CANADIAN ARCTIC SHIPPING ASSESSMENT

Main Report

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By

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for

Transport Canada

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GLOSSARY OF ACRONYMS AND TERMS

Acronyms

ACIA	Arctic Climate Impact Assessment
AECO	Alberta Energy Company, now EnCana.
AHTS	Anchor Handling Tug Supply Vessel
AIRSS	Arctic Ice Regime Shipping System
AOCGMs	Atmosphere-Ocean General Circulation Models
ARCDEV	Arctic Demonstration and Exploratory Voyage
ARCOP	Arctic Operational Platform
ASPPR	Arctic Shipping Pollution Prevention Regulations
Bcfd	Billion cubic feet per day
CASA	Canadian Arctic Shipping Assessment
CCAF	Climate Change Action Fund
CCG	Canadian Coast Guard
CHC	Canadian Hydraulics Centre
CHS	Canadian Hydrographic Service
CIF	Cost, Insurance, Freight (charter part term)
CMAC	Canadian Marine Advisory Committee
COGLA	Canadian Oil and Gas Lands Administration
CTA	Coasting Trade Act
DGPS	Differential Global Positioning System
ENSO	El Nino –Southern Oscillation
EU	European Union
FOB	Free on board (charter party term)
FSICR	Finnish/Swedish Ice Class Rules
GCMs	General Circulation Models
GDP	Gross Domestic Product
GPS	Global Positioning System
IACS	International Association of Classification Societies
IBA	Impact and Benefit Agreement
IMO	International maritime Organisation
INAC	Indian and Northern Affairs Canada
INNAV	Data reporting system for vessel traffic in Eastern Canada
INSROP	International Northern Sea Route programme
IPCC	Intergovernmental Panel on Climate Change
IPY	International Polar Year
JANSROP	Development and Operation Programme for Environmental Sustainability in Eastern Eurasia
JBNQA	James Bay & Northern Quebec Agreement
KRG	Kativik Regional Government
LNG	Liquified Natural Gas
LOA	Length overall
LTD	Tender-assist drill unit
MGP	Mackenzie Gas Pipeline
Mmcfd	Million cubic feet per day
MTQ	Ministry of Transport, Quebec

NAO	North Atlantic Oscillation
NEAS	Nunavut Eastern Arctic Shipping
NEP	North East Passage, alternative to NSR which see.
NEB	National Energy Board
NORDREG	Northern traffic reporting system – primarily Arctic
NOT	Nunavut Ocean Transport
NSR	Northern Sea Route
NTI	Nunavut Tunngavik Incorporated
NWP	Northwest Passage
NWT	Northwest Territories
OBO	Ore Bulk Oil carrier
PCA	Panama Canal Authority
PC/UMS	Panama Canal Universal Management System
POAC	Port Operations in Arctic Conditions
POL	Petroleum, Oil Lubricants
SCA	Suez Canal Authority
SDC	Steel Drilling Unit
SDRs	Special Drawing Rights
SHP	Shaft Horsepower, equivalent to brake horsepower less transmission losses
TEU	Twenty Foot Equivalent Unit (regarding Containers)
VLBCs	Very Large Bulk Carriers
WMO	World Meteorological Organization

Terms

Food mail	Federally subsidized transportation of foodstuffs to remote communities
Lateral cargo	Cargo carried between ports within the region
Meromictic	Layers of water which do not mix
Omni TRAX	Short line railroad operator and owner of the Port of Churchill
Retrograde cargo	Cargo hauled from the Arctic to southern ports
StatsCanada	Statistics Canada
Thermohaline	Term for global density-driven circulation of the oceans.

1. EXECUTIVE SUMMARY

Scope

The Canadian Arctic Shipping Assessment follows on from the Canadian Arctic Shipping Assessment Scoping Study, and is a high level overview of current and future shipping activity in the Canadian Arctic. Information is derived from secondary sources and draws heavily on the knowledge and resources of the consultant team. Limited original research was called for.

The report has provided a Northern Context for climatic, socio-economic, commercial and regulatory issues as well as historical background. Various aspects of Arctic shipping have been addressed, including through transits using the Northwest Passage. Data issues have also been addressed, together with background material on a range of related topics.

Objective

To provide a resource document for Transport Canada Marine Policy

Forecast period

Climate forecasts have been provided to 2050, in line with available documentation and modelling. As appropriate these forecasts have been applied to shipping routes, particularly the Northwest Passage (NWP). Other forecasts are to 2020.

Key Issues

The following summarizes key aspects of Arctic shipping and related issues.

Climate Change

- Climate change is real and is occurring faster and perhaps more dramatically in the Arctic than elsewhere.
- Arctic average temperatures have risen, ice concentrations have shown a steady decline, glaciers are retreating, shore erosion is becoming a problem, in some areas ice is forming later and disappearing earlier than in the past.
- Climate models are predicting ice-free summers in the Arctic but not before 2070.
- The Arctic will remain ice covered during the winters.
- Large annual variations in summer ice concentrations will continue and there will be increased opportunity to take tactical advantage of lighter ice conditions when they occur.
- In the Canadian Arctic, large quantities of drifting second and multi-year ice will continue to congest the Northwest Passage during the 21st Century.
- Reduction in ice cover, a stormier climate and rising sea levels will lead to higher storm surges. These will cause increased shoreline and infrastructure damage.

Socio Economic Issues

- The four regions, Nunavut, NWT coastal communities, Nunavik, and the coastal Cree communities of Quebec, Ontario and Manitoba hold many similarities in terms of their demographic make-up, socio-economic conditions and natural resource potential. Mackenzie River communities, which are also reviewed, have different dynamics.

- The population in Canada's North will rise throughout the CASA forecast period, driven largely by a young population with fertility rates more in line with what southern Canada experienced in the 1950s and 1960s. The economy will provide some limitations as to whether this pace can persist, and we can expect to see signs of this in the latter years of the forecast, as the rate of increase declines.
- Nunavut is home to a rich store of natural resources, however, their development will occur at a moderate pace reflecting concerns of project impacts on the natural environment by the local population, and the difficulties of Arctic resource development, marketing and shipping.
- Growth in population and economic activity in the Inuvialuit Settlement Region hinge on the development of the Mackenzie Gas Project, though the majority of benefits will flow to Inuvik and not the coastal communities.
- In Nunavik, economic development has been slow to proceed. Outside the expansion of Falconbridge's Raglan Mine, the most noteworthy development has been the recent Land Claims Agreement between Canada, Quebec and the Nunavummiut.

Northwest Passage

Based solely on steaming distance, the Northwest Passage could be competitive for traffic between a number of ports of origin and destination as follows:

- The east and west coasts of North America for a narrow range of port pairs
- Eastern Asia (north of Singapore) and the entire east coast of North America
- Northeast Asia and the western Mediterranean including the (Iberia Peninsula)

The Northern Sea Route provides a shorter distance for all port pairings in Europe and the west coast of North America, and better access for port pairs in eastern Asia (north of Singapore) and Northern Europe.

Ice conditions for the deep-draft route through the Northwest Passage are more severe than for the shallow-draft route, while the depth restriction of 10m in the latter is an impediment for many types of standard vessel. Ice-free conditions from Barrow in Alaska to the Beaufort Sea are found in shallower in-shore areas. Deeper draft is not available unless well offshore, which is often beyond the ice edge.

While there appears to have been changes in ice conditions since 1972 that could extend the potential shipping season, this also involves great variability depending on whether the year in question is colder or warmer than average. Even in warmer years, passage may be much more difficult than usual because of additional multi-year ice entering the straits (especially at the western end).

Both the Panama Canals and Suez Canals have firm plans for significant expansion, while the Northern Sea Route has the potential to provide commercial shipping with a viable Arctic navigation route well in advance of the Northwest Passage.

Sensitivity to scheduling delays is expected to prevent container shipping from using the Northwest Passage – certainly within the 2020 timeframe. Unless climate change advances significantly faster than anticipated, substantial movements of bulk cargo through the Northwest Passage also appear improbable within this period. There may however be increased numbers of opportunity transits, including project cargo.

Community Re-Supply – Dry Cargo

Current shipping demand involves 20-22 seasonal vessel trips in the eastern Arctic together with 14-15 seasonal tug-barge trips in the western Arctic. Additional tug-barge activity occurs on the Kivalliq coast out of Churchill, and on the Hudson Bay coast of Ontario and Quebec. By 2020, annual re-supply demand would require 28-30 ship trips. Additional ships will be needed for this demand as season extension will not be sufficient to enable the extra trips to be made by the existing fleet[1]. Because of the current age of the fleet, it is likely that most ships would need to be replaced by 2020.

Tug barge activity in the eastern Arctic cannot be estimated, but demand in the western Arctic will 20-22 trips each season.

Communities on the Mackenzie River either have all weather of winter road access. Most marine activity is by combined deck/bulk barges that operate in tows of three to six barges. There are six to seven dedicated deck cargo tows each season plus 12-14 deck/bulk tows. The latter include cargo for the Western Arctic. Shipping needs for dry cargo will change very little over the forecast period. River community demand will increase deck/bulk tows by one to two tows.

Community Re-Supply – Transportation Fuels

Current demand is met by two fleets, with Nunavik served by 5 tanker trips each season and the eastern Arctic served by 15 trips each season. Service in the western Arctic is by tug-barge units that carry both deck cargo and bulk fuel. The number of trips, and mode of service, in the eastern Arctic depends critically on the contracting policies of the Government of Nunavut and a prediction cannot be made as to whether this traffic will be served by Canadian or foreign flag tankers. However, demand will increase considerably to 2020 and will require careful management to minimize costs. Fleet renewal will be essential as the tankers currently serving Nunavut and Nunavik are between 25-35 years old.

The primary cargo moved by Mackenzie River tows is bulk fuel, and there will be some increase over the forecast period.

Resource Projects – Re-Supply

We have no benchmark data on which to estimate demand as each stage in the process, from prospecting through to production, has very different demand profiles in terms of fuel and logistics. The degree of activity, particularly in the Kivalliq and Kitikmeot, for projects that can be most economically served by marine is considerable and will have a marked influence on shipping demand for both dry cargo and fuel.

[1] It was announced at CMAC Northern in Iqaluit, 25 April 2007, that both primary carriers will be adding ships to their core fleets in the 2007 season.

Based on scaling from the only reference point available[2], re-supply demand for operational projects in 2020 is estimated at 52,000 tonnes of dry cargo and 140,000m^3 fuel into the western Arctic. Demand for the Mary River mine is not known.

Climate change could materially increase demand if a port and tank farm are available in the Coronation Gulf/Bathurst Inlet area. Up to 100,000 tons of dry cargo and 250,000m^3 of fuel could be added to demand and directed southwards on winter roads. This could also change the community re-supply profile for the western Arctic.

Resource Projects – Dry Cargo Shipping

Shipping of concentrates from the Coronation Gulf could be in the range 6 to 12 loads per year depending on ship size used. Shipping from Mary River could be in the range 30 to 70 loads per year depending on volume sold and ship size.

There are relatively few merchant vessels available that have a suitable ice class to meet the needs of dry cargo projects. Proponents will need to either build vessels to their own account, or contract long term for suitable ships.

Resource Projects – Oil and/or Gas Shipping

There is very little likelihood of oil or gas being moved by vessel within the study time frame. The Mackenzie Gas Pipeline is expected to come on stream within the study time frame, but this will depend on North American gas prices and possibly on whether the federal government is prepared to take a financial stake[3], as it did with Hibernia. Shipping demand on the river will be in the range 550-600,000 tonnes of pipe, logistics materials and fuel.[4]

Because of developments in the Russian Arctic and oil shipments through Primorsk in the Russian Baltic, ice class tankers are more available than dry cargo vessels.

Stewardship and Regulatory Issues

Sovereignty related issues have prevented the NORDREG traffic reporting system from becoming mandatory, which directly affects Canada's ability to discharge its stewardship obligations in Arctic waters. Lack of ice breaker capability and resources to adequately update charting of Arctic waters similarly affects stewardship capabilities, as well as the ability to facilitate development of Arctic resources.

Regulatory issues, primarily associated with the Coasting Trade Act, but also through Marine Navigation Service Fees, materially increase re-supply shipping costs to Arctic destinations and prevent Canada benefiting from added value processing, or transhipment, of Arctic resources.

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2 Falconbridge's Raglan project.

3 Reported in the Globe and Mail March 13[th], and Financial Post May 17[th], 2007 that the proponents are seeking an equity role in the pipeline by the federal government. http://www.canada.com/nationalpost/financialpost/story.html?id=25d5538e-9bf7-4871-a686-ea2fbda480d7&k=45876

4 *Mackenzie River Preliminary Marine Risk Analysis*, The Mariport Group July 2006 for Transport Canada Marine Safety

2. INTRODUCTION & BACKGROUND TO THE STUDY

Introduction

The Arctic remains Canada's last frontier. There are no roads[5], no rail lines[6] and air services are infrequent, costly and subject to weather disruption. Shipping has been the mode of choice since before Confederation and the only economically effective means of shipping goods to, from and within the region.

Marine activity is critical to the communities within the Arctic archipelago and on the mainland fringes. The seasonal window for service is, at best, half a year but supply lines are long and tenuous with goods landed over the beach and effectively delivered at high water mark.

Resource development is also challenged by the climate, the need to establish a complete infrastructure for each project and Canada's marine regulatory regime. In addition, resource development has to be able to respond to pricing in the international market place, which does not offer a premium for projects that require costly development and support. The federal government has, sporadically, been involved in the region, most recently during the decade 1975-1985[7]. Other Arctic nations, notably Russia, have taken a long-term interest in the Arctic and its resources providing ships, support and facilities.

While climate change may open the shipping window somewhat, it will bring its own challenges with the potential for greater quantities of drifting multi-year ice that will hazard lightly strengthened vessels.

Background

Several key considerations make Arctic marine transportation an important issue for Transport Canada. These include:

- Changing climatic and socio-economic conditions in the North;
- A lack of surface transportation infrastructure between Northern communities and high costs of air transportation;
- Emerging resource development opportunities;
- Implications of changing sea-ice conditions for international and domestic shipping to and from Canadian Arctic locations;
- The potential for increases in foreign vessel transits through Canadian territorial waters;
- Implications of an aging domestic fleet;

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[5] The Dempster Highway terminates at Inuvik.

[6] Rail lines serve Churchill and Moosonee on the southern fringes of the region.

[7] Federal activities are addressed in more detail in the body of the report. They included the national Energy Plan, investment in Arctic oil and gas exploration, resource development and Arctic shipping.

- Economic liability in relation to existing pollution compensations schemes; and
- A renewed interest in Arctic issues across federal departments.

In late 2005, Transport Canada commissioned a *Canadian Arctic Shipping Assessment Scoping Study* (Scoping Study) to assist the department in determining the requirement for more comprehensive assessments of shipping in Canadian Arctic waters. An intradepartmental team collaborated in the design and outcomes of the Scoping Study, which involved consultations with key stakeholders including the three territorial governments plus the Federal Councils in the territories.

The Scoping Study recommended further specific analytical work and highlighted data sources, relevant methodologies, information gaps, and key players in several important areas. These outcomes would form the basis of further departmental work, including this current assessment of Canadian Arctic shipping, which represents a partial response to the recommendations of the Scoping Study.

The objectives of the present study are to develop a sound information base on the state of marine transportation in the Canadian Arctic and an appreciation of projected climatic and socio-economic changes, with their potential impacts on current and future shipping in the Canadian Arctic waters. These findings are intended to support the department in future policy-making with respect to marine transportation in Canadian Arctic waters.


Area Covered by The Canadian Arctic Shipping Assessment
Arctic Ocean
Greenland Sea
Denmark Strait
ICELAND
Beaufort Sea
M'Clure Strait
Baffin Bay
Davis Strait
Nuuk
Atlantic Ocean
Labrador Sea
Hudson Strait
Iqaluit
Taloyoak
Baker Lake
Rankin Inlet
Arviat
Hudson Bay
NUNAVUT
YUKON TERRITORY
Whitehorse
NORTHWEST TERRITORIES
Yellowknife
Fairbanks
Juneau
BRITISH COLUMBIA
Prince George
CANADA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUÉBEC
NEWFOUNDLAND
Happy Valley–Goose Bay
St. John's
Charlottetown
N.B.
N.S.
ME.
Vancouver
Seattle
Calgary
Regina
WASHINGTON
MONT.

3. THE NORTHERN CONTEXT

3.1 Methodology

The Canadian Arctic Shipping Assessment has been derived from a combination of high-level original resources within the topics covered, as well as secondary data sources and in-house documentary material in the possession of the consultants. Some limited statistical data has been provided by Transport Canada and, as is usual in today's research environment, use has been made of World Wide Web resources.

The report does not contain original research, although the section on the Northwest Passage could be considered as such. The report also draws on the resources and knowledge of the consultant team in both assessing current traffic and forecasting activity to 2020.

As appropriate, methodological introductions are provide for each chapter of the report.

3.2 Climatic Issues & Developments

The vast majority of climatologists believe that the changes that we are seeing have been induced by human activities. Climate models have been predicting warming for some time and indicated that affects of change would be the most dramatic in Polar Regions. Signs validating these forecasts are being seen. Arctic average temperatures have risen dramatically in the last few decades. Ice concentrations have shown a steady decline. Glaciers are retreating; shore erosion is becoming more pronounced in some areas and rising permafrost temperatures have already had a significant affect on essential infrastructure. An acceleration of these climate trends is predicted during this century, which will have a dramatic social and economic effect on the Arctic.

Purpose

The purpose of this section of the report is to provide Transport Canada marine policy analysts and planners an overview to global warming with an emphasis on the impacts of warming on the Canadian Arctic and Arctic shipping. It provides background on the evidence of climate change, the greenhouse effect, why changes are occurring faster in the Arctic, climate forecasting, sea ice, impact of ice on potential trans Arctic routes; sea level rise, shoreline affects, weather, ice shelf break up, and identify some of the relate weather/climate issues.

Discussion

According to the IPCC "Climate Change 2007: The Physical Science Basis" there is clear observational evidence that the climate is warming. The report states that "*Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level" and "At continental, regional, and ocean basin scales, numerous long-term changes in climate have been observed. These include changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones*."

Climate, climate change and global warming are terms that one frequently hears or reads about these days (2007). Climate is defined by the Intergovernmental Panel on Climate Change (IPCC) glossary as: "*in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system."* Indeed, the key to understatnding climate change or global warming is to understand the climate system, first on a global scale and then on specific regional scales such as the Arctic.

The climate system consists of the atmosphere, the oceans, snow and ice or cryosphere, living organisms of the biosphere and the soil and rock of the geosphere. The climate system is driven by the energy it receives from the Sun and our climate is a reflection of the net result of how the solar energy is distributed and/or consumed by the climate system. The atmosphere and the oceans play major roles in this system but the interaction between all the components exists in a delicate balance. The atmosphere allows the short wave solar radiation to pass almost freely through. Some is either absorbed or reflected back to space by clouds but the majority of it reaches the Earth's surface were it can be either absorbed or reflected. Water surfaces; such as the oceans, are excellent solar radiation absorbers and will soak up about 80% of solar energy that it receives. Snow and ice on the other hand reflect about 80% of the solar energy received back into space. At night the Earth radiates long wave or terrestrial radiation back to space. The amount of that energy that actually escapes is a function of the amount of water vapour, carbon dioxide, methane, nitrous oxide, ozone and suspended particulate matter that is present in the atmosphere. The above gases are commonly referred to as greenhouse gases as they absorb or reflect back to the Earth's surface a portion of the outgoing terrestrial radiation thus trapping heat in the atmosphere similar too the effect produced by a greenhouse. Although these greenhouse gases constitute less than 1% of the atmosphere, they play a vital role in maintaining the energy balance of the climate system. The dramatic change in the consumption of fossil and the resulting increase of carbon dioxide in the atmosphere is considered as a major threat to today's climate system. Figure 3.2-1 depicts the basic energy flow of the Earth's climate system.

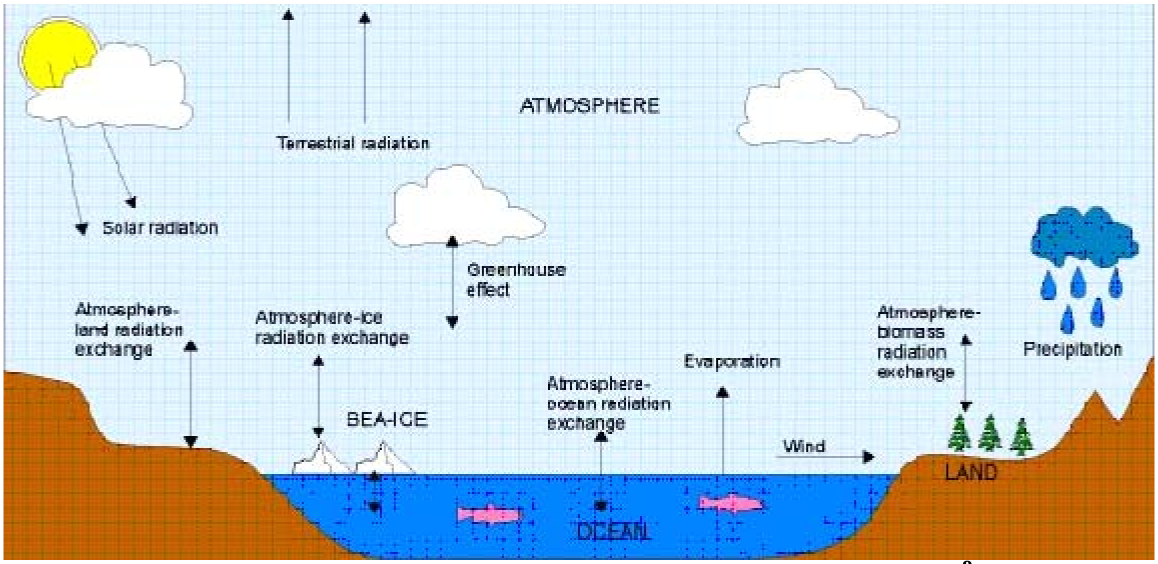


Figure 3.2-1: Basic Climate System Energy Flow[8]

The bulk distributor of the heat from the Sun on a global scale are ocean currents. Significantly more solar energy is absorbed by the equatorial oceans than by the higher latitude oceans. This results in a thermally driven ocean current; such as the Gulf Stream, which transports energy pole ward. As the warm current moves to higher latitudes it cools and becomes less saline due to increased precipitation, fresh water run-off into the ocean, ice melting and mixing with the colder less saline high latitude ocean water. The colder less saline water then sinks and this results in a deep ocean, haline driven current that transports the colder water towards the tropics where it will eventually upwell and be heated. This thermohaline circulation or ocean conveyor belt is depicted as Figure 3.2-2. The main climate change concern is that warmer less saline high latitude oceans could result in a breakdown of the thermohaline circulation which in turn could result in Northern Europe becoming much colder than it currently is.

Weather, can also be considered as a major player in the redistribution of energy and at times it can be both dramatic and disastrous on a regional and local scale. However on the global scale, it is not nearly as efficient as ocean currents.

8 http://www.ace.mmu.ac.uk/eae/Figures/climate_system.html

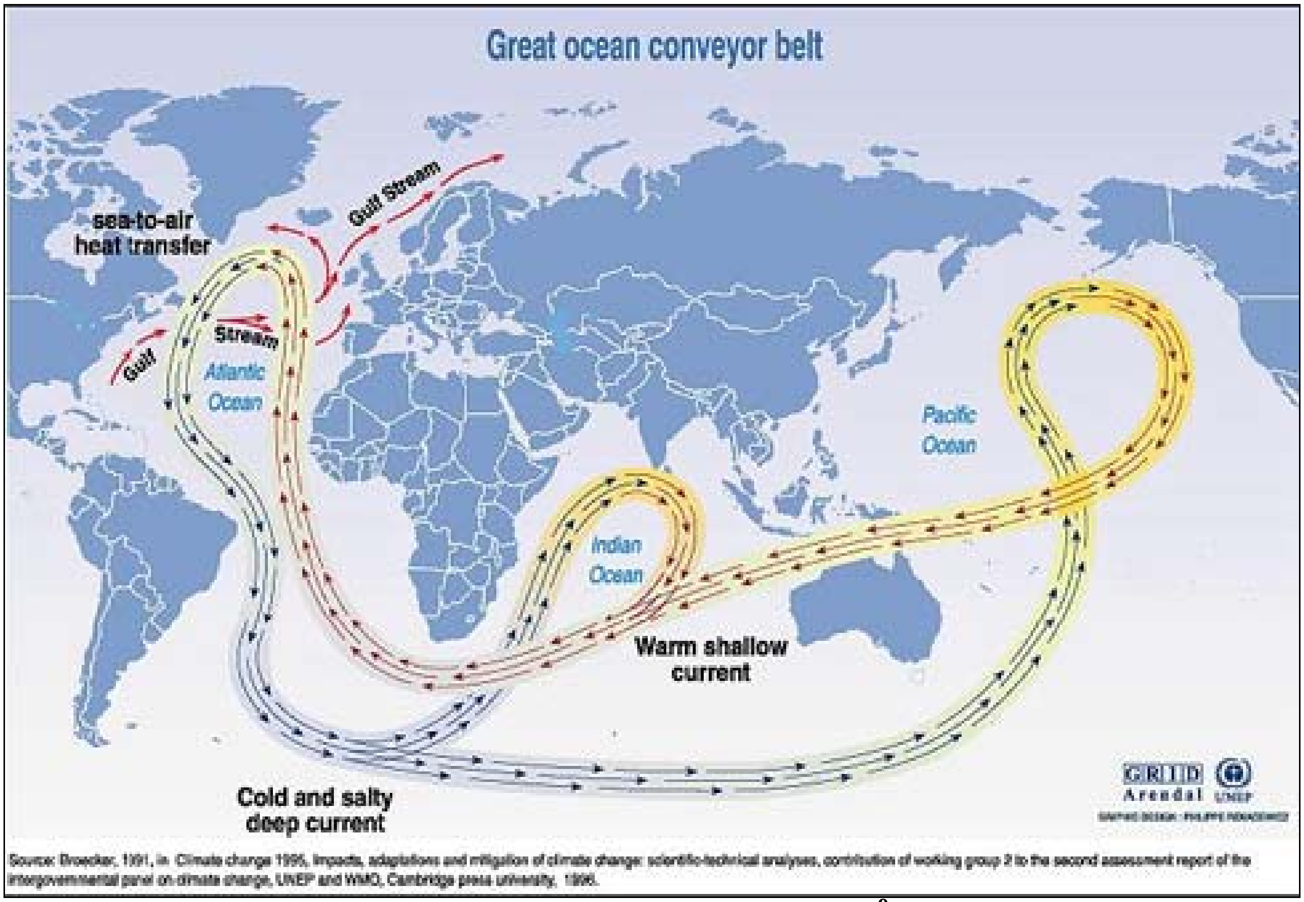


Figure 3.2-2 Major Ocean Currents[9]

For many years, climate scientists have predicted that the Artic would likely be one of the first regions to be affected by global warming and that the region would probably experience greater warming than the rest of the world. Observational data assessed by the IPCC has validated this prediction and shown that the Arctic is warming about twice as fast as rest of the world, and will continue to warm at a rate greater than the rest of the world. While several factors are involved, the principal one is the so-called “ice-albedo feedback”.

Snow and ice currently covers a significant portion of the Arctic; white snow reflects about 80% of the solar energy received back into space, thus keeping temperatures relatively cold. As the Arctic warms, snow and ice melt exposing the underlying land and ocean. The land and ocean exposed, being darker absorb more of the sun’s energy than the ice or snow which in turn accelerates ice melt. In addition, both ice and snow also tend to become less reflective as they warm thus enhancing, or providing positive feedback, to the warming/melting process.

9 http://www.grida.no/climate/vital/32.htm

Climate Prediction

Climate predictions are based on sophisticated models that are numerical representations of components of the Earth's climate system. The modelling process reduces the complex behaviour of the climate into mathematical formulae. While there are a number of simple one dimensional climate models that are used, they only show how the various components of the climate system react with each other in somewhat of a simplistic manner. The work horses are much more complex atmosphere-ocean general circulation models (AOGCMs), often referred to as coupled General Circulation Models (GCM) that represent the atmosphere and ocean in both the vertical and horizontal planes, as well as in time.

The Third IPCC Assessment Report concluded that "*Coupled models can provide credible simulations of both the present annual mean climate and the climatological seasonal cycle over broad continental scales for most variables of interest for climate change.*"

These climate models calculate that the global mean surface temperature could rise by about 1 to 4.5 centigrade by 2100. This dramatic change is depicted in Figure 3.2-3 Some of the result of warming temperatures will be:

- Increased occurrence and severity of extreme weather events (more intense storms, floods, droughts, ice storms).
- Decrease in the amount and extent of winter snow cover.
- An increase of river flow and fresh water discharge into Arctic Ocean.
- Increased precipitation in some areas.
- Less fresh water.
- Thawing permafrost.
- Less river and lake ice.
- Melting glaciers including the Greenland ice sheet.
- Decreasing sea-ice extent.
- Rising sea levels (40-50cm by the year 2100).
- Increased shoreline erosion.
- A decrease in Atlantic Ocean Salinity.

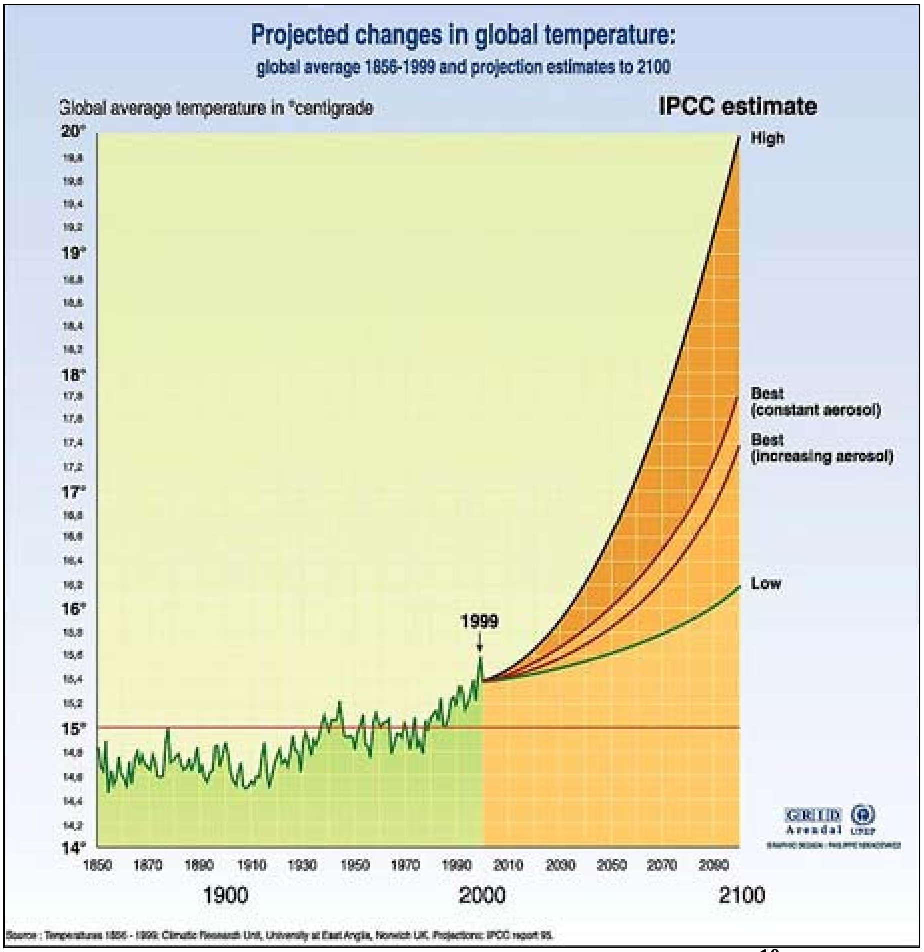


Figure 3.2-3 Global Temperature projections[10]

Some of the societal changes associated with Arctic warming and a decreased sea-ice presence that may have an impact on Arctic marine traffic include:

- Enhanced access to mineral and oil deposits.
- Expanded marine fishery.
- Disrupted surface transportation due to loss of ice roads.
- Increased stress on current infrastructure due to permafrost thawing.

Sea Level Rise

Climate warming of the magnitude forecast by climate models will result in a sea-level rise of 45-50 cm during the 21st Century. This rise will come predominately from the thermal expansion of ocean waters as they become warmer. The melting of sea-ice will not contribute to level rise as it is floating in the sea and is already displacing its own mass. The melting of sea-ice will however decrease overall salinity of the Arctic Ocean. The melting of land based ice such as the Greenland and Antarctic ice sheets will contribute to sea level rise but to a lesser degree than the thermal expansion. Sea level rise combined by higher storm force winds will pose increased threats associated with

[10] http://www.grida.no/climate/vital/impacts.htm

storm surges and coastal shore erosion. Nearly all predictions or climate simulations indicate that the sea level will continue to rise beyond this century due to the long lag times associated with greenhouse gas. The implications for the Arctic are complex and not yet fully understood by the science community.

Permafrost

Climate change poses a serious threat to permafrost of the Northern Hemisphere. Melting the once permanently frozen solid could have a dramatic affect altering ecosystems and damaging infrastructure across Canada, Alaska, and Russia. Simulations suggest that over in excess of 50% of permafrost could thaw by 2050 and as much as 90% by 2100. The impact on the transportation of goods to the Canadian Arctic by winter roads will not likely be significantly impacted by 2020; however, by 2050 the winter road season will be shorter and both the traffic volume and weight that these roads will be able to sustain will decrease. The complexity and cost of building permanent overland roads or rail beds will increase as will the construction costs associated with establishing new Arctic harbour infrastructure. The net result of less ice and costlier ground transportation options will likely result in increased marine transportation to support the extraction of gas, oil and minerals from the Canadian Archipelago region.

Shoreline Erosion

Increasing amounts of open water in the Arctic Ocean combined with rising sea level and the increased harshness of storms will increase Arctic shoreline erosion. The Canadian area that will be most affected is along the low-lying shore of the Beaufort Sea[11]. This area is also experience shoreline submergence, which will also contribute to the erosion problem. Climate change will compound this problem resulting in shoreline damage from high winds, storm surges, and flooding. Storm surges are higher, and thus have more impact when air temperature is lower than the water and when there is little ice cover over the water. The diminishing of land-fast ice, which normally provides protection from erosion, will also amplify the pressure on the coastal environment. The increased frequency of bad weather will introduce secondary threats such as hazardous materials spills, which are particularly damaging to coastal environment at high latitudes.

Weather

Arctic weather is notoriously variable and this will continue as the climate changes. Storms will be become more intense and the frequency of storm and gale force winds will increase. More open water and longer fetches will result in higher ocean wave heights and damaging storm surges. Larger day-to-day variations in temperatures, winds and precipitation will be experienced. More extreme weather events will occur and the frequency of rare events like severe thunderstorms will increase. Small fishing vessels pushing the season in the marginal ice zone will continue to be threatened by the occurrence of freezing spray.

Figures 3.2-4 and 3.2-5 show the sensitivity of the coastlines to sea level, due to climate warming. Sensitivity here means the degree to which a coastline may experience physical changes such as flooding, erosion, beach migration, and coastal dune destabilization. This sensitivity index is obtained by manipulating scores of 1 to 5 attributed to each of

[11] See comment regarding Tuktoyaktuk in the Socio Economic chapter of the report

seven variables: relief, geology, coastal landform, sea-level tendency, shoreline displacement, tidal range, and wave height[12].

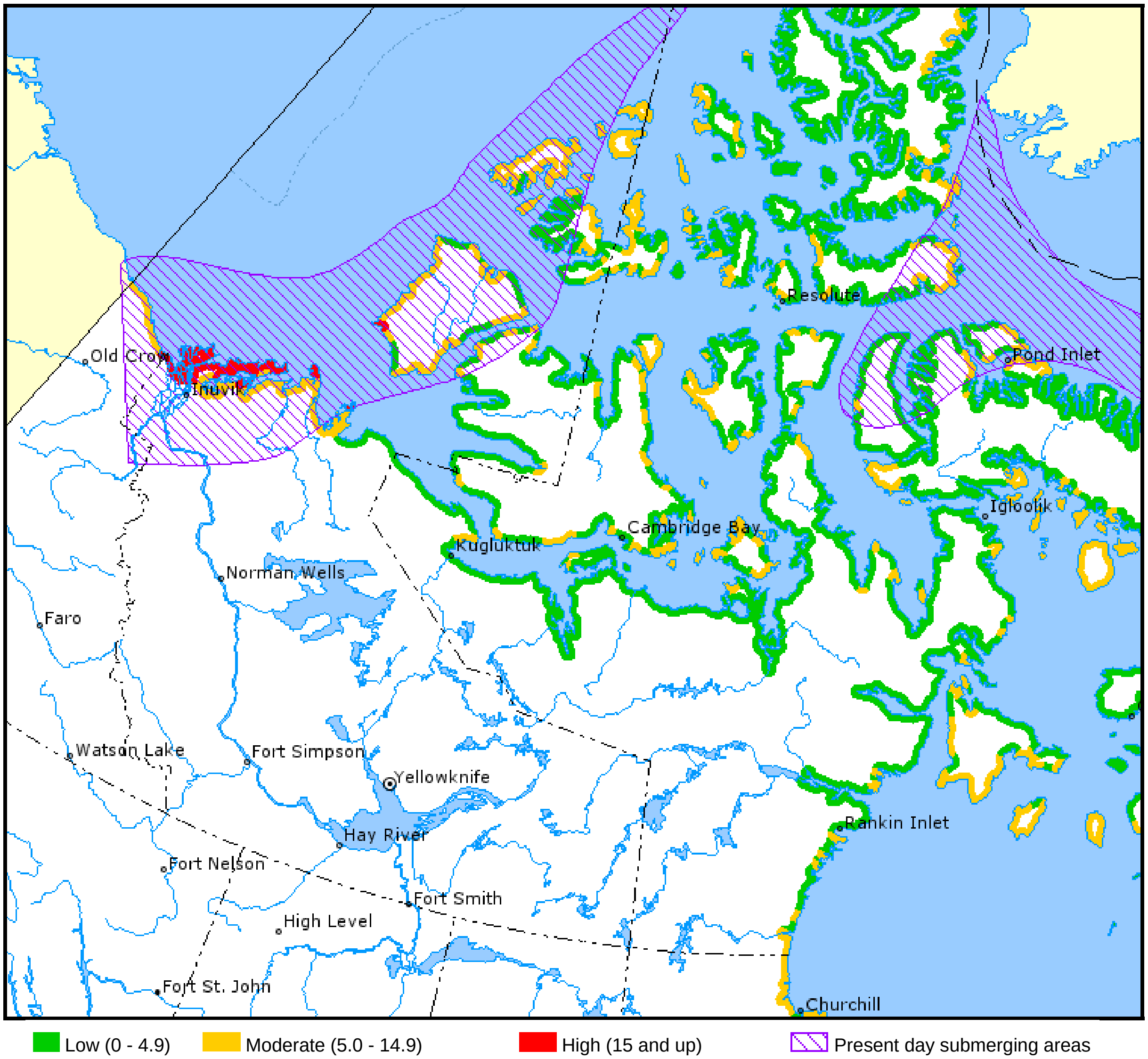


Figure 3.2-4 Eastern and Western Arctic regions sensitive to sea level rise[13]

12 For more detail see: http://atlas.nrcan.gc.ca/site/english/maps/climatechange/potentialimpacts/coastalsensitivitysealevelrise/1

13 see http://atlas.nrcan.gc.ca

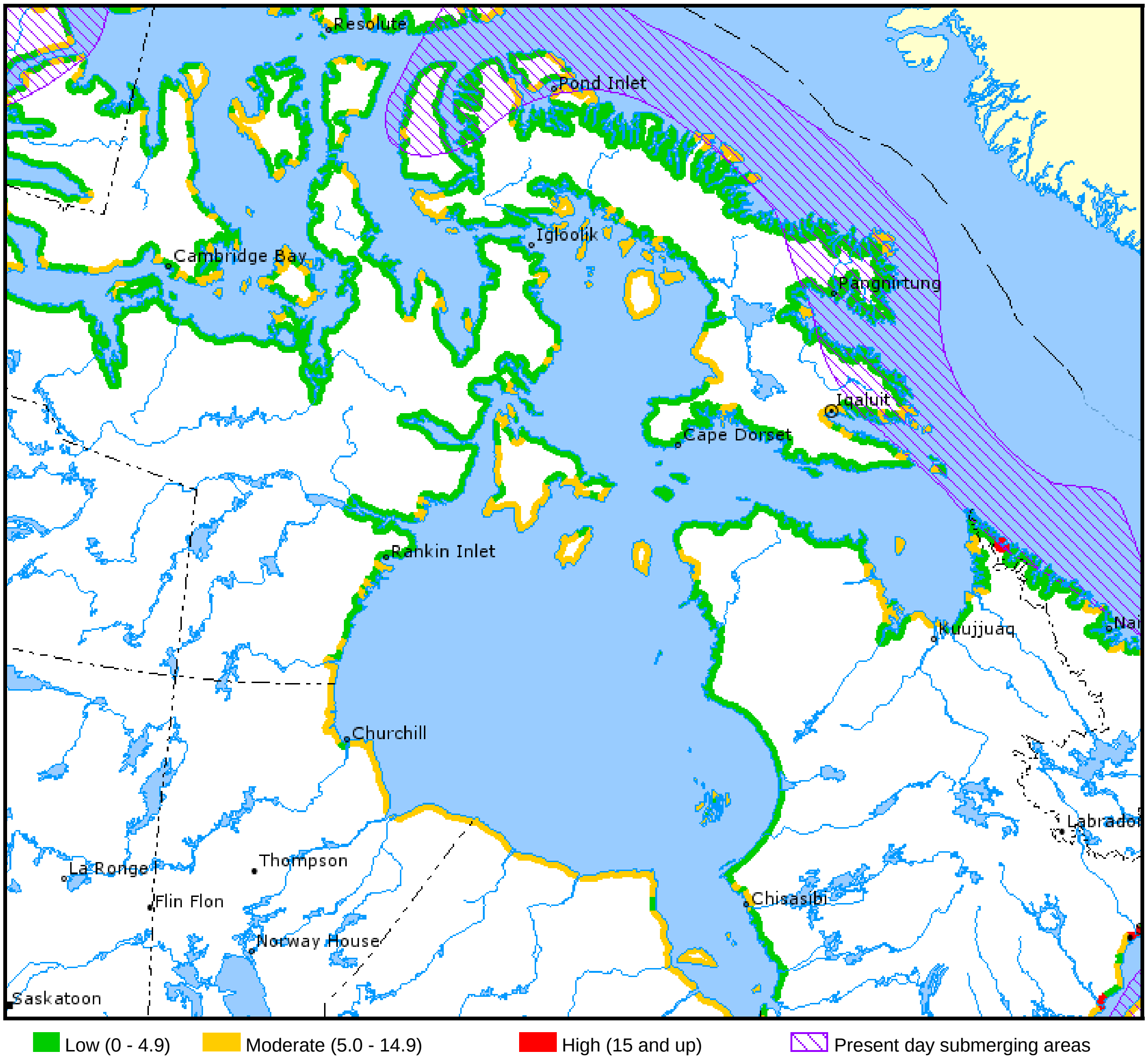


Figure 3.2-5 Hudson Bay and Quebec regions sensitive to sea level rise[14]

Ice Shelf Break Up

As the climate warms ice sheets and glaciers will retreat. The increasing rate of retreat of numerous well known glaciers is clearly evident today. Vast quantities of water are contained, primarily in the ice sheets of Antarctica and Greenland. As these ice sheets melt they contribute to sea level rise and potentially decrease the salinity of the oceans which may disrupt the deep ocean thermohaline currents. The contribution to Arctic sea level rise this century is expected to be small. However, there will be an increase in the break up of the Greenland ice sheet with is subsequent result of an increased number of icebergs into Baffin Bay. A combined increase of marine traffic and icebergs could result in more ship damaging accidents.

14 http://atlas.nrcan.gc.ca

Arctic Sea-Ice Trend

Studies of total ice coverage in the Arctic Basin derived from satellite images and an examination of Canadian Ice Service historical charts both indicate that there has been a 3-4% decrease in the total Arctic ice coverage per decade since 1970. This decrease appears to have accelerated, with 2005 having the lowest coverage on record. There is some speculation that accelerated melting in the Arctic will continue. It has even been suggested that the entire Arctic-Ocean will be seasonally ice-free by 2030. This scenario is unlikely and the retreat seen in 2005 was a probably a combination of climate warming and a phenomenon called the Arctic Oscillation. This is short-term variation on a roughly decadal time scale and may coupled to the North Atlantic Oscillation (NAO). These oscillations will continue to add variability to Arctic ice regime.

Arctic ice thickness taken from submarine transits under the ice have shown a significant decrease in thickness and hence total ice volume by as much as 40% over a 35 year period.

Figure 3.2-6 shows a dramatic change is summer sea-ice coverage. It is interesting to note the relative clearing of the NEP to the NWP.

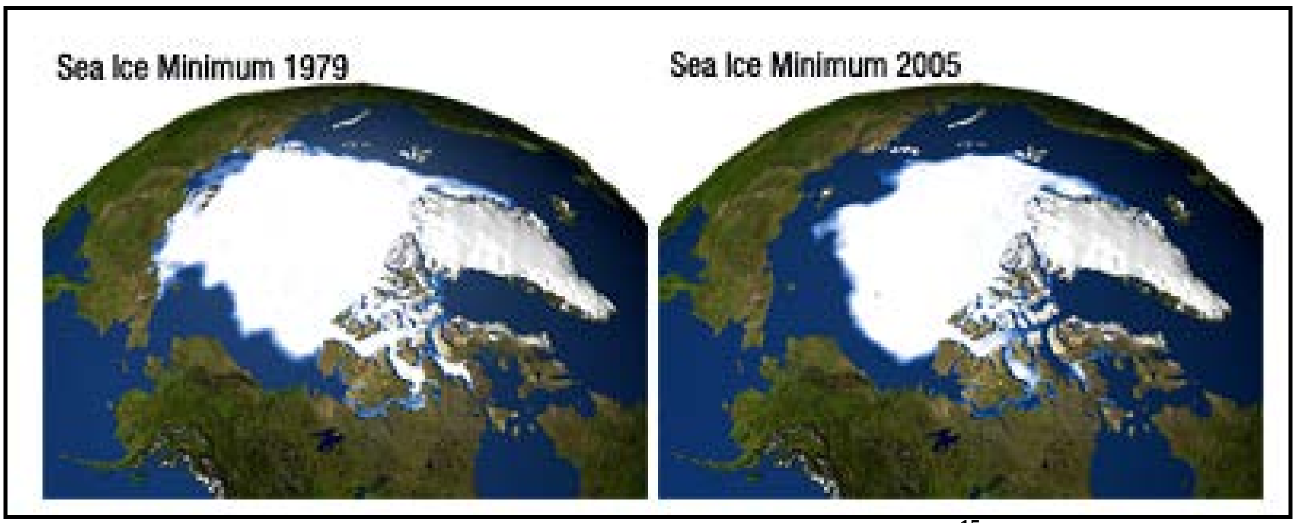


Figure 3.2-6 Satellite views of polar ice changes[15]

Figure 3.2-7, obtained from the Canadian Ice Service, demonstrates the large inter annual variability of the ice in the most frequently traveled segment of the North West Passage. This type of variability is seen throughout is typical of other Arctic shipping routes.

15 See http://www.nasa.gov/centers/goddard/news/topstory/2005/arcticice_decline_prt.htm

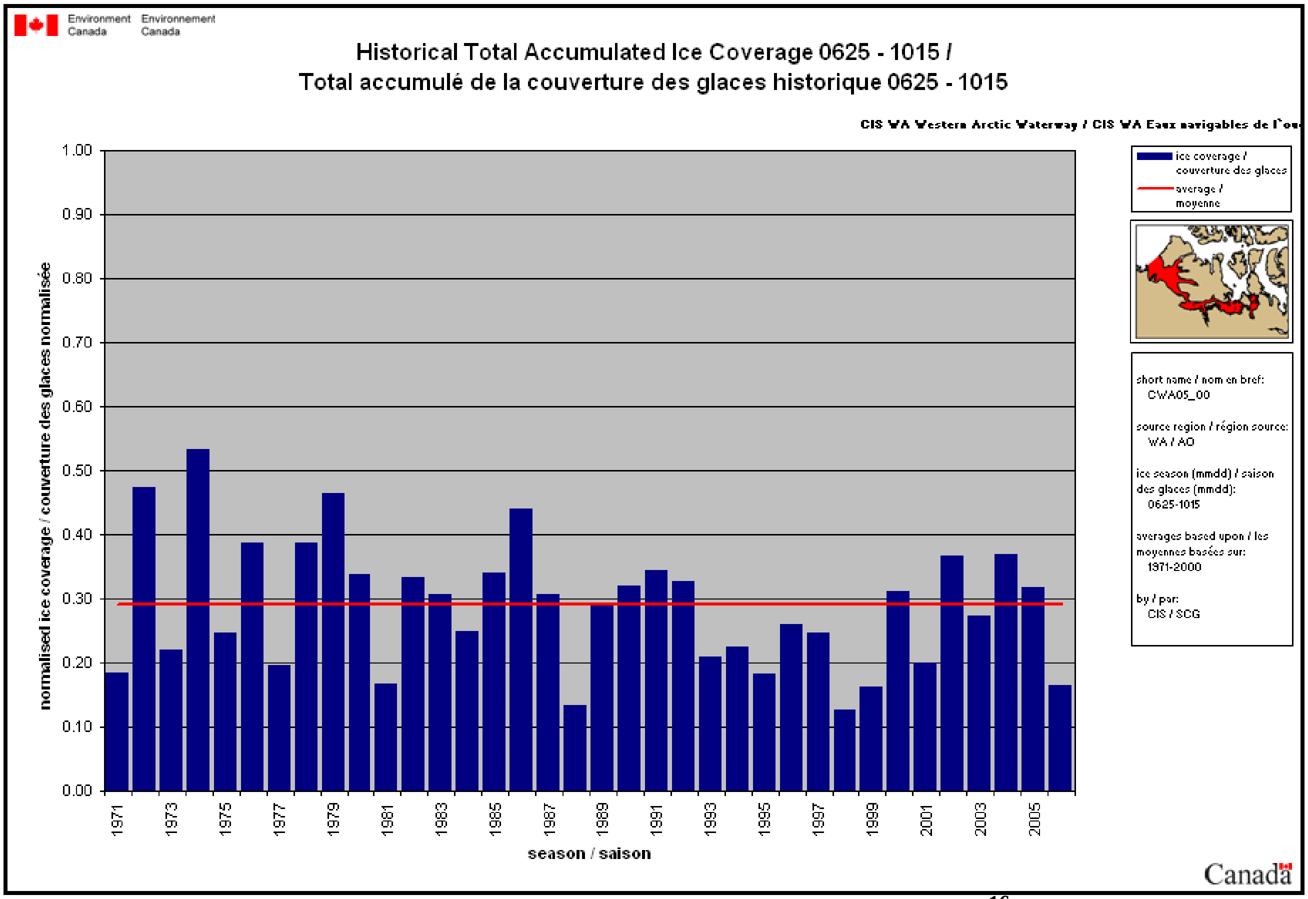


Figure 3.2-7 Year over year variability in ice cover[16]

Arctic Ice Regime Climate Forecast

Predicting climate is by no means an exact science and models are only a mathematical attempt to define the extreme complexity of the Earth's climate system. None of the major Global Climate Models (GCMs) evaluated by the IPCC yield exactly the same results but generally they predict:

- Arctic temperatures will increase by mid-century with summer temperature increasing by 1-2 deg. C, autumn by 7-8 deg. C, winter (by 8-9 deg. C and spring by about 5 deg. C.
- A continuing reduction in Arctic sea-ice extent in the order of 30% by the year 2050.
- A continuing decrease in ice volume likely in the order of 40% by 2050.
- Possible disappearance of summer ice by 2070 but more likely 2100.
- The entire Arctic Basin will remain ice covered during winters of the 21st Century.

16 http://ice-glaces.ec.gc.ca

Ice Thickness

Ice thickness is both difficult and costly to measure on a scale that would adequately represent the Arctic Basin. There are a number of near shore measurements routinely available but none that would represent the mobile ice packs. Instruments have been design to measure ice thickness by using upward looking sonar. These are great devices for studying ice dynamics but costly to deploy. They also lack a near real time data communication capability. Airborne sensors have also be developed for low slow flying aircraft. This method provides data for a wider area than the upward looking sonar systems and data communication is not a significant issue. However, this method is also extremely costly given the size of the Arctic ice pack. Consequent, thickness is general inferred from the ice type which are as follows[17]:

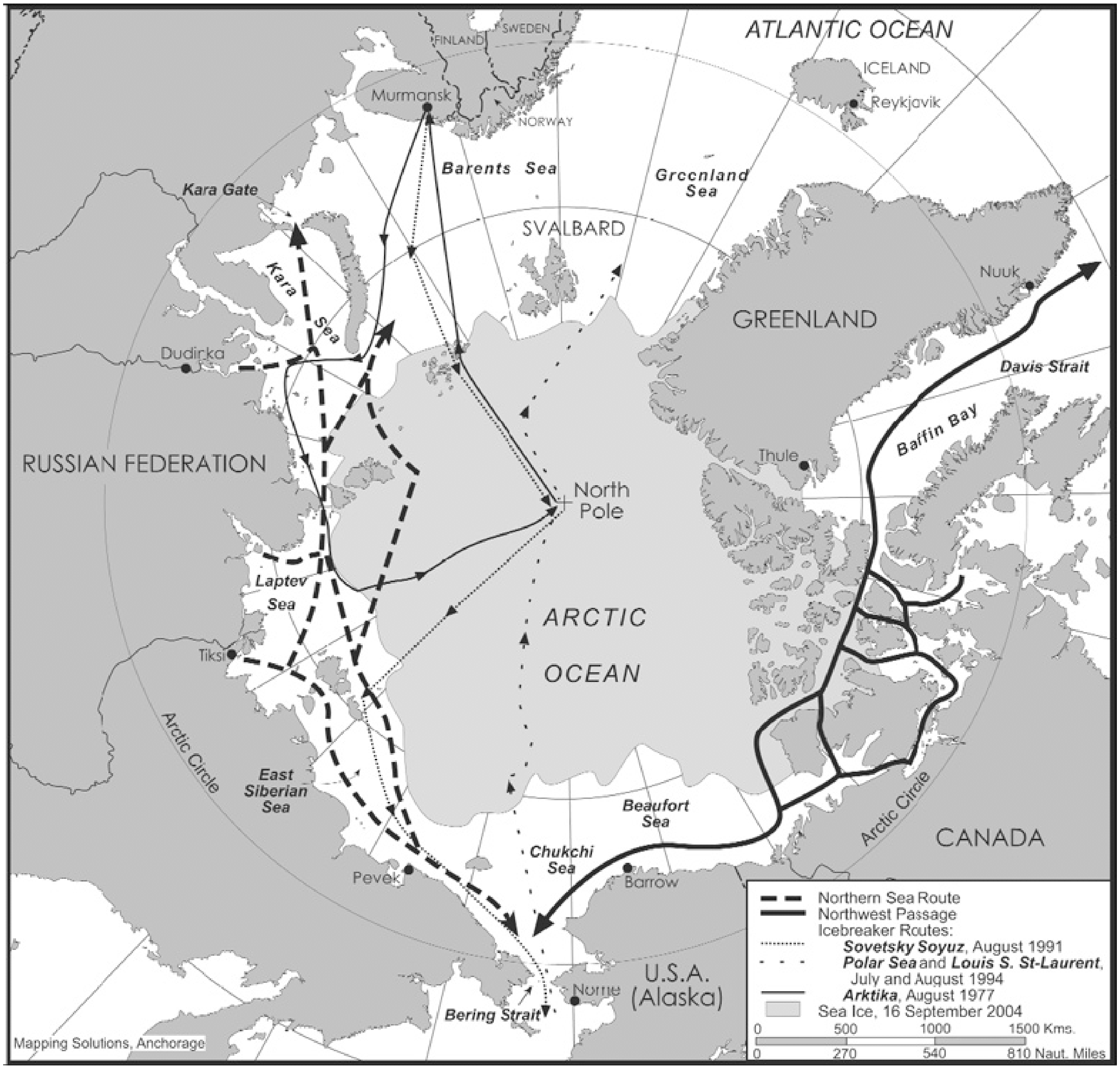
> **New Ice** - Recently formed ice composed of ice crystals that are only weakly frozen together (if at all) and have a definite form only while they are afloat.
>
> **Nilas** - A thin elastic crust of ice (up to 10 cm in thickness), easily bending on waves and swell and under pressure growing in a pattern of interlocking "fingers" (finger rafting).
>
> **Young Ice** - Ice in the transition stage between nilas and first-year ice and 10-30 cm in thickness.
>
> **First-Year Ice** - Sea ice of not more than one winter's growth, it developing from young ice and has a thickness of 30 cm or greater.
>
> **Old Ice -** Sea ice that has survived at least one summer's melt. Its topographic features generally are smoother than first-year ice and can be a few metres thick. Old ice is also much harder than first year ice, and can be much more damaging to ships, if hit at a normal cruise speed.

Arctic Shipping Routes

Map 3.2-1 below is a general portrayal of the major Arctic marine routes shown from the perspective of Bering Strait looking northward and depicts the two major routes for trans-Arctic shipping. An over the pole route for summer traffic may also be possible, at least periodically, late in the 21st Century. The Northern Sea Route encompasses all routes across the Russian Arctic coastal seas from Kara Gate to the Bering Strait. The Northwest Passage (NWP) is passage between the Atlantic and Pacific oceans along the northern coast of North America.[18]

[17] Definitions derived from:http://ice.ec.gc.ca/WsvPageDsp.cfm?ID=181&Lang=eng, which see for more comprehensive information

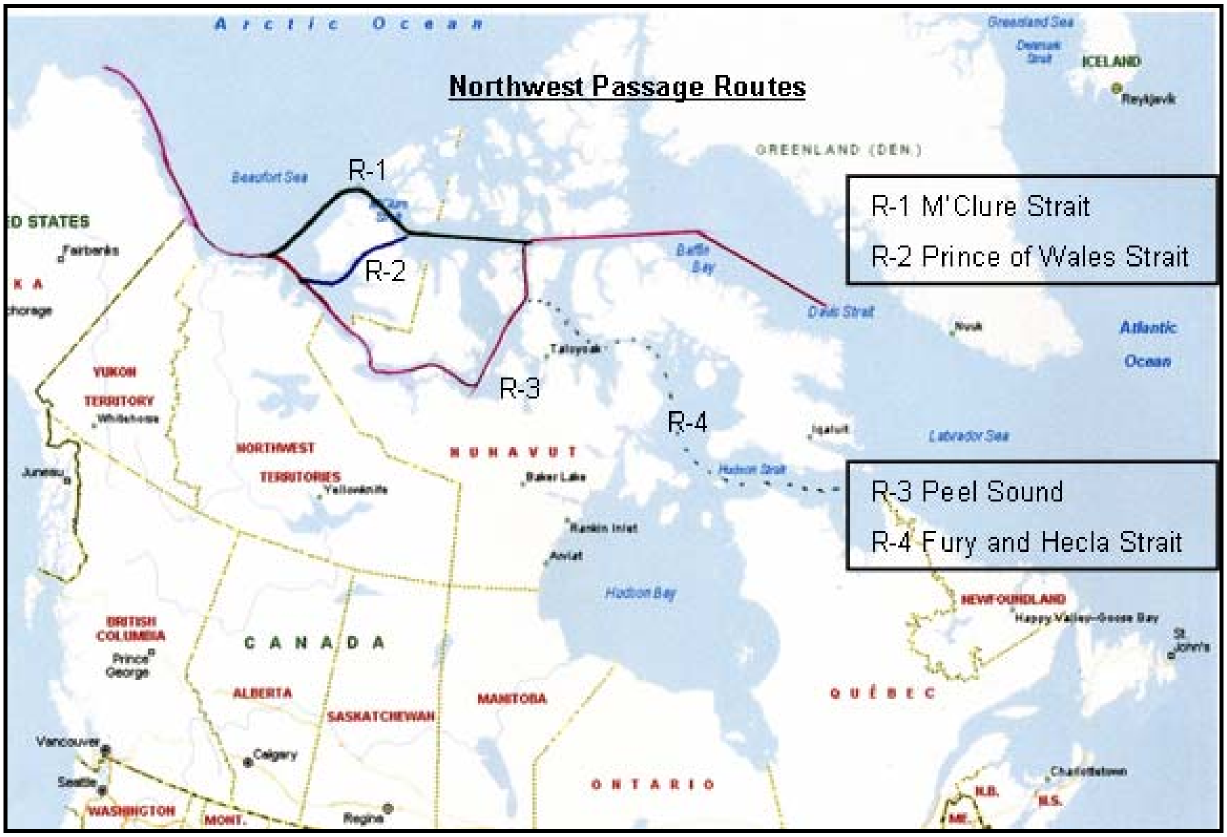
[18] (Taken from Marine Arctic Workshop 28-30 September 2004) http://www.marinelog.com/DOCS/PRINTMMV/MMVjularc1.html



Map 3.2-1 Polar Routes

Northwest Passage

Although climate modelling for the Arctic indicates a general retreat of sea-ice throughout the 21 Century, it is import to note that the horizontal resolution of these models (generally 200 KM) is not fine enough to take into account the complexity of the Canadian Archipelago. Hence there is more uncertainty when it comes to predicting future ice conditions in the Northwest Passage based solely on the output of climate models. There are potentially 7 routes through the Canadian Archipelago of which three are considered as being practical for routine marine traffic and the fourth which is less so. The routes are depicted in the following map:



Map 3.2-2 NWP Navigation Routes

Route 1:

Davis Strait, Lancaster Sound, Barrow Strait, Viscount Melville Sound, M'Clure Strait, Beaufort Sea, Chukchi Sea, Bering Strait, Bering Sea. This is the shortest and deepest route with no draft restrictions, but the most difficult way due to the severe ice in McClure Strait. Old, hard and dangerous ice is present most of the time which can seriously hamper progress and potentially damaging to even ice strengthened ships. By 2020 the frequency of an open summer passage will increase. Even in those years when M'Clure Strait is passable there will be a risk of encountering old/multi-year ice. It is likely that this passage will remain ice congested most years. Since M'Clure Strait is considered to be the constraining point for this route; the following graph for the historical minimum ice period is provided. It indicates that significant multi-year is the norm. The trend, for the 1968-2006 period indicates a gradual decrease in ice coverage. Little change is expected before 2050.

This route, based on the Zone/Date System (see section 7.4) is closed to vessels below Arctic Class 3 which can operate there between 20 August and 30 September. In a warm year that season could be extended an estimated 10-15 days. During a cold year it would likely remain closed.

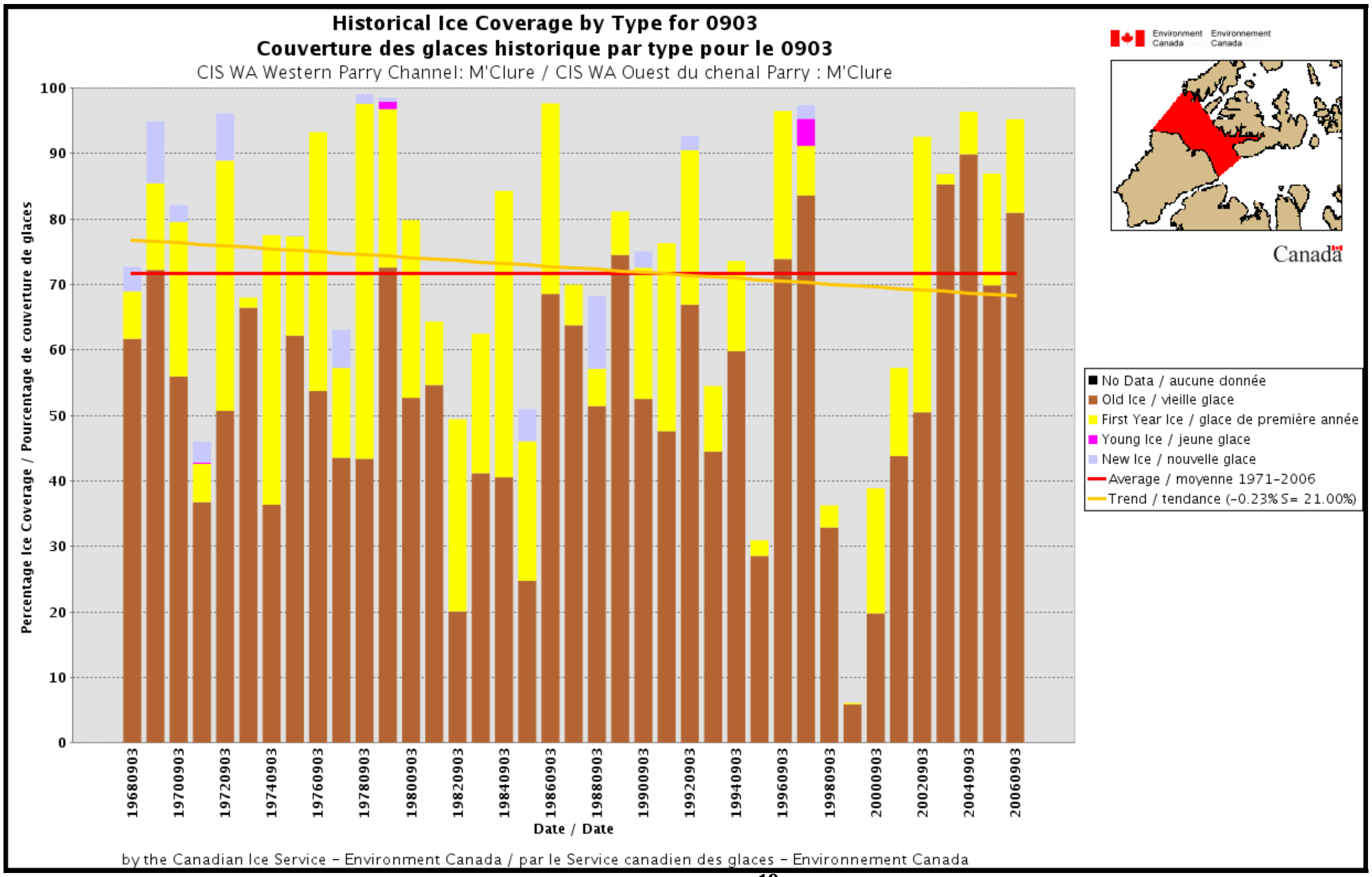


Figure 3.2-8[19]

Route 2:

Davis Strait, Lancaster Sound, Barrow Strait, Viscount Melville Sound, Prince of Wales Strait, Amundsen Gulf, Beaufort Sea, Chukchi Sea, Bering Strait, Bering Sea. This is an easier deep draft alternate route which avoids severe ice in McClure Strait. Currently passage through the Prince of Wales straight tends to be the limiting factor. Normally this segment is open during September but there continues to be a threat of encountering some old ice. By 2020 this route could be open for 8-10 weeks during some summers. Large inter-annual-variability will continue and icebreaker escort services will be required. The potential shipping season through this passage will continue to increase through 2050 but the threat of encountering old ice during most years will be significant. Indeed there could be an increase in the presence of old ice as the decrease in land-fast ice in the western portion of the Archipelago would allow more old ice from the Arctic Ocean to pass into channels between the islands. The following graph for the historical minimum ice period is provided. It indicates that significant multi-year ice is the norm. There is a stronger decreasing trend than that of M'Clure Strait for the same period; however, shipping will have to contend with significant amounts of old ice through the year 2050.

19 http://ice-glaces.ec.gc.ca/IceGraph/IceGraph-GraphdesGlaces.jsf

This route, based as well is closed to vessels below Arctic Class 3 which can operate there between 20 August and 30 September. In a warm year that season could be extended an estimated 10-15 days. During a cold year it would likely remain closed.

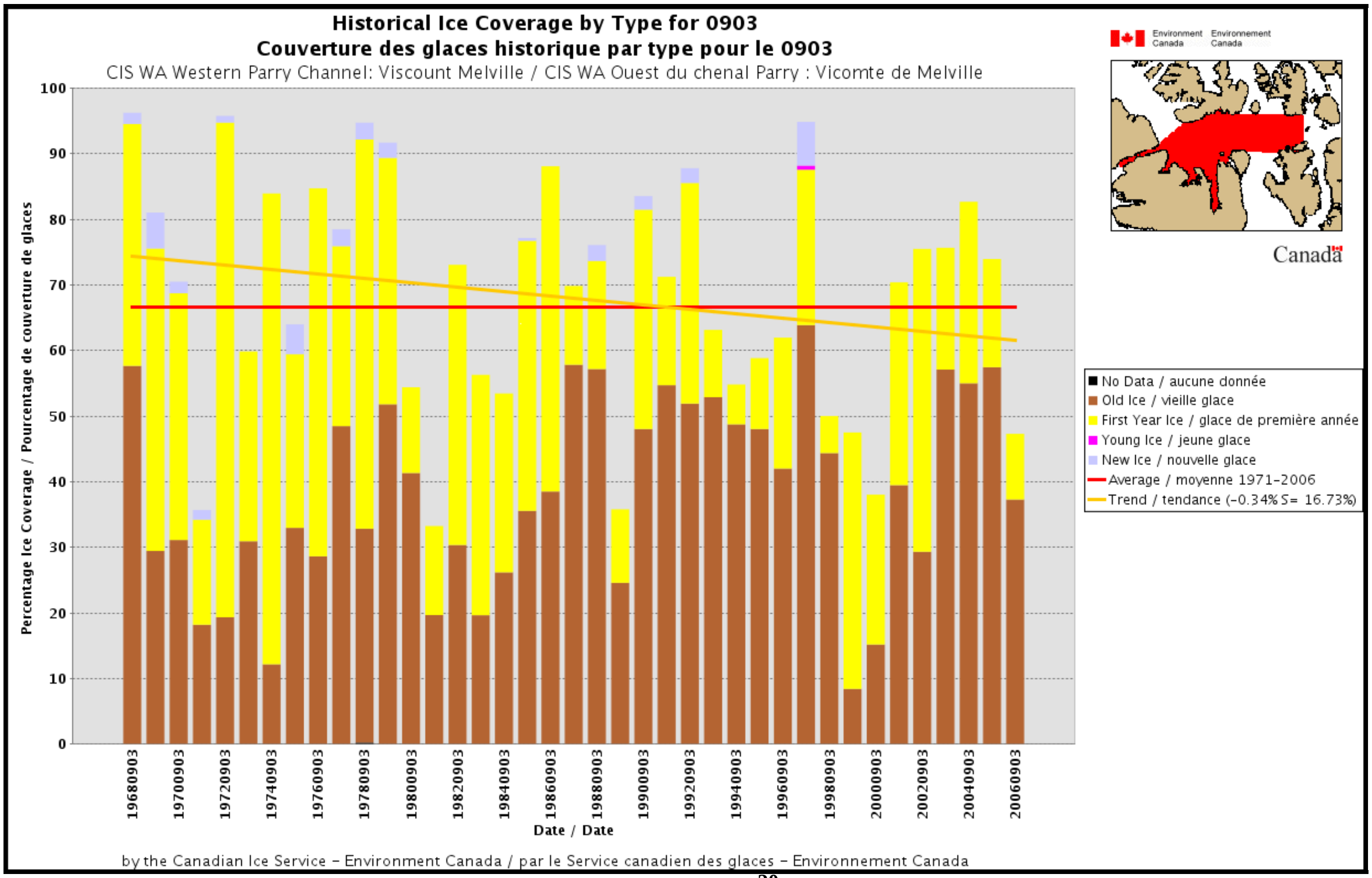


Figure 3.2-9[20]

Route 3:

Davis Strait, Lancaster Sound, Barrow Strait, Peel Sound, Franklin Strait, Victoria Strait, Coronation Gulf, Amundsen Gulf, Beaufort Sea, Chukchi Sea, Bering Strait, Bering Sea.

This is the longest transit and the most frequently used. Navigation of this route is more challenging and the route is limited to ships having a draft of less than 10 metres. Currently this route is passable from mid August to mid September. It is expected that the active shipping for this passage will continue to increase. However, old ice will continue to be a significant navigation hazard and once again there will continue to be large year-to-year variability. Two graphs were selected to illustrate the conditions at or near the ice minimum. The first is for Peel Sound which indicates the presence of old ice throughout the shipping season. The trend indicates a slight increase in the amount of ice presences.

20 http://ice-glaces.ec.gc.ca/IceGraph/IceGraph-GraphdesGlaces.jsf

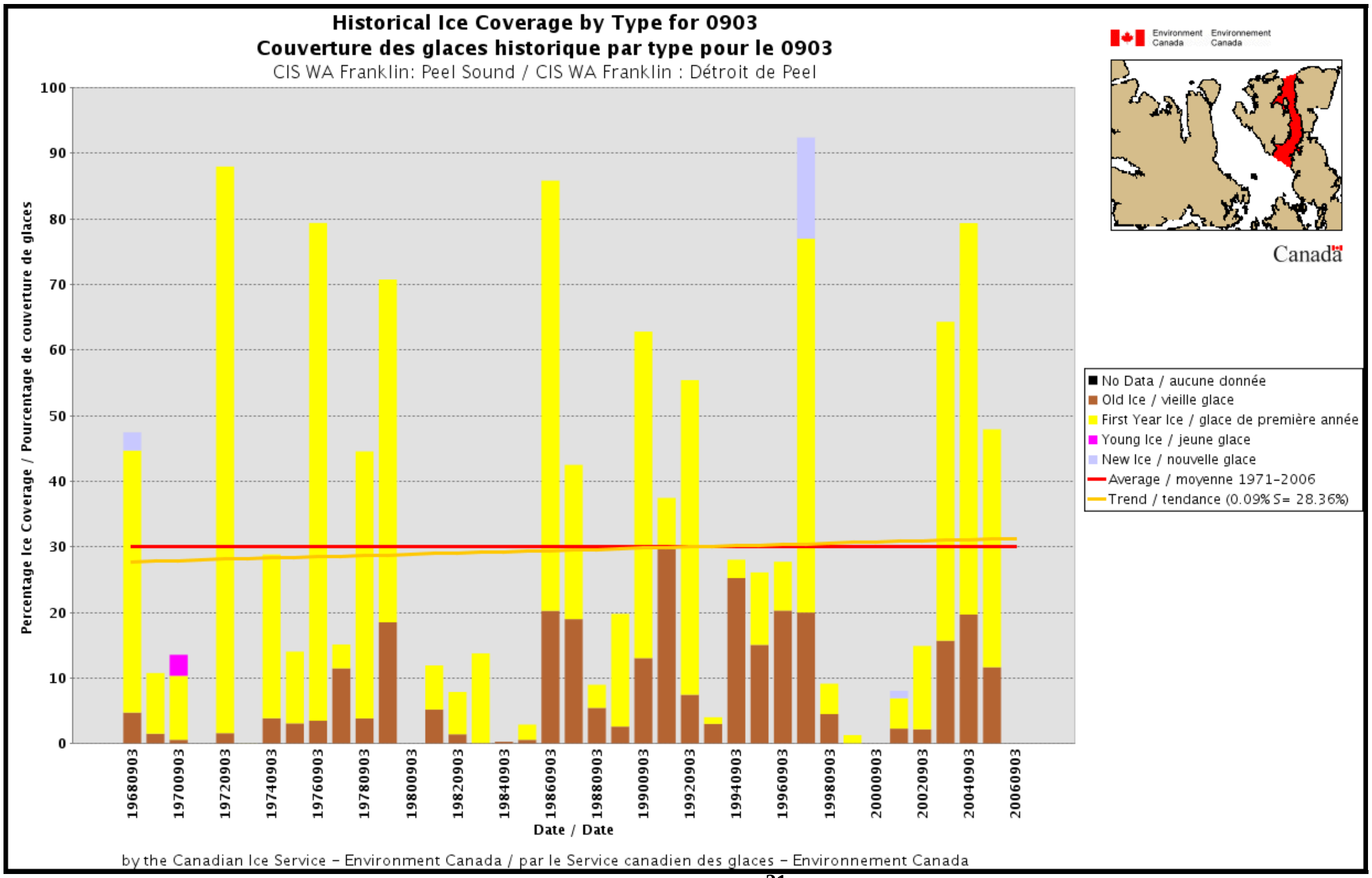


Figure 3.2-10[21]

The second graph is for the normal ice choke point for this route which include the Larsen Sea and the approaches to Victoria Strait. Historically there have been higher concentrations of old ice here, which constrains access to the entrance to the Western Arctic Waterway of the Northwest Passage. Once again there has been a decreasing trend over the last 36 years. Even though this decreasing trend is expected to continue, significant amounts of old ice will persist through 2050 and caution will be required.

21 http://ice-glaces.ec.gc.ca/IceGraph/IceGraph-GraphdesGlaces.jsf

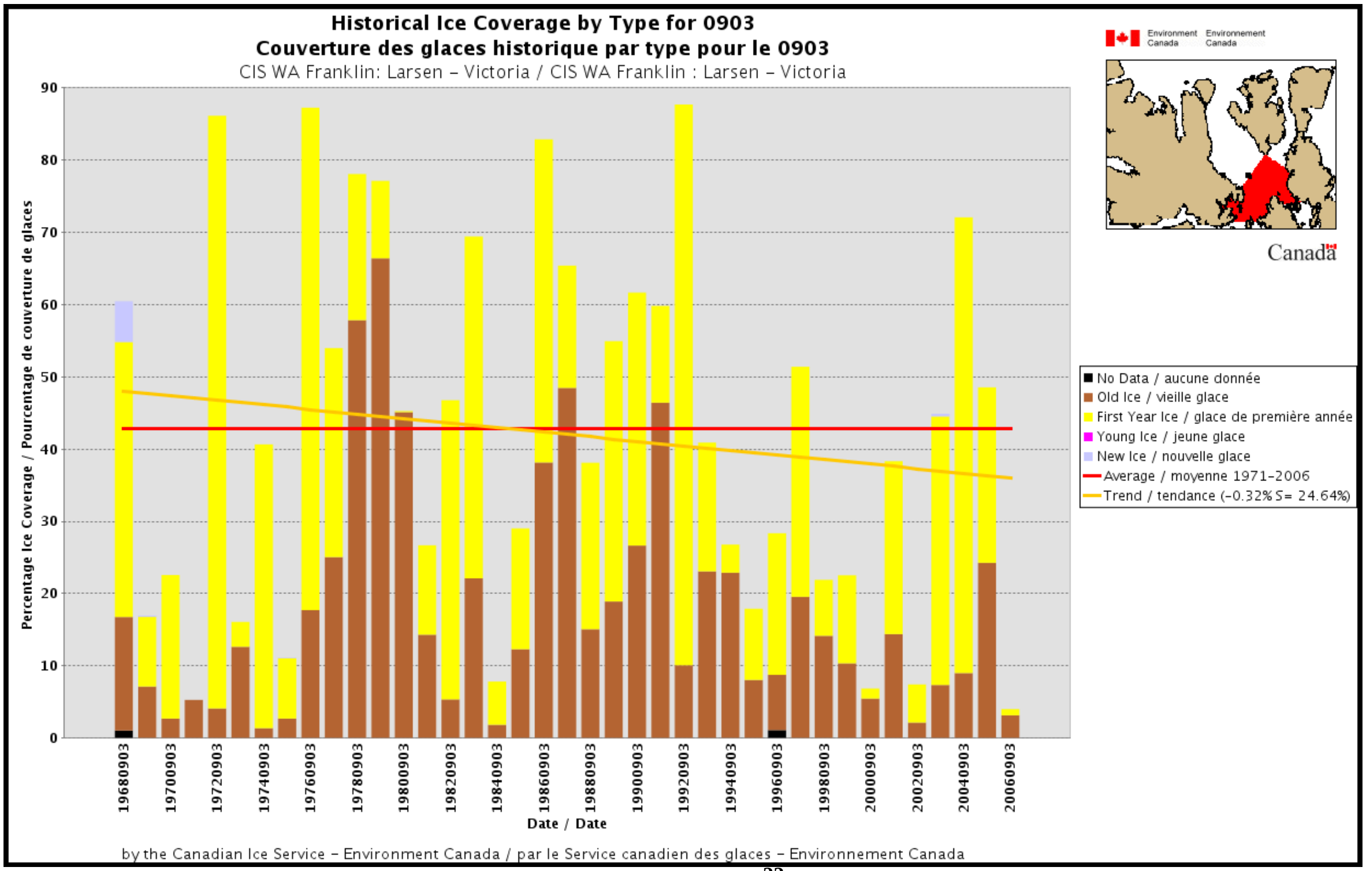


Figure 3.2-11[22]

This route is generally limited by Peel Sound. Based on that, the shipping season for a Type B vessel opens 25 August and closes 30 September. In a warm year it is unlikely that the full route would be open any earlier; however, the closing of the season could be extended at least by 30 days. During a cold year it would like could easily remain closed.

Route 4:

Hudson Strait, Foxe Basin, Fury and Hecla Strait, Bellot Strait, Franklin Strait, Victoria Strait, Coronation Gulf, Amundsen Gulf, Beaufort Sea, Chukchi Sea, Bering Strait, Bering Sea. This route also has a draft limit of 10 metres. It has had light ice years but it will likely remain difficult through 2020. Fox Basin and the Gulf of Boothia can have significant amounts of ice through mid August. Severe ice conditions at and in the vicinity of the western approaches to Fury and Hecla can be expected. Bellot Strait will generally be passable during the later part of August and through mid September but strong tidal currents will continue to be a factor for both the movement of ice and ships. By 2050 the frequency of ice free conditions throughout this route will increase. However, it is not likely that this route will be of interest to those shipping activities requiring reliable transit times as the probability of requiring an icebreaker escort are much higher than other NWP alternatives.

22 http://ice-glaces.ec.gc.ca/IceGraph/IceGraph-GraphdesGlaces.jsf

Figure 3.2-12 for Prince Regent Inlet and the Gulf of Boothia is not considered as reliable and indicator of conditions by the Canadian Ice Service as the quality assurance procedures for the associated data have not been fully completed. The decreasing trend for this area is more pronounced than the other for the three routes, but it is clearly evident that significant amounts of old ice are likely to be present most years. Consequently Route 4 is going to be a challenge most years for a Type B vessel. In addition to frequent congestion in Fury and Hecla Strait, there are potential ice problem in both Bellot Strait and Franklin Straits. Based on the Zone/Date System the season would begin 25 August and close 30 September. During a warm year the closing could be extended by almost 30 days. During a cold summer season it would likely remain impassable for most vessels.

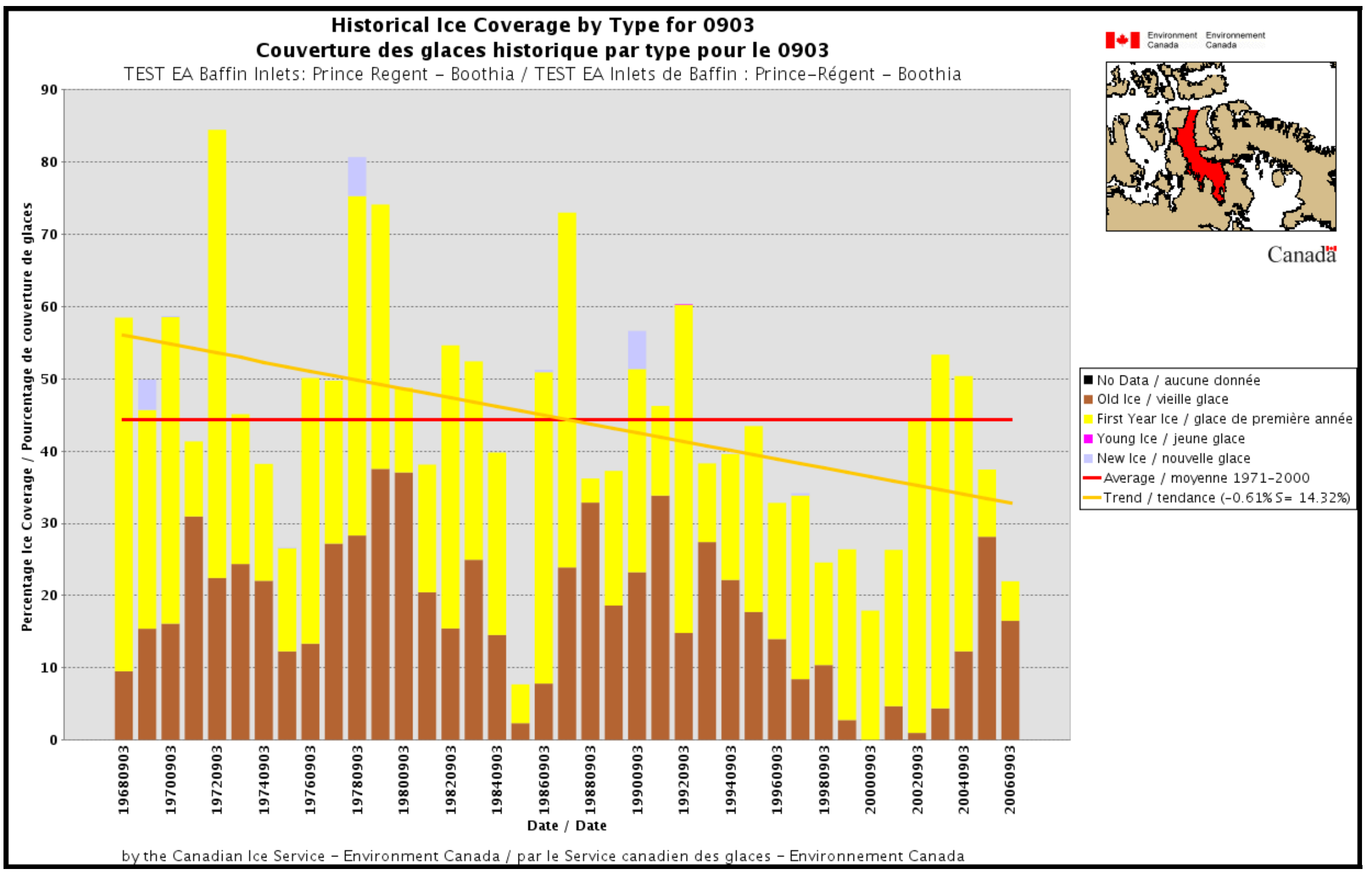


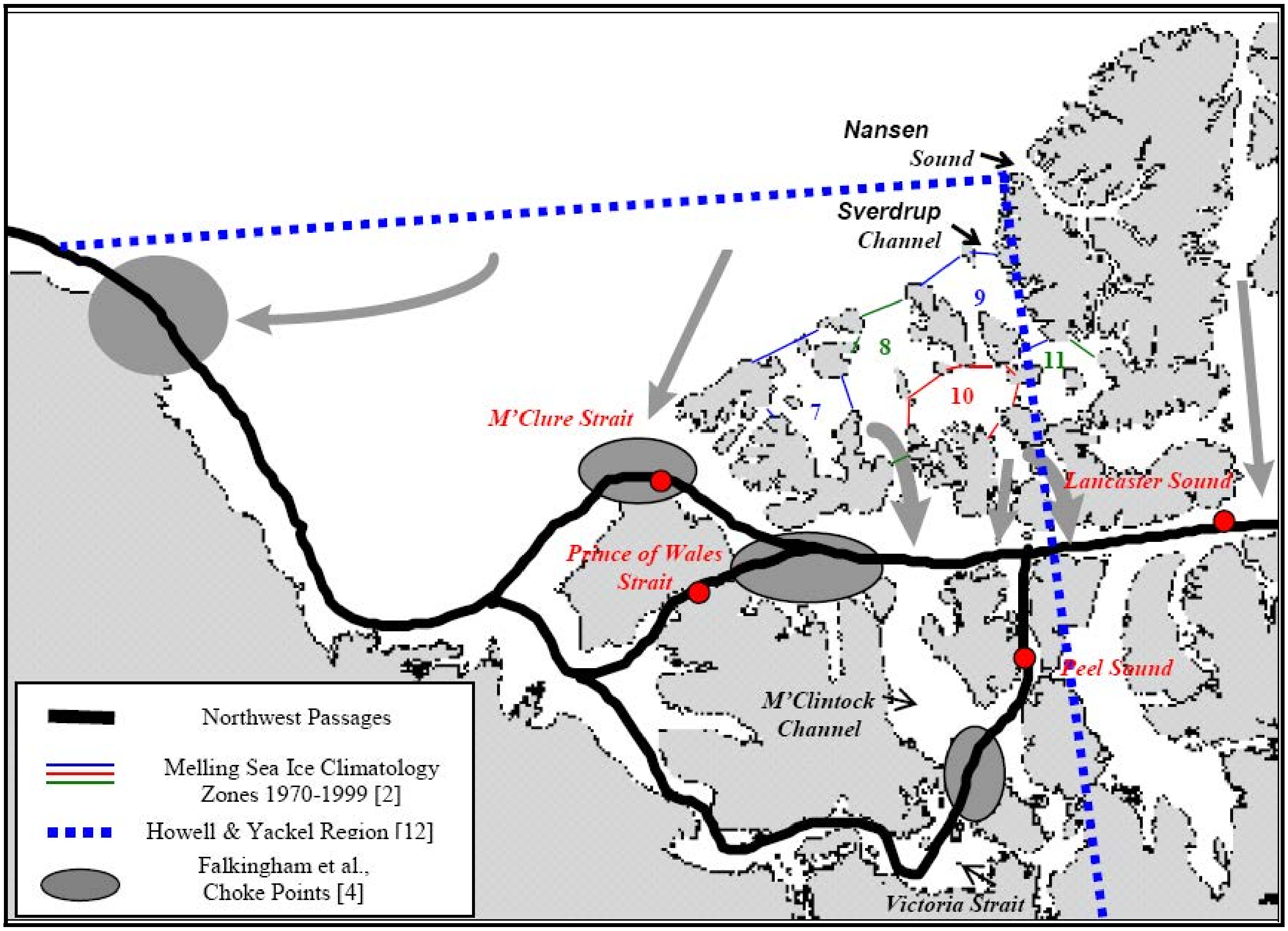
Figure 3.2-12

NWP Ice Condition Summary

Map 3.2-3 below[23] depicts four choke points that will continue to influence the success of transiting the NWP. As the Arctic icepack recedes the ice will tend to become more mobile driven by the winds and ocean currents and at times will create significant barriers at one or more of the choke points depicted. As Arctic warming continues, it is likely that much of first year ice in the Canadian Archipelago will break up much earlier than is currently the case. This will likely allow old hazardous ice from the permanent ice pack

23 Taken from “Shipping in the Canadian Arctic Other Possible Climate Change Scenarios”

to enter the NWP in greater quantities posing a threat to shipping at least to the end of the century.



Map 3.2-3 Arctic choke points

Northern Sea Route

The variability of ice the Northern Sea Route is similar to that experienced in Canadian waters. Currently this route is open to ice strengthened ships[24] for about 15 days per year. Global Climate Models indicate that the summer extent of sea ice along this route will decrease; the length of the shipping season will more than double by 2020; and be in the order of 120 days by 2050. Although variability will continue it will not be as dramatic as in the NWP. Consequently the NSR will likely become the northern route of choice for east to west shipping operations. It will be ice free for a longer period in the summer, navigation is easier and the distance from Europe to Japan or vice versa is marginally shorter.

[24] See Annex 10.2 regarding Norilsk's new ice breaking vessels that are expected to deliver year round capability.

Churchill/Hudson Bay

The shipping route to Churchill is by the Labrador Sea, through Hudson Strait and then directly across the Bay to Churchill or alternatively just south of Southampton Island southwestward toward the western shoreline and then south into Churchill. Typically the route through Hudson Strait opens around the July 01 but can be delayed by almost a month during colder years. Churchill and the western shore of Hudson Bay are generally open by the first week of July but can be delayed up to four weeks in colder years, or if the prevailing westerly winds are absent. Over the last decade this area has had generally lighter ice conditions than in the previous two decades with navigation conditions that would warrant an extension to the closing of the shipping season by 2-3 weeks. Climate change will likely increase the probability of a two to three week extension to the closing date, but it is unlikely that there will a significant impact on the opening date for this route through 2020. By 2050 the frequency of an earlier opening date will increase. Large inter-annual and year-to-year variations will continue throughout the first half of the 21st century.

Another factor affecting Churchill is the rebound of the sea bed following the last ice age. During the last Ice Age, the weight of the ice-sheet depressed the Earth's surface over a large portion of northern Canada. When the ice-sheet melted the pressure was released and the Earth's surface began to re-establish its former equilibrium. This process is known as "isostatic rebound". The west coast of Hudson Bay is known as one of the more dramatic areas of isostatic rebound where the land is still rising at a rate of a meter per century. This rate of rising is about twice as fast as the project sea level rise during this century so potentially could have an effect on the draft available for ships using Churchill, unless compensatory dredging is undertaken on a regular basis.

Ice and Weather Related Issues

A longer active shipping season in the Canadian Arctic raises a number of service level issues for the Government of Canada. It is unlikely that there will be a significant growth in international shipping through the Northwest Passage through 2050. The increase that is projected is related to enhanced access to gas, oil and mineral deposits. Hence a potential benefit to the Northern economy. Some of the environmentally related issues associated with marine activities are:

- The availability of icebreaking services beyond the currently published service levels.
- Icebreaking services fees to support activities other than the normal sealift requirements.
- Weather warnings for areas and periods that currently do not have a programme.
- Enhanced meteorological observing networks to support the warning programme.
- Ice analysis and forecast for non-traditional areas and/or periods.
- Increased aircraft ice reconnaissance and pollution patrols to detect hazardous old ice and the presence of marine polluters.

- Increased satellite coverage to support the ice and pollution detection programs.
- Emergency preparedness especially as it relates to oil spill response in cold and ice covered waters.
- An expanded Arctic fishery will require additional monitoring and enforcement resources.
- Increase marine activity and weakening fast ice strength will likely result in an increase in the number of search and rescue missions required.
- Increased need for 90^{o} orbiting or polar satellites, so the high-Arctic 'hole' disappears from many satellite data sets.
- Improve the communication of sea ice and weather warning data to ships and ensure appropriate decisions are taken to ensure marine and environmental safety.

Ice Climate Research and Development Issues

The International Polar Year (IPY) and the Climate Change Action Fund are making significant contributions to our understanding of Polar science and climate change. The results of their efforts should be continually monitored in terms of the potential impact on marine shipping activities in the Canadian Arctic. Some of the areas identified that would benefit the quality of ice and weather services are:

- Higher resolution regional climate models that would capture the complexity of the Canadian Archipelago and provide seasonal forecasts of ice growth, movement and break up.
- Systematic near real-time ice thickness measurement.
- A better understanding of predicting oil dispersion and mitigating oil spills in cold ice frequented waters.

Summary

Although much has been written and said about the impact of climate change and that an ice free Arctic will likely occur, it is important to note that such ice free conditions are not likely to occur prior to 2070. Even then, the Arctic will continue to be ice covered during the winter and large seasonal, annual and year to year variations will continue to occur. Ice conditions will continue to impede shipping through a major portion of the year. In the Canadian Arctic, large quantities of drifting ice will continue despite Arctic warming and shipping through the Northwest Passage will remain hazardous. Ice strengthened ships will be required and insurances rates are likely to remain high. Decision markers should be able to take tactical advantage of more reliable ice information to move goods in and out of the North; thus, intensifying the shipment of gas, oil and minerals. Regularly scheduled ship passage will continue to be both a physical and economic challenge through 2050.

Post-script regarding northern climate

During the "Viking Age" 800-1100 AD there is evidence that the climate was warmer over Greenland and the eastern approaches to the Northwest Passage. Inuit oral histories also speak of periods that are roughly equivalent to Viking settlement of Greenland, when there was little ice in the arctic.

There is also some evidence that explorers of this era journeyed much further westward into the Canadian Archipelago. The Vikings arrived in Greenland around 900 AD and lived there for about 500 years. There is likely some truth in the belief that Erik the Red, the founder of the first permanent Viking settlement on Greenland, wanted to attract settlers; hence the name. For the first century or so of their Greenland colonization enjoyed a reasonably prosperous and pleasant lifestyle. Greenland's climate was obviously enjoying a warm phase, and the name Eric chose was not necessarily as deceptive as some might think. Near the end of the twelfth century the climate changed. Ice began to creep southward and the world entered a period known as the **Little Ice Age** (LIA). There is some debate as to the beginning and end of the LIA but records indicate that there were three minima around 1650, 1770 and 1850. These minima were separated by relatively warm intervals. Figure 3.2-16 below is a reconstruction of temperatures over the past 2000 years.

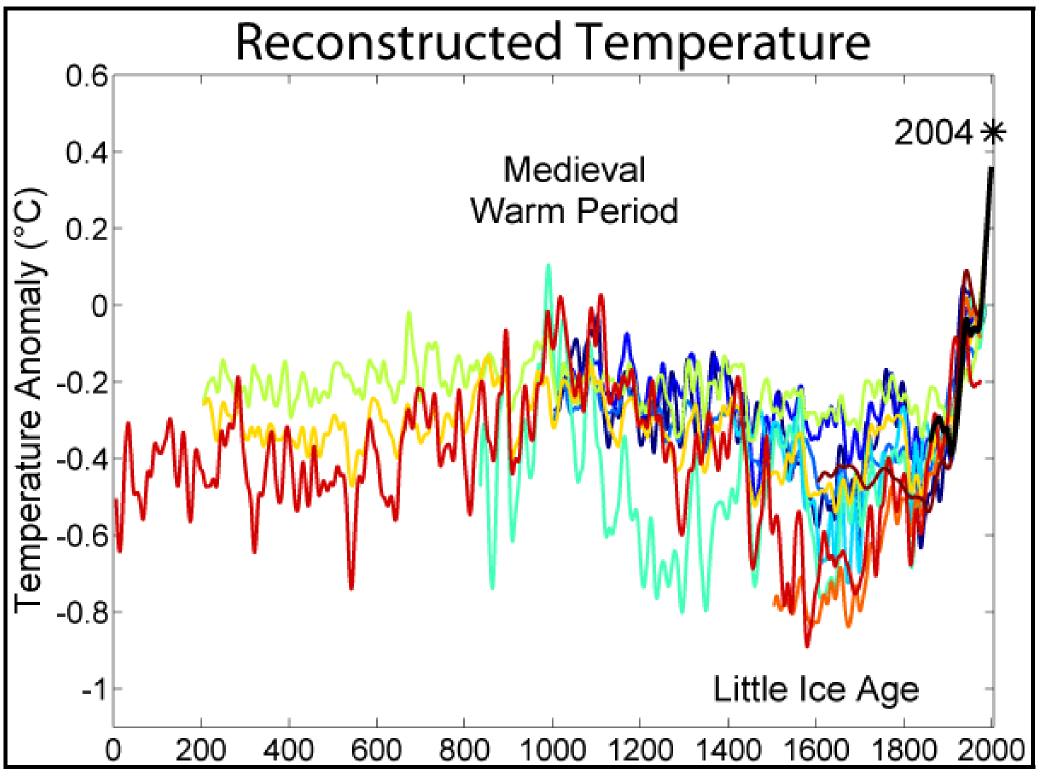


Figure 3.2-16 Reconstructed Long term temperatures[25]

[25] http://en.wikipedia.org/wiki/Image:2000_Year_Temperature_Comparison.png

3.3 Socio-Economic Review and Issues

In this chapter, we present a socio-economic outlook of four Arctic regions in Canada's north: Nunavut, the coastal communities in the Northwest Territories, Nunavik, and the coastal Cree communities in northern Quebec, Ontario and Manitoba. Community locations are given in the map on the following page, and the unique socio-economic situation of most communities is demonstrated by the second map, that shows conventional links with the rest of Canada.

These regions hold many similarities in terms of their demographic make-up, socio-economic conditions and natural resource potential. However, Nunavut is by far the largest of the four with respect to population, geography and potential, so emphasis will be on it. Further to this, because Nunavut is an independent jurisdiction within Canada's confederation, Statistics Canada collects and reports on Nunavut specifically. The other three jurisdictions, Nunavik, the coastal communities in the NWT and the coastal Cree are not reported on individually by Statistics Canada. Therefore statistical data for these regions must come from other sources such as regional statistical agencies.

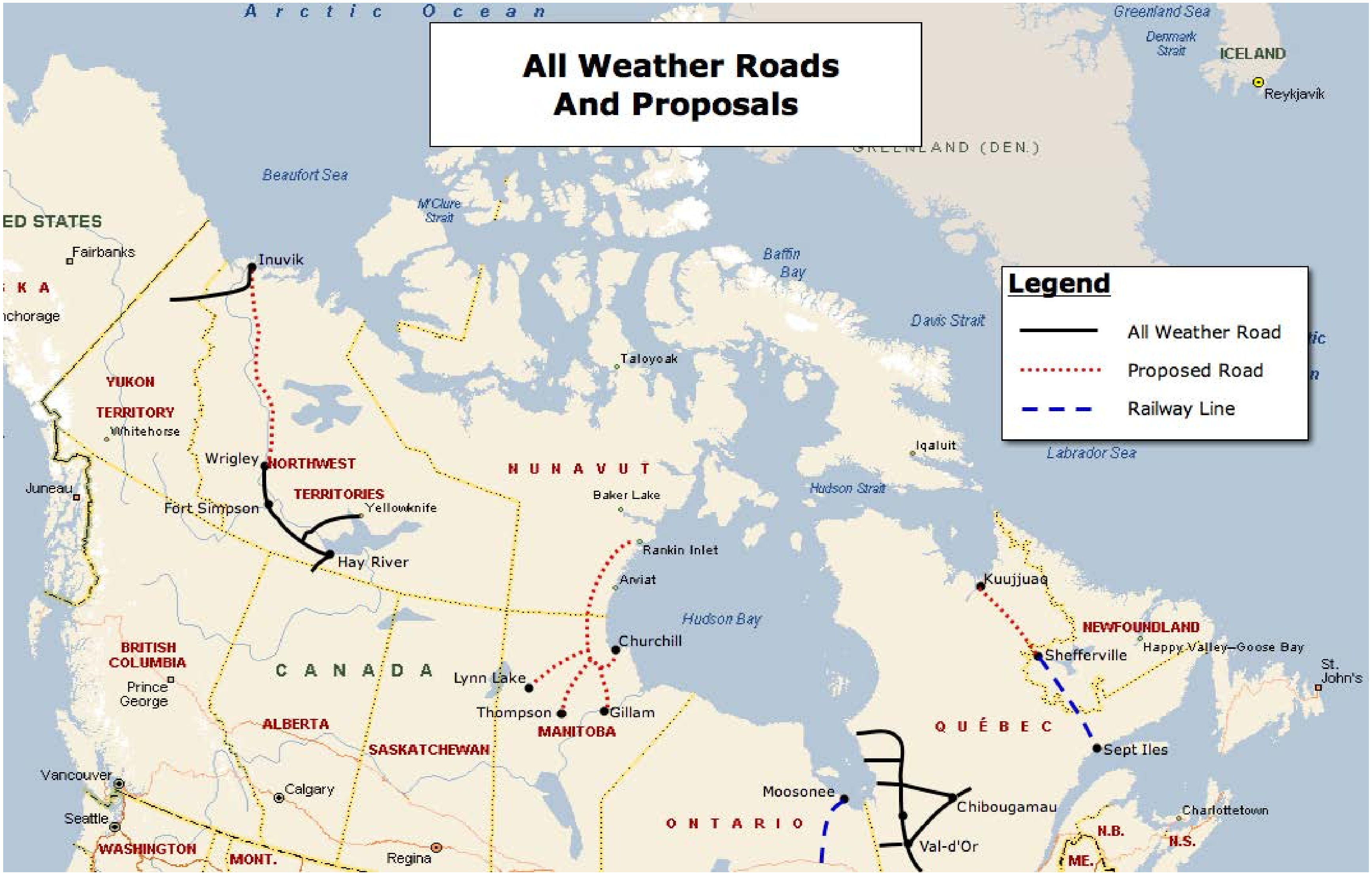
The emphasis will be on demographic projections, noteworthy socio-economic changes and economic development opportunities. These areas will have the greatest impact on marine shipping activity through the demand for consumer goods, community construction materials, and industrial shipments. Socio-economic factors are discussed since they impact both demographic and economic change. The specific shipping-related details are provided separately in Chapter 6.

While the focus of this review is on the CASA forecast time period which extends to 2020, there is some interest in the long-term shipping trends for the Arctic region to the year 2050. As community support is largely matine relateda commentary is provided at the end of this chapter, and again, is focussed primarily on population, natural resource development and general socio-economic changes.

Methodology

The information provided in this section was gathered through secondary sources. Data sources include Statistics Canada, Nunavummit Kiglisiniartiit (Nunavut Bureau of Statistics), NWT Bureau of Statistics, and Indian and Northern Affairs *Indian Registry*. In Nunavut, the Nunavut Economic Forum produces the *Nunavut Economic Outlook* on a semi-regular basis that includes detailed analysis of all aspects of the region's demographic, social and economic future. Similar resources do not exist for the other Arctic regions. Information for these regions was gathered through a variety of government and non-government sources. Information regarding natural resource development was provided by the respective regional governments and Natural Resources Canada, as well as from the resource developers' websites. Additional information can be attributed to the knowledge and experience of the project team in this field of study.


Communities Within The Canadian Arctic Shipping Assessment
Arctic
Beaufort Sea
M'Clure Strait
Grise Fjord
Resolute Bay
Sachs Harbour
Tuktoyaktuk
Inuvik
Holman
Paulatuk
Arctic Bay
Nanisivik
Pond Inlet
Baffin Bay
Clyde River
Davis Strait
Qikiqtarjuaq
Fort Good Hope
Cambridge Bay
Taloyoak
Igloolik
Kugluktuk
Gjoa Haven
Kugaaruk
Hall Beach
Pangnirtung
Bathurst Inlet
Norman Wells
Tulita
Wrigley
Repulse Bay
Iqaluit
Kimmirut
Cape Dorset
Hudson Strait
NUNAVUT
Coral Harbour
Baker Lake
Fort Simpson
NORTHWEST TERRITORIES
Yellowknife
Salluit
Kangirsujuaq
Quaqtaq
Ivujivik
Kangirsuk
Fort Providence
Chesterfield Inlet
Rankin Inlet
Whale Cove
Akulivik
Aupaluk
Kangirsualujjuaq
Hay River
Arviat
Puvirnituq
Tasiujaq
Kuujjuaq
Hudson Bay
Inukjuaq
Churchill
Umijaq
Sanikiluaq
Fort Severn
Kuujjuarapik
QUÉBEC
Peawanuck
Chisasibi
Wemandji
Eastmain
Attawapiskat
Kashechewan
Fort Albany
Waskaganish
ONTARIO
Moose Factory
Moosonee
GREENLAND (DEN.)
Greenland Sea
Denmark Strait
ICELAND
Reykjavik
Nuuk
Atlantic Ocean
Labrador Sea
NEWFOUNDLAND
Happy Valley–Goose Bay
St. John's
Charlottetown
N.B.
N.S.
ME.
ED STATES
Fairbanks
KA
nchorage
YUKON TERRITORY
Whitehorse
Juneau
BRITISH COLUMBIA
Prince George
CANADA
ALBERTA
SASKATCHEWAN
MANITOBA
Vancouver
Calgary
Seattle
WASHINGTON
MONT.
Regina


All Weather Roads
And Proposals
Legend
All Weather Road
Proposed Road
Railway Line
Arctic Ocean
Beaufort Sea
M'Clure Strait
Baffin Bay
Davis Strait
Labrador Sea
Hudson Strait
Hudson Bay
Greenland Sea
Denmark Strait
ICELAND
Reykjavik
GREENLAND (DEN.)
Inuvik
Fairbanks
Anchorage
YUKON
TERRITORY
Whitehorse
Juneau
Wrigley
NORTHWEST
TERRITORIES
Fort Simpson
Yellowknife
Hay River
NUNAVUT
Taloyoak
Baker Lake
Rankin Inlet
Arviat
Churchill
Iqaluit
Kuujjuaq
NEWFOUNDLAND
Happy Valley–Goose Bay
Shefferville
Sept Iles
St. John's
BRITISH
COLUMBIA
Prince George
CANADA
Lynn Lake
Thompson
Gillam
MANITOBA
ALBERTA
SASKATCHEWAN
Calgary
Regina
Vancouver
Seattle
WASHINGTON
MONT.
ONTARIO
Moosonee
QUÉBEC
Chibougamau
Val-d'Or
N.B.
N.S.
ME.
Charlottetown

NUNAVUT

Overview

Nunavut is a region with tremendous opportunities but equally sizeable challenges. The natural resource potential is particularly noteworthy. Gold, diamonds, iron-ore, uranium, rare earths, natural gas and oil are all present in economically feasible deposits. However, most of these resources are land-locked in regions where transportation presents major physical and economic difficulties. Nunavut has no all-weather road or rail links to the south or between communities. There is no deep-sea port.[26] Shipping is seasonal, with most communities receiving at most two re-supply calls a year. Air transportation also has constraints, with runway quality in many communities inadequate for jet service[27].

Furthermore, the region and its population are still young with respect to modern wage-based economic and political development. A large portion of the population's productive activities take place within the non-wage or subsistence economy.[28] The predominantly Inuit society maintains strong ties to the land and their culture. This cultural connection has a profound influence on economic decisions. The Government of Nunavut is formally committed to integrating Inuit Qaujimajatuqangit (Inuit traditional knowledge) into the way it does business. These social conditions and public policy choices represent a vision for a high and sustainable quality of life unique to Canada, and are in contrast to some widely-held values of southern Canadians.

Demographic Outlook

According to the latest *Census,* Statistics Canada reports Nunavut's population was 29,500 in 2006 at the time of the survey. It is widely reported Inuit represent 85 per cent of this total—this will be confirmed with future *Census* data releases. The new *Census* numbers are lower than Statistics Canada population projections of just over 30,000 for 2006. This indicates Nunavut's population growth has been slower than was expected.

[26] There is one exception. A road links Arctic Bay to the Nanisivik Mine where there is also a deep-sea port. However, the mine is now shut down and in the midst of reclamation. The port is still used for transshipment of cargo from commercial vessels to CCG icebreakers for delivery to Kugaaruk and Eureka.

[27] Most runways are gravel, and there are a limited number of jet aircraft that can be fitted with stone suppression kits. Most of these aircraft (737-200, and 727) are now 30 years old.

[28] *2001 Household Survey*, Nunavummit Kiglisiniartiit (Nunavut Bureau of Statistics).

Looking at the details in Table 3.3-1, we can see that net migration has been the primary source of the slower growth, showing a net negative migration in three of the past four years. Still, the number of births reached a record high last year, pushing the natural increase to a new record of 634.

Table 3.3-1: Population Details, Nunavut

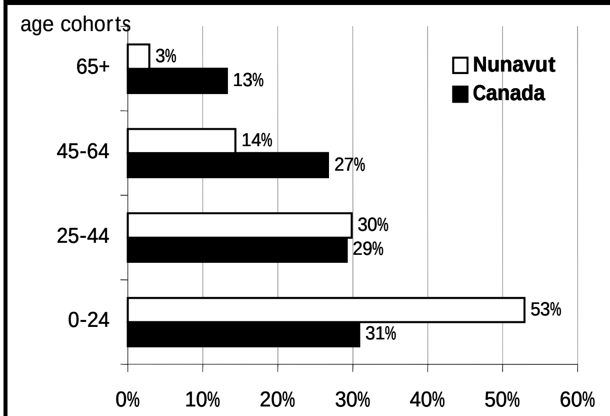
	Births	Deaths	Migration*	Change
1999	663	138	-55	470
2000	754	117	70	707
2001	713	128	48	633
2002	722	130	24	616
2003	762	129	-198	435
2004	725	132	-135	458
2005	754	133	-181	440
2006	770	136	104	738

* Net Interprovincial
Source: Statistics Canada

The most striking fact about Nunavut's demographic profile is the size of its youth population. Nunavummiut who are 24 years of age or younger represent over 50 per cent of the total population (see Chart 3.3-2). This is in stark contrast to the 31 per cent within the same age-cohort Canada-wide.

The demographic distribution has many implications for the region's existing and future economy. The most important is the influence this younger cohort will have on Nunavut's economic, social and political direction. As these Nunavummiut mature, their attitudes, opinions and consumer choices will influence change in Nunavut the same way the Baby Boomer generation did in southern Canada. How this cohort views resource development will be perhaps their most important contribution to the Territory's future. This view will be shaped by the distribution of benefits from the current wave of development.

Chart 3.3-2: Nunavut Demographic Profile, 2006

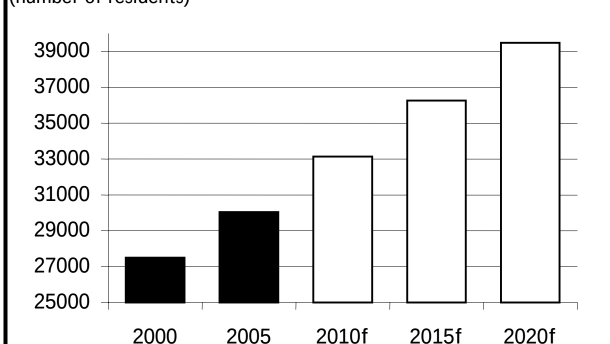


Source: Statistics Canada

Nunavut's economic future does influence our population forecast. We assume only minimal growth through net migration over the first half of the forecast, and in particular over the next few years before resource projects start in the Kivalliq and Kitikmeot Regions. Moving forward, net migration will grow to an average of 100 by the later stages of the forecast period based on the promise of several resource projects moving forward. This combines with Nunavut's projected natural increase to give us an average compound growth rate of 2 per cent from 2005 to 2010, and 1.8 per cent from 2005 out to 2020 (see Chart 3.3-3). A detailed forecast of population by community is provided on the next page in Tables 3.3-4, 3.3-5 and 3.3-6.

Chart 3.3-3: Population Forecast, Nunavut

(number of residents)



Source: Statistics Canada, Impact Economics

Table 3.3-4: Nunavut Community Population Projections (Baffin Region)

	2000	2005	2010	2015	2020
Arctic Bay	664	703	775	849	924
Cape Dorset	1,180	1,260	1,389	1,521	1,656
Clyde River	807	836	922	1,009	1,098
Grise Fiord	168	144	158	173	189
Hall Beach	626	667	735	805	876
Igloolik	1,322	1,568	1,729	1,892	2,060
Iqaluit	5,384	6,303	6,950	7,608	8,284
Kimmirut	445	419	462	506	551
Pangnirtung	1,312	1,350	1,489	1,630	1,775
Pond Inlet	1,254	1,340	1,478	1,618	1,762
Qikiqtarjuaq	534	482	532	582	634
Resolute	221	233	257	282	307
Total	13,918	15,304	16,876	18,475	20,115

Note: 2005 demographic data does not match 2006 Census data perfectly

Source: Statistics Canada, Nunavut Bureau of Statistics, Impact Economics

Table 3.3-5: Nunavut Community Population Projections (Kivalliq Region)

	2000	2005	2010	2015	2020
Arviat	1,953	2,100	2,315	2,534	2,760
Baker Lake	1,550	1,761	1,942	2,126	2,315
Chesterfield Inlet	355	338	373	408	445
Coral Harbour	732	784	864	946	1,030
Rankin Inlet	2,238	2,403	2,650	2,901	3,159
Repulse Bay	629	762	841	920	1,002
Sanikiluaq	703	758	836	915	997
Whale Cove	314	360	397	434	473
Total	8,474	9,267	10,218	11,186	12,180

Note: 2005 demographic data does not match 2006 Census data perfectly

Source: Statistics Canada, Nunavut Bureau of Statistics, Impact Economics

Table 3.3-6: Nunavut Community Population Projections (Kitikmeot Region)

	2000	2005	2010	2015	2020
Cambridge Bay	1,346	1,505	1,660	1,817	1,979
Gjoa Haven	987	1,084	1,196	1,309	1,425
Kugaaruk	622	701	773	846	922
Kugluktuk	1,246	1,327	1,463	1,602	1,744
Taloyoak	740	825	909	995	1,084
Total	4,942	5,443	6,001	6,570	7,153

Note: 2005 demographic data does not match 2006 Census data perfectly

Source: Statistics Canada, Nunavut Bureau of Statistics, Impact Economics

Socio-Economic Outlook

In the most recent *Nunavut Economic Outlook*[29], published by the Nunavut Economic Forum, emphasis was placed on matching economic growth with social conditions. Its analysis spoke of a need for balance between these two elements and that too few social indicators were showing improvements that could ultimately underpin the opportunities for economic growth over the long term.

This has to be a concern for any resource developer considering properties in Nunavut. There is considerable pressure on them to show patience in working with Nunavummiut and not ignore their interests or apprehensions and understand that the pace of development may be slower than their shareholders would prefer to see.

Nunavut's Performance and Potential

Tables 3.3-7, 3.3-8 and 3.3-9 on the following page show Nunavut's economic production has not yet recovered from the closures of Nanisivik, Polaris and Lupin mines that took place starting from the latter half of 2002. But it is important to recognise the minimal impact those three operations had on the domestic economy and local employment. Few Nunavummiut worked at these mines, so while the closures brought a recession to Nunavut in terms of real GDP, there was no slowdown in the growth in domestic demand and employment.

Keeping the economy growing has been expansions in the public sector. It accounts for more than 50 per cent of Nunavut's domestic demand, over 40 per cent of economic output, and half the jobs. Fuelling this expansion are larger transfers from the federal government through the Territorial Formula Financing agreement that sent $839 million to Nunavut in 2005-06, $893 million in 2006-07 and is expected to deliver $942million in 2007-08.[30] These transfers have allowed the Government of Nunavut's budgets to grow to approximately $1 billion.[31] While the pace of spending increases by the government is expected to moderate somewhat, the attention the North is now receiving with respect to economic opportunities, climate change and Arctic sovereignty, combined with recognition from Ottawa that traditional financing arrangements are inappropriate for the North will ensure transfers grow at an average pace of 4 per cent to 5 per cent a year for the next several years fuelling further budgetary increases.

Equally important in recent years has been larger capital investments in public and private infrastructure. A number of new schools and a new hospital have been built, as has the Jericho Diamond Mine. Investments into public housing have been relatively steady at around 80 units a year, but this should increase threefold for the next three years

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[29] *2005 Nunavut Economic Outlook*, Impact Economics, published by Nunavut Economic Forum (2005).

[30] *Territorial Formula Financing Entitlements*, Department of Finance, Government of Canada. (www.fin.gc.ca/FEDPROV/tffe.html)

[31] *Budget 2006-07* and *Budget 2007-08*, Department of Finance, Government of Nunavut (2006 and 2007).

Table 3.3-7: Gross Domestic Product at Market Prices, Expenditure Based

(millions, chained (1997) prices)

	2001	2002	2003	2004	2005
Gross Domestic Product	**847**	**897**	**866**	**885**	**875**
Personal expenditure on consumer goods and services	**370**	**391**	**417**	**434**	**449**
Net government current expenditure on goods and services	**697**	**716**	**741**	**761**	**779**
Government gross fixed capital formation	**105**	**95**	**110**	**108**	**77**
Business gross fixed capital formation	**152**	**161**	**234**	**291**	**319**
Residential structures	18	20	19	28	19
Non-residential structures	81	89	143	190	209
Machinery and equipment	54	51	72	66	93
Domestic Demand	**1,324**	**1,363**	**1,502**	**1,594**	**1,624**
Exports of goods and services	**308**	**303**	**147**	**152**	**143**
Deduct: Imports of goods and services	**797**	**744**	**804**	**864**	**909**
Gross Domestic Product	**847**	**897**	**866**	**885**	**875**
Economic Growth	*5.9%*	*5.9%*	*-3.5%*	*2.2%*	*-1.1%*

Source: Statistics Canada's 2005 Territorial Economic Accounts

Table 3.3-8: Nunavut's GDP by Selected Industry at Chained (1997) Prices

($, millions)

	2001	2002	2003	2004	2005
Fishing, Hunting and Trapping	**0.7**	**1.2**	**1.5**	**1.6**	**0.9**
Mining and Exploration	**155**	**99**	**15**	**15**	**5**
Total Construction	**81**	**127**	**149**	**165**	**152**
Manufacturing	**1.7**	**1.5**	**1.1**	**1.5**	**2.1**
Goods-producing Industries	**247**	**236**	**172**	**189**	**166**
Retail Trade	**2.9**	**3.2**	**3.8**	**3.8**	**3.7**
Transportion and Warehousing	**28**	**30**	**32**	**33**	**34**
Information and Cultural Industries	**24**	**21**	**26**	**26**	**26**
Education Services	**x**	**90**	**92**	**93**	**93**
Health Care and Social Assistance	**54**	**55**	**56**	**55**	**57**
Arts, Entertainment and Recreation	**x**	**1.6**	**1.6**	**1.6**	**1.5**
Accomodation and Food Services	**15**	**15**	**18**	**19**	**19**
Public Administration	**215**	**229**	**231**	**234**	**238**
Service-producing Industries	**x**	**616**	**635**	**635**	**645**
Gross Domestice Product	**851**	**895**	**865**	**881**	**876**
Economic Growth	5.7%	5.2%	-3.4%	1.8%	-0.6%

Source: Statistics Canada, * Omitted data has been supressed under the Statistics Privacy Act

Table 3.3-9: Survey of Employment, Payroll and Hours (SEPH)

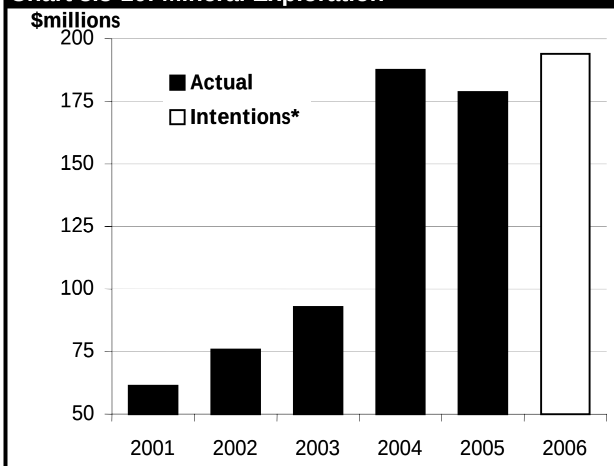
(numbers of wage and salary earners)

	2001	2002	2003	2004	2005
Construction	524	593	621	635	517
Other (incl. primary, manufacturing, utilities*)	981	933	757	603	544
Goods-Producing industries	**1,505**	**1,526**	**1,378**	**1,238**	**1,061**
Wholesale and Retail Trade	1,004	1,056	1,208	1,318	1,288
Transportation and Warehousing	507	516	431	466	497
Education	980	1,007	x	x	x
Health care and Social Assistance	1,473	1,535	1,690	1,971	1,922
Accomodation and Food Services	224	286	435	481	392
Public Administration	2,492	2,719	2,857	3,023	3,337
Service-producing industries	**8,217**	**8,828**	**9,677**	**10,181**	**10,396**
Total Industrial Aggregate	**9,722**	**10,354**	**11,055**	**11,419**	**11,457**

Source: Statistics Canada, * Omitted data has been supressed under the Statistics Privacy Act due to a $200 million contribution from the federal government to Nunavut's public housing strategy. The tremendous need for public housing in Nunavut would suggest this new pace of construction must be sustained, however, no new funding has been guaranteed beyond the $200 million deal.

There are more positive prospects besides this new housing money. In particular, recent years have seen a significant increase in mineral exploration to the point now where there are several properties in advanced stages of exploration or environmental assessment. Chart 3.3-10 reveals a rise in exploration activity beginning in 2004. Sparking this jump is world demand for industrial inputs and the realisation that many of Nunavut's kimberlite pipes are diamondiferous.

Chart 3.3-10: Mineral Exploration

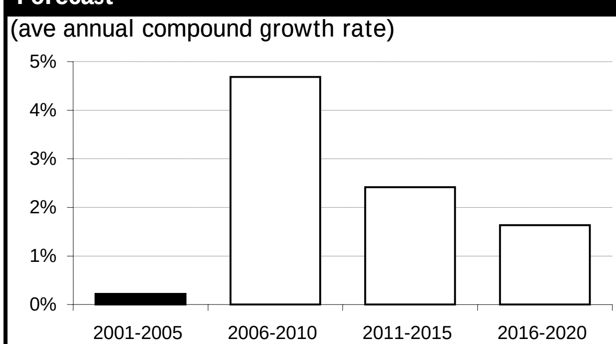


* Revised Spending Intentions
Source: Overview of Trends in Canadian Mineral Exploration

It is important to recognise the importance of the Nunavut Land Claims Agreement in connection with this mineral activity. First, every exploration project that is currently in advanced stages is on Inuit-owned land as established through the Land Claim. This means development of these properties must follow the guidelines established by the Agreement and are administered by Nunavut Tunngavik Incorporated (NTI) or one of the three Regional Inuit Associations that have a role in land management. It also means each project will be required to establish an impact and benefit agreement with local and/or regional Inuit. These agreements typically establish rules around employment, training, contracting, and cash contributions as well as a monitoring agency and a liaison between the local population and the resource developer. Finally, the resource royalty regime in place for Inuit-owned land is between the federal government and NTI, so any future devolution agreement between Canada and the Government of Nunavut would not affect these operations.

The latest *Nunavut Economic Outlook*, which contains a detailed forecast of the real economy, predicts average compound growth to equal 4.7 per cent over the five-year period from 2006 to 2010. As shown in Chart 3.3-11, the economy is expected to grow at a slower rate thereafter.

Chart 3.3-11: Nunavut Economic Outlook GDP Forecast



Source: *Nunavut Economic Outlook*

This forecast was based on an estimate of mining activity that included six new mine start-ups between 2005 and 2020 (including Jericho). In the time since this forecast was completed, resource markets have remained bullish suggesting the forecast is safe. The two biggest projects left out of Nunavut's economic forecast are the major road and port project[32] in the Kitikmeot that would provide access to Izok Lake's base metal concentrate potential among other deposits, and the Mary River Iron Mine and Railway project on Baffin Island. These are discussed in more detail next since they represent significant upside risk to the forecast and to the volume of shipping activity.

***Natural Resource Opportunities*[33]**

There are over 100 active exploration sites in Nunavut. Only those with any probability of becoming a mine inside our established forecast time period are discussed, which includes those at the most advanced stages of exploration and those working through environmental assessments. These projects are discussed according to their geographic location. Again, the purpose of this discussion is to provide a backdrop to the potential impact on population and the demand for shipping, which will be discussed in detail later in this report.

KITIKMEOT REGION

The Kitikmeot region is geologically diverse with over 60 active exploration projects. Gold and diamonds are the primary exploration targets.[34] The Kitikmeot region is home to the only active mine in Nunavut since Tahera began operation at its Jericho Diamond Mine in 2005. The most advanced projects in this region include Doris North gold deposit near Hope Bay, George and Goose Lake gold deposits directly south of Hope Bay on the Back River system, and High Lake base metal deposit near Gray's bay on the Coronation Gulf. Doris North is at the permitting stage with plans to start mining in 2008, while High Lake has more recently begun its permitting process. The latter represents a more significant project with the need for road construction and a port facility, given the nature of base metal mining.

There have been several discoveries of diamonds in the Boothia Peninsula and a surging interest in uranium with some new deposits found near Hornby Bay. Thus far, none of these targets shows immediate signs of development. Nevertheless, the likelihood of a second diamond mine in Nunavut seems probable. But at this point, the most likely scenario would be a discovery near Jericho, and thus have no impact on arctic shipping without the presence of an all-weather road from an Arctic port. Such a road may be developed in concert with a port, given the growing concern in the southern diamond areas regarding the security of the ice road system that is their re-supply lifeline during the winter period.

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[32] The Bathurst port and road project is likely to be overtaken by Wolfden Resources Gray's Bay port and the development of their High Lake and Ulu properties. Wolfden also own Izok Lake and other base metal and gold properties in the same region.

[33] Technical details of this section can be found in *Overview of Trends in Canadian Mineral Exploration, 2006*, Canadian Intergovernmental Working Group on the Mineral Industry, Economics, Investments and Fiscal Analysis Branch, Natural Resources Canada (Ottawa 2007).

[34] *Overview of Trends in Canadian Mineral Exploration, 2006*, Natural Resources Canada (Ottawa 2007).

Uranium presents added complexities. Several years ago, NTI introduced a policy banning the development of uranium on Inuit-owned land. But with the rise in its demand, safer mining, transportation, storage practices, and the desire for economic growth in some regions, this policy is coming under attack by some Inuit leaders. Without trying to predict the outcome of this debate, it is likely that uranium mines will develop slowly, if and when such developments are allowed.

Other developments in the region that have long been on prospectors' radar include the zinc/lead/copper deposits at Izok Lake and Gondor, and the Hackett River silver-zinc deposit. These cannot be developed in absence of road and port infrastructure. The proposed *Bathurst Port and Road* is under environmental review, but finances remain the project's biggest obstacle, with a price tag over $200 million.

Another potential development is in the Committee Bay Greenstone Belt, which is geologically comparable to the gold-producing greenstone belts of Red Lake, Timmins and Kirkland Lake[35]. Committee Bay is located south of Gjoa Haven and north of Baker Lake.

KIVALLIQ REGION

In the Kivalliq Region most attention is on the Meadowbank gold deposit near Baker Lake, where mine approval was delivered in late 2006. The mine proponent has staged equipment for construction of the 75-kilometre access road, and hope to have the mine operating by early 2009. Current forecasts are for mining to continue for eight years, however, it is not inconceivable actual operations will continue for much longer ifgold prices remain strong.

Besides Meadowbank, there were 45 reported exploration projects underway in the Kivalliq Region in 2006[36]. Of interest are a couple diamond targets: the Churchill diamond project south of Chesterfield Inlet and Qilalugaq diamond project near Repulse Bay. These projects are still in exploration phases, and there are no plans beyond that for the moment.

Other gold plays include exploration just south of Meadowbank as well as continued assessment of the Meliadine West property just outside Rankin Inlet. The only base-metal project of note is at Ferguson Lake. Starfield Resources are investigating the nickel-copper deposit there and have established permanent base camps for improved testing. There are also several advancing uranium projects west and southeast of Baker Lake. The Kiggavik deposit was well explored and feasibility studies completed prior to the creation of Nunavut. As noted earlier, these projects have political challenges that may not be resolved in time for a uranium mine operating prior to 2020.

[35] Ibid.

[36] Ibid.

QIKIQTAALUK REGION (BAFFIN)

Diamonds are the primary stone of interest in the Qikiqtaaluk Region, with the southwest region of Baffin Island near Cape Dorset and the Melville Peninsula between Repulse Bay and Igloolik being the principle areas of exploration. There continues to be interest in coal deposits in the High Arctic on Ellesmere and Axel Heiberg Islands.

The only target progressing toward operations in the Qikiqtaaluk Region is the Mary River iron deposit situated 160 kilometres inland, south of Pond Inlet. This project, if made operational, is of a size that could see employment there span generations. The proponent, Baffinland Iron Mines, is in advance stages of testing deposits that were first discovered in 1962.[37] They have initiated port assessments, land transportation modeling, environmental and socio-economic assessments, traditional knowledge studies and are negotiating an impact and benefit agreement with the Qikiqtani Inuit Association in preparation for undergoing an environmental assessment. A best guess would see another year or two of bulk sampling, followed by a three-year environmental assessment process, followed by another three years of rail and mine construction, before commencing with production no sooner than 2015. Of course, such a forecast is subject to numerous risks—the two most pertinent being Baffinland being bought by a larger player with a different operating timeline and a change in the world demand for steel (right now, it would seem this second risk is largely an upside one).

Other Economic Activities

There are other economic opportunities in Nunavut, albeit with far less implications for marine traffic. Over the past several years, Nunavummiut have built a small fishery around the fisheries management zones surrounding Baffin Island. As of last year, Nunavut's total allowable catch for turbot was 6,400 tonnes covering both the in-shore and off-shore.[38] Growth in allocation to Nunavut and some small increases in quotas have allowed the Baffin Fisheries Coalition to lease its own factory-trawler. There is some talk of additional vessels. The federal government has supported a Nunavut Fisheries Training Initiative that will produce trained crew members for the active vessels that should strengthen the economic impact of the industry.

Not all communities are involved in the Coalition. Qikiqtarjuaq currently operates independently, leasing its own fleet of smaller in-shore vessels. Also, there remains a lot of activity by individuals or families operating the smallest of in-shore vessels. During consultations for the Government of Nunavut's *Nunavut Fishery Strategy*, many people indicated a preference for work on these smaller in-shore boats rather than the larger off-shore vessels.

Over the next several years, we can expect some modest increases in the northern most fisheries management zones where investments in science and test fisheries are taking place. Nunavummiut remain hopeful that they will receive a greater share of the existing

[37] Baffinland Iron Mine Corporation (www.baffinland.com)

[38] *2005 Nunavut Economic Outlook*, Nunavut Economic Forum and the *Nunavut Fisheries Strategy*, Government of Nunavut.

quota, though they have lost federal court cases on this matter, so it is uncertain how much addition quota they will receive. In recent years, there has been increased cooperation between Nunavik and Nunavut fishers. It should be noted that any restructuring of quota ownership would not necessarily have an impact on marine activity in the Arctic since it would simply be the case of taking from one operator and giving to another.

Tourism is another economic opportunity in Nunavut. It is based on a combination of business travel, cultural and eco-tourism, hunting and fishing camps, and some cruise ship activity. The progress in Nunavut's tourism has been slow. The challenges range from product development, infrastructure, education and costs. It is hard to imagine a dramatic change in any of these areas over the next decade, though progress is expected. For example, there is a five-year small craft marine infrastructure investment program underway. Some investments in cultural centres/art schools have been announced. But again, none of this spending will have a profound impact on the number of tourists over the short term.

NORTHWEST TERRITORIES

Overview

For the purpose of this study, we are interested in the NWT communities that have an impact on marine activity. This would include the Inuvialuit coastal communities of Sachs Harbour, Paulatuk, Tuktoyaktuk and Ulukkaktok (Holman).

We haven added to this discussion population projections for communities situated along the Mackenzie River[39]. This includes the communities of Inuvik, Fort Good Hope, Norman Wells, Tulita, Wrigley, Fort Simpson and Fort Providence. Their links to Arctic shipping is indirect via the Mackenzie River, and all communities are serviced by all-weather roads (Dempster Highway or Highway #1) in the case of Inuvik, Wrigley, Fort Simpson and Fort Providence, and winter roads to the remaining communities.

With the exception of the gas exploration in the Mackenzie Delta and the economy in Inuvik, there is little economic activity in the coastal communities. Paulatuk, Sachs Harbour and Ulukkaktok are small, traditional Inuvialuit communities. There is some industry around a muskox harvest on Banks Island. Paulatuk is receiving some attention given its proximity to Tuktut Nogait National Park and diamond exploration south of the community and has been able to capture some economic benefits through the construction of a hotel. Tuktoyaktuk is a somewhat larger community and as such has more infrastructure and some government offices are located there. It will benefit economically from the Mackenzie Gas Project (MGP), but not to the same magnitude as Inuvik. Also, the long-term outlook for Tuktoyaktuk may include relocation since a portion of the community's infrastructure is likely to suffer soil erosion making it unsafe. The timeline of the move is being debated, with the range being 10 to 40 years.

[39] Note that only larger communities, and ones having a potential influence on traffic on the Mackenzie have been identified in the mapping and included in the population projection.

Therefore, demographic- and economic-driven demand for shipping will see little change over the CASA forecast period. The largest impact on shipping will be associated with the MGP and the potential for shipping goods destined for the Albertan oil sands via the Mackenzie River. The details of these impacts are discussed later in the report.

Demographic Outlook

With or without the MGP, Paulatuk, Sachs Harbour, and Ulukkaktok will not grow over the life of the CASA forecast period (see Chart 3.3-12 and Table 3.3-13). These communities are at, if not beyond, their sustainable limits. In 2001, the population of these three communities was 858. Projections by the NWT Bureau of Statistics show this number will grow to 884 by 2020, or less than 0.2 per cent annually.[40] All three have some potential to grow through natural resource development if a major discovery was made. Of the three, Paulatuk would be considered as having the best chances of such an outcome. But even a best-case scenario would not likely mean a change in this forecast for the next 10 years.

Table 3.3 - 12: NWT Coastal Community Population Projections

	2001	2005	2010	2015	2020
Paulatuk	317	318	319	325	327
Sachs Harbour	125	119	122	120	122
Tuktoyaktuk	1,001	990	1,020	1,019	1,009
Ulukkaktok	416	434	425	432	435
Total	1,859	1,861	1,886	1,896	1,893
(ave compound growth rate)		0.0%	0.3%	0.1%	0.0%

Source: NWT Bureau of Statistics, Statistics Canada, Impact Economics

Table 3.3 - 13: Mackenzie River Community Population Projections

	2001	2005	2010	2015	2020
Aklavik	682	631	589	542	493
Inuvik	3,399	3,521	4,183	4,469	4,811
Fort Good Hope	585	576	529	541	522
Norman Wells	763	818	1,021	1,065	1,170
Tulita	499	502	503	518	529
Wrigley	187	182	168	163	156
Fort Simpson	1,250	1,233	1,365	1,371	1,416
Fort Providence	822	840	835	832	821
Total	8,187	8,303	9,193	9,501	9,918
(ave compound growth rate)		0.4%	2.1%	0.7%	0.9%

Source: NWT Bureau of Statistics, Statistics Canada, Impact Economics

[40] See NWT Bureau of Statistics *Community Profiles.*

Tuktoyaktuk has some upward potential in terms of population growth if the MGP were to proceed, but does not have the infrastructure to support much growth and is not making investments to change this. However, additional shipping activity through the Northwest Passage, possible development of a northern route to the oil sands[41] and increased vessel traffic supporting operations at Gray's Bay could see demand for port services at Tuktoyaktuk. The Bureau's long-term population projection of 1,009 by 2020 suggests essentially no growth since 2001 when the population stood at 1,001.

The population forecast provided does not include the impacts of pipeline construction. Most would argue the MGP would have a net positive impact on the population of Inuvik and Norman Wells. The NWT Bureau of Statistics projects growth for Inuvik's population to average 2.1 per cent, compounded annually from 2005 to 2020—going from 3,500 to 4,800 over that time period, while Normal Wells is expected to see its population grow from 818 to 1,170 over that same 15 year timeframe. This growth is a combination of Normal Wells growing role as a regional centre, in-migration from surrounding communities and natural increase.

Fort Good Hope, Tulita, Wrigley and Fort Providence are not economic centres and as such, their populations are not expected to change much over the CASA forecast time period. This is true with or without the MGP. Fort Simpson, on the other hand, is growing into a regional centre and therefore is not expected to lose people through out-migration as easily as found in the smaller centres.

Socio-Economic Conditions

It is difficult to isolate the socio-economic issues for the four coastal communities from those of the entire Territory. Some of the statistics available for these communities is presented in Table 3.3-14 below. These data reveal that the communities are primarily Aboriginal, have high wage based unemployment.

Table 3.3-14: Selected Socio-economic Indicators, Inuvialuit Settlement Region

(data from 2005 unless otherwise stated)

	Inuvik	Paulatuk	Sachs Harbour	Tuktoyaktuk	Ulukkaktok	NWT
Population	3,521	318	119	990	434	42,982
Aboriginal	1,978	268	115	938	415	21,413
Aged 0-24	1,379	171	27	494	211	17,508
violent crime (per 100,000 persons)	116	135	*	150	74	66
property crime (per 100,000 persons)	120	44	*	119	88	65
unemployed (2004)	155	31	18	117	32	2,454
unemployment rate (2004)	8	24	31	27	16	10
per cent with at least high school (2004)	73	41	41	37	33	68
ave family income ($)	87,750	47,513	*	56,904	56,180	91,362
2005 Living Cost Differential (Edmonton=100)	148	168	168	163	168	
2004 Food Price Index (Yellowknife=100)	141	222	197	206	188	

* data suppressed
Source: NWT Bureau of Statistics *Community Profiles* & *NWT Community Survey*

41 See discussion in the oil and gas section of the report

Natural Resource Opportunities

The majority of exploration activity taking place in close proximity to the Arctic coastline is targeting oil and gas. At the moment, all interest is centred on the Mackenzie Gas Project. Its development is entirely dependant on the construction of a pipeline that would run down the Mackenzie Valley and link up with existing infrastructure in northern Alberta. The timeline for construction of the pipeline remains uncertain. Imperial Oil has announced that escalating costs for the project will mean a delay, with completion now expected no sooner than 2014, meaning a construction start date no sooner than 2011[42]. If history is any indicator, these dates are anything but secure. The community consultation process has shown significant public concern and in some cases opposition to the project. It is not clear from a regulatory perspective how this will impact the route licensing. Last year, the federal government offered $500 million to the Territory to address socio-economic shortcomings in affected communities, if the pipeline were to be built.

Despite the repeated delays, the general thinking remains not if, but when the pipeline will be built. The MGP proponents must still meet all the requirements of their Environment Impact Statement and complete the public consultation process to the satisfaction of regulators. It is most likely that more science and engineering of the route and technologies will be required. A progressive estimate might put construction start-up by 2011, but a more prudent estimate would put construction three to five years later, assuming the demand is still there and the project proponents remain interested.

Other Natural Resource Opportunities

In addition to the Mackenzie Delta gas, there are considerable natural gas reserves in the Sverdrup Basin that borders on Nunavut and the NWT in the high Arctic. While some investment remains dedicated to investigating the possibility of bringing this gas to market, the possibility of this occurring over the next 15 years is almost nil.

There are a few diamond exploration projects underway, but few are advanced enough to show development opportunities at this time. Current activity includes some high-resolution survey work on Banks Island, some sampling on Victoria Island and some early work south of Paulatuk.

The Mackenzie River Communities

There are no natural resource projects in the works at this time that would influence the communities along the Mackenzie River. Exploration is ongoing but much of this activity is either in the Mackenzie Mountain range or well east of the River. For this exploration, Norman Wells and Fort Simpson are the primary service centres, and this will not change. Despite the extensive exploration efforts, there have been no new discoveries in the past several years.

[42] Imperial Oil on behalf of the Mackenzie Pipeline Project proponents, News Release, March 12, 2007 (www.imperialoil.ca)

Discussion has continued regarding the construction of a bridge across the Mackenzie River at Fort Providence. However, recent information reveals the cost of that bridge has more than doubled since first announced.[43] While the territorial government seems committed to the project, it is not clear at this time whether it will go ahead. The project would have temporary influence on activity in Fort Providence and could mean some barge activity from Hay River during construction, but otherwise, would not have a long-term impact.

NUNAVIK

Overview

Geographically, Nunavik represents all land north of the 55th parallel in the province of Quebec. Nunavik shares many demographic and socio-economic similarities with Nunavut. The population is dominated by Inuit, with a non-Aboriginal population under 1,000 of the 10,800 residents in 2006. The population is young, and as in Nunavut, more than 50 per cent are under the age of 25.

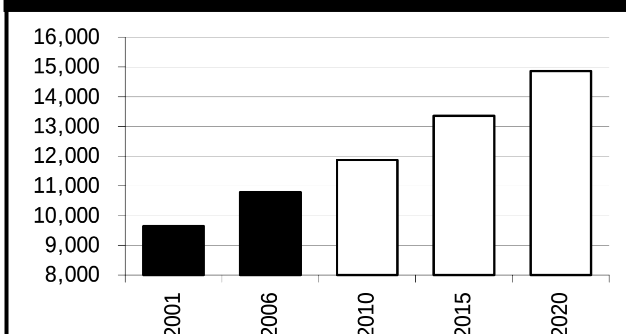
The economies are also similar. A large portion of productive activities take place in the non-wage economy, including hunting, trapping, fishing, sealing, and arts and crafts. Like Nunavut, the wage economy is growing through government, commercial fishing and sealing, tourism, construction and resource development.

Nunavik benefits from a strong central body. The Makivik Corporation operates for the betterment of both economic and social progress. Of relevance to shipping, it has initiated a community port programme that is financially supported by both the federal and provincial governments. There is currently no all-weather road link to Nunavik's fourteen communities.

Demographic Outlook

The population in Nunavik is expected to grow at a pace of 2.4 per cent over the next ten years, before slowing somewhat in the final few years of the CASA forecast period (see Chart 3.3-15). More detailed population projections are presented on the following page in Table 3.3-16.

Chart 3.3-15: Nunavik Population Projections



Source: Statistics Canada Demography Unit, Indian and Northern Affairs

All of this growth will be as a result of natural increase. As mentioned in the overview, much of Nunavik's population are under the age of 25. The *2001 Census* reported 40 per cent of the population at that time were under the age of 14, which makes Nunavik's population

[43] *Hansard*, Mr. David Ramsey (Kam Lake), NWT Legislative Assembly, 6th Session, Day 4, 15th Assembly. Page 90.

younger than that in Nunavut. But like Nunavut, Nunavik's own baby boomer generation will have a dramatic impact on the economic and social outlook of the region over the next 20 years as this cohort's influence on decision making increases.

Table 3.3-16: Nunavik Community Population Projections

	2001	2006	2010	2015	2020
Akulivik	472	507	558	628	699
Aupaluk	159	174	192	216	240
Ivujivik	298	349	384	432	481
Inukjuak	1,294	1,597	1,758	1,978	2,202
Kangirsuk	436	466	513	577	642
Kangirsualujjuaq	710	735	809	910	1,013
Kangirsujuaq	536	604	665	748	833
Kuujjuarapik	555	568	625	704	783
Kuujjuaq	1,932	2,132	2,347	2,641	2,939
Puvirnituq	1,287	1,457	1,604	1,805	2,009
Quaqtaq	305	315	347	390	434
Salluit	1,082	1,241	1,366	1,537	1,711
Tasiujaq	228	248	273	307	342
Umijaq	348	390	429	483	538
Total	9,642	10,783	11,871	13,356	14,866
(ave compound growth rate)		2.3%	2.4%	2.4%	2.2%

Source: Statistics Canada Demography Unit, Indian and Northern Affairs Canada

Nunavik's economic potential rests with Quebec support for resource development in the region. This will be slow to move north over the forecast period, partly because of the absence of road infrastructure, but it will certainly grow. Outside this, the opportunities that exist will not employ large numbers of Inuit. Therefore, the population projections that approach 15,000 by 2020 have to be considered the limit of the region's economic carrying capacity without additional resource development.

Governance in Nunavik

The changing governance of Nunavik has important implications for social and economic performance and potential. It is reviewed briefly in this section.

In 1975, Québec signed the James Bay and Northern Québec Agreement (JBNQA), which was the first of its kind in Canada. The JBNQA triggered the creation of several institutions. The mandate of the Makivik Corporation arises from the JBNQA and is to administer the compensation funds paid to the Inuit by the federal government. Makivik also has the mandate to represent the Inuit politically. The Kativik Regional Government (KRG) was also created out of the JBNQA and has administrative jurisdiction over the Nunavik territory. KRG has assumed responsibilities of many federal and provincial programs.

Nunavik is currently in final negotiations for an Agreement in Principle for self-government. These discussions were recently stalled as a result of the provincial election, but are expected to be resolved in the near future. In the meantime, the Minister of Indian and Northern Affairs Canada tabled the *Nunavik Inuit Land Claims Agreement* in the House of Commons on 28 March of this year. This should clear the way for greater economic prosperity in the future, with clarification given to issues of surface and sub-surface rights and land management.[44]

This transfer of authority will likely result in some initial economic growth, but as in Nunavut, it will be short-lived, after which economic progress will return to its former path. With that said, as with Nunavut, the long-term implications of this Agreement on socio-economic wellbeing should be very positive, since it will allow dedicated programming dollars reinforce the unique values of the region.

Socio-Economic Outlook

The greatest impact on socio-economic outcomes is a result of Makivik Corporation activities and investments, acting as the primary support mechanism for economic development in Nunavik. It has created several subsidiary companies, four of which are wholly owned[45]. Numerous joint ventures and shares in other companies exist, all of which operate in the Nunavik/Nunavut regions. All profits are used to support the socio-economic development of the region.

In 2002, the Quebec government, Makivik Corporation and the Kativik Regional Government signed a "Partnership Agreement on Economic and Community Development in Nunavik". The 25-year partnership agreement is focused on:

- Accelerating the development of the hydroelectric, mining and tourism potential
- Sharing the benefits of the economic development of Nunavik
- Favouring economic spin-offs for Nunavik Inuit
- Favouring a greater autonomy for Makivik and KRG and to provide them more responsibilities for the economic and community development of Nunavik Inuit
- Enhancing public services and infrastructure in Nunavik[46].

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44 Government of Canada, Press Release, *Canada's new Government Introduces the Nunavik Inuit Land Claims Agreement Act (March 28, 2007).*

45 Air Inuit, First Air, Nunavik Arctic Foods Inc. and Halutik Enterprises Inc. The latter company offers a diversified array of services including a fuel service, heavy equipment rentals, and gravel production.

46 Partnership Agreement on Economic and Community Development in Nunavik. April 9, 2002.

An existing agreement instructs Quebec to pay the Makivik Corporation 1¼ per cent of the total production value of any hydroelectric project in the region. Makivik agrees to use these payments for economic and community development and will decide the appropriate use and redistribution of the payments in consultation with the Landholding Corporation of the community affected by the hydroelectric project.

Natural Resource Opportunities

All mining activities in Nunavik fall under the environmental and social protection regimes of the JBNQA. Quebec agrees to facilitate the signing of agreements between Makivik and the mining company concerning remedial measures and monitoring, financial arrangements, employment and local contracts.

Raglan Mine

Since April 1998, Falconbridge has been operating the Raglan mine in northern Nunavik – the only mine currently operating in Nunavik. This nickel mine is located inland, 60 kilometres west of Kangiqsuuaq, and linked by an all-weather road to an airstrip and to the ship-loading facilities at Deception Bay, 100 kilometres north of the mine[47].

Falconbridge and Makivik entered into an Impact and Benefit Agreement (IBA) in 1995 which asserted that the two neighbouring villages will benefit from the project's economic spin-offs, with guaranteed contributions and operations profit-sharing payments over an 18-year period made into a trust fund. Over the initial five-year period of mine operations, Inuit participation fell short of expectations, as has the net benefit to socio-economic wellbeing.

Last summer, the mine proponents announced a major investment strategy to expand production capacity and access new reserves. This investment will amount to $590 million over several years, which should ensure the mine remains in production through the forecast period of this study. In addition to the infrastructure spending, Falconbridge has also commenced resource royalty payments to Makivik Corporation. The first cheque was received in April, 2006, worth $9.3 million.[48]

Hydro-Electric Projects (includes Cree communities in Quebec and Ontario)

It is common to associate James Bay and to some extent Hudson Bay with Hydro-Quebec's Le Grande mega-projects Phases I and II. There are hydro projects in Ontario and Manitoba that also affect littoral areas in James and Hudson Bay. The hydro projects have both positive and negative socio-economic impacts in Nunavik and the coastal Cree communities. They are raised in this review because they are affecting population and thus re-supply demand

[47] See Falconbridge Website www.falconbridge.com

[48] Falconbridge Corp., *Falconbridge Preparing to Invest Several Hundred Million Dollars in Infrastructure and Facilities at Raglan Nickel Mine in Nunavik*, Press Release, (August 9, 2006).

As mentioned, while Makivik have negotiated a royalty payment from existing power production, it has not fully endorsed the Great Whale project. Meanwhile, the Cree have generally opposed the hydro developments across the three provinces.
"In 2002, the Cree and the Government of Quebec sign the landmark Agreement Concerning a New Relationship, also known as Paix des Braves. Far more than an economic deal, this is seen as a "nation to nation" agreement. Paix des Braves allows for continued hydroelectric development in exchange for Cree employment in the hydroelectric industry and $3.5 billion in financing over 50 years. In Cree communities, the agreement means development through the expansion of infrastructure, including housing, community centres, health services and expanded opportunities in education[49]."

Most recently, the Cree in Quebec struck a deal with Hydro-Quebec on resource management and development that paved the way for the Eastmain 1-A project. The communities will receive positive economic spin-offs from this development as well as compensation for the project.

COASTAL CREE COMMUNITIES OF QUEBEC, ONTARIO & MANITOBA

Overview

The communities that stretch around the southern half of Hudson Bay are all home to northern Cree. They have been combined in this study only as a function of their influence on marine activity. Otherwise, these communities are somewhat diverse with respect to their economic, social and political development and potential.

These communities are generally larger than the Inuit communities in Nunavut and Nunavik, with only three of the twelve having populations under 1,000. Chisasibi is the largest of these with a population that exceeds 4,000. It is also the northern most Cree community with all-year road access.

As described earlier, the Cree communities are among the most impacted by the hydroelectric developments around James Bay and Hudson Bay, again, with Chisasibi being the centre of attention given its new location on the dammed Le Grande River[50].

Some of the communities within this grouping are relatively vibrant and growing, given the steady inflow of hydro dollars and those that have a role as regional centre to the others. Meanwhile other communities, like Kashechewan, have become better known for their failings and tragic stories of suicide.

By and large, the northern Cree are committed to traditional pursuits and a subsistence economy. However, similar to Inuit, they are becoming increasingly involved in

[49] Canadian Geographic, Diana Gee-Silverman, *A brief history of the Cree*, as found on Canadian Geographic's website (http://www.canadiangeographic.ca/magazine/ND05/indepth/history.asp) April, 2007.

[50] This community had to be moved from its original location on Fort George Island as a result of the hydro project.

industrial activities associated with resource development. These communities are also in various stages of land claim settlements and self-government negotiations.

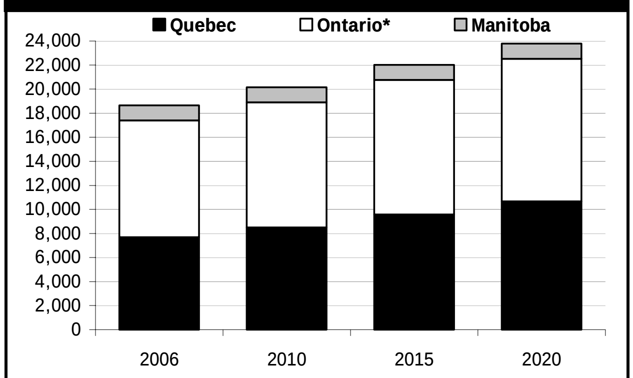
Demographic Outlook

The population projection for the Coastal Cree communities presents unique challenges. Most notable is the possible relocation of Kashechewan. This is an extremely timely issue. At the time of this report, the community had rejected offers by the Government of Canada to resettle to an area north of Timmons. Negotiations on a second option are underway. Whatever the final decision, we expect a major displacement of the Keshechewan First Nation members. But for the purpose of this study, we have no choice but to leave the community out of the population forecast.

The population of Keshechewan and its neighbouring Cree communities are very young with a history of high fertility rates. Thus, we can expect the natural rate of increase to add to the overall population, despite the poor socio-economic conditions.

We have assumed for this forecast that the few resource development activities taking place in the region will support some migration away from these isolated communities. But, in the case of Attawapiskat, their impact and benefit agreement could actually attract Band members back to the community. Overall, populations throughout Ontario's coastal Cree communities will grow at rates around 2 per cent for the first half of the forecast before declining to rates closer to 1 per cent in the final five years (see Chart 3.3-17). A more detailed forecast is provided in Table 3.3-18.

Chart 3.3-17: Coastal Cree Population Projections



* Ontario does not include Kashechewan

Source: Statistics Canada, INAC Indian Registry, Impact Economics

For the Cree communities in Quebec, their situation is somewhat different. They have benefited from a steadier stream of investments in their infrastructure and social wellbeing as a result of the hydro-projects on their land. The populations of all four communities showed healthy increases over the past five years. This growth should continue at a pace of 2.5 per cent over the first five years, falling slightly to 2.2 per cent by the end of the forecast period.

Churchill is the lone community in Manitoba that borders the Hudson Bay (it consists of a town and a neighbouring Indian Reserve). Little change is expected in either community over the CASA project timeline. The much talked about Port of Churchill, purchased for $1 by OmniTRAX over ten years ago, has not grown into the viable transportation link that some envisioned; as a result there is little in the way of economic activity or opportunity in the community. The population has actually been on the decline in recent years. The combination of port activity, some tourism, and government support should sustain the population that has remained. With that said, there are some who are looking seriously at the Churchill-Murmansk route as an alternative to shipping through the St Lawrence Seaway.

Table 3.3-18: Coastal Cree Communities Population Projections

(Quebec, Ontarion and Manitoba, including community of Churchill)

Quebec	2001	2006	2010	2015	2020
Waskaganish	1,699	1,864	2,055	2,316	2,582
Eastmain	613	650	717	808	901
Wemandji	1,095	1,215	1,339	1,510	1,683
Chisasibi	3,467	3,972	4,379	4,935	5,503
Total	6,874	7,701	8,490	9,569	10,669
(ave compound growth rate)		2.3%	2.5%	2.4%	2.2%
Ontario					
Attawapiskat	1,293	1,549	1,735	1,908	2,061
Fort Albany	-	1,805	1,986	2,144	2,316
Fort Severn	401	493	542	586	621
Kashechewan	-	1,900*	1,900*	1,900*	1,900*
Peawanuck	193	221	239	258	271
Moose Factory	-	3,626	3,862	4,171	4,400
Moosonee	1,916	2,006	2,046	2,128	2,181
Total	-	9,700	10,409	11,195	11,850
(ave compound growth rate)			1.8%	1.5%	1.1%
Manitoba					
Churchill (Reserve)	316	330	338	347	355
Churchill (town)	963	923	923	923	923
	1,279	1,253	1,261	1,270	1,278
(ave compound growth rate)		-0.4%	0.2%	0.1%	0.1%

* We cannot accurately forecast the population for Kashechewan because of the uncertainty surrounding its possible relocation. The total for the region therefore does not include this community.

Source: Statistics Canada Census, Indian and Northern Affairs Canada Indian Regristry, Impact Economics

Purportedly, it could shorten shipping time by some four days. However, for this proposal to move forward, Churchill would require significant additional port and rail investment. The proposal is reportedly being studied at present by both Canada and Russia; costs, cargoes and volume have not been determined. At this time the route is not a part of the CASA forecast[51], but should be monitored.

[51] Hon. Janis G Hanson, debates from the Senate (Hansard) 1st Session, 39th Parliament Vol 143, Issue 65, Thursday Feb 1st, 2007. www.parl.gc.ca/39/1/parlbus/chambus/senate/deb-e/

Resource Development

Besides the hydro-projects described earlier, there are a few resource projects worth noting that will affect the coastal Cree communities, though it is worth noting that none at this time would require Arctic marine transportation.

The newest development is DeBeers' *Victor Diamond Project* currently in construction phase with production expected in 2008. This deposit is located 90 km south of Attawapiskat and will be accessed via a winter road from the south and air service from Timmins, as well as several Cree communities. The Attawapiskat First Nation has signed an Impact and Benefit Agreement with DeBeers on employment, training, education, and compensation for social impacts.

The Victor discovery has set off further diamond exploration in the area, though there are no additional mine projects currently known. This exploration has stretched into Quebec and along the Hudson Bay coast.

Exploration in the northern Hudson Bay region has targeted gold, diamonds and uranium. The greatest interest is near the Eastmain River corridor where the primary target is gold. Goldcorp has the largest interest in the area. Again, depending on the location of any discovery, there exists an opportunity to build roads to most of these locations.

Socio-Economic Outlook to 2050

There is currently little research into the long-term socio-economic prospects of Canada's Arctic regions. Few demographic models extend forecasts beyond 20 years. Meanwhile, while there is evidence of mineral wealth throughout the north, especially for Nunavut, the numbers do not yet show these to be economically feasible. In Quebec and Ontario, there is potential for further energy generation and planning is currently at the political stage with relation building between proponents and Aboriginal community leaders. As would be expected, these two factors (demographic change and economic growth) remain the primary influences on shipping demand.

A typical approach to long-term modelling of this nature focuses on three variables: demographic projections, capital stock (investment projections) and technological change. For the communities being studied, establishing robust forecasts to 2050 for any of these three variables presents numerous challenges. They bring into question such things as sustainability of communities, reversal of current trends (especially in the case of demographics, which show positive growth but at a decreasing rate), and projecting technological change which would depend on unknown scientific and engineering discoveries, not to mention the success of adaptation strategies toward climate change.

The methodology in predicting technological change requires some additional explanation. Often, economists will study historical data to establish a baseline of information on demographics and capital stock. After combining the two to show past economic growth, the residual term becomes a proxy for past technological change.[52] In

[52] This is a simplification of the process involved. Further detail goes beyond the scope of this paper.

all cases these past trends are used to project economic growth into the future. All of these calculations depend on extensive and reliable data—something that does not exist for Canada's Arctic regions. Thus, any prediction of technological change would be entirely speculative, with no reference point.

In the absence of a model, and recognizing the difficulties in forecasting these variables, we can still speculate on demographic and investment changes given some knowledge of the socio-economic and political trends. This will provide a general direction for the socio-economic conditions across the Arctic region as a whole. In this brief subsection, we provide some of those insights.

Demographic Trends

The overriding trend in demographics throughout the Arctic appears to be a slowing in population growth. Eventually, fertility rates throughout all of Aboriginal Canada will gravitate toward the national average, which itself is declining.[53] As this occurs, the natural rate of change (births minus deaths) in Aboriginal populations will eventually decline.

At the moment, much of the discussions on Aboriginal populations in Canada's Arctic focus on the number or percentage of youth. By 2050, this large cohort will be approaching or will have surpassed 65 years of age and will be having significant impacts on things like health care and regional productivity in the same way the *baby boomer* generation is influencing socio-economic conditions in the south today.

While the general trend will be that of slowing growth, there will be exceptions. As in the south where there is a significant deruralization occurring, the same can be expected in the north. Capital cities and regional and economic centres will grow in population at the expense of smaller, more isolated communities through inter-regional migration. Communities like Iqaluit, Rankin Inlet, Baker Lake, Kugluktuk and Cambridge Bay will all likely grow at a stronger pace than smaller communities in the later years of the forecast period. The precise nature of this trend is not known, and there are no published reports from statistical agencies that would tell us which communities will become increasingly unsustainable through out-migration. We have to assume that the communities in decline would be equally distributed throughout the Arctic regions. Further, under the current political climate, it is not likely that government would remove its support for a community, and therefore we can assume that while some communities may become increasingly marginalized, they will not cease to exist—an important assumption for shipping demand.

The same holds true for regions other than Nunavut. For example, population movement between Inuvialuit communities is likely to remain in the direction of Inuvik; that is, it will grow at the expense of the four coastal communities. In Nunavik, the capital city of Kujjuaq will likely receive people from the smaller communities, especially in light of the recent land claim agreement that will expand the size of government, and so on. Of

[53] Fertility rates are available from Statistics Canada.

course, there will be slight variations, and major events like mine openings will alter this trend, at least temporarily.

There are other theories. An optimistic scenario for these smaller communities is that technology and even climate change will make them increasingly sustainable, allowing for such things as greater e-commerce, increased tourism, and the potential for new discoveries.

Another theory is that out-migration from the north to the south will not occur since there is little history of it. The next 40 years offers more than enough time to change this history. What's more, if the economy in the Arctic communities and regions cannot produce the number of jobs necessary to employ the population who are slowly becoming better educated, they may find work elsewhere. A labour shortage already exists in some sectors of Canada's economy and in some regions. Over the next 20 to 40 years, this could be enough to convince Inuit, Inuvialuit or Cree to relocate.

So, while we are relatively certain communities will not disappear, most evidence is pointing toward a difficult road ahead for the smaller, residential communities in the absence of any major economic investment. Meanwhile, the pressures on the larger centres will be of a physical nature, as they grow beyond the capacity of their infrastructure.

Investment Trends

Predicting changes in capital investment in Canada's Arctic communities over the longer term is more difficult than doing so for demographics. The reasons are twofold. First, there is no data on capital stock. And second, the current level of investments into some communities' municipal infrastructure is not keeping up with the growth in demand. For example, in Nunavut, there are components within general municipal infrastructure that are facing excessive pressures from the population and it appears the Government of Nunavut does not have the fiscal capacity to address them all. To assume that investments will keep up with the pace of demand over the next 40 years assumes that the governments will have the financial means of doing so. At the same time, to assume otherwise would suggest that eventually some communities' infrastructure will suffer catastrophic failure. It would not be prudent to predict such an outcome. Therefore, we must assume that over time funding to these regions will grow to a sustainable level.

Besides public infrastructure investments, we can consider private investment. In all four regions, this essentially means natural resource exploration and development and any related construction (such as transportation infrastructure). The potential of Canada's north in terms of natural resources is well documented, but to date development has been slow. Previously, this report has outlined which deposits were most likely to be developed from now until 2020. Beyond that date, the main factor to consider must be world demand and the availability of alternate and more accessible resources.

The significant industrial developments currently underway in China and India will eventually reach a more sustainable pace. The precise timing of this levelling off is not known. At that time, if there are no other countries entering into a similar industrialization phase, world demand for industrial inputs will level off and prices for raw material will fall. What this does to the feasibility of known and yet to be discovered deposits in the NWT, Nunavut, Nunavik, and throughout the Hudson Bay regions will depend on numerous factors, including the size of deposit, cost of access, and discoveries elsewhere in the world.

A prudent assumption is one that includes a continuation of the pace of development we have seen over the past ten years, and expect to see until 2020. In Nunavut, this means mines will continue to open at a pace similar to what is expected over the next ten years. Of note, the Mary River Iron Project is the only known deposit large enough to give it the potential of outliving the 2050 longer-term timeframe if world demand keeps the deposit financially viable, and the project can actually be implemented.

Northern Quebec and Ontario are more difficult to predict. There have been no major discoveries for some time outside the Victor diamond deposit that would otherwise suggest a strong growth in mining. However, improved transportation infrastructure into these regions could open them up to greater exploration. It would not seem prudent to suggest the Raglan and Victor mines will be the only two ever developed in such a vast geographic area. Therefore, a longer-term outlook might assume further discoveries between now and 2050. As noted earlier in this section, potential developments near the Coastal Cree communities will not necessarily impact shipping due to the existence of road and rail infrastructure.

Summary

Understanding the socio-economic conditions present in the four Arctic regions being considered as part of the CASA is important when related to marine activity. Health, education and even politics of the communities will have a bearing on economic growth and demographic change. Population has a direct impact on marine activity through demand for re-supply. Natural resource development, which is the primary economic driver in all four regions (together with public administration) will also influence shipping demand through their life span from exploration to reclamation.

Natural resource development is discussed in greater detail in Annex 10.4, together with known shipping implications in Chapter 6. Table 3.3-19 provides a summary of population forecasts, and these are used in Chapter 6 as a basis for re-supply estimates.

Table 3.3 - 19: Summary of Population

(by region)	2001	2006	2010f	2015f	2020f
Nunavut [1]	26,745	29,474	33,096	36,231	39,448
NWT Coastal Communities [2]	1,859	1,866	1,886	1,896	1,893
Mackenzie River Communities [2]	8,187	8,303	9,193	9,501	9,918
Nunavik	9,642	10,783	11,871	13,356	14,866
Coastal Cree Communities [3]	-	18,654	20,160	22,033	23,797
Total	-	69,080	76,206	83,017	89,921

1) incorporates *2006 Census*, 2) Census data is not used because of problems with reporting, 3) does not include Kashetchewan

Sources: Statistics Canada Demography Unit & *2006 Census*, Nunavut and NWT Bureau of Statistics, Indian Registry, Impact Economics

3.4 Arctic Navigation: Commercial & Regulatory Issues

i) Commercial Issues

Navigation in ice-infested waters is recognized by the marine industry as more hazardous than in temperate waters. The primary adjudicators of this risk have, traditionally, been marine underwriters who determine the areas of the world's oceans that are "within warranty limits". This means that the ship is allowed to trade to all such areas within the terms of its hull and machinery policy at the agreed premium.

Certain areas of the world may be considered to be outside warranty limits, either at all times of the year or for certain periods of the year. The Gulf of St. Lawrence is seasonally outside warranty limits as is the Baltic. All areas north of 60ºN have generally been considered outside such limits at all times, although geographic regions, limits and times may differ depending on the underwriter.

Where a vessel is chartered for a particular voyage, or for a period of time, the language will contain a statement regarding trade within Institute Warranty Limits. If operation is contemplated into areas where ice is expected during the voyage or period of charter, then the charterer will be required to pay the shipowner an additional premium (AP) to meet the underwriter's expectation of risk to the ship. These premiums are not standard and may vary considerably between different underwriters for the same voyage[54]. The charter party will also contain an ice clause, which may be along the lines of the following:

> *The vessel not to be ordered to nor bound to enter any ice-bound place or any place where lights, lightships, marks and buoys are or are likely to be withdrawn by reason of ice on the Vessel's arrival or where there is risk that ordinarily the Vessel will not be able on account of ice to reach the place or get out after having completed loading or discharging. The Vessel not to be obliged to force ice, nor to follow ice-breakers when inwards bound. If on account of ice the Master considers it dangerous to remain at the loading or discharging place for fear of the Vessel being frozen in and/or damaged, he has liberty to sail to a convenient open place and await the Charterer's fresh instructions. Detention through any of above causes to be for the Charterer's account.*[55]

Risk of incident is often perceived rather than actual, and formal risk assessment[56] of Canadian Arctic navigation based on Transportation Safety Board data for 1990 through 1996 demonstrated that seasonal open water navigation in the region was less risky than winter navigation in the Gulf of St. Lawrence, yet there was a considerable difference in approach to and level of AP's.

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[54] Mariport research for the Canadian Ice Service in 2000.

[55] *Shipbroking & Chartering Practice* Second Edition. Lloyd's of London Press 1984.

[56] *Breaking Institute Warranty Limits – the Canadian Experience* Christopher Wright, The Mariport Group Ltd, CBMU semi-annual meeting 20 May 1999.

Generally, shipowners will not build additional ice capability into their vessels unless there is a perception of a trading opportunity that will give an enhanced charter rate. In the past, construction of vessels with ice capability (see Annex 10.2) has been limited mainly to vessels of nominal ice strengthening because such attributes could be achieved at low cost. Achieving higher levels, such as 1A & 1A Super (relative to Finnish/Swedish Ice Class Rules) costs 20-30% more than an open water vessel and demand for such capability has been very limited. Recent developments in Russian oil and gas have persuaded more owners[57] to build to higher capabilities, but these are primarily tankers. The market for highly ice capable vessels remains thin and there is even less availability for dry cargo vessels with good ice characteristics. Consequently, chartering market vessels for Canadian Arctic oil resource development may be feasible, given that the demand is for summer open water trade as apposed to the primary market for these vessels which is winter Baltic/North Europe. Rates would be at a premium on market plus AP's.

The situation for dry cargo vessels is much more restricted and FedNav, who have been a major Canadian Arctic bulk carrier supplier, sold the Federal Baffin and Federal Franklin[58] when the Arctic mines at Polaris and Nanisivik shut down. On delivery in 1995 these were the highest ice class bulk carriers available. Problems with regard to dry cargo vessel availability for even seasonal Canadian Arctic trading led the federal government to build the mv Arctic in 1976 to enable concentrates to be shipped to market. The lack of ice capable ships continues, and both Wolfden with their High Lake base metal mine and Mary River iron ore mine may need to build their own vessels unless shipowners can be persuaded to build adequate vessels against a long term contract, offering a charter rate that can be accommodated relative to mine fob[59] costs and market cif[60] expectations.

Reference should be made to the route choice model in section 7.2 of the report which outlines the factors that need to be considered in relation to Arctic Navigation. While this section focuses on the North West Passage (NWP), the principals relative to voyage planning are equally appropriate to resource development as to transit planning. As vessels for these and future resource operations are export oriented, Canadian regulatory requirements relative to the coasting trade have little impact, although they may result in lost opportunities for added value within Canada.

The situation is very different for vessels which service Arctic communities and may also carry logistics materials for Arctic mines and oil and gas operations. Such vessels are small (under 20,000dwt), need good ice capability, have extensive cargo handling gear

[57] Lloyds List reported on January 18th 2007 that there were 83 large ice strengthened tankers in service and that 14 were on order. Areas of employment were primarily for oil shipment out of Primorsk. Quebec employed five of these tankers on a seasonal basis and others would be needed for Sakhalin. The degree of ice strengthening was not given in the article.

[58] Despite its ice capability, the ship was heavily damaged when beset in pressure ice off Navy Board Inlet in October 1995, together with the *Louis St. Laurent*.

[59] Free on Board

[60] Cost, insurance and freight

and carry lighterage equipment (barges, tugs, fork lifts etc). They tend to be relatively more costly than vessels that might be designed to the needs of resource product shipment and have to meet all Canadian regulatory requirements and costs. This makes goods delivery into the Arctic very expensive and is an added factor in the feasibility of Arctic resource development[61].

ii) Regulatory Issues

The primary regulatory instrument relative to Arctic Navigation is the Arctic Shipping Pollution Prevention Regulations (ASPPR) which embodied, inter alia, the Zone Date System. This provides, based on historic ice data, a series of 16 zones with entry/departure dates for vessels of particular ice capability. Section 7.4 of the report shows the zones and access with reference to a class 1A vessel. This approach has worked well during a period of relatively stable and predictable ice conditions, and has become integrated into commercial planning relative to Canadian Arctic Navigation.

In recognition of the limits of firm entry and exit dates and changing ice conditions, Transport Canada Arctic Ship Safety developed a concept to permit navigation relative to the ice capability of the vessel with and without escort, and perceived ice conditions. The Arctic Ice Regime Shipping System (AIRSS) allows flexibility in navigation planning and has been used successfully in permitting access to Kugaaruk by a 1A Super tanker when the Zone Date System would have required an Arctic Class 2 vessel. While AIRSS is a valuable tool and has improved Arctic access, industry has had some reservations because it does not include any consideration of speed, which is left to the discretion of the bridge team. Speed is a major factor in ship/ice interaction as the photograph below shows.

Under global climate change, and with the availability of satellite ice imagery, the flexibility offered by AIRSS will enable shippers to take advantage of navigation opportunities, while still being guided by the zone date system for seasonal access.

Other initiatives by Transport Canada that have materially improved safety in the Arctic and reduced pollution have related to tanker loading guidelines for vessels that are not double hulled, oil transfer guidelines from ship to shore and passenger vessel guidelines.

A major Canadian initiative was the Polar Code which was developed with other national administrations having an interest in Arctic and Antarctic navigation. As the Guidelines for Ships Operating in Arctic Ice-Covered Waters the document was examined in IMO technical committees and recommended for adoption in 2002[62].

In evaluating the cost/benefit relationship of the Polar Code[63] it was found that the most effective preventative technique for foreign flag vessels was to engage the services of a

61 Polaris and Nanisivik mitigated their logistics costs by sourcing much of their needs offshore, and shipping on the carriers that hauled concentrates outbound.

62 www.tc.gc.ca/marine safety/CES/Arctic/menu

63 *Formal Safety Assessment of the Polar Code*, Consulting and Audit Canada March 1999

qualified ice navigator. Several incidents, which resulted in large insurance claims, such as the Reduta Ordona and the loss of the Finn Polaris in 1991 could probably have been prevented through the availability of an experienced navigator for Arctic waters.

The foregoing aspects of Canadian regulation affect both foreign and domestic flag vessels operating in Arctic waters. As long as cargo is shipped to or from a non-Canadian port, then the Coasting Trade Act (CTA) does not apply. Reference is made in section 5.2 to the impact of the CTA on cruise tourism with foreign flag vessels. For cargo vessels operating on occasional voyages within Canada, transportation is permitted if Canadian flag vessels are not available and on payment of the appropriate duty of 1/120th per month of the duty on the fair market value of the vessel[64]. For direct importation of non-NAFTA vessels, the duty is set at 25%. NAFTA vessels may be imported without payment of duty. Canada also has a requirement relating to construction and safety standards that require all imported vessels to be upgraded to current international and structural safety equipment standards. This added burden is contrary to the practice of most national regulators, in that when a ship is sold it is permitted to continue in trade under its original MARPOL and SOLAS certificates.

As ships for Arctic trade are unlikely to be available from NAFTA sources, the combination of duty and upgrades presents a significant financial burden that is reflected in the rates billed for transportation services[65].

Canadian crewing regulations also present a major additional cost to domestic shipowners. The Canada Shipping Act crewing regulations have complex, prescriptive rules that materially disadvantage Canadian owners, leading to higher operating costs. Crewing requirements are generally higher than for comparable ships under US and North European flags.

The application of user fees such as Marine Navigation Services Fees, dredging fees and ice breaking fees will not have a significant impact on foreign flag vessels operating into the Arctic, but they do impact re-supply vessels operating to/from southern Canada, increasing their costs.

iii) Sovereignty

Canada's sovereignty of Arctic waters has been an ongoing issue, not only relative to the NWP and vessel transits between the Atlantic and Pacific, but also with regard to making the NORDREG arctic reporting system compulsory. Issues over sovereignty go to the heart of Canada's stewardship of Arctic waters, and its ability to ensure that the environment is respected and protected. Marine safety also needs situational awareness of ships in order to adequately respond in emergency situations. Thus reporting to

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64 For a review of impediments see Marine Transportation in Ontario, A study for the Ontario Marine Transportation Forum and the Ontario Ministry of Transportation. The Mariport Group Ltd. December 2006. see http://www.omtf.org/subfiles/mariport_study.pdf

65 The Excise Offshore Application Act of 1983 permitted vessels to be imported into Arctic service without duty or upgrades. If they operated in Arctic service for five years they were grandfathered into Canadian flag.

NORDREG should be seen as a marine safety issue, rather than one of sovereignty assertion.

iv) Charts and Navaids

Chapter 9 of the report discusses problems associated with adequate charts in Arctic waters. Funding for adequate charting of Arctic to modern standards is sadly lacking. This affects safe navigation for community re-supply, resource development, including fisheries. Undertaking a comprehensive and long term programme can be considered as an essential component of sovereignty assertion.

v) Ice Breaking Services

Canada's ability to support any shipping activity in its Arctic waters, whether it is community re-supply, resource development or transit assistance is compromised because of lack of funding for ice breaking services. Operational funding shortfalls affect seasonal deployment and may prevent shippers taking advantage of AIRSS, if the transit needs ice breaker support. Capital resources have not been available to update the elderly and inefficient fleet of ice breakers on which summer navigation in the Arctic, and winter navigation in the Gulf of St Lawrence depends. Potential resource and project cargo activity, particularly in the western Arctic may not be supportable with the current fleet, and its mission capabilities.

vi) Summary

The Arctic suffers from major commercial cost barriers that are inherent with operation in ice-infested waters and may well affect the feasibility of a project because of the lack of market access to suitable ships. The added cost and/or commitments to third parties to provide transportation could act as a major barrier to resource development, hen the promoter needs to concentrate capital resources on mine development.

Canadian regulatory initiatives in relation to the Arctic have been successful and delivered a high degree of safety and environmental protection. However, marine regulations not specifically associated with the arctic result in significantly higher costs and do not necessarily lead to greater marine safety. The debate on sovereignty has also limited the effectiveness of the NORDREG traffic reporting system.

Tools, such as AIRSS, may permit more flexibility in terms of regional access, particularly if the open water season is extended through global climate change. However, as Section 3.2 of the report has demonstrated, there may considerable variability in ice conditions and climate change may lead to more multi year ice in areas that previously had been relatively clear of such hazards. Season length and accessibility are critical issues for commercial ventures that need to minimise risk.

Issues such as adequate and timely charting and availability of ice breaker support for both resource development and re-supply activities affect reliability for marine delivery and impact project feasibility. These support systems all need to be upgraded from current levels.

In the 1970’s and 80’s the Canadian federal government took steps to overcome some of the barriers at that time (see Annex 10.2). If Canada’s Arctic is to develop over the period to 2020 and beyond, then recognition of the unique cost and regulatory barriers that affect development is needed. Regulatory barriers that impose added costs without compensatory benefit need to be evaluated with a view to mitigating their impact. Such actions, coupled with federal/territorial risk sharing on Arctic resource development could bring major socio-economic benefits to the region and lead to more ventures than are discussed in Chapter 6 being implemented.

4. ARCTIC SHIPPING HISTORIC CONTEXT

4.1 Methodology & Background

This section draws on the collective knowledge of the team as well as Mariport's archived material on development in the Arctic. As the history of the Arctic in not a major focus of the report, in-depth research has not been undertaken, but the team is confident that the section offers a comprehensive overview.

As a background to shipping activities in the Arctic, an abbreviated time line is given below.

1867	Creation of the Dominion of Canada on 1st July following approval of the British North American Act on 29th March.
1870	Rupert's Land (then owned by the Hudson Bay Company) and the North-Western Territory became part of Canada as the Northwest Territories on 15th July. At the same time, Manitoba is separated from Rupert's Land as a province.
1876	The District of Keewatin (now Kivalliq) is formed as part of the Northwest Territories.
1880	Britain cedes the Arctic Islands to Canada.
1889	Ontario is enlarged to encompass Lake of the Woods and north of the Albany River (the Hudson Bay shore).
1898, 1901	The Yukon Territory is separated from the Northwest Territories on 13th June 1898 and boundaries are adjusted to those of today in 1901.
1904/05	An Arctic port for Canada is investigated on the shore of Hudson Bay.
1909/10	Port Nelson is recommended as a superior location to Churchill and rail line and terminal development commenced in 1910.
1917	Construction is stopped because of concerns relative to Port Nelson[66].
1927	Construction recommenced, but with Churchill as the terminus.
1931	Construction of Churchill completed and first wheat shipments made[67].
1954	DEW Line commences construction, roughly along the 69th parallel.
1957	DEW Line completed 31st July. Two mid-Canada line sites also had a marine location, Winisk (ON) and Kuujjuarapik (QC).
1959	Canadian Coast Guard takes over administration of the annual sealift.

[66] The source of the information does not go into detail on the reason, but it appears to be connected with ship approaches and cost of constructing a port.

[67] To Britain, which remained the focus of grain shipping through Churchill into the 1970's

1985	North Warning System introduced, with 21 of DEW Line stations decommissioned. Increased automation installed in all stations to reduce manning.
1989	Quebec takes over their regional sealift from the Canadian Coast Guard.
1999	Nunavut created.
2000	Nunavut takes over their sealift administration from CCG.

4.2 Community Re-Supply

Originally, Sealift was the annual call by the Hudson Bay re-supply boat and most communities would see, at best, one visit per season. Some did not receive any calls if conditions were not favourable, and oil was not a part of the supply, except boxed kerosene for lamps. Hudson Bay owned their own ships, and the last one, the *Nascopie*, was wrecked off Cape Dorset in 1947. This situation changed commencing in 1947 with the construction of the Mid Canada monitoring stations and escalated in 1954 with the construction of the DEW Line. Construction demanded a major sealift into sites across the Arctic, including fuel for generators and thus bulk oil delivery was also commenced. Crosbie Shipping at that time managed operations, and up to 50 vessels were under charter some seasons. At this time the economic foundation of many Inuit communities changed for the worse, with the collapse of the white fox market, communities requiring federal government intervention to survive.

The DEW Line activity segued into a combination defence and community re-supply, particularly as some stations were (and still are) close to a community. The CCG sealift commenced in 1959 and served both the Eastern Arctic and Northern Quebec (Nunavik) with dry cargo and oil. Chimo Shipping, a Crosbie subsidiary, took over responsibility from Hudson Bay re-supply in the early 1970’s, and was the major shipping company involved.

The Kivalliq was served out of Montreal by Chimo Shipping for dry cargo until 1975 when the federal government mandated a change in re-supply base to Churchill. NTCL was selected to set up an operation with four barges and a single tug, the *Keewatin*. These were, like their barges on the Mackenzie River, bulk oil (in the hull) and dry cargo on deck. As a regulated common carrier, they provided a tariff that was reviewed and approved by the federal government. In 1989 the Quebec government took over contractual authority for Nunavik, and contracts were then let to Quebec companies.

The Western Arctic had been served down the Mackenzie by the Hudson Bay Company as a part of their interest in the north. These services were taken over by commercial tug and barge carriers in the 1930’s. The main carrier was NTCL, although during the peak oil exploration years others, such as ATL (a FedNav subsidiary), were also in operation. Cooper Barging was also a regulated carrier with a smaller operation on the Liard and Mackenzie Rivers. NTCL and Cooper continue in service today, and have been joined by a third carrier, Horizon North Logistics, which has operations based in Tuktoyaktuk

In managing the Eastern Arctic Sealift, CCG divided the Eastern Arctic (except the Kivalliq) into five regions, and Montreal shipping companies bid on each zone, or a combination of zones. Contracts of carriage were for one year only until the late 1990s, when they were let for two years at a time. The original companies were:

- Desgagnes
- Logistec
- Crosbie
- FedNav.

FedNav sold their vessel to Desgagnes in 1991 with a charter back at an agreed rate for the Arctic season. When the agreement period terminated, Desgagnes reportedly doubled the charter rate and squeezed FedNav out of the Eastern Arctic in 1994.

Transport Igloolik (Northern Stores) came into community re-supply with the arrival of the mv *Aivik* in 1990. Previously the Northern Stores boat (successor to the Hudson Bay Company in 1987) offered service on a space available basis only.

Traditionally, all cargo was moved out of Montreal, but a combination of high costs, stevedore work practices and a high incidence of dockside damage prior to goods being loaded persuaded the main carriers to look elsewhere. Desgagnes moved in 1995 to Côte Ste Catharine, two locks and 12 miles above Montreal. Logistec followed suit a few years later, and moved to Valleyfield, four locks and 38 miles above Montreal.

Rates were relatively high because no single carrier had a large volume. Desgagnes - and to a limited extent Logistec - had business in Nunavik which helped sustain their operations. Other carriers, except Igloolik, and Crosbie, had to depend solely on Nunavut business.

However, all government and contractor sealift cargoes were booked through CCG's central office which, in later years, charged an administration fee. When started it was set at 7%, but was later raised to 8%. Private shippers could (and did) book directly with the carriers serving their community and paid the sealift rate, but not the surcharge. As a result, the bulk of dry cargo was handled privately and the Sealift reports by CCG only covered a fraction of actual shipments, even though CCG provided a superior claims service.

In the run up to creation of Nunavut, Desgagnes came to an agreement with the Co-ops in Nunavut regarding a joint shipping activity, and this became Nunavut Sealink and Supply; Logistec and Igloolik joined forces as Nunavut Eastern Arctic Shipping, while Crosbie created a regional Nunavut shipping company, Nunavut Ocean Transport (NOT), based in Pangnirtung.

NTCL at that time owned Nortran, a packaging operation for the Eastern Arctic and furtherance of goods out of the west. When Nunavut bid the sealift in 2001, Nortran and Desgagnes joined forces as the N^3 Alliance and won all of the Eastern Arctic delivery at prices that significantly undercut the old CCG rates. NOT was unsuccessful, and stayed in operation only to serve their longstanding customer in Nanisivik. NOT has since ceased operations and disposed of its equipment.

Bidding the Eastern Arctic (except the Kivalliq) to a single carrier was a recommendation in the Nunavut Transportation Strategy[68] as a means of increasing volume with a view to achieving cost reduction. However, in the take over of re-supply activity by Nunavut from CCG, many of the services provided by CCG were abandoned, without any attempt to replace them. A good example was the beach master, who prepared the beaches each season and managed the transfer of cargo from ship to shore. Also, the knowledge and experience built up by the CCG central booking office was lost. Transfer of booking responsibility to the shipping companies lead to considerable teething troubles with the N^3 Alliance operation. The learning process was just about completed when Nunavut re-bid dry cargo and split the Eastern Arctic up again into a number of regions.

While the CCG had managed oil deliveries as well as dry cargo, prices charged by the Montreal based tanker companies for Arctic delivery became very high. In 1993, GNWT determined to bid the Eastern Arctic oil re-supply internationally. Excluded from the process were Iqaluit and Resolute, which were under contract to Shell until 1996. Also excluded were the Kivalliq, because of preferred carrier status conferred on NTCL, and the Kitikmeot region, because of its remoteness from tanker accessible refineries. The initial contract was won by Petroles Norcan a Canadian entity owned by Glencore, a major international commodity trader. The company used non-Canadian tankers to deliver oil from the USA and Europe. The result was a significant reduction in costs to the Territory. In 1996, the contract was re-bid, and NTCL won the award, continuing the approach of using high quality offshore tankers to deliver the oil. NTCL won a second three-year contract that took supply through to 2002. NTCL owned no tankers, and their model had been to charter-in vessels to move offshore oil that they sourced.

In 2002, Nunavut re-bid oil re-supply for the Eastern Arctic, including the Kivalliq (the Kitikmeot was again excluded). The oil was also to be sourced from Canada in a separate contract. This process overturned offshore sourcing that had been commenced in 1993 where the operator was responsible for both purchase and transportation. The oil carried by NTCL out of Churchill for this region cross-subsidised the deck cargo, helping keep these costs down. They were unable to match the freight rates bid by tanker operators, and were forced out of the Kivalliq business. Dry cargo reverted to conventional vessels operating out of Montreal, overturning 30 years of supplier contact developed within western Canada.

The new oil supply contract went to Woodward's[69], who already owned some small tankers, and acquired a 30-year old Finnish tanker that they re-flagged into Canada for the contract. They have since acquired another small tanker for Arctic service.

68 Written by LPS Avia and Mariport for the Government of Nunavut in 2000 and delivered in 2001

69 Woodward's are a Goose Bay NL based company that has long held the oil supply business for the NATO base in Goose Bay, as well as other contracts in Labrador.

Petroleum products service into Nunavik has long been the preserve of Petronav, a Desgagnes subsidiary. Service to the Cree communities of Hudson Bay uses bulk/deck barges in a manner similar to service by NTCL to Mackenzie and the Western Arctic.

4.3 Cruise Tourism

Arctic cruising has a long history, although more in the European than Canadian Arctic regions. The first European cruises to the Arctic were to the Svalbard Islands off Norway in the 1890’s. The first Canadian Arctic cruise season was not until 1983, when Travel Dynamics, a US cruise operator, took their ship the *Illyria* north of 60^o. The first Northwest Passage by a cruise ship was reportedly in 1984.

4.4 Fisheries

Until recently there was little by way of a formal Arctic fishery. Licences were sold to Newfoundland and offshore companies. Vessels fished offshore and were supported at sea for catch transfer and re-fuelling. Monitoring of shipping activity was difficult as boats often did not report to NORDREG and there was little oversight by federal or territorial authorities.

Fishing was largely a subsistence activity by the community, operating from minimal harbour facilities or off a beach. Consumption and sales were essentially local, although some packing companies have developed in recent years and Makivik Corporation had an interest in Seaku Fisheries and Unaaq Fisheries. These companies do provide some local employment, but the fishery input to them is relatively small.

4.5 Resources

The following discussions are oriented towards operations that have a shipping impact. Other operations existed in the Arctic in the past, but were essentially land locked.

i) Minerals

The first example of mineral exploration in the Arctic was Martin Frobisher’s attempt to prove a gold mine existed on Baffin Island. The first samples were returned to England in 1576 as a by-product of a trip to the Arctic to seek a route to Asia. He returned in 1577, taking 1,200 tons of rock back to England, although there was no gold in the rock and the rock was later determined to be iron pyrite, or fool’s gold.

Very little activity occurred over the ensuing centuries; expeditions were entirely focused on the Northwest Passage, and for their part, the Hudson Bay Company concentrated on the fur trade. It was not until 1955 that another mineral operation commenced and this was the North Rankin Nickel that built a mine and concentrator at Rankin Inlet, shipping concentrates starting in 1957. The mine was based on a nickel/copper deposit found in 1928, but the high prices for nickel created by the Korean War dropped off and the mine closed in 1962. The storage shed on the bluff above Johnson Cove is still used today as a warehouse.

Exploration in the Arctic was ongoing and the massive deposit that became the Polaris Mine on Little Cornwallis Island was found by oil and gas prospecting crews in 1960. Delineation of the mine was undertaken in 1973; design and commercial arrangements for development were completed by 1979. Construction commenced in 1980, with the bulk of the processing plant and fuel storage prefabricated on a 122m x 30m double-hulled barge that was towed north in 1981, and the first shipment made on the mv *Arctic* in 1982. Concentrate, shipped to world markets, contained zinc and lead and moved at about 200-250,000 tonnes pa. The last season saw 196,000 tonnes shipped. Inbound logistics and fuel were handled by the ocean-going ships that carried the concentrates, mainly the *Arctic*. The mine shipped its last concentrate cargoes during the 2002 season and de-commissioning of the site was completed in 2004.

An important aspect of the operation, and one which made the mine feasible, was a unique tailings disposal operation that utilized the meromictic Garrow Lake, about 4km from the mine. The lake is permanently stratified, both chemically and thermally, into three layers. The lowest layer is hypersaline and devoid of aquatic life, and this is where the tailings were pumped.

The other major mine in Nunavut was the Nanisivik Mine[70]. The deposit was mapped by the Geologic Survey of Canada in 1954, exploration commencing in 1957. However it was not until 1972 that active development of the mine commenced and it was opened in 1976. Public Works and Services built the dock for the mine and the operator paid port dues, charges and wharfage on concentrates shipped across the dock. While some re-supply materials were brought in on bulk carriers that handled outbound cargo, Crosbie Shipping, later Nunavut Ocean Transport, had a long-term relationship to move goods in from Montreal.

The mine produced zinc, lead and silver, typically shipping 80-100,000 tonnes pa. The original ore deposit was expected to be worked out by 1988, but a combination of ongoing exploration and healthy zinc prices meant that the mine could continue in operation. The mine closed in 2002, some four years before its planned shut down due to working out of some of the ore body. As with the Polaris Mine, the reason was international metal prices which, for the Nanisivik operation, had fallen to levels below the cost of production. The mine's milling machinery, power operators, conveyors, storage buildings and ship loader have been acquired by Wolfden Resources for installation at Gray's Bay. Shipment via the Northwest Passage is expected in the 2007 or 2008 season.

Another mine that had a relatively short history was the AsbestosCorp Mine in Nunavik. This company shipped 250,000tpa asbestos ore to Germany (Nordenhamn) for processing from 1972 until the market for asbestos collapsed in the 1980's due to health concerns. The mine shut down in 1985.

[70] The federal government had an 18% equity stake in the mine, possibly represented by the dock, which was built by Public Works Canada.

ii) Oil and Gas

The Arctic is said to hold 25% of the world's remaining oil and gas resources (USGS, 2000). The Canadian Arctic holds a significant portion of remaining Canadian reserves which are estimated to total 180 billion barrels of oil (second only to Saudi Arabia), and 594 trillion cubic feet (Tcf) of natural gas[71].

The oil and gas resource is distributed over a series of sedimentary basins that extend throughout the Arctic Islands (see Figure 4.5(ii)-1).

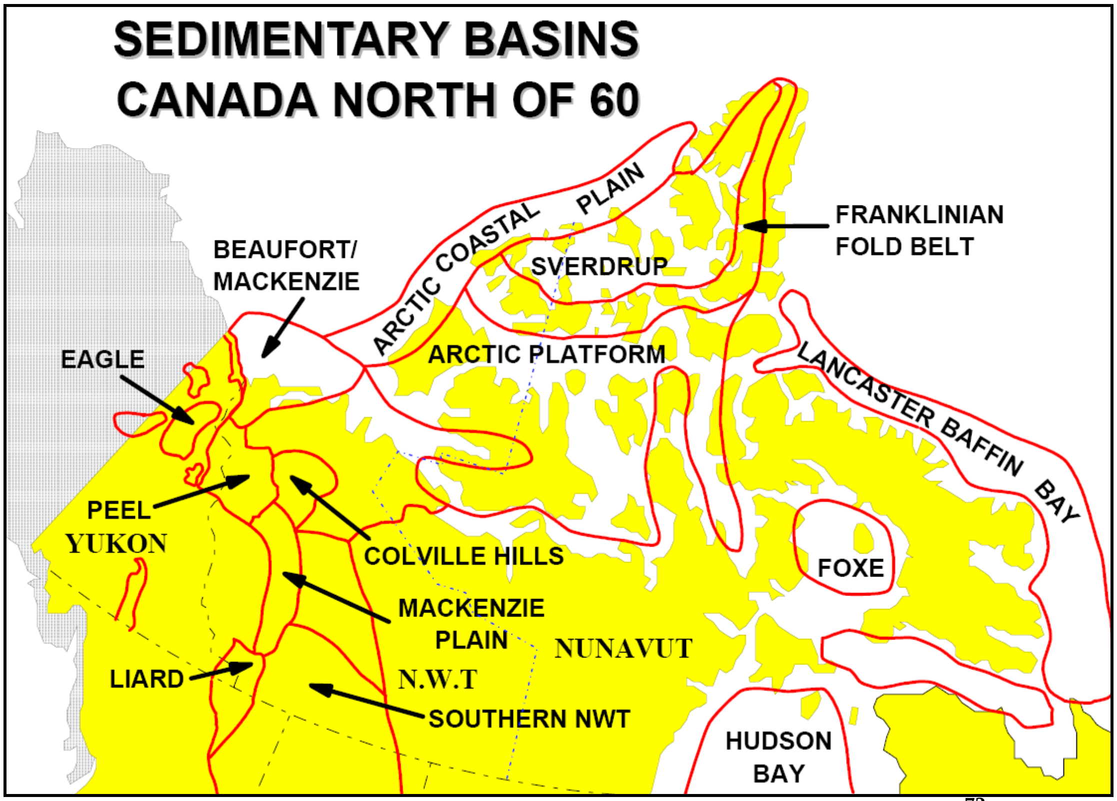


Figure 4.5(ii)-1 Sedimentary Basins in Canada North of 60°N[72]

While production of oil from the Arctic Islands, Beaufort Sea and Mackenzie Delta has historically been quite low, Canada's north possesses an estimated 33 percent of Canada's remaining conventionally recoverable resources of natural gas and 25 percent of the remaining recoverable light crude oil[73]. The discovered resource of the Arctic basins approaches 31 Tcf of gas and 1.6 billion barrels of oil[74] (see Table 4.5(ii).1).

[71] Government of Canada, 2007; Natural Resources Canada, 2006

[72] Drummond, 2005, p. 2

[73] Center for Energy, 2007; Minister of Indian Affairs and Northern Development, 2006

[74] Drummond, 2005; Indian and Northern Affairs Canada, 2006

Region	Crude Oil 10^6 m³	Million barrels	Natural gas 10^9 m³	Trillion cubic feet
Northwest Territories	70.5	(443)	178.3	(6.3)
Nunavut	0.9	(6)	190.7	(6.7)
Arctic Offshore	193.0	(1214)	506.5	(17.9)
Total	264.4	(1663)	875.5	(30.9)

Compiled and integrated from several published sources which may underestimate or overestimate actual field resources

Table 4.5(ii)-1 Discovered Resource Inventory[75]

The potential for resource extraction (ultimate recoverable resource) in the area is thought to be approximately 14.7 billion barrels of oil and approximately 433 trillion cubic feet for gas[76].

Historic Oil and Gas Activity

Oil and gas activity in the Arctic began in 1955 under the auspices of the Geologic Survey of Canada with Project Franklin that studied Arctic geology. The oil industry in Canada applied for exploration permits in 1959, at a time when there was no regulatory process to approve them. The Federal government approved permits in 1960, and the first well was drilled by Dome on Melville Island over the winter of 1961/62. Panarctic Oils was formed in 1968 as a joint venture between the federal government and industry, with the government holding the majority shareholding. Drilling in 1969 discovered the massive Drake gas field[77]. The Arctic continues to be an under-explored region for hydrocarbons, with about 1,000 wells drilled to Alberta's 150,000.

Beaufort Sea

In the early 1970s, exploration moved from the Mackenzie Delta to the shallow waters of the Beaufort Sea. As operations moved further out into the Beaufort where water depths reached 15 metres or more, gravel berm construction became too expensive and time consuming. The primary companies involved in offshore exploration, Dome Petroleum, Gulf Canada and Imperial Oil, all developed other methods including sand and gravel-filled caissons, steel caissons with permanent rig and camp infrastructures, barges and drilling ships. Dome converted an oil tanker to a permanent drilling caisson and then designed a submersible barge called the Mat on which to rest the Single Steel Drilling Caisson (SSDC). Companies also designed and built an innovative fleet of icebreakers and supply ships to support the offshore operations (see Annex 10.2). Nearly 200

75 Indian and Northern Affairs Canada, 2006, p. 9

76 The Oil and Gas Industry uses a range of terms: "discovered", "remaining conventionally recoverable", "ultimate". Each has a different form of estimation, and not all sources agree with each other. Best available information has been provided.

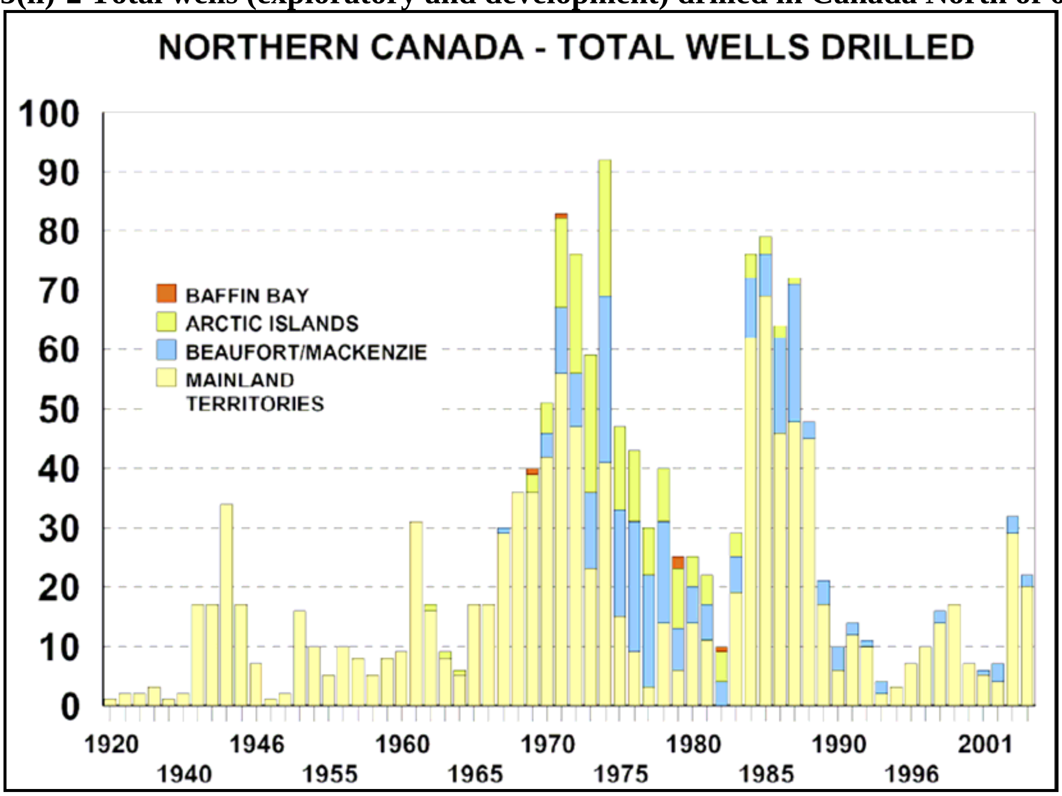
77 Wikipedia 6th April 2007

exploration wells were drilled onshore and offshore, and approximately 30% were successful see Fig 4.5(ii)-2[78].

In 1980, the federal government implemented the National Energy Program (NEP). Designed to encourage Canadian oil and gas supply self-sufficiency, the NEP offered lucrative Petroleum Incentive Program grants to companies exploring in frontier regions, which had the effect of stimulating more exploration. Both programs encouraged exploration activity in the North and off the coast of Newfoundland. In 1983, the Federal government also introduced the Excise offshore Applications Act that permitted non-Canadian vessels to be imported duty free and without upgrades, provided they traded within the Arctic for five years. At the end of the five-year period vessels were grandfathered into the Canadian flag.

Development and production did not follow in the North. World market prices, high during the 1970s, had crashed by the early 1980s. This, along with lack of transportation infrastructure to southern gas markets and the eventual ending of federal funding programs and tax incentives, brought a corresponding end to Arctic exploration. There was a long gap in offshore well drilling between 1989 and Devon Canada's exploratory programme in 2005.

Fig 4.5(ii)-2 Total wells (exploratory and development) drilled in Canada North of 60°N[79]



78 Drummond, 2006

79 Source: (Drummond, 2006, p. 3)

Oil and gas exploration took a hiatus as resource prices declined and industry interest waned. New activity did not really begin until a new well was drilled in the Mackenzie Delta in 2001, signalling a return of industry to the Arctic. A new application for a gas pipeline out of the region was filed as the Mackenzie Gas Project in 2004.

Most of the offshore drilling activity was based out of Tuktoyaktuk. In 1978, through the lobbying effort of Dome Petroleum head Jack Gallagher, the federal government further stimulated activity throughout the Arctic with the Frontier Exploration Allowance to offset the very high costs of onshore and offshore exploration. Companies spending more than $5 million on one well could write off 120% of the costs against their corporate taxes. In 1978 alone, companies spent an estimated $150 million, and wrote off between $130-$140 million[80].

High Arctic

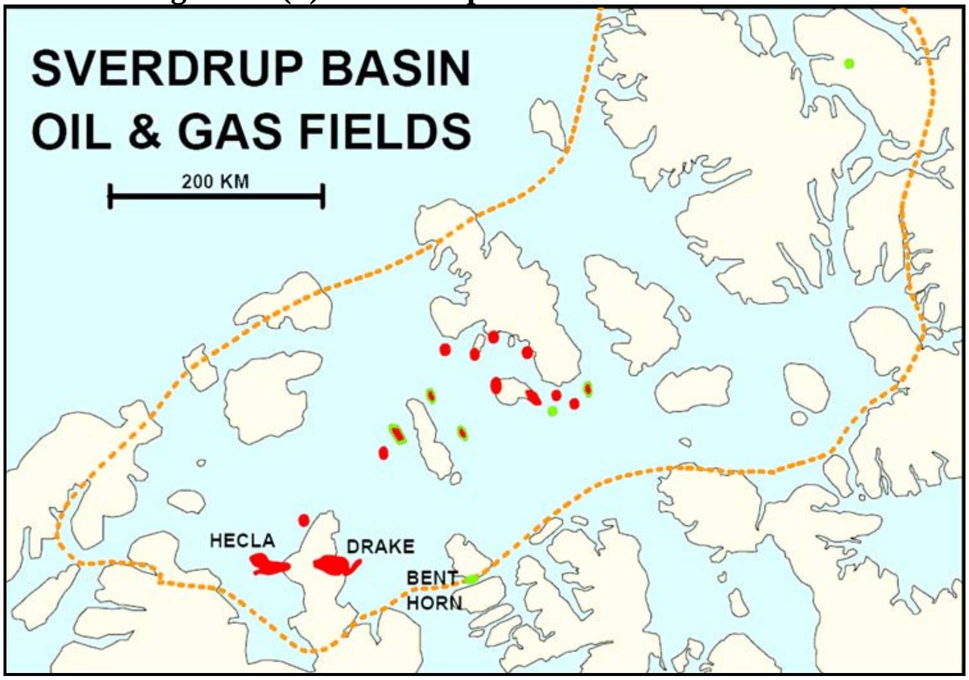
Exploration was also taking place in the Canadian High Arctic, north of the 75th parallel in the Sverdrup Basin. In 1962, Dome Petroleum drilled the first well in the High Arctic at Winter Harbour on Melville Island. Panarctic Oils had discovered 6 trillion feet of natural gas at Drake Point on Melville Island. In 1974, Panarctic also made a discovery of oil at Bent Horn on Cameron Island. Bent Horn oil was of high enough quality that it could be used to replace diesel fuel without any refining, and an initial sale was made to the Northern Canada Power Commission in 1986 for testing at the Resolute Bay electrical generating plant[81]. This was the only oil field to be commercially produced in the Canadian High Arctic.

By 1982, 162 wells had been drilled and 60,000 kilometers of seismic had been shot throughout the Sverdrup Basin, resulting in reserves totaling 13 trillion cubic feet of gas and 300 million barrels of oil. Subsequent exploration has added to these totals (Figure 4.5(ii)-3).

80 Clark, Hetherington, O'Neil, & Zavitz, 1997, pp. 205-206

81 Anecdotal information suggests that at least part of the fuel requirements for the Polaris mine at Little Cornwallis Island were served by the Bent Horn field.

Figure 4.5(ii)-3 Sverdrup Basin Oil & Gas Fields[82]



Development

High Arctic

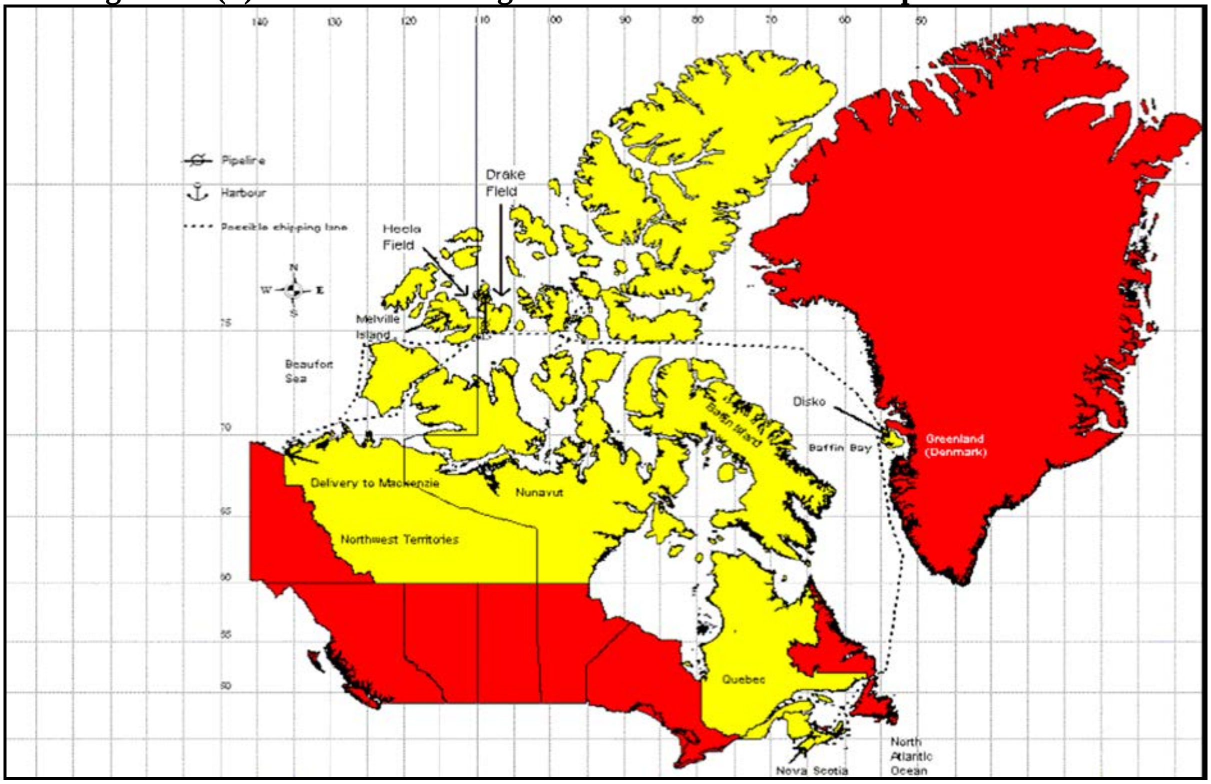
Activity in the late 1970s and 1980s led to a series of major development proposals for shipping the oil and gas resource out of the Arctic (Figure 4.5(ii)-4).

Gas pipeline and shipping proposals were focused on two main Arctic areas, the Beaufort Sea/ Mackenzie Delta region and the Sverdrup Basin of the High Arctic. The giant Hecla and Drake gas fields in the Sverdrup Basin (see Figure 4.5(ii)-3) prompted the Arctic Pilot Project Liquefied Natural Gas proposal in 1981.

The Arctic Pilot Project, a consortium of Petro-Canada, Dome Petroleum, Nova An Alberta Corporation and Melville Shipping, proposed a $1.7 billion project to produce gas from the Drake Point gas field on Melville Island and transport it to southern markets. The gas was to be shipped south via pipeline to Bridport Inlet on Melville Island where it was to be liquefied and shipped by Arctic Class 7 tanker through Lancaster Sound to LNG terminals in eastern Canada, Europe and the United States. Petro-Canada submitted an application for a liquid natural gas export licence to the National Energy Board in 1979, but the application process was never completed and was indefinitely adjourned in 1986.

82 Drummond, 2005, p. 29

Figure 4.5(ii)-4 Overview of High Arctic Natural Gas Development Schemes[83]



Exploration in the High Arctic also prompted the Polar Gas Project proposal. Polar Gas was formed in late 1972 to study the feasibility of transporting gas through a 3,763 km pipeline south through the Kivilliq region of what is now Nunavut to northern Manitoba and onward to join the TransCanada Pipeline system in northwestern Ontario. Part of the study included looking at pipe laying methods suitable to High Arctic conditions for underwater channel crossings.

In 1977, Polar Gas applied to the National Energy Board for permission to build a natural gas pipeline system from the Arctic Islands. In 1978, Polar Gas completed an environmental statement and filed a socio-economic statement with the NEB and the Department of Indian and Northern Affairs. By the mid-1980s, Polar Gas had not proceeded further with its application due to low world market prices for natural gas, despite proposing another project to build a pipeline from the Arctic Islands to connect with the Mackenzie Valley pipeline, if it got built following the end of the Berger-imposed moratorium.

Oil production out of the High Arctic was pursued and Bent Horn oil was loaded at the Cameron Island production facility and transported annually by the OBO *Arctic*. The ship had been built in 1978 by the federal government and a consortium of Canadian owners as an arctic research vessel to serve Arctic mines. It was converted to the OBO configuration, together with a new bow and upgraded ice class in 1986 to handle the Bent

[83] Chan, Enyon, & McColl, 2005, p. 5

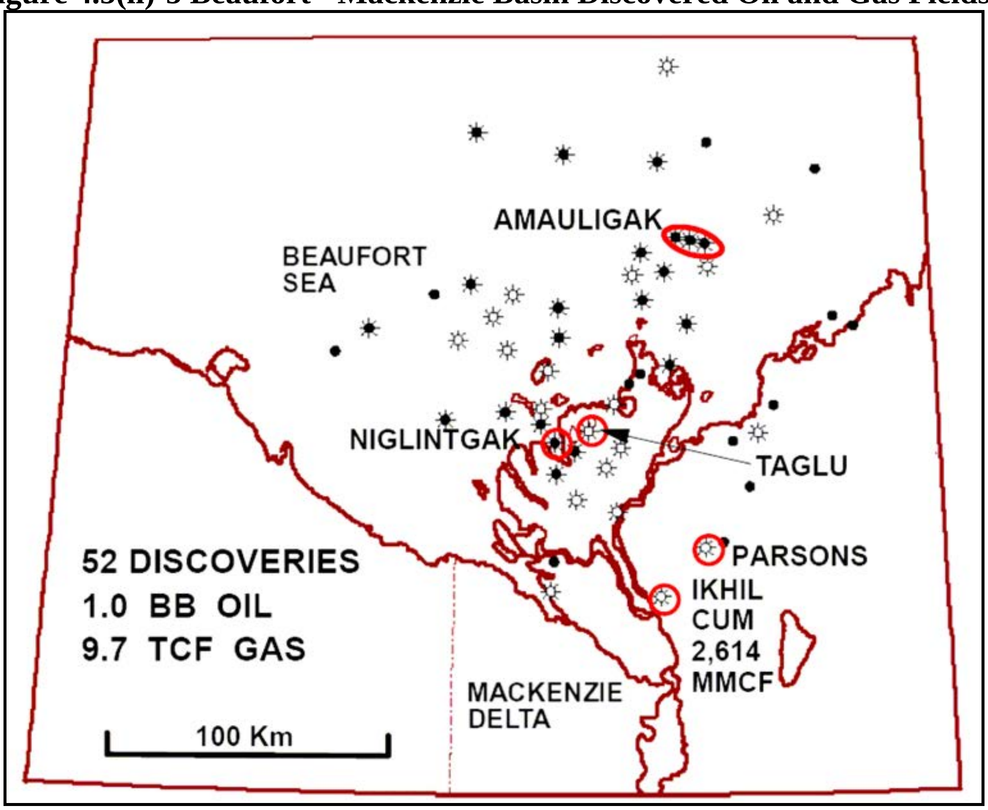
Horn crude. The field shipped 450,000m^3 of oil between 1986 and 1996, when Panarctic shut in the field because of concerns regarding possible pollution during shipping. The first shipment was about 16,000m^3 and the peak season was 1993 when about 57,000m^3 was shipped south.

Beaufort Sea/ Mackenzie Delta

There have been four applications to ship gas out of the Beaufort Sea/ Mackenzie Delta region since the Taglu discovery in 1972. By the late 1980's there were over 50 discoveries proving over 1 billion barrels of oil and close to 10 Tcf of gas (see Figure 4.5(ii)-5).

Oil production tests were held on the large Amauligak field in the Beaufort Sea when 50,000m^3 of oil were shipped to Japan in 1986[84]. The oil was then shipped down the Alaska Oil Pipeline to Valdez.

Figure 4.5(ii)-5 Beaufort - Mackenzie Basin Discovered Oil and Gas Fields[85]



[84] In the *Gulf Beaufort*, a 150,000dwt ore/oil carrier that had been brought into the Arctic earlier to act as a storage vessel for diesel fuel.

[85] Reinson & Drummond, 2004, p. 27

5. ARCTIC SHIPPING ACTIVITY – CURRENT

5.1 Methodology & Background

This section has used Statistics Canada data, where appropriate, and has referenced the Nunavut Transportation Strategy of 2001 and 2007, as well as other documents, to provide a basis for quantities and movements. Exemplary data for ship movements was derived from the INNAV ship movement file using daily snapshots of vessel positions. A compilation of ship activity for 2005 is given in Annex 10.4[86]. Reference should be made to Section 9 of the report, Data Issues, for a discussion of the StatsCanada data.

5.2 Annual Re-Supply by Region

It must be kept in mind that dry cargo re-supply for the Eastern Arctic, i.e. Qikiqtaaluk, Kivalliq and Nunavik is essentially integrated by the shipping companies into a single region. Also, air cargo[87] and food mail[88] are significant components of the overall supply chain into the region. Because of different contracting policies by Nunavik and Nunavut, POL deliveries are handled separately.

Current estimates for re-supply activity are given below by region. These quantities are best estimates, and are assessed in terms of dry cargo shipping using $3.5m^3$/tonne of cargo. Actual consumption figures per capita are based on Mariport's planning quantities[89] as comprehensive historical data is not available. Demand in terms of cubic metres of cargo dictates shipping capacity and trips needed by dry cargo vessels. Petroleum products are again for planning purposes, and related to cubic metres of fuel rather than tonnages. This is because the products are light distillates. The re-supply estimates exclude additional demand due to airports and North Warning stations, exploration and mining activity. The quantities do not include retrograde or lateral cargo movements within the region, nor do they include estimates for transhipped (i.e. double-handled) cargo. Estimates for these quantities are provided in section 5.7ii, and derivation of quantities is given in Section 9 of the report.

The exception to this estimation technique are the river communities on the Mackenzie River. Here, all communities south of and including Wrigley are road and/or ferry connected to all weather highways. Inuvik, in the delta region is all weather road connected to the Dempster Highway and has very little demand for river transportation. Places like Fort McPherson on the Peel River and Tsiigehtchic are served out of Inuvik by road and ferry. Communities are also connect by winter roads[90], consequently their use of river transportation, except for petroleum products, is very limited. Even with petroleum products, demand has been reduced in recent years by changes in energy

86 There is a reporting exclusion zone at the mouth of the Mackenzie and including Tuktoyaktuk. This may have resulted in some western Arctic activity being unreported. In addition, none of Kivalliq Marine's activity out of Churchill in 2005 was reported by INNAV.

87 Estimated 20-25,000 tonnes per annum to Nunavut as of 2005.

88 About 7,000 per annum for all Nunavut, of which 5,000 tonnes goes to Eastern Nunavut as of 2005.

89 See Chapter 9 for a discussion of these factors.

90 Deline on Great Bear Lake is only accessible by air, or winter road. Some transhipment of cargo probably takes place in Tulita.

sources for power generation. Inuvik, which used to burn residual oil from the topping plant at Norman Wells, now uses natural gas from a local supply for power generation. Norman Wells also uses local gas supplies for power generation. Estimates for this region will be made using total tonnage figures reported in section 9.2 of the report, with adjustment for Western Arctic deliveries and company activity. All shipments for the Western Arctic are integrated into tows on the Mackenzie. Barges are topped off at Tuktoyaktuk to ocean drafts for final delivery.

Transportation services on the Mackenzie and in the Delta are handled by three companies (see Annex 10.4 for fleet information):

- Cooper Barging Services haul deck cargo only from their base at the ferry crossing on the Liard River near Fort Simpson to Norman Wells and Tulita. Much of this cargo is understood to be on behalf of Imperial Oil at Norman Wells.
- Horizon North Logistics (previously E Grubens Transportation) reportedly have a contract to supply petroleum products to communities in the Delta region. The company is delivering three new double hulled deck/bulk barges this season.
- Northern Transportation Company Ltd. has been the primary carrier on the Mackenzie since the 1930's. Their 2007 schedule shows one call to Norman Wells, four calls to Fort Good Hope, four to Tulita (same dates as Fort Good Hope), two to Aklavik, one to Inuvik, Delta points and Tuktoyaktuk. Within the Great Slave Lake area they show one call each at Yellowknife for bulk fuel only and a call at Luselk'e are the far east end of the lake. No estimate is possible for these movements.

Following are estimates for each region of the Arctic. The derivation of these numbers is described in more detail in Chapter 9.

i) Qikiqtaaluk
- Population, 2006 census 16,005
- Probable dry cargo quantities 35,211 tonnes or 124,000m^3
- Probable petroleum product demand 51,216 tonnes or 67,000m^3

ii) Kivalliq
- Population, 2006 census 9,266
- Probable dry cargo demand 20,385 tonnes or 71,000m^3
- Probable petroleum product demand 29,651 tonnes or 38,500m^3

iii) Kitikmeot
- Population, 2006 census 4,741
- Probable dry cargo demand 10,430 tonnes or 36,500m^3
- Probable petroleum product demand 15,171 tonnes or 20,000m^3

iv) NWT Coastal communities
- Population projection at 2005 1,861
- Probable dry cargo demand 4,094 tonnes or 14,000m^3
- Probable petroleum demand 5,955 tonnes or 8,000m^3

v) Nunavik

- Population, 2006 census 10,783
- Probable dry cargo quantities 23,723 tonnes or 83,000m^3
- Probable petroleum product demand 34,506 tonnes or 45,000m^3.

vi) Cree Communities

- Population, best current estimate 11,769[91]
- Probable dry cargo 12,769 tonnes or 44,000m^3
- Probable petroleum product demand 17,654 tonnes or 23,000m^3

vii) Mackenzie River Communities

The total volume shipped on the Mackenzie (from Section 9.2) is about 106,000 tonnes. Out of this quantity, an estimated 14,524 tonnes of dry cargo and 21,126 tonnes of POL were destined for the Western Arctic. Thus the net quantity for the Mackenzie would be about 70,350 tonnes, of which 15,000 tonnes was dry cargo shipped by Cooper Barging. Based on the discussion in section 9.2, this would indicate a residual quantity of dry cargo for NTCL of about 5,000 tonnes (it is not known whether Horizon North currently handle deck cargo except locally within the Delta region). Thus probable river and Delta quantities for dry cargo are 20,000 tonnes and 50,350 tonnes of POL. These levels fit reasonably well with estimates in section 9.2.

Community Re-Supply Summary (Excluding Coastal Cree Communities)

Eastern Arctic

- Dry cargo 278,000m^3 POL 150,500m^3

Western arctic

- Dry Cargo 50,500m^3 POL 28,000m^3

Mackenzie River

- Dry cargo 70,000m^3 POL 65,455m^3

CASA Region (Including Coastal Cree Communities)

- Probable total dry cargo community re-supply activity 442,500m^3
- Probable total POL community re-supply activity 266,955m^3

There are other movements, and these are included in 5.7, which sums total estimated current cargo activities. Reported vessel activity in 2005 was:

- 12 tugs and tows in the western Arctic
- 18-21 tows on the Mackenzie River, not all of which were through tows.
- 17 dry cargo trips between southern Canada and the eastern Arctic
- 20 tanker trips, of which 14 were between southern Canada and the eastern Arctic, and six between Churchill and the Kivalliq and other destinations.

91 As discussed in Chapter 9, population figures exclude Moosonee, which is rail connected, and Moose Factory, where goods move year round on a combination of small boats and sleds.

There may be some additional tug and barge operations or ships chartered in to serve mines, or to supplement the fleet. Companies involved in Arctic re-supply, together with known fleet details are given in Annex 10.4. Also, see Ships in Arctic 2005 in Annex 10.4 for a full list of vessels reported as operating in the Arctic that year, and the voyages they undertook.

The dry cargo fleet of ships has an estimated single trip capacity of 107,600m^3 Eastern Arctic community dry cargo demand**,** excluding Cree communities, is estimated at 278,000m^3, but this excludes supply to Eureka, North Warning stations, exploration[92] and development projects. Lateral and retrograde cargo affects capacity only insofar as carriage lengthens the voyage, and reduces time available for trips out of southern base ports within the normal season. Data is not readily available on this additional activity, but with a typical deployment of three trips per ship, seasonal capacity of the existing fleet is about 322,800m^3. While some cargo has been moved out of Churchill by tug and barge into the Kivalliq since NTCL ceased operation there, the fleet is probably operating at over 80% capacity, which suggests additional equipment is needed[93].

5.3 Cruise Tourism

In the context of the CASA, tourism means cruise ships, which for Arctic cruises tend to be much smaller than is the norm in other destinations. Table 5.3-1 shows cruise ships that have been involved in Arctic itineraries in recent years. The *Bremen*, *Hanseatic* and *Kapitan Khlebnikov* have all undertaken complete NWP transits in previous seasons. No cruise ships undertook a NWP transit in 2005.

There is one small cruise ship, the *Norweta* operating on the Mackenzie. This ship is 18 passengers and operates six cruises each season, three northbound and three south bound between Hay River and Inuvik.

Table 5.3-1 Characteristics of recent cruise ships visiting Nunavut and Nunavik

Name	Draft	Passengers
Akademik Ioffe*	5.90m	110
Bremen	4.55m	164
Clipper Adventurer*	4.65m	116
Explorer*	4.20m	102
Hanseatic	4.80m	188
Kapitan Khlebnikov*	8.50m	112
Le Levant	3.00m	95
Polar Star*	6.55m	105
Lyubov Orlova	4.65m	262

***** Arctic Voyages in 2005

Itineraries are constrained by the Coasting Trade Act (CTA) and for many vessels cruises will originate or end in Nuuk in Greenland with a Canadian origin/destination at

92 The Mary River iron ore project will have a very heavy supply demand in the 2007 season as they prepare for shipping a 250,000 tonne bulk sample to steel mills.

93 At CMAC Northern in Iqaluit, 25-26 April 2007, both NEAS and NSSI announced that they were bringing in new vessels this season. The NSSI vessel may be a replacement for the *Mathilda Desgagnes* which is 48 years old.

Churchill (MB). Some ships will undertake a Canada/Canada cruise, but generally only where they have in excess of 100 berths. Ships with 100 or more berths are exempt from paying duty under the relevant customs tariff[94] (subject to there being no Canadian vessel available), ships with less than 100 berths pay duty at the tariff indicated in the CTA[95].

Recently, the Makivik Corporation has teamed up with an experienced Canadian cruise manager to form Cruise North Expeditions Inc. Commencing with the 2005 season, the company has chartered in an ice-capable passenger vessel for the open water season. The operation is partially funded by the province of Quebec through a tourism development agreement with Nunavik.

5.4 Fisheries

Primary attention with regard to fishery development has been in the Qikiqtaaluk of Nunavut region, concentrating on turbot and shrimp. These resources have been extensively fished by southern Canadian and foreign trawlers, and while some royalty income has filtered through to Nunavut, there has been little economic benefit. Fisheries in the Kivalliq and Kitikmeot regions are less well defined, and appear to be mainly arctic char. Quotas of up to 600,000kg per annum of both sea run and land locked char are considered achievable, but the resource does not appear to be well defined.

There has recently been some investment in fishing vessels by Nunavut corporations, with the mf *Saputi*, mf *Inuksuk*, mf *Katsheshuk ll* and mf *Oujukoaq*. However, these vessels are managed out of St. John's NL and concentrate on traditional resources in the Davis Strait.

5.5 Resource Based Traffic

i) Minerals

With the closure of the Polaris and Nanisivik mines there are no mines operating at present in Nunavut or the Northwest Territories that involve Arctic shipping. The Jericho diamond mine in Nunavut is inland, and other activities are at present exploration and/or development related. Thus they have an influence on re-supply activities, increasing quantities beyond those needed purely for community activity. Principal current mineral activities and deepwater ports are shown in the maps on the following pages.

The major current operation is the Raglan nickel mine developed by Falconbridge (now owned by Xstrata PLC), which is in the Cape Smith Belt. The deposit was found in the 1960's but was only recently deemed economic to develop. The mine ships through Deception Bay using the storage facilities and loader built in the 1970's for Asbestoscorp. Shipment of nickel concentrates, using the Canadian flag icebreaking OBO[96] *Arctic*, commenced in 1998, at about 130,000 tpy. Upgrades planned for 2007 should see shipping tonnages of 150,000 tpy through to 2015, which is when the ore body will

[94] Vessel duties reduction of removal regulations.

[95] The tariff is 1/120th of the fair market value of the vessel per month. No amortization to lesser periods is permitted.

[96] OBO = Ore Bulk Oil carrier.

probably be worked out. The ore includes nickel, copper, cobalt and other rare metals. The mv *Arctic* generally brings in petroleum products and other logistics materials to supply the mine on its return trips from Quebec City. The ore is railed from Quebec City to Sudbury for processing. There is an agreement with the Makivik Corporation[97] for local employment and profit sharing that contributes to the well being of Nunavik. Current traffic is 4-5 trips per season. This will increase to 5-6 trips with the higher concentrate production indicated above.

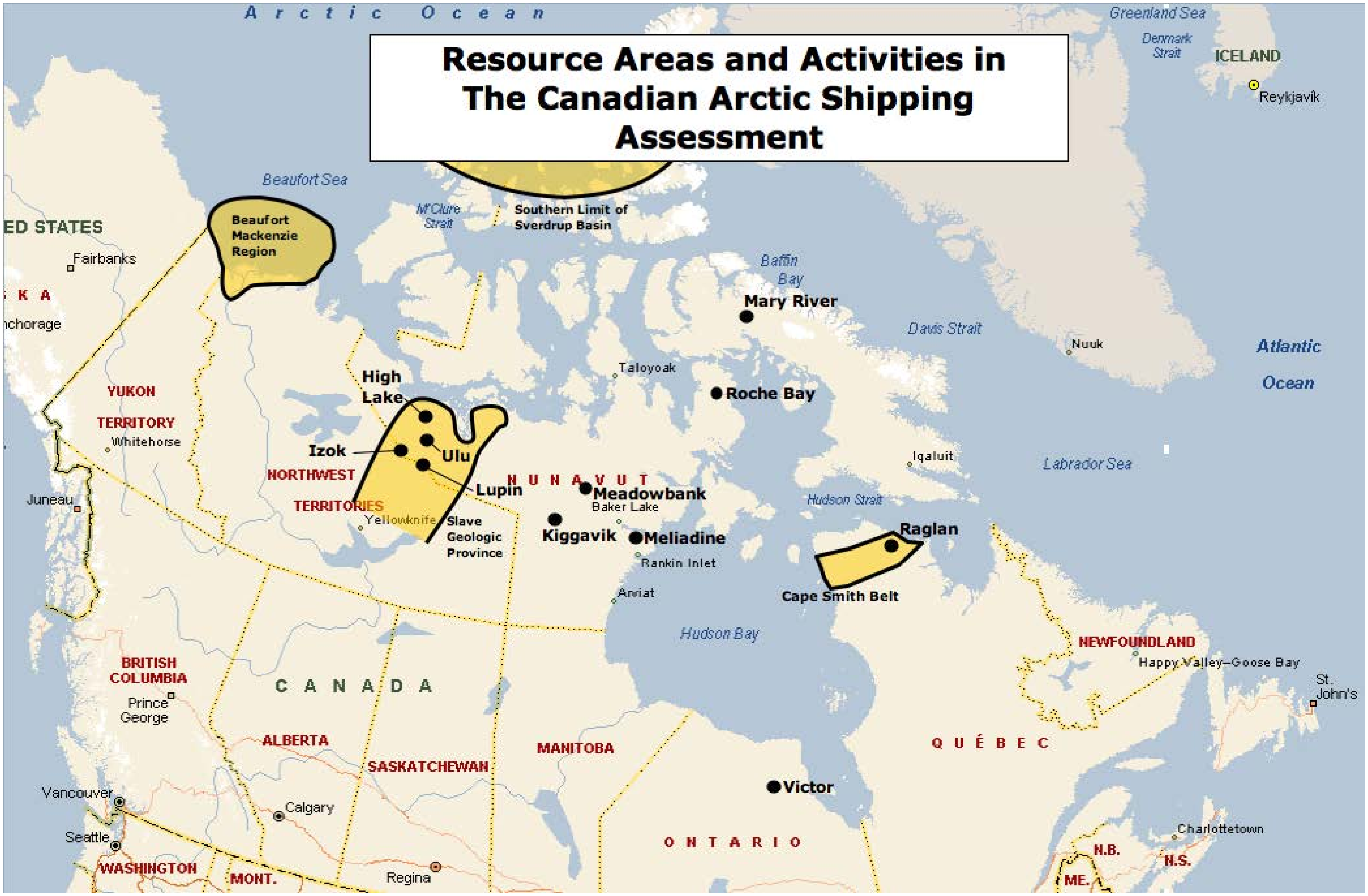
ii) Oil and Gas

There are currently no oil and gas exploration activities planned in Arctic waters following the recent return of exploration by Devon Energy into the Beaufort Sea in 2005 (see Case Study, below). Ever since the removal of the National Energy Program incentives and a change in the nature of world oil and gas markets in the 1980's exploration, activity has dwindled in the Arctic oceans.

The federal government INAC (2007) provides annual calls for nominations for exploration licenses in the Arctic region, for both the Beaufort/Mackenzie and the High Arctic/Sverdrup Basin areas. Currently, the only active commitment is for Devon Energy to undertake one more well program to meet their license obligations by 2009. Industry activity is currently awaiting more certainty on their ability to ship their oil and gas resources out of the Arctic, and this currently hinges on the fate and timing (now set at 2014) of the Mackenzie Gas Project.

[97] Makivik Corporation is a non-profit corporation mandated to manage the heritage funds of the Inuit of Nunavik. It is a major business entity in leveraging employment and benefits. One of its activities is First Air, a key Canadian Arctic air carrier.


Deep Water Port Facilities In The Canadian Arctic Shipping Assessment
Arctic Ocean
Greenland Sea
Denmark Strait
ICELAND
Reykjavík
GREENLAND (DEN.)
Beaufort Sea
M'Clure Strait
Nanisivik
Baffin Bay
Davis Strait
Nuuk
Atlantic Ocean
Taloyoak
YUKON TERRITORY
Whitehorse
Iqaluit
Labrador Sea
NORTHWEST TERRITORIES
Yellowknife
NUNAVUT
Baker Lake
Hudson Strait
Deception Bay
Rankin Inlet
Arviat
Hudson Bay
Churchill
NEWFOUNDLAND
Happy Valley–Goose Bay
St. John's
BRITISH COLUMBIA
Prince George
CANADA
ALBERTA
SASKATCHEWAN
MANITOBA
QUÉBEC
Vancouver
Calgary
Seattle
WASHINGTON
MONT.
Regina
ONTARIO
Charlottetown
N.B.
N.S.
ME.
Fairbanks
Juneau


Resource Areas and Activities in The Canadian Arctic Shipping Assessment
Arctic Ocean
Beaufort Sea
Beaufort Mackenzie Region
M'Clure Strait
Southern Limit of Sverdrup Basin
Baffin Bay
Mary River
Davis Strait
Greenland Sea
Denmark Strait
ICELAND
Reykjavik
Nuuk
Atlantic Ocean
Labrador Sea
Taloyoak
Roche Bay
Iqaluit
High Lake
Izok
Ulu
Lupin
NUNAVUT
Meadowbank
Baker Lake
Kiggavik
Meliadine
Rankin Inlet
Arviat
Hudson Strait
Raglan
Cape Smith Belt
Hudson Bay
Slave Geologic Province
Yellowknife
NORTHWEST TERRITORIES
YUKON TERRITORY
Whitehorse
Juneau
Fairbanks
Anchorage
ED STATES
BRITISH COLUMBIA
Prince George
CANADA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUÉBEC
NEWFOUNDLAND
Happy Valley–Goose Bay
St. John's
Victor
Vancouver
Seattle
Calgary
Regina
WASHINGTON
MONT.
Charlottetown
N.B.
N.S.
ME.

Case Study: Devon Beaufort Sea Exploration Drilling Program

The following is a case study of the Devon Canada Beaufort Sea Exploration Program. It is thought that the considerations addressed by Devon in their study effectively illustrate the considerable difficulties of operating in Canada's Arctic waters.

Context:

In 2004 Devon Canada Corporation undertook a comprehensive study with respect to an exploration drilling program in the southern Beaufort Sea, north of the Mackenzie River Delta. Devon identified ten drilling targets located in relatively shallow water (6.8 m to 12.2 m and the average drilling depth is approximately 3500 m) (Devon Canada Corporation, 2004, pp. 2-1). The winter drilling season in the area identified for drilling by Devon typically lasts from 120 to 150 days

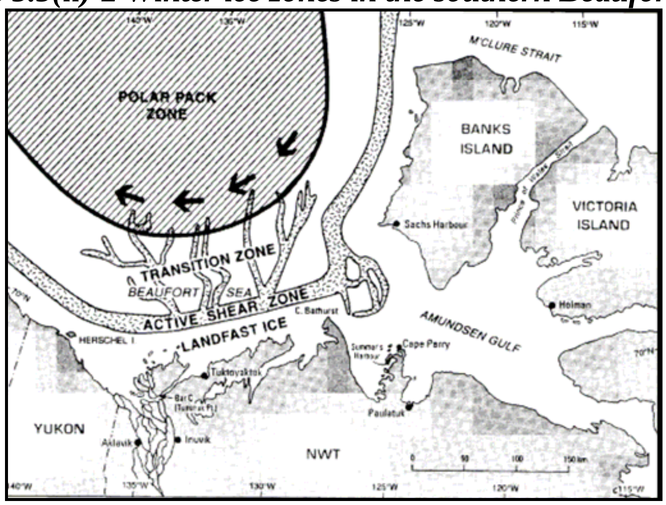
The weather in the southern Beaufort Sea is know to be extreme and was an important factor in program planning. The Beaufort's physical environment can produce a wide range of weather conditions from extreme low air temperatures, high winds, variable sea ice cover, few daylight hours and snow or blowing snow in winter months. While summers are milder with open-water conditions and long hours of daylight, periods of poor visibility, storm waves, and pack ice intrusions can occur. Freeze-up begins in early to mid-October, and the outer edge of the landfast ice stabilizes beyond the location of Devon's drill sites by mid-December to mid-January. Spring breakup occurs from mid- June to early July. By late July, waters to a depth of 20 metres are generally clear of ice.

While wave heights are typically low (1 m or less) during the open-water season, extreme storm waves (up to 5-6 m) can occur during severe fall storms and increase in intensity with water depth. Ocean currents are generally in the range of 0.2 m/sec or less, though the Mackenzie River outflow can strongly influence currents, creating flows with maximum values in excess of 0.5 m/sec at peak discharge. During the open-water season, heavy pack ice can move into the nearshore waters of the Beaufort Sea under the influence of strong winds from the north. These intrusions result in the high degree of variability in the length of the open-water season observed from year to year. Heavy pack ice generally grounds in the 12–15 m of water and does not significantly affect the shallower inshore waters where most drilling is located. In these shallow areas, any drifting pack ice generally consists of small floes, with ice thickness and ridging that are not excessive.

Among the most significant concerns associated with Arctic exploration and transport are naturally occurring ice islands, which are comparable to large icebergs with a thickness of up to 60 meters (Clark et al., 1997). Further, it is not the stationary ice which operators need to concern themselves with, rather it is the ice under the influence of wind and currents that poses the greatest threat. As a result, Hetherington notes that "the hazard presented by moving ice must be *considered as the controlling factor in all Beaufort offshore operations" (in Clark et al., 1997, p. 95).*

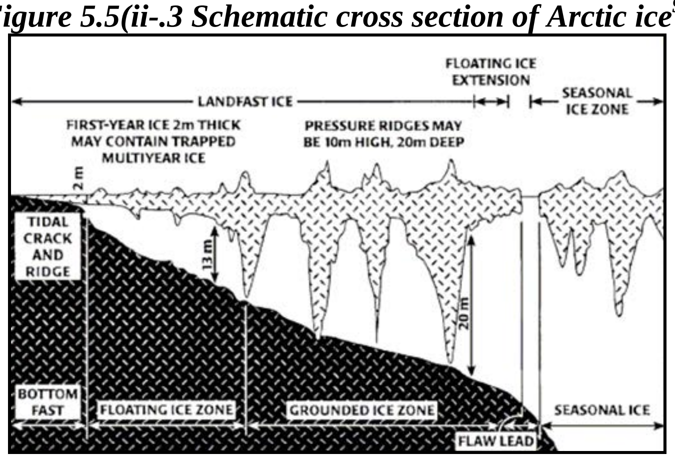
During freeze-up, winter and breakup periods, three ice zones are evident in the region: the landfast ice zone, transition zone, and the permanent polar pack. See Figure 5.5(ii).2, below.

Figure 5.5(ii)-2 Winter ice zones in the southern Beaufort Sea[98]



From late October to late November land fast ice begins to form in the shallow near shore waters of the Beaufort. The outer edge of the land fast ice progresses northwards in a series of discrete steps caused by periodic winds from the north that cause ridging in the thin, growing ice. The outer edge of the land fast ice normally stabilizes near the 20m water depth contour in late December to mid-January. Land fast ice is known to be quite stable with ice surfaces generally quite smooth at shallow depths and becoming progressively rougher at increasing depths, see Figure 5.5(ii).3.

Figure 5.5(ii-.3 Schematic cross section of Arctic ice[99]



98 Clark et al., 1997, p. 24

99 *Clark et al., 1997, p. 26*

Arctic Related Impacts on Transport:

Devon's Program activities were categorized into three main phases with impacts for transportation in the Arctic waters being most significant in the pre-operations phase. It is in this phase that the supplying (by barge) and mobilizing of the drilling platform would occur. Of note, however, is that the natural environment can significantly influence or impact Devon's project at any stage.

Devon identified three self-supporting drilling platform options that could be used for this drilling program: the Steel Drilling Caisson originally developed by Dome in the 1980's (SDC), Land fast Tender-assist Drill Unit (LTD), or an ice Island. All three drilling platforms being considered have been designed to accommodate anticipated ice forces in winter, including those from normal and extreme ice loading. In terms of transporting the platforms, Devon identified that three towing vessels would be required to move the SDC from its current storage site. The lighter LTD platform could be towed with either fewer or lower powered vessels (with the exception of the year one when it would be towed into the Beaufort Sea from the fabrication site). The ice island activities meanwhile potentially involve barge staging of construction materials and supplies at a sheltered moorage near the drill site. Further, the ice island platform would require the most supply barge support (up to 15 barges) while the SDC and LTD would require three to six barges, based on requirements for re-supply.

Adverse ice conditions can affect platform transport and re-supply during the open-water season. Expected ice loadings, variability in these conditions, ice interaction behavior and ice load levels are reasonably well understood for all the platforms that Devon is considering. Potentially detrimental ice situations can be identified through techniques such as ice monitoring, ice load measurement, ice event forecasting and ice alert systems. Poor ice integrity could create significant safety risks and in a worst case scenario could result in the suspension of drilling. Also, factors such as high wind-chill and blowing snow in winter, fog and poor visibility during breakup and freeze-up, and storm waves in fall are all important factors during pre-operations and operations phases. In fact Devon indicated that it could be necessary to suspend sea-going transport in adverse weather conditions during the open-water season.

Mobilization including the transport of the SDC would occur in late August. Alternately, the LTD would be towed from the Pacific Ocean through the western portion of the Beaufort Sea in early August, arriving in late August. Drilling would then commence by late December with the SDC, February with the LTD or early March with the ice island.

In terms of the potential for climate change to impact upon the Program, Devon noted that various studies have been conducted on the Beaufort Sea ice conditions. Devon noted that while effects of climate change on ice conditions are of long-term interest, it was their opinion that there was not likely to be an impact *on this Program given its immediacy and short duration (i.e., four years between 2005 and 2009).*

The good news with respect to operations in the ice-infested waters of the Arctic is the availability of precedent now that the work is relatively common practice. Significant changes have occurred in ice management systems since exploration began in the 1970's in the Arctic. The Ice Early Warning System is a collection of survey techniques that used air and satellite photos and relied heavily on radar and can be very effective when combined with high levels of communication (Clark et al., 1997).

Costs of Arctic Exploration:

Devon noted that their budgeted annual expenditures for the Beaufort Sea Drilling Program would be dependent upon the drilling platform system selected and other factors. However, Devon estimated that using the Steel Drilling Caisson option would cost Canadians $80 million per year. Of the $80 million allocated to this Program annually, transportation was estimated at approximately $14.1 million, or almost 18 percent of the budget.

5.6 Through Traffic

At present there are very infrequent commercial transits of the NWP. In 2005 there was one Russian tug, possibly towing a barge or floating dock, or perhaps just re-positioning for a tow. It is expected that the mill machinery, loader, generation equipment and other mine machinery from Nanisivik will undertake a partial transit to Gray's Bay on the Coronation Gulf in 2007 or 2008. There are usually one or two cruise ship transits, but none were reported in 2005.

5.7 Overall Shipping Activity

i) Vessel Movements

Based on 2005 traffic reported by INNAV[100] and analysed by Mariport, following are the vessels that operated in Arctic waters that year and the voyages they undertook. Ship movements are based on the table in Annex 10.4.

Table 5.7-1 Summary Shipping Movements in Canadian Arctic Waters in 2005

SHIP	TRIPS	FLAG[101]	PURPOSE	PERIOD
Aivik	4	Ca	Community re-supply dry	Jul - Nov
Akademik Ioffe	2	Fo.	Cruise	Jul – Sep
Amazon Express[102]	1	Fo	Cruise	Aug – Sep

100 If a vessel did not report to NORDREG, then there is no record of its operation in Arctic waters.

101 Ca = Canadian, Fo = Foreign Flag

102 Although on a cruise, this is a large private yacht, rather than a cruise ship. Passenger capacity not known.

SHIP	TRIPS	FLAG[101]	PURPOSE	PERIOD
Anna Desgagnes	3	Ca	Community re-supply dry	Jul –Nov
Arctic	4	Ca	Bulk/Deception Bay	Jun-Nov
Camilla Desgagnes	3	Ca	Community re-supply dry	Jul – Oct
Carina	1	Fo	Logistics/Deception Bay	Oct/Nov
Cecilia Desgagnes	3	Ca	Community re-supply dry	Jul – Oct
Clipper Adventurer	1	Fo	Cruise	Aug/Sep
Da Peng Hai	1	Fo	Bulk/Churchill	Oct
Dorsch	6	Ca	Comm. Re-supply POL	Jul – Oct
Edco	1	Fo	Bulk/Churchill	Oct/Nov
Edgar Kotakak	4	Ca	Comm. re-supply dry/POL	Aug/Sep
Enforcer	1	Fo	Bulk/Churchill	Sep/Oct
Explorer	3	Fo	Cruise	
Federal Agno	1	Fo.	Bulk/Churchill	Sep
Federal Polaris	1	Fo	“ “	Jul
Federal Progress	1	Fo	“ “	Sep
Filia	1	Fo	“ “	Sep
Great Creation	1	Fo	“ “	Aug
Hudson Bay Explorer	1	Ca	Survey work	Jul – Oct
Imandra	1	Fo	Bulk/Churchill	Sep
Inviken	1	Fo	“ “	Sep
Jock McNiven	1	Ca	Fuel transfer	Aug
Kapitan Klebnikov[103]	2	Fo	Cruise	Jul-Sep
Keewatin	1	Ca	Mine logistics & fuel delivery	Aug – Oct
Kelly Ovayuak	1	Ca	Comm. re-supply dry/POL	Sep –Oct
Ken Emerald	1	Fo	Bulk/Churchill	Oct
Ken Ryu	1	Fo	“ “	Sep/Oct
Kitikmeot	2	Ca	Comm. re-supply dry/POL	Aug – Oct
Mallika Naree	1	Fo	“ “	Oct
Maria Desgagnes	3	Ca	Comm. re-supply POL	Jul – Oct
Mathilda Desgagnes	1	Ca	“ “ “ dry/POL	Jul
Mokami	1	Ca	“ “ “ dry/POL	Aug
Nunakput	3	Ca	“ “ “ dry/POL	Aug – Sep
Petrolia Desgagnes	2	Ca	Comm. re-supply POL	Jul – Aug
Polar Star	1	Fo	Cruise	Sep
Theotokos	1	Fo	Bulk/Churchill	Oct
Tuvaq	8	Ca	Comm. re-supply POL	Jul – Nov
Umiavut	3	Ca	“ “ “ dry	Jul – Oct
Vladimir Ignatyuk[104]	1	Fo	NWP Towing?	Aug – Sep
Yong Jia	1	Fo	Bulk/Churchill	Sep

[103] The vessel is a converted icebreaking research vessel. It now operates as an adventure cruise ship.

[104] Tug, presumed towing a barge, floating dock or similar.

SHIP	TRIPS	FLAG[101]	PURPOSE	PERIOD
Total Trips	**80**			
Bulk/Churchill	15			
Bulk/Deception Bay	4	May be additional unreported early or late season trips		
Tugs with tows	13	all but one combined dry POL re-supply in western Arctic		
Comm. re-supply dry	17			
" " " POL	20			
Cruise	10	With six ships		
Logistics	2	one a tow that combined mine logistics and fuel re-supply		
Other	1			

ii) Quantity and Cargo

Estimated dry cargo community re-supply activity in the CASA region is 442,500m^3, while estimated POL community re-supply activity is 266,955m^3.Additional consumption for north warning, exploration, and airport re-fuelling brings estimated dry cargo activity up to 454,750m^3 and petroleum products up to 330,655m^3.

Further activity in Nunavik serving the Raglan Mine consists of the following:

- Mine support, dry cargo[105] 17,500 tonnes or 17,500m^3
- Mine support POL 46,000 tonnes or 59,000m^3
- Mine shipments south 130,000 tonnes of concentrates.

Churchill exports wheat and other agricultural products. Quantities fluctuate widely year over year; the quantity given below is from StatsCanada data for 2004.
There was one NWP transit by a commercial vessel in 2005. Cargo type and quantity was unknown.

Estimated total shipping activity in the CASA region :

Dry Cargo	472,250m^3
Petroleum	389,655m^3
Bulk Mine	130,000 tonnes
Bulk Ags[106].	400,000 tonnes

These figures are for actual deliveries, and do not include transhipped (i.e. double-handled) cargo, retrograde or lateral cargo movements. These fluctuate year-by-year depending on opportunity and projects.

105 Unlikely to be cube cargo, assumed to be 1m^3 per tonne. Re-supply values at 3.5m^3 per tonne are derived from historic data and represent a cargo mix that includes high volume elements.

106 Grains and other agricultural products from Churchill

6. ARCTIC SHIPPING ACTIVITY – DEMAND TO 2020

6.1 Methodology & Background

As discussed in Chapter 3.2, economic progress in Nunavut needs employment, but the traditional way of life is unable to support the aspirations of the younger generation, thus some form of wage employment is essential for the future of the territory. In terms of resources, the future Nunavut economy will need to be based on a combination of the following areas of activity:

- Arts and crafts
- Tourism
- Fisheries
- Resource development

Each plank of the economy will have a different demand on marine access and shipping. Arts and crafts, for example, will have little impact beyond the traditional annual re-supply activity although there will be an important link into cruise tourism. For example those communities, such as Cape Dorset, that have a major presence in Nunavut arts and crafts will influence cruise itineraries as operators will see these communities as a key component of the sell for specific cruises. Other aspects of the economy, and their demand on shipping capacity, are discussed in the following sections of this chapter. Forecasts are provided where reference material is available upon which to base projected quantities and vessel traffic.

The forecasts of future shipping demand by communities draws heavily on population forecasts provided in Chapter 3.2. Detailed estimates are provided in Chapter 9.

6.2 Annual Re-Supply by Region

Forecasting activity to 2020 has to be undertaken primarily based on population. This analysis follows the regional format from Chapter 5, and is assessed in terms of dry cargo shipping using 3.5m^3/tonne of cargo. Actual consumption figures per capita are based on Mariport's planning quantities[107] as comprehensive historical data is not available. Demand in terms of cubic metres of cargo dictates shipping capacity and trips needed by dry cargo vessels. Petroleum products are for planning purposes, again related to cubic metres of fuel rather than tonnages because the products are light distillates.

Estimates of future dry cargo traffic for Mackenzie River and Delta communities have been based on a 10% increase in current demand. The reason for this is that communities other than Inuvik and Fort Good Hope are projected to decrease in population over the forecast period. Inuvik, being road connected has relatively little demand for dry cargo movement, and most of the demand for petroleum product is met by using local gas supplies for power generation. Population growth for the communities detailed in Section 3.3 is 27%, but only 7% if Inuvik is excluded. POL movements would probably increase at a greater rate than dry cargo, because these are not road shipped. We will assume a 15% increase in POL to 2020.

[107] See Chapter 9 for a discussion of these factors.

Estimates for re-supply activity by 2020 are given below. These presume that the same relationship in term of dry cargo and POL/capita can be projected forward from 2005.

i) Qikiqtaaluk
- Projected population, 2020, 21,038[108]
- Probable dry cargo quantities 46,284 tonnes or 162,000m^3
- Probable petroleum product demand 67,322 tonnes or 87,000m^3

ii) Kivalliq
- Projected population, 2020, 12,181
- Probable dry cargo demand 26,798 tonnes or 94,000m^3
- Probable petroleum product demand 38,979 tonnes or 51,000m^3

iii) Kitikmeot
- Projected population, 2020, 6,232[109]
- Probable dry cargo demand 13,710 tonnes or 48,000m^3
- Probable petroleum product demand 19,942 tonnes or 26,000m^3

iv) NWT Coastal communities
- Projected population 2020, 1,893
- Probable dry cargo demand 4,164 tonnes or 14,250m^3
- Probable petroleum demand 6,058 tonnes or 8,200m^3

v) Nunavik
- Projected population, 2020, 14,866
- Probable dry cargo quantities 32,705 tonnes or 115,000m^3
- Probable petroleum product demand 47,571 tonnes or 62,000m^3.

vi) Cree Communities
- Projected population, 2020 best estimate 16,245[110]
- Probable dry cargo 17,000 tonnes or 60,000m^3
- Probable petroleum product demand 24,368 tonnes, or 32,000m^3

vii) Mackenzie River and Delta communities
- Probable Dry Cargo Demand 22,000 tonnes or 77,000m^3
- Probable petroleum product demand 58,000 tonnes or 75,400m^3

108 As noted in Chapter 9 this population includes Kugaaruk. Although part of the Kitikmeot Region it is served through the Eastern Arctic

109 As discussed in Chapter 9, the population figure excludes Kugaaruk, which is served via the Eastern Arctic

110 As discussed in Chapter 9, population figures exclude Moosonee, which is rail connected, and Moose Factory, where goods move year round on a combination of small boats and sleds.

Projected Community Re-Supply Summary to 2020

Eastern Arctic (excl. Coastal Cree)
- Dry cargo 369,000m^3 POL 200,000m^3

Western Arctic
- Dry Cargo 62,250m^3 POL 34,200m^3

Mackenzie River
- Dry cargo 77,000m^3 POL 75,400m^3

CASA Region (Including Coastal Cree Communities)
- Probable total dry cargo community re-supply activity 570,250m^3
- Probable total POL community re-supply activity 341,600m^3

There are other movements in support of airport re-fuelling, mineral exploration and mine support. These are included in 6.7ii, which sums total estimated cargo activities.

Total estimated dry cargo community demand by 2020 in the Eastern Arctic (Kivalliq, Nunavik and Qikiqtaaluk), but excluding the Cree communities, would be an increase of about 30% on current demand, and will require additional trips and probably ships to serve it. POL demand will also have risen by some 30% to 200,000m^3, and additional trips will be needed to cover this volume. However, comparison with the current fleet is inappropriate in that most of the dry cargo ships and tankers will need to be replaced before 2020 because of age. For example, the tanker *Tuvaq* would be 43 years old, and the tanker *Dorsch* 40 years. In dry cargo, the *Aivik* would be 40 years old, and the *Cecilia Desgagnes* 49 years.

In the western Arctic demand is projected to rise by just over 20%. Additional trips will be needed to serve community demand, but as in the east comparison with the current situation is inappropriate, as much of the fleet may need replacement.

The core fleet operated by NTCL for Mackenzie River and Western Arctic service is now single skin deck/bulk barges and tow boats that were built in the 1970's. Other equipment dates back to the 1950's and 60's. Cooper Barging introduced three new deck barges in 2001, and HNL will bring in three new double skin deck/bulk barges in 2007. Operating mainly in fresh water for a limited season means that such equipment does not suffer corrosion degradation in the same way that ocean going vessels do[111].

Exploration, and active projects in the Arctic will also add considerably to this demand, however, formal data is not available to make projection as to overall activity. See 6.7 for further discussion

6.3 Cruise Tourism

Activity will depend, to a very large extent, on how Nunavut and Nunavik market cruise tourism. As this will remain a seasonal activity, and the number of ships is limited, there is unlikely to be any significant change over current levels. There is also the issue of the SOLAS convention modification to two-compartment subdivision that comes into force

[111] Marine equipment operating in Arctic waters does not experience the same corrosion rates as vessels in temperate waters.

in 2010. Depending on the status of the ships (which all tend to be older) and the willingness of the owners to invest in the ships, the fleet may actually decline. As noted under chapter 5.3, adventure tourism vessels tend to be smaller, at under 200 passengers. However the mainstream cruise industry is fixated on size, with passenger capacities of 2,000 to 4,000 persons, consequently very few of this class of ship have been built in the last five years.

Arctic cruises are a niche market, although not as popular as Antarctic cruises that have a specific cachet as well as better wild life opportunities.

Additional cruises may be scheduled in the future by the operators of the Norwegian Coastal Hurtigruten route. This company has been very active in Chilean and Antarctic cruises using those ships that are not needed during the northern hemisphere winter. They have recently delivered a new cruise-oriented vessel, the *Fram,* which will be used on Greenland coastal voyages during the northern summer. This vessel (unusually for an adventure cruise product) will carry 328 passengers with a much higher level of comfort than most of the vessels currently in Arctic cruises. It is entirely feasible that the vessel will include the Canadian Arctic on future itineraries. Cruise North Expeditions[112] will also be an influence on future activity, although primarily benefiting Nunavik.

Increased activity in this aspect of marine vacations depends on a number of factors, not the least of which is effective marketing of the Arctic, by Nunavut, as a cruise destination. At present there appears to be very little effort to reach out to cruise companies to promote the region and make it more accessible. The initiatives undertaken by Nunavik demonstrate the opportunity if a regional body takes the lead in promoting activities.

Provision of small craft harbours[113] could make community access easier, but lack of port facilities in the Arctic are not a major barrier to port calls as vessels use zodiacs for passenger transfer and this is seen as part of the "adventure" by passengers booking an Arctic cruise. A dock is desirable where a ship might turn around, but this also depends on the availability of hotel space and good air capacity and connections.

A forecast as to numbers of ships and trips is not possible.

6.4 Fisheries

With the wealth of fishery opportunities in Nunavut it can be expected that more vessels will be introduced, but vessel deployment in order to fully benefit Nunavut will need effective port bases from which to operate that are close to the resource. A protected dock with adequate water depth at all tidal stages is only a portion of the need in the fisheries sector. Access to marine fuels; an adequate afloat maintenance and repair resource; warehousing and storage, possibly with temperature controlled facilities for product delivery into the fresh chilled seafood market, coupled with daily air cargo support and

[112] Cruise North is only one part of a broad programme by the Makivik Corporation to enhance tourism in the region.

[113] Nunavut has an initial programme for seven such facilities that is awaiting $40m in federal funding. Serving all Nunavut communities is estimated to cost $120-130m. These facilities would be similar to ones provided in Nunavik, are not deep draft and may dry at low water.

proximity to the fishery, will be essential features of infrastructure for fishery support. Without such development, Arctic fisheries are unlikely to grow[114].

The vessels currently owned by Nunavut corporations are understood to be *Saputi, Inuksuk, Katsheshuk II* and *Oujukoaq.* The vessels are managed out of St. John's NL, and activity levels in terms of transits to and from base ports in Nunavut to fishing grounds cannot be determined. Operations by foreign flag vessels in Canadian waters are not well reported, but they will add to overall ship movements in the Arctic. These vessels tend to be re-fuelled at sea, and do not use Canadian ports except in emergencies.

6.5 Resource Based Traffic

i) Minerals

a) Qikiqtaaluk

As noted in Annex 10.5, the Mary River iron ore project is expected to be operational within the 2020 time frame. Baffinland Iron Ore Mines have indicated shipment levels of about 12m tonnes pa, but quantities could be more or less, depending on contracts, and where the mine is in its ramp-up period. Assuming 200,000dwt vessels there would be about 60 loaded transits each season.

b) Kivalliq

Mineral opportunities identified for the Kivalliq region thus far are:

- Gold
- Diamonds
- Uranium.

All of these activities need logistics materials inbound, but do not require shipping for products as these are more readily flown out in the aircraft that bring in operating personnel and are a part of the supply chain. The Meadowbank gold prospect near Baker Lake is in active development, and will influence shipping activities within the forecast period. The Kiggavik uranium prospect[115] and Meliadine gold could also be operational, and again influence inbound logistics and fuel. Actual quantities of dry cargo and fuel cannot be estimated at present.

c) Kitikmeot

Wolfden's High Lake mine is expected to be operational within the forecast period, as is Hope Bay gold and possibly Ulu. Other projects are not sufficiently advanced to make a prediction regarding their time frame. However, the presence of a dock at Gray's Bay could well accelerate schedules. Another factor in traffic demand that could be influenced both by

[114] NunavutNew/North reported April 23 that an agreement between the Nattivak Hunters and Trappers and the Barry Group(NL) will jointly harvest their turbot quotas and land the catch at Qikiqtarjuaq as soon as a vessel offloading facility and fish processing plant are built. At present 100% of the turbot is landed in Greenland

[115] Although reported to be in feasibility analysis, the attitude of NTI to uranium extraction could prevent early development

climate change and the ability to ship logistics materials, is the reversal[116] of re-supply flows to the diamond mines at Jericho, Diavik, Ekati and possibly Snap Lake.

High Lake and associated gold operations could require in the order of 52,000 tonnes of dry cargo and 140,000m^3 inbound[117] POL each season with 300-400,000 tonnes of concentrates outbound. Inbound activity is likely to be handled by the same ships that carry concentrate. Depending on ship size and quantity shipped, vessel transits could be in the range 6-12 during an extended season. If the re-supply routes to the diamond mines are reversed, this could add around 100,000 tonnes of dry cargo and 250,000m^3 of oil to annual volumes[118].

d) Nunavik

The region is effectively unexplored, although the Cape Smith belt is seen as having resources similar to those in the Slave Geologic Province (see Annex 10.5). The Nunavik Exploration Fund is supported by the Quebec Government with a view to training Inuit as prospectors and have them bring back interesting rocks for analysis. Prizes are offered for the most promising finds. It is hoped, by this grass roots prospecting, to find other major deposits that could match Raglan and provide continuity in the resource sector. It is unlikely that a new deposit could be brought on line prior to 2020.

The Raglan deposit is expected to be exhausted by 2015, and may not be generating any traffic. However, mines such as Polaris and Nanisivik ran well beyond their original planned life and it is possible that Raglan will still be in operation, if additional resources are discovered and/or metal prices increase. It is possible that the Raglan South property, being developed by Canadian Royalties will in production, but their volumes are predicted at about 30,000 tonnes annually, or about one ship load of concentrates.

e) Hudson Bay The Quebec Cree communities around the foot of Hudson Bay and James Bay appear to have very little involvement with marine activity or fisheries. The James Bay Cree in Quebec are focused on Quebec hydro-electric programmes and managing trust funds established to compensate for loss of traditional lands. Chisasibi, Wemandji and Eastmain are gravel roads linked into the Quebec road system at Matagami.

The largest Ontario Cree community is Moosonee, which is rail linked to Cochrane in the south. Because of the rail connection, Moosonee has been a re-supply service centre for the communities around James Bay and on the Ontario and Quebec Hudson Bay coast. Moosonee is 1.5 miles from Moose Factory, which is an island community that is home to the Weeneenayka

116 At present annual re-supply is via winter roads from the south through Yellowknife and up the Ingraham Trail. This routing could become increasingly difficult with climate change. A route through the Arctic and then heading south would be more secure in terms of season length and load capability. Estimates for fuel delivery suggest that it would also be lower cost.

117 Estimated, based on quantities used by Raglan in 2005 for 130,000 tonnes of concentrate.

118 Slave Geologic Province Transportation Corridor Final report, Arthur Andersen, March 1999.

General Hospital. The hospital is administered by Queen's University, providing health care services for the regional Ontario communities, and a major local employer.

DeBeers' Victor diamond mine is 90km inland from Attawapiskat and will have a major influence on the economy of the neighbouring communities. Support is intended to be by winter road, thus there will be little impact on marine services during the open water season. However, the Attawapiskat band have acquired Moosonee Transport, and they could find ways to bring additional business to their new shipping operation.

ii) Oil and Gas

The following price, land availability, regulatory process, fiscal framework and development design assumptions have been made to guide this forecast:

- The Joint Review Panel[119] recommends approval of the Mackenzie Gas Project and the National Energy Board approves the project in late 2008, with the facilities coming into full operation in 2014.
- The Mackenzie Valley Pipeline is approved as an open access facility that will not restrict third party producers from accessing and making use of the NEB-regulated Mackenzie Gas and liquids pipelines, and the Canadian Oil and Gas Lands Administration (COGLA) regulated Mackenzie Gas Gathering System Facilities on reasonable commercial terms.
- The Mackenzie Gas Project makes their decision to construct in 2010, becoming operational by 2014[120].
- The initial design capacity of the Mackenzie Valley Gas Pipeline starts at 1.2 Bcfd, and is increased by installation of 10 additional compressor stations to expand it from its initial capacity of 1.2 Bcfd to its maximum capacity of 1.8 Bcfd during the forecast period.
- Oil and gas price confidence is expressed by the MGP decision to proceed. Long term forecasters are predicting prices to exceed $7.00 Cdn per mm Btu in real terms (AECO price[121]) and oil prices remaining above $50/bbl is assumed over the forecast period (GLJ Petroleum Consultants Ltd., 2007; Sproule Associates Limited, 2007)
- Annual federal land and periodic private land sales continue to be held for the Beaufort Sea and Arctic Islands of Nunavut (Sverdrup Basin). (Department of Indian and Northern Affairs, 2007).
- Discussions on the devolution or sharing of federal offshore oil and gas resources begin in earnest once the Mackenzie Gas Project decision to

[119] The Joint Mackenzie Valley Environmental Review Board, National Energy Board panel reviewing the environmental assessment of the Mackenzie Gas Project

[120] The recent decision by Alaska to re-open discussions on a joint US/Canada pipeline could change the dynamics of the MGP, by bringing additional gas and equity partners to the table.

[121] The Alberta spot natural gas price is commonly referred to as the "AECO price."

construct is made. The current fiscal framework (royalties and taxation) does not substantively change.

- LNG shipping of Arctic reserves will not be pursued as a viable option as other reserves around the world are mostly owned by the same major companies and are easier and more cost-efficient to access.

Beaufort Sea Region

Mackenzie Delta/Beaufort Region development activity will be driven by future progress on the Mackenzie Gas Project. Recent industry commitments forecast construction of the MGP to start in 2010 and be completed by 2014. The construction of the MGP will create an incremental demand for 245 mmcfd of gas supply connecting discovered reserves to maximize the Inuvik Area Gas Plant capacity of 1,075 mmcfd. There are enough discovered reserves on the Mackenzie Delta to fill the pipe at its initial design capacity, slowing the immediate need for exploration activity [122].

The MGP will have an influence on shipping activity in the western Arctic. It is understood that Imperial Oil have been exploring seasonality and ice conditions associated with moving complete units in to handle gas production and processing in the delta region[123]. There is also a possibility that they will ship oil requirements around Alaska[124] as an alternative to railing oil to Hay River, and then barging it down the Mackenzie.

Exploration activity in the Arctic ocean is expected to stay moribund, other than the Devon Energy activity, until 2015 as new supplies of gas will not be required until production from the existing fields begins to decline (2025).

Exploration and development drilling activity in the Mackenzie Delta region is assumed to proceed at levels a little higher than that experienced in the 2004 to 2005 time frame - at two to four exploration wells per year. For each discovery well, two delineation wells are anticipated. Seismic activity is assumed to include one 260 km 2D program that will be run for every four exploration wells drilled, and one 200 km^2 3D program for each well.

Alberta Oil Sands

A potential area of activity that could develop over the 2010 to 2020 period and beyond is the movement of project cargo to Tuktoyaktuk for furtherance to the oil sands north of Fort McMurray. A preliminary analysis[125] of an Arctic route for offshore sourced process equipment, with shipment via the Mackenzie, Great Slave Lake, Slave, Peace and Athabasca Rivers has shown a significant transportation cost benefit over the conventional route by ship to Duluth (MN), and then by rail and road. In addition, weight limitations of about 450 tonnes are increased to over 1,000 tonnes, and size limitations are effectively removed. The total amount of traffic is unknown at present, but one

122 Headwater Group, 2006.

123 Discussions with Horizon North Logistics March 2007

124 NTCL demonstrated the feasibility of this operation in 2005 when they delivered 3,500m^3 to Devon Energy, and 7,000m^3 to NWT Power from a barge loaded in Vancouver.

125 The Mariport Group Ltd. April 2007

company has indicated that they could move as many as forty heavy loads[126] over the 2010 to 2012 period.

Sverdrup Basin and Other Regions

Activity in the Sverdrup Basin and other regions is expected to remain moribund through the period to 2020. Industry collected a substantial amount of 2D seismic data during this period. If any activity occurs, industry may undertake select 3D seismic activity in areas with existing significant discovery licenses, to apply more advance technical review of existing finds.

The stranded giant gas fields at Drake and Hecla are not likely to be developed within this period. There have been suggestions that developing these by way of a Gas to Liquids plant may make the resource actually accessible to Canadian and International markets[127].

6.6 Through Traffic

Although section 7, which analyses the Northwest Passage, shows that there is little likelihood of regularly scheduled through traffic, one area that could grow is with project cargo and heavy lifts being shipped between east and west. There is little data available on this traffic which is closely controlled by six companies. Such moves could readily use the more accessible southern route, as vessel sailing drafts will generally be less than 10m. Icebreaker assist/escort could, however, be needed.

Partial transits will increase. We have identified[128] the potential for project cargo moves into the Mackenzie River, mainly from the Pacific, but potentially from the Atlantic as well. One company – Synenco – has identified some 40 heavy lift/module moves for their Northern Lights project.

In addition to mining support and shipping at Gray's Bay, the diamond mines in NWT could create a need for annual re-supply if global climate change continues to shorten their traditional southern winter road re-supply from Yellowknife via the Ingraham Trail.

If there were a move to stabilize supplies to Diavik, Ekati, Snap Lake and Jericho via a port accessible from the Arctic, then up to 100,000 tonnes of logistics materials and 250,000m^3 of fuel[129] per season could need to be shipped. Project cargo and mine logistics would be additional to this demand and could be shipped from east or western origins.

6.7 Overall Shipping Activity

i) Vessel Movements

It is only possible to give a general indication of shipping movements in the CASA region to 2020 as this will depend on ship sizes and deployment by the companies. Most of the existing Canadian flag fleet will need to be replaced.

[126] Work relative to this route is still ongoing. Details of load sizes may not be known until end 2007.

[127] *Transportation Fuels for the Canadian Arctic*, Wright, C and Terblanche, K POAC 2001

[128] *Preliminary Analysis of a Northern Route to the Alberta Oil Sands and GNWT Economic Development* The mariport Group for GNWT Transportation June 2007

[129] *Slave Geologic Transportation Corridor Needs/Feasibility Study* Arthur Anderson LLP March 1999.

The Mary River mine is planning to use Very large Bulk Carriers (VLBC's), and assuming a start up shipping rate of 12.5m tpa[130], this would need 60-70 loaded transits over an extended season. The High Lake project will use different sizes of vessels, and for Izok Lake the proposal was 50,000dwt vessels operating a shuttle to Nuuk in Greenland for transshipment. The vessels were to be OBO's and would haul petroleum products and mine logistics on the return trip. At an expected shipping rate of 300-400,000 tonnes/year this would need 6-8 transits to move the cargo over an extended season. The vessels would trade elsewhere during the rest of the year. If ships of 25-30,000dwt were used, then loaded transits would increase to 10-12 over the season.

For re-supply there may need to be additional ships brought into Canadian flag to handle demand, although climate change may affect the season enough to enable the existing fleet to work a longer season[131]. Another factor is that, at present, vessels call many ports on a voyage in order to maximize loads out of their base ports. With increased volumes at all ports, it should be possible to reduce the number of port calls per voyage, making better use of ship time, although on the downside there would be more trips south of 60ºN to reload cargo. Thus there is a limit to how much additional capacity can be squeezed out of the existing fleet.

In 2005 there were 17 re-supply trips by ships (as opposed to tugs and barges) to serve dry cargo needs, and 20 tanker trips to serve petroleum product needs. The eastern Arctic region will see the biggest changes, and there may need to be 23-25 dry cargo re-supply trips and 25-30 tanker trips. Numbers and origins of tanker trips will depend on contracting policies by Nunavut and Nunavik. GNWT has successfully experimented with a joint venture to bring POL around Point Barrow. It is possible, that with increased resource demand, more of these cargoes could be brought into Tuktoyaktuk from the Pacific.

Western Arctic activity will be driven by demand from within the Kitikmeot region of Nunavut, as very little population change in NWT coastal communities is expected during the forecast period. Overall community demand is expected to grow from 50,500m^3 of dry cargo to 62,250m^3. POL demand will grow from 28,000m^3 to an estimated 34,200m^3. This added activity may add two barge loads to seasonal demand

ii) Quantity and Cargo

Estimated dry cargo community re-supply activity in the CASA region will be 570,250m^3, while estimated POL community re-supply activity will be 341,600m^3. Estimated additional consumption for north warning, exploration, and airport re-fuelling brings dry cargo activity up to 589,500m^3 and petroleum products up to 413,750m^3.

Further activity in support of High Lake would add:

- Mine support, dry cargo[132] 52,000 tonnes or 52,000m^3
- Mine support POL 140,000 tonnes or 182,000m^3
- Mine shipments 300-400,000 tonnes of concentrates[133]

[130] Advice from Baffinland Iron Ore Mines at CMAC Northern, Churchill November 2006.

[131] The climate change chapter has suggested increased storm activity in the Arctic. These could materially affect the safety of beach cargo delivery and lead to longer trips.

[132] Unlikely to be cube cargo, assumed to be 1m^3 per tonne

Churchill is expected to continue exporting wheat and other agricultural products. We have maintained the 2004 levels from section 5.7 for planning purposes. These estimates exclude support logistics and fuel for Mary River, Meadowbank, Meliadine and Hope Bay for which we have no reference base from which to estimate quantities.

Estimated minimum shipping activity in the CASA region by 2020:

- Dry Cargo 641,500m^3 (excluding Mary River and three gold mines)
- Petroleum 595,750m^3 (excluding Mary River and three gold mines)
- Bulk Mine 12-13,000,000 tonnes (including Mary River)
- Bulk Ags. 400,000 tonnes (Grains, peas, beans etc.)

These figures are for actual deliveries, and do not include transhipped (i.e. double-handled) cargo, retrograde or lateral cargo movements. These fluctuate year-by-year depending on opportunity and projects. We have not included possible cargo for re-supply to the diamond mines currently served from the south via NWT, but this activity could well add another 250,000m^3 of petroleum products as well as 100,000 tonnes of support materials in the Western Arctic. Project cargo for the oil sands could also add several shipments per season, mainly into Tuktoyaktuk.

[133] See Annex 10.5 for a discussion of quantities

7. THE NORTHWEST PASSAGE

This section starts off by placing the Northwest Passage and its components into a geographic and historical context. It then develops a model of the process through which a ship operator makes a choice between alternative routes. Recognizing that relative distances using the principal routes (the Panama Canal, Suez Canal, Northern Sea Route and Northwest Passage) is a primary factor in that determination – assuming no sea ice impediments – distances between port pairings are examined. Tables and maps are provided to show which routes are favoured, and where the boundaries between competing routes lie. Chapter 3.2 complements this discussion, and contains a detailed analysis of the NWP from a climactic perspective.

All of the component routes within the Northwest Passage pass through a number of zones categorized under the Zone/Date System. For clarity, the existing Zone/Date parameters for all of the zones are developed for an Arctic Class 1A ship and shown on a single map. The primary deep and shallow-draft routes are examined in the context of the relevant zones, and schematics are developed showing the relative dates of permitted entry for each Ice Class ship.

The Arctic Ice Regime Shipping System (AIRSS) is then examined, and a relationship between the Zone/Date System and AIRSS is considered in the context of a 2006 study undertaken by the Canadian Hydraulics Centre. The findings of the CHC study are examined to provide some direction with respect to how ice conditions, as they affect shipping, might alter consequent to climate change.

The alternative routes are then described with specific reference to ship size limitations, trade, expansion plans and transit costs. A table of ship sizes with respect to the most common types of ship is provided. A comparative costing for the four available routes is constructed for a Panamax bulk carrier for a voyage between Shanghai and New York.

7.1 Available Routes

Map 7.1 shows the primary routes used to transit – or attempt to transit – the Northwest Passage during the exploratory and pioneering phases (courtesy Athropolis Arctic Maps). The routes in Map 7.1 are as follows:

Route 1 (black)	typical route used for calls at primary communities, ice breaker assistance currently required south of Bylot, Lancaster Sound, Peel Sound, Victoria Strait, Dease Strait and Dolphin and Union Strait
Route 2 (white)	Roald Amundsen’s first navigation by ship (the *Gjoa*) in 1905, via King William Island and Simpson Strait
Route 3 (green)	*St. Roch’s* first west-east crossing in 1940-42, demonstrating Canadian sovereignty

Route 4 (yellow)	*St Roch's* return route in 1944, first vessel to travel the deep-sea route via Parry Channel and Prince of Wales Strait Subsequently this route was used by the *Manhattan* in 1969
Route 5 (brown)	Franklin expedition, fleet crushed and foundered west of King William Island in 1848
Route 6 (magenta)	Robert M'Clure proved route existed (by ship and sled)

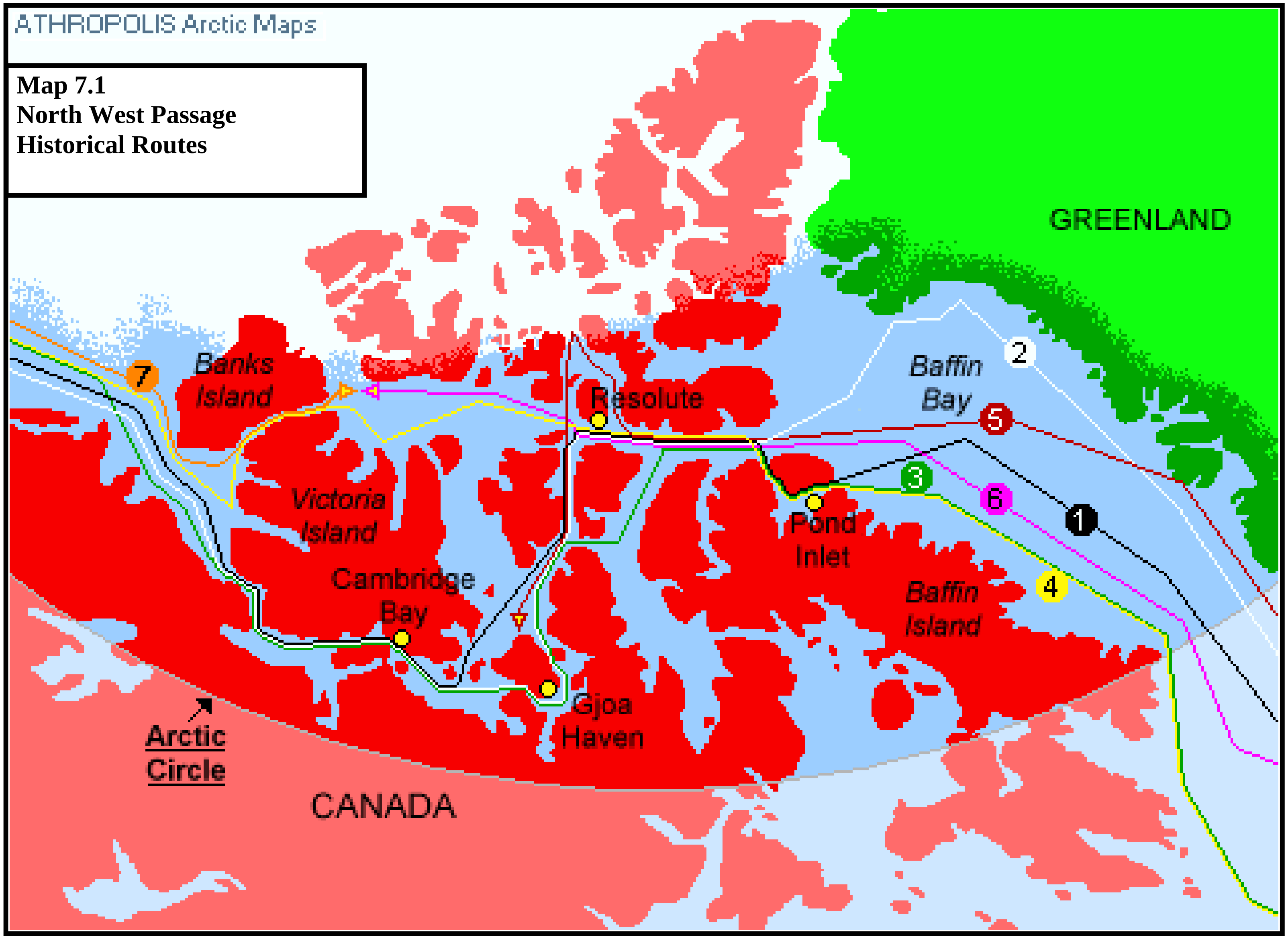
This historical context can be useful in any discussion of Arctic sovereignty, and specifically the treatment of the Northwest Passage.

Map 7.2 shows all of the potential routes that would be available for transit should the lower archipelago become ice-free. In this event, there would be no need to go south of Bylot Island.

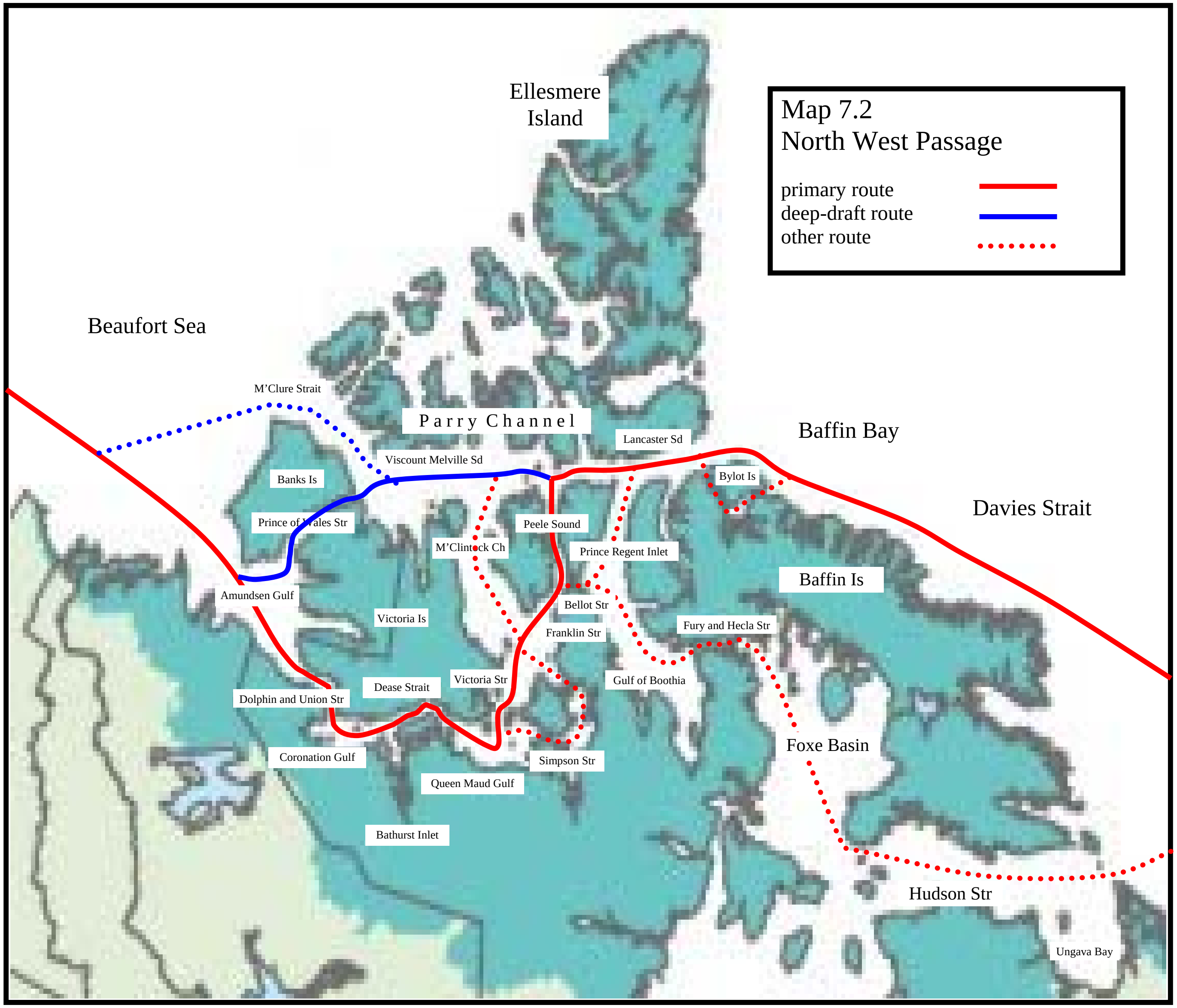
The **deep-water route** via Parry Channel and Prince of Wales Strait is mentioned above. Attempts to use the M'Clure passage have always been thwarted by ice (with the sole exception of the Russian icebreaker *Kapitan Khlebnikov* westbound in 2001 on an "adventure" cruise).

The **primary route** south of Victoria Island uses Peel Sound, then proceeds via Franklin Strait and west of King William Island via Victoria Strait, and continues through Dease Strait. This route is draft limited to 10m. M'Clintock Channel provides an alternative routing west of Prince of Wales Island. With a maximum depth of 6.4m, but less severe ice conditions, the waters to the east and south of King William Sound, exiting via the Simpson Strait into Queen Maud Gulf, have been used extensively. A variation is via Prince Regent Inlet and Bellot Strait, but it suffers from ice jams and swift currents. None of these routes are suitable for moderate or deep-draft ships.

A final variation is via Hudson Strait, Foxe Basin, Fury and Hecla Strait, Gulf of Boothia and Bellot Strait – where it connects with the primary route. This **southern route** is not typically considered to be part of the Northwest Passage. It involves two difficult straits and several locations where ice accumulates heavily.



Map 7.1
North West Passage
Historical Routes


Map 7.2
North West Passage
primary route
deep-draft route
other route
Ellesmere Island
Beaufort Sea
M'Clure Strait
Parry Channel
Lancaster Sd
Baffin Bay
Viscount Melville Sd
Banks Is
Bylot Is
Davies Strait
Prince of Wales Str
Peele Sound
M'Clintock Ch
Prince Regent Inlet
Baffin Is
Amundsen Gulf
Bellot Str
Victoria Is
Franklin Str
Fury and Hecla Str
Victoria Str
Gulf of Boothia
Dease Strait
Dolphin and Union Str
Foxe Basin
Coronation Gulf
Simpson Str
Queen Maud Gulf
Bathurst Inlet
Hudson Str
Ungava Bay

7.2 The Route Choice Model

Use of the Northwest Passage by commercial shipping is a function, relative to other routings, of:

- Route constraints
- Transit time
- Voyage costs
- Reliability/risk

Route constraints are a function of:

- Permanent physical characteristics, primarily minimum depth, width, air draft
- Anticipated weather and sea conditions
- Anticipated ice cover/type
- Ship dimensions and capabilities, including ice rating
- Support availability, ice breakers, specialist navigators

Transit time is a function of:

- Distance
- Service speed
- Possible delays

Voyage costs are a function:

- Transit time
- Daily hire (or equivalent) and fuel consumption
- En route service charges
- Incremental insurance premiums for being outside warranty limits

Reliability/risk is a function of:

- Predictability of transit conditions
- Accident/incident probability (and response/mitigation)

The decision to choose one route over another is laid out schematically in Diagram 7.1 on the following page. This is perhaps best looked at as a function of demand and supply, where demand is the ship (in blue) and supply is the route (in green). It is the interaction of demand and supply that provides the primary factors on which a choice will be made:

- Is the route suitable (binary – yes/no)?
- What are the costs?
- What are the risks/size of possible variances?
- What is the total voyage time?
- What are the risks/sizes of possible variances?
- What is the time sensitivity?

When making a route choice, an experienced ship operator should take into account any environmental sensitivities that may apply to a specific route. Typically, however, when these are over-and-above standard operating practices, they are institutionalized through compulsory pilotages, ice navigators, oil spill response plans, proof of financial responsibility, ice strengthening minimums (e.g. Zone/Date System, AIRSS), etc.

Frequently, the host country will provide guidance documents that provide useful passage planning tools as well as required procedures. For the Canadian Arctic, these include the DFO's Marine Environmental Handbook, pollution prevention guidelines for cruise ships, AIRSS user assistance package, ice navigation training aids, etc.

7.3 Route Choice and Distances

The Northwest Passage appears to offer a distance advantage for traffic between a number of primary origins and destinations, namely:

- The east and west coasts of North America
- Eastern Asia and the east coast of North America
- Eastern Asia and Europe and the Mediterranean
- Europe and the west coast of North America

Each one of these routes is examined below, using distance tables and route maps, to determine which port pairings are viable from the perspective of distance alone.

i) Routes between Ports in North America

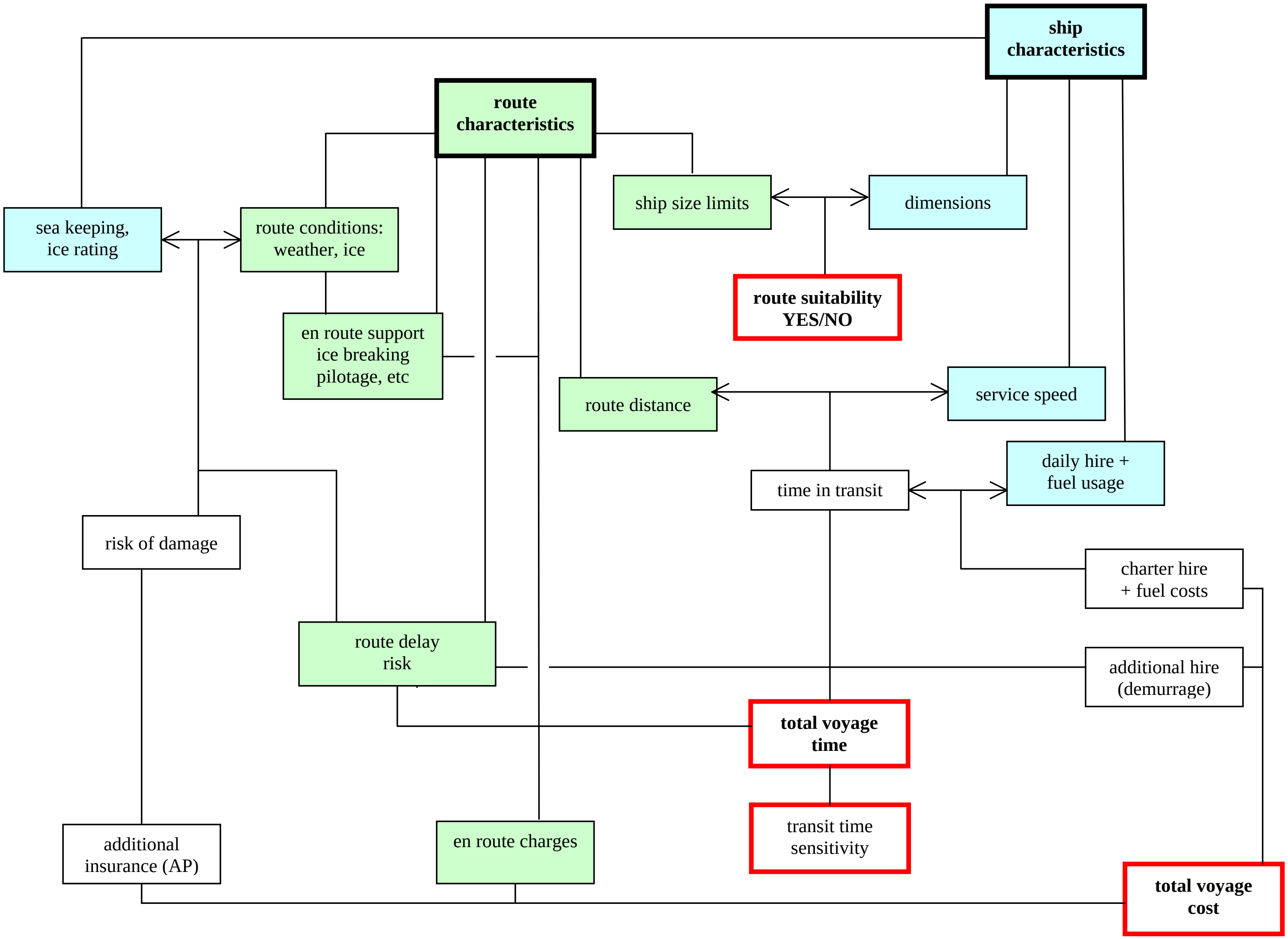
With an available choice of either the Panama Canal (mapped in red) or the Northwest Passage (blue), the shortest all-water distances between major ports on the west and east coasts of North America are shown in Table 7.1. The cells highlighted in red are distances via the Northwest Passage and those highlighted in blue are via Panama.

The specific ports against which distances are shown were selected to minimize presentation clutter. For example, *Seattle* is referenced on Victoria, because it matters not, with respect to the Seattle/Victoria leg, whether the Panama Canal or Northwest Passage is chosen for a trip originating or ending in Seattle, as both routes pass Victoria (the reference port).[134]

It should also be recognized that route distances are far from precise in practice, when actual distance steamed is affected (for example) by the selection of a great circle or rhumb line course, weather or ice-avoidance routing, the location of pilot stations, etc.

[134] This approach is used throughout the section. *St Lawrence* ports are referenced on St John's, *Northern China* ports are referenced on Busan, *Southern China* ports on Hong Kong, etc.

Diagram 7.1 ROUTE CHOICE



The port groups shown on the three route maps provide an indication of where a realistic route choice is available (all other things being equal).

Table 7.1 North America Origin/Destination Port Groups distances (nautical miles)

	St John's *St Lawrence*	Halifax	New York *Boston*	Philadelphia *Newport News*	Jacksonville	Miami
	NW Passage			**Panama Canal**		
Anchorage *Valdez*	5434	5964	6529	6587	6133	5980
Ketchikan *Prince Rupert*	5944	6474	6026	5851	5397	5244
Victoria *Vancouver/Seattle*	6338	6194	5629	5454	5000	4847
Astoria *Portland*	6378	6024	5459	5284	4830	4677
San Francisco *Oakland*	6009	5479	4914	4739	4285	4132
Long Beach/Los Angeles	5662	5132	4567	4392	3938	3785
San Deigo	5597	5067	4502	4327	3873	3720

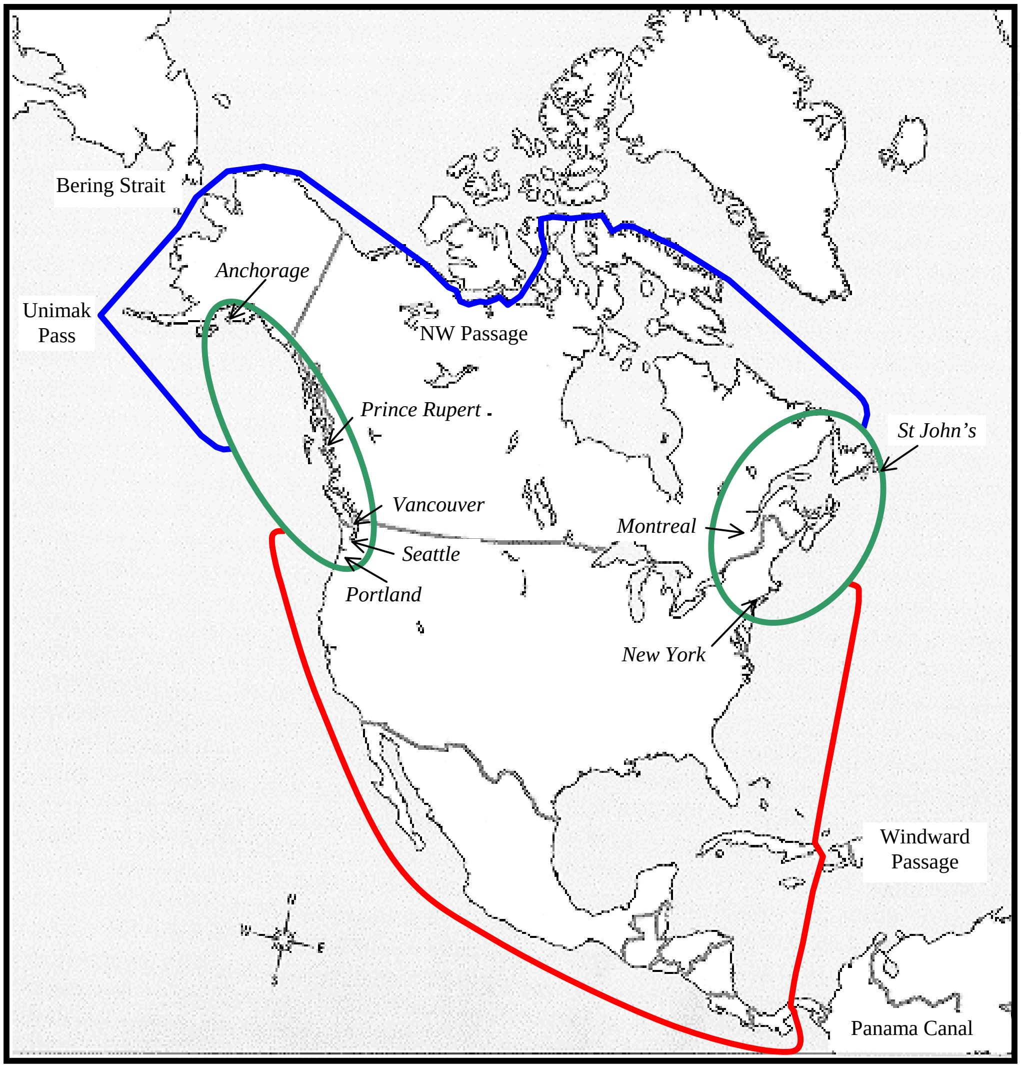
Map 7.3 of North America, in combination with Table 7.1 above, shows the port groups where route choice may be available. The effective ranges as shown on the map are Anchorage(AK)/Portland(OR) and St John's(NL)/New York(NY). However, this does not mean that Portland to New York is shorter via the Northwest Passage. As the origin port is shifted down the west coast, the viable destination port via the Northwest Passage effectively moves up the east coast. Anchorage to New York is a viable Northwest Passage route, as is Portland, Oregon to St John's and ports on the St Lawrence. New York to Portland is not.

ii) Routes Between Ports in Asia and North America

With an available choice of the Suez Canal, the Panama Canal, the Northern Sea Route and the Northwest Passage, the shortest all-water distances between major ports in East Asia and the east coast of North America are shown in Table 7.2. The cells highlighted in blue are distances via the Northwest Passage (mapped in blue) and those highlighted in red are via Suez. Again, certain ports are used as reference ports for other port groups for overall clarity.

Map 7.4 in combination with Table 7.2 shows the port groups where route choice between the Northwest Passage and Suez may be available. The effective ranges as shown on the map are Miami(FL)/St John's and Vladivostok/Singapore. It should be noted, however, that traditional world map projections mean that some of the more visually-intuitive pairings are not actually valid. Changes in ice conditions that allow the use of the most direct route via Barrow(AK), Viscount Melville and M'Clure Straits, reduce the Northwest Passage distance and expand the range of viable origin/destination ports.

Map 7.3
North America Origin/Destination Port Groupings
Northwest Passage and Panama Canal Routes Compared



The green ellipse on the west coast defines the range of ports that may be closer to a port within the green ellipse on the east coast if the Northwest Passage is used – where distance is the sole criteria. In other words, the further north the origin port is in one ellipse, then the further south is the destination port in the other ellipse, where the route distance is shorter via the Northwest Passage than via the Panama Canal.

Also shown on the map is the Trans-Pacific Landbridge route between East Asia and the central/ eastern population centres and eastern seaboard ports of North America. This is the route currently favoured for container shipments (primarily imports into North America).

Not shown on either the table or the map are the routes via Panama or the Northern Sea Route. This is because the Northwest Passage is the shortest route for all East Asian ports except in the extreme southeast section (Singapore, for example) which favour the Suez Canal over all other routes.

Under current circumstances, where neither of the northern routes is available, the all-water routes of choice between the ports under consideration split between the Panama Canal and Suez. Panama is favoured for all northern ports in Asia to all east coast ports in North America; while Suez captures most south eastern ports in Asia to the more northern of the east coast ports in North America.

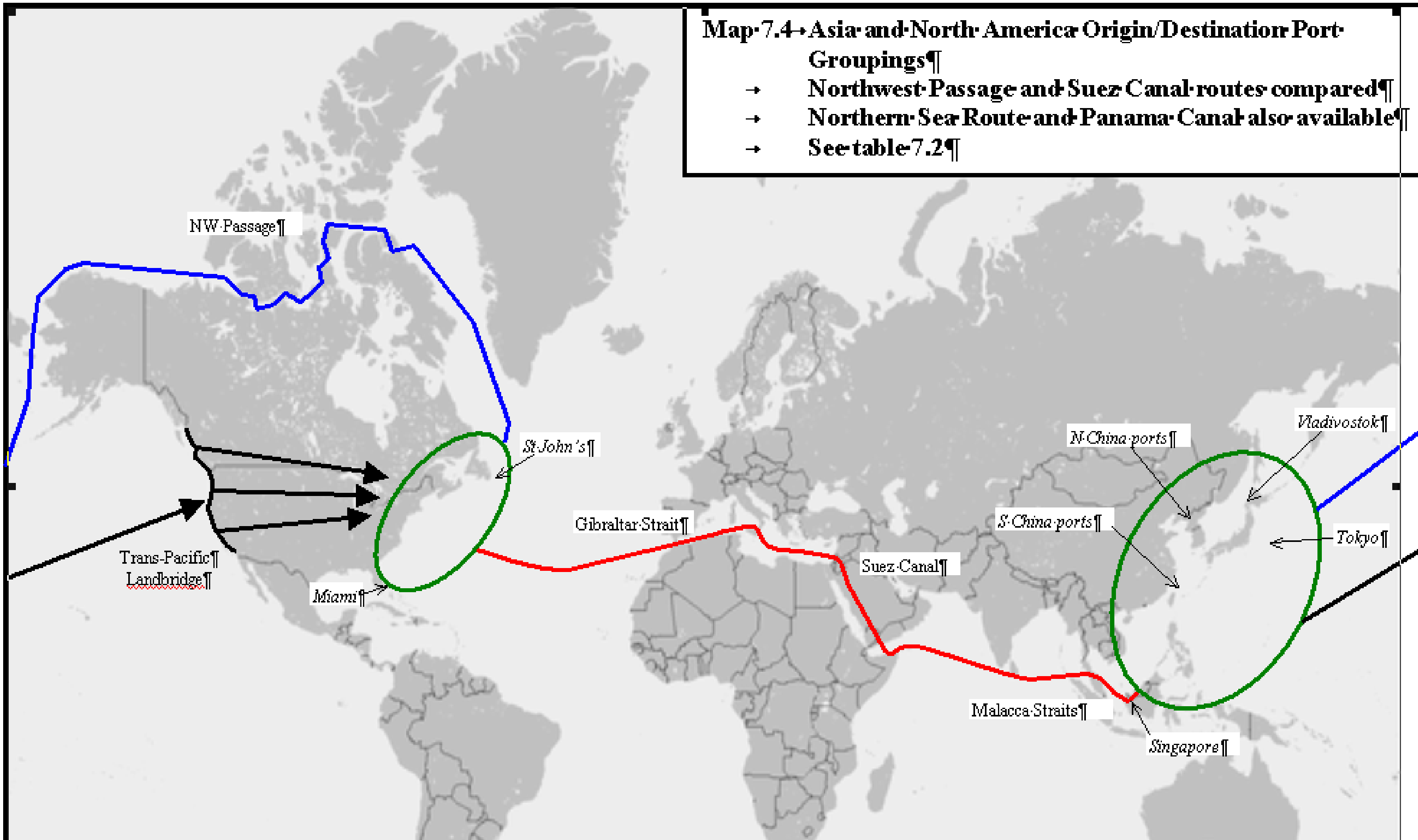
If the Northern Sea Route is available, as well as both canals (with the Northwest Passage closed), the Northern Sea Route has the potential to capture many of the origin/destination port combinations, especially where northern Asia ports are combined with northern ports on North America's eastern seaboard.

Table 7.2 North America Far East Origin/Destination Port Groups
Distances in Nautical Miles

	St John's *St Lawrence*	Halifax	New York *Boston*	Philadelphia *Newport News*	Jacksonville	Miami
			NW Passage			
Vladivostok	6611	7141	7706	7881	8335	8488
Tokyo	6715	7245	7810	7985	8439	8592
Busan *North China*	6990	7520	8085	8260	8714	8867
Kaohsiung	7933	8463	9028	9203	9657	9810
Hong Kong *South China*	8176	8706	9271	9446	9900	10053
Manila	8407	8937	9502	9677	10131	10284
Singapore	9173	9715	10208	10373	10748	10819
			Suez Canal			

Map 7.4 Asia and North America Origin/Destination Port Groupings

- **Northwest Passage and Suez Canal routes compared**
- **Northern Sea Route and Panama Canal also available**
- **See table 7.2**



The green ellipse in Eastern Asia defines the range of ports that may be closer to a port within the green ellipse on the east coast of North America if the Northwest Passage is used — where distance is the sole criteria. The further south the port is in the Eastern Asia ellipse, the more likely a Suez routing would be preferred. Changes in ice conditions that allow the use of the most direct route via Barrow, Viscount Melville and M'Clure straits reduce the Northwest Passage distances and expand the range of viable port pairings.

iii) Routes between Ports in Asia, Europe and the Mediterranean

With an available choice of all four routes, the shortest all-water distances between major ports in Eastern Asia, Europe and the Mediterranean are shown in Table 7.3. The cells highlighted in blue are distances via the Northwest Passage (mapped in blue), those in red are via Suez and those in magenta are via the Northern Sea Route. Reference ports are again used to reduce clutter.

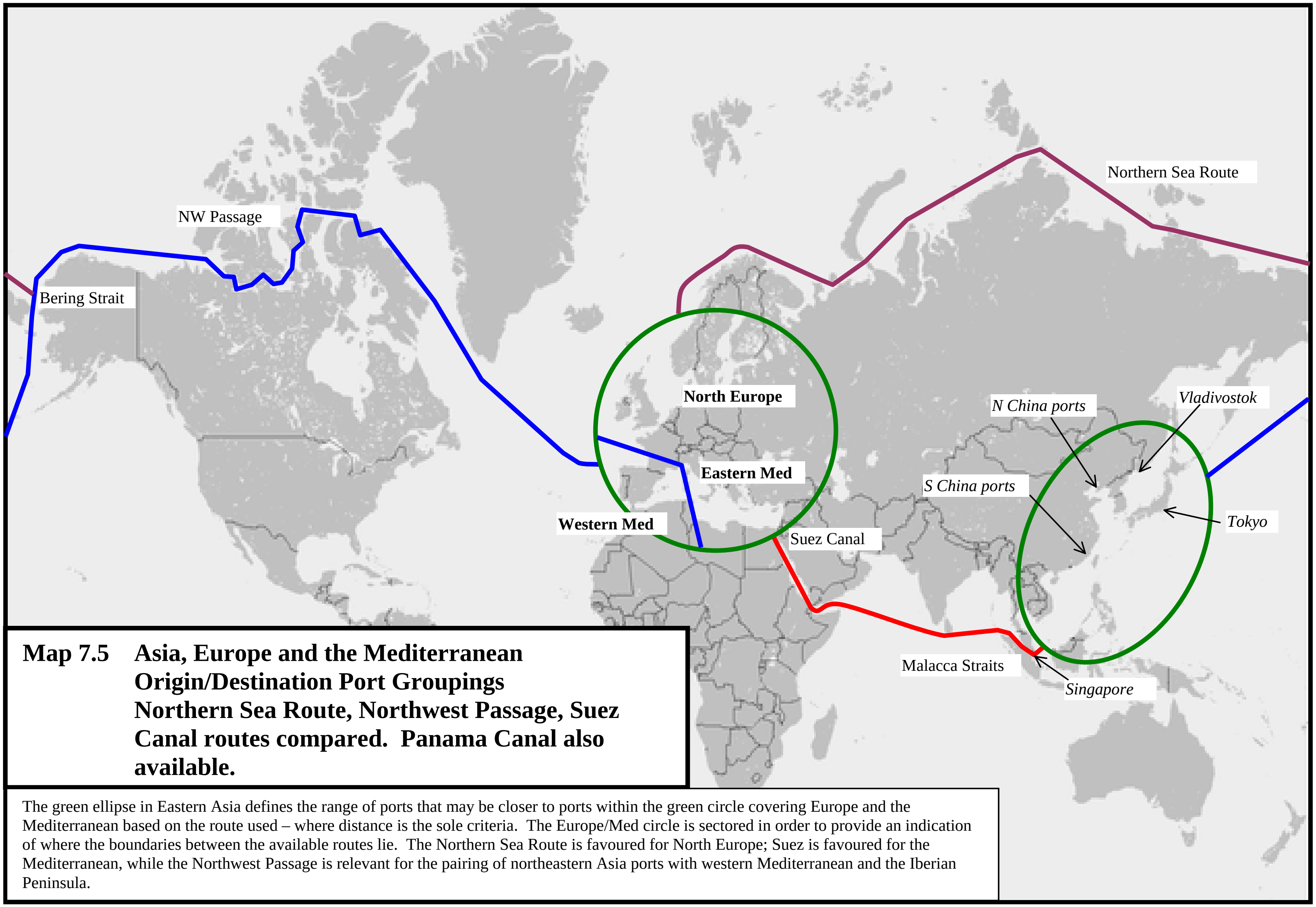
Map 7.5 in combination with Table 7.3 shows the port groups where the route choice is between the Northern Sea Route, the Northwest Passage and Suez. The Panama Canal is not in the picture for any port pairing.

The Europe/Mediterranean/North Africa circle is sectored in the map to give an idea of where the route boundaries are. It should be noted, however, that some of the differences that result in choosing one specific route over another at these boundaries are quite small and could be subject to a variety of offsetting factors (discussed in later sections).

Table 7.3 European to Far East Origin/Destination Port groupings
Distances in nautical miles

Table 3 Distances (nautical miles)			Vladi-vostok	Tokyo	Busan *N China*	Kaoh-siung	Hong Kong *S China*	Manila	Sing-apore
					Northern Sea Route				
Oslo	*Baltic*		7164	7269	7543	8486	8730	8933	8441
Hamburg	*North*		7263	7368	7642	8585	8829	9032	8342
Rotterdam	*Sea*		7320	7425	7699	8642	8886	9089	8285
London	*English Ch*		7389	7494	7768	8711	8955	9158	8216
Gibraltar	*Iberian Pen*	**NW**	8135	8239	8514	8547	8303	8100	6963
Marseille	*W Med*	**Pass**	8841	8945	8784	7841	7597	7394	6257
Trieste	*C Med*		8144	8039	7765	6822	6578	6375	5238
Istanbul	*Black Sea*		8058	7953	7679	6736	6492	6289	5152
Alexandria	*E Med*		8057	7952	7678	6735	6491	6288	5151
					Suez Canal				

In general, the favoured routing from all ports in East Asia (except for the extreme south eastern sector) to all ports in North Europe is via the Northern Sea Route. The favoured route from all ports in East Asia (including Singapore) to the eastern and central Mediterranean is via the Suez Canal. The Northwest Passage is relevant for the western Mediterranean and the Iberian Peninsula, but only for those ports located in northeast Asia.



Map 7.5 Asia, Europe and the Mediterranean Origin/Destination Port Groupings Northern Sea Route, Northwest Passage, Suez Canal routes compared. Panama Canal also available.

The green ellipse in Eastern Asia defines the range of ports that may be closer to ports within the green circle covering Europe and the Mediterranean based on the route used – where distance is the sole criteria. The Europe/Med circle is sectored in order to provide an indication of where the boundaries between the available routes lie. The Northern Sea Route is favoured for North Europe; Suez is favoured for the Mediterranean, while the Northwest Passage is relevant for the pairing of northeastern Asia ports with western Mediterranean and the Iberian Peninsula.

iv) Routes between Ports in Europe and North America

The Northwest Passage is a shorter all-water route than Panama between port pairings in northern European (down to the Iberian Peninsula) and the west coast North America (north of central California). For all of these port pairings, however, the Northwest Passage is longer than the Northern Sea Route.

Based on relative ice conditions, the Northern Sea Route is likely to become an established transit route long before the Northwest Passage.

v) Summary

Taking steaming distance as the sole criteria; with all of the four primary all-water routings available (Panama Canal, Suez Canal, Northern Sea Route and the Northwest Passage), and assuming that the vessel in question is not restricted in choice of route by its dimensions, the analysis above has demonstrated that the Northwest Passage offers a distance advantage for traffic between a number of primary origins and destinations, namely:

- The east and west coasts of North America for a narrow range of port pairs
- Eastern Asia (north of Singapore) and the entire east coast of North America
- Northeast Asia and the western Mediterranean (including the Iberian Peninsula)

The Northern Sea Route provides a shorter distance than the Northwest Passage for all port pairings in Europe and the west coast of North America. It also provides better access for port pairs in eastern Asia (north of Singapore) and Northern Europe.

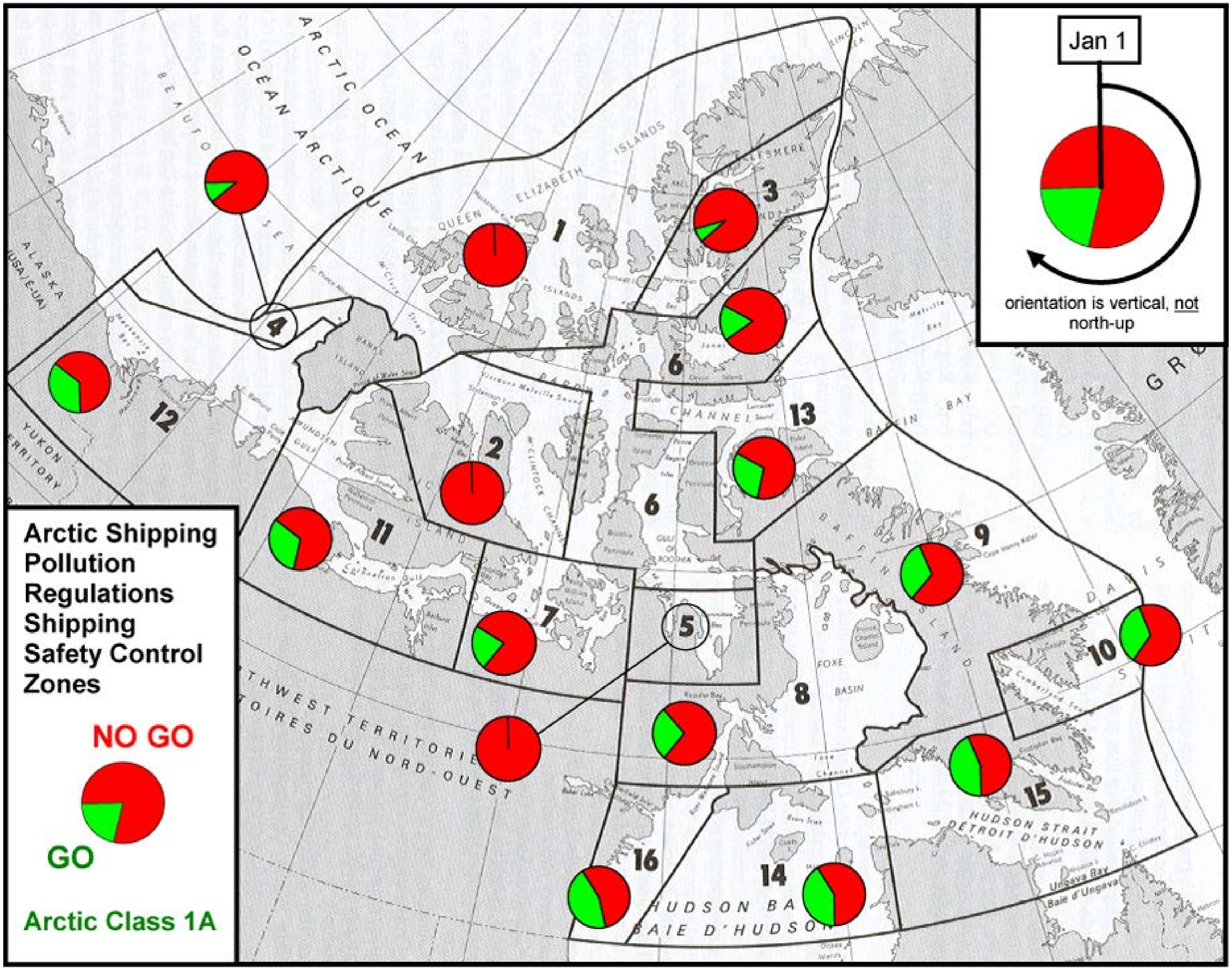
7.4 Zone/Date System

The Arctic Shipping Pollution Prevention Regulations were drafted in 1972. They regulate navigation in Canadian waters north of 60^{o} through the Zone/Date System. The System consists of 16 geographic zones and an associated table that shows when a vessel of a specific class is permitted to enter a zone. The system assumes that the prevailing ice conditions in each zone are consistent year-on-year. The most severe ice conditions are expected in Zone 1 and decrease progressively, with the least in Zone 16. The zones and dates are based on historical ice data. There have been no changes to the Zone/Date System since implementation.

Map 7.6 is a pictorial representation of the spread of permitted zone entry dates for an Arctic Class 1A ship.

i) Zone/Date System and the Northwest Passage

A ship using either the standard or deep-draft routes crosses a number of individual zones during its transit of the Northwest Passage.


Arctic Shipping Pollution Regulations Shipping Safety Control Zones
NO GO
GO
Arctic Class 1A
Jan 1
orientation is vertical, not north-up
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
ARCTIC OCEAN
OCÉAN ARCTIQUE
BEAUFORT SEA
ALASKA (USA/É-UA)
YUKON TERRITORY
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
FOXE BASIN
HUDSON STRAIT
DÉTROIT D'HUDSON
HUDSON BAY
BAIE D'HUDSON

ARCTIC SHIPPING POLLUTION REGULATIONS
SHIPPING SAFETY CONTROL ZONES - PERMITTED DATES OF ENTRY
NORTH WEST PASSAGE - SHALLOW-DRAFT ROUTING
CONTROL ZONES ENCOUNTERED

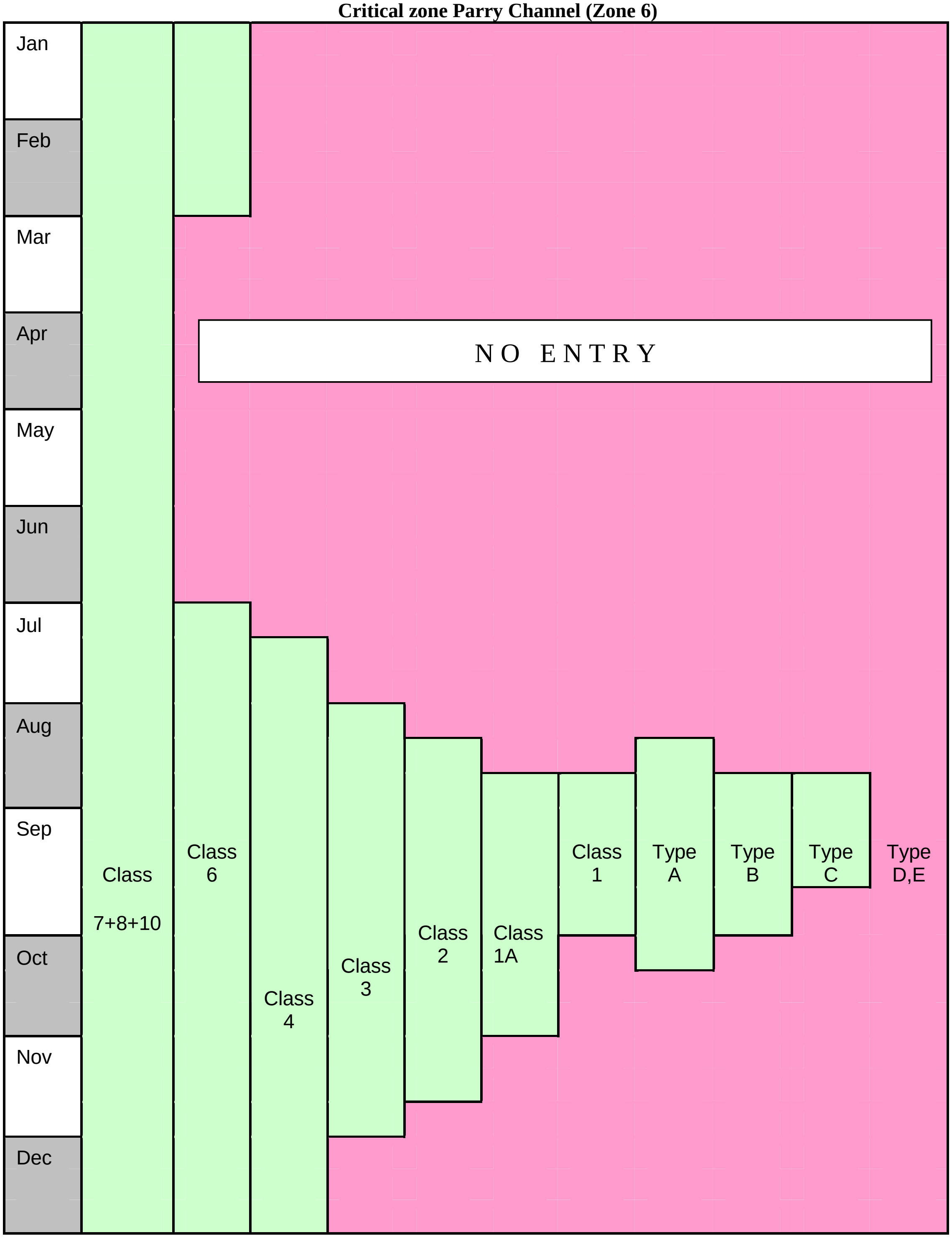
Dolphin and Union - Dease - Victoria - Peel - Lancaster

		12 Amundsen S	11 P/Wales S	7 Q/Maud G	**6** **Parry Ch**	13 Lancaster Sd
Arctic Class	**10**	all year	all year	all year	all year	all year
	8	all year	all year	all year	all year	all year
	7	all year	all year	all year	all year	all year
	6	all year	Jul 1/Mar 31	Jul 1/Mar 31	Jul 15/Feb 28	all year
	4	Jun 1/Jan 31	Jul 5/Jan 15	Jul 15/Jan 15	Jul 20/Dec 31	Jun 1/Feb 15
	3	Jun 10/Dec 31	Jul 5/Dec 15	Jul 20/Dec 15	Aug 1/Nov 30	Jun 10/Dec 31
	2	Jun 15/Dec 5	Jul 10/Nov 20	Aug 1/Nov 20	Aug 15/Nov 20	Jun 25/Nov 22
	1A	Jul 1/Nov 10	Jul 15/Nov 10	Aug 10/Nov 5	Aug 25/Oct 31	Jul 15/Oct 31
	1	Jul 1/Oct 31	Jul 15/Oct 20	Aug 10/Oct 15	Aug 25/Sep 30	Jul 15/Oct 15
Type	**A**	Jun 15/Nov 10	Jul 10/Oct 31	Aug 1/Oct 25	Aug 15/Oct 15	Jun 25/Oct 22
	B	Jul 1/Oct 25	Jul 15/Oct 20	Aug 10/Oct15	Aug 25/Sep 30	Jul 15/Oct 15
	C	Jul 1/Oct 25	Jul 15/Oct 15	Aug 10/Oct 10	Aug 25/Sep 25	Jul 15/Oct 10
	D	Jul 1/Oct 20	Jul 15/Oct 10	Aug 10/Oct 5	no entry	Jul 30/Sep 30
	E	Jul 1/Oct 20	Jul 15/Sep 30	Aug 10/Sep 30	no entry	Aug 15/Sep 20

critical zone (Parry Ch)

Note: under the Arctic Ice Regime Shipping Systems (AIRSS) a vessel may enter a control zone where the ice numeral, derived from the concentration of ice types in the zone and the ice class of the ship, is positive. This permits flexibility in the face of known conditions, rather than an outright prohibition irrespective of the pertaining conditions.

ARCTIC SHIPPING POLLUTION REGULATIONS
SHIPPING SAFETY CONTROL ZONES - PERMITTED DATES OF ENTRY
NORTH WEST PASSAGE - SHALLOW-DRAFT ROUTING
via Peel Sound
Critical zone Parry Channel (Zone 6)



Note: under the Arctic Ice Regime Shipping Systems (AIRSS) a vessel may enter a control zone where the ice numeral, derived from the concentration of ice types in the zone and the ice class of the ship, is positive. This permits flexibility in the face of known conditions, rather than an outright prohibition irrespective of the pertaining conditions.

ARCTIC SHIPPING POLLUTION REGULATIONS
SHIPPING SAFETY CONTROL ZONES - PERMITTED DATES OF ENTRY
NORTH WEST PASSAGE - DEEP-DRAFT ROUTING
CONTROL ZONES ENCOUNTERED

M'Clure Strait - Parry Channel

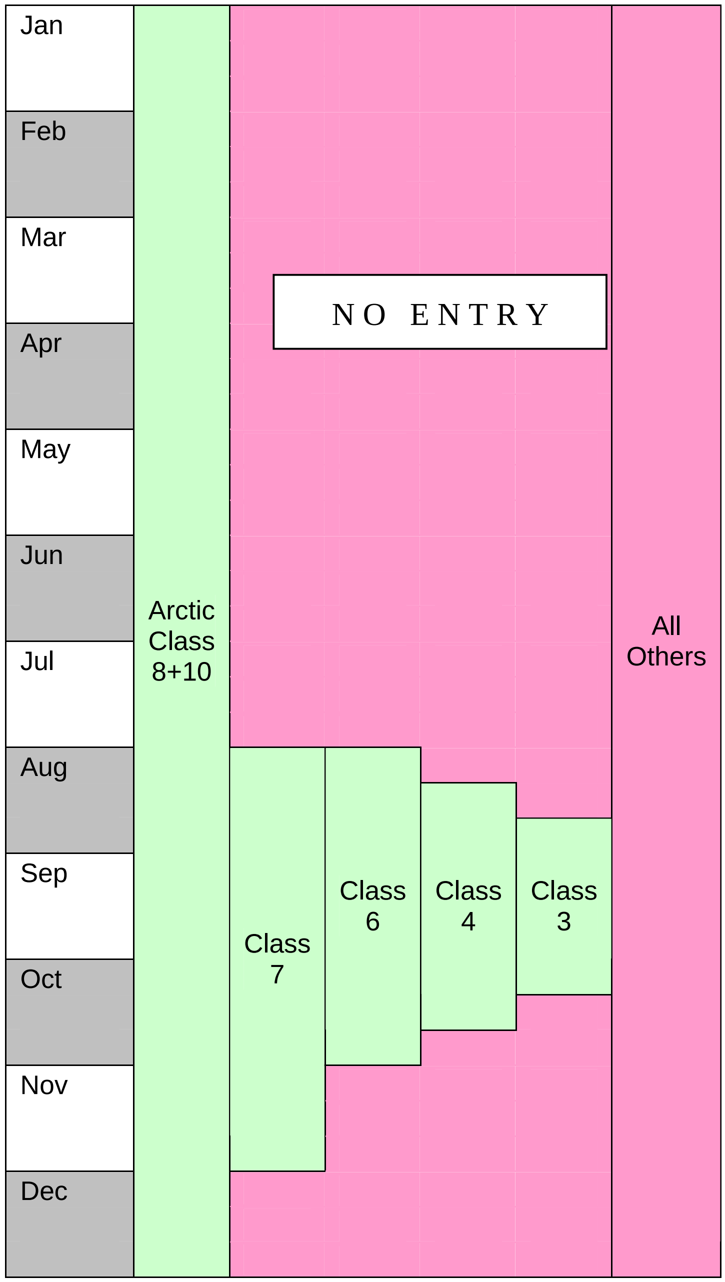
Parry Channel and Prince of Wales Strait

		1 **M'Clure St**	12 Amundsen S	11 P/Wales S	2 **P/Wales N**	6 Parry Ch	13 Lancaster Sd
Arctic Class	**10**	all year	all year	all year	all year	all year	all year
	8	July 1/Oct 15	all year	all year	all year	all year	all year
	7	Aug 1/Sep 30	all year	all year	Aug 1/Nov 30	all year	all year
	6	Aug 15/Sep 15	all year	Jul 1/Mar 31	Aug 1/Oct 31	Jul 15/Feb 28	all year
	4	Aug 15/Sep 15	Jun 1/Jan 31	Jul 5/Jan 15	Aug 15/Oct 15	Jul 20/Dec 31	Jun 1/Feb 15
	3	Aug 20/Sep 15	Jun 10/Dec 31	Jul 5/Dec 15	Aug 20/Sep 30	Aug 1/Nov 30	Jun 10/Dec 31
	2	no entry	Jun 15/Dec 5	Jul 10/Nov 20	no entry	Aug 15/Nov 20	Jun 25/Nov 22
	1A	no entry	Jul 1/Nov 10	Jul 15/Nov 10	no entry	Aug 25/Oct 31	Jul 15/Oct 31
	1	no entry	Jul 1/Oct 31	Jul 15/Oct 20	no entry	Aug 25/Sep 30	Jul 15/Oct 15
Type	**A**	no entry	Jun 15/Nov 10	Jul 10/Oct 31	no entry	Aug 15/Oct 15	Jun 25/Oct 22
	B	no entry	Jul 1/Oct 25	Jul 15/Oct 20	no entry	Aug 25/Sep 30	Jul 15/Oct 15
	C	no entry	Jul 1/Oct 25	Jul 15/Oct 15	no entry	Aug 25/Sep 25	Jul 15/Oct 10
	D	no entry	Jul 1/Oct 20	Jul 15/Oct 10	no entry	no entry	Jul 30/Sep 30
	E	no entry	Jul 1/Oct 20	Jul 15/Sep 30	no entry	no entry	Aug 15/Sep 20

critical zones

**ARCTIC SHIPPING POLLUTION REGULATIONS
SHIPPING SAFETY CONTROL ZONES - PERMITTED
DATES OF ENTRY**

**NORTH WEST PASSAGE - DEEP-DRAFT ROUTING
Prince of Wales Strait (Zone 2)**



M'Clure Strait more restricted

Note: under the Arctic Ice Regime Shipping Systems (AIRSS) a vessel may enter a control zone where the ice numeral, derived from the concentration of ice types in the zone and the ice class of the ship, is positive. This permits flexibility in the face of known conditions, rather than an outright prohibition irrespective of the pertaining conditions.

For an east to west transit, a shallow-draft ship would typically transit Davies Strait and Baffin Bay on the Greenland side where ice is less prevalent. Both routes then enter Zone 13 (Lancaster Sound) and proceed into Zone 6 (Parry Channel).

At this point, the shallow-draft ship follows Peel Sound and enters Zone 7 (Queen Maud Gulf) northwest of King William Island. Zone 11 is entered as the ship approaches Dease Strait. Zone 12 covers the progress of the ship from the Amundsen Gulf to the Beaufort Sea.

Meantime, a deep-draft ship would continue along Parry Channel, entering Zone 2 in Viscount Melville Sound, and thence southwest along Prince of Wales Strait, before entering Zone 12 (and rejoining the shallow-draft route) in the Amundsen Gulf.

Both routes may involve significant choke points where severe ice conditions can be expected.

The go/no-go dates for each class of ship in each zone is shown in the accompanying tables and graphics for both the shallow and deep-draft routes through the Northwest Passage. The entry dates for Zone 1 and the M'Clure Strait are also included in the deep-draft table for reference.

ii) Arctic Ice Regime Shipping System (AIRRS)

Variations in ice conditions can result in the Zone/Date System permitting the entry of a ship into a zone where known ice conditions are overly-severe for the ship as designed. Equally, entry may not be allowed when ice conditions are relatively benign. This led to the creation of the Arctic Ice Regime Shipping System (AIRRS) and its implementation in 1996 as a regulatory standard. AIRRS provides the master and ice navigator with a formula to calculate an Ice Numeral based on known ice conditions in the zone and the ice classification of the vessel. If the Ice Numeral is positive then the ship may proceed. If negative, then entry is not permitted.

Although AIRRS has the potential to replace the Zone/Date System, it is generally used to allow access to a zone outside of the proscribed entry dates.[135]

AIRRS uses a ship classification system based on Canadian Arctic Class (CAC) and international Ship Types. Table 7.4 below provides further information (and equivalencies for Arctic Class ships)[136].

[135] Over three seasons starting in 2004, AIRRS was used to permit the tanker Tuvaq into Kugaaruk; under the Zone/Date System a tanker of the Tuvaq's ice class would not have been permitted at any time.

[136] The ice classes referenced are those in the Canadian regulations; other national and multi-national designations exist. There is also a Polar Class referenced in Canadian literature relative to the Polar Code. These classes are not exactly the same as the ones in the table. The lowest Polar classes are equivalent to Baltic 1AS and 1A.

Table 7.4
Arctic and Ice Class Equivalencies

Arctic Class	CAC/Type	Operating Role	Ice Type
10	CAC1	unrestricted	multi-year ice
8	CAC2	transit or controlled ice breaking	multi-year ice
7			
6	CAC3	transit or controlled ice breaking	second year ice
4			
3	CAC4	transit or controlled ice breaking	thick first year ice
2			
1A			
1			
	A	transit	medium first year ice
	B	transit	thin first year ice – 2nd stage
	C	transit	thin first year ice – 1st stage
	D	transit	grey-white ice
	E	transit	grey ice

iii) Canadian Hydraulics Centre Study (2006)

Following a two-year research program funded by the Climate Change Action Fund and Transport Canada, CHC produced a technical report in February 2006 entitled *Impact of Climate Change on Arctic Shipping: Vessel Damage and Regulations*.[137] The primary objective of the project was to assess the impacts of climate change on the likelihood and severity of damage to vessels operating in Arctic waters, and to address the impacts of climate change on the pollution prevention regulations governing ship traffic in the Arctic. It was also intended to provide advice to Transport Canada on the further development of Arctic shipping regulations, to assist shipping companies in evaluating the future length of the shipping season, and ship investment and design decisions.

The report extracts, collates and analyzes ice data in order to determine the existing and potential changes to the ice regimes in the Northwest Passage and the Hudson Strait (Churchill access). Using historical ice analysis charts, the study provides graphical representations of the applicable Ice Numerals for a Type B vessel for a colder and a warmer year between 1968 and 2004 (specifically 1986 and 1998) and compares potential access under AIRRS to permitted access under the Zone/Date System. The report provides examples of how the Zone/Date window for Zone 11 could be modified for the two sample years. Graphics covering all of the zones relevant to each route are provided in Appendix B, but without the potential window modifier.

Each relevant zone was then examined for actual ice behaviour, in order to obtain a better understanding of how navigation is affected, and the relevance of the existing zone dates when local peculiarities are taken into account. Zone 2 was added as it is part of the deep-draft channel within the Northwest Passage through the Prince of Wales Strait – even though a Class B vessel is not currently permitted any access.

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[137] *The Impact of Climate Change on Arctic Shipping: Vessel Damage and Regulations* Technical Report CHC-TR-038, Ivan Kubat, Anne Collins, Bob Gorman and Garry Timco, Canadian Hydraulics Centre, National Research Council Canada

Some zones exhibit a significant shift in the potential access window. The tendency for slightly later openings and significantly later closures is apparent for some zones. In others, especially at the western end of the Northwest Passage, a warmer year results in greater amounts of multi-year ice drifting into the zones which would close a window for some classes of ship. A greater range of variability year-on-year can be expected as climate change progresses.

Probably the most important conclusion of the report is as follows:

> "*The results suggest shifting the opening and closing dates in most of the Zones for Type B vessel…. Type B vessel does not adequately reflect the tendency for negative ice numerals in some Zones, even in warmer than normal summers, i.e. even if temperatures increase in the Canadian Arctic over this century. On the other hand, the shipping season for Type B vessel in some Zones closes prior to the growth of the limiting ice season.*"

A critique of the study is outside the scope of this review. That said, using warmer years as a surrogate for climate change would not appear to take into account long term thinning of multi-year ice. In addition, it also examined melting degree days while not assessing the impact of freezing degree days of the corresponding winter.

iv) Interpretation

Using the Ice Numeral graphics provided in the CHC report for the Type B vessel, the consultants endeavoured to find some method of describing potential ice trends for each zone through to 2020 on the basis of the predicted warming trend. In the end, however, it was concluded that there was insufficient information to generate reliable material.

Interpretation of the graphics was restricted to the material as presented, i.e. for the two years analyzed by CHC: 1986 being the colder year, and 1998 the warmer. Table 7.5 following should therefore be treated with extreme caution – it is an interpretation of the charts provided, it does not invalidate the Zone/Date System, nor does it provide any prediction of ice conditions in the future. The material is laid out to show a standard and a deep-draft transit of the Northwest Passage east-to-west, and also access to Churchill.

ZONE/ROUTE	WARMER YEAR		COLDER YEAR		REMARKS
	opening	**closing**	**opening**	**closing**	
NWP standard					
13	9 days earlier	45 days later[a]	20 days earlier	40 days later	
6	10 days later	60 days later[a]	closed	closed	Larsen Sound choke
7	15 days later	45 days later[a]	closed	closed	
11	20 days later	40 days later	55 days later	35 days later	CHC conclusion pps37/8
12	45 days earlier	35+ days later[a]	20 days later	40+ days later[a]	potential choke point
NWP deep-draft					
2	August 30	October 10	closed	closed	Type B no entry
Churchill access					
15	15 days earlier	later[a]	25 days later	later[a]	
14	no change	later[a]	25 days later	later[a]	
16	20 days earlier	30+ days later[a]	no change	30+ days later[a]	

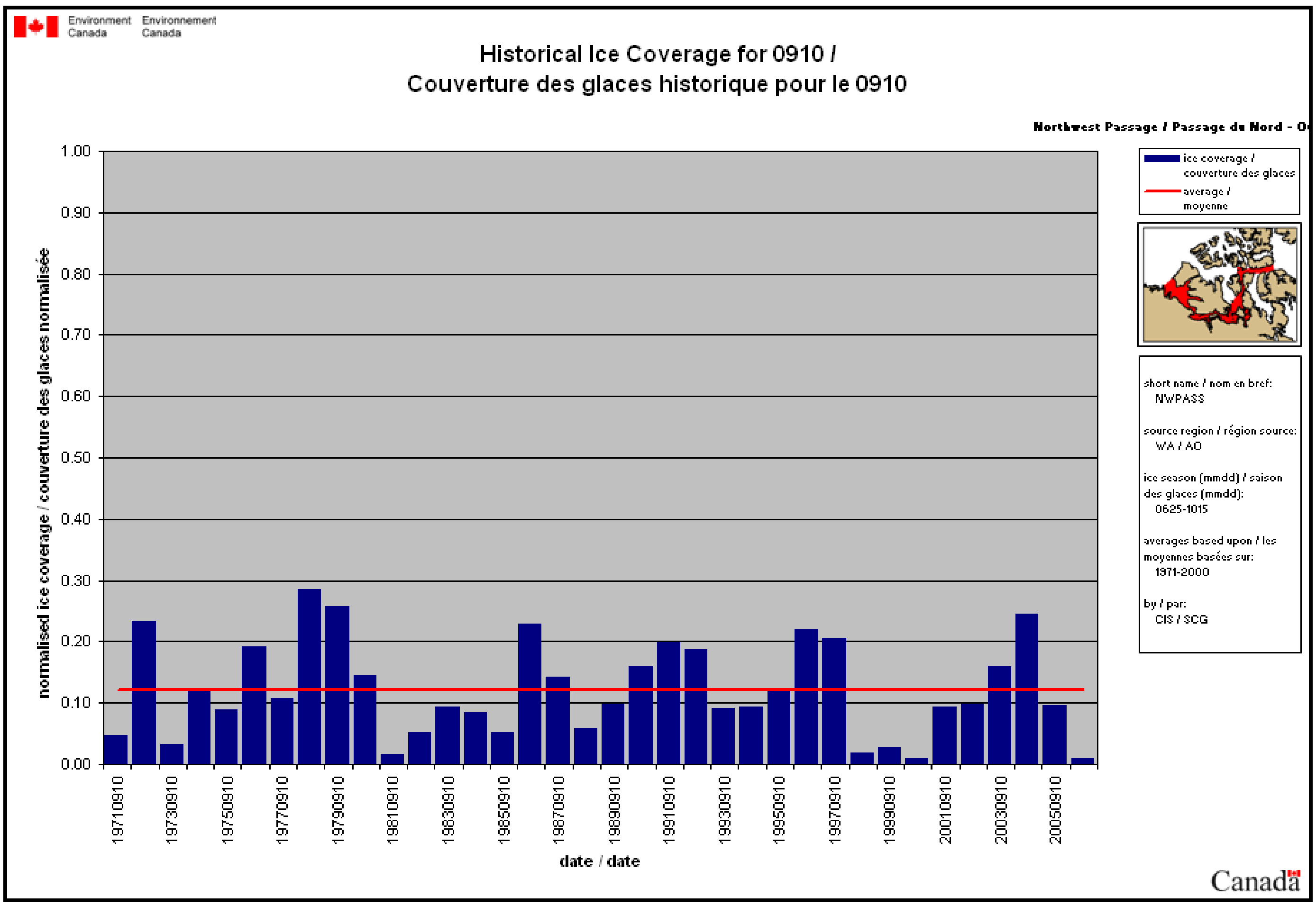
[a] indicates that subsequent time series data was not available

The trends in the CHC report, although only based on two years of the 36-year record are consistent with the conclusions generally arrived at by climate change forecasts for the NWP.

Warm years do not necessarily translate into earlier entry to zones as depicted in the Zone date System. Indeed, for 1998 (the warm year examined) multi-year and old ice posed some risks during the early part of the entry period in Zones 6, 7 and 13.

The data examined indicated that a significant change could potentially be made to Zone 11 by delaying its opening/entry date by as much 35 days during a warm year and extending its closing date by a month. However, the closing dates in adjacent areas would not change as dramatically and a Type B vessel would likely have to depart by the current closing date to avoid becoming icebound within the NWP or requiring icebreaker assistance; i.e. an in-transit vessel is affected by the route as whole.

The following chart tracks the history of the normal minimum ice period (September 10) from 1971 to 2006. The record shows significant year-to-year variability, but little in the way of a discernible trend line.



The results suggest that a further examination of the whole record would likely be appropriate before altering the current Zone dates. The study does clearly imply, however, that the use of AIRRS would provide marine operators with greater flexibility in navigating the Northwest Passage.

With respect to climate change, CHC's findings are supportive of the predictions of the majority of climate change scientists (see Chapter 3.2 and references in Annex 10.1) that ice conditions throughout the Northwest Passage will continue to be a significant hazard to shipping until at least the later decade or two of the 21st Century.

For the Port of Churchill access, the CHC results suggest that during warm years access to Churchill would be longer by a month or more; but as much as two months shorter during a cold year – due to ice conditions in Zone 15 (Hudson Straits).

7.5 Alternate Routes

i) Panama Canal

Size Limits

The maximum ship dimensions currently permitted for transit are:

length overall	m	ft	
standard	289.6	950	
passenger and container	294.3	965	
beam	32.31	106	
height above waterline	57.91	190	or 62.5/205 subject permission
draft	12.04	39.5	

The draft limit of 39ft 6in is based on Gatun Lake Tropical Fresh Water (0.9954 grams/cc at 85°F (29.6°C) at a datum of 81ft 6in (24.84m) or higher. In dry seasons, the maximum draft is adjusted in intervals of 6in with three week's notice. The Panama Canal is about 80kms in length. There are three sets of locks: Gatun on the Atlantic side, Pedro Miguel and Miraflores on the Pacific. Each lock chamber is 33.5m wide and 304.8m long. The average transit time is slightly under 24 hours.

Trade

Ocean-going traffic transits in 2006 amounted to 12,772, and small traffic transits a further 1,422. Container ship transits at 3,290 constituted 26% of the total commercial transits. Drybulker transits were 2,769 (22%), reefer ships 2,096 (17%), tankers were 1,561 (12%). Vehicle carrier transits were 770 (6%), passenger ships 219 (1.7%) and gas carriers 123 (1%).

The primary trade route served is East Coast USA – Asia, with a cargo throughput of 93 million tons – amounting to some 45% of the total. Much of the balance is trade within the Americas, although Europe to the US West Coast is significant at 10 million tons. Inter-coastal US trade was 2.3 million tons while inter-coastal Canadian trade was a miniscule 40 tons. Canada originated 7.8 million tons of cargo and was the destination for 2.6 million.

The Canal is operating close to capacity. In addition, many ships recently delivered and under construction are too large to transit the existing system. Even in the archetypal Panamax bulk carrier class, some ships are being constructed with dimensions that preclude transit – recognizing that the majority of Panamax bulkers never use the canal, and that the size category is as much commercially-based as route-specific[138].

Expansion

The people of Panama recently agreed by referendum to proceed with a US$5.25bn expansion of the canal. This is scheduled for completion by 2015. Two sets of new locks will be constructed, various segments of the canal deepened and water levels elevated. It is planned to increase the maximum vessel dimensions to a length of 1,200ft (366m), beam of 160ft (49m) and a draft of 50ft (15m). The re-constructed canal should be able to handle a laden 12,000 TEU container ship.

With its development plans, the Panama Canal Authority (PCA) is specifically targeting container traffic between Asia and the East Coast of North America. The PCA estimates it currently has a market share in this trade of 38%, with US intermodal having 61% and Suez 1%. It expects to capture 49% of that trade consequent to the expansion. Interestingly, the PCA estimated that its share would decrease to 23% without the expansion, allowing US intermodal to grow to 65% and Suez to 12%. The forecasts for other sectors are 2% annually for passenger ships and vehicle carriers, and 1% in the dry bulk sector.

Charges

Mandatory transit charges include tolls, locomotive charges (per wire), transit reservation fees, security charges and oil spill contingency response. Additional charges may be levied for tugs, launch hire, line handling onboard and inspections.

Tolls are levied on the basis of the Panama Canal Universal Management System (PC/UMS) which calculates the net Panama Canal tonnage based on 100 cbft of volumetric capacity. Rate levels depend upon whether the ship is laden or in ballast. For container ships, the ACP recently adopted a pricing system based on a TEU:PC/UMS ratio, which is being phased in over three years commencing May 2005. Laden container ships are now being charged on a fee per TEU.

Because of the need to finance the US$5.25bn expansion, it is expected that the PCA will introduce further revisions and increases. A fee proposal document has been produced very recently and is apparently causing some concern amongst users.

[138] About 5% of all laden voyages performed by Panamax bulkers transit the Panama Canal, while the total number of ballast transits are less than 15. There are about 1,300 Panamax bulkers in operation, making up about 25% of the total dry bulker fleet.

ii) Suez Canal

The Canal was completed in 1869. It was closed briefly during the Suez crisis of 1957/57 following nationalization, and again in 1967 due to the Six Day War. It did not re-open until 1975. The Canal is run by the Suez Canal Authority.

The draft limit in the Suez Canal is generally quoted as 53ft (16m). This permits the passage of laden Suezmax tankers, while large tankers and bulk carriers are generally only able to use the Canal when in ballast. There are provisions for laden tankers that exceed the draft limit to discharge cargo at the south end of the canal and reload it at the north. The actual draft limit is dependent upon the beam of the vessel. The current Beam and Draft Table provides a range of permissible beam/draft from 164ft beam/62ft draft to 254ft beam/40ft draft.

The Suez Canal is 192kms in length. The breadth in the buoyed channel is 180m and depth is 19.5m. The Mubarak Peace Bridge crosses the Canal at El Qantara, and has a clearance of 70m.

There are no locks. The Canal operates as a single-lane with four passing points. Ships transit in convoy. There are two southbound convoys and one northbound daily. The northbound convoy passes the first southbound convoy anchored in the Great Bitter Lakes and the second moored to the bank in the Cut. The permitted speed is between 11 and 16km/h; and a transit takes about 14 hours. Pilotage is compulsory and mooring boats and their crews accompany the vessel.

Improvements are planned to increase the maximum depth in order to accommodate vessels with a draft of 72ft (22m) by 2010. This should allow the passage of loaded VLCCs and Capesize bulkers, however, it is not clear how deepening would alter the Beam and Draft Table.

There were 18,193 canal transits in 2005.

Tolls
Tolls are calculated in Special Drawing Rights(SDRs) on a sliding scale for different types of vessel, with a separate fee structure for laden and ballast condition. The basis of the toll is the ship's Net Suez Canal Tonnage. The SCA may pay a rebate after receipt of a voyage cost calculation showing the relative cost for each route (via the Cape of Good Hope, via the Suez Canal or other routing).

iii) Northern Sea Route

The Northern Sea Route, which extends from the Russian islands of Novaya Zemlya to the Bering Strait, is described in more detail in Annex 10.3.

Various parts of the Northern Sea Route have been in regular use for coastal Russian cargo movements for many years between July and October. The first successful transit (one that did not involve substantial damage) took place by the Russian icebreaker *Fedor*

Litke in 1934[139]. The vessel escorted two freighters through the NSR the following year. In 1940, a German armed raider was escorted for part of the route eastbound this was the first foreign transit, but also the last one for more than fifty years.

In 1967 the Soviet Union first offered to re-open the Northern Sea Route to foreign shipping, with icebreaker support (provided for a fee). But it was not until 1991 that potential of the route began to be taken seriously, after President Gorbachev renewed the offer, and Russia began to promote the transit of foreign cargoes on Russian vessels. Subsequently, a small number of foreign, commercial ships have operated over parts of route.

Because few foreign ships have ever transited the Northern Sea Route in its entirety, there is no established scale of charges, and actual costs are expected to be subject to negotiation.

There are several potential sub-routes within the Northern Sea Route. The shorter and deeper alternatives are more exposed to adverse ice conditions. None of the routes are currently viable for non-ice strengthened vessels at any time of the year, because of the risk of structural damage and the low transit speeds achievable.

Ocean currents in the north polar region, in combination with the Canadian Arctic archipelago, result in a heavier concentration of Arctic multi-year ice in Canadian waters than in Russian waters. In the context of climate change, and assuming that Russia continues to encourage foreign use of the Northern Sea Route and provides adequate support, there can be no doubt that commercial shipping will begin using the Northern Sea Route well before the Northwest Passage. Indeed, it seems probable that even the trans-polar route will become viable before the Northwest Passage.

It is noteworthy that Russian experience in its Arctic waters has demonstrated that large ships are especially unwieldy in heavy ice. Their length hampers manoeuvrability, and their width (which exceeds that of the available icebreakers) undermines the principles of convoy operations.

7.6 Ship Types, Dimensions and New Technology

Table 7.6, following, provides some information on each common and distinct category of ship that is most influenced by route choices. The dimensions provided are representative only, and may vary quite considerably between ships with similar deadweight, gross tonnage or TEU capacity.

Most major trade routes operate in ice-free waters year round. Consequently, there is little incentive for a shipowner to invest in ice strengthened ships, or in new ice-fighting technology, if his ships predominantly trade in geographic areas where these features

139 The Northern Sea Route, Its Development and Evolving State of Operations in the 1990s, N D Mulherin, CRREL Report 96-3, April 1996

Table 7.6

Representative ship classes in international trade and dimensions

Representative Ship Dimensions

	range of dwt or TEU	length m	breadth m	summer draft m	summer dwt tonnes	TEU	tonnages gross	tonnages net	tonnages panama	tonnages suez
handysize bulker	20-35,000 dwt	174	26.00	10.60	31,000		19,000	17,000	20,000	19,000
handymax bulker	35-50,000 dwt	211	30.90	11.50	44,000		30,000	18,000	32,000	
panamax bulker	60-80,000 dwt	225	32.30	14.25	75,000		39,000	26,000	35,000	40,000
capesize bulker	130,000+ dwt	290	45.00	17.75	170,000		80,000	45,000	n/a	
aframax tanker	90-110,000 dwt	245	42.00	14.00	110,000		63,000	35,000	n/a	64,500
suezmax tanker	125-150,000 dwt	265	46.00	16.90	150,000		78,500	46,000	n/a	86,000
VLCC	200-300,000 dwt	330	60.00	21.10	300,000		160,000	95,000	n/a	160,000
panamax container ship	3-4,000 TEU	241	32.30	12.52	45,000	3,161	41,000	24,000	note	
post-panamax container ship	5-9,000 TEU	323	43.00	14.60	135,000	8,063	90,000	55,000	n/a	
Emma Maersk		397	56.00	15.50	156,907	11,000	170,094	55,396	n/a	

notes:
tonnages (except for deadweight) are volumetric measurements
relationship between tonnages is dependent upon design and measurement standards
container ships transiting Panama are now assessed on a TEU:tonnage equivalance

have no market value. While naval architects can enhance the performance of a vessel in ice, the design adjustments involved always compromise earning capacity in ice free waters as well as employment flexibility.

Contrarily, a shipowner will be prepared to invest in ice capabilities if navigating in ice is part of the regular business in which he expects to deploy that specific ship. This will only happen if the ship is either to be traded to polar origins or destinations (i.e. not in the course of a through passage), or if it will regularly transit a trans-polar route. It is possible to envisage ships, designed and built specifically for polar originating/destined cargo routes, being deployed for in-transit voyages where the intended trade falls short.

It is worth noting that the transit of the *Manhattan* through the Northwest Passage in 1969 was a test of the feasibility/viability of the carriage by tanker of Alaskan North Slope crude oil to refineries in the eastern USA. Although the test was considered successful, this route was not pursued, and a strategic decision was made to ship the oil to Valdez by pipeline and onward to US west coast refineries by tanker. This decision was likely influenced as much by national strategic interests as it was by the feasibility of the trans-polar route or its economic viability. In addition, it is only an accident of national geography that makes a shipment of Prudhoe crude an international transit movement rather than a nationally-originating Arctic cargo.

The spreadsheet reproduced on the following page is intended to show how a ship operator might prepare a voyage costing in order to identify a preferred route via the Suez or Panama Canals, the Northwest Passage or the Northern Sea Route. The approach follows the Route Choice model provided earlier in this section.

The route Shanghai to New York was chosen simply because it is a route where the Northwest Passage is distance competitive; it is not intended to demonstrate the economics of any actual trade. A Panamax bulk carrier was selected because it is a major ocean workhorse with over 1,300 ships in operation worldwide and it is a sector which is largely traded spot or on short-term contracts of affreightment. Taking into account existing Panama Canal constraints, the Panamax bulker is inherently cost-efficient when deployed on a trans-Panama trade route.

Due to available water depths, a fully loaded Panamax bulker would be routed via the Prince of Wales Strait. A comparable calculation could be undertaken for an enlarged Panama Canal for a larger vessel.

Model Inputs/Assumptions

All of the required input assumptions are provided in section 1, which gives ship and route specifications. The ship specification provided (tonnages, cargo deadweight, speed and fuel consumption) uses data (rounded) for an actual 2001-built standard Panamax bulk carrier.

The daily charter hire is close to the prevailing rate, in April 2007, for a Panamax bulk carrier. The spreadsheet allows the user to input a hire premium for an ice classed ship.

This is reflected in the charter rate in section 2 at the input percentage. It is also automatically reflected in a prorated reduction in the chosen additional insurance premium.

The need for an en route bunker call is a function of the route distance compared to the input maximum route mileage without a bunker call. The estimated cost for the bunkers-only port call can be input by the user.

Voyage disbursements and route specific elements were generated as follows:-

- The price of fuel (In this case Heavy Fuel Oil) is input by the user.
- Delay estimates are determined by the user for weather, ice and canal transits.
- ***Suez Canal***: using the ship specification and the Suez Canal calculator provided by LethSuez at www.lethagencies.com/calculator.asp?Port=SUEZTREG, the resulting figure should be entered into section 1.
- ***Panama Canal***: using costing information found in Panama Canal Authority's (ACP) website at www.pancanal.com, the calculation is performed in the PanCan spreadsheet (see below) and automatically carried into the main spreadsheet.
- Because there are no existing tariffs for en route costs for ships using either the Northern Sea Route or the Northwest Passage, these are user inputs.
- The basic Additional Insurance Premiums (APs) are user inputs.

Panama Canal Costs

Panama Canal net tonnage		33,500		
tolls				
dry bulk				
1st 10,000	10,000	$ 2.96	29,600	
next 10,000	10,000	$ 2.90	29,000	
remainder	13,500	$ 2.85	38,475	
				97,075
miscellaneous				
locomotives	4	200	800	
oil spill response		350	350	
booking fee		$ 0.39	13,065	
inspection		110	110	
security charge		400	400	
launch service		170	340	
				15,065
total				**112,140**

COMPARATIVE VOYAGE COSTS, PANAMAX BULKER, SHANGHAI TO NEW YORK

1. Ship and Route Specification

input assumptions into yellow cells

deadweight				
summer	75,000	mt at	14.2	m
winter	73,500	mt at	13.8	m
cargo deadweight	63,250	mt at		
fuel capacity	2,400	cbm		
net suez tonnage	38,000	mt at		
net panama tonnage	33,500	mt at		
panama draft limit	39.5	ft		
max cargo deadweight	59,000	mt		
speed	14.0	knots		
fuel consumption (IFO 380)				
steaming	32.5	mt		
in port	2.5	mt		
IFO 380	$ 330			
daily charter hire	$ 45,000			
ice class premium	10%	on charter hire for NW Passage and Northern Sea Route only		
bunker call, for trips over	10,000	nm, assumes port call for bunkers = one day including deviation		
bunker port costs	$ 15,000			

	delay estimates			en route
	weather	ice	canals	costs*
Suez Canal	0	0	1	190,000
NW Passage	2	5	0	250,000
Northern Sea Route	2	2	0	200,000
Panama Canal	1	0	1	120,000

additional insurance premiums (APs), adjusted by ice class

	100%	90%
NW Passage	250,000	225,000
Northern Sea Route	200,000	180,000

2. Comparative Voyage Costs

Shanghai to New York	**Suez Canal**	**NW Passage**	**Northern Sea Route**	**Panama Canal**
distance	**12,492**	**8,577**	**10,688**	**10,595**
days				
steaming days	37.2	25.5	31.8	31.5
bunker port call	1.0	-	1.0	1.0
canal time (including waiting)	1.0	-	-	1.0
weather delays	-	2.0	2.0	1.0
ice delays	-	5.0	2.0	-
total days on hire (rounded-up)	**40.0**	**33.0**	**37.0**	**35.0**
charter hire	1,800,000	1,633,500	1,831,500	1,575,000
en route costs				
bunker call	15,000	-	15,000	15,000
canal costs	190,000	-	-	120,000
NWP/NSR	-	250,000	200,000	-
fuel costs				
steaming	398,740	273,775	341,157	338,189
port + delays	2,328	6,165	4,282	2,860
additional insurance premium	-	225,000	180,000	-
total voyage cost	**2,406,068**	**2,388,440**	**2,571,939**	**2,051,049**
maximum cargo (weighs out)	63,250	61,750	61,750	59,000
cost per tonne	**$ 38.04**	**$ 38.68**	**$ 41.65**	**$ 34.76**

* enroute costs:
Suez: LethSuez calculator
PanCan: attached worksheet
Northern Sea Route and NW Passage: unknown, guesstimates used (cost recovery??)

JS/Arctic2007/route costing
April 26, 2007

Model Outputs
Comparative Voyage Costs are presented in Section 2, which uses the route distances provided together with all of the input assumptions to calculate total days on hire, en route costs, fuel costs, APs, total voyage cost and cost per tonne of cargo (for a commodity that weighs-out, rather than cubes-out). The model automatically takes into account cargo deadweight/draft limitations for each route.

7.7 Potential Target Markets/Routes

As described earlier, the choice of one route over the available alternatives is a function of total anticipated cost and transit time. The assessment will also take into account various risk factors that affect cost and transit time, including the potential for en route delays and damage.

Within the relatively small number of papers and articles that analyze route choice in any depth, it is noticeable that the Northwest Passage is compared to the existing Panama and Suez Canal routings – often without reference to the Northern Sea Route. There are potential political risks associated with use of the Northern Sea Route. In general, however, as climate change occurs, one must anticipate that the Northern Sea Route will always be available for in-transit commercial shipping at any time that the Northwest Passage becomes available for the same traffic. This tends to limit the number of port pairings and general routes that might use the Northwest Passage to those identified in the Route Choice and Distances section of this paper.

i) Container Shipping

Deep-sea container shipping is dominated by a relatively small number of companies, many of them operating in close cooperation with others through formal alliances. Each company or alliance maintains a broad range of services covering all (or most) of the main trade lanes. These services consist of numerous loops or strings that provide extensive customer choice and permit trans-shipment between loops to service other destinations on indirect basis. The container shipping business is highly competitive, using freight rates and levels of service to capture and retain business. All modern services are based on port calls that occur on a fixed day of the week and offer precise transit times between nodes – this leaves them very sensitive to any delays that occur, whether en route or in port.

The primary trade lane where an ice-free Northwest Passage would provide a significant saving in steaming time is between ports in East Asia and those on the east coast of North America (see Map 7.4). This places the Northwest Passage in direct competition with:

- The trans-Pacific and trans-continental intermodal route via ports on the west coast of North America and railways in the USA and Canada (the landbridge route)
- The Panama Canal, and
- The Suez Canal (currently a very small player).

The market share information, referenced in the earlier discussion of the Panama Canal expansion project, is particularly germane to this discussion. Not least, because this whole expansion project is motivated by the retention and expansion of the Canal's share of this trade.

So what are we really talking about?

- Ships with a service speed of more than 20 knots;
- Very few with any ice strengthening;
- Post-Panamax vessels that have lengths and widths that hamper operations in ice; and
- Service patterns that are highly insensitive of delays.

In the absence of year-round ice-free navigation in the Arctic, there is no basis for this trade to switch to an Arctic route within the time frame under consideration. When there is an opportunity, it is likely that the Northern Sea Route or the trans-polar will be preferred.

ii) Bulk Cargo Shipping[140]

Although some bulk cargo is shipped to a fairly regular schedule, many are traded on the spot market. Therefore there appears to be some potential for the Northwest Passage to capture these movements during those periods where ice is least problematic. The following discussion reflects on a number of known movements that could be viewed as potential in-transit users of the route.

a) Iron Ore

Canada ships approximately 5mt pa to Japan, China and Korea. Quantities may increase in the future because of the recent imposition of an export tax on Indian iron ore. Canadian ore moves from Sept Iles and Port Cartier via the Cape of Good Hope in VLBC's (200,000dwt and larger). Very little of this is open market, and most moves under contracts with the steel mills. An enhanced depth in the Suez Canal might attract this trade.

b) Grain

The USA exports about 53mt pa of grains to Asia. This is primarily out of US Gulf ports, although small quantities do ship out of the east coast, mainly Baltimore.

Canadian grain exports to Asia are shipped out of the west coast, while Atlantic basin markets are served out of the St. Lawrence and Churchill. The availability of an Arctic route may make cargoes originating in the St. Lawrence economically feasible. Shipments from Churchill might also be possible into Far East markets, but vessels would need to

140 tonnages approximate and developed from different sources and for different years; primary sources Fearnley, Dry Cargo International, Skillings and Maritime Research Inc (MRI).

safely navigate the Fury and Hecla Strait as well as the Bellot Strait, both of which pose navigation challenges in addition to severe blockage by ice. St Lawrence ports could handle capesize vessels (with in-stream top-off in some circumstances), while Churchill is limited to panamax vessels (due to draft, berth and turning restrictions).

c) Coal[141]

Canada exports coal (primarily metallurgical) through Prince Rupert and Vancouver. Most goes to Asia, but some metallurgical coal is shipped to Europe. Traditionally, this was seen as a repositioning voyage for panamax vessels[142] in ballast from Japan and the Far East and attractive voyage rates could be obtained. Recently, capesize vessels have been showing up in this trade, and cargoes of up to 150,000mt have been reported. Rates quoted have been in the range $US 20-30[143], depending on cargo size. There is an active voyage market for these moves.

US thermal and metallurgical coal exports to the Far East run about 20mt pa, mainly out of the US east coast. Typically this is a panamax market, although ships up to capesize can be loaded as maximum berth depths are 15.2m. A trade that used to be practised was to load to max draft at Hampton Roads, and then top off at Richard's Bay in South Africa.

d) Alumina

Australia ships between 2.5 and 3mt pa of alumina to Canada, mainly to ports in the Gulf of St. Lawrence and Saguenay River. Vessel sizes are typically handymax.

e) Crude Oil

It is unlikely that Alaskan oil would be shipped from Valdez to refineries on the US east coast, because they are not set up to handle the sour crude. Most goes into West Coast refineries, although some moves to St Croix in VLCC's via Cape Horn. A possible additional source of oil in Alaskan waters is from subsea wells in the Bering Sea. Although this oil would be closer to the US east coast via the Northwest Passage, shipping economics under the US Flag suggest that it is more likely that the oil would be shipped into US West Coast refineries to make up short falls from North Slope oil.

About 4mt pa of North Sea oil is traded to Asia, but this should be viewed as a cargo for the Northern Sea Route.

[141] Coal is a cubic cargo for bulk carriers large than handy max size (35-45,000dwt), having stowage rates similar to grain

[142] 55,000 tonnes at full Panama draft.

[143] Dry cargo freight rates have risen significantly in 2006; the MRI index was in the range 280/290 during the early part of the year, and rose to 360/370 by the last quarter.

iii) Impediments to In-transit Bulk Movements

The standard route through the Northwest Passage is draft-limited to 10m. This has the potential to rule out many of the standard types of ship unless they are very lightly loaded. The deep-draft routes via the Prince of Wales Strait (or M'Clure Strait) would be suitable in this sense, but have the most extreme ice conditions in the Canadian Arctic – conditions that are likely to get worse rather than better during the early stages of climate change.

The availability of high (as opposed to nominally) ice-strengthened vessels within the major bulk carrier types (as available on the open market) is quite limited. Climate change would have to be sufficiently far advanced to permit ice-free transits, as well as avoid punitive additional insurance premiums and the risk of severe structural damage and potential pollution.

Unless climate change advances significantly faster than forecast, substantial in-transit movements through the Northwest Passage appear improbable in the timeframe under consideration.

8. UPDATE PROCEDURES

As will be appreciated from the need for, and nature of, this report the Arctic is not a region that is well documented. Information is scattered through many sources, not all of which are immediately obvious as having relevance. The international environment also has material influences both relative to climate, the economy and the viability of natural resources. Thus in updating a work of this sort, many references need to be accessed and then applied with experience of the Canadian Arctic.

The methodologies within the individual chapters have provided a background to different aspects of the Arctic, but ongoing contact with persons and entities active within the region is crucial. Some of this contact can come from conferences, but these are often international in nature and may not be entirely relevant to the Canadian Arctic. For example, the international marine regulatory environment is much less limiting than that in Canada, thus solutions that work in the Russian Arctic may be impossible to apply in Canada.

Regional visits, attendance at CMAC Northern bi-annual workshops, meetings with relevant departmental officials in Nunavut, NWT, Manitoba, Quebec, Ontario and the Yukon are also of importance in gaining an understanding of the region and establishing parameters within which to utilize the resources provided in the Annexes. Contact with the carriers (which is possible at CMAC) is also necessary in order to understand their concerns regarding service to, from and within the Arctic.

With regard to appropriate reference material given in Annex 10.1 reading within the Canadian and international marine press reveals that commodities and container shipping is as important as utilizing the references provided. This provides a crucial shipping and commodities perspective to development potential in the Arctic region.

Attention to the issues addressed in Chapter 9 of the report will also go a long way to enabling the report to be updated, over time, with more accurate data.

Should Transport Canada aim to develop a collaborative process with the many agencies and bodies that are involved with the demand or supply for Arctic Shipping, it could set up an informal Arctic Shipping network to inform Arctic Shipping issues. Such a network would identify the key agencies, and people. Regular forms of communication within the network could serve to enable Transport Canada to update key information sources.

With respect to in-transit access to the Northwest Passage, Canada's primary concern should be that transiting vessels recognize Canadian sovereignty and comply fully with the prevailing regulations. This includes comprehensive notification, adherence (as appropriate) to the Zone/Date System and AIRSS, the ability to avoid/mitigate pollution and security risks, and the provision of access to adequate and guaranteed financial security resources. As a consequence, equitable access is permitted, risks are minimized, and demands on Canadian en route support services will be reasonable.

The critical variables are the demand for in-transit access; and (on the supply side) recognition of sovereignty; effective regulation; and the provision of adequate resources.

In the absence of in-transit demand, the supply side can continue to service Canadian re-supply and extraction needs with relatively minor modification. Consequently, understanding potential demand and its timing is critical to appreciating when the supply side must be enhanced. As described in chapter 7.2, in-transit demand is a function of the cost and reliability of the Northwest Passage relative to the Panama Canal, Suez Canal and the Northern Sea Route. It is therefore essential for Transport Canada to:

- Maintain a thorough appreciation of the status of the alternative routes as they relate to the most relevant trades
- Continuously monitor the effect of climate change on ice conditions in the Northwest Passage
- To monitor and understand how changes in shipping technology related to ice capabilities may affect potential demand.

9. DATA ISSUES

9.1 Traffic and Quantities

Because of the difficulty in collecting data[144] for Arctic discharge points, alternate references should always be used to carry out a thorough screening. Unless this is done, and a review methodology established, erroneous conclusions could be drawn. In terms of official resources, data should be gathered from StatsCanada at both the loading and discharge ports. Transport Canada may be in a position to obtain more comprehensive data from StatsCanada than could an outside agency.

For dry cargo, the critical export ports are:

- Churchill
- Côte St. Catherine
- Valleyfield.
- Hay River
- Fort Simpson.

Other ports may ship goods to the eastern Arctic, for example explosives may be loaded at Sept Iles, but the primary load ports should provide a good check on overall quantities.

For the Western Arctic, goods are loaded in Hay River and Fort Simpson and as the ports are essentially private operations, obtaining accurate formal data will be difficult, unless the principal companies are persuaded to provide data. This then requires a fallback to informal sources, which would include the shipping companies, and if Transport Canada were to seek aggregate data by region on the understanding that it was for internal policy purposes, information may be supplied. Makivik Corporation in Nunavik may keep some data, and Community and Government Services in Nunavut is making efforts to gather information on quantities and could be in a position to supply some data.

The final step is one of reasonableness relative to population and activity in the community. Mariport has provided planning quantities that have been used successfully in the Arctic, and these should be both checked whenever the opportunity arises and used to confirm community quantities.

Dry cargo quantities can vary considerably year by year, depending on whether major construction projects are taking place. Nunavut has a publicly available five-year capital plan, and NWT and Nunavik may well have similar documents that can be used as a guide to indicated quantity variations.

With regard to petroleum products, reporting of handled quantities is a regulatory requirement and thus data should be reliable[145]. However, errors can occur, and Transport

[144] Data for mine related ports such as Deception Bay can, generally, be relied on.

[145] This is not the case with Hay River, which should have reported 60-70,000 tonnes of POL shipped in 2004, but reported only 5,670 tonnes. This was less than the quantity reported as shipped at Tuktoyaktuk, and which would have come from Hay River in the first place.

Canada should request tank capacities in the communities, checking that the quantity of oil reported as delivered does not exceed the total tankage. (Note that this will be the sum for Power Corporation and the community as well as any separate airport and North Warning tankage.) Oil quantities can be materially affected by aircraft re-fuelling practices, and several locations in the CASA study area have oil consumption figures well above those expected from community demand for transport, heating and power generation. Also, some community deliveries include quantities for military or North Warning sites. Hall Beach is one such location.

Unusual quantities that crop up in one year should be queried, as should cargoes that do not necessarily fit with the region. An example of this is the 62,586 tonnes of logs supposedly exported from Diana Bay in 2004. As far as we are aware, the location is above the tree line and would have required considerable shipping capacity which was not evident in the shipping movements. It is possible that there is a similar port name in British Columbia, and the two were mixed up.

The following tables show how the raw data from StatsCanada has been utilised. Annex 10.4 has a list of communities showing the most common name and alternates. For clarity, quantities and movements should always be aggregated under a single name.

9.2 Reference Points

The following reference points with regard to quantities are taken form Mariport file material.

- The NWT, in its 2003 Short Sea submission, indicated that the Mackenzie carried 106,000 tonnes of cargo, and that the Dempster Highway carried 16,000 tonnes. The year was not given, but the implication was that it was for 2002. NTCL in discussions indicated that they moved 12-14 tows per season (a tow is typically six barges with a capacity of 7,000 tonnes) and that the mix was usually 20% deck and 80% bulk. This put their POL movements in the range 84-98,000 tonnes/season, and 17-20,000 tonnes dry cargo, which fitted with other data that NTCL moved 90,000 tonnes of cargo in 2002. Cooper Barging typically carry 15,000 tonnes per season[146], purely within the river. Information was not available on Horizon North Logistics, but the quantities for the western Arctic appear to be in line with these figures, once an allowance has been made for river deliveries, and road connections.
- Mariport was provided with actual quantity data for Kugluktuk over 1994-1998 inclusive. Average total shipments were 7,285 tonnes with a maximum of 9,804 and a minimum of 5,019. A breakdown of bulk to deck was not available for all years, but the average fuel delivery was at a rate of 3.3 tonnes per capita, and for dry cargo the figure was 2.69 tonnes per capita.
- Mariport had access to MTQ data for Nunavik for 1989 through 1993. Dry cargo averaged 13,812 tonnes, with a maximum of 15,280 tonnes and a minimum of 13,101 tonnes. Fuel averaged 48,376m^3, (about 37,000 tonnes).

146 Personal communication Mariport and Michael Cooper, 2003.

Maximum deliveries were 50,553m^3, minimum deliveries 45,842m^3. Kuujjuaq was again a major consumer. Dry cargo consumption averaged 1.68 tonnes per capita, but did not include deliveries by Moosonee Transport to Kuujjuarapik.

COMPARATIVE CURRENT POPULATION AND TRAFFIC DATA[147]

NUNAVUT	Population 2005	Stats Canada Traffic in Tonnes 2004		Prototype Data	
Qikiqtaaluk		**DRY**	**POL**	**DRY[148]**	**POL[149]**
Cape Dyer	-	1,823	-		
Douglas Hbr	-	545	-		
Port Burwell	-	-	-		
Resolution Bay	-	264	-		
Arctic Bay	703	888	1,780		
Qikiqtarjuaq	482	566	2,141		
ClydeRiver	836	-	2,138		
Cape Dorset	1,260	1,229	2,923		
Iqaluit	6,303	12,311	47,026[150]		
Grise Fjord	144	281	607		
Hall Beach	667	724	2,773		
Igloolik	1,568	1,794	4,141		
Kimmirut	419	392	1,149		
Nanisivik[151]	-	837	629		
Pangnirtung	1,350	1,276	3805		
Pelly Bay (Kugaaruk)[152]	701	697	3,750		
Pond Inlet	1,340	2,598	4,344		
Resolute Bay	233	475	3,451		
Community total	***16,005***	***26,003[153]***	***76,907[154]***	***35,211***	***51,216***
Airport Demand					**25,000**
N. Warning Demand		**2,632**	**0[155]**	**500**	**2,500**
Exploration				**1,000**	**2,500**
Mine Support				**0**	**0**
Total Prototype				**36,911**	**81,507**

147 This is based on community population only. Air support, mining, oil and gas activity will create extra quantities.

148 Calculated at 2.2 tonnes per capita.

149 Calculated at 3.2 tonnes per capita.

150 Iqaluit imports significantly more fuel than is needed for community support because of the airport and re-fuelling operations there. The airport is a major re-fuelling stop for small jet aircraft flying between the US West Coast and Europe.

151 Transhipment point for Kugaaruk and Eureka by CCG icebreakers. Mine closed in 2002, and no local population.

152 Kugaaruk is included under Qiqiktaaluk for shipping purposes only. It is part of the Kitikmeot

153 Excludes 697 tonnes double-handled at Nanisivik and Kugaaruk.

154 Excludes 3,750 tonnes reported landed at Kugaaruk as this probably exceeds available tankage. The tanker proceeded from Kugaaruk to other ports in Nunavut and quantity reports may have become confused with what was on board, rather than what was delivered.

155 It seems illogical that North Warning sites imported no oil, even taking into account quantities included with community delivery.

	Population 2006	Stats Canada Traffic in Tonnes 2004		Prototype Data	
Kivalliq[156]		**DRY**	**POL**	**DRY**[157]	**POL**[158]
Baker Lake	1,761	190	5,273		
Sanikiluaq[159]	758	648	1,480		
Chesterfield Inlet	338	101	1,311		
Coral Harbour	784	343	2,408		
Arviat	2,100	253	2,221		
Rankin Inlet	2,403	1,130	11,834		
Repulse Bay	762	1,330	1,595		
Whale Cove	360	84	1,004		
Community Total	***9,266***	***4,079***	***27,126***	***20,385***	***29,651***
Airport Demand					**2,000**
N. Warning Demand					**0**
Exploration				**500**	**2,000**
Mine Support					**0**
Total Prototype				**20,885**	**33,651**
Kitikmeot[160]					
Bathurst Inlet		-	-		
Cambridge Bay	1,505	-	-		
Gjoa Haven	1,084	-	2,180		
Kugluktuk	1,327	-	3,977		
Taloyoak	825	-	1,126		
Umingmaktok		-	-		
Community Total	***4,741***		***7,283***	***10,430***	***15,171***
Airport Demand					**-inc-**
N. Warning Demand					**1,000**
Exploration				**1,000**	**2,500**
Mine Support				**0**	**0**
Total Prototype				**11,430**	**18,671**

156 The Kivalliq region has had service out of both Churchill by tug and barge as well as Montreal by ship.

157 Calculated at 2.2 tonnes per capita.

158 Calculated at 3.2 tonnes per capita.

159 Historically, Sanikiluaq has been served out of Moosonee by tug and barge with occasional ship calls.

160 Figures appear to exclude goods shipped for mining exploration, particularly Wolfden at Gray’s Bay.

NORTHWEST TERRITORIES	Population 2005	Stats Canada Traffic in Tonnes 2004		Prototype Data	
Arctic Coast		**DRY**	**POL**	**DRY**	**POL**
Holman	434	-	1556		
Paulatuk	318	-	989		
Sachs Harbour	119	-	378		
Tuktoyaktuk[161]	990	-	852		
Total Coastal NWT[162]	***1,861***		***3,775***	***4,094***	***5,955***
Airport Demand					**-inc-**
N. Warning Demand					**-inc-**
Exploration				**500**	**2,500**
Mine Support				**0**	**0**
Total Prototype				**4,594**	**8,455**
NUNAVIK		**DRY**	**POL**	**DRY**	**POL**
Akulivik	507	809	1,467		
Deception Bay[163]		17,479	46,289		
Aupaluk (Hopes Advance Bay)	174	706	1,043		
Inukjuaq (Port Harrison)	1,597	2,511	4,544		
Ijujivik	349	562	1,509		
Kangirsuk (Payne Bay)	466	1,256	2,394		
Kangirsualujjuaq (George River)	735	1,019	1,999		
Kangirsujuag (Wakeham Bay)	604	1,149	2,355		
Kuujjuarapik[164] (Great Whale)	568	520	6,173		
Kuujjuaq (Fort Chimo)	2,132	2,992	16,058[165]		
Puvirnituq	1,457	1,325	8,472		
Quaqtaq[166] (Koartac, Diana Bay)	315	405	2,399		
Salluit (Saglec)	1,241	2,205	4,722		
Tasiujaq (Leaf Bay)	248	1,714	1,257		
Umiujaq	390	251	1,052		
QN other		2,580	0		
Community total	***10,783***	***17,430***	***52,002***	***23,723***	***34,506***
Airport Demand					**5,000**
N. Warning Demand					**2,000**
Exploration					**2,000**
Mine Support		**17,479**	**46,289**	**17,500**	**46,000**
Total all		**34,909**	**98,291**	**39,223**	**89,506**

161 Tuktoyaktuk re-shipped 10,859 of POL to Arctic communities. It is NTCL's practice to top off their barges to ocean drafts from rive- restricted drafts at Tuktoyaktuk.

162 We have excluded Inuvik and river communities from the total. Inuvik does receive some petroleum products by barge from Hay River, but power generation is now gas fired, using a local gas field.

163 Falconbridge Raglan Mine re-supply materials and fuel

164 Historically Kuujjuarapik has been served out of both Montreal by ship and Moosonee by tug and barge.

165 3,442 tonnes were transhipped and are excluded from the total. The quantity shipped into Kuujjuaq is exceptionally high, unless the airport is supporting considerable re-fuelling or exploration activity.

166 Statistics Canada reported 62,566 tonnes of logs and wood in the rough from Diana Bay in 2004. We believe this movement is in error, as the location is thought to be above the tree line for Northern Quebec.

CREE COMMUNITIES	Population 2006	Stats Canada Traffic in Tonnes 2004		Prototype Data	
Quebec		**DRY**	**POL**	**DRY**[167]	**POL**[168]
Chisasibi[169]	3,972				
Eastmain	650				
Waskaganish	1,864				
Wemandji	1,215				
Sub Total Quebec	**7,701**				
Ontario					
Attawapiskat	1,549				
Fort Albany	1,805[170]				
Fort Severn	493				
Kashechewan	-				
Moose Factory	3,626				
Moosonee	2,006				
Peawanuck	221				
Sub Total Ontario	**4,068**[171]				
Total All	**11,769**[172]			**12,769**[173]	**17,654**

9.3 Navigation Aids and Charts

An essential service, in any marine environment, is the provision of adequate navigation aids and accurate charts for national coastal waters. The situation in the Arctic does not meet standards for other areas of Canada, and can be considered a data issue in terms of the CASA review

Navigation Aids{ TC \l4 "Navigation Aids}

There are some 160 marine navigation aids in arctic waters that are maintained by Canadian Coast Guard ranging from radar reflectors to buoys, lights, ranges and beacons[174]. Most of these are for the benefit of community access, not for through- transits by deep draft vessels between the eastern and western Arctic. Safe navigation of ships operating in the Arctic still depends largely on the skills of the crews, their knowledge of

167 Dry quantities estimated at 1 tonne per capita based on better connections to the south, greater dependence on the land. We have added 1,000 tonnes to the summary data to cover shipments to Kuujjuarapik.

168 POL quantities estimated at 1.5 tonnes per capita, reasons as for dry cargo.

169 Road connected.

170 Presumed to include Kashechewan data.

171 Excludes Moosonee which is rail connected and acts as the shipping point for the region and Moose Factory

172 Excludes Moose Factory, which is on an island 1.5 miles distant. Goods move winter and summer by a seasonal combination of small boats and sleds.

173 Actual shipping quantities will include cargo for Kuujjuarapik which, although part of Nunavik has a large Cree population, and with which MTL has had a long association.

174 A buoy that had not been repositioned following the winter was partially attributable to the grounding of the cruise ship *Hanseatic* in Simpson Strait on 29th August 1996

the waters and the quality of both official and "company" charts. All masters of re-supply vessels carry their own notes and marked up charts showing safe routes and locations for anchoring.

Modern aids to navigation, like DGPS, can be valuable. However, very few Arctic charts are designed for use with GPS, and considerable care is needed in use of this position-fixing device. There is good satellite coverage, and a study of Rankin Inlet in 1996 showed that there were at least five satellites in view in this area throughout the navigation season. However, without base station reference points, the utility of GPS in close waters has been limited, and a position accuracy better than 30-100 metres 95% of the time, could not be expected. The recent removal by the US military of the intentional performance degradation techniques has improved accuracy and therefore the utility in close waters.

The Canadian Hydrographic Service (CHS) estimates that about 20% of its marine navigation charts relate to Arctic waters, and only 10% of these actually meet modern standards compared with 60% of southern charts. Much of the charting in the Arctic is based on reconnaissance or track type surveys using primitive positioning systems. Many of these charts have been found to miss key shallow draft features, because of the large grid on which they were conducted. Passage planning charts are largely absent and large scale charts covering community access and anchorage areas are available for only 4 out of 26 Nunavut communities. This is hazardous for tankers, which offer a major cost saving delivery system compared with traditional re-supply, but need safe deep water access. Much work has been expended by other organizations in providing environmental guidelines to safeguard the Arctic's fragile ecology from marine disaster, but the basic tool available to the mariner, an accurate and up-to-date chart, is often missing.

CHS have advised[175] that 22 Arctic charts have recently been released. Of these 15 relate to the Mackenzie River, and all but one are new editions of exiting charts. The only new chart is for Melville Sound. Production in 2007/08 will cover five charts, some of which will be new editions. There are another 20 charts that will likely become projects, but there is no schedule for them as yet.

While CHS recognises the issues associated with lack of good charts, they are severely constrained by available budgets in being able to both undertake the necessary bathymetric work, and then move the data through chart production and into the hands of the mariner. Original data gathering is dependent on being able to use host vessels that are operating in areas of the arctic where updates or original work is needed. Some chart work has been undertaken on a cost-sharing basis with companies and territorial governments. New charts for Bathurst Inlet in the western Arctic, and approaches to Rankin Inlet are examples.

If the North West Passage is to be used by deep draft vessels on a regular basis, then an adequate suite of up-to-date charts is essential for all channels. These do not exist at present, and safe navigation by international vessels will not take place unless there is confidence that a safe passage can be undertaken.

[175] Personal communication CHS to Mariport following CMAC Northern in Iqaluit spring 2007.

9.4 Projected Population and Traffic to 2020

The following tables have been developed to largely follow the layout of current population and traffic. Community re-supply has been based on population forecasts from the socio economic section of the report. Other forecasts are by Mariport, and are best estimates as to quantities involved. Forecast data is footnoted.

PROJECTED POPULATION AND TRAFFIC to 2020[176].

NUNAVUT	Population 2020	Planning Data 2020	
Qikiqtaaluk		**Dry**[177]	**POL**[178]
Cape Dyer	-		
Douglas Hbr	-		
Port Burwell	-		
Resolution Bay	-		
Arctic Bay	924		
Qikiqtarjuaq	634		
Clyde Inlet	1,098		
Cape Dorset	1,656		
Iqaluit	8,284		
Grise Fjord	189		
Hall Beach	876		
Igloolik	2,060		
Kimmirut	551		
Nanisivik[179]			
Pangnirtung	1,775		
Pelly Bay (Kugaaruk)	922		
Pond Inlet	1,762		
Resolute Bay	307		
Community total	***21,038***	***46,284***	***67,322***
Airport Demand[180]			**25,000**
N. Warning Demand		**500**	**2,500**
Exploration		**1,000**	**2,500**
Mine Support[181]		**See text**	**See text**
Other Total		**1,500**	**30,000**
Total Projected		**47,783**	**97,322**

176 This is based on community population only. Air support, mining, oil and gas activity will create extra quantities.

177 Calculated at 2.2 tonnes per capita.

178 Calculated at 3.2 tonnes per capita.

179 Transhipment point for Kugaaruk and Eureka by CCG ice breakers. Presumed dry cargo only with POL moved directly by tanker as for 2005 and 2006 seasons.

180 The additional re-fuelling amount from 2005 has not been escalated.

181 Mary River is assumed to be operational, but quantities for logistics support and fuel are not known and dealt with separately in the text. Baffinland Iron Ore Mines have indicated that they expect to ship 12.5 million tonnes over an extended season.

NUNAVUT	Population 2020	Planning Data 2020	
Kivalliq		**Dry**	**POL**
Baker Lake	2,315		
Sanikiluaq	997		
Chesterfield Inlet	445		
Coral Harbour	1,030		
Arviat	2,760		
Rankin Inlet	3,159		
Repulse Bay	1,002		
Whale Cove	473		
Community Total	***12,181***	***26,798***	***38,979***
Airport Demand			**2,000**
N. Warning Demand			**0**
Exploration		**500**	**2,000**
Mine Support		**See text**	
Other Total		**500**	**4,000**
Total Projected		**27,398**	**42,979**
Kitikmeot			
Bathurst Inlet			
Cambridge Bay	1,979		
Gjoa Haven	1,425		
Kugluktuk[182]	1,744		
Taloyoak	1,084		
Umingmaktok			
Community Total	***6,232***	***13,710***	***19,942***
Airport Demand			**-inc-**
N. Warning Demand			**1,000**
Exploration		**1,000**	**2,500**
Mine Support[183]		**52,000**	**140,000**
Mine Shipping		**See text**	
Total Other		**53,000**	**143,500**
Total Projected		**66,710**	**163,442**

A potential influence on both dry cargo and tanker traffic into the Kitikmeot region is the possible reversal of re-supply lines for the diamond mines in NWT. Short winters have become a problem for the winter road system accessed through Yellowknife and the Ingraham Trail. Continued warming and shorter winters, coupled with an active port on the Coronation Gulf could see material flowing south via Lupin and into the mining regions. This activity could add up to 100,000tonnes of dry cargo and 190,000tonnes of fuel

182 Although Cambridge Bay is the administrative centre for the Kitikmeot, Kugluktuk is developing as the commercial centre. Population may well exceed Cambridge Bay by 2020, particularly with mineral development in the Slave Geologic Province.

183 High Lake is presumed to be operational shipping out of Gray's Bay.

NORTHWEST TERRITORIES	Population 2020	Planning Data 2020	
Arctic Coast		**DRY**	**POL**
Holman	435		
Paulatuk	327		
Sachs Harbour	122		
Tuktoyaktuk	1009		
***Total Coastal NWT*[184]**	***1,893***	***4,164***	***6,058***
Airport Demand			**-inc-**
N. Warning Demand			**-inc-**
Exploration		**500**	**2,500**
Mine Support		**0**	**0**
Total Other		**500**	**2,500**
Total Projected		**4,664**	**8,558**
NUNAVIK			
Akulivik	699		
Deception Bay[185]	0		
Aupaluk (Hopes Advance Bay)	240		
Inukjuaq (Port Harrison)	2,202		
Ivujivik	481		
Kangirsuk (Payne Bay)	642		
Kangirsualujjuaq (George River)	1,013		
Kangirsujuaq (Wakeham Bay)	833		
Kuujjuarapik (Great Whale)	783		
Kuujjuaq (Fort Chimo)	2,939		
Puvirnituq	2,009		
Quaqtaq (Koartac, Diana Bay)	434		
Salluit (Saglec)	1,711		
Tasiujaq (Leaf Bay)	342		
Umijaq	538		
Community Total	***14,866***	***32,705***	***47,571***
Airport Demand			**5,000**
N. Warning Demand			**2,000**
Exploration[186]		**1,000**	**2,000**
Mine Support		**0**	**0**
Total Other		**1,000**	**9,000**
Total Projected		**34,705**	**56,571**

184 Totals exclude Hay River, all river communities and Inuvik.

185 Falconbridge Raglan Mine will have closed by 2020, as resources are expected to be depleted by 2015.

186 Resource projects that are as yet unknown could be in active development, given the push in Nunavik to find new opportunities.

CREE COMMUNITIES	Population 2020	Planning Data	
Quebec		**DRY**	**POL**
Chisasibi[187]			
Eastmain			
Waskaganish			
Wemandji			
Sub Total Quebec	***10,609***		
Ontario			
Attawapiskat			
Fort Albany			
Fort Severn			
Kashechewan			
Moose Factory			
Moosonee			
Peawanuck			
Sub Total Ontario[188]	***5,636***		
Total Projected[189]	***16,245***	***17,000***	***24,368***

[187] Road connected.

[188] Population growth rates assumed to be the same as for Quebec Cree communities.

[189] Mariport estimates for Ontario, based on Quebec growth. Excludes Moosonee, which is rail connected and the distribution point for the region, and Moose Factory. Quantities exclude cargo shipped by marine to Moose Factory, but include an estimate of cargo shipped to Kuujjuarapik..