PETROLEUM AND ENVIRONMENTAL MANAGEMENT TOOL

Eastern Arctic Study Area

FINAL REPORT

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EXECUTIVE SUMMARY

The Northern Oil and Gas Branch (NOGB) of the Department of Indian and Northern Affairs Canada (INAC) is responsible for oil and gas resource management in much of northern Canada. To assist in fulfilling its mandate, the NOGB has developed the Petroleum and Environmental Management Tool (PEMT). This tool is intended to be used in assisting decision making for exploration investments, for general awareness of sensitivity issues and for understanding INAC processes.

Information on several Valued Ecosystem Components (VECs) and Socio-economic Components (VSECs) presented in the web based geographic sensitivity analyses tool for the Eastern Arctic study area is presented. Also included is a preliminary analysis of the petroleum potential of the study area.

The study area is located east of Baffin Island, Nunavut and encompasses marine habitat in Baffin Bay and Davis Strait. The boundaries of the study area are based on NOGB leasing grids applied in the Eastern Arctic, under which exploration and production licenses may be issued. Although portions of the study area hold high oil and gas potential and several small oil fields and substantial reserves of gas have been found since the 1960s in the north Baffin region, exploration for oil and gas has been limited to seismic operations and geological field work.

Six VECs and two VSECs were selected to represent the ecological and social components present in the study area. General life history, key habitat requirements, sustainability factors, susceptibility to oil and gas activities, mitigation and comments on the certainty associated with the available data (pertaining to the VECs and VSECs) are included. Oil and gas activities examined included exploration (seismic activities, exploration drilling), production (field development), transportation, and decommissioning and abandonment.

The VECs and VSECs selected for the Eastern Arctic study area are:

- Polar bear (*Ursus maritimus*)
- Bowhead Whale (*Balaena mysticetus*)
- Toothed whales (Narwhal, *Monodon monoceros* and beluga*, Delphinapterus leucas*)
- Arctic Char (*Salvelinus alpinus*)
- Migratory birds
- Species of conservation concern
- Traditional harvesting
- Commercial Fishing.

For each VEC and VSEC, habitat within the Eastern Arctic study area was assigned a sensitivity rating from 1 – 5, where the highest rating (5) identified areas that support a specific ecological function or process that is essential to the survival of the species or cultural resource. The lowest sensitivity ratings (1) include infrequently used areas and areas of relatively low value to the VECs and VSECs. Moderately-Low, Moderate, and Moderately High rankings indicate intermediate levels of

sensitivity. Sensitivity layers accounted for variability in habitat usage and development activities in the open-water and ice covered seasons.

The ranking of petroleum potential used a five point scale from very high (5) to very low (1). Qualitatively, petroleum resource potential in the study area varies between very low and very high. Geological factors in the study area are favourable for oil and gas generation and entrapment, therefore no rankings below moderate were assigned. Very high ranking was given to the areas where the potential has been demonstrated by discovery. Where no discovery has been made, the ranking was lowered to high or moderate dependant on other indicators.

The utility of the PEMT depends on the availability and quality of spatial data for the VECs and VSECs. Currently available data for most VECs in this area is limited and/or dated. The current iteration of the PEMT is therefore a coarse instrument which provides general information and predictions on resource sensitivities. As additional information becomes available, it is important that the tool is updated to reflect the most recent knowledge on the biophysical or cultural components of interest.

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ABBREVIATIONS

CITES	Convention on International Trade in Endangered Species
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DST	Decision Support Tool
INAC	Indian and Northern Affairs Canada
IUCN	International Union for Conservation of Nature
NBRLUP	North Baffin Region Land Use Plan
NLCA	Nunavut Land Claims Agreement
NOGB	Northern Oil and Gas Branch
NOW	North Water
PEMT	Petroleum and Environmental Management Tool
REA	Regional Environmental Assessment
SARA	*Species at Risk Act*
SDS	Sustainable Development Strategy
VEC	Valued Ecosystem Component
VSEC	Valued Socio-Economic Component

GLOSSARY OF TERMS

Base Layer	The base layer of a map is the electronic representation of all the important geographic information that applies to the study area i.e., coast line, river systems, etc.
Component Layer	The component layer of a map is the electronic geographic information that is specifically related to the valued ecosystem components (VECs) or valued socio-economic components (VSECs) which are required to develop the sensitivity layer.
Critical Habitat	An area defined under the *Species at Risk Act* as the habitat that is necessary for the survival or recovery of a listed wildlife species and has been identified as such in the recovery strategy or in an action plan for the species.
Decision Support Tool	A geographic information based system (GIS) that contains a series of sensitivity layers which have been generated for each valued ecosystem component (VEC), valued socio-economic component (VSEC) and the geo-economic potential in the study area. This tool can be manipulated to examine the sensitivity of an area and generate an idea of potential change should an area be opened to exploration and development.
Geo-economic Layer	This layer was based on geological, economic and uncertainty factors and was developed based on a scorecard rating system for each unique grid cell in the Study Area developed by INAC.
Grid	A predetermined set of coordinates used by the Department of Indian Affairs and Northern Development.
Subsistence Harvesting	Harvesting and hunting for wildlife and vegetation to proved essential food and clothing.
Valued Ecosystem Component (VEC)	A part of the biophysical environment that is considered to be important and representative. This importance may be determined on the basis of cultural values and scientific concerns.
Valued Socio-Economic Component (VSEC)	Aspects of the socio-economic environment that are considered to be of vital importance to a particular region or community, including components related to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations.

1 INTRODUCTION

The Northern Oil and Gas Branch (NOGB) of the Department of Indian and Northern Affairs Canada (INAC) is responsible for oil and gas resource management in much of Northern Canada. This mandate includes conducting integrated resource management in keeping with INAC's Sustainable Development Strategy (SDS). The annual issuance of petroleum licenses considers environmental, economic and social-economic issues.

To assist in this process, the NOGB has developed the Petroleum and Environmental Management Tool (PEMT) formerly named the DST (Decision Support Tool) which provides information on environmental and socio-economic sensitivity along with economic factors within areas subject to petroleum licenses issued by the NOGB. The PEMT includes a web application that allows users to display geographic and tabular environmental, socio-economic and economic information at specific locations.

The PEMT is intended to assist Industry with decision making for exploration investments and other groups for general awareness of sensitivity issues and for understanding INAC processes. Within INAC, the PEMT supports the development of strategic options for rights issuance leading to the review of call area extents. The PEMT is also intended to assist in the assessment of cumulative effects. Communities, Northerners, industry and the general public can use the PEMT to access information on land-use planning and environmental assessment themes especially those relevant to oil and gas resource management.

1.1 Objectives

The intention of the PEMT is to provide information on environmental and socio-economic sensitivity alongside economic factors. It is intended to be used in assisting decision making for exploration investments and other groups, for general awareness of sensitivity issues and for understanding INAC processes.

This report provides supporting information on the series of Valued Ecosystem Components (VECs) and Socio-economic Components (VSECs) presented in the web based geographic sensitivity analyses tool. Six VECs and two VSEC were selected to represent a variety of ecological and social components present in the study area. In addition to a rationale behind the sensitivity ranking for each VEC or VSEC, information is presented on general life history, key habitat requirements, sustainability factors, susceptibility to oil and gas activities, mitigation and comments on the certainty associated with the available data.

The sensitivity layers are applied to the Northern Oil and Gas Branch's Leasing Grids, facilitating the preliminary identification of areas of high or low sensitivity among several VECs/VSECs, and corresponding high and low values of petroleum potential in the study area.

2 STUDY AREA

The Eastern Arctic study area is located east of Baffin Island, Nunavut and encompasses marine coastal and offshore habitat in Baffin Bay and Davis Strait (Figure 2.1). The boundaries of the study area are based on the NOGB leasing grids applied in the Eastern Arctic, under which exploration and production licenses may be issued.

2.1 Environmental Setting

The coastal zone of eastern Baffin Island contains the Davis Highlands which form a belt of mountains and plateaus broken up by many steep, vertically walled fjords of up to 2,000 m elevation (1982). To the east of Baffin Island are Davis Straight and Baffin Bay. To the north, Lancaster Sound separates Baffin Island from the rest of the Arctic Archipelago. Baffin Island generally has a northerly airflow all year which results in a cold climate. One effect of this is that the spring thaw typically arrives later than in other parts of the Arctic. Davis Straight is much shallower than Baffin Bay; however, both areas are characterized by open water periods in the summer months (July to October). In the winter (November to June), the study area is dominated by pack ice, with the exception of several polynyas which typically remain ice free for much of the year.

2.2 Oil and Gas Development

The Eastern Arctic Study area is composed entirely of marine habitat. The following description of oil and gas activities associated with development of Arctic hydrocarbon resources only addresses offshore activity.

2.2.1 Exploration

The oil and gas exploratory phase typically involves seismic surveys to provide data about the subsurface geology, followed by the drilling of targets of interest to confirm the presence or absence of hydrocarbons.

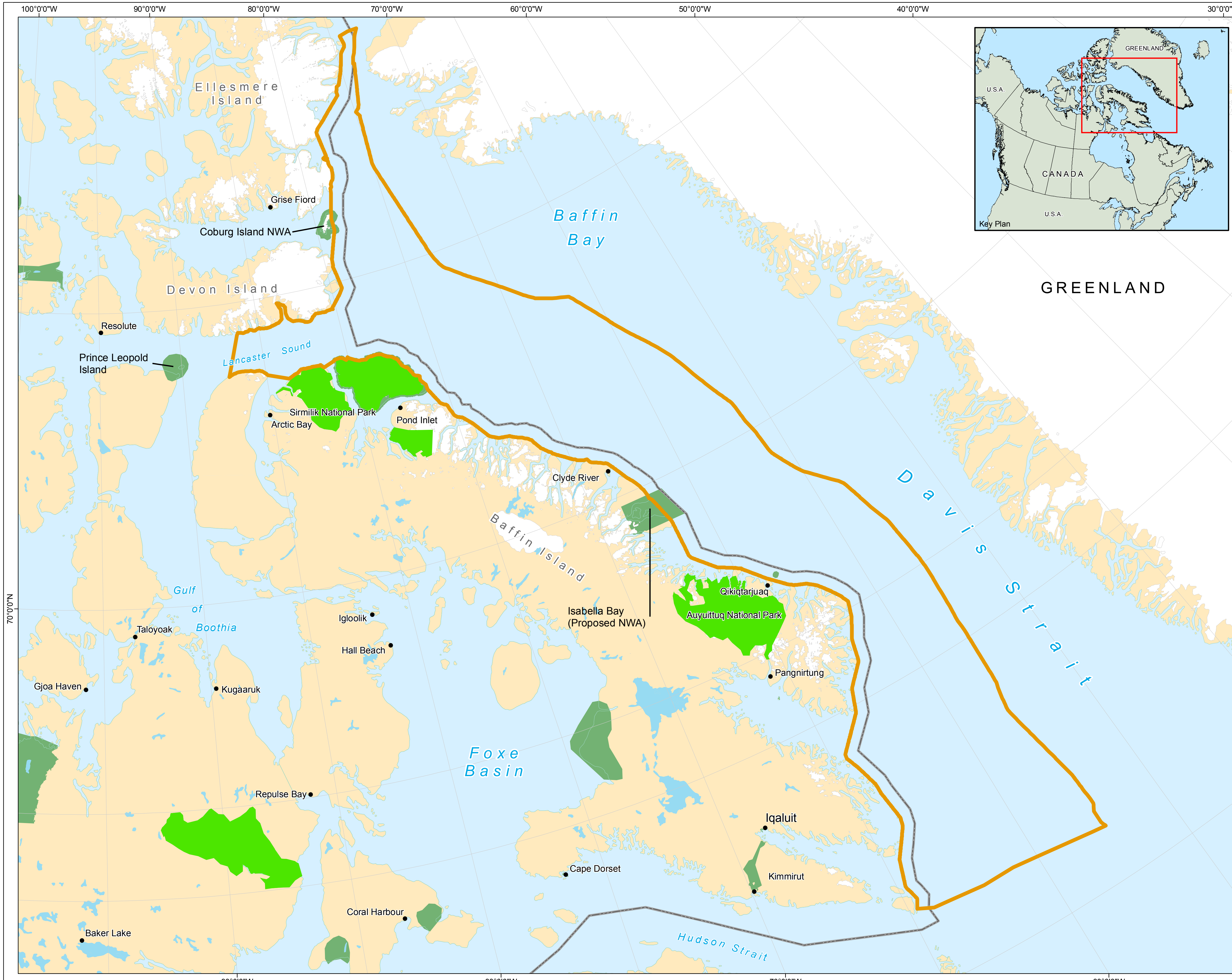
2.2.1.1 Seismic Activities

Seismic energy waves propagate through ‘overburden’ rock to the reservoir targets and beyond and are then reflected back to receivers where they register as a pressure pulse, providing an acoustic image of the subsurface. Seismic surveys can either be two dimensional (2D) or three dimensional (3D), the latter of which is more expensive but produces more extensive data.

Offshore seismic activities are conducted from a seismic survey vessel towing a submerged acoustic energy source array. The vessel will traverse along predetermined lines in the area while the arrays discharge at regular intervals. Offshore seismic is conducted during the open water season, commonly from July through October in this area. The seismic vessel may, or may not come to shore for resupply. Depending on the duration and specifics of the particular survey, the seismic vessel may be supported by other vessels or aircraft to provide supplies, crew changes and ice management support.

Eastern Arctic Study Area

Fig 2-1



Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

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2.2.1.2 Exploration Drilling

Drilling is undertaken to confirm the presence or absence of hydrocarbons once a seismic survey has identified targets of interest. Exploration drilling involves the mobilization of the drilling rig to the site, positioning on site, drilling of the well(s), well completion and testing, well abandonment and demobilization of the rig.

The type of drilling rig used in the offshore environment is largely dependent on water depth and ice conditions. In shallow depths rigs may be positioned on the seafloor or on islands constructed to support the rig. In deeper locations floating drilling platforms or drill ships may be used to drill the well.

Offshore exploratory drilling requires support/supply vessels to transport equipment, supplies and personnel to the rig. Depending on conditions, vessels may also be required to provide ice management services for the rig. Helicopter support is also often needed. In addition to offshore facilities, operations may require a base or support facilities onshore for equipment storage. Waste generation includes drill cuttings, drilling fluids and chemicals, cement, sewage, drainage, rig wash, assorted solid wastes and atmospheric emissions.

Offshore exploratory wells are drilled in a number of sections of decreasing diameter. Steel casing is run down the well and cemented in place. Drill cutting and fluids are returned to the surface in the space between the drill string and steel casing. Drilling fluid is often recycled and used more than once prior to disposal. The top section may be drilled without a conductor casing, resulting in drill cuttings and fluids being discharged directly to the surrounding seabed.

If hydrocarbons are encountered, the potential production of the well is tested. A well test involves allowing hydrocarbons to flow up the well bore to the rig under controlled conditions so that samples can be taken for analyses and to determine the capability of the reservoir to deliver oil and gas. Well testing also usually involves flaring/burning of the reservoir oil and/or gas. Once testing is complete, mechanical packers and cement plugs are used to seal the well and the casing is cut below the seabed and removed.

2.2.2 Production

Once exploration drilling has determined that hydrocarbons are present, field development is initiated, allowing for the production of hydrocarbons. When the field has reached the end of its life span, decommissioning and abandoning takes place.

2.2.2.1 Field Development

Offshore fields are typically developed using numerous directed wells radiating from a single production facility to drain a large area reservoir. Sub-sea infrastructure, such as tie-backs and pipelines, can be used to connect wells back to a production facility. The development infrastructure is designed to address local conditions and may include one or more production centres. Facility components are constructed on shore and transported to the site for installation. Construction of the facility is supported by vessels and aircraft, often supported from a base facility onshore. Waste generation from the field development activity includes sewage, drainage, drill cuttings, drilling fluids, cement, assorted solid wastes and atmospheric emissions.

2.2.3 Transportation

Hydrocarbons produced both onshore and offshore need to be transported to markets either via pipeline or tanker. Some processing may be necessary on the production facility dependent on the development and chemical composition of the hydrocarbons. Additional wells may be drilled in the field and tied into the production facility during production. Reservoir pressures must be maintained in order to achieve as high a recovery factor as possible. Water or gas injection, gas lift, acidizing or fracturing are some techniques which operators may use to enhance recovery. Wastes generated from production facilities include produced water, production chemicals, sewage, drainage, assorted solid wastes and atmospheric emissions.

2.2.4 Decommissioning and Abandonment

Safety, environmental and economic factors are taken into consideration when determining the most appropriate means of decommissioning and abandonment. Operators are typically expected to remove structures in their entirety; however, this decision is based, among other factors, on an understanding of the incremental effects of removal.

2.3 History of Oil and Gas Activities in the Eastern Arctic Study Area

According to the Nunavut Planning Commission (NPC), the eastern portion of Lancaster Sound (and the Sverdrup Basin) have the highest known oil and gas potential of the sedimentary basins of the Arctic Islands (NPC 2000). In the North Baffin region, several small oil fields and substantial reserves of gas have been found since the 1960s and it is expected that further discoveries are possible in the Sverdrup Basin, Lancaster Sound and north Baffin Bay (NPC 2000). Proven oil and gas potential in Nunavut includes oil and gas seeps in the Davis Strait (Sivummut Economic Development Strategy Group 2003).

Exploration for oil and gas in Lancaster Sound Basin has been limited to seismic operations and geological field work along the margins of the basin. Smith *et al.* (1989) rate the oil and gas potential of Lancaster Sound Basin as high, based on a review of the current state of knowledge. No new data of significance has been acquired since this study. It is clear that this basin fulfils many of the criteria of a petroliferous basin but that significant risk remains: specifically, source rock presence and maturity, seal integrity, breaching of traps and timing of migration (Morrell *et al.* 1995)

3 APPROACH AND METHODS

3.1 VEC/VSEC Layer Development

3.1.1 Selection of Valued Ecosystem and Socio-Economic Components

VECs and VSECs were chosen based on their cultural, ecological and economical importance in the study area. Following the methodology used for the development of the DST for the Canadian Beaufort Sea (Gartner Lee Limited 2008), selection of the VECs and VSECs involved developing a preliminary list of VECs and VSECs based on their association and relative importance to the cultural and ecological value of the study area. This list was further refined based on the availability of spatial data required for assessing sensitivity of habitat in the region.

3.1.2 Literature Review

For each of the selected components, information on current status (national and international), distribution, general ecology, key habitat requirements, population status and trends, threats, and considerations for development were compiled and reviewed. Information was obtained from technical and scientific literature. Individuals actively researching in key areas of expertise related to the components on the short list were contacted. Sources of information for this report include:

- Federal Government agencies (e.g., Fisheries and Oceans Canada (DFO), Canadian Wildlife Service (CWS) (Environment Canada), Environmental Protection Branch (Environment Canada), Indian and Northern Affairs Canada (INAC), Natural Resources Canada
- Federal Research Institutes (e.g., Bedford Institute, Institute of Ocean Sciences)
- Government of Nunavut (GN) agencies (e.g., Department of Environment, Wildlife Research Group, Parks)
- Territorial research organizations and institutes (e.g., Nunavut Research Institute (NRI), Prince of Wales Northern Heritage Centre)
- Nunavut Wildlife Management Board (NWMB), Regional Wildlife Organizations (RWO) and local Hunter and Trapper Organizations (HTOs), Nunavut Planning Commission (NPC)
- Universities and Colleges (e.g., ArcticNet, Canadian Arctic Shelf Exchange Study (CASES), Nunavut Arctic College, Arctic Science and Technology Information System (ASTIS) database, International Polar Year and Arctic Institute of North America)
- Strategic assessments from other Arctic nations (Boertmann *et al.* 2009).

3.1.3 Selected Valued Ecosystem Components

The VECs selected for the Eastern Arctic study area include:

- Polar bear (*Ursus maritimus*)

- Bowhead Whale (*Balaena mysticetus*)
- Toothed whales (Narwhal, *Monodon monoceros* and beluga*, Delphinapterus leucas*)
- Arctic Char (*Salvelinus alpinus*)
- Migratory birds
- Species of conservation concern.

As with the DST for the Beaufort Sea (Gartner Lee Limited 2008), one of the main factors in the final selection of VECs was the availability of spatially referenced information that could be used in a GIS approach to mapping the range and key areas associated with VECs. Over the long term it is intended that the PEMT can be expanded with the addition of VECs/VSECs as spatial data becomes available.

3.1.4 Selected Valued Socio-Economic Components

After a review of the Nunavut Atlas (Riewe 1992), the North Baffin Regional Land Use Plan (Nunavut Planning Commission 2000), the Nunavut Wildlife Harvest Study (Priest and Usher 2004) and consideration of petroleum industry activities likely to take place in the study area, traditional harvesting was selected as one of the VSECs.

Additionally, commercial fishing was selected as one of the final VSECs. While the inshore char fishery has been occurring for some time, the near shore and offshore commercial fishery for turbot and shrimp is an emerging, yet important contributor to the economy in Nunavut. Oil and gas activity has the potential to interact with both the commercial fish resource and the commercial fishing activity.

3.1.5 VEC/VSEC Sensitivity Layer Development

To maintain a level of consistency in the application of the PEMT, the development of the sensitivity layers for each selected VEC/VSEC in this study area was based on the methodology undertaken for the Canadian Beaufort Sea DST (Gartner Lee Limited 2008). As such, the decisions were made with a combination of various sources of relevant ecosystem (habitat use and availability) and socio-economic information. Each rating and its spatial distribution across the study area was dependent on data availability. While the general information on the selected VECs/VSECs is comprehensive, much of the habitat usage by VEC's and VSEC's is closely correlated with the seasonal patterns of sea ice. As a result, the spatial distribution of habitat usage may vary substantially on an annual basis and can be highly dependent upon environmental conditions. Taking this variability into consideration, sensitivity ratings were applied based on conservative interpretations of potential impacts for projects among seasons.

3.1.6 Sensitivity Ranking Methodology

Sensitivity ranking considered ecological factors and habitats and the nature of potential effects on each of the VECs and VSECs. Factors considered in developing the rating system included sensitivity to development, susceptibility to habitat change for VECs, life history and occurrence in the study area, and importance to local communities.

The process of rating the sensitivity layers for each VEC and VSEC was largely subjective and based on the unique characteristics of each component. However, to maintain some level of consistency in defining and assigning sensitivity rankings, a framework was developed based on the same guiding principles that were developed for the Beaufort Sea DST (Gartner Lee Limited 2008). Ranking systems considered habitat value and the susceptibility of those habitat values to development. The principles guiding this process were (Gartner Lee Limited 2008):

- Habitats that have specific value for a suite of VECs were incorporated and mapped.
- The ecological value of habitats that support the viability of the population of a VEC were positively reflected in the sensitivity rating for an individual VEC.
- The cultural value of areas to local and indigenous people was positively related to the sensitivity rating of a VSEC; particularly in regard to the ability of the area to support culturally significant activities, history, or education.
- In rating layers the precautionary principle was applied, in that in areas with lesser certainty of either the value of habitats or the implications of development were rated with higher sensitivity.

For each VEC and VSEC, habitat within the Eastern Arctic study area was assigned a sensitivity rating from 1 – 5, where the highest rating (5) identified areas that support a specific ecological function or process that is essential to the survival of the species or cultural resource. The lowest sensitivity ratings (1) include areas that are infrequently used and of relatively low value to the VEC's and VSEC's viability. Moderately-Low, Moderate, and Moderately High ranking indicate intermediate levels of sensitivity. All ratings were defined and assigned based on the unique characteristics of each component and were determined on available literature, spatial data, expert opinion and professional judgment. The following general guidelines were used to define sensitivity ratings for each of the valued components:

High Sensitivity

Sensitivity Rating 5

- Does this area support a specific ecological or cultural function or process that is essential to the cultural resource or survival of the species (e.g., IBA, key migratory bird habitat, community and/or hunting camp, nesting area, polar bear denning sites, spawning habitat, IBA, key migratory bird habitat, etc.) in the region?
- Is the area legally protected (e.g. national or territorial park, MPA, migratory bird sanctuary, critical habitat for VEC)?
- Would routine oil and gas activities in this area likely have a significant impact on the VEC/VSEC (population viability or cultural resource)?

Moderate-High Sensitivity

Sensitivity Rating 4

- Does this area represent habitat or hold cultural resources that are nationally important to the VEC/VSEC? For species, this may occur if an area supports a significant (i.e., 1%) proportion of the national population or for other reasons is key to the national persistence of the resource.
- Would routine oil and gas activities in this area have a high magnitude, measureable impact on population viability or the cultural resource in the region with little expected resilience by the VEC/VSEC?

Moderate Sensitivity

Sensitivity Rating 3

- Does this area represent habitat or hold cultural resources that are regionally important to the VEC/VSEC? For species, this occurs if the habitat supports a high proportion of the regional population or cultural resource at any given time (e.g., beluga estuaries, bowhead feeding aggregations, commercial fishing grounds, traditional harvest location, etc.) or for other reasons is key to regional persistence of the resource.
- Would routine oil and gas activities in this area have a moderate magnitude and a measureable impact on population viability or the cultural resource in the region with some expected resilience by the VEC/VSEC?

Low-Moderate Sensitivity

Sensitivity Rating 2

- Does this area represent habitat or hold cultural resources that are locally important to the VEC/VSEC?
- Would routine oil and gas activities in this area have a low magnitude, but measureable impact on population viability or the cultural resource in the region with high resilience or elasticity by the VEC/VSEC?

Low Sensitivity

Sensitivity Rating 1

- Does this area represent habitats or cultural resources that are little used by the VEC/VSEC?
- Would routine oil and gas activities in this area have little or no measureable impact on population viability or the cultural resource in the region?

3.1.7 Seasonality

Some VECs/VSECs display prominent seasonal use of particular habitat and potential developmental impacts may also be limited temporally by season, therefore seasonality was considered when ranking sensitivity. Sea ice coverage is the major limiting factor to marine based oil and gas activities in the study area, and is often restrictive to certain activities such as shipping, seismic exploration and drilling. To maximize the utility of the PEMT, sensitivity layers were developed to account for variability in habitat usage and development activities in the open-water and ice covered seasons. For the purposes of these sensitivity layers, the summer (open-water) season is defined as the ice free period between early July and late October. The winter season is defined as the ice covered period between early November and late June.

3.1.8 Potential Interactions between Oil and Gas Activities and Valued Environmental Components

A number of interactions may occur between routine oil and gas activities and the socio-economic or biophysical environments. When developing sensitivity layers, the potential effects of these interactions were considered.

3.1.8.1 Seismic Survey

- Underwater acoustic disturbances (vessel and seismic)
- Discharge of effluent (sewage, ballast)
- Physical presence of equipment (seismic vessel and equipment)
- Aircraft support.

3.1.8.2 Exploration Drilling

- Underwater acoustic disturbances (drilling rig, support vessels)
- Discharge of effluent (sewage, ballast, rig wash)
- Discharge of drilling wastes (moods, cuttings)
- Physical disturbance of seabed (physical footprint and sediment suspension)
- Light (presence and illumination)
- Physical presence of equipment
- Aircraft support
- Ice platforms and roads.

3.1.8.3 Field Development

- Underwater acoustic disturbances (vessels, drill rig)
- Discharge of effluent (sewage, drainage)
- Discharge of drilling wastes (muds, cuttings and water)
- Physical disturbance of seabed (platform and pipeline footprints and sediment suspension)
- Coastal disturbance due to onshore support infrastructure (i.e., pipeline landfall)

- Physical presence of equipment (drill rigs, support vessels, other equipment)
- Dredging
- Aircraft support
- Ice platforms and roads.

3.1.8.4 Production

- Underwater acoustic disturbances (production platform/rig and support vessels)
- Discharge of effluent (sewage, drainage)
- Discharge of produced water
- Aerial emissions (support vessel and production platform/rig)
- Light (presence and illumination)
- Physical presence of equipment
- Ice platforms and roads.

3.1.8.5 Decommissioning

- Underwater acoustic disturbances (vessels and aircraft)
- Discharge of effluent (sewage, drainage)
- Physical disturbance of seabed (sediment re-suspension and physical smothering of fauna)
- Coastal disturbance due to removal of coastal support infrastructure (i.e., pipeline landfalls)
- Light (presence, illumination)
- Physical presence of equipment
- Ice platforms and roads.

3.2 Geo-Economic Layer Development

Very few wells have been drilled in this region and limited seismic information available along the Canadian margin make the quantitative assessment of undiscovered resources unachievable at this time. Only one discovery has been made in the entire region; the 1981 gas/condensate discovery at Hekja 0-71 in the southwestern corner of the area of interest. This discovery confirms the presence of an active petroleum system in the local area and serves to augment views of potential in adjacent assessment units.

More generally in Baffin Bay, most geological factors necessary for hydrocarbon accumulations are thought to be present. Potential source rocks, active oil seeps, potential reservoirs and a diversity of traps have been indicated in summaries of geological knowledge of the region (INAC 1995, internet site). More recent work by the Geological Survey of Canada as part of the Geo-mapping for Energy and Minerals program of the Government of Canada (http://gsc.nrcan.gc.ca/gem/energ/capse_e.php) and results emerging from exploration work on the Greenland shelf are confirming the overall geological favorability of the region for oil and gas.

The petroleum potential of the Baffin Bay region is based on a quantitative evaluation of assessment units undertaken by the United States Geological Survey as part of a circum-Arctic assessment of petroleum potential (US Geological Survey 2008). Mean estimates of oil, gas and NGL potential were summed and normalized to unit area as a guide to relative potential.

A qualitative ranking of these assessment units was applied to those areas within Canadian waters and extrapolated south of the Arctic Circle to the full extent of the area of interest. This extrapolation follows general geological trends but may not accurately reflect changes in geological orientations to be demonstrated by detailed surveys.

The qualitative assessment of petroleum potential is intended to give a general overview of potential for future exploration success across this large region. The ranking used is as follows using a five point scale ranging from very high (5) to very low (1). This scheme has been adapted from Jackson and Sangster, (1987). In similar forms it has been widely used as a qualitative ranking of potential for mineral and energy resource assessments.

Very High (5)

- Geological environment is very favourable
- Significant deposits/accumulations are known.

High (4)

- Geological environment is very favourable
- Occurrences are commonly present but significant deposits/accumulations may not be known
- Presence of undiscovered deposits/accumulations is very likely.

Moderate (3)

- Geological environment is favourable
- Occurrences may or may not be known
- Presence of undiscovered deposits/accumulations is possible.

Low (2)

- Some aspects of the geological environment may be favourable but are limited in extent
- Few if any occurrences are known
- Low probability that undiscovered deposits/accumulations are present.

Very Low (1)

- Geological environment is unfavourable
- No occurrences are known
- Very low probability that undiscovered deposits/accumulations are present.

4 SENSITIVITY LAYERS

4.1 Polar Bear

4.1.1 Rationale for Selection

Polar bears are an integral component of the Arctic ecosystem in Nunavut as they are the top predator within the food web. Polar bears also have significant cultural and economic importance to the Inuit and are hunted by almost all communities (Priest and Usher 2004). Over a five year period from 1996 to 2001 the mean number of polar bears taken from hunting was approximately 1339 (Priest and Usher 2004). Hides are sold commercially as luxury items and may bring high prices in the fur market. Inuk guided hunting is also a source of income from the tourist industry and polar bear watching tours have also become popular (COSEWIC 2008).

4.1.2 Polar Bear Summary

4.1.2.1 Life History

Conservation Status

Polar bears have been classified as 'Special Concern' by COSEWIC in 2002 (COSEWIC 2008) and have not yet been assessed under SARA. Polar bears are protected under Appendix II of CITES and classified under IUCN as Lower Risk: Conservation Dependent. Polar bear policy and management in Nunavut is complicated because it involves polar bear populations which inhabit other territories and provinces in Canada and is managed under federal jurisdiction as well as management boards established under the NLCA.

Distribution

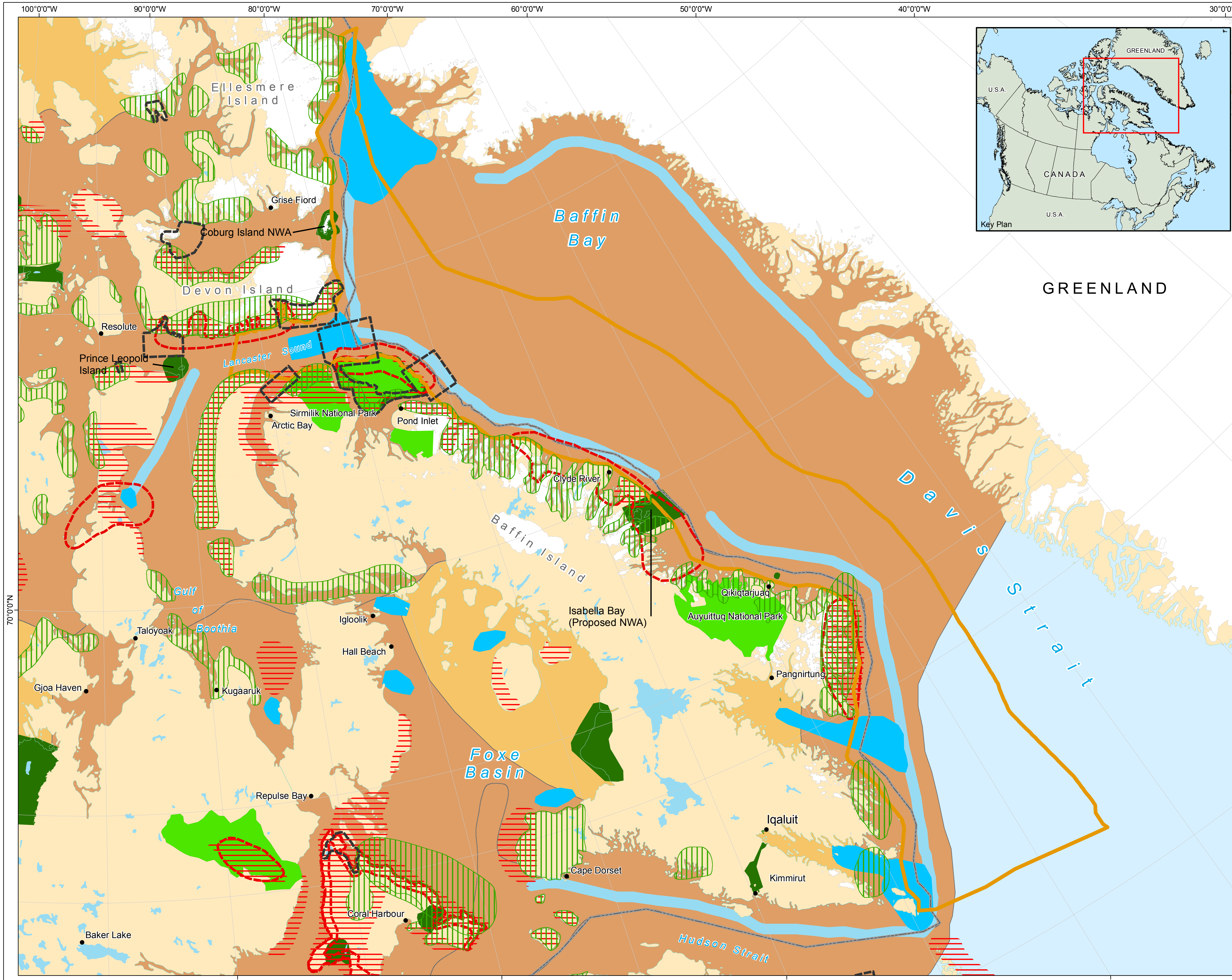
Seasonal distribution of Polar bears in the eastern Arctic study area is summarized in Figure 4-1.

Polar bears are found throughout Nunavut and range from the northern end of Ellesmere Island south to the Belcher Island (Taylor *et al.* 2001; COSEWIC 2008). The Eastern Arctic study area overlaps with four of the eleven polar bear sub-populations that inhabit the Nunavut region (from COSEWIC 2008); Kane Basin (164 bears, COSEWIC 2008), Lancaster Sound (2541 bears, COSEWIC 2008) (Baffin Bay (1546 bears, COSEWIC 2008) and Davis Strait (2251 bears, COSEWIC 2008). Estimated total population numbers for all sub-populations in Canada is approximately 11,000 – 19,000 (COSEWIC 2008).

Satellite tagging studies of polar bears performed by Taylor, *et al.* (2001) showed their range extending from as far west as Viscount Melville Sound, as far north as Kane Basin where their northern boundary is formed by Kennedy Channel, and as far south beyond the tip of southern Baffin Island. They are also observed, on rare occasion, in Foxe-Basin and Hudson Strait. Polar bears are more likely to use the windward side of Baffin Island than the onshore retreats of the Hudson Strait during the summer season (Taylor *et al.* 2001). Polar bears that winter on ice off the east coast of Baffin Island will either summer on the onshore areas or retreat into Lancaster Sound to the east of Viscount Melville Sound (Taylor *et al.* 2001).

Eastern Arctic, Nunavut, Canada Polar Bear Range and Key Seasonal Habitat

Fig 4-1



Polar Bear Denning Area 4,7
IBP - Polar Bear Habitat 5
Summer Retreat 7
WASI - Polar Bear Site 2
Shore Lead 6
Polynyas 3
Core Polar Bear Range 1,6
Lower Density Polar Bear Range 6

Base Features
Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

[1]COSEWIC. 2008. COSEWIC assessment and update status report on the polar bear Ursus maritimus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 75 pp
*digitized by Nunami Stantec 2010

[2]Ferguson, S.H. 1995. Wildlife Areas of Special Interest to the Department of Renewable Resources. Wildlife Management Division, Department of Renewable Resources, Government of the Northwest Territories. Nunavut Wildlife Management Board version adapted from original 1987 publications. 80 pp
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[3]Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Morthwest Territories. Canadian Wildlife Service Occasional Papers 109.
*digital data provided by CWS, reproduced with the permission of Environment Canada

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[6]Stirling, I. 1998. Polar Bears. The University of Michigan Press. Ann Arbor, Michigan.
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*digitized by Government of Nunavut 2005

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Ecology

Habitat requirements for polar bears include ice, open water, coastal areas and land. Their distribution on the ice is closely linked to the distribution of ringed seals, their preferred prey and to a lesser degree the bearded seal (Stirling 1980). Specific ice habitat selection by polar bears seems to be complex even just within Nunavut. During spring and summer, Polar bears in the Eastern Arctic use areas of active ice (thick first-year ice found in large floes) for feeding (Ferguson, *et al.* 2000a). These ice types likely represent areas where most spring seal pupping occurs (Ferguson *et al.* 2000a). Polar bears tend to select first-year ice in winter as new ice forms and multiyear ice in autumn when maximum ice melt has occurred (Ferguson, *et al.* 2000a; Ferguson, *et al.* 2001). Polar bears also show the ability to anticipate seasonal fluctuations. For example, polar bears were found close to ice edges in spring in advance of the availability of ice edges (Ferguson, *et al.* 2000a). As ice melts in the summer some bears may remain on the multi-year ice while others may follow the receding ice (Taylor, *et al.* 2001). Here they will inhabit coastal land and live off stored body fat or feed on grasses, lichens, mosses and berries (COSEWIC 2008).

Shelter dens are an important component of polar bear habitat. In the northern regions of Nunavut, shelter dens are found on multi-year ice and are used during the winter. In contrast, shelter dens in southern regions of Nunavut were found in areas of no sea ice and are used during the autumn (Ferguson, *et al.* 2000a).

Pregnant females require suitable habitat to make dens during the winter months so they can give birth and feed their young cubs. The majority of maternity denning occurs on land; however, multiyear ice has also provided suitable denning habitat to some pregnant females. Most maternity dens are dug into snowdrifts on south-facing slopes of hills or valleys. In more southerly populations it is not uncommon for them to be dug into the banks of creeks or lakes. Van De Velde (2003) reported that dens made by pregnant females and bears of other age and sex classes tend to be found in the same areas year after year. It is also believed that in the treeless coastal areas most female polar bears den within a few kilometres of the coastline (Van De Velde, *et al.* 2003).

Polar bears are carnivorous and hunt throughout the year in areas of multi-year ice. They prey predominantly on ringed seals, but also catch bearded seals, harp seals, hooded seals, harbour seals, and occasionally, young walrus, beluga whale and narwhal (COSEWIC 2008). During the summer they will also eat grasses, lichens, mosses, and berries. Studies have shown that these bears consume the majority of the calories they need for an entire year during the spring and early summer (COSEWIC 2008).

Female polar bears are sexually mature at the age of four or five years old (COSEWIC 2008). Males usually reach sexual maturity at the age of five or six, but due to competition with larger adult males they will not usually mate for their first time until they are at least eight years old (COSEWIC 2008).

Mating occurs during the spring. Only pregnant females enter dens for a significant period of the winter. The rest of the population remains active and will only return to temporary shelter dens when the weather is sufficiently bad (Ferguson, *et al.* 2000b). The gestational period is only two months and females cannot breed more often than every three years (Stirling and Derocher 2007). Cubs are nursed inside maternity dens until late February to mid-April. Cubs are typically weaned at two and a half years of age and may stay with their mothers for three and a half years (COSEWIC 2008).

Seasonal fidelity to local areas seems to occur with both sexes in Nunavut. They also seem to occupy fixed home ranges rather than continuous expanding ranges (Taylor, *et al.* 2001).

4.1.2.2 Key Habitat

Polar bears rely on sea ice habitat for survival as it provides them access to the seal species that make up the majority of their diet. For this reason, Polar bear habitat shows the same spatial variability from year to year as the sea ice. When this variability is compounded with the uncertainty of the effects that climate change has on arctic ice patterns, it becomes very difficult to accurately identify the spatial boundaries of polar bear key habitat as they are changing from year to year and decade to decade. Key habitat for polar bears includes areas of active ice (leads, polynyas) in the spring and early summer when access to prey is most critical. Landfast ice on the eastern coast of Baffin Island also provides important foraging habitat for polar bears in the spring when seals and their pups are in their birth lairs. Polar bears tend to return to the same den year after year or an area of similar habitat quality (Lunn, *et al.* 2004; Stirling, *et al.* 2004). In the eastern Arctic Study area, these denning areas are concentrated along the eastern coast of Baffin Island, Devon Island and Ellesmere Island.

4.1.2.3 Sustainability Factors

Limitations to polar bear populations include relatively low reproductive capacity, hunting, environmental contamination, offshore and land-based oil and gas exploration, industrial development and climate change.

Female polar bears have low reproductive rates, which makes them vulnerable to any threat that could impact health and population abundances (COSEWIC 2008).

Polar bears are vulnerable to pollutants directly and indirectly. They are the top predator in Arctic food webs and therefore are susceptible to bioaccumulation[1] within this ecosystem. These toxins can accumulate in polar bear tissues from the prey items consumed. Pollutants may interfere with hormone regulation, immune system function, and possibly reproduction (Stirling 1990).

4.1.2.4 Susceptibility to Oil and Gas Activities

Increased human activity, oil and gas exploration and coastal development in the Arctic may diminish important land based maternity denning habitat and possibly spring feeding habitats at the ice edge.

[1] Bioaccumulation is the process of accumulation of a substance leading to progressively higher concentrations of a contaminant up through a food chain, via predators ingesting prey that have previously accumulated contaminants in their body tissue

Seismic Exploration

Marine based seismic exploration can only proceed in areas of open water. Although it is not uncommon to see polar bears swimming in open water, adverse interactions with polar bears would be unlikely and effects would be limited.

Ice-based Activities

The presence of stationary drill-ships and drill-sites has been shown to attract polar bears, possibly from seal utilization of rig-induced cracks (Stirling 1998). This may increase access to prey (Richardson, *et al.* 1995) but may also increase the threat of killing these bears in areas of higher human activities.

Shipping

Polar bears do not seem to be deterred from noise associated with offshore oil activities (even when swimming in the water), construction, ice-breakers or vessel traffic (Richardson, *et al.* 1995).

Hydrocarbon Release

Physiological studies on the effects of oil on polar bears show there is a high probability that a single major oil spill in a critical habitat area for polar bears may have a significant effect on the population (COSEWIC 2008). Polar bears have been shown to be extremely sensitive to the toxic effects of oil and quickly succumb to kidney failure and death when exposed to situations where their fur became oiled, and oil was ingested while grooming (Stirling 1998).

4.1.2.5 Potential Effects of Climate Change on Polar Bears

Climate change poses a significant threat to polar bears because they rely on the ice for traveling, feeding habitat, and denning. Polar bears rely directly on sea ice as a mechanism to travel around the Arctic and indirectly as habitat for their prey (ringed and bearded seals) (Stirling and Øritsland 1995). They have local site fidelity and fixed home ranges which makes them particularly susceptible to changes in their habitat (Derocher, *et al.* 2004). Changes in the timing, duration, extent and quality of ice thickness due to climate change and its effect on polar bear health, abundance and range has received notable attention from several researchers (Derocher, *et al.* 2004; Stirling and Parkinson 2006; Stirling and Derocher 2007; Stirling, *et al.* In press). The main threat consistently identified is habitat loss of sea ice as a result of climate change (Stirling and Derocher 2007).

With changing ice conditions, polar bears may be forced to coastal land areas earlier on in the summer season (Stirling and Parkinson 2006). This may alter the amount of time they spend foraging on seals and would require a longer time spent not feeding and more time relying on stored body fat (Stirling and Parkinson 2006). Changes in the timing and duration of sea ice may also affect polar bears indirectly by changing the distribution of ringed seals forcing them to search for alternative food sources (Stirling and Parkinson 2006). Polar bears may be forced onto coastal land-based areas with higher human activities. Inuit hunters in Nunavut have reported that they see more polar bears near settlement areas during the open water season in recent years (Stirling and Parkinson 2006). All of these changes would increase the difficulty of survival in an already harsh environment (Derocher, *et al.* 2004).

4.1.3 Sensitivity Ranking

Sensitivity ranking for Polar bear habitat in the eastern arctic study area is summarized in Figure 4-2 (winter season) and Figure 4-3 (summer sensitivity).

High Sensitivity (5)

Habitat defined as highly sensitive for polar bears includes critical habitat as identified under SARA to protect areas that are essential to the survival of species that are listed as threatened or endangered under federal legislations. Critical habitat for polar bears in the Eastern Arctic study area has not yet been identified or protected. Habitat that is legally protected as a park or conservation area is also considered highly sensitive.

Moderate/High Sensitivity (4)

Areas with seasonally dynamic ice, landfast ice, polynyas, and leads provide important feeding areas for polar bears during critical times of the year. These areas are rated as moderate to high sensitivity given that a proportion of the population may be concentrated in the areas at certain times of the year. As sea ice conditions are highly variable from year to year, these areas are rated as moderate/high sensitivity in the summer and winter seasons to indicate that this habitat is important to the polar bear population for periods throughout the year.

Polar bears show high fidelity to denning sites and these areas are essential to the survival of the species. Denning sites are used by polar bears during the open water season for conserving energy while seal hunting is not practical or in the winter for maternity dens.

Areas identified as important polar bear habitat under the Government of Nunavut’s Wildlife Areas of Special Interest, or under the international Biological Program are also given a rating of moderate/high sensitivity for the summer and winter seasons

Moderate Sensitivity (3)

Habitat rated as moderate sensitivity includes areas of dense annual pack ice which provides foraging habitat during non-critical times of the year. This includes the offshore regions of the polar bear core range that are covered in sea ice for most of the winter season.

Low/Moderate Sensitivity (2)

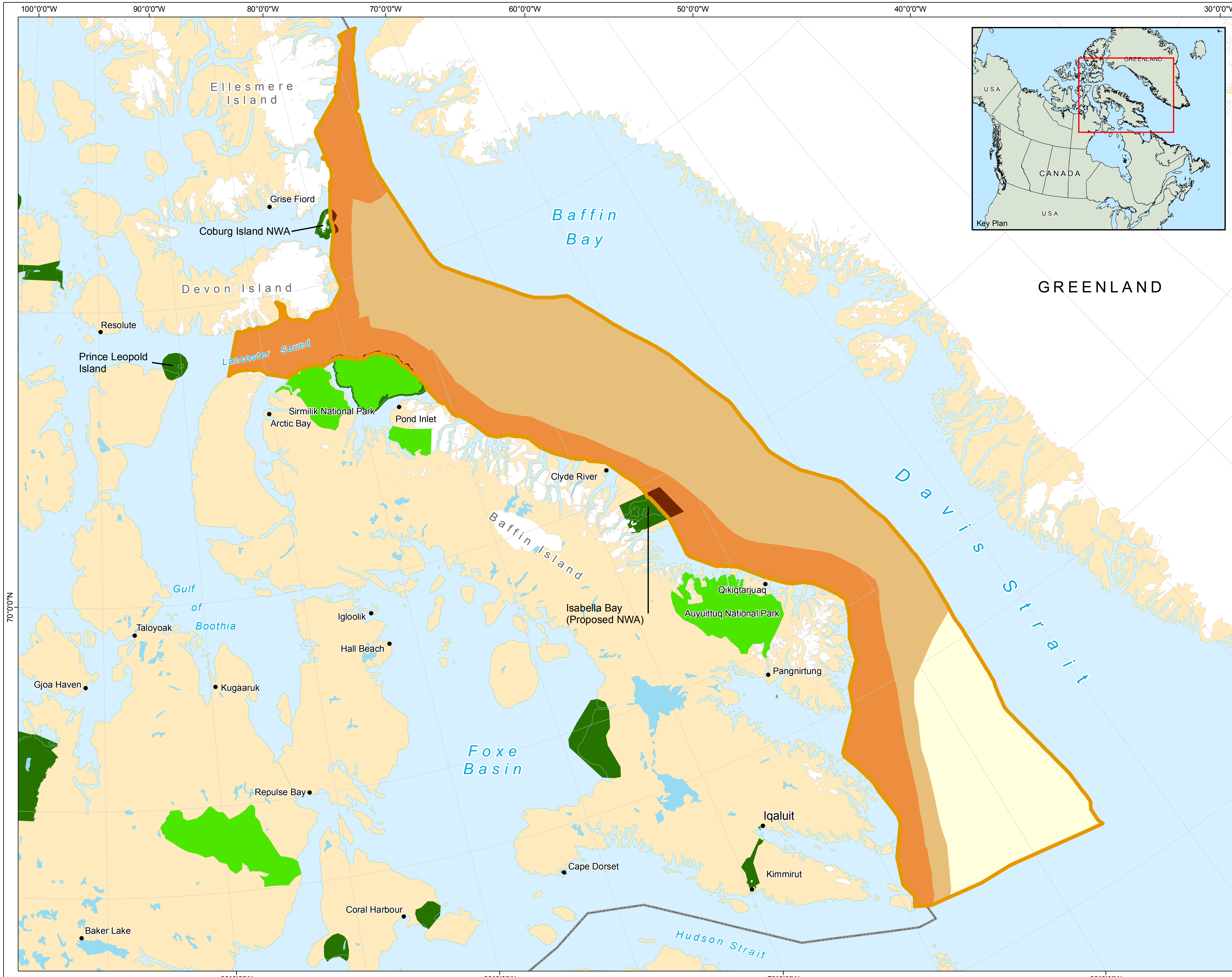
Multiyear pack ice provides limited denning or foraging use for polar bears in the Davis Strait/Baffin Bay region but may be utilized by bears for foraging in early summer before the sea ice recedes completely.

Low Sensitivity (1)

Low sensitivity areas include offshore regions of open water during the summer and areas outside of the core polar bear range.

Eastern Arctic, Nunavut, Canada
Polar Bear
Winter Sensitivity Rating

Fig 4-2



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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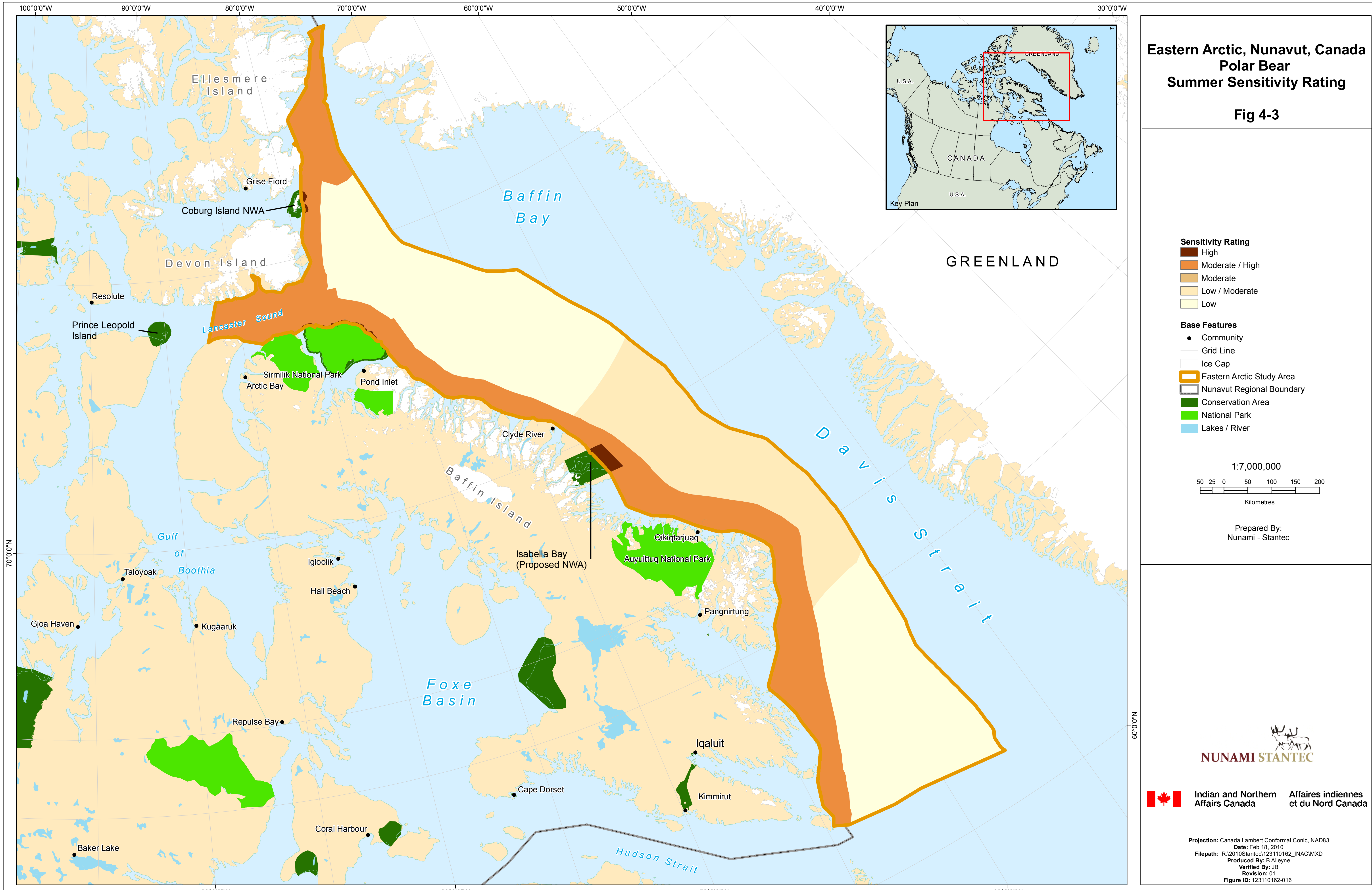
Eastern Arctic, Nunavut, Canada
Polar Bear
Summer Sensitivity Rating

Fig 4-3



4.1.4 Mitigation

Polar bears are often curious about development activities and are rarely deterred by the presence of ships, icebreakers, or land-based or ice based facilities, therefore mitigation programs often focus on the prevention of increased interactions between bears and oil and gas activities. As distribution and movement patterns can be variable and dependent on annual ice conditions, monitoring programs are used to ensure that oil and gas activities cause minimal disturbance to bears, and to identify habitat usage in the development area on an ongoing basis. Buffers around sensitive habitat, including denning areas, restrict disruptive activities and reduce disturbance to bears during critical life stages. Close communication with local communities and Hunter and trapper organizations, and the use of wildlife monitors onsite during development activities ensure that interactions with bears are minimized and activities do not interfere with critical aspects of habitat use and foraging opportunities.

4.1.5 Data Sources and Certainty

Data collected on denning locations and general seasonal habitat use by polar bears is plentiful and assumed to be accurate, however, recent data (e.g., data collected within the last decade) on polar bear habitat use in Baffin Bay and Davis Strait is limited. Given the close relationship between polar bear habitat use and shifting sea ice conditions, there is uncertainty around how long this information will remain valid. Although there is wide speculation, it is generally unknown how polar bear populations will adjust to longer summer seasons and loss of sea ice habitat. As habitat use is expected to shift over the short and long term, it is important to update the spatial data regarding habitat use as it becomes available and adjust the sensitivity ratings for polar bear habitat accordingly.

4.1.6 Summary

Polar Bears range throughout the Eastern Arctic Study Area and are an integral component of the Arctic ecosystem in Nunavut as they are the top predator within the food web. The eastern Arctic study area overlaps with four of the eleven polar bear sub-populations that inhabit the Nunavut region.

Habitat requirements for polar bears include ice, open water, coastal areas and land.

Polar bears prefer productive waters near shorelines, the edge of the pack ice and polynyas as these areas provide access to the seals that they prey on. Moderate to high sensitivity areas for polar bears in the study area include areas with seasonally dynamic ice, landfast ice, polynyas, and leads that provide important foraging habitat for polar bears during critical times of the year, known denning sites which are concentrated along the eastern coast of Baffin Island, Devon Island and Ellesmere Island, and areas identified as important polar bear habitat under the Government of Nunavut's Wildlife Areas of Special Interest, or under the international Biological Program.

Habitat rated as moderate sensitivity includes the offshore regions of the polar bear core range that are covered in sea ice for most of the winter season. Multiyear pack ice is rated as moderate to low sensitivity because it provides limited denning or foraging use for polar bears in the Davis Strait/Baffin Bay region but may be utilized by bears for foraging in early summer before the sea ice recedes completely. Low sensitivity areas include offshore regions of open water during the summer and areas outside of the core polar bear range.

Climate change poses a significant threat to polar bears because they rely on the ice for traveling, feeding habitat, and denning.

4.2 Bowhead Whale

4.2.1 Rationale for Selection

The bowhead whale is a culturally and ecologically important species. The present significance of bowheads to humans can be expressed in terms of their future potential as a renewable subsistence and aesthetic resource (Reeves and Mitchell 1990). Bowheads are low-level trophic feeders and filter large amounts of zooplankton from the sea to feed. This makes the bowhead whale essential to the ecosystem as a major consumer of primary and secondary productivity. They are heavily influenced by ice distribution all year round which offers primary productivity and protection from killer whale predation (Finley 2001). Bowhead whales are also known to be preyed upon by killer whales but to what degree is uncertain (i.e., calves taken, mortalities, injuries) (Burns, *et al.* 1993; Higdon 2007).

Commercial whaling of the bowhead whale was extensive during the 1600s to the 1900s and was highly profitable. The Inuit hunt of the bowhead in Nunavut is a historic event and embedded in their culture. Inuit of Nunavut presently harvest one bowhead every two to three years and still represents a notable economy in these communities of Nunavut. Four out of 28 communities participated in the hunt over a five year period from 1996 to 2001 and the mean number of bowhead whales taken was approximately one (Priest and Usher 2004). The whale muktuk is widely distributed and consumed.

4.2.2 Bowhead Whale Summary

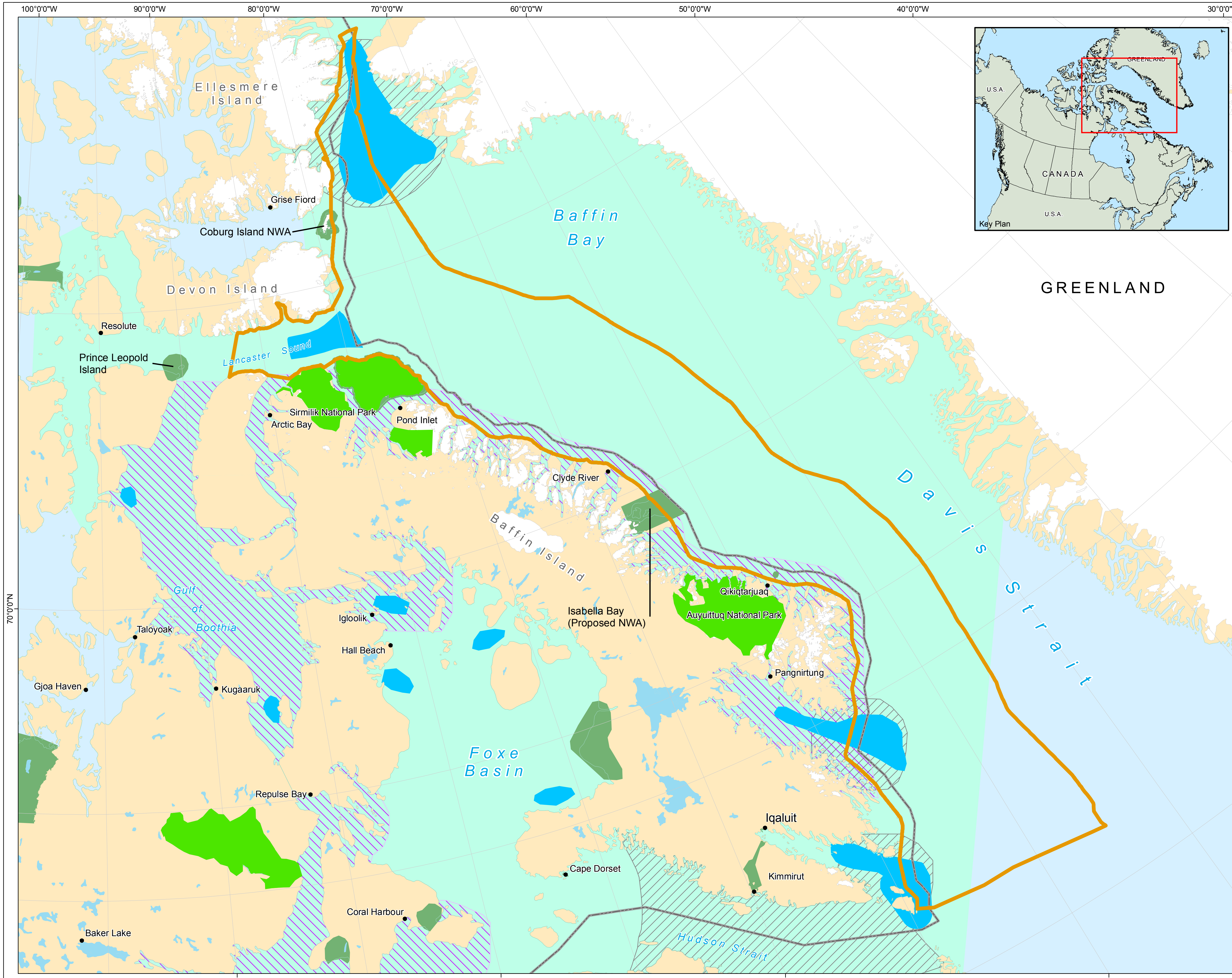
4.2.2.1 Life History

Conservation Status

The Eastern Canada-West Greenland bowhead whale population is listed as special concern by COSEWIC (COSEWIC 2009) Internationally they are listed as “least concern” on the IUCN Red List.

Distribution

Bowheads have a nearly circumpolar distribution in the northern hemisphere. From recent satellite tagging studies, DFO (2006) concluded that there is one, not two, populations as previously thought (COSEWIC 2009). A population estimate for this group is presently not available (COSEWIC 2009). They are widespread in Nunavut and known to summer mainly in north-western Hudson Bay (around Repulse Bay and Frozen Strait), northern Foxe Basin, the Lancaster Sound Region and north-western Baffin Bay and Prince Regent Inlet (Dueck, *et al.* 2006; Wheeler and Gilbert 2007). In Canada, they winter in Hudson Strait, Davis Strait/Baffin Bay and have been observed in the North Water Polynya in March (Dueck, *et al.* 2006; Koski, *et al.* 2006; Wheeler and Gilbert 2007). Summer and winter distribution of Bowhead whales is summarized in Figure 4-4.



Eastern Arctic, Nunavut, Canada Bowhead Whale Distribution and Key Seasonal Habitat

Fig 4-4

Bowhead Summer Aggregation Areas[1]
Bowhead Wintering Areas[1,2,4]
Bowhead Whale Distribution[1]
Polynyas[3]

Base Features

Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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Nunami - Stantec

References:

[1] COSEWIC. 2009. COSEWIC assessment and update status report on the bowhead whale Balaena mysticetus, Bering-Chukchi-Beaufort population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp pp
*digitized by Nunami Stantec 2010

[2] Dueck, L., S. Ferguson, B. Wheeler, S.P. Luque and M. Gilbert. (in press). Habitat Use By Bowhead Whales of the Eastern Canadian Arctic.
*digitized by Nunami Stantec 2010

[3] Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Canadian Wildlife Service Occasional Papers 109.
*digital data provided by CWS, reproduced with the permission of Environment Canada

[4] Richard, P.R., J.R. Orr, R. Dietz and L. Dueck. 1998. Sightings of Belugas and other marine mammals in the North Water, late March 1993. Arctic 51:1-4.
*digitized by Nunami Stantec 2010

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Ecology

Bowheads occur in marine waters and in conditions ranging from open water to leads, polynyas and heavy pack ice. Bowheads are reported to be capable of breaking up to one foot of ice and therefore, may be found in high ice environments (Finley 2001).

Bowheads in Foxe Basin aggregate along the land-fast ice edge in June and July before the ice breaks up. The whales use the ice edge for socializing and feeding, possibly because the ice edge offers both food and shelter (Thomas 1999).

Bowhead whales are known to congregate in areas that have major underwater bathymetric features such as Isabella Island (Finley 2001). Most feeding activity takes place in deep troughs where food is most concentrated, and most social-sexual activity takes place on Isabella Bank, possibly because it offers both protection from orcas and shelter from strong currents (Finley, *et al.* 1994).

The majority of biological information on bowheads comes from studies on harvests from the Alaskan population. Bowheads are slow swimmers and are among the more vocal of the baleen whales (Clark and Johnson 1984). Studies suggest that calls may function to maintain social cohesion of groups and monitor changes in ice conditions (Evans and Raga 2001). Sexual activity occurs during much of the year, with most conceptions occurring in late winter or early spring. Gestation lasts 12 – 16 months with one offspring per pregnancy (Evans and Raga 2001).

Bowheads have well adapted features for the Arctic environment. Such adaptations include long lifespan (live upwards of 100 years old) (Evans and Raga 2001), large energy storage capability, acoustic abilities and senses (possibly used for navigation amongst the ice) and long-range communication and a padded crown on their head for pushing through ice to breathe (Finley 2001). In terms of feeding, common prey species include crustacean zooplankton, particularly euphasiids and copepods, and epibenthic organisms, such as mysids and gammariid amphipods (Lowry 1993; Finley 2001). Bowheads are known to feed during the spring, summer and fall and likely feed during winter as well (Burns, *et al.* 1993).

4.2.2.2 Key Habitat

Critical sensitive bowhead whale habitats, as articulated by Laidre, *et al.* (2008), are regions of shallow water/continental shelf. Important bowhead habitat includes dense annual pack ice, shear-zone/leads, polynyas, open water, and ice edges (pack ice and open water). Loose annual pack ice and shelf break regions are also used by bowhead whales (Laidre, *et al.* 2008).

4.2.2.3 Sustainability Factors

Threats to bowhead whales include predation, accidental ingestion, environmental contamination, disease, offshore oil and gas exploration, shipping, illegal hunting and tourism.

The severe depletion of the bowhead population by commercial whalers is the main reason that the species is listed as endangered in several parts of its range. Recent reports suggest that killer whales may be the primary threat to bowheads in the eastern Canadian Arctic (Finley 2001; Moshenko, *et al.* 2003; Higdon 2007). Ingestion of foreign material through the process of skim feeding is also a possible threat (Finley 2001). Bowheads can live >100 years and therefore are susceptible to the accumulation of toxins over a long period of time.

4.2.2.4 Susceptibility to Oil and Gas Activities

An additional concern comes with increased interest in offshore developments and tourism, which could possibly affect whale populations with associated traffic, underwater noise and possible oil spills. Bowhead whales use long-range communication and are sensitive to low-frequency industrial sounds (Burns, *et al.* 1993). At Isabella Bay, bowheads react strongly at far distances to outboard-powered boats and ships and attempt to flee either by moving into shallow waters or traveling long distances away (Finley 2001). Migrating bowheads have been reported to stay 20 km from seismic, ice-breaking and support vessels and drilling ships (Finley 2001).

Seismic Exploration

Potential effects to bowhead whales relating to underwater seismic sound are relatively well documented for the western Arctic, Beaufort Sea and similar effects should be expected for the eastern Canadian Arctic. Such effects to bowhead whales include habitat avoidance, temporary reductions in feeding, socializing and other behaviours. Low frequency communication masking is also a potential effect on this species, more so given such frequencies have been shown to travel longer distances in/near ice environs. Current understanding suggests that effects on temporary or permanent hearing to bowhead whales are unlikely but supporting evidence is lacking.

Ice-based Activities

For the most part, ice-based activities are not likely to notably influence bowhead whale habitat; however note is made that bowheads regularly occur in regions considered as heavy ice (10/10ths ice) hence this general conclusion may not always be accurate.

Shipping

The primary effects on bowhead whales relating to shipping are vessel-strikes (resulting in injury or mortality) and underwater noise. Vessel – bowhead whale strikes can partially be avoided by implementation of vessel-speed restrictions (typically less than 14 knots or 10 knots). Ice-breaking, for example is known to produce underwater sound sufficient to displace bowhead whales from preferred habitat up to 30 km away.

Hydrocarbon Release

Potential effects to bowhead whales from a hydrocarbon release relate primarily to chronic effects such as contamination and toxicity. Acute effects (direct exposure) include baleen (hair like apparatus the bowhead uses to filter prey from water) fouling, eye irritation and possibly vapor inhalation.

4.2.2.5 Potential Effects of Climate Change on Bowhead Whales

Tynan and DeMaster (1997) list the bowhead as a possible indicator species for climate change in the north, making the species of special interest for scientific reasons. Climate change is likely to cause changes in ice distribution and condition, surface temperatures, currents and mixing. Such changes in Nunavut could alter the bowhead whales' migration patterns, feeding locations and make it more susceptible to predation and hunting. Such changes will have direct and indirect effects on bowhead health, population and distribution.

For example continued increases of killer whales in Nunavut as described by Higdon (2007) could result in elevated levels of bowhead predation. This may have detrimental effects on the population especially because killer whale predation has been noted as the major cause of bowhead mortality in Nunavut (Finley 2001). As well, primary productivity is highly variable and dependent on nutrient availability. Such processes are greatly influenced by climate change and therefore, feeding habitat of bowheads may be altered (Finley 2001). Bowhead fecundity is probably related to zooplankton production (*Calanus*) therefore, climatic change is likely to have an impact on population growth (negative or positive) through changes in the extent of sea ice (Finley 2001).

Laidre, *et al.* (2008) indicate that three types of sensitivities by bowhead whales are likely to be influenced by climate change: narrowness of distribution and specialization in feeding; seasonal dependence on ice; and, reliance on sea ice as a structure for access to prey and predator avoidance.

4.2.3 Sensitivity Ranking

Sensitivity rankings for eastern arctic bowhead whales were developed using two primary types of information: i) known and likely range/distribution of this species (as determined from available literature sources [e.g., COSEWIC status reports] and professional experience in this region); and ii) ecological sensitivity described recently by Laidre, *et al.* (2008). Hence, application of the ecological sensitivity components included by Laidre, *et al.* (2008) may not always be consistent with known locations of bowhead habitat. It is important to note that the definition of winter (November – June) and summer (including July – October) heavily influences the sensitivity layers given the very large influence of ice in this region. To address and incorporate the extreme variability imposed by the dynamic ice regime, 30 year median ice charts, produced by the Canadian Ice Service, were used in applying the ecological sensitivities (as described by Laidre, *et al.* 2008, and others) and known ice distribution.

Lastly, a maximum sensitivity approach was used in differentiating between sensitive bowhead whale habitat types. In other words, if an area could be considered as having two different sensitivity rankings (for one or more months), only the highest sensitivity ranking was mapped.

Sensitivity ratings for the winter season are presented in Figure 4-5 and summer sensitivity ratings are presented in Figure 4-6.

High Sensitivity (5)

Isabella Bay, and the proposed Ninginuaik National Wildlife Area, is a well-known critical bowhead whale feeding habitat and hence designated as highly sensitive.

Highly sensitive habitat for bowhead whales also includes important summer feeding areas and areas that have been identified as primary over-wintering habitat.

Though bowhead whales of the eastern Canadian Arctic are known to occur in the NOW polynya this region likely cannot be considered as primary over-wintering habitat – Hudson Strait is such an area but does not fall within the study area for this project, and hence no highly-sensitive habitat is designated here.

Moderate/High Sensitivity (4)

Moderate to high sensitivity rating was given to areas that provide valued seasonal habitat for bowhead whales. This includes shallow water (approximately 10 m to 100 m depth) and the continental shelf (approximately 100 m to 300 m depth) which provides habitat year round and the shear-zone, leads, polynyas and open water next to pack ice that provides habitat for bowhead whales in the winter. Areas adjacent to over-wintering habitat are also considered moderately to highly sensitive.

Much of the summer continental shelf and shallow-water habitat within the Eastern Arctic study area is classified as moderate to high bowhead whale habitat sensitivity. The Lancaster Sound region was designated as moderate to highly sensitive summer bowhead whale habitat for the increased number of animals in this region during July. Four types of moderate to highly sensitive bowhead habitat were identified within the Eastern Arctic study area:

1. Those regions approximating the main shear-zone/lead off the coast of Baffin Island
2. Two regions adjacent to known bowhead whale over-wintering areas (Cumberland Sound and Frobisher Bay)
3. Lancaster Sound and northern Baffin Bay. Large numbers of bowhead whales are well-known to use Lancaster Sound in June and evidence exists to suggest open-water regions next to pack-ice in northern Baffin Bay are used by numerous whales in late winter (June).
4. The NOW polynya.

Moderate Sensitivity (3)

Moderately sensitive bowhead whale habitat includes areas of dense annual pack-ice and summer habitat where shear zones, leads, open water and open water adjacent to pack-ice are present.

In the summer (July primarily) the offshore region within the study area joining Baffin Bay and Davis Strait contains dense annual pack-ice, and hence this is the basis for the ranking of moderate sensitivity in this region. Winter habitat ranked as moderately sensitive bowhead whale habitat includes much of the Eastern Arctic study area and is based primarily on the presence of dense annual pack-ice in these regions.

Low/Moderate Sensitivity (2)

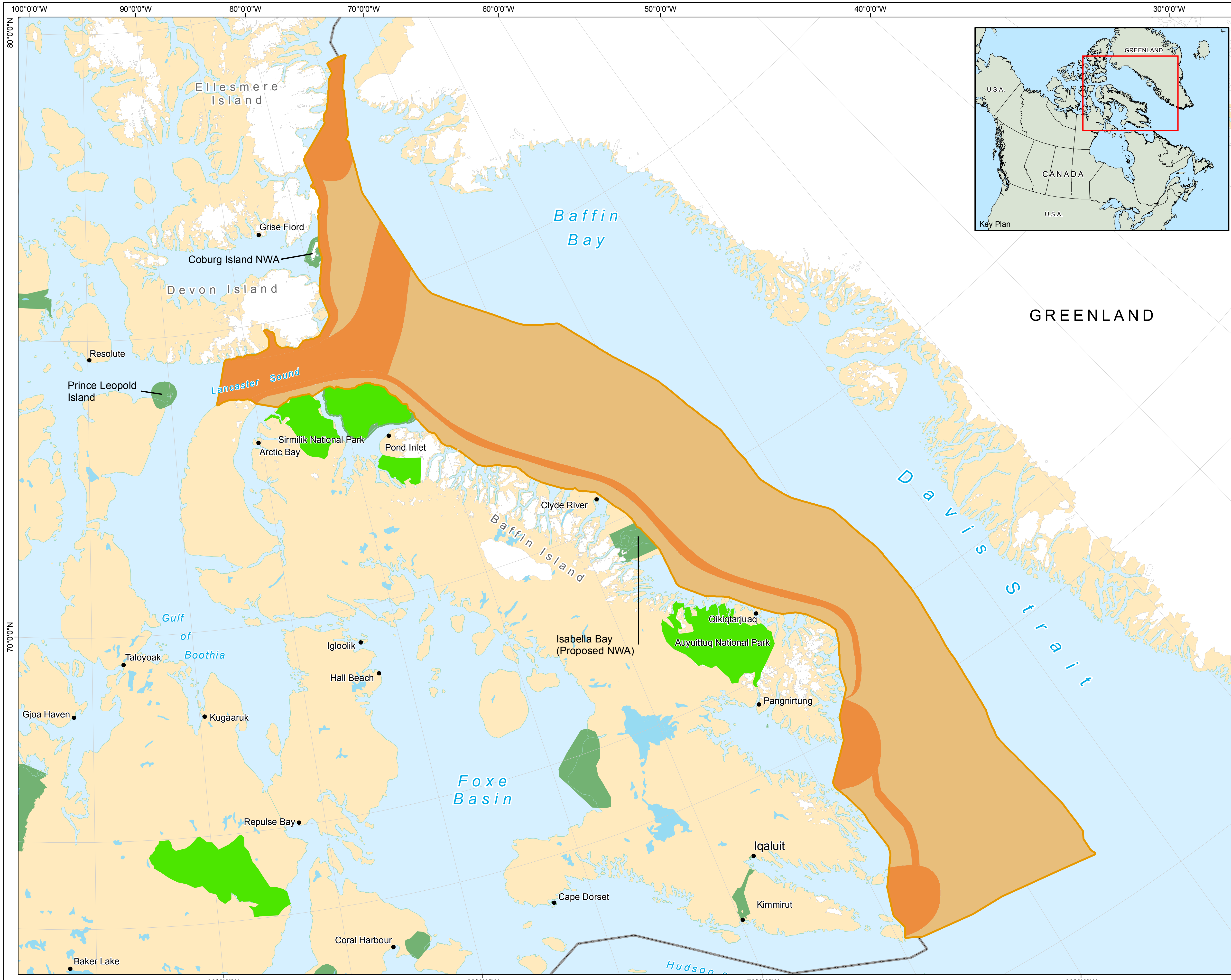
Areas that overlap with known bowhead whale habitat, or adjacent to known bowhead whale habitat were rated as low to moderately sensitive. This rating was also given to areas with loose annual pack-ice in the summer and winter, and shelf break habitat in the summer.

In the summer, bowhead whale habitat ranked with low to moderate sensitivity (4) was defined to represent the loose off-shore annual pack-ice in southern Baffin Bay and northern Davis Strait. This would be primarily for July and August given that ice is largely absent in this region (30 year median) in September and October. Ice median charts indicate that, for most of the winter, loose annual pack-ice and low-moderate sensitive habitat is lacking.

Low Sensitivity (1)

Low sensitivity was given to areas where the bowhead whale is not known to inhabit, but potential habitat exists. This includes areas in the summer months such as shore-fast ice, deep ocean basins, estuaries, and lagoons. It also includes waters less than 5m in depth and land fast ice in winter.

In the summer, low sensitivity habitat in northern Baffin Bay was defined primarily on the basis of the deeper water and distance from pack-ice. Presence of offshore open-water in July in north-western Baffin Bay therefore was designated with low sensitivity. Though much of the coastal (within 30 km) region within the Eastern Arctic study area has land/shore-fast ice for most of the winter (and hence could be considered with low sensitivity) 30-year ice median charts indicate that this is not the case in November.



Eastern Arctic, Nunavut, Canada
Bowhead Whale
Winter Sensitivity Rating

Fig 4-5

Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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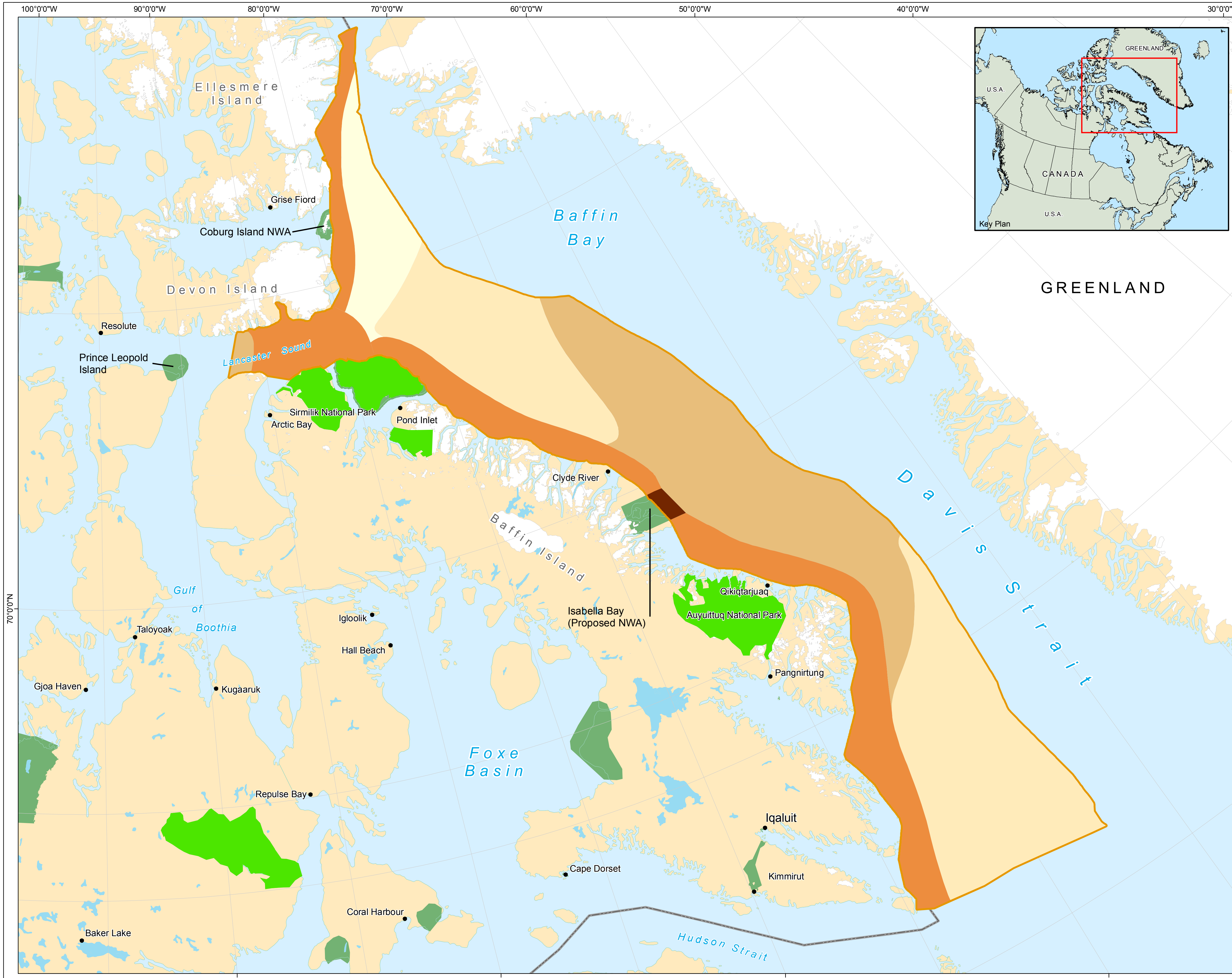
Eastern Arctic, Nunavut, Canada
Bowhead Whale
Summer Sensitivity Rating

Fig 4-6



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

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4.2.4 Mitigation

The most effective available mitigation tool is planning to avoid spatial and seasonal bowhead whale habitat where possible. Other common mitigations include the use of dedicated Marine Mammal Observers aboard related vessels, designation of a marine mammal exclusion zone around active seismic arrays, vessel speed restrictions, and minimum aircraft altitude restrictions. Unfortunately, in the Eastern Arctic, knowledge on sensitive, and biologically important habitat, is at a very coarse level (commensurate with few studies). Implementation of dedicated surveys for these animals prior to potential contact with industry will assist proponents and government to more confidently plan and approve project implementation.

4.2.5 Data Sources and Certainty

Data sources used to determine habitat range of bowhead whales in the Eastern Arctic study area are identified on Figure 4-4.

Certainty in defining sensitive bowhead whale habitat in the eastern Canadian Arctic is directly correlated to the certainty and predictability of ice distribution and movement, which is low. To address this low certainty and predictability Nunami adopted use of 30 year median ice maps produced by the Canadian Ice Service (Canadian Ice Service 2010, internet site). Largely to account for this uncertainty authors conservatively applied the ice data as it relates to ecological sensitivity. For example, shear-zone leads are well-known to be important bowhead whale habitat; however the location of predominant shear-zone leads is not regular or consistent. Use of the 30 year median ice charts allowed authors to designate a conservative region where the primary shear-zone would typically be located.

4.2.6 Summary

Bowhead whales of the Eastern Canada-West Greenland population, listed as ‘special concern’ by COSEWIC, are found throughout the Eastern Arctic Study Area. Bowhead whale presence in this region in summer is primarily related to feeding and migration. Ecological studies suggest bowhead whale winter presence is unrelated to feeding and may relate to predator avoidance (killer whales). Bowhead whales filter feed on zooplankton, the distribution and abundance of which is governed heavily by oceanographic and physical conditions. Bowhead whales are highly adapted to sea-ice and presence in regions categorized as 100% ice is common. Critical sensitive bowhead whale habitats are regions of shallow water/continental shelf. Important bowhead habitat includes dense annual pack ice, shear-zone/leads, polynyas, open water, and ice edges (pack ice and open water). Loose annual pack ice and shelf break regions are also used by bowhead whales. Susceptibility of bowhead whales to oil and gas activities related primarily to vessel-strikes and habitat displacement resulting from anthropogenic underwater sound. Advanced planning and available mitigation measures can be effective in minimizing such effects to bowhead whales. Given their common preference for ice regions, bowhead whale habitat is likely to be influenced by climate change. Bowhead whale summer sensitivity is greater coastally and in Lancaster Sound, with critical habitat defined at Isabella Bay. Offshore regions in Baffin Bay and Davis Strait constitute low to moderately sensitive summer habitat. Moderate to highly sensitive winter bowhead whale habitat was defined in Lancaster Sound, the continental shear-zone region along Baffin Island and near known over-wintering regions. Most offshore regions in winter are likely less sensitive bowhead whale habitat.

4.3 Toothed Whales

4.3.1 Rationale for Selection

Toothed whales were chosen as a VEC to represent the species known to occur in the Eastern Arctic study area. Available information on killer whales is notably limited (but growing); hence this species was not included in the designation of sensitive toothed whale habitat (but is included below for context).

Beluga whales and narwhals are both culturally and ecologically important species in the eastern Canadian Arctic. Over a five year period from 1996 to 2001 the total annual mean number of belugas taken from hunting was approximately 1339 and are hunted by many communities (20 out of 28) (Priest and Usher 2004). Inuit knowledge suggests that belugas are easier to hunt than other marine mammals (walruses) because they are not as suspicious of humans and are easily approached (Richard 2001). It is used for its meat, which is mostly used for dog food and skin which is desirable and profitable to Inuit (Richard 2001). Narwhals are hunted in Nunavut by several communities (18 out of 28) for subsistence use (Dietz, *et al.* 2001; Priest and Usher 2004). Over a five year period from 1996 to 2001 the total annual mean number of narwhal taken from hunting was approximately 734 (Priest and Usher 2004).Their skin and underlying fat is consumed and the tusks are sold and are quite valuable (DFO 1998a, 1998b).

Ecologically, belugas and narwhals are relatively different though both are likely preyed upon by various marine mammals of the Arctic including polar bears (COSEWIC 2008) and killer whales (Higdon 2007). Belugas in the Eastern Arctic appear to frequent shallow-water environs whereas narwhals prefer deeper waters. Beluga whales are known to travel in large groups whereas narwhals are found in groups of two to 12 (DFO 2005, internet site). Stomach content analyses imply that both species differ in prey species: arctic cod as the primary beluga whale prey and squid/turbot for narwhals. Both species use underwater noise for communication and prey detection (echolocation).

4.3.2 Toothed Whale Summary

4.3.2.1 Life History

Conservation Status

Beluga

Eastern High Arctic – Baffin Bay population: population estimate 21,213; “Special Concern” under SARA (COSEWIC 2004a).

Cumberland Sound Population: population estimate 1547 (COSEWIC 2004a). “Threatened” according to COSEWIC (2004a), No schedule or status by SARA.

Western Hudson Bay population: population estimate >23,000 (COSEWIC 2004a). “Special Concern’ according to COSEWIC (2004a). No schedule or status by SARA.

Narwhal

Narwhals are designated as ‘Special Concern’ by COSEWIC in 2004, listed under Appendix II of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) but to date has not been assessed under *SARA*. The narwhal was assessed in 2008 and is currently listed as ‘Near Threatened’ by the IUCN (IUCN 2010, internet site), which has been increased from ‘Data Deficient’ in 1996. The Nunavut Wildlife Management Board is the main tool for wildlife management in Nunavut. The Department of Fisheries and Oceans provides scientific advice and regulatory support and is a co-management partner. Additional co-managing institutions include the Hunters and Trappers Organizations and the Regional Wildlife organizations (COSEWIC 2004b).

Killer Whale

Northwest Atlantic/Eastern Arctic Population—Data Deficient (COSEWIC 2001). There are no estimates for population numbers in Nunavut.

Distribution

The known distribution of toothed whales is presented in Figure 4-7.

Beluga

Of the seven Canadian sub-populations, three (the Eastern High Arctic-Baffin Bay, Cumberland Sound and Western Hudson Bay sub-populations), are known to occur in the Eastern Arctic study area. The endangered (COSEWIC 2004a) Ungava Bay sub-population is not considered as occurring in the Eastern Arctic study area (as determined through review of Figure 5 of COSEWIC (2004a). Also, the area of extent of Eastern Hudson Bay belugas may include a small part (southern most extent) of the Eastern Arctic study area but are not included here.

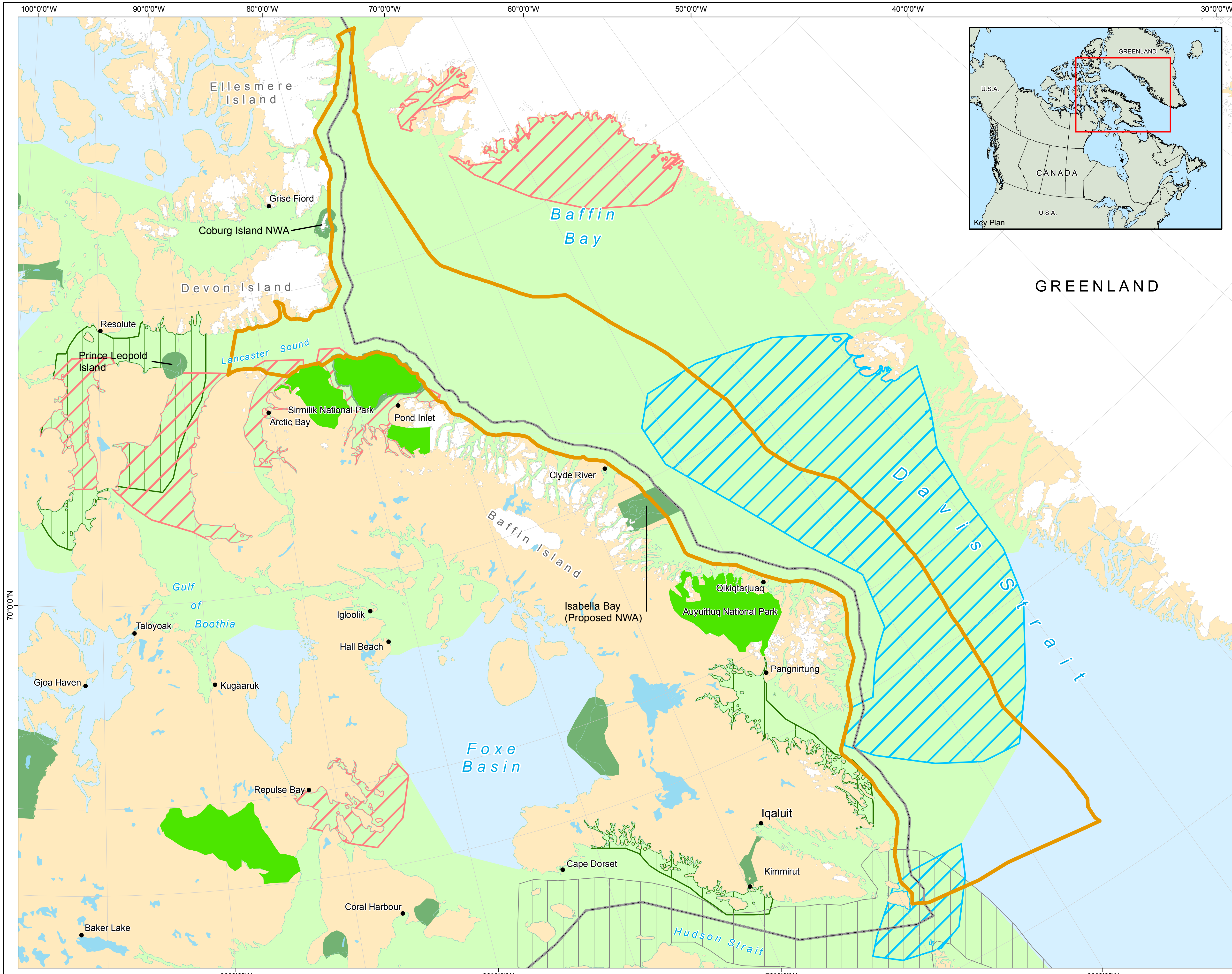
Narwhal

There are two populations of narwhal that inhabit the ocean off of Nunavut, the Baffin Bay population and the Hudson Bay population. The Baffin Bay narwhal population occupies the area from the Southern end of Baffin Island to the northern waters of Hall Basin. However, narwhals and their remains were observed further west during the summer (DFO 2002). During the spring, as the ice edge recedes, narwhals start their northern migration along the offshore ice-edge east of Baffin Island. Hundreds of individuals then migrate west into sounds of northeastern Baffin Island, Lancaster Sound and adjoining waters as ice permits. They reach summering habitats (Eclipse Sound, Navy Board Inlet, Admiralty Inlet Prince Regent Inlet and Peel Sound) where they concentrate at edges of fast-ice (COSEWIC 2004b). Some may also use the Foxe Basin via Fury and Hecla Strait to spend a portion of their summer and have been observed in Queens Channel and McLean Strait between King Christian and Lougheed Island (COSEWIC 2004b).

Autumn migration commences as sea ice begins to freeze in late September or early October. Southward migration along the east coast of Baffin Island occurs in late September (Dietz, *et al.* 2001). Dietz, *et al.* (2001) showed that narwhals begin a southern migration from Pond Inlet around 22 – 29 September and move eastward toward Lancaster Sound. The majority of the Baffin Bay population will use Lancaster Sound as their migration route, migrating south-eastward along the east coast of Baffin Island, visiting fjords along the way. Wintering areas for this population are Baffin Bay and northern Davis Strait (COSEWIC 2004b). Those that summered in Fury and Hecla Strait may migrate via Lancaster Sound or may continue through Foxe Basin and Hudson Strait (COSEWIC 2004b). Some individuals from this population may also overwinter in the north-water of Baffin Bay and have been observed at least as far north as Smith Sound during winter (Finley and Renaud 1980; Richard, *et al.* 1998).

Killer Whale

Killer whales are distributed worldwide and are known to inhabit Arctic waters; however, no clear migratory patterns have been documented. Killer whale presence in Nunavut is limited by ice. High densities of killer whales have been observed in Lancaster Sound. “Hotspots” for killer whales in the Eastern Arctic include Cumberland Sound, Pond Inlet/Bylot Island, Lancaster Sound, Admiralty Inlet and western Hudson Bay (particularly Repulse Bay area) (Higdon 2007).



Eastern Arctic, Nunavut, Canada
Toothed Whales
Seasonal Distribution

Fig 4-7

- Toothed Whale Distribution [1,2,3]
- Narwhal Winter Concentration [1]
- Narwhal Summer Concentration [1]
- Beluga Winter Range [3]
- Beluga Summer Core Area [2,3]

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

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50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

[1]COSEWIC. 2004. Assessment and Update Status Report on the Narwhal Monodon monoceros in Canada. Ottawa. vii + 50p pp. (Canadian Wildlife Service, Environment Canada)
*digitized by Nunami Stantec 2010

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Ecology

Beluga

Habitat requirements of beluga whales are seasonal. During spring break-up (late spring) belugas concentrate along ice-edges and leads (Stirling 1980). In summer they concentrate in shallow estuaries and coastline environments where they may be avoiding predation from killer whales, moulting, calving and/or feeding (COSEWIC 2004a). During their long migrations from these estuarine areas, (mid-August until mid/late September) the Eastern High Arctic beluga sub-populations uses deep water areas (800 meters) for what appears to be intensive feeding activities (COSEWIC 2004a).

Belugas are long-lived (15 – 30 years) mammals (COSEWIC 2004a). They feed most intensively during late summer in deep water and possibly feed on Arctic cod in these areas (COSEWIC 2004a). From traditional Inuit knowledge, belugas are reported to feed on Greenland Halibut (*Reinhardtius hyppoglossoides*) at floe-edges in Cumberland Sound and Arctic Bay (COSEWIC 2004a). They are also known to feed on capelin, saffron cod and some invertebrates (COSEWIC 2004a).

Mating occurs during late winter to early spring (Kleinenberg, *et al.* 1964) with peak mating before mid-April (COSEWIC 2004a) in offshore ice-filled waters. Inuit Knowledge from hunters also indicates that mating occurs along floe-edges in spring and far offshore (COSEWIC 2004a).

Timing of peak calving is not well understood and this may be because it occurs during late spring migration in offshore areas (COSEWIC 2004a). However others, (Sergeant 1973), have suggested it occurs in warm estuarine waters during the early summer (COSEWIC 2004a), though others have reported females entering estuaries with calves (COSEWIC 2004a). From these studies it can be assumed that calving occurs during the months of mid-June to August. From Inuit knowledge calving is said to occur from July to September in estuarine environments (COSEWIC 2004a). In summer, males and females are segregated in estuaries and juveniles and calves stay with their mothers (COSEWIC 2004a).

Narwhal

Narwhals tend to concentrate in the coastal waters that offer deep waters during the summer. Richard *et al.* (1994) observed that during the late summer months, narwhals tend to concentrate at continental shelves where water is 300 – 600 m in depth. These results indicated a preference for deep water during the late summer and may be related to bottom-feeding activity. Dietz, *et al.* (2001) concluded that narwhal whales showed preferences for deep fjords and continental slopes along the east coast of Baffin Island (also demonstrated by migrating Greenland narwhals from Melville Bay to Disko Island (Greenland) (Dietz, *et al.* 2001).

Deep water habitats may also be used as calving grounds as well as feeding areas (COSEWIC 2004b). Leads, fast ice and broken pack ice density also seem to be key factors in habitat selection (COSEWIC 2004b).

During winter, narwhals occupy the offshore pack ice of which provides shelter from the rough seas and predation from killer whales (Dietz, *et al.* 2001; DFO 2002).

Mating occurs in spring in offshore pack ice and females start bearing calves at six to eight years of age (Evans and Raga 2001). Calves are usually born every three years between the months of July and August (COSEWIC 2004b) and females will bear only one calf at a time (Evans and Raga 2001).

Narwhal predominantly travel locally in small pods of less than 10 individuals during summer (Richard, *et al.* 1994). They congregate together to form large aggregations of hundreds of individuals during migrations in spring and fall (COSEWIC 2004b).

They do not seem to vocalize often, but increase vocalizations when groups travel in large, loosely dense organizations. It is believed that such vocalizations are used to communicate to straying members (Shapiro 2006). Narwhal also use sounds for echo-location of prey (Richardson, *et al.* 1995).

It is unknown what species narwhals may be feeding on due to their deepwater and pack ice habitat preferences. It has been hypothesized that they feed on Greenland halibut (turbot) (Richard, *et al.* 1994) arctic and polar cod (deepwater fish) (Richard, *et al.* 1994); however, no conclusions have been made. As determined through stomach contents, they are known to feed on shrimp (Pandalus) and squid (DFO 2002).

Killer Whale

Life history characteristics have only been well documented for resident killer whales (those that feed on fish live in complex groups and re-visit certain areas). Whether or not eastern killer whales are segregated into “transient” marine mammal-eating and ‘resident’ fish-eating ecotypes is presently not known. The available data of killer whales in Nunavut provides observations of predation on both marine mammals and fish, although marine mammal predation events dominate suggesting that they are transient (Higdon 2007).

Females give birth at an average age of 15, with an average inter-calf interval of about five years (Evans and Raga 2001). Mortality is very high (about 50%) in the first six months of life, but once an individual has reached that age, average longevity is about 50 years for females and 29 years for males (Evans and Raga 2001). Olesiuk, *et al.* (1990) provide evidence of reproductive senescence in some older females (mean age of onset of post-reproduction was 40) (COSEWIC 2001). Gestation is about 17 months, and, although the precise age of weaning is not known, it is probably between 1 – 3 years (COSEWIC 2001; Evans and Raga 2001).

Both Inuit and scientific knowledge indicate that, in addition to fish, killer whales prey on a variety of Arctic marine mammal species (narwhal, beluga and bowhead whales). For example, Inuit of Pond Inlet and Arctic Bay have extensive knowledge of relationships between killer whales, narwhals and sea ice (COSEWIC 2001). In the spring, killer whales follow narwhals through Pond Inlet, Eclipse Sound and Navy Board Inlet and narwhals avoid predation through cracks and leads in Admiralty Inlet. Killer whales do not enter the fjord until the ice has cleared, at which time narwhals must use shallow water to avoid killer whales. In the fall, when new ice begins to form, both species depart the area. Killer whales leave first, and narwhals delay their departure until orcas leave (COSEWIC 2001). Most reported beluga predation events in Nunavut have occurred in Hudson Bay and Cumberland Sound. Bowhead whale predation in Nunavut has been reported in northwest Hudson Bay, Foxe Basin, Hudson Strait, throughout Baffin Bay and Lancaster Sound. There have also been a high percentage of bowhead whales predation event reported, as killer whales often leave superficial scratches and bite marks visible to humans (Finley 2001).

4.3.2.2 Key Habitat

Beluga

Belugas do not rely directly on land for any part of their life cycle. Generally, they inhabit shallow coastal areas and estuarine environments in the summer; thus coastal development (i.e., marine terminal construction and especially vessel traffic) may deter beluga from preferred habitat (avoidance behaviour) and could cause increased environmental contamination. Planning could consider sensitive times of year for belugas, site-fidelity, migration routes and local concentration areas (e.g., estuaries).

Critical physical and biotic habitat factors for beluga whales include regions of loose pack-ice, polynyas, shallow water/continental shelf, interactions between polynyas and shallow water and estuaries/lagoons. Important areas to belugas whales include shear zones/leads, open water, the shelf break and the interface between pack-ice and open water. Belugas are also known to use multiyear pack-ice (Laidre, *et al.* 2008). Areas not categorized as important, or used, by beluga whales include shore-fast ice, dense annual pack-ice, deep ocean basins and where pack ice and shallow continental shelf regions interact (Laidre, *et al.* 2008).

Narwhal

Throughout the Arctic, narwhals prefer deep or offshore waters (Hay and Mansfield 1989). During winter, Canadian narwhals can be predictably found in the winter pack ice of Davis Strait and Baffin Bay along the continental slope. These areas contain ecological parameters that make this habitat favorable including high gradients in bottom temperatures, predictable open water (<5%) and relatively high densities of Greenland halibut (Laidre, *et al.* 2004). During the winter, intense benthic feeding occurs in contrast to lower feeding activity during the summer, and therefore may be considered the most important habitat for narwhals (Laidre and Heide-Jorgensen 2005).

Critical physical and biotic habitat factors for narwhals include dense annual pack-ice, shear zone/leads, shelf break, deep ocean basins, and estuaries/lagoons/fjords. Important areas to narwhals include open-water and the interface between open-water and pack-ice. Narwhals are also known to use loose annual pack-ice (Laidre, *et al.* 2008). Areas not categorized as important, or used, by narwhals include shore-fast ice, multi-year pack ice, polynyas, shallow water/continental shelf, pack ice and continental shelf interactions and polynya and shallow-water interactions (Laidre, *et al.* 2008).

Killer whale

While habitat use likely varies between each population, killer whales generally appear to use and tolerate wide habitat variability (depth, size of water body, water temperature) (COSEWIC 2001). It is generally believed that killer whales do not range into regions of pack ice (due to their large dorsal fin) but this assumption has not been verified. Killer whales occasionally move into freshwater, though usually only for short periods (hours or days) (Higdon 2007).

4.3.2.3 Sustainability Factors

Beluga

Threats to beluga whales include predation, environmental contamination, offshore oil and gas development, shipping, hunting and commercial fisheries (Huntington in press).

Polar bears and killer whales are known predators of belugas however; walruses also injure or kill beluga whales (COSEWIC 2004a).

The ability for contaminants to accumulate in the tissue of beluga whales has been widely studied in the St. Laurence population. Such contamination is linked to reproductive impairment, immunosuppression, and tumour incidence (Becker 2000; Hickie, *et al.* 2000).

Beluga whales exhibit strong site-fidelity, making them easy targets for commercial and subsistence hunters (COSEWIC 2004a). With the introduction of new hunting technologies, Inuit have expressed an increase in competition during the beluga hunt and suggest this may result in larger harvest numbers (Kilabuk 1998).

Narwhal

Threats to narwhals include ice entrapment, predation by killer whales and polar bears, disease and parasites, climate change, environmental contaminants, offshore oil and gas activities, shipping, hunting and commercial fisheries (COSEWIC 2004b; Huntington in press).

Killer Whale

A likely natural source of mortality is the propensity for this species to mass strand (infrequent) or become entrapped in ice (Newfoundland and the Canadian Arctic) (COSEWIC 2001). Since population sizes are generally small, even infrequent occurrences of such events may have dramatic impacts on populations (COSEWIC 2001).

The largest source of killer whale mortality is hunting, mostly by Greenland Inuit. Killer whales have been sporadically hunted by Canadian Inuit historically but takes are likely non-existent at present (Higdon 2007).

In the Pacific, killer whales are among the most heavily contaminated marine mammals on earth (Higdon 2007); however, studies of contaminant levels in Arctic killer whales are still in initial stages. The effects of contaminants on Arctic killer whales have been identified as a research priority (Higdon 2007).

4.3.2.4 Susceptibility to Oil and Gas Activities

Beluga

Reaction of beluga whales to offshore oil and gas exploration and to vessels range from great tolerance to extreme sensitivity (Richardson, *et al.* 1995). Sensitive reactions involve short-term displacement and may change local distribution (Richardson, *et al.* 1995). The relative broad range of reactions from belugas may be a result of their ability to adapt to repeated ongoing man-made noises (Richardson, *et al.* 1995). However, belugas often flee from fast and erratically traveling vessels and have been reported to displace up to 24 km away (Richard 2001). As well, belugas have been observed by Inuit to react negatively (avoidance behaviour) to noisy anthropogenic sources (boats) and suggested to have caused declines in abundances at Pangnirtung (Kilabuk 1998 in COSEWIC 2004a). Inuit also suggest that avoidance behaviour caused belugas to be less healthy (skinnier) (Kilabuk 1998).

Narwhal

Environmental contamination could disrupt biological functions, offshore oil and gas exploration may deter from preferred habitat, migration routes and increase the risk of oil spills, shipping may also disrupt migration patterns, hunting could deplete stock sizes and commercial fisheries may alter food webs by reducing available prey (Huntington in press).

Potential increases in shipping and offshore oil and gas development may induce temporary or long term changes in habitat, distribution and migration (Richard 2001; Huntington in press).

Increased vessel traffic and offshore oil development may also negatively affect the narwhal populations through habitat displacement and/or ship strikes (though strikes are less likely with fast moving whales such as the narwhal). Behavioural studies of narwhal reaction suggest narwhals "freeze" (seek shallow water and remain immobile) when approached by vessels (COSEWIC 2004b). As well, some Inuit hunters suggest that narwhals are sensitive to and avoid noise from industrial machines and explosions (COSEWIC 2004b).

Killer Whale

Killer whales do not rely on land for any component of their life history or for habitat requirements. However, they are extremely susceptible to bioaccumulation of contaminants, hence coastal development inducing marine discharges from land based activities need to be taken into account.

Susceptibility of toothed whales to specific oil and gas activities is similar to those described for Bowhead whale (Section 4.2.2.4).

4.3.2.5 Potential Effects of Climate Change on Toothed Whales

Beluga

The effects of climate change on beluga whales are uncertain. They are highly adapted to Arctic seas, yet capable of survival far from sea ice, and sometimes select open-water habitats at least for part of the year (Moore and Huntington 2008). It is likely that climate change will result in changes in the extent and duration of sea ice (Huntington in press). This may alter beluga migrations and may cause them to penetrate further into the Arctic environment possibly allowing new feeding habitat to be exploited (Huntington in press).

Changes in sea ice regimes with climate change will impact the timing and extent of primary production (Moore and Huntington 2008). This may have negative effects on the beluga whale prey or could cause shifts in the location of prey (Moore and Huntington 2008).

Climate change has also been attributed to increases in the number of killer whales along the coasts of Nunavut (Higdon 2007). Such changes in the range of killer whales may cause increased predation on belugas resulting in higher incidences of mortality, injury and avoidance behaviour (Higdon 2007). This coupled with decreases in available ice refuge may result in negative effects on beluga population (Higdon 2007; Moore and Huntington 2008; Huntington in press).

Narwhal

Due to their strong association with ice, climate change may induce changes in habitat, migration pattern and predation rates. Changes in primary productivity may alter the location of prey and may cause the occupation of new feeding areas (Moore and Huntington 2008). Narwhals follow ice edges during migration and changes in the timing of ice break-up and freezing may alter their seasonal migratory cycle (Moore and Huntington 2008). Changes in extent and duration of sea-ice has resulted in increased killer whale presence in Nunavut (Laidre, *et al.* 2006). Due to their predation on narwhals, it is likely that if this trend continues, more narwhals will be killed by killer whales. Such climate changes could also decrease shelter habitat, thus elevating predation risk by killer whales, polar bears, hunters and exposing them to a rough ocean environment of Baffin Bay (Moore and Huntington 2008).

According to Laidre, *et al.* (2008), narwhals appear to be one of the three most sensitive Arctic marine mammal species most sensitive to climate change (primarily based on their reliance on sea ice and specialized feeding).

Killer Whale

In recent years Inuit hunters have noted that killer whales are increasing throughout Nunavut, particularly Hudson Bay, where they were unknown prior to the mid-1900s (Reeves and Mitchell 1988). This increase has been related to a decline in sea ice in Hudson Strait, suggesting that declining ice cover has influenced killer whale movements and distribution; allowing them to both extend their range and stay longer in Arctic regions (Higdon 2007). This has implication on the arctic ecosystem as increases in killer whale numbers in Nunavut will likely increase predation rates (Higdon 2007).

4.3.3 Sensitivity Ranking

Sensitivity rankings for Eastern Arctic toothed whales were developed using two primary types of information: i) known and likely range/distribution of this species (as determined from available literature sources [e.g., COSEWIC status reports] and professional experience in this region); and ii) ecological sensitivity described recently by Laidre, *et al.* (2008). Hence, application of the ecological sensitivity components included by Laidre, *et al.* (2008) may not always be consistent with known locations of toothed whale habitat. It is important to note that the definition of winter (November – June) and summer (July – October) heavily influences the sensitivity layers given the very large influence of ice in this region. To address and incorporate the extreme variability imposed by the dynamic ice regime, 30 year median ice charts, produced by the Canadian Ice Service, were used in applying the ecological sensitivities (as described by Laidre, *et al.* 2008, and others) and known ice distribution.

Lastly, a maximum sensitivity approach was used in differentiating between sensitive toothed whale habitat types. In other words, if an area could be considered as having two different sensitivity rankings (for one or more months), only the highest sensitivity ranking was mapped. Sensitivity ranking for toothed whale habitat in the eastern arctic study area is summarized in Figure 4-8 (winter season) and Figure 4-9 (summer sensitivity).

High Sensitivity (5)

Areas identified as highly sensitive for toothed whales includes areas designated as critical for any of the toothed whale species and a spatially limited area (<100 km) during the summer months that provides specific ecological function essential to toothed whales. In the winter months this rating was also given to the following:

- Areas known to consistently contain large concentrations of toothed whales
- Full winter polynyas
- Areas that have been identified as core overwintering habitat for belugas
- Areas within Davis Strait or Baffin Bay with limited open water throughout the winter for narwhals.

Highly sensitive summer toothed whale habitat was not identified in the Eastern Arctic study area. However, highly sensitive winter habitat was described to represent known beluga whale over-wintering areas near Cumberland Sound and mouth of Frobisher Bay; as well as Lancaster Sound and northern Baffin Bay (where large numbers of toothed whales are found in June).

Moderate/High Sensitivity (4)

Areas with moderate to high sensitivity in the summer includes habitat with loose (beluga) or dense annual pack ice (narwhal), shallow continental shelf, estuaries, lagoons and fjords for belugas and shear-zone/leads, fjords, shelf-break, deep ocean basins for narwhals. In winter, areas where large concentrations of beluga or narwhals are known to occur, polynyas, shallow or coastal areas with light and highly moveable ice cover for belugas or habitat next to known beluga over-wintering sites. Moderate to highly sensitive areas in the winter include deep offshore, continental slope regions of Davis Strait and Baffin Bay for narwhals (with limited open water for a portion of the winter).

Summer toothed whale habitat of moderate to high sensitivity was determined primarily to reflect known ranges of beluga and narwhals (north eastern coast of Baffin Island, Lancaster Sound and Devon Island region), their preference for fjords (both beluga and narwhal), shallow continental shelf regions (belugas within their range) and areas of ‘shelf break’ (for narwhals).

Two areas of moderate to highly sensitive toothed whale winter habitat were identified: i) the NOW polynya (where belugas have been recorded in March); and, ii) the continental shelf region in the south western portion of the study area which is adjacent to known beluga overwintering habitat (and which may also entail June shear-zones and limited open water for a portion of the winter).

Moderate Sensitivity (3)

Moderate sensitivity during the summer months was given to areas of open water, shelf-break, and the ice-edge (pack ice next to open water). This rating would also apply to areas that contain moderate to large numbers of toothed whales and shear zones and leads that are utilized by belugas.

Moderate sensitivity during the winter months was given to areas that contain moderate sized concentrations of narwhal or beluga whales, coastal leads (<50 km from shore), in or near (<20 km) coastal pack ice, and near land-fast ice or the ice edge. Deep water, the shear zone, leads and polynyas are also moderately sensitive for narwhals.

Moderately sensitive toothed whale summer habitat was described primarily to capture the ice edge (pack ice next to open water) region of north western Baffin Bay. Moderate to large numbers of toothed whales may potentially occur in the Lancaster Sound region in July and hence this area has been also designated as moderately sensitive summer habitat.

Toothed whale winter habitat of moderate sensitivity was determined to represent the predominant shear zone/lead area offshore of Baffin Island (presumably important for narwhals) and regions entailing ice-edges (proximity to pack ice) in June in north eastern Baffin Bay.

Low/Moderate Sensitivity (2)

Loose annual ice or multiyear pack ice in summer and open-water habitat (>20 km from pack ice or land-fast ice or ice edge) in winter is considered low to moderately sensitive habitat for toothed whales. This sensitivity rating also applies to areas with low densities of toothed whales and areas of multiyear pack ice in winter.

Coastal summer toothed whale habitat in the south-western corner of the Eastern Arctic study area was identified as low to moderately sensitive habitat primarily on the reasonable likelihood of beluga whale presence in this region.

Low to moderately sensitivity winter toothed whale habitat was identified in the south-eastern portion of the Eastern Arctic study area, primarily on the basis that this region is far from ice-edges (land fast ice and pack ice) and largely ice-free in November.

Low Sensitivity (1)

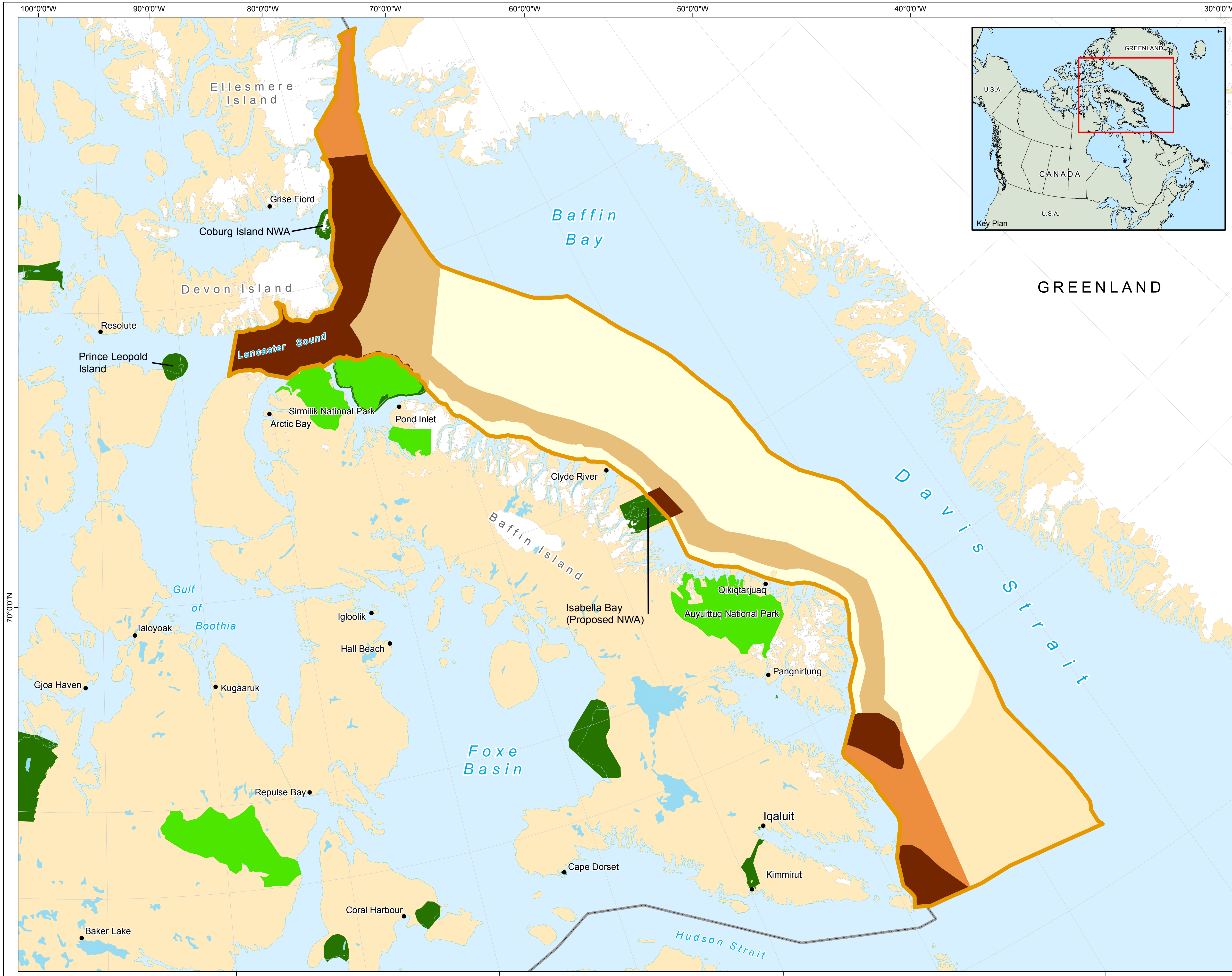
Low sensitivity habitat includes areas where no beluga or narwhal summer habitat is identified, summer offshore (> 100km), deep water (non-shelf break), and open-water habitat or winter regions of consistent very dense ice concentration and land-fast ice.

According to Laidre, *et al.* (2008) narwhal summer habitat is primarily coastal in nature and important offshore, deep water habitat is primarily during winter months. Similarly, beluga whales prefer coastal environs in the summer. Consequently, low sensitivity summer toothed whale habitat was identified for the majority of the offshore portion of the Eastern Arctic study area. A narrow band of low sensitivity coastal toothed whale habitat, extending south of Clyde River to Cumberland Peninsula, was identified given that narwhal and belugas are not known to be common in this region.

In the winter, two regions of low sensitivity were identified: i) a narrow coastal region extending from Pond Inlet to Cumberland Peninsula (to reflect land-fast ice in this region for most of winter); and, ii) offshore regions of Baffin Bay and Davis Strait with consistently high ice concentration for all winter months (according to 30 year median ice charts).

Eastern Arctic, Nunavut, Canada
Toothed Whale
Winter Sensitivity Rating

Fig 4-8



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

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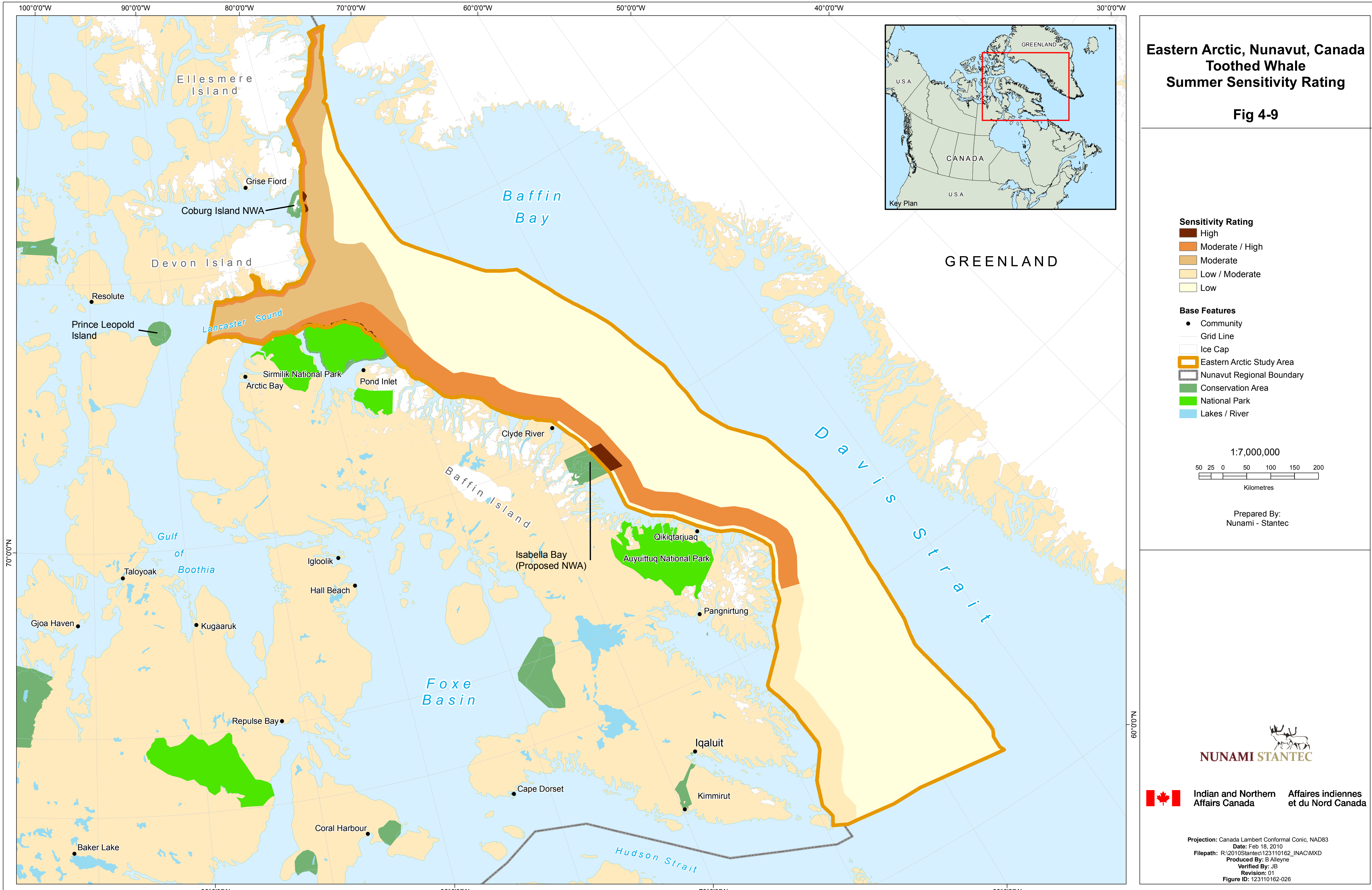

Eastern Arctic, Nunavut, Canada
Toothed Whale
Summer Sensitivity Rating
Fig 4-9
Sensitivity Rating
High
Moderate / High
Moderate
Low / Moderate
Low
Base Features
Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River
1:7,000,000
50 25 0 50 100 150 200
Kilometres
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Figure ID: 123110162-026
Key Plan
GREENLAND
U.S.A
CANADA
U.S.A.
100°0'0"W
90°0'0"W
80°0'0"W
70°0'0"W
60°0'0"W
50°0'0"W
40°0'0"W
30°0'0"W
70°0'0"N
60°0'0"N
Ellesmere Island
Grise Fiord
Coburg Island NWA
Devon Island
Resolute
Prince Leopold Island
Lancaster Sound
Sirmilik National Park
Arctic Bay
Pond Inlet
Baffin Bay
GREENLAND
Clyde River
Baffin Island
Davis Strait
Isabella Bay (Proposed NWA)
Qikiqtarjuaq
Auyuittuq National Park
Pangnirtung
Gulf of Boothia
Taloyoak
Igloolik
Hall Beach
Gjoa Haven
Kugaaruk
Foxe Basin
Repulse Bay
Iqaluit
Cape Dorset
Kimmirut
Coral Harbour
Baker Lake
Hudson Strait

4.3.4 Mitigation

Mitigation measures identified to reduce potential effects to bowhead whales (Section 4.2.4) are equally appropriate for toothed whales.

4.3.5 Data Sources

Data sources used for the determination of narwhal and beluga whale habitat ranges are found on Figure 4-7. Certainty regarding narwhal and beluga whale distribution in the Eastern Arctic is not high. This is in part due to the highly dynamic nature of sea ice in this region and the challenges of studying relatively small marine mammals over large areas which are underwater for more than 90% of the time.

4.3.6 Summary

The known narwhal and beluga ranges overlap with the Eastern Arctic Study Area. Key seasonal habitat for toothed whales includes dense annual pack-ice, shear zone/leads, shelf break, deep ocean basins, estuaries, lagoons, and fjords. Other important areas to toothed whales include open-water and the interface between open-water and pack-ice. Due to their strong association with ice, climate change may induce changes in habitat, migration pattern and predation rates.

Highly sensitive summer toothed whale habitat was not identified in the Eastern Arctic study area. Highly sensitive winter habitat includes beluga whale over-wintering areas near Cumberland Sound and mouth of Frobisher Bay; as well as Lancaster Sound and northern Baffin Bay. The NOW polynya and the continental shelf region in the south western portion of the study area are rated as moderate to highly sensitive winter habitat and the north eastern coast of Baffin Island, Lancaster Sound and Devon Island region was identified as moderate to highly sensitive summer habitat. Moderate sensitivity was given to the summer ice edge region of Baffin Bay, Lancaster Sound and the shear zone/lead area offshore of Baffin Island. Low to moderately sensitive summer habitat includes the south-western corner of the Eastern Arctic Study area and the south-eastern portion of the Eastern Arctic study area (in winter). Areas with low sensitivity include the majority of the offshore portion of the study area (summer and winter), and a narrow band of coastal summer habitat from Clyde River to Cumberland Peninsula.

4.4 Anadromous Arctic Char

4.4.1 Rationale for Selection

Anadromous Arctic char are an important fish species culturally, nutritionally and economically. Arctic char are well adapted to arctic lakes and rivers and in many cases the only fish species which can inhabit the more northern aquatic systems.

4.4.2 VEC Summary

The Arctic char (*Salvelinus alpinus*) is a member of the Salmonidae family, which includes various salmon species and some trout species such as lake trout. This VEC refers to anadromous Arctic char only. The lacustrine form of Arctic char does not enter marine waters and therefore is not included within this VEC.

4.4.2.1 Life History

Conservation Status

Arctic char is considered very abundant in Nunavut (Scott and Crossman 1973; Richardson, *et al.* 2001; Evans, *et al.* 2002; Coad and Reist 2004). Populations can vary between systems depending on habitat availability and fishing pressure.

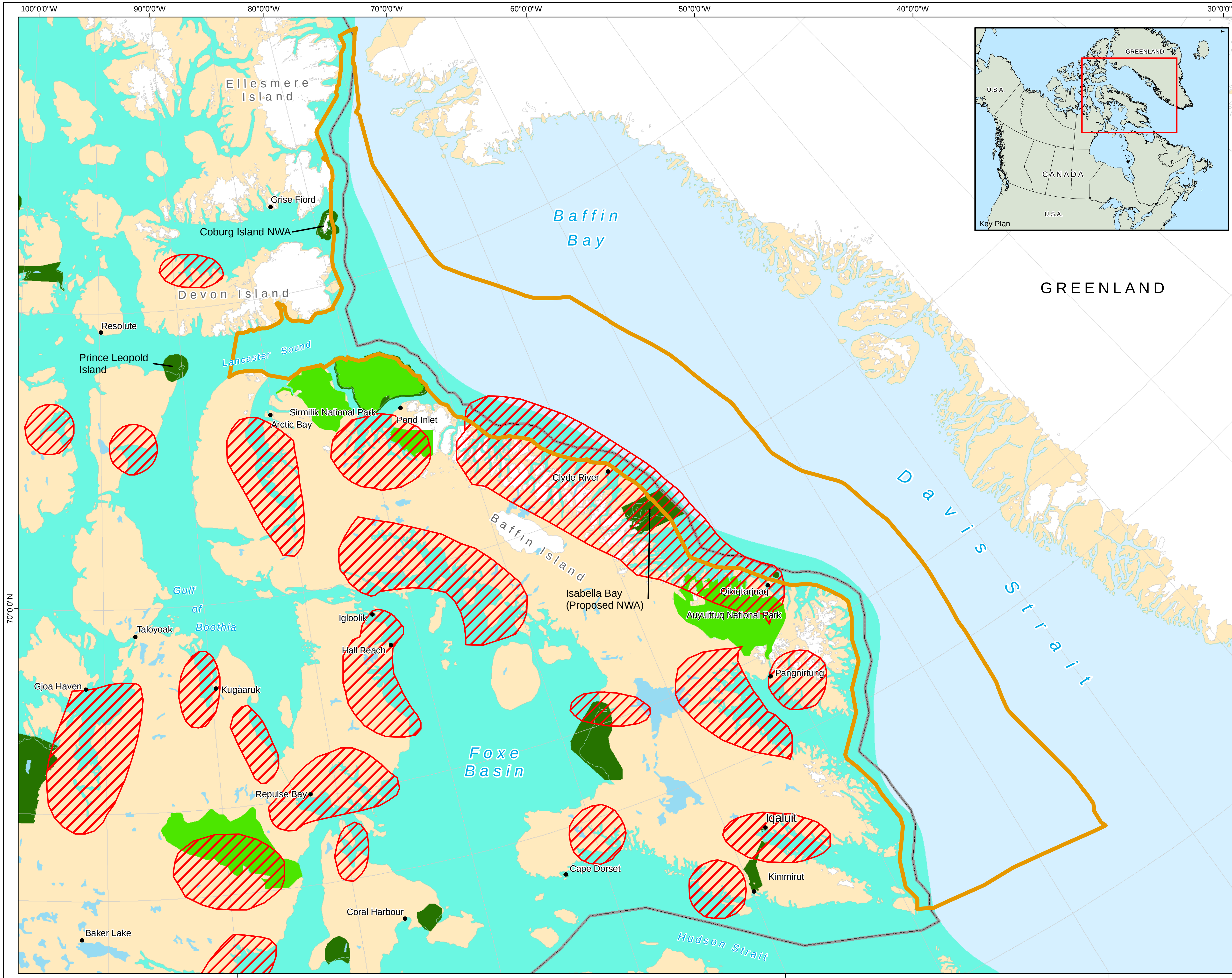
Distribution

Arctic char exhibit the most northerly distribution of any freshwater fish (Scott and Crossman 1973). They are not found much farther south than 60°N (Mercier, *et al.* 1994). In Nunavut, Arctic char are found along the west coast of Hudson Bay, throughout coastal areas of Kitikmeot, and on many Arctic islands, including Banks, Victoria, Devon, Somerset, and Baffin (McPhail and Lindsey 1970; Scott and Crossman 1973; Mercier, *et al.* 1994) (Figure 4-10). The largest recorded Arctic char run migrates upstream in the Iqaluit River, on northern Baffin Island (282,500 individuals; Mercier, *et al.* 1994).

In the Eastern Arctic marine region, anadromous Arctic char are associated with most river mouths and nearshore areas along the eastern coast of Baffin Island and Lancaster Sound (Figure 4-10).

Eastern Arctic, Nunavut, Canada
Arctic Char Distribution

Fig 4-10



Arctic Char Area of Abundance[1]
Arctic Char Range[1]

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

1. Mercier, F., F. Rennie, D. Harvey and C.A. Lewis (Eds.). 1994. Arctic Marine Workshop Proceedings. Winnipeg, Manitoba. Park Establishment Branch, National Parks Directorate, Parks Canada Department of Canadian Heritage.

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Ecology

Arctic char are a large freshwater species, attaining a maximum size of over 100 cm (Coad and Reist 2004) and a maximum weight of over 10kgs (Scott and Crossman 1973). Although growth rates vary considerably throughout their range, growth is typically slow (Scott and Crossman 1973). For example, Arctic char from Frobisher Bay, Baffin Island do not attain lengths of 50 cm until the age of 14, and may live in excess of 24 years (Grainger 1953). In the marine environment, anadromous Arctic char feed on several marine fish species, including capelin, sand lance, Arctic cod, and young Greenland cod (Richardson, *et al.* 2001). In freshwater environments, Arctic char feed on algae, insects, fish and plankton (Richardson, *et al.* 2001).

Arctic char exhibit anadromous and lacustrine life history types, although the majority of Arctic char populations, especially at more northern latitudes, are anadromous (Scott and Crossman 1973; Richardson *et al.* 2001). Arctic char spawn in the fall, in lakes or rivers where there is gravel or other similar substrate (Hunter 1976). Char eggs require moving water to pass over them (Hunter 1976). In the Tugaat River overwintering areas may be a limiting factor for arctic char (Read 2004), this is probably true for other rivers and lakes as well.

Anadromous: Adult anadromous Arctic char occur in rivers, lakes, estuaries, and marine environments (Richardson, *et al.* 2001). They spawn in shallow waters (<2 m) of rivers and lakes (Richardson, *et al.* 2001). Preferred spawning substrates include cobble and gravel (Richardson, *et al.* 2001). In the spring, adult Arctic char migrate downstream to marine waters to feed (Richardson, *et al.* 2001). Most fish remain in the vicinity of the estuary of their natal river, although tagging studies have shown that some fish may travel up to 80 km (Scott and Crossman 1973). Adult Arctic char return to freshwater systems in the fall and overwinter there (Richardson, *et al.* 2001). Juvenile Arctic char are generally found in shallow creek and lacustrine habitats (Richardson, *et al.* 2001).

Lacustrine: Adult lacustrine Arctic char occur in the pelagic zone of lakes during the summer, and make seasonal shifts to benthic/littoral lake areas in the fall (Richardson, *et al.* 2001). As the lacustrine form of Arctic char do not enter marine waters, they will not be discussed further in this report.

4.4.2.2 Key Habitat

Throughout Nunavut, many arctic char populations experience heavy fishing pressure (Carder and Peet 1983; Carder 1991, 1995; Read 2000; Read 2004). As such, commercial, recreational, and subsistence fisheries for Arctic char should be carefully managed to avoid overexploitation and to ensure the long-term sustainability of harvests. Spawning, rearing and overwintering, critical to maintaining sustainable char populations, all occur in freshwater rivers or lakes. Feeding of adult Arctic char occurs in coastal waters often close to river mouths. Adult Arctic char will obtain most of their annual energy requirements in these coastal waters during the short open water season. Access and maintaining the ecological integrity of these coastal areas are critical to healthy Arctic char stocks. Special management or mitigation measures should be considered on activities and/or timing of these activities in coastal areas utilized by Arctic char.

4.4.2.3 Sustainability Factors

The primary threat to anadromous Arctic char populations has been from over harvesting. Climate change may also pose a threat. Reduction of river discharges resulting from climate change may restrict Arctic char from moving up river in the fall or lead to failures in spawning or overwintering due to low water conditions. Climate change may also allow new species to occupy areas previously used by Arctic char. This may lead to these new species out competing Arctic char for space and food. Growing interest in hydrocarbon exploration in the Easter Arctic may in the future put new pressure on Arctic char sustainability.

4.4.2.4 Susceptibility to Oil and Gas Activities

Seismic Exploration

Few studies have been conducted on the effects of seismic operations on salmonids and most of these studies involved the effects of the use of explosives to conduct seismic activities. No studies on the effects of seismic have been conducted specifically with Arctic char. The use of air guns has greatly reduced mortalities in fish during seismic surveys. Mortality is generally restricted to the immediate few meters under the air gun, affecting mainly fish eggs and larval fish. Mortality of fish eggs and larval fish by air guns is far less than natural mortality (Saetre and Ona 1996). Pacific herring have exhibited a number of behavioural responses such as startle response, alarm and avoidance (Schwarz and Greer 1984) during seismic activities however these responses stop shortly after cessation of seismic operations. Seismic operations can also cause declines in catches of fish. Reductions of over 50% in catches of cod (Løkkeborg 1991; Engas, *et al.* 1996), haddock (Engas, *et al.* 1996), and rockfish (Skalski, *et al.* 1992) have been reported.

There is the potential that Arctic char feeding migrations may be disrupted during seismic operations in coastal waters. The disruption of feeding migrations may reduce the amount of energy the Arctic char can obtain during the short feeding season. This could result in reduced survival or reproductive success due to insufficient energy reserves.

Ice-based activities

As Arctic char use freshwater lake and river systems during the ice covered season, no effects are expected from ice-based activities in the marine and coastal areas.

Shipping and Related Coastal Infrastructure

Shipping itself is expected to have minimal effects on Arctic char. Coastal infrastructure related to shipping such as docks or causeways may have potential short or long-term effects on Arctic char. The construction of docks would likely only have short-term effects during the period of construction when Arctic char migration may be disrupted. The construction of causeways which extend out from shore may also cause short-term disruptions in feeding migrations. The potential for longer-term effects are unknown but the migrations of adults of similar species such as Dolly Varden char and Arctic cisco do not appear to be affected by causeways constructed in the Alaskan Beaufort Sea (Fechhelm, *et al.* 1999).

Drilling and Production

Exploration drilling or production activities would likely only have potential effects on Arctic char if these activities occurred in nearshore areas or mouths or rivers containing anadromous char. No data is available on the effects of drilling and production activities on Arctic char however underwater noise created by drilling or production activities may cause disruptions in char migration or lead to reduced catches by local fishermen. Drilling or production in the offshore is unlikely to have effects on Arctic char populations. Ancillary activities related to production such as pipelines from the offshore to land would cause temporary disruption of char migration and feeding during construction of the pipeline in nearshore areas if constructed during the open water season.

Hydrocarbon Release

The accidental release of hydrocarbons into the marine environment could lead to adult Arctic char mortality, reduced health or reduced quality due to tainting. Small releases of hydrocarbons are unlikely to have a significant effect, except perhaps on a few individuals. Chronic small releases of hydrocarbons may lead to reduced health of char populations and/or tainting, which could lead to reduced overwintering and reproductive success. Large releases of hydrocarbons during key periods of Arctic char migration may lead to large scale mortality or reduced health levels, which could lead to reproductive failure of one or more age classes.

4.4.2.5 Potential Effects of Climate Change on VEC

The effects of climate change on Arctic char are unknown. Changes in river discharge may either positively or negatively affect Arctic char populations. Increased discharge may provide easier access to and from the sea as well provide better overwintering habitat. Decreased discharge may lead to blockages occurring where Arctic char cannot return to their natal system to overwinter or spawn. Climate change may also affect sea temperature and currents, thereby changing food availability. This could result in either a benefit if food availability increased or a negative effect if food availability declined. Increased water temperatures may also result in increased competition for space and food by species which were previously limited in their range by temperature. This competition could lead to reduced stocks of Arctic char.

4.4.3 Sensitivity Ranking

Sensitivity ranking is based on the use of marine waters by anadromous adult Arctic char, the size of the aggregations utilizing specific coastal areas and the season. The use of coastal areas by Arctic char for feeding is important for overwintering and reproductive success. Sensitivity ranking for Arctic char habitat in the eastern arctic study area is summarized in Figure 4-11 (winter season) and Figure 4-12 (summer sensitivity).

High Sensitivity (5)

There are no high sensitivity areas for Arctic char in marine waters. Spawning, rearing and overwintering all occur in freshwater.

Moderate/High Sensitivity (4)

Moderate to high sensitivity is applied to river mouths and estuaries during the open water season (summer).

The mouths and estuaries of Arctic char rivers are important aggregation areas for feeding and as a gateway for char moving upriver to overwinter and spawn, and downriver to the sea for feeding. Activities or hydrocarbon spills in and around the mouth or estuary of an Arctic char river has the potential to affect a large proportion of the adult population, thereby potentially affecting overwintering or reproductive success of one or more year classes.

Moderate Sensitivity (3)

Moderate sensitivity is applied to habitat between the shore and 0.5 km during the open water season (summer).

Aggregations of adult Arctic char utilize the nearshore coastal areas during the open water season for feeding. A majority of an adult char's energy budget is obtained during this open water period. Activities or spills which may affect their feeding activities could reduce their energy input resulting in reduced overwintering or reproductive success. Arctic char tend to remain close to shore but it is not known how far offshore they move, therefore a precautionary approach was taken in selecting a distance of 0.5 km out from shore to delineate this sensitivity area.

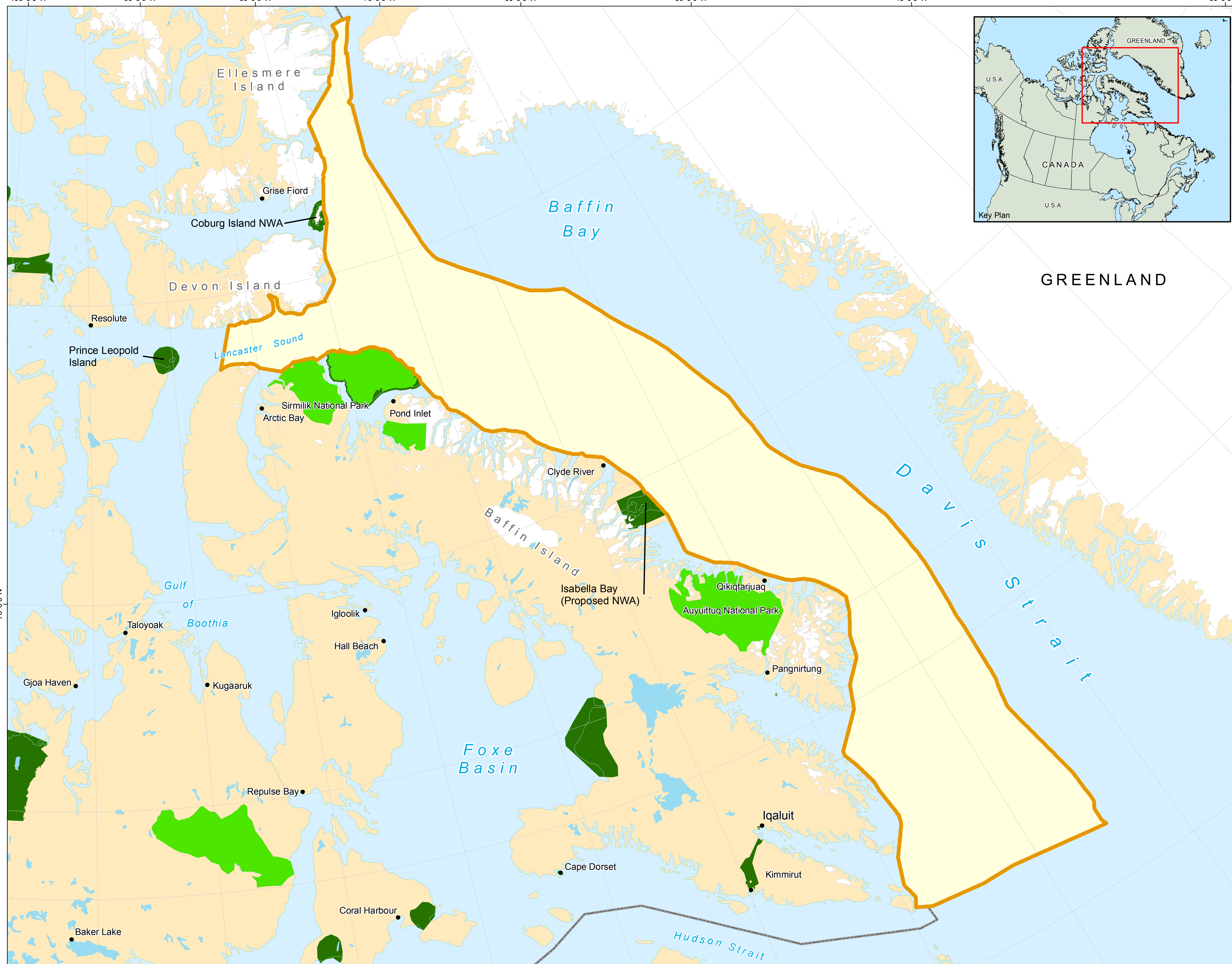
Low/Moderate Sensitivity (2)

This area of sensitivity ranges from 0.5 km to 10 km offshore during the open water season. This range is arbitrary due to the lack of available information on the use of this area by Arctic char however it does attempt to take a precautionary approach in determining the potential use of this area by Arctic char. Although it is suspected that most Arctic char stay relatively close to shore, some Arctic char may venture further offshore. The extent offshore and numbers of char which might utilize these waters, if any, is unknown. Due to the uncertainty of the use of this area by Arctic char the sensitivity ranges from low to moderate.

Low Sensitivity (1)

Arctic char do not utilize coastal or offshore marine waters during the ice covered season. As there is no to minimal risk to species sustainability in these areas during this time period the sensitivity ranking for Arctic char is low.

Although some individuals of Arctic char may venture into offshore waters (>10 km from shore), Arctic char appear to mainly stay in coastal nearshore areas during the open water season. Arctic char which may use the offshore environment would likely be small in number and widely dispersed. It is unlikely that activities occurring in offshore waters would have any effect on the sustainability of Arctic char populations. The ranking for the offshore during the open water season is low for the VEC Arctic char.



Eastern Arctic, Nunavut, Canada
Arctic Char
Winter Sensitivity Rating

Fig 4-11

Sensitivity Rating

- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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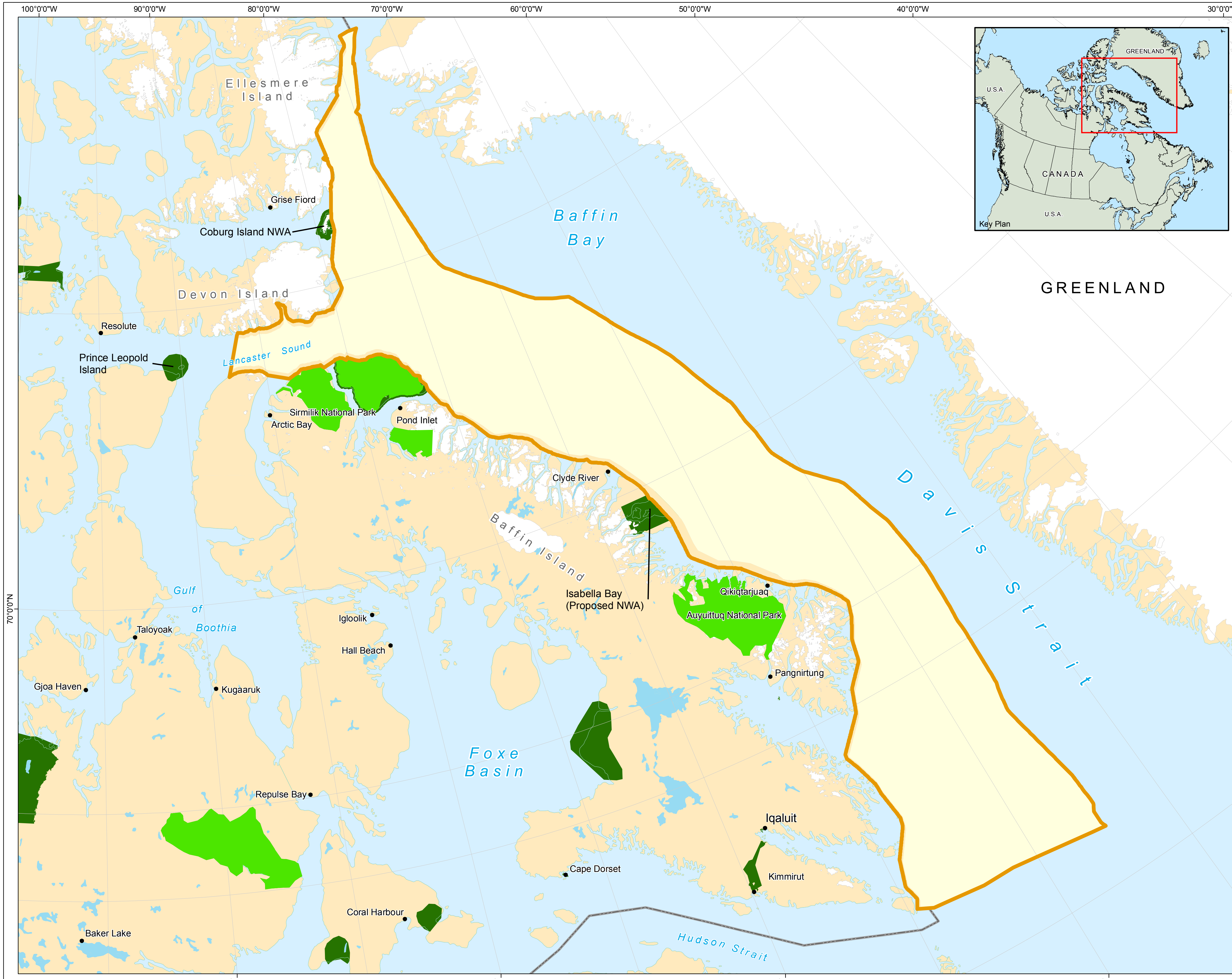
Eastern Arctic, Nunavut, Canada
Arctic Char
Summer Sensitivity Rating

Fig 4-12



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200
Kilometres

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4.4.4 Mitigation

The following mitigation will reduce the potential for negative effects on anadromous Arctic char populations.

- Ramp-up or soft start during seismic operations
- Regular communication with HTO's and local harvesters on timing of seismic or other activities occurring nearshore in order to avoid peak migration periods of Arctic char.
- Timing of construction activities (e.g., pipelines) in the nearshore to avoid major migration periods of Arctic char. Construction where possible is preferable during the ice on period.

4.4.5 Data Sources and Certainty

Data sources for Arctic char have mainly been from DFO reports and from past personal communications with local fishermen. Much of the data collected for Arctic char has been related to stock assessments and focused on river or lake systems where exploratory or commercial fisheries have occurred. Information on effects from hydrocarbon activities has come from studies presented in peer reviewed reports; however none of these studies involved Arctic char. Despite the paucity of available data on Arctic char and on the effects from hydrocarbon activities, there is a medium level of confidence in the conclusions presented. Effects from hydrocarbon activities known from studies conducted on other fish species, provides a reasonable substitute for understanding the potential effects on Arctic char.

4.4.6 Summary

Anadromous Arctic char are an important fish species to local inhabitants having cultural, nutritional and economic benefits. The highest ranked sensitivity areas for anadromous Arctic char in the marine environment are the mouths and estuaries of rivers and adjacent nearshore coastal areas. These areas are critical for adult Arctic char feeding. Although the open water season is short, a majority of the annual energy budget required by an Arctic char is obtained during this period. Mitigation includes ramp-up or soft starts for seismic operations. Regular communications with HTOs and harvesters when activities are planned for river mouths or adjacent coastal areas and ensuring adequate and well maintained spill equipment on board and/or on land.

4.5 Migratory Birds

4.5.1 Rationale for Selection

Migratory birds are of high socio-economic value in Nunavut and are sensitive because they nest in colonies and occur in large congregations. Ecological and population processes are affected by large-scale climatic fluctuations, and top predators such as seabirds can provide an integrative view on the consequences of environmental variability on ecosystems. Seabirds are also a key offshore indicator of anthropogenic disturbance. Seabirds have strong cultural significance and are often featured in carvings.

4.5.2 Migratory Birds Summary

4.5.2.1 Description

The marine areas of Nunavut and the Northwest Territories supports approximately 10 million pairs of breeding birds annually for breeding, feeding, migration, moulting, or wintering. In addition these areas support hundreds of thousands of non-breeding birds that inhabit the area (Mallory and Fontaine 2004a). The Canadian Wildlife Service has defined a key marine habitat site as an area that supports at least 1% of the Canadian population of at least one migratory species.

There are three important habitat types that are essential to migratory birds, the coastline, the open sea, and polynyas. Many species of birds rely on coastal habitats to feed during breeding or migration or to rear their young. Open water areas are important for feeding, spring migration staging areas and as moulting and overwintering areas (Mallory and Fontaine 2004). Polynyas are open water areas surrounded by ice which are a critical habitat type for seabirds. They vary in size and shape and are created by a variety of environmental factors but they provided a reliable source of open water amidst the ice. Polynyas and shore leads provide open water for feeding, migrating corridors and staging areas since they typically support a higher biodiversity than the surrounding ice.

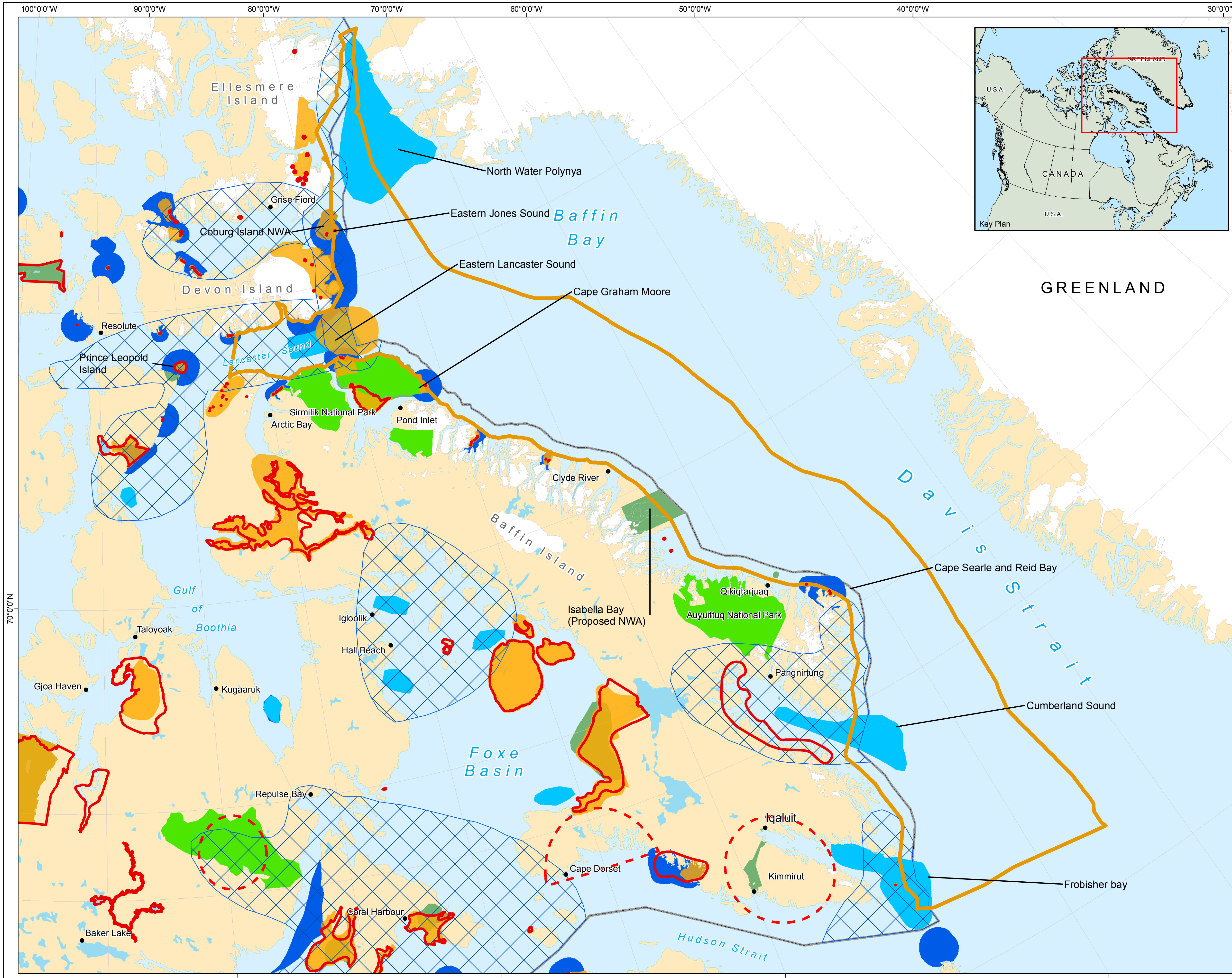
4.5.2.2 Key Terrestrial and Marine Migratory Bird Habitat

Key Migratory Bird Marine and Terrestrial Habitat Sites

The CWS has identified key marine and terrestrial habitat areas that are essential to the welfare of various migratory bird species in Canada (Mallory and Fontaine 2004; Latour, *et al.* 2006). These sites are lands that CWS has identified where special wildlife conservation measures may be required and act as a guide to the conservation and land use planning efforts of other agencies (e.g., Nunavut Planning Commission) having interests in the Northwest Territories and Nunavut (Latour, *et al.* 2006). As such, not all sites are targeted to become protected areas (Mallory and Fontaine 2004). The locations within the study area are featured on Figure 4-13. A short description is provided below.

Eastern Arctic, Nunavut, Canada Migratory Birds Distribution

Fig 4-13



Key Marine Habitat Sites [4]
Key Terrestrial Habitat Sites [3]
WASI Site - Gyrfalcon and Peregrine Falcon [2]
Biological Hot Spots [5]
Important Bird Area [1]
Polynyas [4]

Base Features

Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River

1:7,000,000

50 25 0 50 100 150 200
Kilometres

Prepared By:
Nunami - Stantec

References:

[1]BirdLife International. 2008. Important Bird Area. Accessed: November, 2008. Available at: http://www.bsc-eoc.org/iba/spmaps.jsp

[2]Ferguson, S.H. 1995. Wildlife Areas of Special Interest to the Department of Renewable Resources. Wildlife Management Division, Department of Renewable Resources, Government of the Northwest Territories. Nunavut Wildlife Management Board version adapted from original 1987 publications. 80 pp
*digitized by Government of Nunavut 2005

[3]Latour, P.B., J. Leger, J.E. Hines, M.L. Mallory, D.L. Mulders, H.G. Gilchrist, P.A. Smith and D.L. Dickson. 2006. Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut. 3rd ed. Canadian Wildlife Service Occasional Paper No.114.

[4]Mallory, M.L. and A.J. Fontaine. 2004. Key marine habitat sites for migratory birds in Nunavut and the Morthwest Territories. Canadian Wildlife Service Occasional Papers 109.
*digital data provided by CWS, reproduced with the permission of Environment Canada

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Migratory Bird Sanctuaries

There are eleven Migratory Bird Sanctuaries in Nunavut. The *Migratory Birds Convention Act* prohibits activities in Migratory Bird Sanctuaries. These sanctuaries are for the purpose of protecting migratory birds and their habitat. Migratory Bird Sanctuaries can have a marine component, which often are nearshore areas used by migratory birds for feeding or other activities. Prohibitive measures can be placed on what and how activities can take place in these sanctuaries and are set out in the *Bird Sanctuary Regulations*. Although important fish habitat could be protected through a MBS, it is not an effective measure unless there is valuable bird habitat associated with the area that coincides with important or critical fish habitat.

There are no Migratory Bird Sanctuaries in the Eastern Arctic study area.

Important Bird Areas

Important Bird Areas (IBAs) are created to identify, conserve, and monitor a network of sites that provide essential habitat for threatened birds, birds restricted by range or by habitat, and congregatory species. The IBA program is an international conservation initiative coordinated by BirdLife International. The Canadian co-partners for the IBA program are Bird Studies Canada and Nature Canada (Formerly the Canadian Nature Federation). The locations of the IBAs found in the study area are featured on Figure 4-13. A short description of each IBA featured can be found below. Each IBA is also identified as being either globally, continentally, or nationally significant. Further information on the Canadian IBA Sites Catalogue can be found at http://www.bsc-eoc.org/iba/IBAsites.html.

Biological Hotspots

Parks Canada sponsored an Arctic Marine Workshop which hosted over 30 experts on the Canadian Arctic (Mercier, *et al.* 1994). Together they identified marine areas of high biological diversity (hot spots), which are as areas of high productivity, with high species diversity and/or high species abundance. While detailed information is not available for each hotspot identified, for the purposes of this report they are treated as important to migratory birds.

4.5.2.3 Key Terrestrial and Marine Sites

North Water Polynya

The NOW Polynya is the largest (27,000 km^2) polynya in the Canadian Arctic and is located in northern Baffin Bay between Ellesmere Island and Greenland. This polynya remains open water year round and is considered one of the most productive polynyas in the northern hemisphere (Stirling 1980; Hobson, *et al.* 2002). The NOW Polynya is a key marine habitat site for the millions of seabirds that breed nearby and many of these (about 14 million) migrate north along shore leads in the spring (Renaud, *et al.* 1982). Various important species that using this area include the Black-legged Kittiwakes (*Rissa tridactyla*) (16% of the Canadian population), Thick-billed Murres (*Uria lomvia*) (12% of the Canadian population), Northern Fulmar (*Fulmarus glacialis*) (1% of the Canadian population), Ivory Gulls (*Pagophila eburnea*) (14 colonies, 30% of the Canadian population), Black Guillemots (*Cepphus grille*) (2% of the Canadian population) (Mallory and Fontaine 2004).

Within the NOW Polynya is Coburg Island which is an International Biological Programme site (Nettleship 1980) and has been protected since 1995 as Nirjutiqavvik National Wildlife Area and includes waters within 10 km of the high tide line. Both Coburg Island and the Inglefield Mountain Ivory Gull colonies (Nunataks) are considered Important Bird Areas in Canada (CEC 1999).

Eastern Jones Sound

The Eastern Jones Sound site occurs between southern Ellesmere Island, Coburg Island, and northeastern Devon Island and contains two key terrestrial sites (Coburg Island and eastern Devon Island). Over 500,000 breeding marine birds are found in this area and include Black-legged Kittiwakes (16% of the Canadian population), Thick-billed Murres (12% of the Canadian population), Northern Fulmars (1% of the Canadian population), Ivory Gulls (4 colonies, 4% of the Canadian population), Black Guillemots, Glaucous Gulls (*Larus hyperboreus*), Long-tailed Ducks (*Clangula hyemalis*), Common Eiders (*Somateria mollissima*), and Atlantic Puffins (*Fratercula arctica*).

Within Eastern Jones Sound, Coburg Island is an International Biological Programme site (Nettleship 1980) and has been protected since 1995 as Nirjutiqavvik National Wildlife Area and includes waters within 10 km of the high tide line. Both Coburg Island and Devon Island contain Ivory Gull colonies (Nunataks) and are considered Important Bird Areas in Canada (CEC 1999). Devon Island is considered globally significant for congregatory species and nationally significant for threatened species and species with restricted ranges (BirdLife International 2008, Internet site).

Eastern Lancaster Sound

Eastern Lancaster Sound site is a completely marine area and often forms as an early, open water feature during spring ice breakup. There are six major breeding colonies in this area and most of the birds inhabiting these colonies use Eastern Lancaster Sound during migration or use it for feeding (McLaren 1982). Large proportions of the Canadian population of Black-legged Kittiwakes (35% of the Canadian population), Northern Fulmars (57% of the Canadian population) and Thick-billed Murres (27% of the Canadian population) occur in this area (Nettleship 1980). In addition to the resident breeding colonies, millions of non-breeding birds spend the summer in the area and numerous migrants pass through on their way to breeding areas in the central Canadian High Arctic and northwest Greenland (McLaren 1982).

Eastern Lancaster Sound is an Important Bird Area in Canada (CEC 1999). This area is considered to be globally significant to congregatory species as well as for concentrations of colonial waterbirds and seabirds (BirdLife International, 2008 Internet site).

Cape Hay

Cape Hay is located at the eastern entrance to Lancaster Sound and is one of the five largest Thick-billed Murre colonies in Canada (over 10% of the Canadian population). A variety of bird species occur in this area including Black-legged Kittiwakes (over 10% of the Canadian population), Northern Fulmars, Black Guillemots and Dovekies (*Alle alle*). Cape Hay is an important area for marine birds and significant concentrations of them may be found throughout the region depending on annual fluctuations in ice breakup and distribution of prey (McLaren 1982; Dickins, *et al.* 1990; Riewe 1992).

According to the coastal atlas of environmental protection, the shoreline around Cape Hay is listed as being 'highly sensitive' to oil spills from May to October, the offshore area is listed as being 'highly sensitive' from May through August and 'moderately sensitive' from September through April (Dickins, *et al.* 1990).

Cape Hay is a Canadian Important Bird Area (CEC 1999) and an International Biological Programme site (Nettleship 1980). Cape Hay is considered to be globally significant for congregatory species and concentrations of colonial waterbirds and seabirds. It is continentally significant to congregatory species (BirdLife International, 2008 Internet site). Additionally, it is part of the Bylot Island Migratory Bird Sanctuary (established in 1965) and the Sirmilik National Park (established in 2001).

Cape Graham Moore

Cape Graham Moore is a completely marine site approximately 70 km north of the Pond Inlet community. Both the Thick-billed Murres and the Black-legged Kittiwakes occur in Cape Graham Moore and their numbers represent more than 1% of the Canadian population (Mallory and Fontaine 2004b). A wide variety of species are drawn to the leads and polynyas in this area during spring break-up including fulmars, kittiwakes, murres, and guillemots. Also present are Dovekies and Ivory Gulls.

Cape Graham Moore in an International Biological Programme site (Nettleship 1980) and a Canadian Important Bird Area (CEC 1999). This IBA is considered globally and continentally significant for congregatory species and globally significant for concentrations of colonial waterbirds and seabirds. Since 1965 the Cape has been part of the Bylot Island Migratory Bird Sanctuary and is also located just outside the boundary of Sirmilik National Park which was established in 2001. According to the coastal atlas for environmental protection, the shoreline around the Cape is listed as 'extreme sensitivity' from May to October for impact of oil spills. The offshore area is listed as being of 'high sensitivity from May through August and 'moderate sensitivity' from September through April (Dickins, *et al.* 1990).

Cape Searle (Qaqulluit) and Reid Bay (Minarets; Akpait)

Cape Searle and Reid Bay are primarily marine sites (2,747 km^2 marine vs. 94 km^2 terrestrial). Qaqulluit contains Canada's largest Northern Fulmar colony at 22 – 27% of the Canadian population (Nettleship 1980; Alexander *et al.* 1991). Other numerous birds at this site include Glaucous Gulls, Iceland Gulls (*Larus glaucoides*) and Black Guillemots (Nettleship 1980). One of Canada's largest Thick-billed Murre colonies (about 10% of the Canadian population) occurs at Akpait along with about 4% of the Canadian population of Northern Fulmars (Nettleship 1980; Alexander *et al.* 1991). Additionally Black-legged Kittiwakes, Glaucous Gulls and Black Guillemots also nest there. Numerous other species use the area for feeding including Common Eiders, Canada Geese (*Branta canadensis*) and Common Ravens (*Corvus corax*).

Cape Serale and Reid Bay are International Biological Programme sites (Nettleship 1980) and Important Bird Areas in Canada (CEC 1999). Cape Serale is recognized as globally significant for congregatory species (BirdLife International 2008, Internet site). Reid Bay is considered globally and nationally significant for congregatory species and globally significant for colonial waterbirds and seabird concentrations (BirdLife International, 2008 Internet site).

Cumberland Sound

The Cumberland Sound area contains a recurrent polynya at its mouth and is located approximately 250 km from two major bird colonies; Cape Searle and Reid Bay (see description above). Numerous species occur within the Sound including Common Eiders, Iceland Gulls and Dovekies. The largest breeding colony of Iceland Gulls in Canada occurs on the islands in Cumberland Sound. Additionally, there are Black Guillemots (over 1% of the Canadian population), Black-legged Kittiwakes (1% of the Canadian population), Thick-billed Murres (10% of the Canadian population) and Northern Fulmars (27% of the Canadian population).

Frobisher Bay

Frobisher Bay contains both marine and terrestrial areas. The area contains a large annual polynya and many small polynyas among the islands. Numerous species of birds use this area including Thick-billed Murres (3% of the Canadian population), Black-legged Kittiwakes (1% of the Canadian population), Glaucous Gulls, Northern Fulmars, Razorbills (*Alca torda*), Dovekies, Black Guillemots, Common Eiders, Iceland Gulls, Ivory Gulls, Harlequin Ducks, Canada Geese, Long-tailed Ducks and various gulls (*Larus spp.*)

Hantzsch Island within Frobisher Bay is an International Biological Programme site (Nettleship 1980) and a Canadian Important Bird Area (CEC 1999). Hantzsch Island is considered globally and continentally significant for congregatory species and globally significant for colonial waterbirds and seabird concentrations (BirdLife International 2008, Internet site).

4.5.2.4 Susceptibility to Oil and Gas Activities

Hydrocarbon Release

It has been well documented that seabirds can be dramatically affected by anthropogenic changes in the environment such as oil spills. The *Exxon Valdez* oil spill in the Gulf of Alaska in 1989 was responsible for the death of an estimated 100,000 to 300,000 birds (Piatt, *et al.* 1990). Those species most severely affected by the spill were murres, other alcids and sea ducks (Piatt *et al.* 1990).

The intensity of the effects of an oil spill on seabirds depends on several factors including the size of the local bird population, their foraging behaviour, whether these populations are aggregated or dispersed at the time of the spill and on the type and persistence of the oil spilled (NRC 1985). Birds suffer from contact with oil from direct fouling of feathers which reduces their insulative properties in addition to the direct toxicological effects of ingestion. Species that spend a large amount of time swimming on the sea surface and those that form large aggregations are the most vulnerable.

4.5.2.5 Potential Effects of Climate Change on Migratory Birds

Climate changes will affect seabirds in a variety of ways both directly and indirectly. Direct effects include a rise in air and sea temperatures, changing ice distribution and rise in sea levels, while indirect effects include changes in prey distribution. A rise in sea level may damage essential shoreline nesting areas. Direct mortality from predation and storms are the two primary natural threats to seabirds. Increasing temperature may bring increasing storms which could increase general mortality and during the breeding season could inhibit nesting effort or destroy eggs and chicks. Climatic changes will affect the habitat of seabirds which may shift their distribution and abundance.

Because seabirds are dependent on the marine environment for high quality prey, they are good indicators of change in the marine food web (Montevecchi 1993). The marine prey of seabirds is directly affected by a variety of physical and biological characteristics including changes in sea temperatures, extent of sea ice and primary productivity in the ocean (Springer, *et al.* 1996).

Arctic seabirds have evolved under the influence of ice and snow and show many life-history characteristics to reflect this. Changes due to global climate change are expected to increase air temperature which will influence the presence and amount of ice and snow. The species that are the most reliant on the presence or amount of ice and snow are expected to be the first affected by climate change. Timing, location and length of migrations may all be affected by climate change.

4.5.3 Sensitivity Ranking

Sensitivity ranking for migratory bird habitat in the eastern arctic study area is summarized in Figure 4-14 (winter season) and Figure 4-15 (summer sensitivity).

High Sensitivity (5)

Habitat given a rating of high sensitivity includes areas globally important migratory birds because they meet any of the following criteria:

(a) It supports 1% of the North American population (following the IBA guidelines)

(b) It supports a very significant (i.e. 10%) portion of the Canadian population of a migratory bird species at any time during the year and/or an endangered species (e.g., breeding areas for the endangered Ivory Gull)

(c) It has been identified as being either globally or continentally significant Important Bird Area

(d) It is legally protected (e.g. national or territorial park, marine protected area, migratory bird sanctuary, critical habitat for VEC under the *Species at Risk Act*).

In the study area these areas include:

- NOW Polynya
- Eastern Jones Sound
- Eastern Lancaster Sound
- Cape Hay
- Cape Graham Moore
- Cape Searle (Qaqulluit) and Reid Bay (Minarets; Akpait)
- Cumberland Sound
- Frobisher Bay.

Moderate/High Sensitivity (4)

Moderate to high sensitivity was given to areas nationally important to migratory birds including:

- Areas that either support a significant (i.e. 1%) proportion of the national population at any time during the year or have been identified as nationally significant Important Bird Areas
- Areas identified as key to the national persistence of a migratory bird species. Following (Mallory and Fontaine 2004), areas that support at least 1% of the national population are considered key habitat by the Canadian Wildlife Service and include marine areas within a 30 km radius of the major nesting colonies
- Biological hotspots identified by Parks Canada, which includes areas of high productivity and numbers of seabirds (NPC 1995).

In the study area these areas include biological hotpots identified by CWS (outside of those areas listed as a 5 above).

Moderate Sensitivity (3)

Moderate sensitivity was given to areas that are regionally important to migratory birds because they support a high proportion of the regional population or have been identified as key to regional persistence.

In the study area these areas include areas of moderate to high densities but less than 1% of the Canadian population, including:

- Coastal areas
- Offshore areas to the limit of summer pack ice
- Floodplains
- Upland areas
- Areas within the known range migratory birds whose populations are heavily dependent on the Canadian Arctic (the PEMT uses the summer range of Baird's Sandpiper).

Low/Moderate Sensitivity (2)

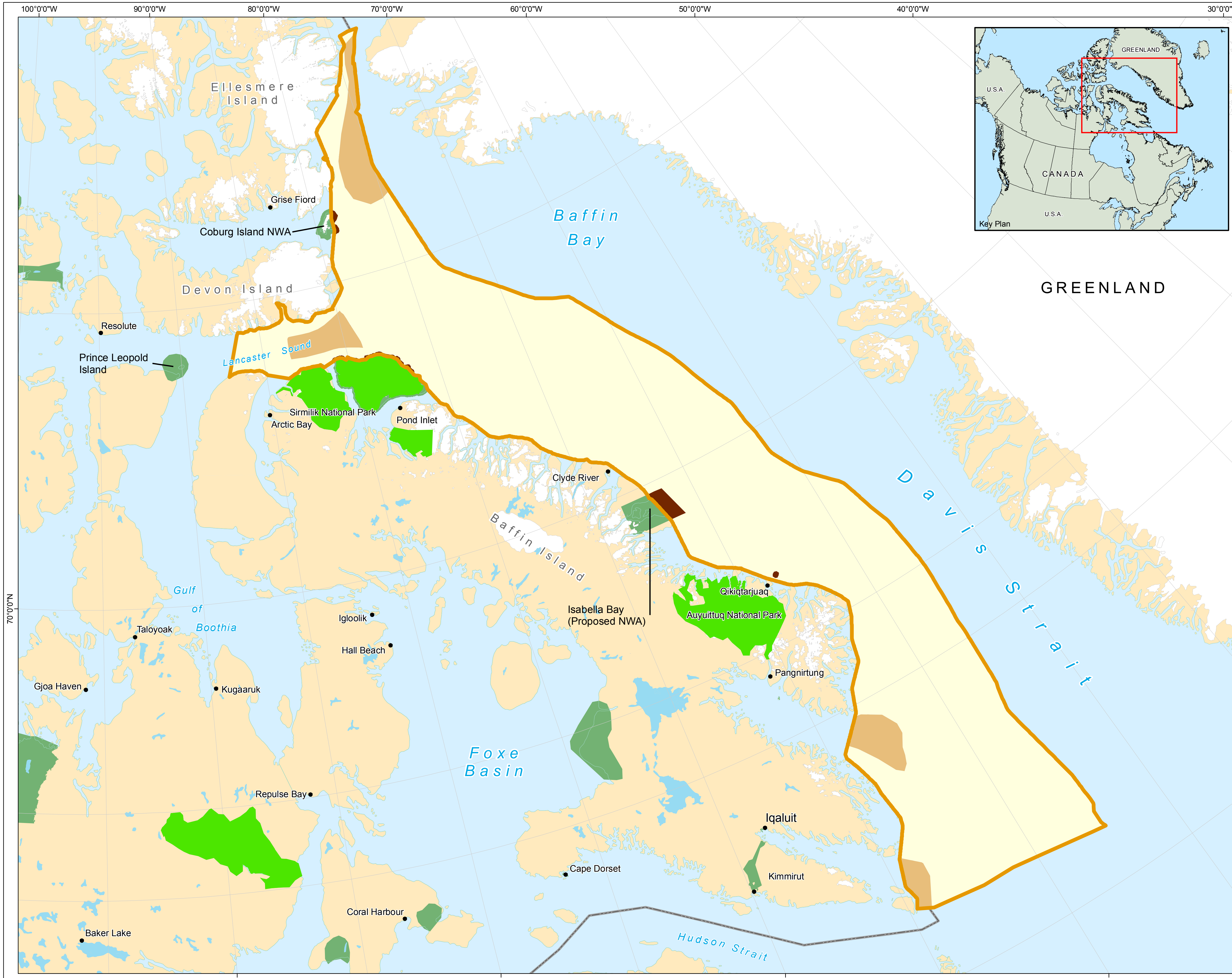
Low to moderate sensitivity was given to areas considered locally important to migratory birds. In the study area these areas include areas with low to moderate densities. This includes areas which, while not permanently covered in ice, are outside the usual ranges of most migratory birds.

Low Sensitivity (1)

Low sensitivity was given to areas that have very limited or no use by migratory birds. In the study area these areas include areas of permanent ice (the summer extent of pack ice).

Eastern Arctic, Nunavut, Canada
Migratory Birds
Winter Sensitivity Rating

Fig 4-14



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

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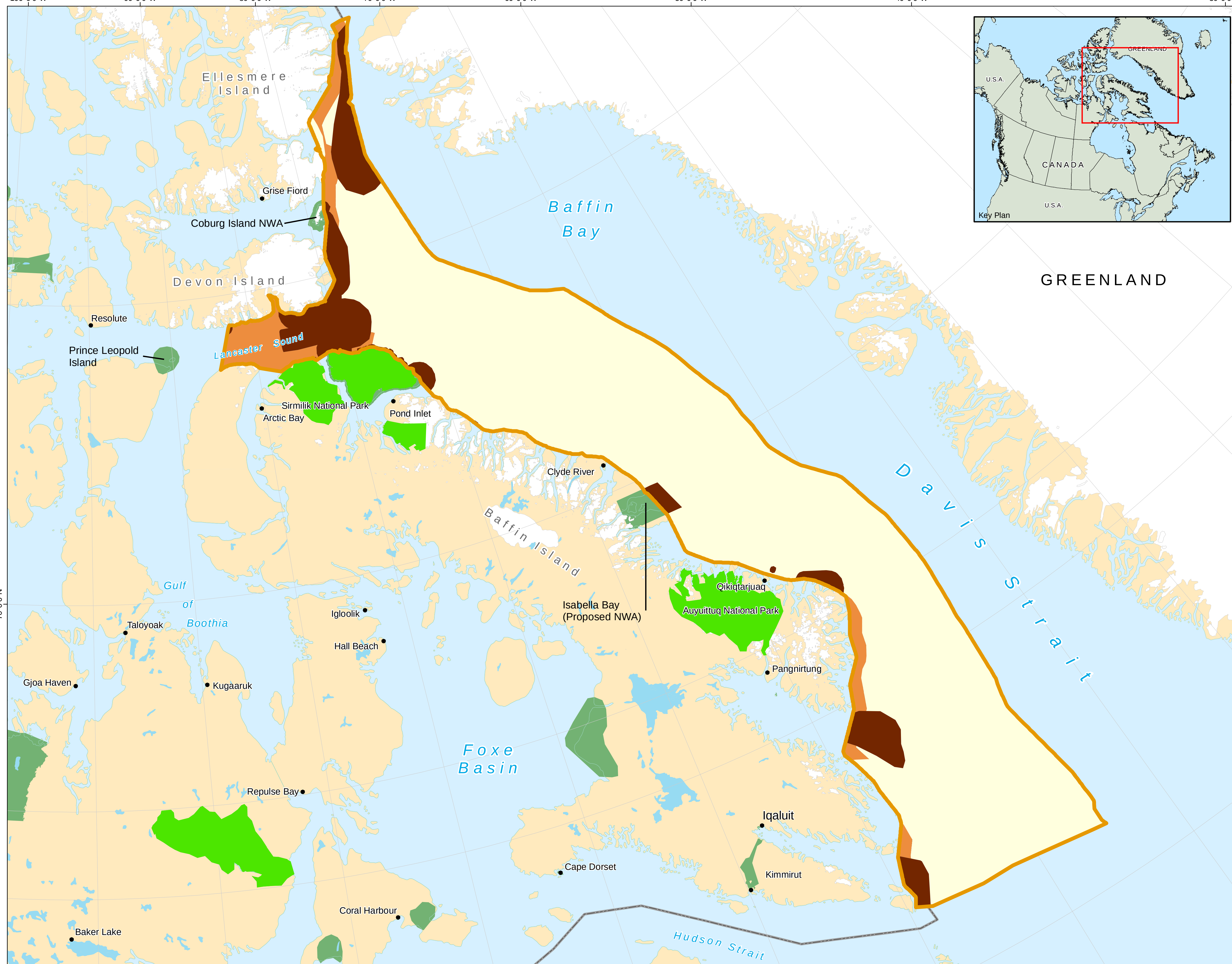
Eastern Arctic, Nunavut, Canada
Migratory Birds
Summer Sensitivity Rating

Fig 4-15



Sensitivity Rating

- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

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50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

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4.5.4 Mitigation

Key mitigation measures limit human disturbance to key areas for migratory birds, particularly for species that congregate in large numbers and/or are "at risk." Mitigation measures include (but are not limited to): (a) placing flight restrictions over bird colonies; (b) adopting measures to reduce the volume, duration and frequency of noise-producing activities; (c) where possible, scheduling activities that may cause disturbance when most birds are absent (e.g., from October to April); (d) when possible, siting activities away from the most sensitive areas for birds; and (e) routing marine traffic to avoid concentrations of birds, especially molting or brood-rearing flocks, where practical.

4.5.5 Data Sources and Certainty

For most bird species in the Eastern Arctic, information on their distribution, abundance, and population trends is limited. Despite these limitations, a number of initiatives have identified key areas for migratory birds. These include priority setting exercises to identify important bird areas (BirdLife International 2008, Internet site), key marine and terrestrial habitat sites for migratory birds (Mallory and Fontaine 2004; Latour, *et al.* 2006), and biological hotspots (Mercier, *et al.* 1994). While information is incomplete, these areas represent key habitat for migratory birds, many of which are highly dependent on the Canadian Arctic for their survival. It is likely that as more information becomes available and conditions change in the Arctic, this list of key areas will evolve. Additional information would also make it easier to distinguish areas at the lower end of the sensitivity scale.

4.5.6 Summary

Migratory birds are of high socio-economic value in Nunavut and are sensitive because they nest in colonies and occur in large congregations. The CWS has identified key marine and terrestrial habitat areas in the Canadian Arctic that are essential to the welfare of various migratory bird species. Routine effects on migratory from oil and gas activities are generally minimal and can often be effectively mitigated. Seabirds can be particularly susceptible to the effects of oil spills.

A rise in sea level due to climate change may damage essential shoreline nesting areas. Increasing temperature may result in increased storm activity which could increase mortality, inhibit nesting effort or destroy eggs and chicks. Climatic changes will affect the habitat of seabirds which may shift their distribution and abundance.

Highly sensitive habitat for migratory birds in the eastern Arctic Study Area includes the North Water polynya, Eastern Jones Sound, eastern Lancaster Sound, Cape Hay, Cape Graham Moore, Cape Searle (Qaqulluit) and Reid Bay (Minarets; Akpait), Cumberland Sound, and Frobisher Bay. Moderate to highly sensitive habitat include biological hotspots identified by CWS (outside of those areas listed above as highly sensitive). Moderately sensitive habitat includes coastal areas, offshore areas to the limit of summer pack-ice, floodplains, upland areas, and areas within the known range migratory birds whose populations are heavily dependent on the Canadian Arctic. Low to moderate sensitivity was given to areas with low to moderate densities of birds including areas which, while not permanently covered in ice, are outside the usual ranges of most migratory birds. Low sensitivity was given to areas that have very limited or no use by migratory birds, which includes areas of permanent ice (the summer extent of pack ice and terrestrial ice caps).

4.6 Species of Conservation Concern

4.6.1 Rationale for Selection

Species of conservation concern often have additional ecological, cultural and/or economic importance. Regulators, Aboriginal groups, and other stakeholders are particularly concerned about species whose populations have been determined to be at risk. For the purposes of this report they are considered species: (a) listed on Schedule 1 of *SARA* (Government of Canada 2002); (b) assessed by COSEWIC as endangered, threatened, or special concern; and/or, (c) categorized by the IUCN as critically endangered, endangered, vulnerable, or near threatened (IUCN 2010). Those species that are included under this VEC are summarized in Table 4-1.

Table 4-1: Marine and Marine Associated Species at Risk in the Eastern Arctic

Species	SARA Status (Schedule 1 or 2)	COSEWIC Status	IUCN Status	Report Reference
Bowhead whale (Eastern Canada-West Greenland populations)	No Status (no Schedule)	Special Concern (COSEWIC 2009)	Least Concern (IUCN 2010 Internet site)	4.2
Polar bear	No Status (No Schedule)	Special Concern (COSEWIC 2008)	Vulnerable (IUCN 2010 Internet site)	4.1
Beluga Whale (Eastern High Arctic – Baffin Bay population)	No Status (No Schedule)	Endangered (COSEWIC 2004a)	Near Threatened (IUCN 2010 Internet site)	4.3
Beluga Whale (Cumberland Sound population)	No Status (No Schedule)	Threatened (COSEWIC 2004a)	Near Threatened (IUCN 2010 Internet site)	4.3
Beluga Whale (Western Hudson Bay population)	No Status (No Schedule)	Endangered (COSEWIC 2004a)	Near Threatened (IUCN 2010 Internet site)	4.3
Ivory gull	Endangered (Schedule 1)	Endangered (COSEWIC 2006b)	Near Threatened (IUCN 2010 Internet site)	4.5, 4.6
Walrus	No Status (No Schedule)	Special Concern (COSEWIC 2006a)	Data Deficient (IUCN 2010 Internet site)	4.6
Narwhal	No Status (No Schedule)	Special Concern (COSEWIC 2004b)	Near Threatened (IUCN 2010 Internet site)	4.3

4.6.2 Species of Conservation Concern Summary

4.6.2.1 Life History

Conservation Status

Polar Bear

See Section 4.1.2.1.

Bowhead Whale

See Section 4.2.2.1.

Beluga

See Section 4.3.2.1.

Narwhal

See Section 4.3.2.1.

Walrus

Walruses traditionally provided important staples in the subsistence economy of the eastern Canadian Arctic and Greenland Inuit (COSEWIC 2006a). The hunt and the sharing of its proceeds continue to be of great social and cultural significance (Richard 2001). The meat is consumed and considered an important source of protein (Hovelsrud ,*et al.* 2008). Walrus ivory is also harvested and sold (COSEWIC 2006a; Hovelsrud, *et al.* 2008). Many communities in Nunavut hunt the walrus (Priest and Usher 2004). Over a five year period from 1996 to 2001 the total annual mean number of walruses taken from hunting was approximately 768 (Priest and Usher 2004).

Walruses are considered to have a major role in the marine ecosystem, strongly influencing productivity and ecological function through predation on benthic invertebrates, disturbance to bottom sediments and facilitating flow of nutrients in the water (Ray, *et al.* 2006). Further, the walrus is taxonomically important as the only living representative of the Family Odobenidae.

Ivory Gull

The Ivory Gull was first designated as Special Concern in 1979, in 2006 it was designated as Endangered by COSEWIC (COSEWIC 2006b) and is listed as Endangered and is on Schedule 1 under SARA. It is considered May Be at Risk in Nunavut on the basis of restricted distribution, small and declining population, and potential sensitivity to disturbance (Government of Nunavut Department of the Environment (Avatiliqiyikkut) 2005, internet site).

The Canadian population of Ivory Gull has declined by 80% over the last 20 years based on Aboriginal Traditional Knowledge and intensive breeding colony surveys over the last four years (COSEWIC 2006b). There are numerous threats to this species including contaminants in food, hunting in Greenland, disturbance at breeding locations and they are subject to climate change from degradation of ice-related foraging habitats.

Distribution

Available data on range and seasonal use of species of conservation concern are summarized in Figure 4-16 (winter) and Figure 4-17 (summer).

Polar Bear

See Section 4.1.2.1.

Bowhead Whale

See Section 4.2.2.1.

Beluga

See Section 4.3.2.1.

Narwhal

See Section 4.3.2.1.

Walrus

The walrus has a discontinuous circumpolar distribution in the Arctic. Within Nunavut, the Atlantic walrus ranges from Bathurst and Prince of Wales islands to Davis Strait and from James Bay to Kane Basin (DFO 2008). Four distinct stocks of Atlantic walrus have been identified in Canada, all reside in Nunavut: South and East Hudson Bay, Hudson Bay—Davis Strait, Foxe Basin and Baffin Bay (Stewart 2002).

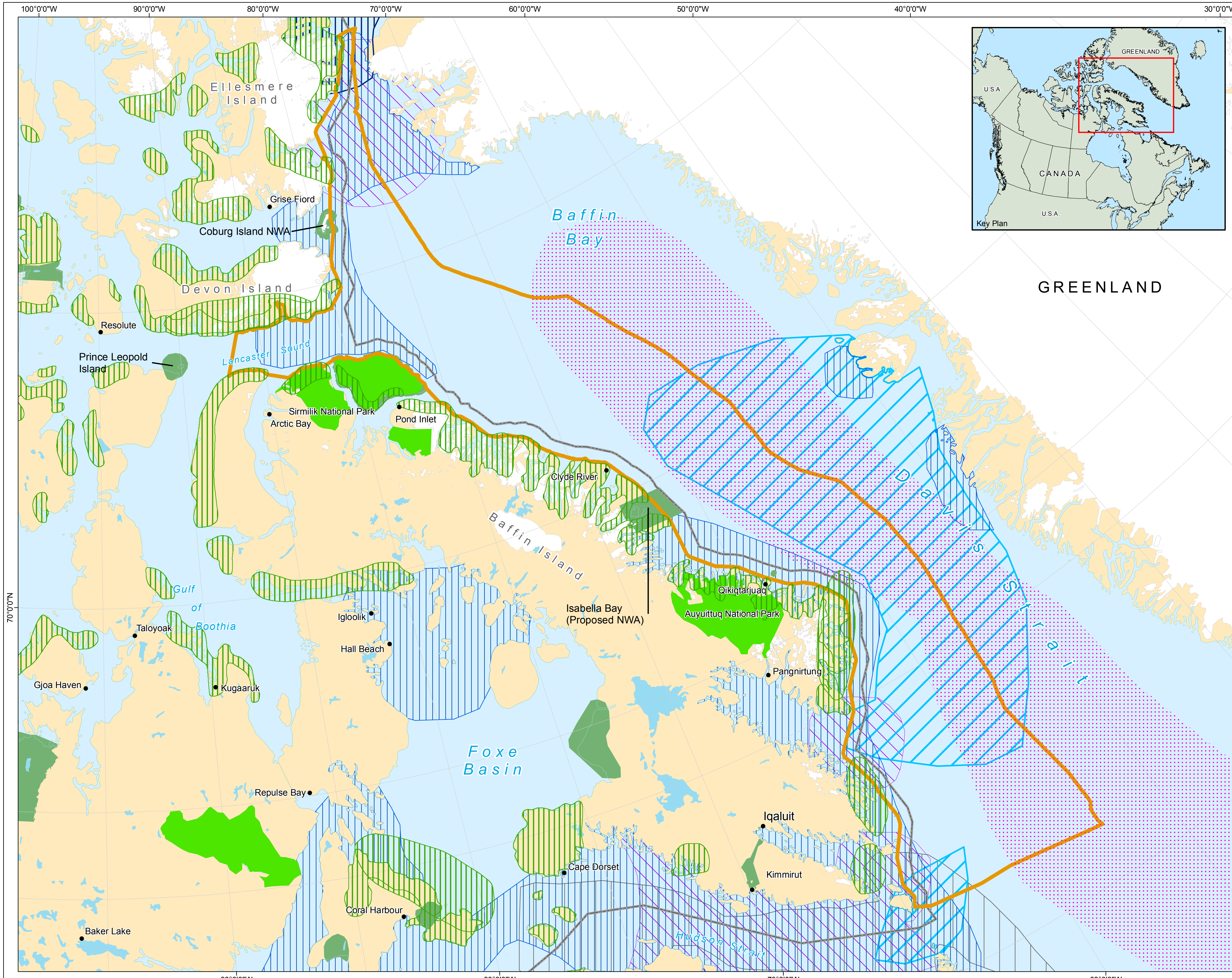
Atlantic walruses are known to occur throughout the year in some parts and only seasonally in other parts of the eastern arctic study area. The Northern Hudson Bay—Davis Strait population is distributed over an area of about 385,000 km^2, from Arviat on the west coast of Hudson Bay north and east through Hudson Strait to Clyde River on the east coast of Baffin Island. Walruses are widely distributed in the relatively shallow waters of northern Foxe Basin, an area of about 50,000 km^2, where they live year-round. The Baffin Bay population is distributed over an area of about 150,000 km^2 that extends west to Bathurst Island, north to Kane Basin and northwest to Greenland (COSEWIC 2006a). This population concentrates year-round at the northwest tip of Devon Island; however; some individuals will migrate through Lancaster Sound during the summer along the coastal waters of southern Devon Island.

Ivory Gull

The Ivory Gull breeding population has a circumpolar, patchy distribution in the Arctic. The Canadian breeding population of Ivory Gull exclusively breeds and nests in the Territory of Nunavut, but accounts for 20 – 30% of the global population (Stenhouse, *et al.* 2004). Breeding colonies are concentrated in approximately 3% of Nunavut around Jones and Lancaster Sounds on southeastern Ellesmere Island, eastern Devon Island, and the Brodeur Peninsula of northern Baffin Island. There is one outlying colony to the west on Seymour Island, off the northern coast of Bathurst Island (SARA 2010). The Inglefield Mountains of Ellesmere Island have consistently supported 30 – 40% of the Canadian Ivory Gull population over the past two decades (Latour, *et al.* 2006), while the importance of the Seymour Island colony has increased over time to a similar level (Gilchrist and

Mallory 2005). Most of the remaining individuals are on the Brodeur Peninsula of Baffin Island, but within the past decade ten colonies near the coast have been abandoned, while only three new ones further inland have been documented (Latour, *et al.* 2006). The Sydkap Ice Field on southern Ellesmere Island was formerly home to a large colony of up to 300 Ivory Gulls, but was abandoned during surveys in 2002 and 2003 (Latour, *et al.* 2006). The colonies on eastern Devon Island were always relatively small, and have also been largely abandoned (Latour, *et al.* 2006).

The wintering population distribution is poorly known but are known to winter within the eastern arctic study area along the southern edge of the pack ice of Davis Strait, the Labrador Sea, the Strait of Belle Island and the northern Gulf of St. Lawrence (COSEWIC 2006b).



Eastern Arctic, Nunavut, Canada Species Of Conservation Concern Winter Distribution

Fig 4-16

Ivory Gull Winter Range [3]
Narwhal Winter Concentration [1]
Polar Bear Denning Area [7,9]
Walrus Winter Distribution [2]
Walrus Winter Concentration Area [7]
Beluga Winter Range [5]
Bowhead Wintering Area [4,6,8]

Base Features

Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

[1]COSEWIC. 2004. Assessment and Update Status Report on the Narwhal Monodon monoceros in Canada. Ottawa. vii + 50p pp. (Canadian Wildlife Service, Environment Canada)
*digitized by Nunami Stantec 2010

[2]COSEWIC. 2006. Assessment and Update Status Report on the Atlantic Walrus Odobenus rosmarus rosmarus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 65pp.
*digitized by Nunami Stantec 2010

[3]COSEWIC. 2006. COSEWIC assessment and update status report on the ivory gull Pagophila eburnea in
Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 42 pp
*digitized by Nunami Stantec 2010

[4]COSEWIC. 2009. COSEWIC assessment and update status report on the bowhead whale Balaena mysticetus, Bering-Chukchi-Beaufort population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp pp
*digitized by Nunami Stantec 2010

[5]DFO. 2002. Beluga. Department of Fisheries and Oceans. Underwater World Series. p.8 pp
*digitized by Nunami Stantec 2010

[6]Dueck, L., S. Ferguson, B. Wheeler, S.P. Luque and M. Gilbert. (in press). Habitat Use By Bowhead Whales of the Eastern Canadian Arctic.
*digitized by Nunami Stantec 2010

[7]Mercier, F., F. Rennie, D. Harvey and C.A. Lewis (Eds.). 1994. Arctic Marine Workshop Proceedings. Winnipeg, Manitoba. Park Establishment Branch, National Parks Directorate, Parks Canada Department of Canadian Heritage.
*digitized by Nunami Stantec 2008

[8]Richard, P.R., J.R. Orr, R. Dietz and L. Dueck. 1998. Sightings of Belugas and other marine mammals in the North Water, late March 1993. Arctic 51:1-4.
*digitized by Nunami Stantec 2010

[9]Urquhart, D.R. and R.E. Schweinsburg. 1984. Polar bear life history and known distribution of polar bear in the Northwest Territories up to 1981. Northwest Terrotories Renewable Resources. Yellowknife NWT. 70 pp
*digitized by Government of Nunavut 2005

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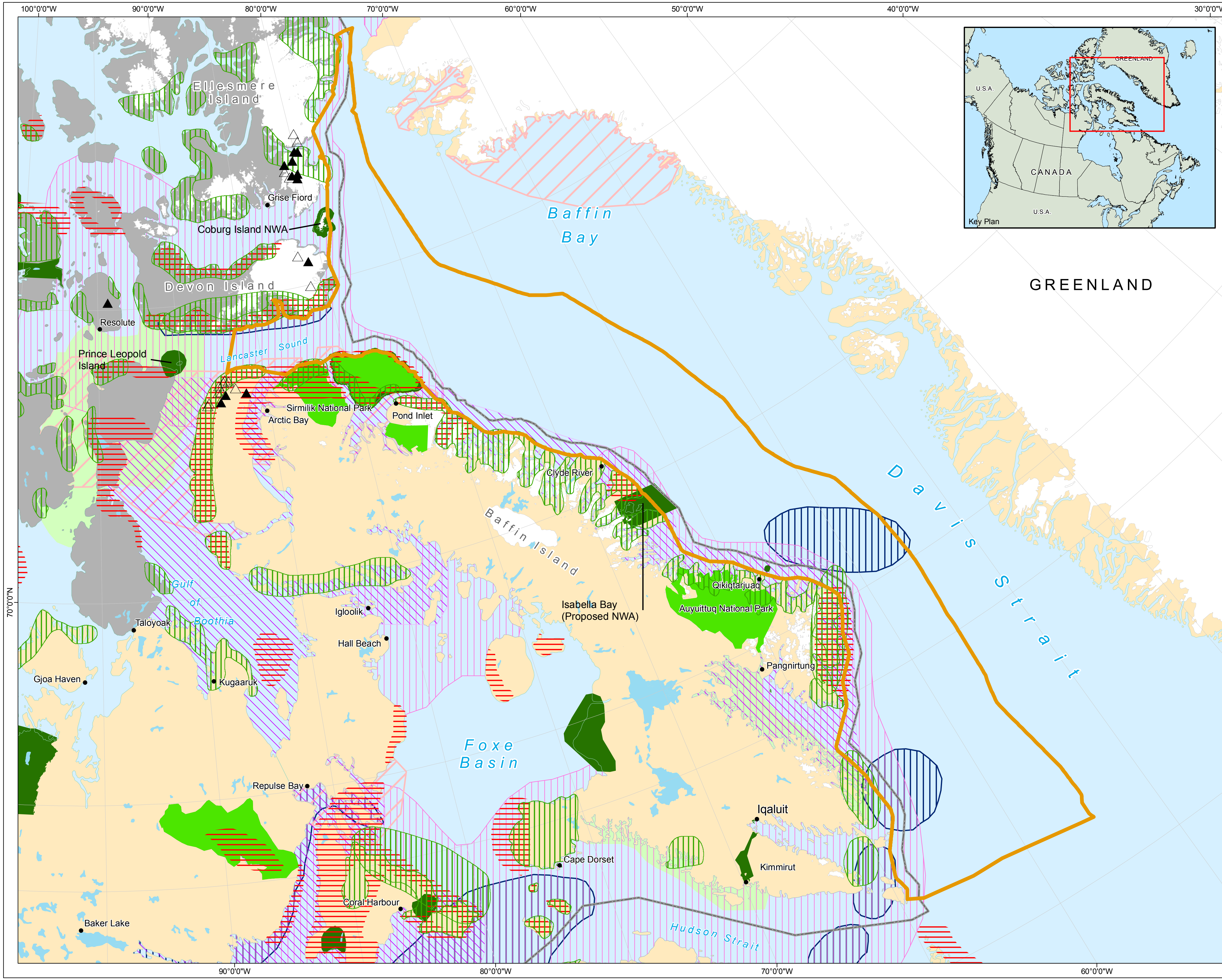
Eastern Arctic, Nunavut, Canada Species Of Conservation Concern Summer Distribution

Fig 4-17



Known Ivory Gull Colony[4]

Potential Ivory Gull Colony[4]

Bowhead Summer Aggregation Areas[5]

Polar Bear Denning Area[7,8]

Polar Bear Summer Retreat[7]

Narwhal Summer Concentrations[2]

Peary Caribou Range

Walrus Summer Distribution[3]

Walrus Summer Concentration Area[7]

Beluga Summer Core Area[1,6]

Base Features

Community

Grid Line

Ice Cap

Eastern Arctic Study Area

Nunavut Regional Boundary

Conservation Area

National Park

Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

[1]COSEWIC. 2004. COSEWIC assessment and update status report on the beluga whale, Delphinapterus leucas, in Canada. Ottawa. ix + 70 pp. (Canadian Wildlife Service, Environment Canada)
*digitized by Nunami Stantec 2010

[2]COSEWIC. 2004. Assessment and Update Status Report on the Narwhal Monodon monoceros in Canada. Ottawa. vii + 50p pp. (Canadian Wildlife Service, Environment Canada)
*digitized by Nunami Stantec 2010

[3]COSEWIC. 2006. Assessment and Update Status Report on the Atlantic Walrus Odobenus rosmarus rosmarus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 65pp.
*digitized by Nunami Stantec 2010

[4]COSEWIC. 2006. COSEWIC assessment and update status report on the ivory gull Pagophila eburnea in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vi + 42 pp
*digitized by Nunami Stantec 2010

[5]COSEWIC. 2009. COSEWIC assessment and update status report on the bowhead whale Balaena mysticetus, Bering-Chukchi-Beaufort population and Eastern Canada-West Greenland population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 49 pp pp
*digitized by Nunami Stantec 2010

[6]DFO. 2002. Beluga. Department of Fisheries and Oceans. Underwater World Series. p.8 pp
*digitized by Nunami Stantec 2010

[7]Mercier, F., F. Rennie, D. Harvey and C.A. Lewis (Eds.). 1994. Arctic Marine Workshop Proceedings. Winnipeg, Manitoba. Park Establishment Branch, National Parks Directorate, Parks Canada Department of Canadian Heritage.
*digitized by Nunami Stantec 2008

[8]Urquhart, D.R. and R.E. Schweinsburg. 1984. Polar bear life history and known distribution of polar bear in the Northwest Territories up to 1981. Northwest Terrotories Renewable Resources. Yellowknife NWT. 70 pp
*digitized by Government of Nunavut 2005

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Figure ID: 123110162-021

Ecology

Polar Bear

See Section 4.1.2.1.

Bowhead Whale

See Section 4.2.2.1.

Beluga

See Section 4.3.2.1.

Narwhal

See Section 4.3.2.1.

Walrus

Atlantic walruses require large areas of shallow water (80 m or less) with bottom substrates that support productive bivalve communities, open water and suitable ice or land nearby upon which to haul-out (COSEWIC 2006a).

In winter, walruses are found near the floe-edge and use their head and tusks to create breathing holes in the young ice (Richard 2001). The rest of the year, they often gather in large herds and are associated with moving pack-ice (Richard 2001). In the high Arctic walruses will winter in the polynyas (Richard 2001). When ice is lacking in summer and fall they tend to congregate on land in a few predictable haul-out locations (Appendix B, Figure 4-1.4) (COSEWIC 2006a). The largest haul-out sites in Nunavut are located on the northwest shores of Coats Island, Bencas Island and Walrus Islands of Hudson Bay (Richard 2001). Suitable land habitat is defined by low, rocky shores with steep or shelving subtidal zones where animals have easy access to the ocean for feeding activities or for escape. Walruses generally move to more sheltered areas when there are strong onshore winds and heavy seas (Mansfield 1959).

Walruses are known to travel long distances by swimming or by riding ice floes but their seasonal movements are not well understood. They feed predominantly on bivalve mollusks and arctic cod; however, gastropod mollusks, sea cucumbers, sea urchins, polychaete worms, amphipod and isopod crustacean, brachiopods and prialupids have also been found in stomach contents (COSEWIC 2006a). Little is known of their physiological requirements or ability to adapt to changes in food availability or environmental conditions.

Walruses are polygynous[2]. Males compete intensely for females from February through April. Implantation of the embryo is delayed until late June or early July, and gestation is about 11 months (COSEWIC 2006a). Most young are born in late may and early June and suckle for 25 – 27 months (COSEWIC 2006a). Females mature between the ages of 5 – 10 years and give birth to a single calf about once every three years (COSEWIC 2006a). Walruses have a lifespan of approximately 35 years (Richard 2001).

[2] Males mate with more than one female

Ivory Gull

Ivory Gulls have very restrictive requirements for breeding sites, primarily isolation from terrestrial predators (particularly the Arctic Fox, *Alopex lagopus*) that are located near marine waters that are partially free of ice in late May and early June. They can be found nesting on flat terrain or on cliffs several hundred meters above the ice sheets (SARA 2010). Most nests are located within 100 km of nearby polynyas and/or recurring leads (COSEWIC 2006b). Most nest sites on Ellesmere and southeast Devon Island are on granite nunataks 20 – 50 km inland, while on west Devon, Baffin, Cornwallis, and Somerset Islands, the colonies are 20 – 40 km inland on large barren limestone plateaus where the lack of vegetation in turn results in an absence of lemmings and foxes (Gilbert and Nancekivell 1982; COSEWIC 2006b). They begin to breed after their second year, laying one or two eggs per clutch (COSEWIC 2006b). Both parents incubate the eggs alternately for about 25 days. The survival of the young chicks is dependent on weather conditions, predation and human disturbance (SARA 2010).

Very little is known about the ecology and behaviour of the Ivory Gull outside the breeding colonies. They appear to occasionally form small groups of 20 to 30 but more often are relatively solitary (SARA 2010). They are known to remain close to the pack ice or close to polynyas, scavenging on carrion on the ice (COSEWIC 2006c).

4.6.2.2 Key Habitat

Polar Bear

See Section 4.1.2.2.

Bowhead Whale

See Section 4.2.2.2.

Beluga

See Section 4.3.2.2.

Narwhal

See Section 4.3.2.2.

Walrus

Walruses predominantly rely on sea ice and shallow water habitat; however, during the summer and fall months they tend to congregate and haul-out on land in a few predictable locations, typically situated on low, rocky shores. This seasonal terrestrial use should be considered during land-use planning.

Land and marine based conservation for this species should focus on areas where it is found to haul-out in large numbers. See Figure 4-17 for locations of summer concentrations which relates to haul-out areas and essential habitat for this species.

Some walrus haul-out habitat is currently protected under land managed by the Government of Canada and includes:

- Polar Bear Pass, National Wildlife Area
- Nirjutiqavvik National Wildlife Area, Coburg Island
- Bylot Island Migratory Birds Sanctuary, Wallaston Islands
- East Bay Bird Sanctuary, Southampton Island
- Bowman Bay Wildlife Sanctuary, Baffin Island
- Northeast coast Bathurst Island, proposed National Park.

These conservation areas provide little and only temporary protection for this species.

Ivory Gull

The Ivory Gull requires nesting sites that are free from predators and in proximity to early season open water areas for foraging. These requirements greatly restrict the possible breeding locations of Ivory Gulls in the Canadian Arctic. For example, much of the western arctic and Ellesmere Island are unsuitable for nesting because during the breeding season (late May–early June), there is no ice-free ocean regularly available. In addition, vegetation and therefore arctic fox persists in these areas (COSEWIC 2006b).

Two predominant habitat types are consistently used for breeding locations. The first type is represented by the southeast of Ellesmere and Devon Islands provides sheer granite cliffs amidst glacial terrain. These sheer cliffs eliminate predation by arctic foxes and are too far inland and so high that avian predators are likely few (COSEWIC 2006b). The second type is the vast vegetation-free gravel limestone plateaus on the Brodeur Peninsula of Baffin Island, parts of Cornwallis Island, west of Devon Island, and northeast Somerset Island (COSEWIC 2006b). Because these plateaus lack vegetation, the arctic fox is absent from these areas. Their location far inland lowers the probability of predation by arctic fox or polar bear that are foraging along the coast (COSEWIC 2006b). Other parts of the Canadian Arctic offer similar nesting habitat, but appear unsuitable as they are over 100 km from polynyas, which provide critical foraging habitat for Ivory Gull during the early part of the breeding season (COSEWIC 2006b).

4.6.2.3 Sustainability Factors

Polar Bear

See Section 4.1.2.3.

Bowhead Whale

See Section 4.2.2.3.

Beluga

See Section 4.3.2.3.

Narwhal

See Section 4.3.2.3.

Walrus

Atlantic walrus populations in Canada may be limited or threatened by environmental contamination, hunting, offshore oil and gas activities, shipping, commercial fisheries and climate change (Huntington in press). Their preferred shallow coastal habitat and restricted seasonal distribution make walruses relatively easy to hunt and vulnerable to environmental changes.

Analysis of walrus tissue detected contaminants such as lead, mercury, cadmium, nickel, cobalt, copper, strontium, Dichloro-Diphenyl-Trichloroethane (DDT) and Polychlorinated biphenyls (PCBs) prove that contaminants can accumulate in walrus tissue; however, the effects of environmental contamination are unknown (Wiig, *et al.* 2000).

Ivory Gull

Several threats to the Ivory Gull population have been recognized. Mercury concentrations in Ivory Gulls on Seymour Island have increased steadily since 1976, to the point that five of six eggs tested in 2004 met or exceeded the threshold believed to impair reproductive success (COSEWIC 2006b). Illegal shooting of adults in Greenland has accounted for the vast majority (81%) of band recoveries (Stenhouse, *et al.* 2004). Research is inconclusive regarding the sensitivity of Ivory Gulls to disturbance while breeding. While some accounts reported a high sensitivity to disturbance by air and ground traffic near breeding colonies, numerous other reports suggest Ivory Gulls may be more tolerant of disturbance than other seabirds (COSEWIC 2006b). Further research is required to determine the Ivory Gull's sensitivity to anthropogenic factors.

Ivory Gulls typically produce a clutch size of two eggs compared with the more typical 3-egg clutch seen in most other gulls, suggesting a relatively low productivity rate (COSEWIC 2006b). Additionally some colonies have shown intermittent breeding and failed to produce young in some years. Predation and human disturbance may also influence productivity at the breeding colonies (COSEWIC 2006b).

Ivory Gulls are at particular risk of mortality due to hunting. While Canadian Inuit are permitted to harvest some gulls, most of the hunting is occurring in Greenland during spring and fall migration (COSEWIC 2006b).

4.6.2.4 Susceptibility to Oil and Gas Activities

Polar Bear

See Section 4.1.2.4.

Bowhead Whale

See Section 4.2.2.4.

Beluga

See Section 4.3.2.4.

Narwhal

See Section 4.3.2.4.

Walrus

Disturbances (i.e., noise, vessel or human activity) may induce haul-out clearing and stampedes. This effect may cause mortality, increased expended energy (especially in calves), communication masking, change in thermoregulation and increased stress (COSEWIC 2006a). Prolonged or repeated disturbances may cause walruses to abandon their haul-outs (Mansfield and St. Aubin 1991; Richardson, *et al.* 1995).

At present levels of industrial activity, potential threats to walruses are low. Ship noise and oil and gas exploration could displace walruses from their haul-outs and interfere with their communication (Stewart 2002).

Ivory Gull

Industrial activities are a threat to the nesting areas of Ivory Gulls on the Brodeur Peninsula, Baffin Island. In addition to the physical and sensory disturbance associated with human activities, they may attract previously scarce or absent mammalian and avian predators that will also prey on other local sources of food including gull colonies (COSEWIC 2006b).

All seabirds, in particular gulls, are considered to be highly vulnerable to oil pollution. The Ivory Gull may be particularly susceptible to an oil spill since it is a more pelagic species than most other seabirds. Oiled Ivory Gulls have not been documented, but since they are often far offshore they would not be expected to be able to reach land or be recovered and so are considered at high risk from oil pollution (COSEWIC 2006b).

4.6.2.5 Potential Effects of Climate Change on Species of Conservation Concern

Polar Bear

See Section 4.1.2.5.

Bowhead Whale

See Section 4.2.2.5.

Beluga

See Section 4.3.2.5.

Narwhal

See Section 4.3.2.5.

Walrus

It is possible that direct effects of climatic warming or cooling on walruses are likely limited and not necessarily negative (Moore and Huntington 2008). Born, *et al.* (2003) hypothesized that a decrease in the extent and duration of Arctic sea ice in response to warming might increase food availability for walruses by increasing bivalve production and improving access to feeding areas in shallow inshore waters (COSEWIC 2006a). Others have suggested that walrus populations will decline in recruitment and body condition as a result of climate change because they rely on sea ice as a platform for hunting, breeding, and resting (Moore and Huntington 2008). Laidre, *et al.* (2008) demonstrated that walrus fitness was positively correlated to sea ice. As well, North American Marine Mammal Commission (NAMMCO) (2006) noted that hunting pressure on walruses will likely increase as the amount and duration of ice cover in the Arctic declines (COSEWIC 2006a). Predation by killer whales and polar bears may also increase in the absence of ice as walrus are forced to use terrestrial sites (COSEWIC 2006a).

The indirect effects of climate change may pose a greater threat to walruses than the change itself. In the event of warming, human populations in the north might increase and expand into previously unpopulated areas; in the event of cooling, walruses may be forced southward closer to existing communities (COSEWIC 2006a).

Ivory Gull

Climate change may also have an impact on Ivory Gull depending on how it affects the distribution of open water early in the breeding season (COSEWIC 2006b). Because the Ivory Gull is associated with pack ice year-round an increase in the extent or thickness of ice cover would reduce their foraging capabilities and have potential effects on reproductive productivity. Alternatively, a decrease in ice cover or thickness may increase available habitat for foraging and have a positive effect on reproductive productivity in the breeding season (COSEWIC 2006b).

4.6.3 Sensitivity Ranking

Sensitivity ranking for species of conservation concern is based on the presence or absence of populations, colonies or important seasonal habitat of any species identified as sensitive by COSEWIC, SARA, or IUCN. Sensitivity ratings are presented in Figure 4-18 (winter) and Figure 4-19 (summer).

High Sensitivity (5)

A rating of high sensitivity indicates that these areas are identified as ‘Critical Habitat Areas’ as legally defined under the *Species at Risk Act* and represent critically important habitats to the survival of at least one of the species included in this VEC. No such areas have been identified in the study area.

A rating of high sensitivity also represents areas that overlap with the range of any species classified as ‘critically endangered’ by the IUCN.

Moderate/High Sensitivity (4)

A rating of moderate/high sensitivity represents areas that overlap with the range of any species identified as endangered under SARA, COSEWIC or IUCN.

Moderate Sensitivity (3)

A rating of moderate sensitivity represents areas that overlap with the range of any species identified as 'Threatened' under SARA or COSEWIC or 'Vulnerable' under IUCN.

Low/Moderate Sensitivity (2)

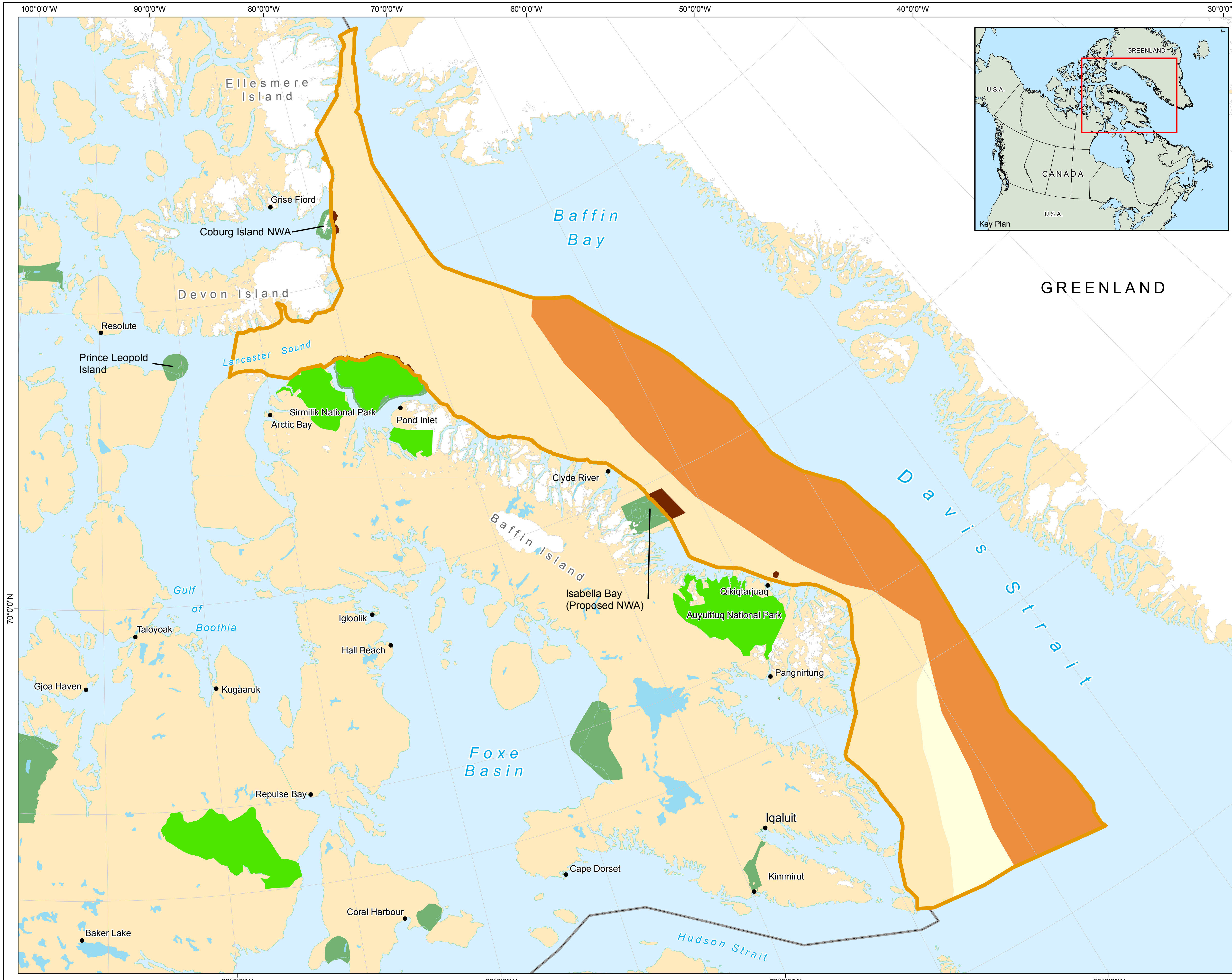
A rating of low/moderate sensitivity represents areas that overlap with the range of any species Identified as 'Special Concern' under SARA or COSEWIC or 'Near Threatened' under IUCN.

Low Sensitivity (1)

A rating of low sensitivity represents areas that overlap with the range of any species Identified as 'data deficient' under SARA, COSEWIC or IUCN or 'least concern' under IUCN, or areas where no species of conservation concern are known to inhabit.

Eastern Arctic, Nunavut, Canada Species Of Conservation Concern Winter Sensitivity Rating

Fig 4-18



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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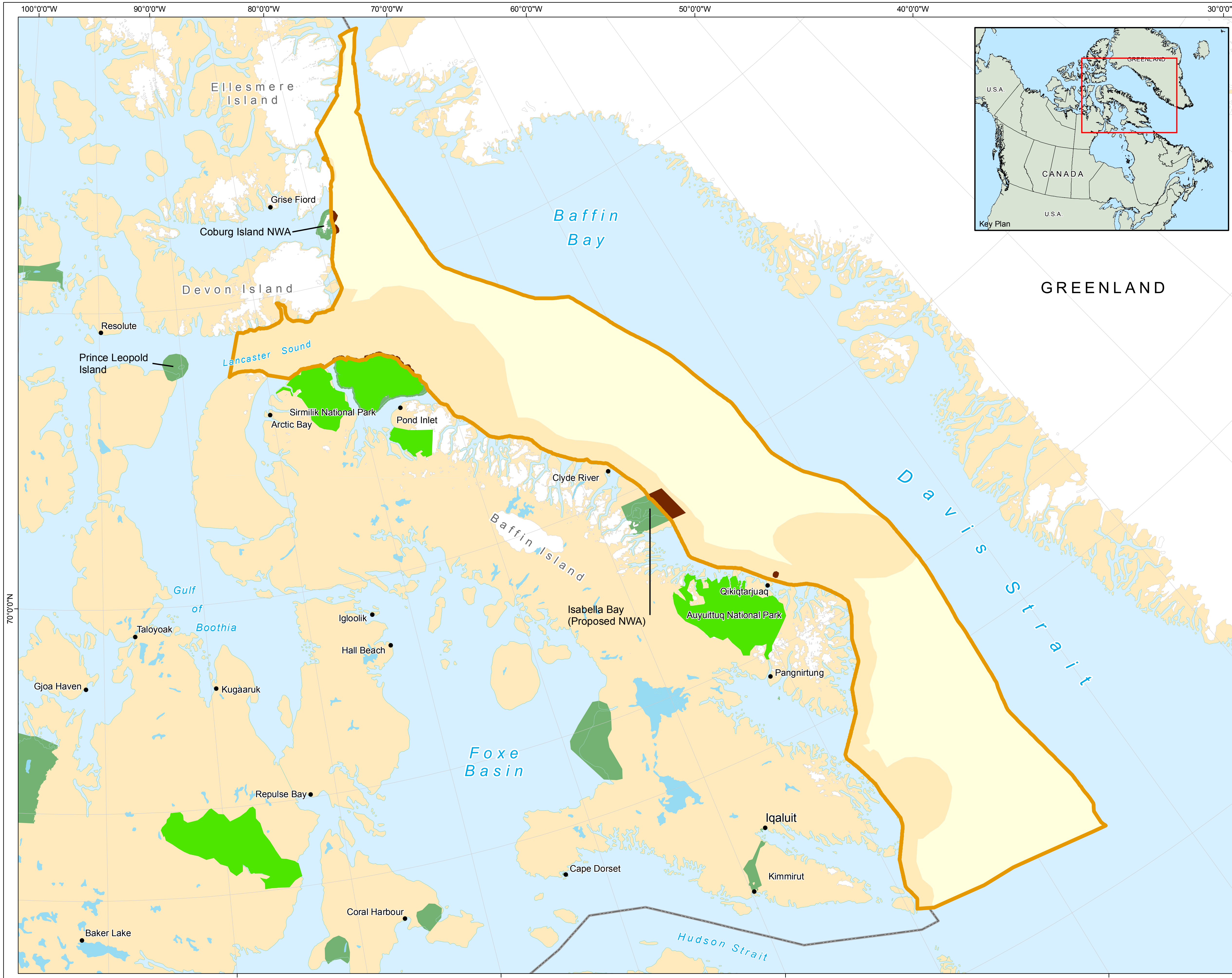

Eastern Arctic, Nunavut, Canada Species Of Conservation Concern Summer Sensitivity Rating

Fig 4-19

Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References:

1. Department of Environment, Government of Nunavut
2. Freshwater Institute
3. Dept. of Env. Gov of Nunavut, 1987

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4.6.4 Mitigation

Species specific mitigation strategies are summarized in Sections 4.1.4 (polar bear), 4.2.4 (bowhead whale), 4.3.4 (beluga and narwhal), and 4.5.4 (ivory gull). Additional mitigation required for walrus include vessel speed restrictions, noise restrictions, and minimum aircraft altitude restrictions around known haul-out sites.

As with most species in the Arctic, knowledge on sensitive, and biologically important habitat, is at a very coarse level (commensurate with few studies). Implementation of dedicated surveys for these animals prior to potential contact with industry will assist proponents and government to more confidently plan and approve project implementation.

4.6.5 Data Sources and Certainty

All data collected for the development of sensitivity layers for species of conservation concern was based on the most recent available government or COSEWIC documents. As previously mentioned, arctic species dependence on sea ice habitat translates into inherent uncertainty in the long term accuracy of the current information.

4.6.6 Summary

Species of conservation concern often have additional ecological, cultural and/or economic importance. There are six species of conservation concern with ranges that overlap with the Eastern Arctic Study area. Moderate to high sensitivity areas for species of conservation concern are in central Davis Strait and Baffin Bay where ivory gulls overwinter. Low to moderate sensitivity rating was given to areas where walrus concentrate in the summer; and marine and sea ice habitat where polar bears, bowhead whale, narwhal, and beluga whale are distributed.

4.7 Traditional Harvesting

4.7.1 Rationale for Selection

Traditional harvesting is of significant social, cultural and economic value to the Inuit in the study area. Marine and terrestrial wildlife have provided food and clothing and materials for tools, arts and crafts for Inuit and their ancestors for thousands of years and continue to do so (NPC 2000). The availability of traditionally harvested foods lowers the demand for imported food which is both costly and often less nutritious. Additionally, traditional harvesting and subsequent distribution and use of the harvest provide important opportunities to maintain and enhance Inuit culture.

4.7.2 Traditional Harvesting Summary

4.7.2.1 Background

Inuit have survived for generations on food and materials provided through subsistence harvesting. According to the 2001 Aboriginal Peoples Survey, approximately seven out of ten Inuit still participate in traditional harvesting across Inuit regions (Buell 2006). In Nunavut, the replacement cost of food obtained from traditional harvesting is estimated to be $30 million per year (Sivummut Economic Development Strategy Group 2003). Year-round, staple-food sources include caribou, seal and Arctic char. In the spring, harvesters are able to travel to the floe edge and shore leads to harvest seal, beluga, narwhal and polar bears (Nunavut Planning Commission 2000). Items such as sealskins can provide clothing and are an important resource for Nunavut's arts and crafts industry (Sivummut Economic Development Strategy Group 2003). Further details of harvesting activities within the study area, including the timing of activities, can be found in Section 4.7.2.2.

The following is a list of the main species which are harvested in the Eastern Arctic study area:

- Polar Bear
- Ringed Seal
- Bearded Seal
- Seabirds and their eggs
- Eider duck
- Caribou
- Muskox
- Walrus
- Narwhal
- Beluga
- Arctic Foxes.

4.7.2.2 Description of Traditional Harvesting Activities by Community Area

Information outlining specific harvesting locations is limited. The Nunavut Wildlife Harvest Study provides information about the number of harvesters and harvested species in Nunavut over the five year period between 1996 and 2001; however, the locations of harvest are not available. The Nunavut Atlas (Riewe 1992) provides information on important wildlife areas and harvesting locations for each community in Nunavut (Figure 4-20 and Figure 4-21). The information in the Nunavut Atlas is dated; however, it is the most comprehensive record of harvesting areas currently available for Nunavut. Additionally, while the NBRLUP illustrates important areas for wildlife and harvesting, it does not provide detailed information on harvesting locations within the study area. Accordingly, the following summary of traditional harvesting in the study area relies on information from the Nunavut Atlas (Riewe 1992). For a summary of this information, see Table 4-2.

The Nunavut Atlas (Riewe 1992) provides the following definitions for Inuit land use intensities:

- **High Intensity** – areas used every year
- **Medium intensity** – areas used (within the last 30 years), but not necessarily used every year
- **Low intensity** – areas used prior to 1960, but rarely used by hunters in 1987.

Devon East (East side of Devon Island and Lancaster Sound)

Coburg Island is used by Grise Fjord residents to hunt thick-billed murres and other seabirds and to collect their eggs. They travel there by a combination of snowmobile and boat. There are several campsites present on Coburg Island, an area which has an Inuit land use intensity rating of high.

There are major snowmobile travel routes from Croher Bay south into Lancaster Sound and then east towards Baffin Bay. These snowmobile routes are used in winter and spring by Arctic Bay hunters travelling to the south-eastern Devon Island area where they hunt Muskox and marine mammals. Several campsites exist in the area which has a high rating of Inuit land use intensity. Arctic Bay hunters are also reported to hunt polar bear, narwhal, walrus and seal in the Lancaster Sound area in the late winter and spring periods. Narwhals are taken at the floe edge in spring. At the time that the Nunavut Atlas was produced, hunters had been able to hunt polar bears in the south-eastern Devon Island area.

Admiralty Inlet (for southern portion of Lancaster Sound)

There are several camping sites present along the southern portion of Lancaster Sound, an area which is rated as high Inuit land use intensity. Hunters from Arctic Bay use this area for hunting ringed and bearded seals. In the winter, ringed seals are taken at breathing holes in the ice, but in spring, they are hunted when basking on the ice. Bearded seals are hunted mostly in late spring at the floe edge or in open water during the summer. Inuit from Arctic Bay and Pond Inlet use the northern coasts of Borden Peninsula and Navy Board Inlet for seal hunting in open water during the summer and at floe edges in the late spring. Residents of Pond Inlet hunt walrus in late spring at the floe edges and during summer in the open water or at haul-out sites such as the Wollaston Islands. In the spring and summer, narwhals are hunted in Navy Board Inlet and in southern Lancaster Sound.

Pond Inlet

The area along the coast of Bylot Island and Baffin Island has many camping sites and few fishing sites. There is a major travel route along the coast of Bylot Island, as well as along the coastline of Baffin Island. The Inuit land use intensity directly along the coastline is rated as high. The area further out into Baffin Bay has an Inuit land use intensity rating of medium.

The coastal areas of Bylot Island are an important area for polar bears. This area is reported as the north-eastern limit of travel for Pond Inlet hunters. Seal and narwhal are hunted south of Cape Walter Bathurst. Walrus hunting occurs throughout the entire coastal area in the winter.

Inuit from Pond Inlet hunt ringed and bearded seals intensely year-round in all marine areas along Baffin Bay. The marine area by southeast Bylot Island and Guys Bight, Erik Harbour is where duck hunting occurs.

The offshore area of fast ice in Baffin Bay is used for polar bear and seal hunting in some years. This is especially the case in March – April when a combination of grounded icebergs and reduced current allow for the growth of new fast ice.

Clyde River

There are major travel routes along the coastline of Baffin Island with the Inuit land use intensity of this area, which extends into Baffin Bay, rated as high. There are snowmobile and dog team travel routes between Pond Inlet and Clyde River. Several campsites are located along the coastline and offshore in Baffin Bay, as well fishing sites in various locations along the coast. The marine area, including all adjacent fjords, bays and inlets, is reported to be used intensively by Clyde River hunters for polar bears, ringed seals, and bearded seals on the fast ice and at the floe edge from December through June. In Eglinton Fjord and at the mouth of Clyde Inlet, seals are hunted in fall and winter. Cape Christian is a popular sealing area. In Sam Ford Fjord and Scott Inlet, ringed seal pups are hunted in spring. Harp seals are harvested in Clyde Inlet during the summer. The area off the mouth of Clyde Inlet is used year round. During the summer, narwhals as well as some belugas are hunted in this area. In the summer and fall, Eider ducks are hunted in Inugsuin Fjord.

Home Bay

Continuing south along the coast of Baffin Island, the area of Home Bay is also rated as having a high level of Inuit land use. There are various major travel routes in this area, as well as several camping sites. The marine area east of Isabella Bay is intensively used by Clyde River hunters who hunt ringed and bearded seals as well as polar bears during the winter and spring, especially in Isabella Bay. Along the coasts of Isabella Bay and its islands, Arctic foxes are trapped. During summer and fall, narwhals and harp seals are hunted in Clyde Inlet and Inugsuin Fjord. The northern part of Home Bay and the adjacent fjords are used to hunt ringed seals and polar bears during winter and spring. Alexander Bay is noted as a favoured location for hunting polar bears, and is also where walrus are hunted in the spring.

Qikiqtarjuaq hunters use Home Bay for ringed seal hunting, especially during the spring. In Ekalugad and Pitchforth fjords, they hunt narwhals during the summer. In the mouth of Alexander Bay, they also hunt walrus, narwhals, harp and bearded seals. Narwhals are pursued at the floe edge in spring and early summer and close to Cape Hooper. Polar bears are hunted throughout the area to the southeast of Cape Hooper during winter and spring. Eider duck and Arctic tern eggs are collected on many of the small outer islands in Home Bay during the summer.

Cape Dyer

There are major travel routes along the coast of Baffin Island, as well as many camping sites. There are also several fishing sites present. This area has a high rating of Inuit land use intensity. Qikiqtarjuaq Inuit hunt in the marine area for marine mammals year round. The fjords, inlets and bays from Broughton Island to Cape Dyer are used intensively year round for hunting ringed seals and during the summer for hunting harp seal and bearded seal. Polar bears are hunted over this entire area during winter and spring and walrus are hunted early during the summer with the breakup of fast ice. During the spring, waterfowl (especially eiders and murres) are harvested at the floe edge and during open water season they are hunted in the fjords. During late summer, fishing for Arctic char occurs in several of the fjords, especially Padle Fjord. East of Broughton Island, narwhals and ringed seals are hunted during spring at the floe edge and in Merchants Bay, Padle Fjord, around

Broughton Island and near Paugnang Island during the summer. In Padle Fjord, Belugas are sometimes hunted during the summer and in the spring at the floe edge. Exeter Sound and Bay are used by Pangnirtung and Qikiqtarjuaq residents to hunt ringed seals each winter and spring.

Hoare Bay

The Hoare Bay area has a high level of Inuit land use. There are several camping sites and fishing sites along the coast of the Cumberland Peninsula of Baffin Island. These hunters hunt ringed seal and walrus in the Hoare Bay area during winter, spring and summer.

Hoare Bay is used infrequently by hunters from Qikiqtarjuaq

Cumberland Sound

There are several major travel routes present in the area, as well as several campsites and fishing sites. At the mouth of Cumberland Sound, the intensity of Inuit land use has been rated as medium. For the rest of the area, the land use intensity has been rated as high.

Pangnirtung hunters occasionally hunt marine mammals in the offshore area at the mouth of Cumberland Sound.

Some caribou are hunted along the Cumberland Peninsula of Baffin Island. Along the travel routes in this area, from the Ujuktuk Fjord-Kumlein Fjord area, polar bears are occasionally hunted.

Along the east and west coasts of Cumberland Sound as well as amongst the Leybourne Islands, polar bears are hunted in winter.

Walrus are hunted in the Lemieux Islands area during summer.

In Cumberland Sound, part of the Pangnirtung hunter's annual quota of 40 narwhals is taken, as well as about 50 belugas. They also hunt ringed seals and harp seals in this area.

Domestic Arctic char fisheries occur in many coastal areas of Cumberland Sound.

Resolution Island

The intensity of Inuit land use for Resolution Island, as well as the coastline and part of the Davis Strait is rated as high. There are several campsites and fishing sites present on Resolution Island. There are also major travel routes in the area.

Iqaluit hunters use the area just north of Resolution Island (Edgell Island) to hunt harbour seals, although they are quite uncommon in this region. This is often done in conjunction with waterfowl hunting during the summer. Common eiders and other waterfowl as well as their eggs are taken in Gabriel and Graves Straits. Hunting camps are set up in the summer on the northern portion of Resolution Island, Lower Savage Island, and Edgell Island. Both Iqaluit and Kimmirut hunters have historically hunted ringed, bearded, harp and sometimes hooded seals on the coastal area adjacent to Meta Incognita Peninsula, including Annapolis and northern Gabriel Straits.

Kimmirut residents hunt caribou and polar bears at Meta Incognita Peninsula and the adjacent coastal waters.

The southern portion of Resolution Island and further out into the Davis Strait is not used for traditional harvesting.

Frobisher Bay

This area has several camping and fishing sites as well as many major travel routes. It is rated as having a high intensity level of Inuit land use.

The portion of the Davis Strait along the coast of Lemieux Islands was used by members of the Allen Island Outpost Camp for ringed, bearded, and harp seal hunting throughout the year. Iqaluit and Pangnirtung hunters also use this portion of the Davis Strait for polar bear hunting.

Iqaluit hunters have used the eastern half of Beekman Peninsula and both Brevoort and Lemieux Islands for caribou and polar bear hunting. Pangnirtung hunters harvest seals, caribou and walrus in the vicinity of the Lemieux islands.

Previously, there were two families reported as living year round at the Allen Island Outpost Camp, trapping Arctic foxes, hunting waterfowl and fishing for Arctic Char for domestic use close to the camp. Walrus are hunted year round in this area, the annual take for which is around 100. Ringed seals are hunted year round, while bearded (hunted on the north and east coast of Loks Land) and harp seals are hunted mostly during the summer. Common Eiders and other waterfowl are also hunted off of Loks Land. Iqaluit residents hunt for harbour seals at Cyrus Field Bay, Lupton Channel, Beare Sound, and the north-west and east coasts of Lok Lands in conjunction with waterfowl hunting.

During the summer, caribou and wolf hunting by Iqaluit hunters takes place in the coastal region of Hall Peninsula and Blunt Peninsula. On Loks Land during the summer, caribou are occasionally hunted. This area has been used for hunting caribou, waterfowl, Arctic foxes and for Arctic Char fishing.

During summer, waterfowl hunting as well as egg gathering occurs in Kendall Strait and near Gross and Potter Islands. Although fairly uncommon, when harbour seals are seen here during the summer, they are harvested. South from Frobisher Bay including the areas adjacent to Potter, Gross, and Palmer islands, hunting for ringed, bearded, harp and occasionally hood seal and walrus takes place. Residents of Lake Harbour use this area occasionally for caribou and seal hunting.

Table 4-2: Harvested Species by Community and Time of Year – Eastern Arctic Study Area (Riewe 1992)

Location	Community	Harvested Species	Harvesting Season	
			Winter (Nov – June)	Summer (July – Oct)
Devon East	Arctic Bay hunters	Muskox	✓	
		Polar Bear	✓	
		Seal	✓	
		Walrus	✓	
		Narwhal	✓	

Location	Community	Harvested Species	Harvesting Season	
			Winter (Nov – June)	Summer (July – Oct)
Admiralty Inlet	Arctic Bay hunters	Ringed Seal	✓	
		Bearded Seal	✓	✓
		Harp Seal		✓
	Arctic Bay and Pont Inlet hunters	Seal	✓	✓
		Polar Bear	✓	
	Pond Inlet hunters	Walrus	✓	✓
		Narwhal	✓	✓
Pond Inlet	Pond Inlet hunters	Polar Bears	✓	
		Ringed Seal	✓	✓
		Bearded Seal	✓	✓
		Narwhal		
		Walrus	✓	
		Eider duck		
Clyde	Clyde River hunters	Polar Bear	✓	
		Ringed Seal	✓	
		Bearded Seal	✓	
		Harp Seal		✓
		Narwhal		✓
		Beluga		✓
		Eider ducks		✓
Home Bay	Clyde River hunters	Ringed Seal	✓	
		Bearded Seal	✓	
		Harp Seal		✓
		Polar Bear	✓	
		Arctic Foxes		
		Narwhal		✓
		Walrus	✓	
	Broughton Island hunters	Ringed seals (esp. silver jars)	✓	
		Harped Seal		✓
		Bearded Seal		✓
		Narwhal	✓	✓
		Walrus		✓
		Eggs of Eider duck and Arctic Tern		✓
		Polar Bears	✓	

Location	Community	Harvested Species	Harvesting Season	
			Winter (Nov – June)	Summer (July – Oct)
Cape Dyer	Broughton Island hunters	Ringed Seal	✓	✓
		Bearded Seal		✓
		Harp Seal		✓
		Polar Bears	✓	
		Walrus		✓
		Seabirds*	✓	✓
		Arctic Char		✓
		Narwhal	✓	✓
		Beluga		✓
	Pangnirtung and Broughton Island hunters	Polar Bear	✓	
		Ringed Seal	✓	
Hoare Bay	Pangnirtung hunters	Polar Bear	✓	
		Ringed Seal	✓	✓
		Walrus	✓	✓
Cumberland Sound	Pangnirtung hunters	Polar Bear	✓	
		Caribou		
		Narwhal		
		Walrus		✓
		Beluga		
		Ringed Seal		
		Harp Seal		
		Arctic Char		
Resolution Island	Iqaluit hunters	Harbour Seal		✓
		Waterfowl and eggs		✓
	Iqaluit and Lake Harbour hunters	Ringed seal		
		Bearded seal		
		Harp seal		
		Hooded seal		
	Lake Harbour hunters	Caribou		
		Polar bear		

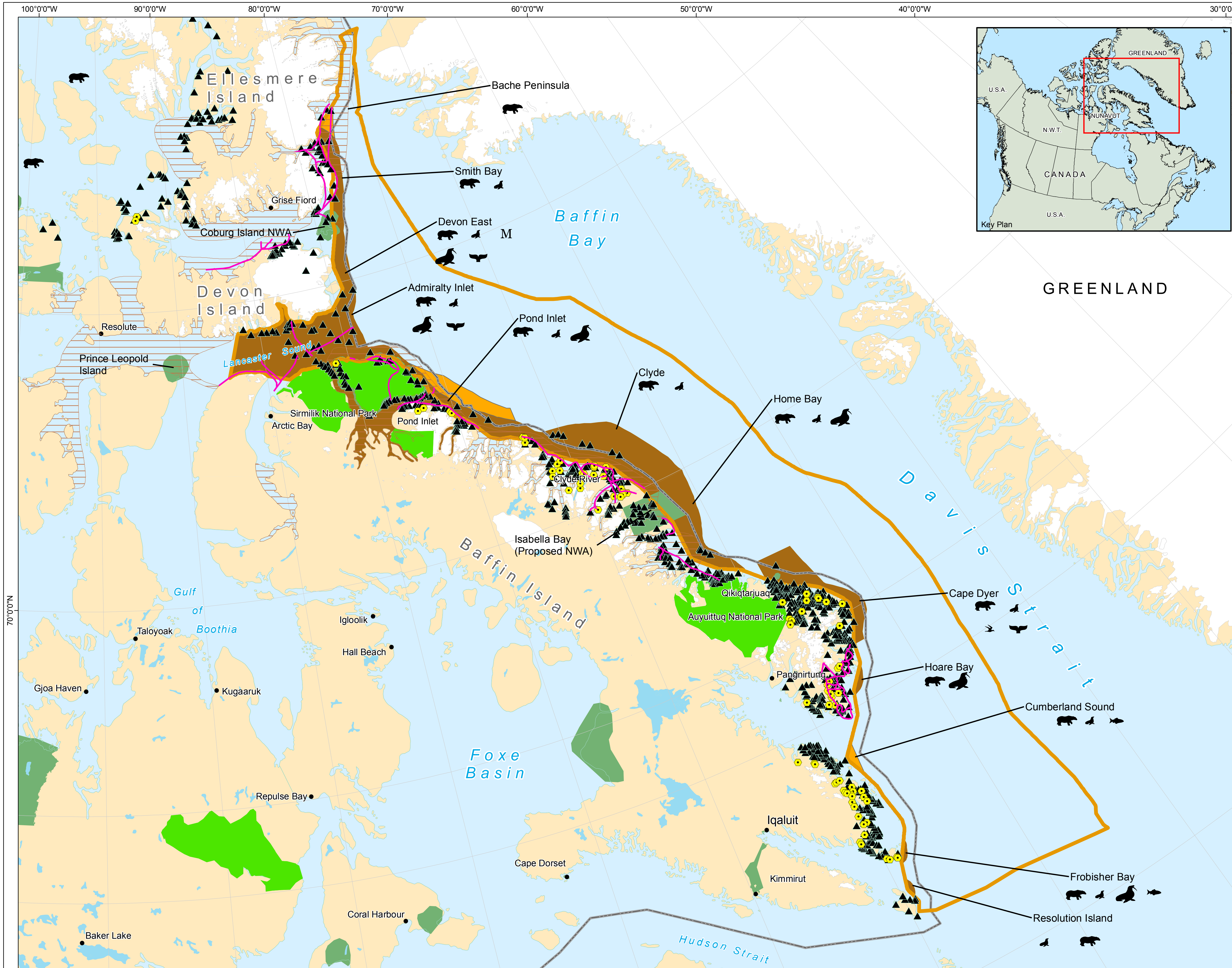
Location	Community	Harvested Species	Harvesting Season	
			Winter (Nov – June)	Summer (July – Oct)
Frobisher Bay	Allen Island Outpost Camp members	Ringed seal	✓	✓
		Bearded seal	✓	✓
		Harp seal	✓	✓
		Guided Polar Bear hunts	✓	
		Walrus	✓	✓
		Waterfowl		✓
	Allen Island Outpost Camp permanent residents (2 families)	Arctic Fox	✓	✓
		Waterfowl		✓
		Arctic Char	✓	✓
	Iqaluit hunters	Caribou		✓
		Polar Bear	✓	
		Harbour Seal		✓
		Waterfowl and eggs		✓
		Ringed seal		
		Bearded seal		
		Harp seal		
		Hooded seal		
		Walrus		
	Pangnirtung hunters	Polar Bear	✓	
		Seal		
		Caribou		
		Walrus		
	Lake Harbour hunters	Caribou		
		Seal		

NOTE:
*Thick-billed murre, kittiwake, black guillemot, fulmar, and glaucous and Thayer's gulls

Readers are cautioned that the information presented above was collected several decades ago and while traditional harvesting activity remains strong, areas of use, levels of harvest and management actions will have changed over time.

Eastern Arctic, Nunavut, Canada
Traditional Harvest
Winter

Fig 4-21



Fishing Sites [1]
Camp Sites [1]
Major Travel Routes [1]
Seal Harvest [2]

Hunting Type Indicators [1]*

Arctic Char
Seal
Beluga
Muskox
Narwhal
Polar Bear
Seabird and/or Eggs
Walrus
Waterfowl and/or Eggs

Inuit Land Use [1]

High Intensity
Medium Intensity

Base Features

Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

References

[1] Riewe, R. (Ed.). 1992. Nunavut Atlas. Edmonton, Alberta. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut.

[2] Nunavut Planning Commission (NPC). 2000. North Baffin Regional Land Use Plan.

* Symbols indicate hunting in the appoximate area or vicinity.

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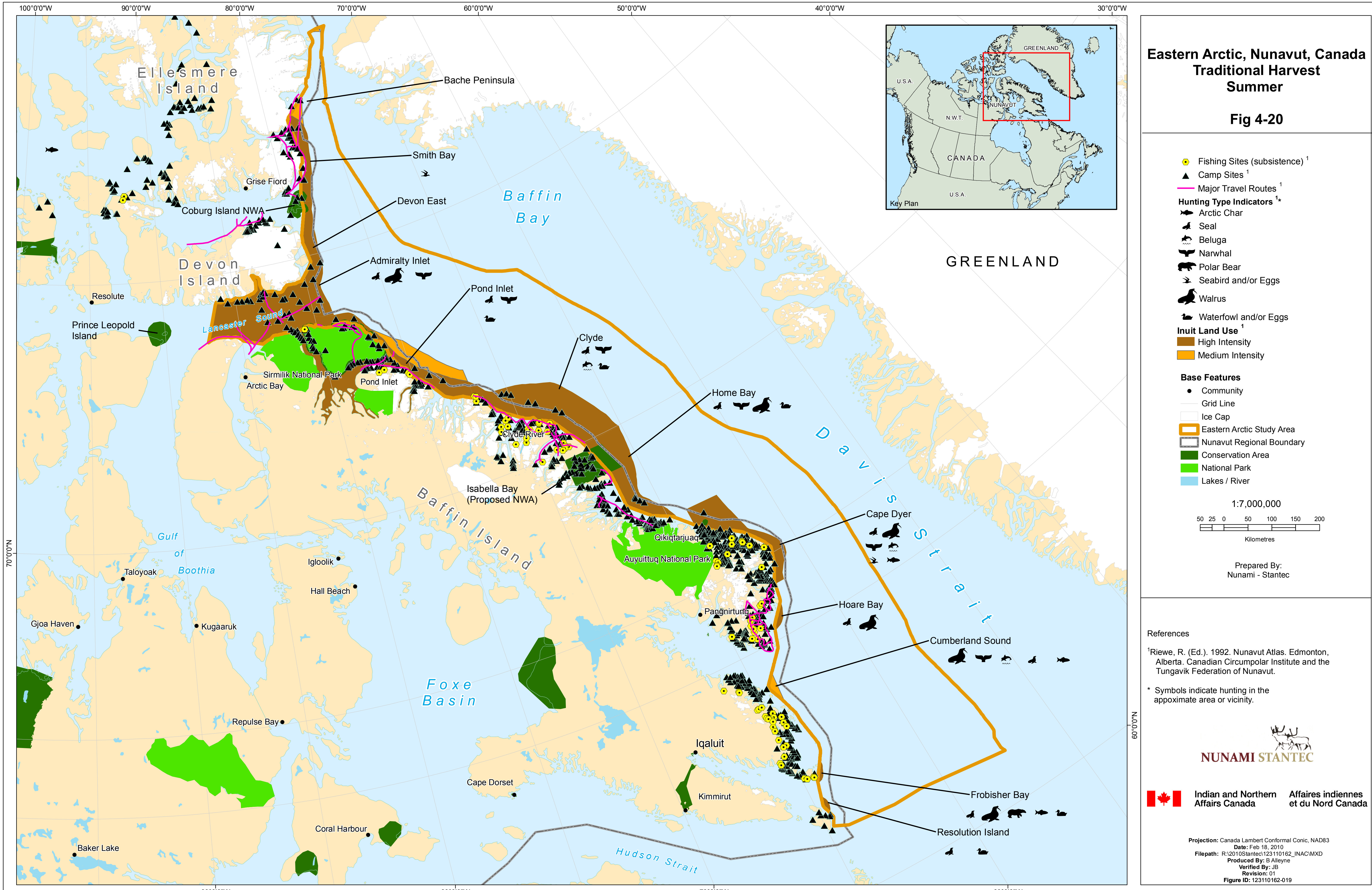

Eastern Arctic, Nunavut, Canada
Traditional Harvest
Summer
Fig 4-20
Fishing Sites (subsistence) 1
Camp Sites 1
Major Travel Routes 1
Hunting Type Indicators 1*
Arctic Char
Seal
Beluga
Narwhal
Polar Bear
Seabird and/or Eggs
Walrus
Waterfowl and/or Eggs
Inuit Land Use 1
High Intensity
Medium Intensity
Base Features
Community
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River
1:7,000,000
50 25 0 50 100 150 200
Kilometres
Prepared By:
Nunami - Stantec
References
1Riewe, R. (Ed.). 1992. Nunavut Atlas. Edmonton, Alberta. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut.
* Symbols indicate hunting in the appoximate area or vicinity.
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Figure ID: 123110162-019
GREENLAND
U.S.A.
N.W.T.
NUNAVUT
CANADA
U.S.A.
Key Plan
100°0'0"W
90°0'0"W
80°0'0"W
70°0'0"W
60°0'0"W
50°0'0"W
40°0'0"W
30°0'0"W
70°0'0"N
60°0'0"N
Ellesmere Island
Bache Peninsula
Smith Bay
Grise Fiord
Coburg Island NWA
Devon East
Baffin Bay
Devon Island
Admiralty Inlet
Resolute
Prince Leopold Island
Lancaster Sound
Pond Inlet
Sirmilik National Park
Arctic Bay
Clyde
GREENLAND
Home Bay
Clyde River
Davis Strait
Isabella Bay (Proposed NWA)
Baffin Island
Cape Dyer
Qikiqtarjuaq
Auyuittuq National Park
Gulf of Boothia
Igloolik
Taloyoak
Hall Beach
Hoare Bay
Pangnirtung
Gjoa Haven
Kugaaruk
Cumberland Sound
Foxe Basin
Repulse Bay
Iqaluit
Cape Dorset
Frobisher Bay
Kimmirut
Resolution Island
Coral Harbour
Baker Lake
Hudson Strait

4.7.2.3 Susceptibility to Oil and Gas Activities

The analysis of susceptibility of traditional harvesting to oil and gas activity is restricted to consideration of routine exploration and development activities. As such, the potential effects of a catastrophic event such as an oil spill are not considered. Most oil and gas activities in the study area will occur in the marine environment; however, shore bases to support activity may be required.

Harvested species and their habitats sensitivity to oil and gas activity will affect the presence and abundance of the species and therefore availability for harvest. Sensitivity of wildlife species is reported elsewhere in this study. Traditional harvesting activity and oil and gas activity may interact directly when both activities occur in the same area at the same time. Industry activity may be both mobile (seismic) or stationary (drilling, shore support base) providing opportunities for a number of direct interactions with traditional harvesting such as breaking of ice, noise propagation, visual disruption, etc, which can potentially negatively affect harvesting.

Seismic Exploration

Seismic activity in the study area is expected to be conducted by marine vessels during the open water season. As activity is expected to be conducted offshore, direct interaction with traditional harvesting is expected to be limited; however, vessel traffic may interfere with migration of marine wildlife and potentially affect the availability of species for harvesting.

Ice-based Activities

It is likely that drilling in the study area would be undertaken by drill ships or other mobile structures. Therefore oil and gas activities affecting ice in the study area would be expected to be related to ice management and transfer of people and materials to offshore drilling locations. Noise associated with ice breaking may indirectly affect harvesting as species may avoid areas of activity. Depending on the drilling season, location and resupply locations, ice breaking could interact with traditional harvesting. Ice breaking and resulting ship tracks can present a safety hazard as a result of open water and rough ice when the tracks freeze.

Shipping

Shipping to support oil and gas activity may disrupt migrations of marine wildlife and consequently their availability for harvest. The presence of marine vessels in a traditional harvesting area may prevent or discourage harvesters from utilizing the areas. Intensive shipping such as regular transits between a shore base and an offshore location may result in traditional harvesters moving to another area, if possible.

4.7.2.4 Potential Effects of Climate Change on VEC

The effects of climate change are not fully understood; however, changes to the northern environment resulting from climate change are being observed. The reduction in ice cover during summer periods has been well documented and may lead to increased human activity in the marine environment. Ice also provides habitat for species such as polar bear, a reduction in ice cover can negatively affect wildlife populations and their availability for harvest. Barren-land caribou populations are declining in northern Canada; while a range of factors may be responsible for this decline, climate change effects are noted as one potential cause of the decline. Reduction in species populations resulting from climate change will reduce the opportunity for traditional harvest and may also result in the imposition of and/or reduction in harvest quotas.

4.7.3 Sensitivity Ranking

In developing the sensitivity layer for traditional harvesting, consideration was given to the Areas of Importance identified in Appendix G of the NBRLUP and the frequency and amount of documented harvesting activity. Four levels of importance are defined for areas in the NBRLUP, based on a combination of importance to community harvesting and wildlife productivity. The Areas of Importance presented in the NBRLUP cover most of the Eastern Arctic study area.

For that portion of the study area not covered by the NBRLUP, the presence of species of harvest interest and the intensity of harvesting activity as presented in the Nunavut Atlas was evaluated to determine sensitivity rankings.

Sensitivity levels for traditional harvesting are defined as follows:

High Sensitivity (5)

Highly sensitive ratings are given to those areas deemed essential harvesting locations (community cannot survive without the area), an area that provides essential habitat with no alternative available, or an area that supports rare, threatened or endangered species or is protected or proposed for legislative protection (NBRLUP). This rating is also given to areas documented as important/intense harvesting area in references, areas where key wildlife habitat documented to be present and areas that are proximate to communities.

Moderate/High Sensitivity (4)

Areas of great importance to the community and where much of the community's harvest comes from are rated moderately to highly sensitive. This rating also applies to areas that provide important wildlife habitat (however, alternate habitat is available) (NBRLUP), areas documented as important harvesting area in references, or travel routes to harvesting and/or camping locations.

Moderate Sensitivity (3)

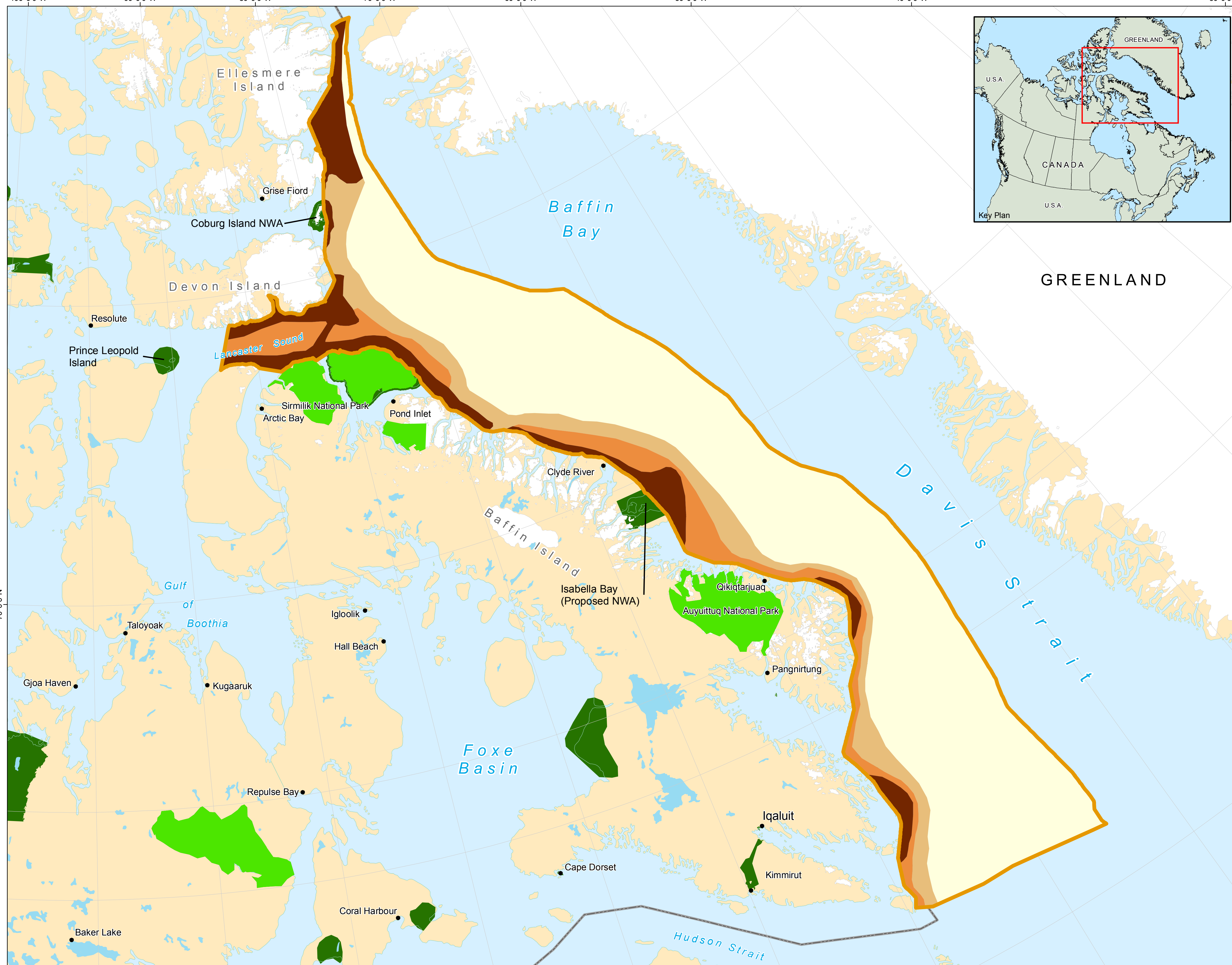
Moderate sensitivity was applied to areas of general harvesting use by the community or where a smaller proportion of harvest comes from these areas than more important areas. Generally there are fewer species present, key habitat for harvested species is not present, and alternate habitat is available (NBRLUP) however, some harvesting has been documented to occur.

Low/Moderate Sensitivity (2)

This rating applies to areas where species of harvest interest may be present, but there is limited documented harvesting.

Low Sensitivity (1)

These areas are not used much by the community and little information exists to assess its importance to wildlife (NBRLUP). There is little to no documented harvesting and no important habitat for species of traditional harvest interest is known to be present.



Eastern Arctic, Nunavut, Canada Traditional Harvest Winter and Summer Sensitivity Rating

Fig 4-22

Sensitivity Rating

- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

Prepared By:
Nunami - Stantec

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4.7.4 Mitigation

Traditional harvesting is dependent on the availability of species to harvest and the opportunity to practice harvesting. Species presence depends on the availability of habitat and healthy and viable populations. The opportunity to practice harvesting requires time to participate in the activity, equipment to conduct harvesting and access to species of interest. Many northern industrial activities have developed work schedules that not only reflect the time and cost of accessing work sites, but also provide northern residents sufficient length of time off to pursue traditional harvesting opportunities. Access to species of interest and harvesting areas can be maintained by industry avoidance of harvesting areas completely, or at times of the year when harvesting activities occur. Compensation may be considered to provide resources for harvesters to travel to different areas or compensate for the loss of access when avoidance is not possible.

4.7.5 Data Sources and Certainty

Data used to document traditional harvesting and subsequent sensitivity ratings is both limited and dated. Harvesting practices and locations are known to shift with time as species occupy different areas, legislative mechanisms reduce harvest of certain species (e.g., quotas, protected areas) and technology and socio-economic factors change the way in which harvesting occurs. Consultation with communities can serve to provide current information on traditional harvesting practices in relation to specific types and locations of oil and gas activity in the study area.

4.7.6 Summary

Inuit depend on food and materials provided through subsistence harvesting. As reported in the 2001 Aboriginal Peoples Survey, approximately seven out of ten Inuit still participate in traditional harvesting (Buell 2006). In Nunavut, the replacement cost of food obtained from traditional harvesting is estimated to be $30 million per year (Sivummut Economic Development Strategy Group 2003). Traditional harvesting occurs in both the marine and terrestrial environment with staple-food sources including caribou, seal and Arctic char. Marine-based harvesting primarily occurs in Lanacaster Sound, in the many bays and fjords along the coast of Baffin Island and at the floe edge. Traditional harvesting activity and oil and gas activity may interact directly when both activities occur in the same area at the same time. Industry activity may be both mobile (seismic) or stationary (drilling, shore support base) providing opportunities for a number of direct interactions with traditional harvesting such as breaking of ice, noise propagation, visual disruption, etc, which can potentially negatively affect harvesting. Interaction between oil and gas activity on wildlife and wildlife habitat is a potential indirect interaction with traditional harvesting as it can affect the availability of a species to be harvested. Sensitivity ratings for traditional harvesting were largely based on the definitions of the Areas of Importance in the NBRLUP and have been applied to the Eastern Arctic Study Area. Data used to document harvesting is dated and activity levels and locations are known to change over time; consultation with communities can serve to provide up to date information and improve mitigation.

4.8 Commercial Fishing

4.8.1 Rationale for Selection

Commercial fishing is an important and developing sector of the Nunavut economy. The vision of the Nunavut Fisheries Strategy is "to see fisheries emerge as a driving economic catalyst for Nunavut resulting in increasing prosperity for current and future generations of Nunavummiut recognizing the principles of sustainable use and Inuit Quajimajatuqangit" (Nunavut Department of Economic Development and Transportation 2009, internet site). Nunavut is currently involved in highly competitive offshore, near shore and inland fisheries (Nunavut Department of Economic Development and Transportation 2009, internet site). The Baffin region, within the Eastern Arctic study area, is where large-scale offshore turbot (*Reihardtius hippoglossoides*, also known as Greenland Halibut) and shrimp fisheries (Northern or pink shrimp – *Pandalus borealis*) have been established. There is also an inshore commercial turbot fishery as well as an Arctic Char *(Salvelinus alpinus)* fishery within Cumberland Sound. It is estimated that the commercial turbot and shrimp fishery contribute a combined $8 million annually to the Nunavut economy. The Nunavut Fisheries Strategy also indicates that there is potential to develop a commercial fishery for clams, scallops and crabs in the future (Nunavut Department of Economic Development and Transportation 2009, internet site). There is a growing expectation for the commercial fishing industry to create meaningful employment opportunities and contribute to economic growth in the region.

After a review of commercial fisheries in the study area and consideration of its current and potential economic importance, commercial fishing was selected as one of the final VSECs.

4.8.2 Commercial Fishing Summary

4.8.2.1 Background

The Inuit have historically relied on a subsistence lifestyle, living in coastal communities and harvesting from the sea. Harvests have traditionally included Arctic char, seals and other marine mammals (Nunavut Department of Economic Development and Transportation 2009, internet site). In the Nunavut Fisheries Strategy, the Government of Nunavut and Nunavut Tunngavik Incorporated (2005) discuss the cultural importance of the marine environment to the Inuit and the potential economic growth which the Nunavut fishing industry could have going forward. Fishing has always been a part of the Inuit subsistence lifestyle; however, it is only relatively recently that Nunavut's fishery, especially the offshore fishery, has emereged as a commerical opportunity.

4.8.2.2 Description of Commercial Fishing Activities

The North Atlantic Fisheries Organization (NAFO) allows fishing for Turbot (*Reihardtius hippoglossoides*), also known as Greenland Halibut, in Subarea O (subdivisions OA and OB) of the Northern NAFO Regulatory Area (GSGislason & Associates Ltd 2002). There are several locations where Turbot fishing occurs along the coast of Baffin Island, in subdivision OA and OB, within the Eastern Arctic Study area (Baffin Fisheries Coalition 2005, internet site) (Figure 4-23). Large-scale offshore turbot fisheries and shrimp fisheries (Northern or pink shrimp – *Pandalus borealis*) have been established in the Baffin region. There is also an inshore commercial fishery for turbot in Cumberland Sound on south Baffin Island, very close to the southern portion of the Eastern Arctic study area. Nunavut's largest fish processing facility is in Pangnirtung with smaller operations in Iqaluit, both of which are very close to the Eastern Arctic study area (Nunavut Department of Economic Development and Transportation 2009, internet site). Depending on seasonal ice conditions, both fisheries normally operate between April and December (Nunavut Department of Economic Development and Transportation 2009, internet site).

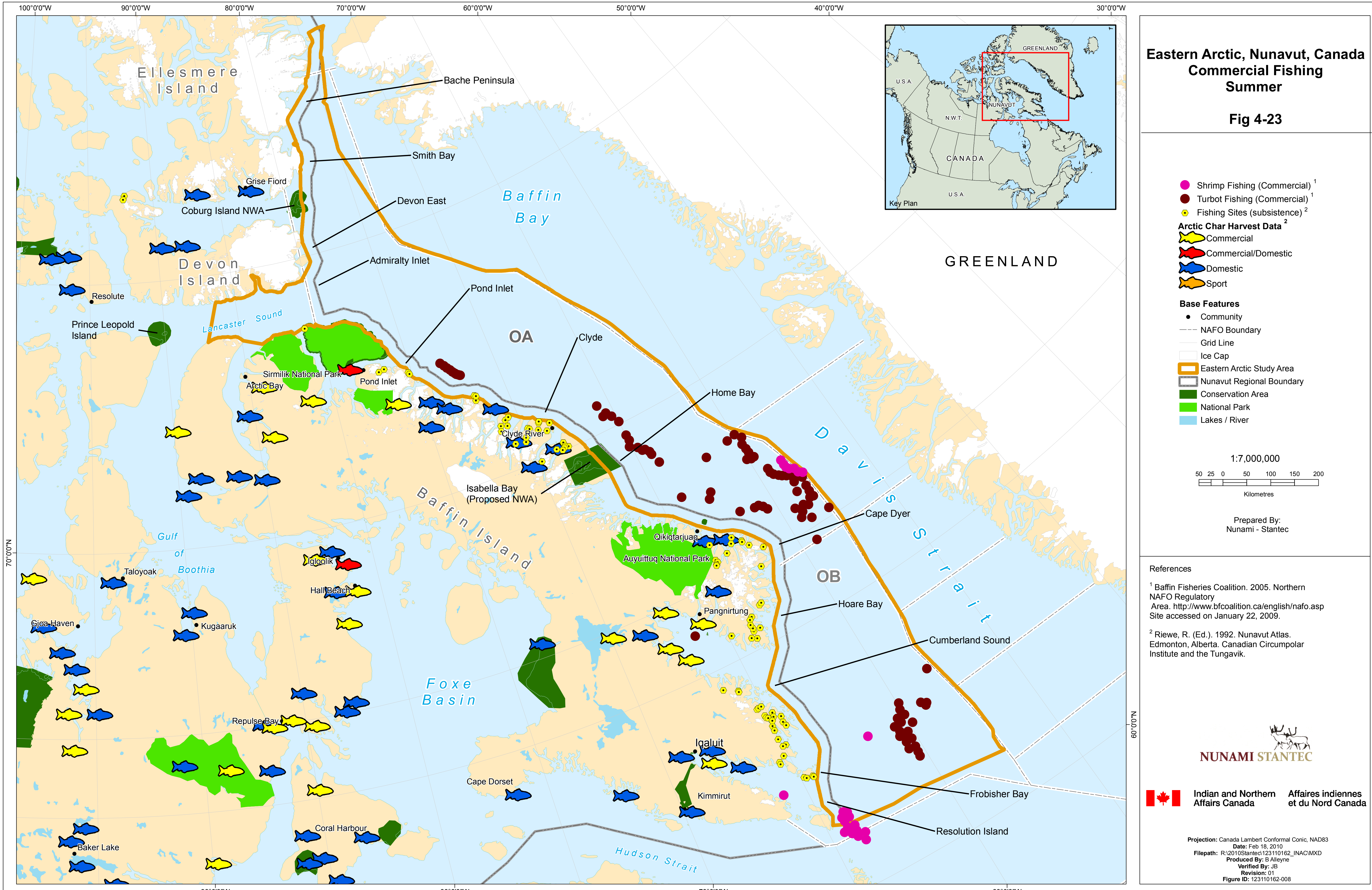
Historically, Nunavut's involvement in offshore turbot and shrimp fisheries has been in the form of royalties paid by outside fishers, thereby causing significant loss of economic development from the territory (Government of Nunavut & Nunavut Tunngavik Incorporated 2005). According to GS Gislason & Associates Ltd., the 2001 Division 0A quota for Canada, all of which was allocated to Nunavut, was 3,500 tonnes of Turbot. The 2001 Division 0B quota of Turbot for Canada was 5,500 tonnes, of which 1,500 tonnes went to Nunavut residents, 2,500 tonnes went to company quotas, and 1,500 tonnes went to a competitive fishery (GSGislason & Associates Ltd. 2002). However, apart from the Turbot fishery in Cumberland Sound, which falls within NAFO subdivision 0B, the entire subdivision 0A and 0B quotas are leased by Nunavut interests to non-Nunavut companies that fish offshore (GSGislason & Associates Ltd. 2002). Some of the turbot caught by the non-Nunavut companies is delivered and processed at the Pangnirtung Fisheries Ltd. plant in Pangnirtung, which is a joint venture between the Government of Nunavut and a local Inuit owned company called Cumberland Sound Fisheries Ltd. In 2001, about 365 tonnes of fish from offshore fisheries were delivered for processing to the Pangnirtung plant, which accounts for less than half of the offshore trawl catch (GSGislason & Associates Ltd. 2002). In 2002, according to GS Gislason & Associates Ltd, an estimated 20 Nunavut residents worked on offshore trawlers.

None of the offshore shrimp is caught by Nunavut vessels or processed in Nunavut. The product is usually delivered to Newfoundland and Nova Scotia (GSGislason & Associates Ltd. 2002). In 2002, according to GS Gislason & Associates Ltd., all licences held by Nunavut corporations were leased to and fished by non-Nunavut companies in return for royalty payments and employment and training opportunities. Approximately 55 Inuit were employed on shrimp trawlers in 2002 (GSGislason & Associates Ltd. 2002).

In the Pond Inlet area of Baffin Island, Arctic Char commercial fishing occurs in the Coutts Inlet area (Figure 4-23). There is a commercial quota of 910 kg round weight (rnd) of anadromous Arctic Char there. Records have not been kept as to whether the area is actually being used for commercial fishing; however, Pond Inlet residents requested the quota to be opened for fishing during the 1977 – 78, 1979 – 80 and 1980 – 81 seasons. In 1979, the total commercial catch of Arctic char was 2,570 kg rnd. The fish were sold by Toonoonik Sahoonik Co-operative within the community.

According to DFO (2009), the Arctic Char commercial fishery in Cumberland Sound occurs in Kingnait Fjord .In 2000, the Pangnirtung Hunters and Trappers Association noticed a decline in Arctic Char population and requested that Kingnait Fjord be closed to commercial fishing by the Nunavut Wildlife Management Board (NWMB). The NWMB announced closure to commercial fishing for five years, and communities were encouraged to minimize their subsistence fishing in the area to help the stocks recover. The HTA then requested that Kingnait Fjord be reopened for commercial fishing in 2002 and again in 2003. DFO indicated that a total harvest from all sources of 2,000 kg (4,409 lb) would pose a low level risk to the population. Since the summer 2005/2006, an annual exploratory license with a 2,000 kg quota has been established for this fishery (DFO 2009). The Fisheries Management Harvest Information System (FHMIS) is a DFO database which provides information on harvest in kg round weight by DFO fiscal year, April 1 to March 31 (DFO 2009). According to FMHIS, in the summer 2005/2006, 1,919 kg round weight was harvested for commercial purposes, in summer 2006/2007 the commercial harvest amount was 1,617 kg, in winter 2007/2008 the commercial harvest was 1,258 kg and in summer and winter 2008/2009 the commercial harvest was 3,129 kg.

There have been reports that subsistence harvesting from this stock have at times been as high, or higher than, the commercial harvest; however, a good record of the subsistence harvest of this stock and the total yearly harvest (both subsistence and commercial) is not available (DFO 2009).



Eastern Arctic, Nunavut, Canada
Commercial Fishing
Summer
Fig 4-23
Shrimp Fishing (Commercial) 1
Turbot Fishing (Commercial) 1
Fishing Sites (subsistence) 2
Arctic Char Harvest Data 2
Commercial
Commercial/Domestic
Domestic
Sport
Base Features
Community
NAFO Boundary
Grid Line
Ice Cap
Eastern Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
Lakes / River
1:7,000,000
50 25 0 50 100 150 200
Kilometres
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References
1 Baffin Fisheries Coalition. 2005. Northern NAFO Regulatory Area. http://www.bfcoalition.ca/english/nafo.asp Site accessed on January 22, 2009.
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Key Plan
GREENLAND
U.S.A.
N.W.T.
NUNAVUT
CANADA
Ellesmere Island
Devon Island
Baffin Bay
GREENLAND
Davis Strait
Baffin Island
Foxe Basin
Gulf of Boothia
Hudson Strait
Lancaster Sound
OA
OB
Bache Peninsula
Smith Bay
Devon East
Admiralty Inlet
Pond Inlet
Clyde
Home Bay
Cape Dyer
Hoare Bay
Cumberland Sound
Frobisher Bay
Resolution Island
Grise Fiord
Coburg Island NWA
Resolute
Prince Leopold Island
Sirmilik National Park
Arctic Bay
Clyde River
Isabella Bay (Proposed NWA)
Qikiqtarjuaq
Auyuittuq National Park
Pangnirtung
Iqaluit
Kimmirut
Cape Dorset
Igloolik
Hall Beach
Repulse Bay
Coral Harbour
Taloyoak
Kugaaruk
Gjoa Haven
Baker Lake
100°0'0"W
90°0'0"W
80°0'0"W
70°0'0"W
60°0'0"W
50°0'0"W
40°0'0"W
30°0'0"W
70°0'0"N
60°0'0"N

4.8.2.3 Susceptibility to Oil and Gas Activities

Commercial fishing and oil and gas activity may interact when both activities occur in the same area at the same time. Industry activity may be both mobile (seismic) or stationary (drilling). Interactions with commercial fishing may include access restrictions due to presence of vessels or indirect interactions with species, including sensory disturbance, habitat loss/alteration, direct mortality and changes to the aquatic food web as a result of chemical contaminants.

Seismic Exploration

Seismic activity in the study area is expected to be conducted by marine vessels during the open water season which overlaps with the fishing season. Seismic vessels deploy air guns which produce sound pressure waves under water. The pressure waves have the potential to cause changes in fish behavior, physiological damage and mortalities.

Ice-based Activities

It is likely that drilling in the study area would be undertaken by drill ships or other mobile structures during the open water season. Therefore oil and gas activities affecting ice in the study area would be expected to be related to ice management at the drill site and transfer of people and materials to offshore drilling locations. Some ice breaking may be required during ice management or during transits to a shore base in early or late season. Noise associated with ice breaking may cause sensory effects to fish and the presence of industry vessels may prevent access by fishing vessels.

Shipping

Shipping to support oil and gas activity has the potential to interact with habitat, fish species and fishing activity. Intensive shipping such as regular transits between a shore base and an offshore location may increase the interaction and result in effects to the VSEC.

4.8.2.4 Potential Effects of Climate Change on VEC

The effects of climate change are not fully understood; however, changes to the northern environment resulting from climate change are being observed. The reduction in ice cover, increased inputs of fresh water to the marine environment and changes in ocean currents all have the potential to effect habitat and species abundance and distribution.

4.8.3 Sensitivity Ranking

In developing a sensitivity layer for commercial fishing, the sensitivity rating was dependent on the presence of commercial species and the frequency and amount of documented commercial fishing activity. Currently the commercial fishing season primarily coincides with the open water season which is likely when oil and gas activities would be expected to occur in the study area. Sensitivity ranking for commercial fishing in the eastern arctic study area is summarized in Figure 4-24 (winter) and Figure 4-25 (summer).

Determination of sensitivity for Commercial Fishing is based on:

High Sensitivity (5)

High sensitivity areas include those where commercially fished species are present in area, there is a commercial quota established, and there is active commercial fishing.

Moderate/High Sensitivity (4)

Moderate to high sensitivity applies to areas where commercially fished species are present a commercial quota is established, but there is no current commercial fishing activity during open water season.

Moderate Sensitivity (3)

Moderate sensitivity was given to areas were commercially fished species are present in area and traditional subsistence fisheries are known to occur.

Low/Moderate Sensitivity (2)

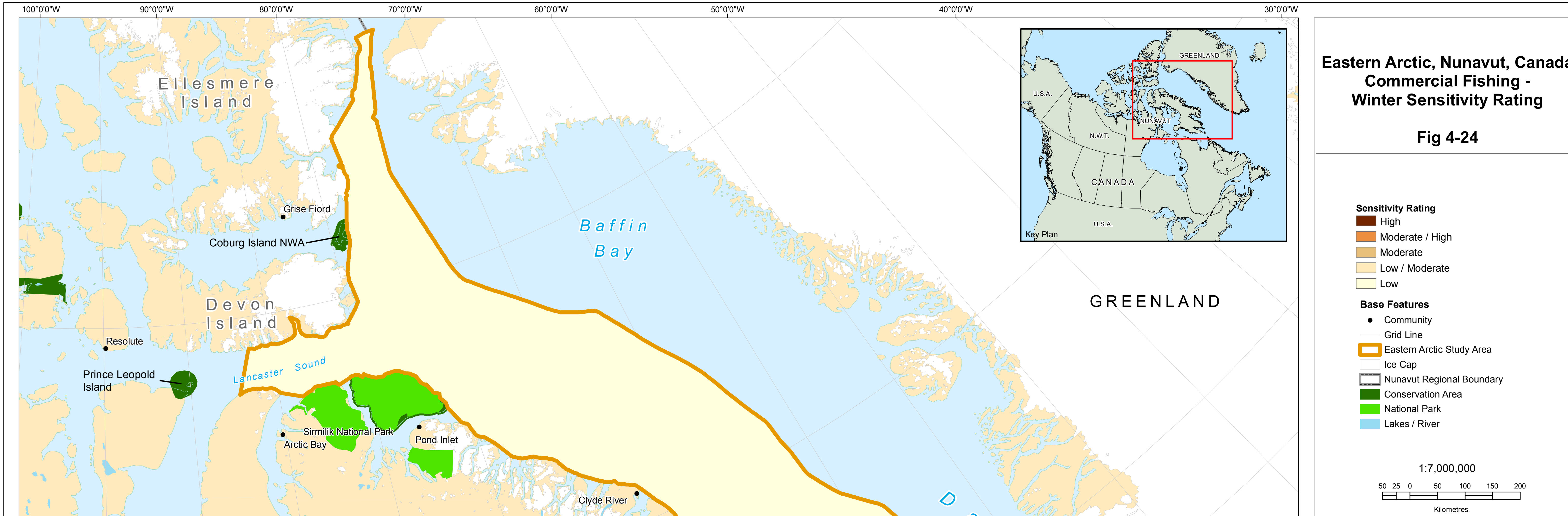
Areas where limited information is available but suggests that commercial fish species and habitat may be present were given a low to moderate sensitivity rating.

Low Sensitivity (1)

Low sensitivity applies to areas where there is no documented information on presence of commercial fish species and no documented information about habitat for commercial fish species.

Eastern Arctic, Nunavut, Canada
Commercial Fishing - Winter Sensitivity Rating

Fig 4-24



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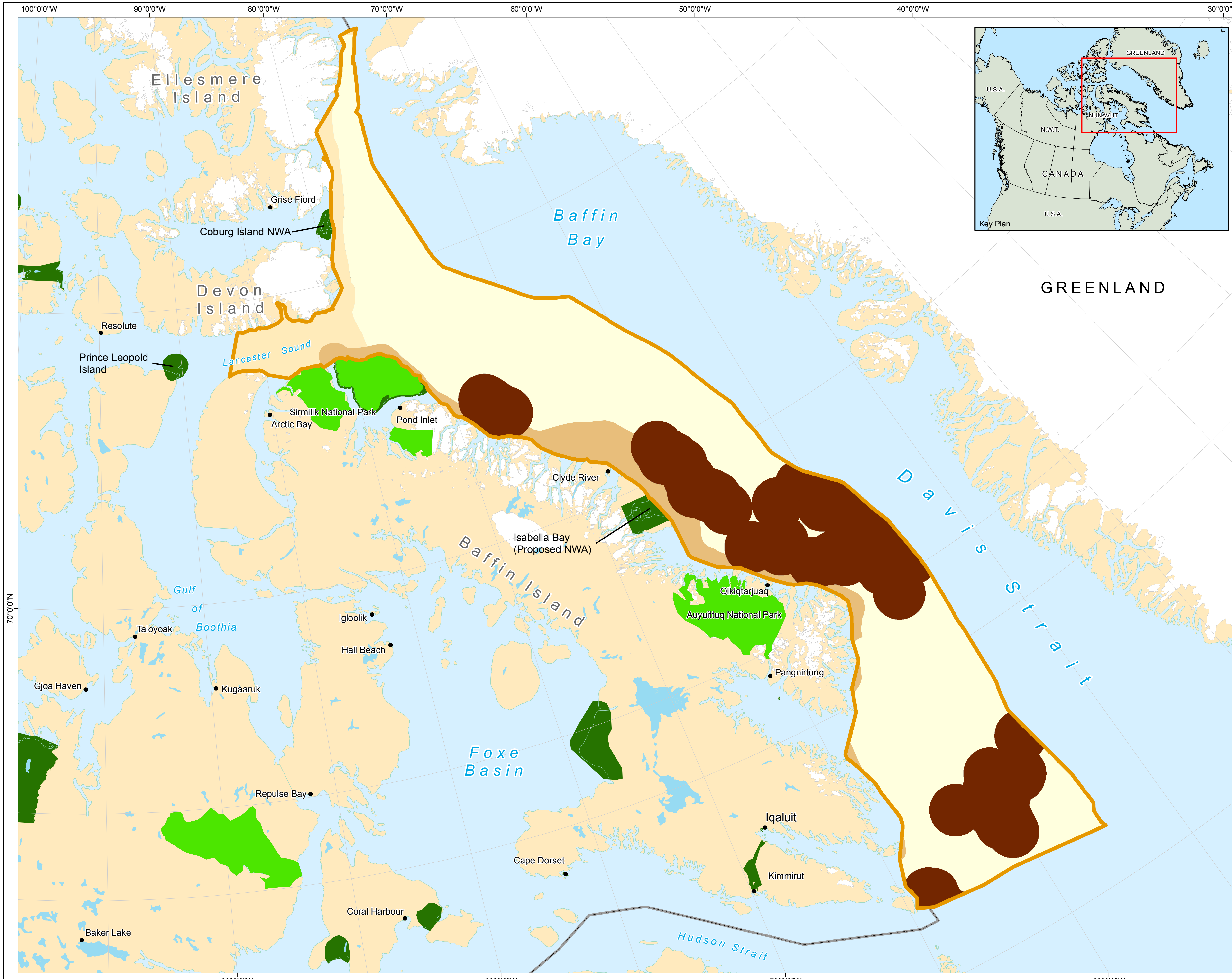
Eastern Arctic, Nunavut, Canada Commercial Fishing - Summer Sensitivity Rating

Fig 4-25



Sensitivity Rating
- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features
- Community
- Grid Line
- Eastern Arctic Study Area
- Ice Cap
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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4.8.4 Mitigation

Commercial fishing is dependent on the presence of commercial fish species, the allocation of commercial quota and the opportunity to conduct fishing operations. Species presence depends on the availability of habitat and healthy and viable populations. Avoidance of important fish habitat and fishing areas will reduce the potential for sensory disturbance, habitat change and the potential to affect food sources through the release of contaminants. Avoidance can be accomplished through physically avoiding an important area or by conducting operations when species are not present (e.g., winter when anadromous Arctic char are in inland waters). Seismic operations present a potential for direct impact to fish and their availability for harvest. Options to mitigate the impact on fish from seismic operations include reducing the energy level in the seismic guns and/or ramping up energy levels whereby the intensity is gradually increased to allow fish an opportunity to adjust to the final energy level.

Fishers require access to the fish to carry out the activity. Oil and gas operators can prevent direct interaction with fishing activity by avoidance or where possible conducting activities during periods where fishing does not occur.

4.8.5 Data Sources and Certainty

Commercial fishing activities in the Eastern Arctic study area are documented spatially and to some degree temporally in a number of references. The most comprehensive and recent information for the study area is included in the Nunavut Fisheries Strategy (Government of Nunavut and Nunavut Tunngavik Incorporated 2005) and a report entitled “The Marine-Related Economy of NWT and Nunavut” (GSGislason & Associates Ltd. 2002). Some information on commercial fisheries is also provided in the Nunavut Atlas (Riewe 1992). Commercial fishing quotas change over time in response to a number of factors. Readers should contact the Department of Fisheries and Oceans to ensure they have the latest information.

4.8.6 Summary

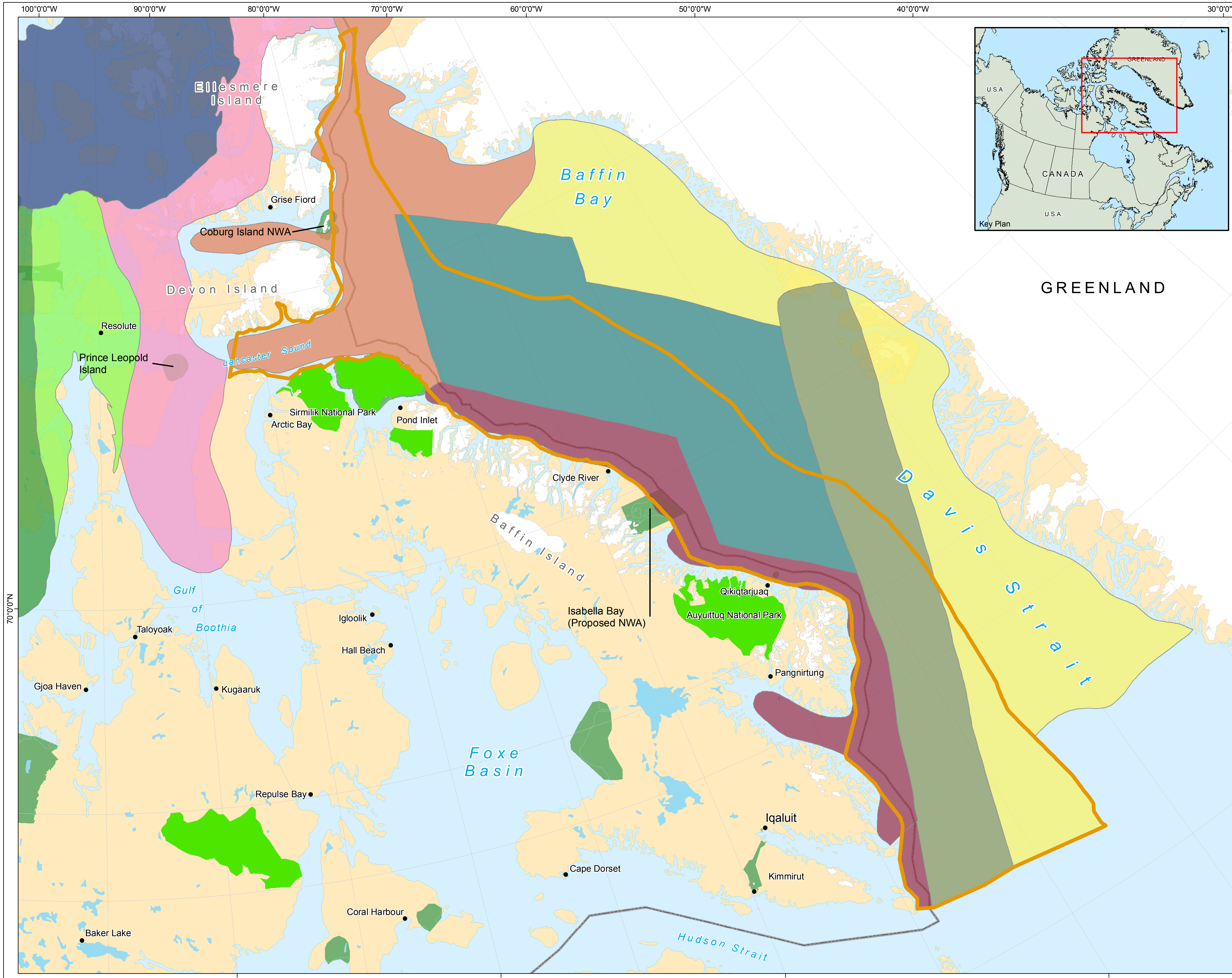
Large-scale offshore turbot fisheries and shrimp fisheries (have been established in the Eastern Arctic Study Area. There is also an inshore commercial fishery for turbot in Cumberland Sound on south Baffin Island, very close to the southern portion of the Eastern Arctic study area. Depending on seasonal ice conditions, both fisheries normally operate between April and December (Nunavut Department of Economic Development and Transportation 2009, internet site). Interactions between oil and gas activity and commercial fishing may include access restrictions due to presence of vessels or indirect interactions with fish species, including sensory disturbance, habitat loss/alteration, direct mortality and changes to the aquatic food web as a result of chemical contaminants. The sensitivity rating for commercial fishing was dependent on the presence of commercial species and the frequency and amount of documented commercial fishing activity. Areas of highest sensitivity occur where commercial fish species are present, a commercial quota is in place and commercial fishing activity is known to occur. Recognized as an important component of

Nunavut's economy, there is potential for expansion of the fishery; therefore data and sensitivity ratings need to be updated regularly.

5 GEO-ECONOMIC LAYERS

Qualitatively, petroleum resource potential varies between very low and very high across the region. Based on available geological information on the region (US Geological Survey 2008) (Figure 5.1), relative variations in potential between assessment units are expressed on a 5-point scale with all grids falling within assessment units ranging between 2 and 5. Any grid falling on or outside the AU boundaries but within the Baffin PEMT area of interest may be regarded as having minimal potential and should score 1.

Petroleum potential is presented in figure 5-2. Given that geological factors through most of the Basin are favourable for oil and gas generation and entrapment no rankings below moderate were assigned. Very high ranking was given to the areas where the potential has been demonstrated by discovery. Where no discovery has been made, the ranking was lowered to high or moderate according to this scheme, notwithstanding other promising indicators.



Eastern Arctic, Nunavut, Canada Geological Assessment Units

Fig 5-1

Assessment Unit[1]
- Baffin Bay Basin
- Boothia-Cornwallis Uplift
- Eastern Franklinian Shelf
- Eurekan Structures
- Greater Ungava Fault Zone
- Northeast Canada Rifted Margin
- Northwest Greenland Rifted Margin
- Sverdrup Mesozoic
- Western Franklinian Shelf

Base Features
- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River

1:7,000,000

Kilometres

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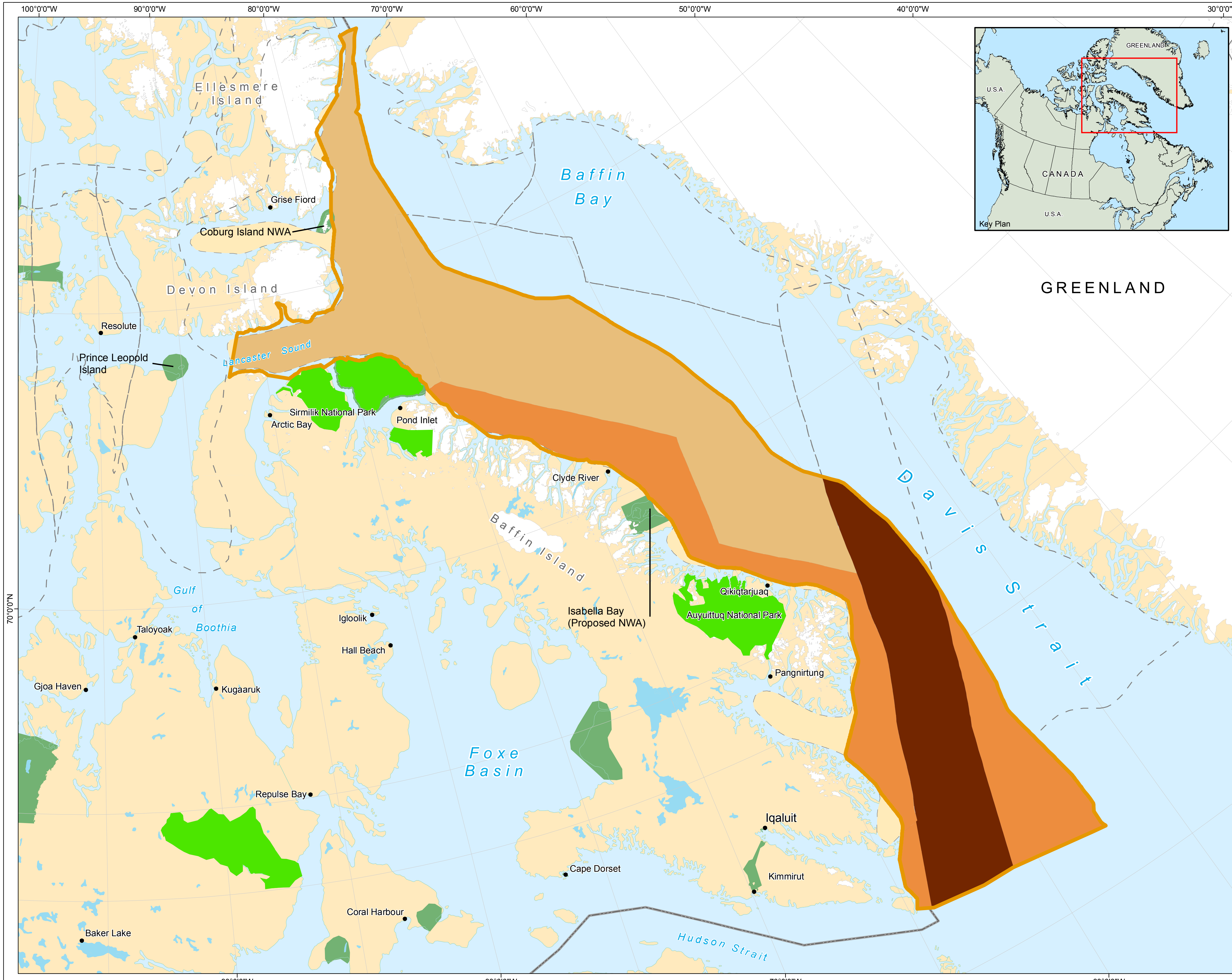

Eastern Arctic, Nunavut, Canada Relative Petroluem Potential

Fig 5-2

ForLegend_Sensitivity_INAC_Colours

Sensitivity Rating

- High
- Moderate / High
- Moderate
- Low / Moderate
- Low

Base Features

- Community
- Grid Line
- Ice Cap
- Eastern Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park
- Lakes / River
- Geological Assessment Units

1:7,000,000

50 25 0 50 100 150 200

Kilometres

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6 CONCLUSIONS AND RECOMMENDATIONS

The practical utility of the Petroleum and Environmental Management tool is dependent on the availability and quality of spatial data on habitat use for each of the VECs and VSECs. As additional information becomes available, it is important that the tool is updated to reflect the most recent knowledge on the biophysical or cultural components of interest. As VECs and VSECs for this analysis were chosen based partially on the current availability of spatial data, it is also important to update and strengthen the PEMT's utility by adding additional components to the analysis once the required data becomes available. Additional components that could not be analyzed due partially to insufficient data (seals, walrus, and tourism) are recommended for inclusion to the PEMT tool once data become available.

Biophysical and cultural components of the Arctic Environment are closely connected with ice regimes. As sea ice dynamics and seasonal patterns become less and less predictable, so too do the spatial delineations that are defined for the PEMT tool. As ice plays such an important role in delineating habitat use and biological resource distribution, the PEMT tool would benefit from the addition of components of the physical environment, which potentially includes some measure of sea ice distribution between seasons (perhaps based on the 30 year median), and further analysis of high productivity areas such as polynyas and other known upwelling areas. These are important biological areas but their full importance to ecosystems which appear somewhat impoverished is not fully understood. The importance of these areas is generally acknowledged, however, the lack of information on how they support broader ecosystem food webs imposes limitations on the utility and future certainty for use in the PEMT tool.

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