (but see the location of Cape Wilson, a confirmed active haulout in R.E.A. Stewart et al. 2013). Born et al. (1995 - their Figure 10) identify six haulouts in Foxe Basin, but there is uncertainty with these locations however, as many are incorrectly labeled. For example, a location near Tern Island is labeled as "Rowley Island", and Rowley Island is labeled as "Spicer Island". Riewe (1992) also refers to an *ugli* on Spicer Island. R.E.A. Stewart et al. (2013) do not include either of these islands as haulouts however, and they were therefore not included in this database. Born et al. (1995) also record a haulout at Sturges Bourne Island, and have the correct island identified, so it was included.

Many of the haulouts in northwestern Hudson Bay (e.g., Southampton Island, Coats Island, Bencas Island) have long been known to science, as research has been conducted in these areas since the 1950s (e.g., Loughrey 1959). The 1961-1962 Annual Report of Eastern Arctic Fisheries Investigations by the Fisheries Research Board of Canada (Fisher 1962) maps nine haulouts on Southampton, Coats, Walrus and Bencas Islands, and these haulouts are also identified in numerous other studies. This was considered a primary source for these nine haulouts, with location and status data updated as available using the results from recent DFO surveys (Hammill et al. 2016). There is a varying level of detail in different studies - for example, Fisher (1962) included two haulouts on Walrus Island and one on Bencas Island, whereas Brody (1976b) included five on Walrus Island and two on Bencas Island based on Inuit land use research. Brody (1976b) included the same three Coats Island locations as Fisher (1962), but also included an additional site on the southern end of the island. Land use interviews compiled data extending back the early 1900s, in some cases, and many of these sites may have been abandoned prior to the start of scientific research in this area in the 1950s. They are all included in the database, of "Uncertain" status. Brody (1976b) also includes two haulouts near Terror Point, both west of the location in Fisher (1962). These were also included ("Terror Point IQ1" and "Terror Point IQ2") and given "Uncertain" status. A haulout west of Seahorse Point (as mapped in Fisher 1962) was labeled "Seahorse Point IQ". Two haulouts near the Back Peninsula site (from Fisher 1962) were labeled as "Back Peninsula IQ1" and "Back Peninsula IQ2" (this second one appears to be slightly offshore in the map in Brody 1976b). Orr and Rebizant (1987) list Leyson Point as a haulout, based on interviews in with Inuit hunters in Coral Harbour. The area is indicated in the map in Fisher (1962) but it is not identified as a haulout. It was included here again with uncertain status. Prairie Point is also identified as a haulout by Orr and Rebizant (1987), and Native Point and Renny Point are identified by both this source and Freeman (1962). Hammill et al. (2016) flew over sites and confirmed latitude-longitude (of points, spits, etc.) even if no walruses were recorded, therefore some haulouts are scored both "High" (for spatial accuracy) and "Uncertain" (for status) (e.g., Renny Point).

A haulout mapped by Brody (1976b) (also see Born et al. 1995) along the north coast of Southampton island ("SI North-1") was confirmed by Hammill et al. (2016) to be an active

haulout, and their surveys also identified two new haulout sites in that area (in the database as "SI North-2" and "SI North-3"). Given the volume of scientific research that has been conducted in this area, and the extensive efforts to compile Inuit knowledge (Brody 1976b), it is likely that these two sites are new haulouts that have been established since the 1970s. Brody (1976b) also shows a haulout slightly offshore of southern Southampton Island, closest to Native Point (as mapped by Orr and Rebizant 1987). It was included as "Native Pt offshore" and given "Uncertain" status. Another site ca. 20 km further east of Terror Point in Brody (1976b) was simply named "SI IQ". Brody (1976b) included four locations in Roes Welcome Sound, three on the mainland coast and one slightly offshore, all included as "RWS IQ1", "RWS IQ2", "RWS IQ3", and "RWS IQ4 OS" and all of "Uncertain" status. Brody (1976) shows three haulouts near White Island: one on Nias Island (south of White Island), one on Seekoo Island (west of White Island), and another on a small unnamed island north of Seekoo Island. Five haulouts are shown on Bushnan Island, northwest of Vansitart Island (or possibly on small unnamed islands around Bushnan Island), and one of these was confirmed as "Active" by Hammill et al. (2016). Brody (1976b) also mapped sites on Brooks Bluff (mainland coast north of Bushnan Island) and Sanderson and Danish islands (both near Vansitart Island). Born et al. (1995) map many of these same haulouts (e.g., Cape Pembroke, Bencas Island, Seahorse Point, Terror Point), but also include some locations that were not in the other sources (primarily Brody 1976b). These include two haulouts in East Bay (Southampton island), a haulout on Vansitart island, and another on Sturges Bourne Island. All were added to the database and given an "Uncertain" status.

A number of haulouts in western Hudson Bay are included as "Abandoned" haulouts, primarily based on COSEWIC (2006) (also see Preble 1902; Loughrey 1959; Richard and Campbell 1988; Riewe 1992; Born et al. 1995). Riewe (1992) reported that Hazy Islet and "Little" Walrus and Bibby islands site may still be used by a small number of walruses, although no more recent data are available (although a Kivalliq Inuit Association employee recently reported that walruses still haul out on a small island near Marble Island - which could be Hazy Islet; Jeff Tulugak, KIA, pers. comm.). The Hazy Islet site was mapped by Born et al. (1995) but not listed in COSEWIC (2006). Born et al. (1995) also reported (via an RCMP game report) that walruses were hauled out on Depot Island near the coast north of Chesterfield Inlet in spring 1961, so this was included as an abandoned site.

The database includes nine haulout locations for the Southern Hudson Strait-Ungava Bay-Northern Labrador (SHSUBL) "stock". Born et al. (1995) reported Digges Island to be abandoned as a haulout site (also see Loughrey 1959; COSEWIC 2006). The island is labeled on Reeves' (1995) map, but not marked as a haulout, and no haulouts are mapped in Stewart and Howland (2009). Brooke and Kemp (1986) report summer harvesting at Digges Islands, but do not map any haulouts. A single haulout ("Abandoned") was added to the database, randomly placed on the southern side of the island, near the centre. Reeves (1995) maps two haulouts on Mansel Island, both on the east coast. Other sources (Born et al. 1995; Stewart and Howland 2009) do not map any haulouts here. Brooke and Kemp (1986) note summer harvesting at Mansel Island, which possibly occurs during the last of the ice season and not while animals are hauled out). The two haulouts from Reeves (1995) were added, and scored as "Uncertain". *Uglit* on the Gyr Falcon Islands (59°05'N, 68°57'W) in southern Ungava Bay were abandoned in the early to mid-1900s (Dunbar 1955; Born et al. 1995; COSEWIC 2006). A haulout on Akpatok Island (also in Ungava Bay) was included, and ranked as "uncertain" status (Brooke and Kemp 1986; Born et al. 1995; Stewart and Howland 2009). Walruses also historically hauled out on the Eider Islands near Cape Hopes Advance and at Weggs Island along the southern coast of Hudson Strait (Loughrey 1959; Born et al. 1995). They were also formerly found on islands near Sugluk, in Deception Bay, but had been killed off or driven away from these haulouts some time in the early 1900s (Loughrey 1959; Born et al. 1995). A single haulout was assigned to each of these islands, although the use of "islands" by Born et al. (1995) suggests that multiple sites were historically used in Deception Bay. Charles Island was also considered by Loughrey (1959; also see Born et al. 1995) to be an abandoned haulout, but recent DFO surveys (Hammill et al. 2016) have confirmed that it is again being used by walruses. This is an important finding that supports the need for NPC protection of haulout sites that are presently considered to be abandoned. Also important to note is that only two of these haulouts are on the Nunavik coast. The rest are offshore islands and are therefore under Nunavut jurisdiction.

Nottingham and Salisbury islands in Hudson Strait are considered an area of overlap between the putative SHSUBL and SEBI-WG stocks (see D.B. Stewart et al. 2014). Born et al. (1995) map two haulouts on Nottingham Island, one on the northeast end and another on the northwest end (labeled as "Fraser Island", a small adjacent island). Reeves (1995) included three haulouts in his map, and Stewart and Howland (2009) included only one, on the east side (and slightly south of the one in Born et al. 1995). Brooke and Kemp (1986) map the island as a fall harvesting area of importance, but do not map the haulout locations (also see Kemp 1976). Orr and Rebizant (1987) similarly identify Nottingham Island as a haulout area, but do not map specific haulout locations. Three haulouts are included in the database - two on Nottingham Island and one on Fraser Island. Recent surveys by Hammill et al. (2016) have confirmed that both Fraser Island and one of the Nottingham Island sites are active. For Salisbury Island, there appear to be eight haulouts shown in Born et al. (1995), but they are highly clumped in the map figure and hard to decipher. One of them mapped sites is likely the small reef (400 yards long by 250 wide) called Nooshwetuk, described by Russell (1966) as 15 to 20 miles (25-30 km) east of Salisbury Island. Stewart and Howland (2009) include seven haulouts in their map. Reeves (1995), on the other hand, only includes two. Similar to Nottingham Island as described above, Brooke and Kemp (1986) and Orr and Rebizant (1987) do not map individual haulout sites, only identifying the island generally (as does Kemp 1976). Seven were mapped ("Salisbury Isl. 1-6" and "Nooshwetuk"), and one ("Salisbury Isl. 4") was confirmed by Hammill et al. (2016) as an active site.

The primary source for Canadian haulout location and status in the South and East Baffin - West Greenland stock was Stewart et al. (2014c), who reported on extensive DFO surveys along the eastern Baffin Island coast (i.e., not including Hudson Strait, but see Hammill et al. 2016). Stewart et al. (2014c) started with the 37 presumed active haulout sites mapped by Born et al. (1995: Figs. 10 and 16) for their study area. Some sites were adjacent to each other, such as three locations on Kertaluk Island, which is ca. 10 km long. Stewart et al. (2014c) collapsed sites like this, resulting in 25 identified areas based on Born et al. (1995). As noted previously, variation in haulout location and point accuracy like this could have an influence of the success of 5 km protection buffers if these data are used as is for land use planning. Another three haulout sites were added by Stewart et al. (2014c), two from their surveys (Clephane Bay and Anna's Skerries) and one from Government of Nunavut (GN) researchers (Moonshine Fiord), for a total of 28 haulout locations (and status information) from the authoritative source for eastern Baffin Island. Other secondary sources (i.e., in addition to Born et al. 1995 for the 25 sites) are included in the database where available (e.g., Anders 1967; MacLaren Atlantic Ltd. 1978; MacLaren Marex 1979, 1980a,b; Smith et al. 1979; Ross and MacIver 1982).

The only additional sites added to the database for this area were presumably abandoned haulouts that were mapped and discussed in Born et al. (1995). Clyde Inlet was reported as an important haul-out area by both Freuchen (1935) and Loughrey (1959), although it presumably would never be re-occupied now given the near-by presence of the community of Clyde River. In the early 1900s, the ugli at Padlei, just south of Padloping Island, may have been the biggest one along the east Baffin coast (Mansfield 1958; Reeves 1978). A local hunter interviewed by Born et al. (1995) identified two *uglit* in the Cumberland Sound region that were no longer used by walrus: one on Miliakdjuin Island (reportedly abandoned after 1947 due to disturbance by motorboats) and the other on a little island off Kekertukdjuak in the mouth of Kingnait Fiord. Riewe (1992) reported a ugli on some very small islands just southwest of Sumner Island (in Frobisher Bay), which was included here as abandoned given that no other evidence for it is available (other than being mentioned by Born et al. 1995).

This stock also occurs off southern Baffin Island, and the primary haulout areas in Hudson Strait are found on Salisbury and Nottingham Islands, which are described above as overlapping with the putative SHSUBL stock based on harvesting by Inuit from communities on both sides of Hudson Strait (see D.B. Stewart et al. 2014). Stewart and Howland (2009) included one haulout on Mill Island (which is shown on a map but not identified as a haulout in Born et al. 1995). Inuit in Cape Dorset also identified it as a haulout (Orr and Rebizant 1976), and this was confirmed (i.e., "Active" status) by Hammill et al. (2016). Walruses formerly hauled out on Wales Island in Hudson Strait (Loughrey 1959; Born et al. 1995), which was

included as an abandoned haulout. Along the eastern Foxe Peninsula coast, Born et al. (1995) mapped four haulout locations (Cape Dorchester, Cape Weston, Wildbird Island, and Cape Queen) (also see Soper 1944; Riewe 1992). Stewart and Howland (2009) mapped the same four locations. Inuit hunters also identify Cape Dorchester as a haulout, along with Nabukjuak Bay (Orr and Rebizant 1987), which is close to Cape Weston and considered as the same point here. Other haulouts close to Cape Dorset include Lona Bay, Shuke Island, Okolli Island, and West Fox Island (Orr and Rebizant 1987). Born et al. (1995) included four haulouts in the general vicinity of West Foxe Island. I assumed one was West Foxe Island, and located the others west of Chorbak Inlet, which was identified on their map (see Born et al. 1995 - it is hard to decipher locations on the maps with accuracy due to the scale). Hammill et al. (2016) confirmed three of these haulouts (Cape Dorchester, Cape Queen, West Fox Island) and "Active" and the rest were scored as "Uncertain" status. Those closest to communities, such as Okolli Island, may be abandoned. Hammill et al. (2016) mapped a haulout at Big Island, near Kimmirut in Hudson Strait. Kemp (1976) reported that there were "some" haulouts along White Strait, which separates Big Island from the mainland, so it is possible that additional sites are found in the vicinity (he also reported *uglit* in the central part of North Bay, which is just southeast of Kimmirut).

The SEBI-WG stock, as the name implies, is also shared with Greenland. A total of 11 West Greenland haulout sites were added to the database. All sites were mapped by Born et al. (1995) (also see Born et al. 1994) and all were classed as Abandoned. No additional effort was made to secure additional information on Greenland sites as they are not relevant to land use planning in Nunavut.

Canadian Low Arctic population

The Canadian Low Arctic population is found in southeast Hudson Bay and has the smallest geographic range of the three populations - the database only includes 12 haulout records (Figure 5). Hammill et al. (2016) conducted the first systematic surveys of walrus in the region and is considered the authoritative source for location and status information (for 6 of the 12 haulouts). Locations of other sites are from various sources including Born et al. 1995 and references therein (e.g., Twomey 1939; Twomey and Herrick 1942; May 1942; Loughrey 1959; Manning 1976; Richard and Campbell 1988), personal communications with OMNR staff, and unpublished observations by the author (a haulout on Split Island). The database includes one abandoned haulout in James Bay (Tremblay 1921).

Conclusions and directions for further study

This database was prepared on behalf of WWF-Canada and is meant to contribute to the NPC's land use planning process for Nunavut. This report has documented walrus haulout locations from a variety of sources, with variable spatial accuracy. There are a number of uncertainties related to locations, including multiple sites located close to each other (but perhaps not close enough to be effectively captured in a 5 km buffer around one point) and uncertainty in locations from different sources. These locational uncertainties, coupled with the fact that haulouts locations can shift over time, new haulouts can be started, and abandoned haulouts can be re-colonized, all point to the importance of treating this database as a start for land use planning, not the final product. The database should be carefully examined for mistakes and errors, and it should be treated as a living document that is regularly updated as new information becomes available. In addition, community knowledge should be considered an invaluable source for refining and updating this database.

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Table 1. Walrus populations and stocks found in eastern Canadian Arctic waters.

Population	Stock	Jurisdiction(s)	
		Countries	Province or Territory (Canada)
Canadian High Arctic - Northwest Greenland (CHA-NW) ¹	Penny Strait - Lancaster Sound (PS-LS)	Canada	Nunavut
	Western Jones Sound (WJS)	Canada	Nunavut
	Baffin Bay (BB)	Canada, Greenland	Nunavut
Canadian Central Arctic - West Greenland (CCA-WG)	Foxe Basin (FB)	Canada	Nunavut
	North and west Hudson Bay (NWHB) ²	Canada	Nunavut
	South and East Baffin and West Greenland (SEBI-WG) ²	Canada, Greenland	Nunavut
	Southern Hudson Strait-Ungava Bay-Labrador (SHS-UB-L)	Canada	Nunavut, Nunavik, NL
Canadian Low Arctic (CLA) ³	n/a	Canada	Nunavut, Nunavik

¹ Formerly referred to as the North Water (Baffin Bay-Eastern Canadian Arctic) population

² Formerly referred to as the Hudson Bay - Davis Strait population

³ Formerly referred to as the South and East Hudson Bay population

Figure 1. Distribution of walrus populations and stocks in eastern Canada (and west Greenland) (from D.B. Stewart et al. 2014).

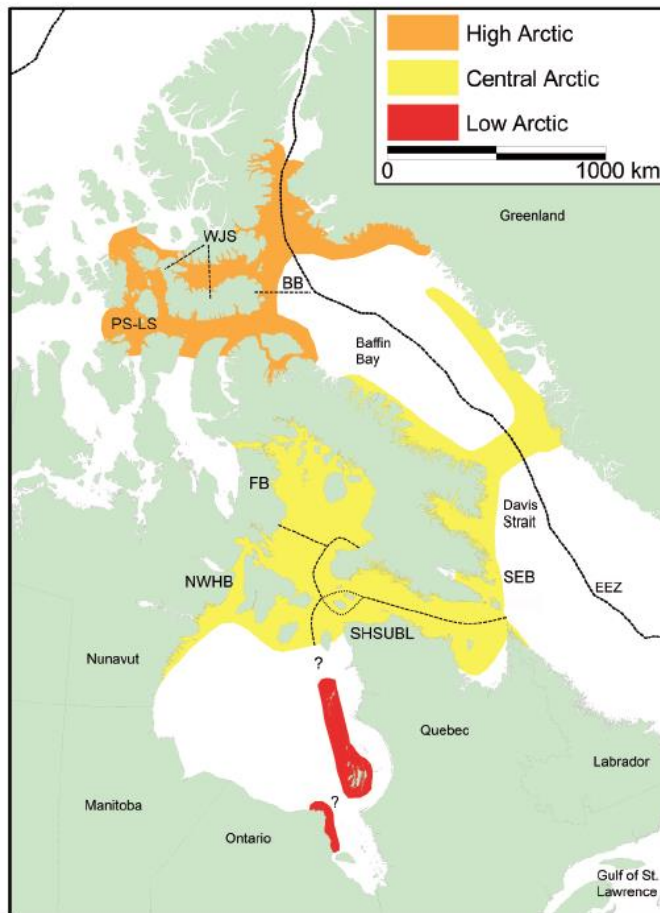


Fig. 1. Approximate distributions of the Atlantic walrus populations that use Canadian waters, updated from COSEWIC (2006) with information from Stewart REA (2008), LGL Limited and North/South Consultants Inc. (2011), Andersen et al. (2014), Dietz et al. (2014). Elliot et al. (2013); Heide-Jørgensen et al. (2013, 2014), Shafer et al. (2014); and Stewart REA et al. (2013, 2014a-c). Walrus management stocks within these populations include: BB=Baffin Bay, FB=Foxye Basin, NWHB=North and West Hudson Bay, PS-LS=Penny Strait–Lancaster Sound, SEB=South and East Baffin, and SHSUBL=South Hudson Strait–Ungava Bay–Labrador, and WJS=West Jones Sound. Question marks (?) indicate uncertainty with respect to distributions and/or movements.

Figure 2. Map showing locations of all walrus haulouts (n = 213, 198 in Canada) in the database. Most (n = 196) are in Nunavut's jurisdiction, including the offshore islands in Hudson Bay and Hudson Strait, and the territory is shown in darker grey colour. Projection information: Lambert Conformal Conic - North America.

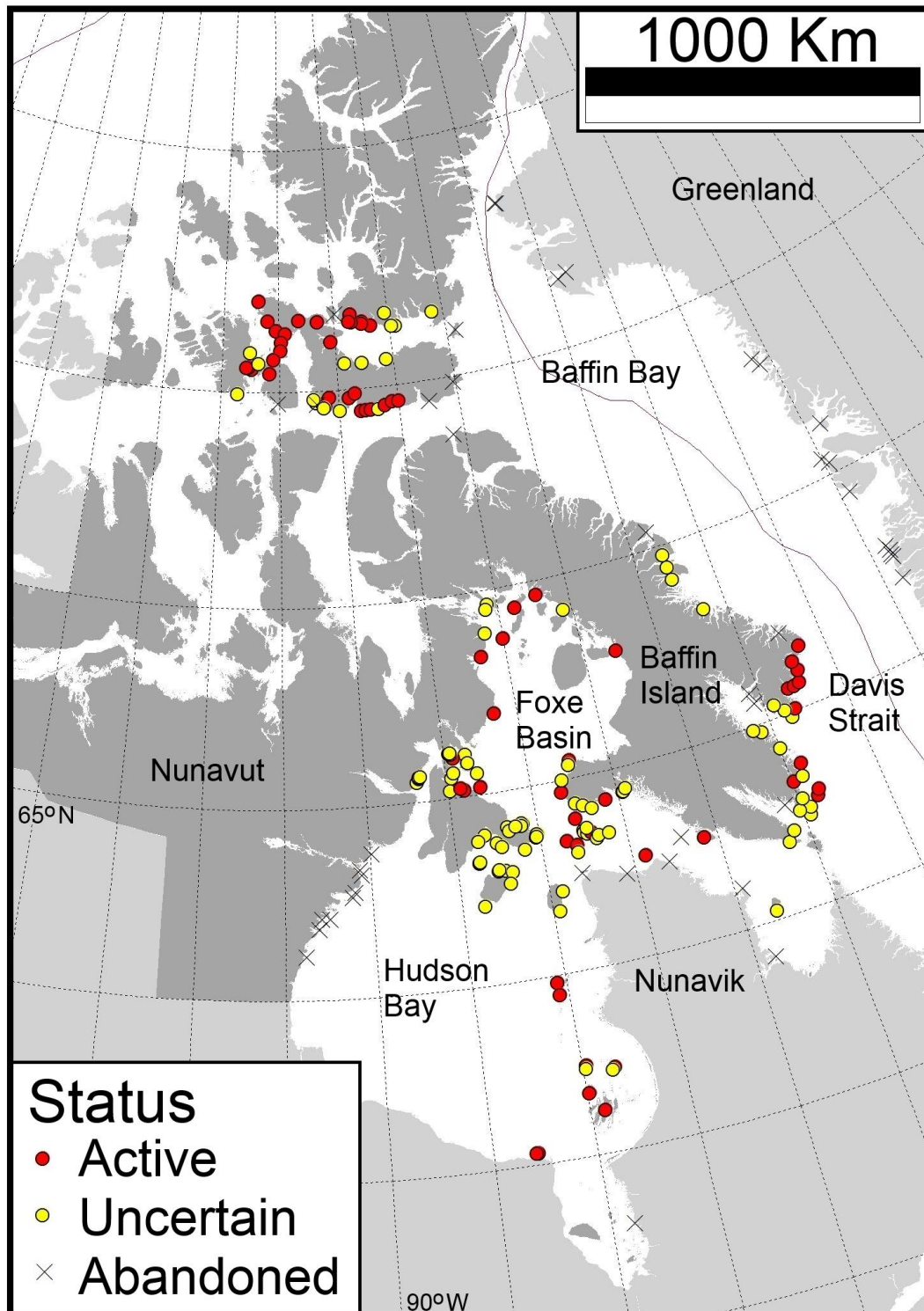


Figure 3. Map showing locations of all walrus haulouts used by the Canadian High Arctic - Northwest Greenland population ($n = 57$, 53 in Nunavut) in the database. Projection information: Lambert Conformal Conic - North America.

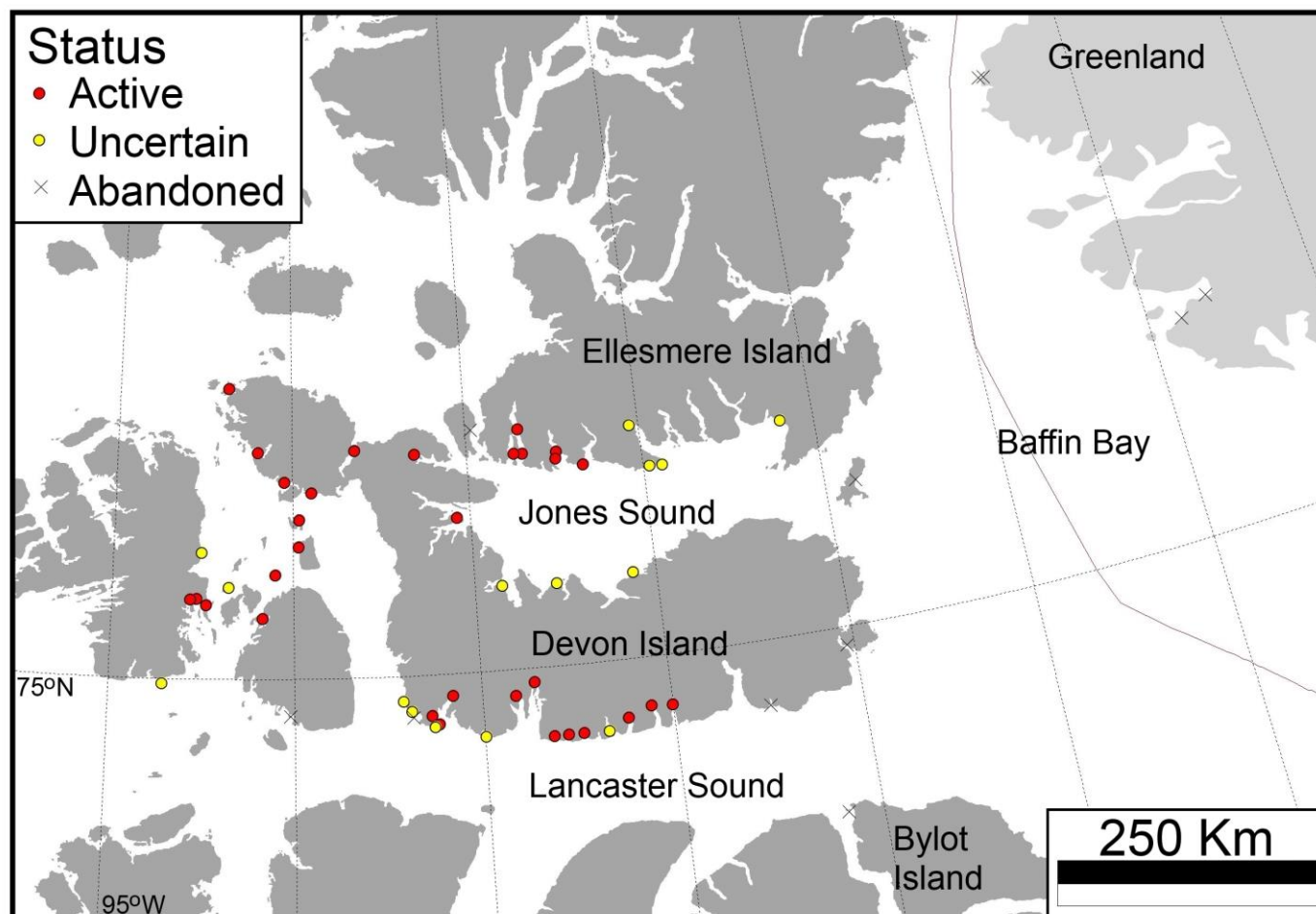


Figure 4. Map showing locations of walrus haulouts used by the Canadian Central Arctic - West Greenland population ($n = 144$, 11 abandoned sites in Greenland) in the database. Not all West Greenland sites are shown. Only two Canadian sites are not in Nunavut jurisdiction (found on the Nunavik coastline). Projection information: Lambert Conformal Conic - North America.

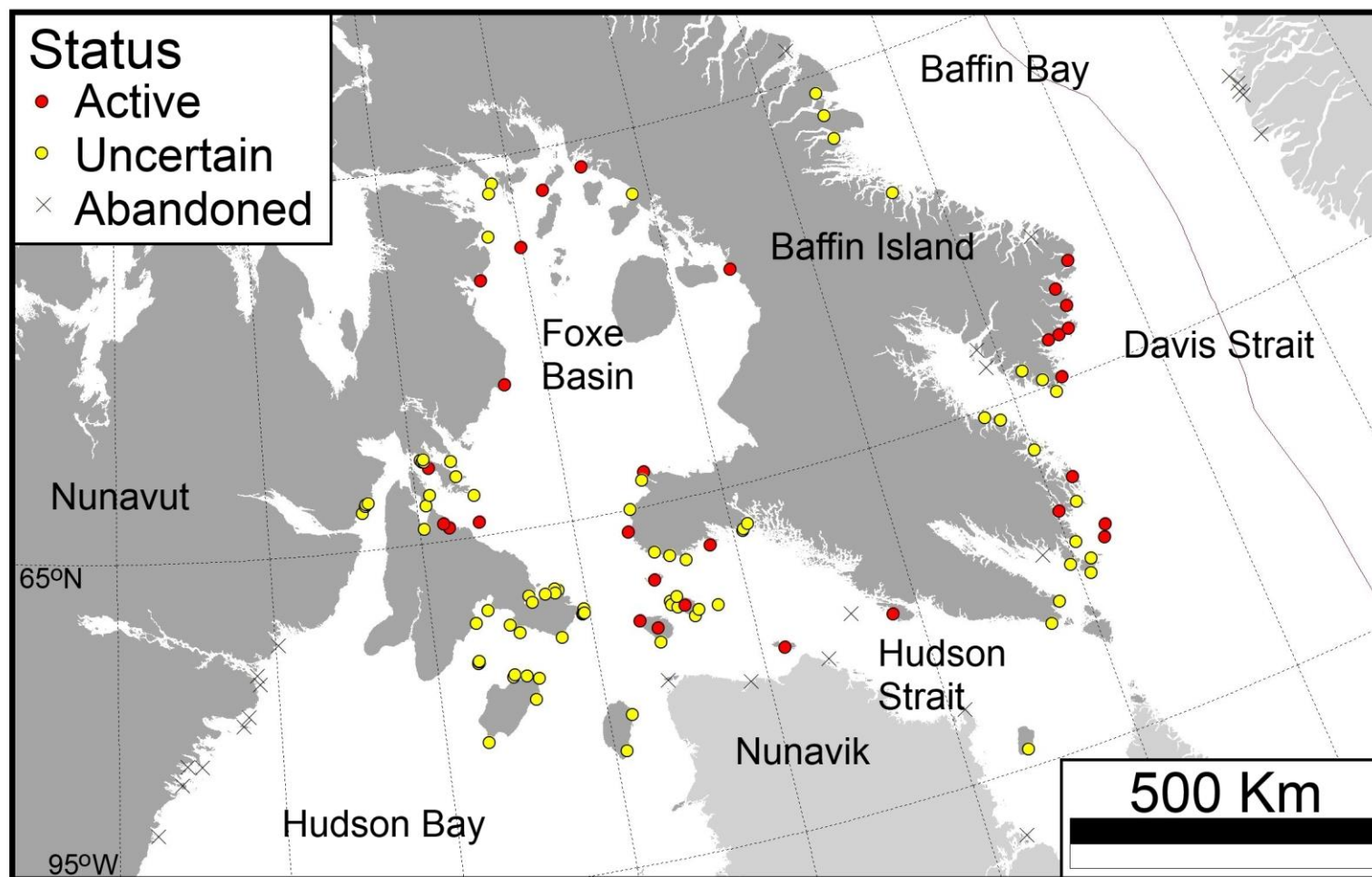


Figure 5. Map showing locations of walrus haulouts used by the Canadian Low Arctic population ($n = 12$) in the database. All sites are on offshore islands and are therefore under Nunavut's jurisdiction. Projection information: Lambert Conformal Conic - North America.

