PETROLEUM AND ENVIRONMENTAL MANAGEMENT TOOL

High Arctic Study Area

FINAL REPORT

Prepared for:

Northern Oil and Gas Branch, Northern Affairs Organization INAC
25 Eddy Street
Gatineau, Quebec K1A 0H4

Prepared by:

Nunami Stantec
4370 Dominion Street, Suite 500
Burnaby, BC V5G 4L7
Tel: (604) 436-3014 Fax: (604) 436-3752

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NUNAMI STANTEC

AUTHORSHIP

Janine Beckett, M.Sc., R.P.Bio. .... Nunami Stantec

Doug Chiperzak, B.Sc. .... Kavik AXYS

Kristina Juul, B.Sc.. .... Nunami Stantec

Nick Lawson, B.Sc. .... Nunami Stantec

Michelle Marcotte, M.Sc., R.P.Bio. .... Nunami Stantec

Doug Mason, Ph.D. .... Nunami Stantec

Ben Wheeler, M.Sc., R.P.Bio .... Nunami Stantec

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 High Arctic study area is presented. Also included is a preliminary analysis of the petroleum potential of the study area.

The study area is located in the High Arctic Archipelago and contains both marine and terrestrial components. The boundaries of the study area are based on the NOGB leasing grids applied in the High arctic, under which exploration and production licenses may be issued. The Sverdrup Basin (and Lancaster Sound) has the highest known oil and gas potential of the sedimentary basins of the Arctic Islands (Nunavut Planning Commission 2000) and it is expected that there is oil and gas potential on Melville Island and Bathurst Island (Sivummut Economic Development Strategy Group 2003). To date, no gas has been produced, and 321,470 m3 of oil has been produced from Bent Horn (Morrell, *et al.* 1995).

The study area is located in the High Arctic Archipelago and contains both marine and terrestrial components. This report provides a summary of oil and gas activities and the history of exploration in the study area, and presents supporting information on the series of Valued Ecosystem Components (VECs) and Socio-economic Components (VSECs) presented in the web based geographic sensitivity analyses tool. 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.

Four VECs and one VSEC 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 High Arctic study area are:

- Polar bear (*Ursus maritimus*)
- Narwhal (*Monodon monoceros)*
- Migratory birds

- Species of conservation concern
- Traditional harvesting.

For each VEC and VSEC, habitat within the High 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.

This region contains two main petroleum basins which are partly superposed. The older and more regionally extensive Franklinian Basin of Lower Paleozoic age (Arctic Platform) is overlain in the central Arctic Islands by a deep south-west to northeast trending depocentre containing strata of Upper Paleozoic, Mesozoic and Tertiary age of the Sverdrup basin.

The region saw extensive exploration from the late 1960s to mid 1980s. After early and unsuccessful drilling in the lower Paleozoic rocks of the Parry Islands Fold Belt along the southern margin of the region, exploration moved north across a major hinge line into the Sverdrup Basin. Success followed soon afterwards with the discovery of a major gas field at Drake Point in 1969, followed by a succession of 18 further discoveries. In 1974, an oil discovery was made at Bent Horn on Cameron Island. To date this is the only discovery in the Arctic Islands to have been placed on production (production ceased on 1996).

The potential of the central part of the Sverdrup Basin is qualified as ‘very high’. The geological environment here is very favorable and significant accumulations are known. The potential of the southern margin of the Sverdrup Basin and areas of the bordering Arctic Platform ranges from ‘high’ to ‘moderate’. In the northern and northeastern Sverdrup the potential is generally low. In these areas, while some aspects of the geological environment may be favorable, few if any occurrences are known and there is a low probability that undiscovered deposits/accumulations are present. The relatively sparse exploration that has occurred across much of the region, including in those areas ranked as ‘low’ may indicate a lack of geological knowledge and uncertainty as to the petroleum potential.

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
HTA	Hunters and Trappers Association
INAC	Indian and Northern Affairs Canada
ISR	Inuvialuit Settlement Region
IUCN	International Union for Conservation of Nature
NAMMCO	North Atlantic Marine Mammal Commission
NBRLUP	North Baffin Region Land Use Plan
NLCA	Nunavut Land Claims Agreement
NOGB	Northern Oil and Gas Branch
OCCP	Olokhaktomiut Community Conservation Plan
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.

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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. Four VECs and one 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.

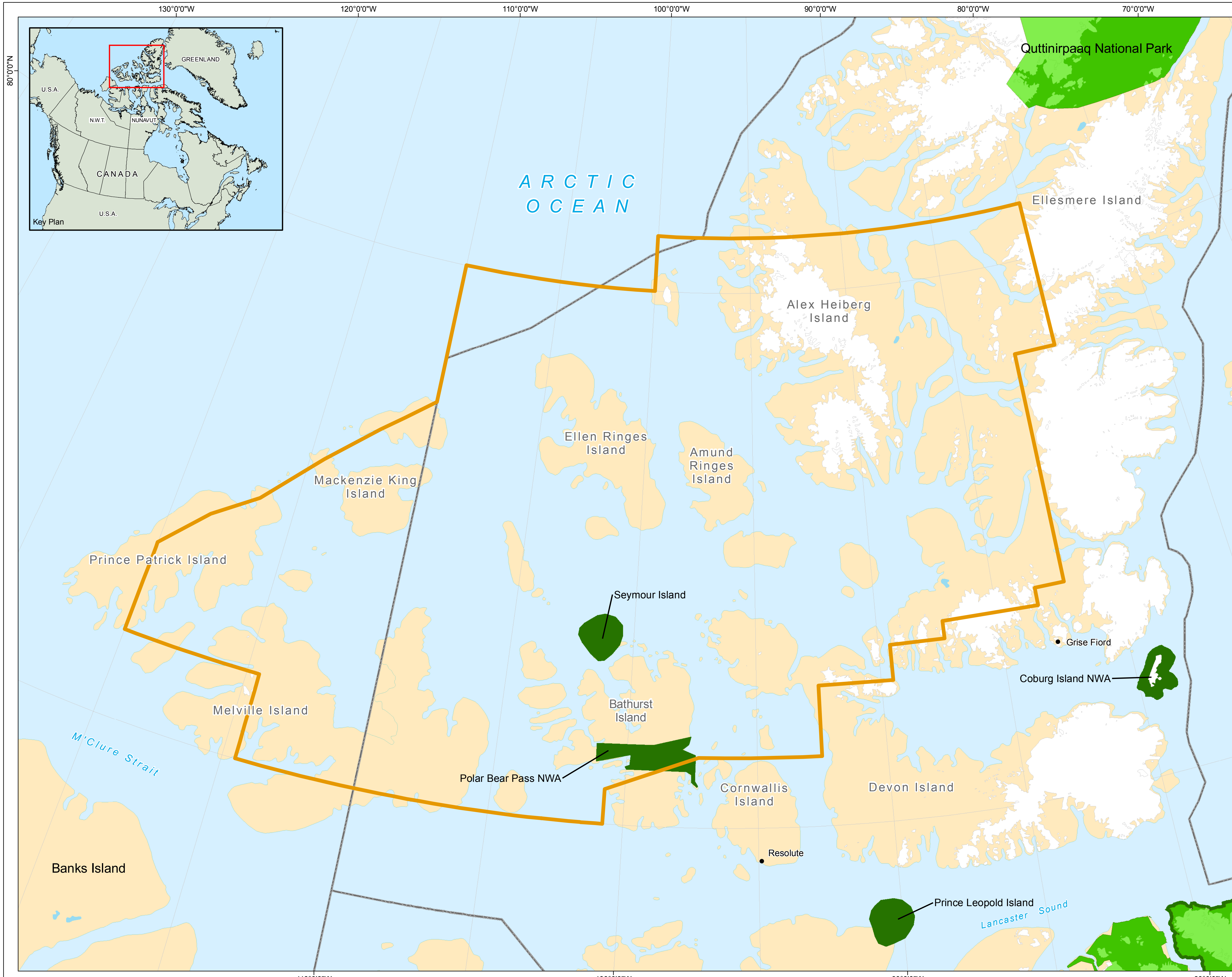
The sensitivity layers are applied to the Northern Oil and Gas Branch's Leasing Grids, facilitating the preliminary identification of areas of high or low sensitivity among several VECs/VSECs, and corresponding high and low values of petroleum potential in the study area.

2 STUDY AREA

The study area is located in the High Arctic Archipelago (Figure 2.1) and contains both marine and terrestrial components. The boundaries of the study area are based on the NOGB leasing grids applied in the High arctic, under which exploration and production licenses may be issued.

2.1 Environmental Setting

The Canadian Arctic Archipelago is a diverse ecozone encompassing islands, ice and water. This area is composed of interconnecting fjords, channels, straits, sounds and gulfs creating a dynamic connection between the marine and terrestrial ecosystems. Many islands make up the archipelago including the Queen Victoria Islands, Ellesmere Island, Bathurst Island and Devon Island. The state of the sea and ice conditions is complex and constantly changing, which affects the use of the region. Early October marks the beginning of freeze-up and by December the waters are normally ice-covered. The ice regime in this area is a mixture of first-year ice, multi-year ice and icebergs. Some landfast ice forms in more sheltered locations such as the inlets, fiords, straits and bays. Multi-year ice is found throughout the High Arctic. In the winter it is usually entrapped in landfast ice and in the summer is it drifting south and east. Hundreds of icebergs drift into the eastern entrances of Lancaster Sound and Jones Sound. Spring brings long hours of sunlight and in May and June cracks and leads start to widen. In July, the open water season begins and the ice is no longer safe to travel on. The winter landfast ice, summer open water, break-up and freeze-up, tidal currents and advancing and retreating ice edges interact in a complex pattern to create polynyas, shear zones, early leads and floe edges. These unique characteristics in the otherwise impenetrable expanse of ice attract both people and wildlife.



High Arctic Study Area

Fig 2-1

Base Features

- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Reg. Boundary
- Conservat'n Area
- National Park

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30 15 0 30 60 90 120

Kilometres

Prepared By:
Nunami - Stantec

NUNAMI STANTEC

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

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2.2 Oil and Gas Development

The High Arctic Study area is composed of marine and terrestrial habitat. The following description of oil and gas activities associated with development of Arctic hydrocarbon resources addresses offshore and onshore 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.

Seismic activities on land will typically involve ground vehicles with seismic charging and recording devices covering the specified area. Onshore seismic is commonly undertaken during the winter when the ground is frozen and snow covered; however, where ground conditions permit, the activity may occur at other times of the year. Support to land based seismic programs usually includes a staging area where equipment and supplies are offloaded from marine transport, a camp, an airstrip, and storage and maintenance facilities.

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.

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 Production and 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 High Arctic Study Area

Following mapping of the prospective geology in the Arctic by the Geological Survey of Canada, oil and gas exploration began in the 1960s. Between 1961 and 1984, 160 wells were drilled, resulting in 17 significant discoveries in the Sverdrup Basin (Sivummut Economic Development Strategy Group 2003). The known reserves in Nunavut account for five per cent of Canada's known oil reserves, and 15 per cent of Canada's known gas reserves, which are estimated to be worth over a trillion dollars in total (Sivummut Economic Development Strategy Group 2003). The Sivummut Economic Development Strategy Group (SEDS) expects that there will be a resumption of oil and gas exploration and development activities in Nunavut and that future oil and gas exploration is expected to start with the known discoveries and only then extend into unexplored areas (Sivummut Economic Development Strategy Group 2003).

Under the Arctic Islands in Nunavut, there are 94 trillion cubic feet of natural gas, which is valued at approximately one trillion dollars and accounts for one quarter of Canada's gas reserves (Buell 2006). According to the Nunavut Planning Commission (NPC), the Sverdrup Basin (and Lancaster Sound) has the highest known oil and gas potential of the sedimentary basins of the Arctic Islands (Nunavut Planning Commission 2000) and it is expected that there is oil and gas potential on Melville Island and Bathurst Island (Sivummut Economic Development Strategy Group 2003). Now that many land claims in the region have been settled, and with new technology and the changing climate allowing more access to hydrocarbon resources , there is renewed interest in harvesting the reserves of the Western Arctic and building a pipeline to bring northern natural gas to southern markets (Buell 2006).

Between 1969 and the late 1980s, more than 400 wells were drilled in the Arctic. Eighteen petroleum fields have been discovered in the Arctic Islands (eight gas, seven oil and gas, three oil) (McCracken *et al.* 2007). The Drake Point field on Melville Island is the largest in the Arctic Islands, with at least 99 billion cubic meters of gas (McCracken *et al.* 2007). A well was drilled at Drake Point in 1969 and struck gas in sandstone, but the gas pressure was so great that the well blew out of control (McCracken *et al.* 2007). The Bent Horn oil field on Cameron Island was discovered in 1974. The oil lies in ancient reef rocks more than 3 km below the surface and the oil field is small, with 12 million barrels of oil (McCracken *et al.* 2007). The first shipment of 100,000 barrels was made in 1985 by an ice-breaking tanker to a refinery in Montreal. Shipments continued until the late 1990s (McCracken *et al.* 2007). Near Lougheed Island is the largest oil field yet found, Cisco, which has an estimated 584 million barrels of oil (McCracken *et al.* 2007). Discovered resources in the Sverdrup and Franklinian Basins include 407 x E9 m3 of gas and 66 x E6 m3 of oil. To date, no gas has been produced, and 321,470 m3 of oil has been produced from Bent Horn (Morrell *et al.* 1995). During this phase of exploration, many large structures evident from seismic exploration were drilled and discoveries of both gas and oil made in the Sverdrup Basin. Less attention was paid to peripheral areas and older rocks of the surrounding Arctic Platform. With the evolution of both exploration concepts and exploration technology since the end of the last phase of exploration, the full potential of the Sverdrup and the Franklinian Basins remains to be discovered.

3 APPROACH AND METHODOLOGY

In this section the methodology of selecting the VECs and VSEC is presented, along with guidelines used to define sensitivity layers for the selected VECs/VSEC, the development of the Geo-Economic layer and how this information was merged in the creation of the decision support tool.

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 VEC's and VSEC's 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).

3.1.3 Selected Valued Ecosystem Components

The VECs selected for the High arctic study area include:

- Polar bear (*Ursus maritimus*)
- Narwhal, (*Monodon monoceros)*
- 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

The following Valued Socio-Economic Component (VSEC) was selected for the High Arctic Beaufort Study Area:

- Traditional Harvesting.

Traditional harvesting plays an important social, cultural and economic role for the residents of the Northwest Territories and Nunavut communities near the High Arctic Study Area. Within Nunavut, it estimated that 70% of Inuit participate in traditional subsistence harvesting, while in the Northwest Territories, approximately 40% of residents over 15 years of age participate in traditional subsistence harvesting (Terriplan Consultants 2008).

The North Baffin Regional Land Use Plan (NBRLUP), covering part of the study area, identifies “Areas of Importance” to planning region communities based on their importance to harvesting and the maintenance of wildlife populations. The Nunavut Atlas (Riewe 1992) identifies important wildlife habitat, illustrates the geographical extent of Inuit land use by each community in Nunavut as well as major travel routes, fishing sites, campsites and the intensity of Inuit land use. Part of the study area falls within the traditional land use area of Uluhaktok, an Inuvialuit community located in the Inuvialuit Settlement Region (ISR) of the Northwest Territories. For this community, the Olokhaktomiut Community Conservation Plan identifies important wildlife habitat and seasonal harvesting areas, wildlife population goals and conservation measures appropriate for each species of concern, and makes recommendations for their management.

Upon review of the extent of Inuit and Inuvialuit land and marine use documented in the Nunavut Atlas, the areas of importance identified in the NBLUP, the priority areas identified in the Olokhaktomiut (Holman) Community Conservation Plan, consideration of the cultural and economic importance of traditional activities and the potential for interaction with petroleum industry activities, traditional harvesting was selected as a VSEC.

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 High 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 substantial (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 mid June and mid September. The winter season is defined as the ice covered period between mid to late September and mid- to late-June.

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

A number of interactions may occur between the socio-economic or biophysical environments. When developing sensitivity layer, 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

This is a qualitative assessment of petroleum potential based on current understanding and is intended to give a general overview of potential for future exploration success across this large region. Figures were produced with input from geologists at the Geological Survey of Canada (Dewing 2010, pers. comm) and adapted from Figure 7 in Chen and Osadetz (2006). On such a large scale, contacts and boundaries may not be accurately represented. This map is presented solely to inform resource management planning and should not be used to infer the presence, absence or size of undiscovered petroleum accumulations.

This region contains two main petroleum basins; the older and regionally extensive Franklinian Basin of Lower Paleozoic age, and the younger Sverdrup Basin of Upper Paleozoic, Mesozoic and Tertiary age.

The Sverdrup basin fills a large rifted depocentre now beneath the Arctic Archipelago. Franklinian strata outcrop along its southern and eastern margin and form much of the Arctic platform surrounding the core of the Canadian Shield. All discoveries to date fall within the Mesozoic rocks of the Sverdrup Basin with the exception of Bent Horn where oil was produced from Devonian rocks. Summary descriptions of the petroleum geology of these basins may be read here (http://www.collectionscanada.gc.ca/webarchives/20071122052027/http://www.ainc-inac.gc.ca/oil/bkgd/prospectus/index_e.html)

The petroleum potential map reflects the potential of both the Franklinian and Sverdrup basins although published work on the region has focused on the younger rocks. The ranking used is as follows using a 5 point scale ranging from very high to very low.

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.

3.2.1 Geological Uncertainty Layer

A very simple depiction of uncertainty was chosen which relates solely to the proximity of a petroleum exploration well.

The ranking is as follows:

1. Grids which contain at least one well (least uncertain)
2. Grids within 20 km of a well site
3. Grids between 20 km and 75 km from a well site
4. Grids between 75 km and 100 km from a well site
5. Grids further than 100 km from a well site.

The assumption is that there is greater uncertainty regarding oil and gas potential for areas further from existing well control. No assessment was made of the penetration or results of the well or its implications for petroleum potential.

3.2.2 Composite Potential-Uncertainty Layer

This layer adds the ranking for petroleum potential per grid to the uncertainty ranking. This highlights areas were the allure of high potential is augmented from an exploration viewpoint by lack of drilling. For instance, areas of high or very high potential where structures have been drilled tend to have lower scores on this layer than similar areas with undrilled structures.

No attempt was made to characterize the economics of development in the High Arctic region.

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 1,339 (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 2002) 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.

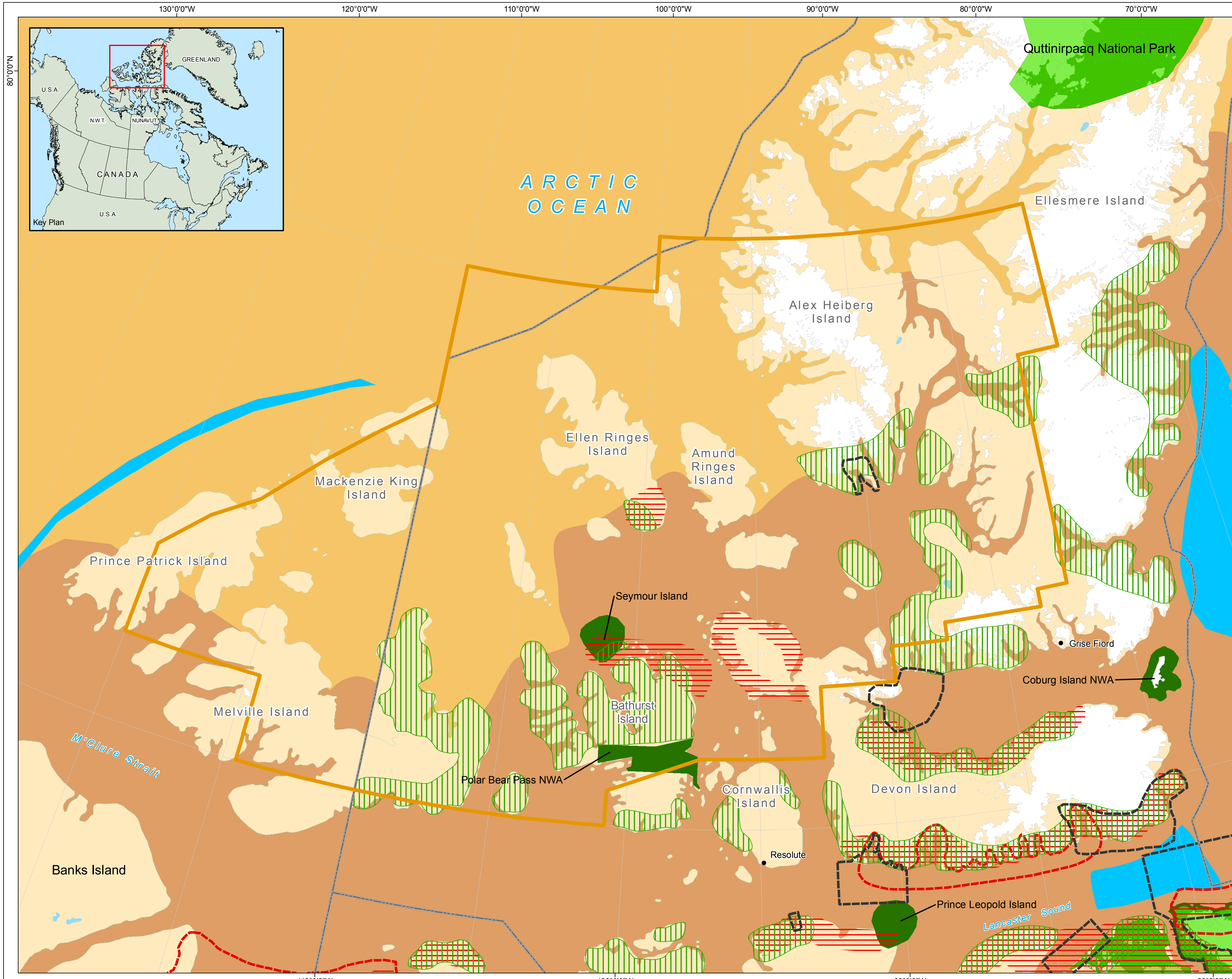
Distribution

Seasonal distribution of Polar bears in the high 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 (COSEWIC 2008; Taylor *et al.* 2008a). The high Arctic study area overlaps with three of the eleven polar bear sub-populations that inhabit the Nunavut region (from COSEWIC 2008); Viscount Melville Sound (215 ± 116 bears) (Taylor *et al.* 2002), Lancaster Sound (2,541 ± 391 bears) (Taylor *et al.* 2008b) and Norwegian Bay (203 ± 44 bears) (Taylor *et al.* 2009). Estimated total population numbers for all sub-populations in Canada is approximately 15,000 (COSEWIC 2008).

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

Fig 4-1



IBP - Polar Bear Habitat [5]
Denning Area [4, 7]
WASI - Polar Bear Site [2]
Polynyas [3]
Core Polar Bear Range [1,6]
Lower Density Polar Bear Range [6]

Base Features
Community
Grid Line
Ice Cap
High Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park

1:4,000,000

30 15 0 30 60 90 120
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
*digitized by Government of Nunavut 2005

[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

[4]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

[5]Nettleship, D.N. and P.A. Smith. 1975. Ecological sites in northern Canada.
Canadian Committee for the International Biological Programme. 330 pp
*digitized by Government of Nunavut 2005

[6]Stirling, I. 1998. Polar Bears. The University of Michigan Press. Ann Arbor, Michigan.
*digitized by Nunami Stantec 2010

[7]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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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 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 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.

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. Landfast ice 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 denning area year after year or an area of similar habitat quality (Lunn, *et al.* 2004; Stirling, *et al.* 2004). Denning areas in the high arctic study area are concentrated along the coastal regions of Melville Island, Bathurst Island, Ellesmere Island, and Alex Heiberg Island. In portions of the high arctic, polar bears are forced onto the land in the summer as the ice recedes and spend up to several months in summer retreat areas while they wait for the ice to return. These areas have been identified on Bathurst Island and northeastern Devon Island (Figure 4-1).

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).

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[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

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.

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. The impact of land-based activities on maternal denning has not been studied.

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

Winter and Summer sensitivity ranking for Polar bear habitat in the high arctic study area is summarized in Figure 4-2.

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 high 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. There is only one IBP site that falls within the high Arctic Study area.

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)

Marine and sea ice habitat outside of the core polar bear range may provide limited denning or foraging use for a lower density of the polar bear population.

Low Sensitivity (1)

Low sensitivity areas include terrestrial habitat and areas outside of the polar bear range.

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 available and assumed to be accurate as it is based on a combination of scientific research and traditional knowledge, however, recent data (e.g. data collected within the last decade) on specific polar bear habitat use in the high arctic study area 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

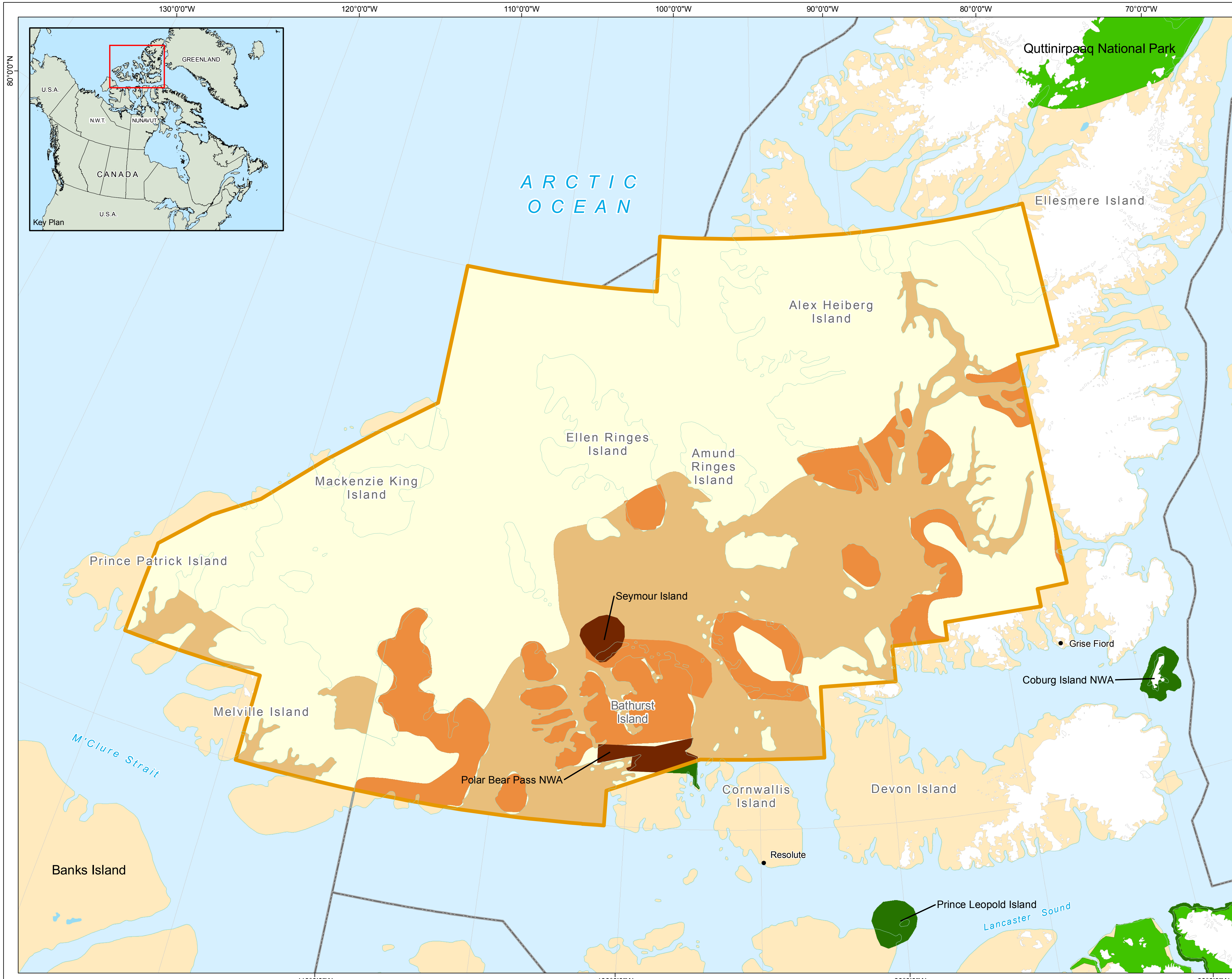
Polar Bears range throughout the High Arctic Study Area and are an integral component of the Arctic ecosystem in Nunavut as they are the top predator within the food web. The High Arctic study area overlaps with three of the eleven polar bear sub-populations that inhabit the Nunavut region.

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. Landfast ice 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 denning area year after year or an area of similar habitat quality (Lunn, *et al.* 2004; Stirling, *et al.* 2004). Denning areas in the high arctic study area are concentrated along the coastal regions of Melville Island, Bathurst Island, Ellesmere Island, and Alex Heiberg Island. In portions of the high arctic, polar bears are forced onto the land in the summer as the ice recedes and spend up to several months in summer retreat areas while they wait for the ice to return. These areas have been identified on Bathurst Island and northeastern Devon Island (Figure 4-1).

Habitat rated as moderate to high sensitivity includes known denning locations in the southern portion of the study area. Multiyear pack ice in the polar bears core range is rated as moderate to low sensitivity because it provides limited denning or foraging use for polar bears but may be utilized by bears for foraging in early summer before the sea ice recedes completely. Low sensitivity areas include those 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.



High Arctic, Nunavut, Canada
Polar Bear
Summer and Winter
Sensitivity Rating

Fig 4-2

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

Base Features
- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

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30 15 0 30 60 90 120

Kilometres

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4.2 Narwhal

4.2.1 Rationale for Selection

Narwhals were selected as a focus for this study primarily on the basis of the overlap between their known range and the High Arctic study area. Narwhals are also an important species to Nunavutmuit for subsistence, cultural and economic reasons. Over a five year period from 1996 to 2001, for example, the total annual mean number of harvested narwhals was approximately 734 (Priest and Usher 2004). Their skin and underlying fat (muktuk) is consumed and the tusks are sold and are quite valuable (DFO 1998a, 1998b).

4.2.2 Narwhal Summary

4.2.2.1 Life History

Conservation Status

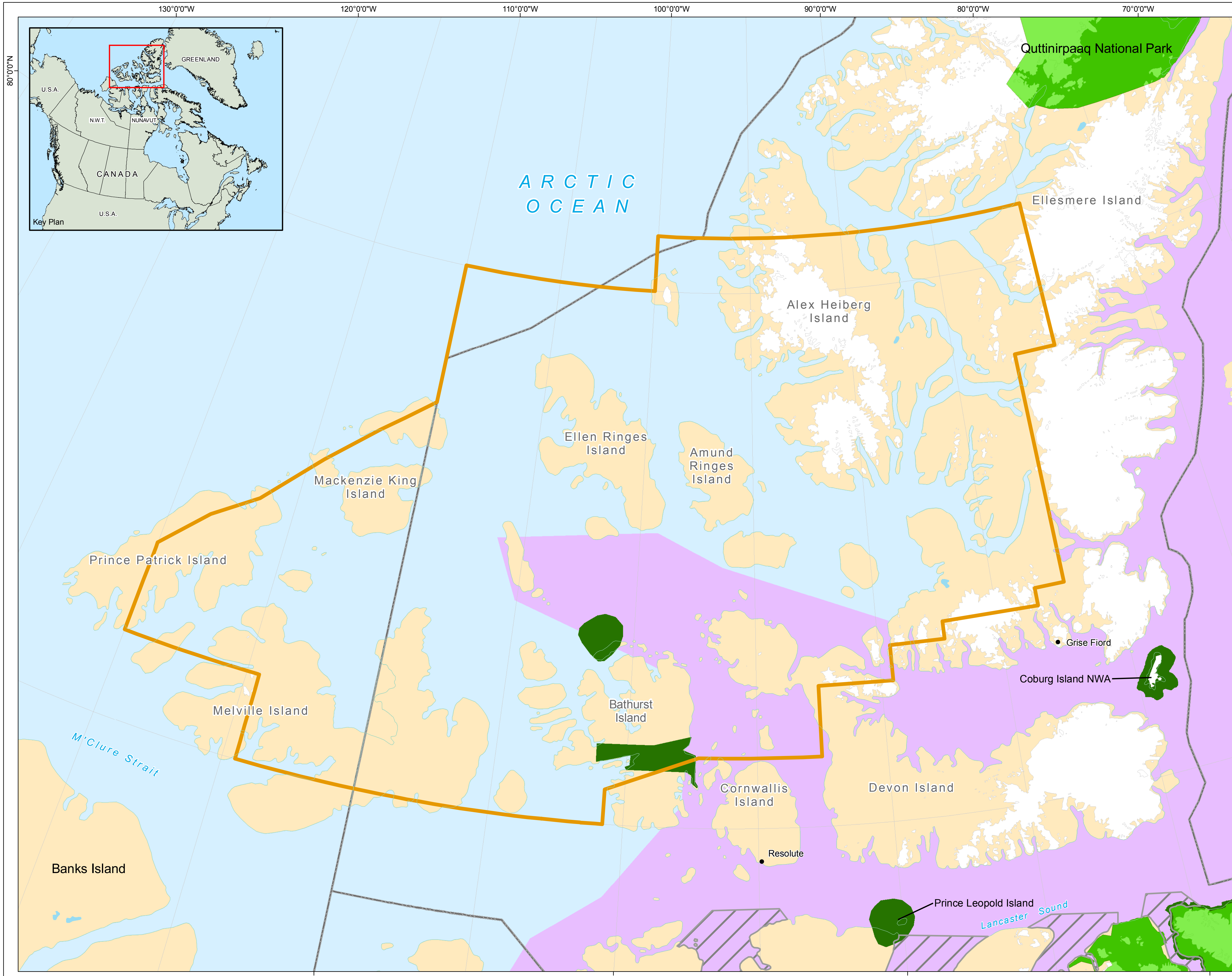
Narwhals are designated as 'Special Concern' by COSEWIC in 2004, listed under Appendix II of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) but to date has not been assessed under SARA. The narwhal is currently listed as 'Near Threatened' by the IUCN (IUCN 2009), which has been increased from 'Data Deficient' in 1996.

Distribution

The Baffin Bay narwhal population occupies the area from the Southern end of Baffin Island to the northern waters of Hall Basin (narrow northern region between Ellsemere Island and Greenland) and probably as far north and west as ice conditions permit (COSEWIC 2004a). 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 2004a). Some may also use the Foxe Basin via Fury and Hecla Strait to spend a portion of their summer (COSEWIC 2004a) and have been observed in Queens Channel and McLean Strait between King Christian and Lougheed Island (COSEWIC 2004a). Figure 4.3 summarizes the narwhal's distribution in the high Arctic study area.

High Arctic, Nunavut, Canada
Narwhal Distribution and Key Seasonal Habitat

Fig 4-3



Narwhal Summer Concentrations [1]
Narwhal Range [1]
Narwhal Potential Range [1]

Base Features

- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

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30 15 0 30 60 90 120
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)
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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.* (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 fiords along the way. Wintering areas for this population are Baffin Bay and northern Davis Strait (COSEWIC 2004a). Those that summered in Fury and Hecla Strait may migrate via Lancaster Sound or may continue through Foxe Basin and Hudson Strait (COSEWIC 2004a). 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).

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

Ecology

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 (Richard *et al.* 1994). Leads, fast ice and broken pack ice density also seem to be key factors in habitat selection (Richard *et al.* 1994).

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 (Richard, *et al.* 1994) 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 (Richard, *et al.* 1994).

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) 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).

4.2.2.2 Key Habitat

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, 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).

4.2.2.3 Sustainability Factors

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 2004a; Moore and Huntington 2008).

4.2.2.4 Susceptibility to Oil and Gas Activities

Environmental contamination could disrupt biological functions, offshore oil and gas exploration may deter animals 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).

Increased land development along the coast may cause negative effects on narwhals. 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 (Finley and Evans 1983; COSEWIC 2004a; Huntington in press). As well, some Inuit hunters suggest that narwhals are sensitive to and avoid noise from industrial machines and explosions (COSEWIC 2004a).

4.2.2.5 Potential Effects of Climate Change on Toothed Whales

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).

4.2.3 Sensitivity Ranking

Sensitivity rankings for narwhal habitat in the High Arctic study area 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 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 narwhal habitat. For example, COSEWIC (2004) states that narwhals are likely found as far north and west (within the Canadian high Arctic region) as ice conditions permit. Thirty 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 narwhal 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.

Two sensitivity maps for narwhals in the High Arctic study area were developed: Figure 4.4 for winter and Figure 4.5 for summer.

High Sensitivity (5)

Areas identified as highly sensitive for toothed whales includes areas designated as critical for narwhals and a spatially limited area (<100 km^2) during the summer months that provides specific ecological function essential to narwhals. In the winter months this rating was also given to that provide core overwintering habitat or where very large concentrations of narwhals are known to occur.

Highly sensitive summer or winter narwhal habitat was not identified within the high Arctic study area.

Moderate/High Sensitivity (4)

Areas with moderate to high sensitivity in the summer includes habitat with loose or dense annual pack ice, shear-zone/leads, fjords, shelf-break, or deep ocean basins. In winter, areas where large concentrations of narwhal are known to occur are considered moderately to highly sensitive.

Moderate to highly sensitive summer narwhal habitat was identified primarily for those regions of loose pack ice in July – September. These regions include waters near King Christian Island and

Penny Strait; as well as south of Prince Patrick and Melville Island (though narwhals have not been observed in these last two western regions). No moderate to highly sensitive narwhal habitat was identified in the High Arctic study area.

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 narwhals. Moderate sensitivity during the winter months was given to areas that contain low to moderate sized concentrations of narwhal, deep water, the shear zone, or leads and polynyas.

Moderately sensitive narwhal summer habitat was described primarily to capture the ice edge (pack ice next to open water) region of Queens Channel north of Cornwallis Island. Narwhal have been sighted in this region. According to 30 year median ice charts, leads in November are likely to be present in Penny Strait, Queens Channel, Austin Channel and Cardigan Strait as identified in Figure 4.4, hence some narwhals may use this moderately sensitive habitat in relation to their fall/winter migration out of the Canadian Arctic archipelago.

Low/Moderate Sensitivity (2)

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 narwhal. This sensitivity rating also applies to areas with low densities of toothed whales and areas of multiyear pack ice in winter.

Much of the southern region of the High Arctic study area contains multi-year ice and hence is considered as low to moderately sensitive habitat. No records of narwhal in this region were located however 30 year median ice charts suggest summer open water habitat is common and therefore narwhals may occur in the areas identified in Figure 4.5. Winter narwhal habitat of low/moderate sensitivity was not identified in the High Arctic study area.

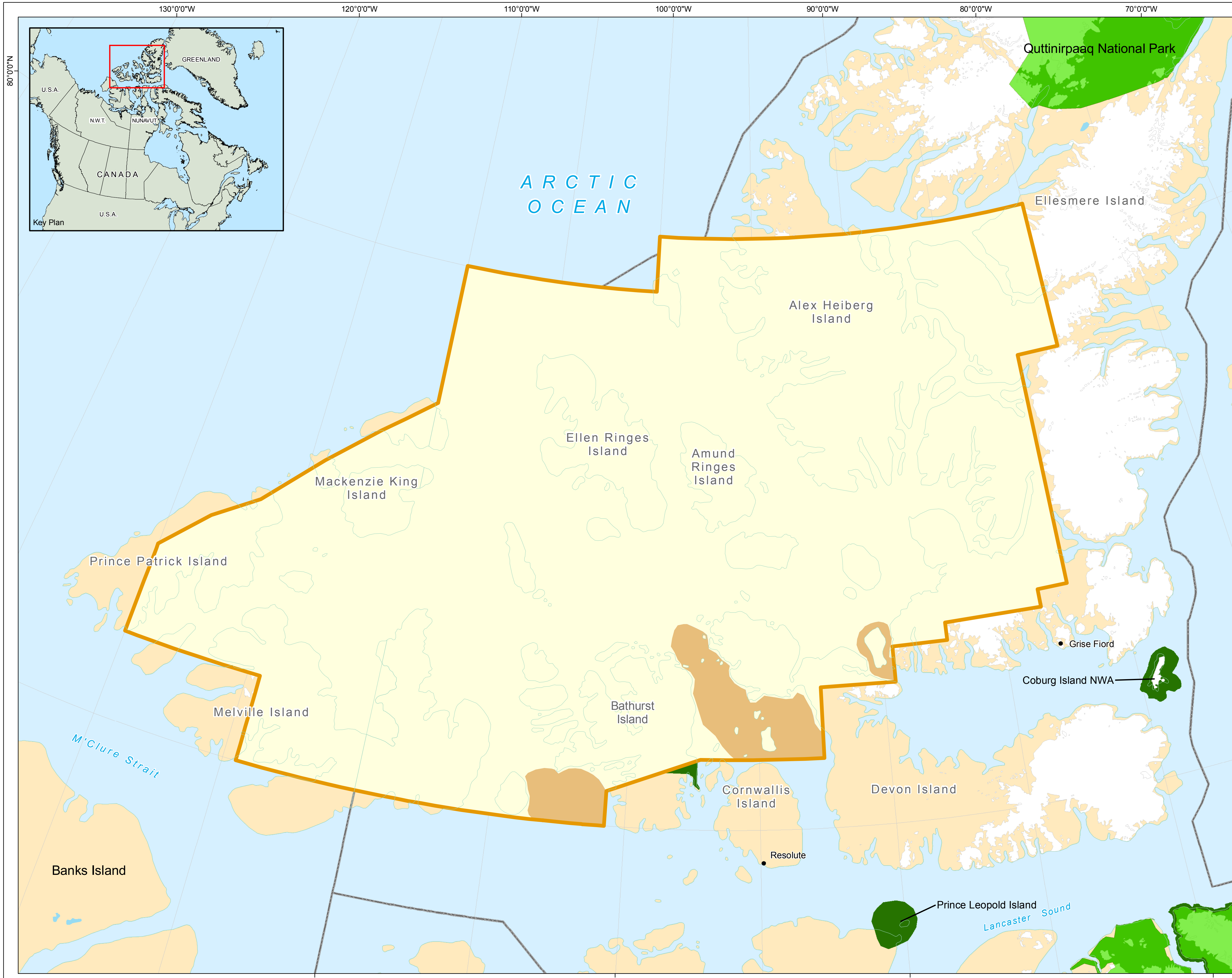
Low Sensitivity (1)

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

Multi-year pack ice and 100% ice concentrations are expected to be more common and consistent in the northern region of the High Arctic study area; hence narwhal presence during this summer here is less likely. In the winter, the majority of the High Arctic study contains dense concentrations of ice and narwhal habitat sensitivity here was ranked as low.

High Arctic, Nunavut, Canada
Narwhal
Winter Sensitivity

Fig 4-4



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

Base Features
- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120
Kilometres

Prepared By:
Nunami - Stantec

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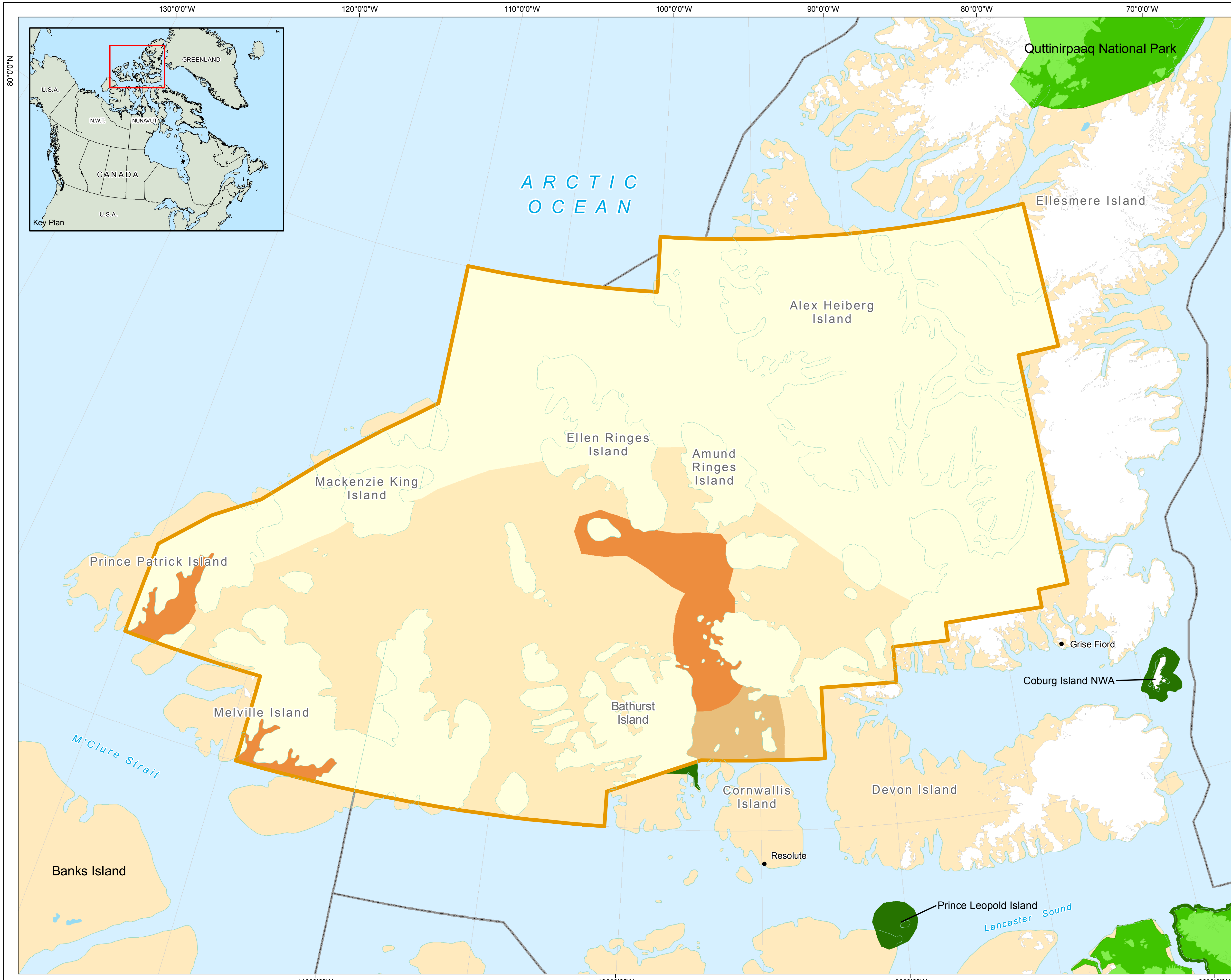

High Arctic, Nunavut, Canada
Narwhal
Summer Sensitivity

Fig 4-5

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

Base Features
- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

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Kilometres

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Figure ID: 123110162-032

4.2.4 Mitigation

The most effective available mitigation tool to avoid potential effects to marine mammals is planning which can notably assist in avoiding sensitive spatial and seasonal narwhal habitat. Unfortunately, in the Canadian Arctic, knowledge on sensitive, and biologically important habitat, is at a very coarse level (commensurate with few, and often older, 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. Other common, minimum standard, mitigations regarding seismic testing are outlined in the Canadian Statement of Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2010, internet site). This document outlines such measures as the use of dedicated Marine Mammal Observers aboard related vessels, designation of a marine mammal exclusion zone around active seismic arrays, soft-starts (ramp-ups) and use of Passive Acoustic Monitoring. Vessel speed restrictions and minimum aircraft altitude restrictions are also common best practices with regard to minimizing the potential for mammal – vessel strikes and disturbance.

4.2.5 Data Sources and Certainty

Data sources used for the determination of narwhal habitat ranges are found on Figure 4.3.

Certainty regarding narwhal distribution in the High Arctic is not high. This is largely due to the limited number, and date, of studies conducted to determine distribution in this area.

4.2.6 Summary

Known Narwhal range overlaps only partially with the High Arctic Study Area. Preferred narwhal habitat includes regions of dense annual pack-ice, shear zone/leads, shelf break, deep ocean basins, estuaries/lagoons/fjords. Such regions are uncommon in the High Arctic Study Area.

Highly sensitive and moderate to highly sensitive summer or winter narwhal habitat was not identified within the high Arctic study area. Moderately sensitive narwhal summer habitat includes the ice edge (pack ice next to open water) region of Queens Channel north of Cornwallis Island. Much of the southern region of the High Arctic study area contains multi-year ice and hence is considered as low to moderately sensitive habitat.

Areas with multi-year pack ice and 100% ice concentrations are expected to be more common and consistent in the northern region of the High Arctic study area. Narwhal presence in the summer here is less likely and hence this habitat is considered to have low sensitivity. In the winter, the majority of the High Arctic study contains dense concentrations of ice and narwhal habitat sensitivity here was also ranked as low.

Due to their strong association with ice, climate change may induce changes in habitat, migration pattern and predation rates.

4.3 Migratory Birds

4.3.1 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 off shore indicator of anthropogenic disturbance. Seabirds have strong cultural significance and are often featured in carvings.

4.3.2 Migratory Birds Summary

4.3.2.1 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 2004). 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.

The Canadian Arctic provides important habitat for many species, including shorebirds. Species nesting in the High Arctic include Ruddy Turnstone (*Arenaria interpres*), Purple Sandpiper (*Calidris maritima*), Red Knot (*Calidris canutus*), Pectoral Sandpiper (*Calidris menanotos*), Baird’s Sandpiper (*Calidris bairdii*), Buff breasted Sandpiper (*Tryngites subruficollis*), Red Phalarope (*Phalaropus fulicaria*). A number of shorebirds that nest in the Arctic depend on Canada heavily on Canada, where much of their global population is found. For example, the percentage of the global population that depends on Canada for habitat is 41% of Red Knots, 45% of Pectoral Sandpipers, 80% of Baird’s Sandpipers (although not all of that habitat is found in the High Arctic) (Zöckler 1998).

4.3.2.2 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.* 2008). 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 (Mallory and Fontaine 2004; Latour, *et al.* 2008). 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 4-6. A short description is provided below.

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.

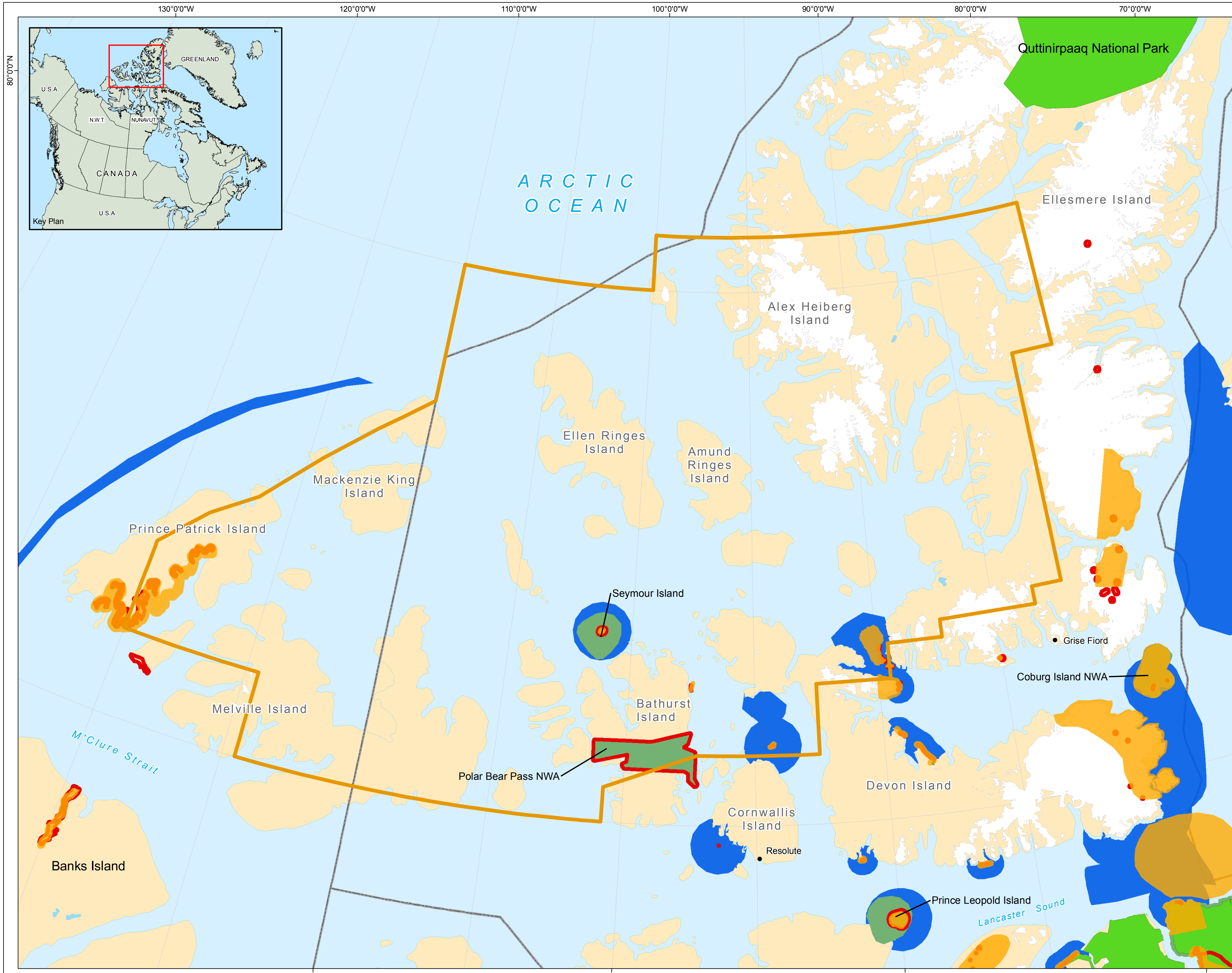
There is one Migratory Bird Sanctuary in the High Arctic study area, Seymour Island.

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 Fig 4-6. 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.



High Arctic, Nunavut, Canada Migratory Birds Distribution

Fig 4-6

Key Terrestrial Habitat Sites [3]
Key Marine Habitat Site [2]
Important Bird Area [1]

Base Features

Grid Line
Ice Cap
High Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park

1:4,000,000

30 15 0 30 60 90 120
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]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

[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.

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4.3.2.3 Key Terrestrial and Marine Sites

Seymour Island

Seymour Island site has a marine and terrestrial component to the protected area. This area is characterized by strong currents and shallow waters which cause polynyas to develop nearby. The island is small (less than 3 km long) but is Canada's largest known breeding colony of Ivory Gulls, which are listed as Endangered under the *Species at Risk Act*. Seymour Island supports about 10% of the Canadian population (about 100 – 125 pairs) from the end of May to September (Mallory and Fontaine 2004).

Seymour Island is part of the International Biological Programme (Nettleship 1980) and an Important Bird Area in Canada (CEC 1999). According to the IBA criteria, Seymour Island has been identified as Globally Significant for congregatory species and nationally significant for threatened and restricted range species (IBA Canada 2009, Internet site). Since 1975 it has been a Migratory Bird Sanctuary which includes the waters 3.2 km from the high tide line.

North Kent Island, Hell's Gate and Cardigan Strait

Hell Gate and Cardigan Strait site has a marine and terrestrial component. It is made up of narrow passages between North Kent, Northern Devon, and southwestern Ellesmere islands. Strong currents flow through these narrows creating a recurring polynya (Smith and Rigby 1981). Several major bird colonies occur in this area. The most commonly occurring bird in this area is the Black Guillemot (*Cepphus grylle*) which occurs year round with the highest numbers in May to September. This area supports between 0.5 and 8% of the Canadian population (Mallory and Fontaine 2004). About 7,500 pairs or 3% of the Canadian population of the Northern Fulmar (*Fulmarus glacialis*) occurs in this area. Common Eider (*Somateria mollissima borealis*), Glaucous Gulls (*Larus hyperboreus*), Thayer's Gulls (*Larus glaucoides thayeri*), Arctic Terns (*Sterna paradisaea*) and the High Arctic Brant (*Branta bernicla*) all occur in the area.

Within the Hell Gate and Cardigan Strait area are Cape Vera, North Kent Island, and Calf Island, both of which are International Biological Porgramme sites (Nettleship 1980) and Important Bird Areas in Canada (CEC 1999). Cape Vera is considered to be an IBA that is globally significant to congregatory species and colonial waterbirds and seabird concentrations (IBA Canada 2009, Internet site). North Kent Island is considered to be globally significant to congregatory species.

Queen's Channel

The Queen's Channel site is located between Cornwallis Island and the Grinnell Peninsula off north-western Devon Island and contains two important terrestrial habitat sites that support seabird colonies within the marine region (Alexander, *et al.* 1991). The Cheyne Islands support the largest known breeding population in the Canadian Arctic of Ross' Gull (*Rhodostethia rosea*) (listed as 'Threatened' under the SARA). Other occurring species include Common Eiders (almost 1% of the Canadian population), Black-legged Kittiwakes (almost 1% of the Canadian population), King Eiders, Black Guillemots.

Within Queen's Channel, Washington Point is an International Biological Programme site (Nettleship 1980), and both Washington Point and the Cheyne Islands are Important Bird Areas in Canada (CEC 1999). Washington Point is an IBA that is considered to be continentally significant for congregatory species and the Cheyne Islands are considered nationally significant for threatened species (IBA Canada 2009, Internet site).

Cheyne Islands

These three islands are located on the west side of Penny Strait. Along with the Churchill area, are the only two known breeding locations of the nationally vulnerable Ross Gull (IBA Canada 2009, Internet site). Unfortunately surveys of these islands have not been conducted since 1978, so the present status of Ross Gulls at this site is not known. The islands are considered a nationally significant important bird area.

Eastern Prince Patrick Island Coast

Prince Patrick Island is located in the western high arctic and features numerous expansive cliffs of up to 80 m high as well as coastal lowland areas (Latour, *et al.* 2008). The Brant makes extensive use of the coastal lowland areas for nesting and moulting. This location could service as much as 50% of the Western High Arctic Brant population (Latour, *et al.* 2008). Additional species that use this important terrestrial site include Snow Geese (Lesser and Greater), King Eider, Common Eider, Long-tailed Ducks, Pacific Loons, Glaucous Gulls, Peregrine Falcons, Black-legged Kittiwakes.

The Brants and their associated habitat are particularly sensitive to disturbance during the summer. Prince Patrick Island has potential for hydrocarbon deposit and is listed as an Important Bird Area in Canada (Latour, *et al.* 2008). This IBA is considered globally significant for congregatory species (IBA Canada 2009, Internet site).

4.3.2.4 Sustainability Factors

Birds are susceptible to disturbance or loss of habitat resulting from development activities and direct mortality resulting from accidents or malfunctions associated with oil and gas development.

4.3.2.5 Susceptibility to Oil and Gas Activities

Migratory birds occurring on open water can generally avoid the routine effects of hydrocarbon development (for example, by moving to avoid passing ships). Human disturbance (such as low-flying aircraft) can affect nesting colonies, in the most extreme case causing them to be abandoned (IBA Canada 2009, Internet site). This is potentially important for bird species that are either concentrated into relatively small areas or are "at risk" (such as the endangered Ivory Gull).

While the PEMT focuses on routine effects, seabirds can be particularly susceptible to the effects of oil spills. The importance of this effect depends on several factors, beginning with the likelihood that birds will come into contact with oil (which in turn depends on when and where the spill occurs). When birds do come into contact with oil, they can lose the ability to insulate themselves (as feathers are coated) or ingest hydrocarbons and experience toxicological effects, both of which can cause mortality. Species that spend a large amount of time swimming on the sea surface and those that form large aggregations are the most vulnerable.

4.3.2.6 Potential Effects of Climate Change on VEC

Climate change 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.

4.3.3 Sensitivity Ranking

Sensitivity ranking for migratory bird habitat in the high arctic study area is summarized in Figures 4-7 (winter season) and 4-8 (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) Supports 1% of the North American population (following the IBA guidelines)

(b) 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) Has been identified as being either globally or continentally significant Important Bird Area

(d) 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: Seymour Island, North Kent Island, Eastern Prince Patrick Island Coast, Key Terrestrial Habitat Sites (e.g., Queen's Channel).

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.

In the study area these areas include Cheyne Islands, Key Migratory Bird Marine Habitat Sites, and biological hotspots.

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: (a) coastal areas; (b) offshore areas to the limit of summer pack ice; (c) floodplains; (d) upland areas; and (e) 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)

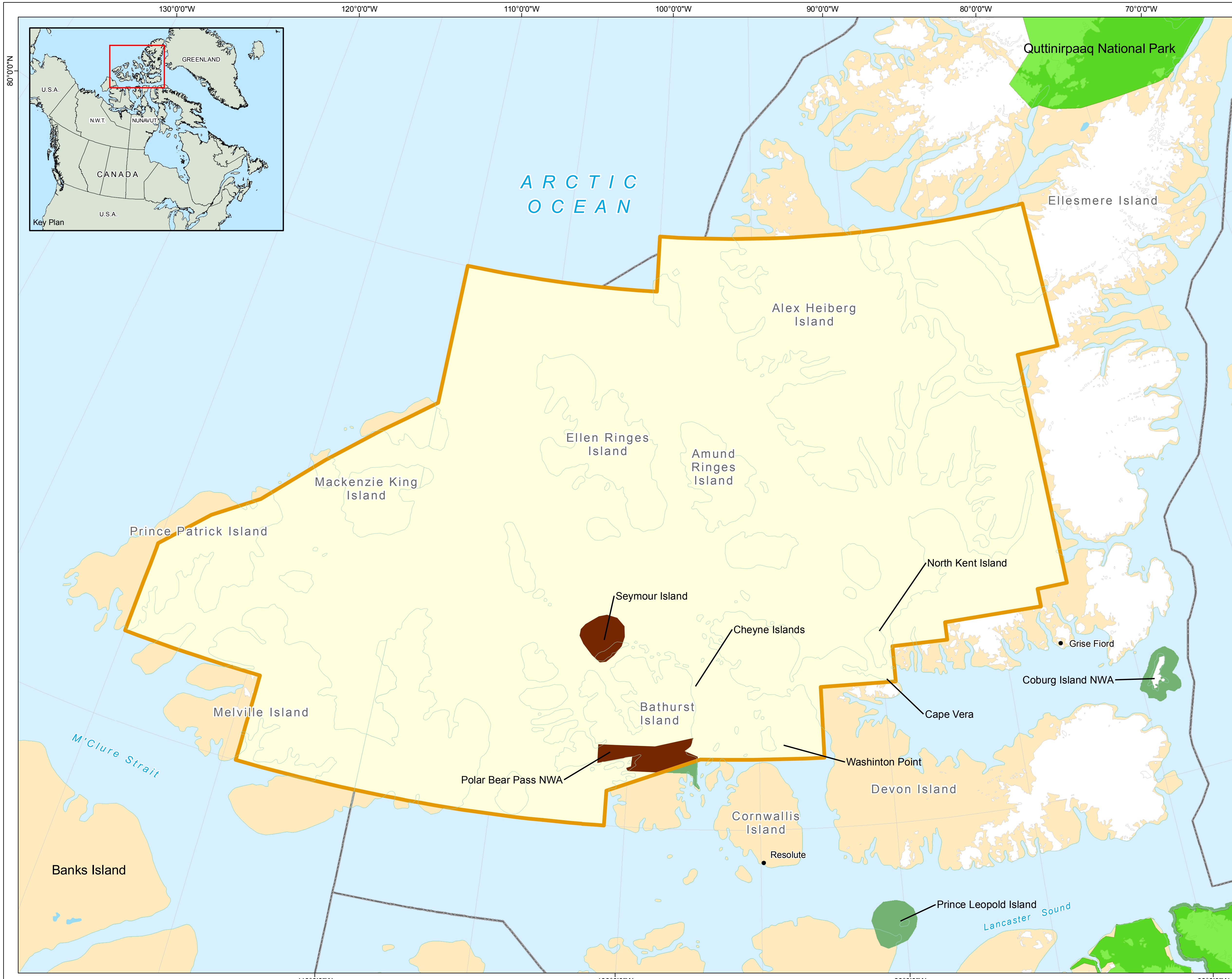
Low to moderate sensitivity was given to areas considered locally important to migratory birds. In the study area these areas include areas with low to moderate densities. This includes areas which, while not permanently covered in ice, are outside the usual ranges of most migratory birds.

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 and terrestrial ice caps).

High Arctic, Nunavut, Canada
Migratory Birds
Winter Sensitivity Rating

Fig 4-7



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

Base Features
- Community
- Geogratis_7M_Province
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120
Kilometres

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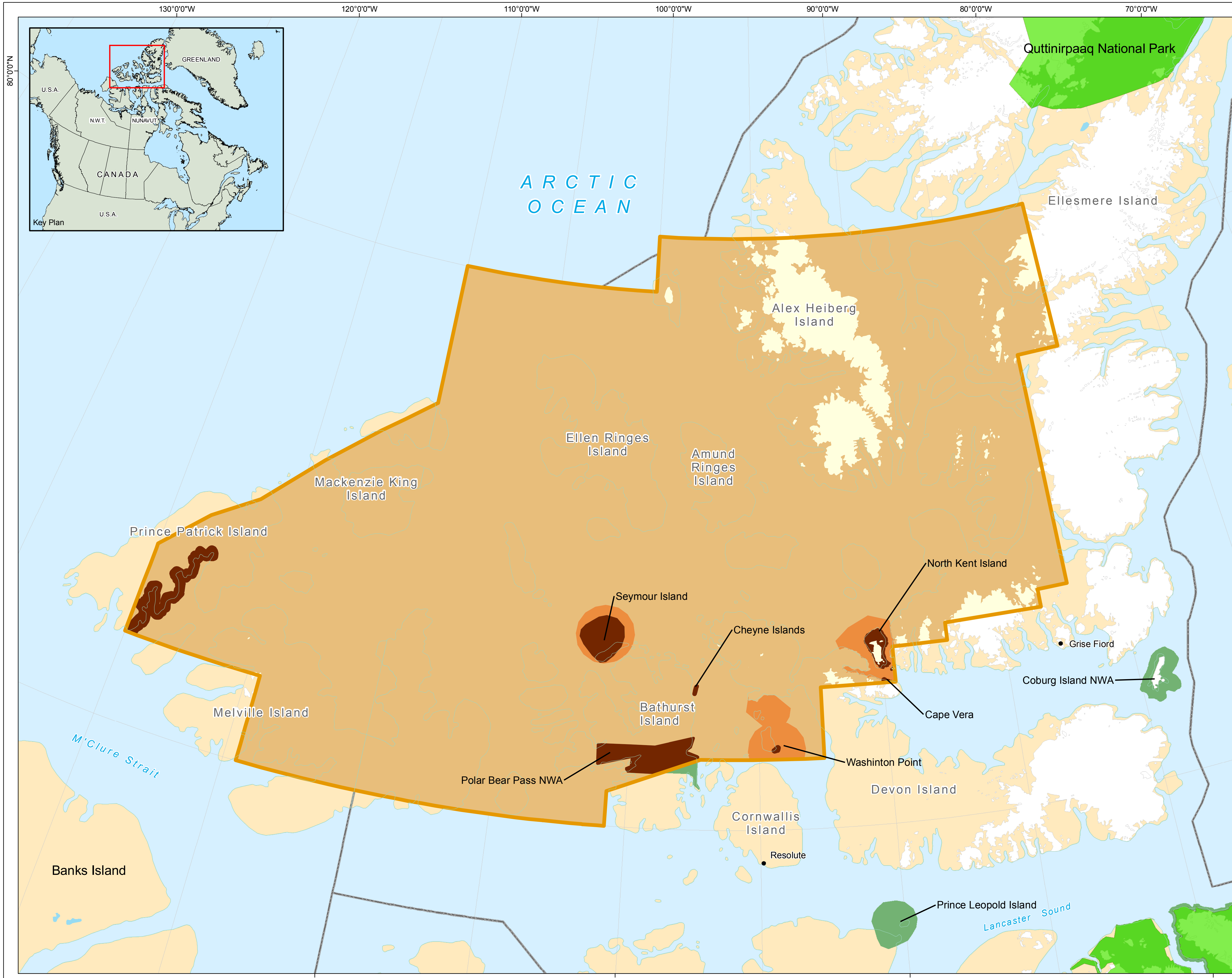
High Arctic, Nunavut, Canada
Migratory Birds
Summer Sensitivity Rating

Fig 4-8



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

Base Features
- Community
- Geogratis_7M_Province
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120
Kilometres

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4.3.4 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); and (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.

4.3.5 Data Sources and Certainty

For most bird species in the High 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.* 2008), 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.

4.3.6 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 birds 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 High Arctic Study Area includes Seymour Island, North Kent Island, Eastern Prince Patrick Island Coast, and Key Terrestrial Habitat Sites (e.g., Queen's Channel). Moderate to highly sensitive habitat includes Cheyne Islands, Key Migratory Bird Marine Habitat Sites, and biological hotspots. 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).

4.4 Species of Conservation Concern

4.4.1 Rationale for Selection

Regulators, First Nations, and other stakeholders are particularly concerned about Species at Risk. For the purposes of this report they are considered species: (a) listed on Schedule 1 of SARA; (b) assessed by COSEWIC as endangered, threatened, or special concern; and, (c) categorized by the IUCN as critically endangered, endangered, vulnerable, or near threatened. Species of conservation concern often have additional ecological, cultural and/or economic importance. In the high Arctic Study area, species of conservation concern include polar bear, narwhal, walrus, Peary caribou, and ivory gull.

4.4.2 Species of Conservation Concern Summaries

See Section 4.1.2 for a summary of the polar bear and Section 4.2.2 for a summary of the narwhal.

4.4.2.1 Life History

Conservation Status

Walrus

The walrus is currently classified as Special Concern (COSEWIC 2006a). In February of 2008 DFO, under the species at risk recovery strategy, issued a recovery strategy for the Atlantic walrus population (Recovery Strategy for the Atlantic Walrus (*Odobenus rosmarus rosmarus*), Northwest Atlantic Population in Canada). DFO is responsible for the management of the walrus population in Nunavut.

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 (18 out of 28) 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.

Peary Caribou

Northern people within their range depend on the caribou for food. The value of the resident caribou harvest was estimated at about $17 million in 2001 and the cultural value cannot be estimated. The caribou are an essential part of northern ecosystems and cultural heritage. They qualify as a "keystone species" because many other forms of life depend on them. Wildlife tourism is important in many parts of Canada occupied by caribou. Both sport and subsistence hunting of caribou is of economic importance in Nunavut.

The Peary caribou in Nunavut was assessed as endangered by COSEWIC and consultations are underway to determine its SARA status, therefore, they are currently designated as Non-active (COSEWIC 2004b).

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

Winter Distribution and key habitat of Species of concern is summarized in Figure 4-9 and summer distribution and key habitat is summarized in Figure 4-10.

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 Nunavut. The South and East Hudson Bay population is distributed over an area of about 65,000 km^2, from the Ottawa Islands south to the Ekwan Point area of James Bay and inhabit the Belcher Islands (Gilchrist and Robertson 2000). 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.

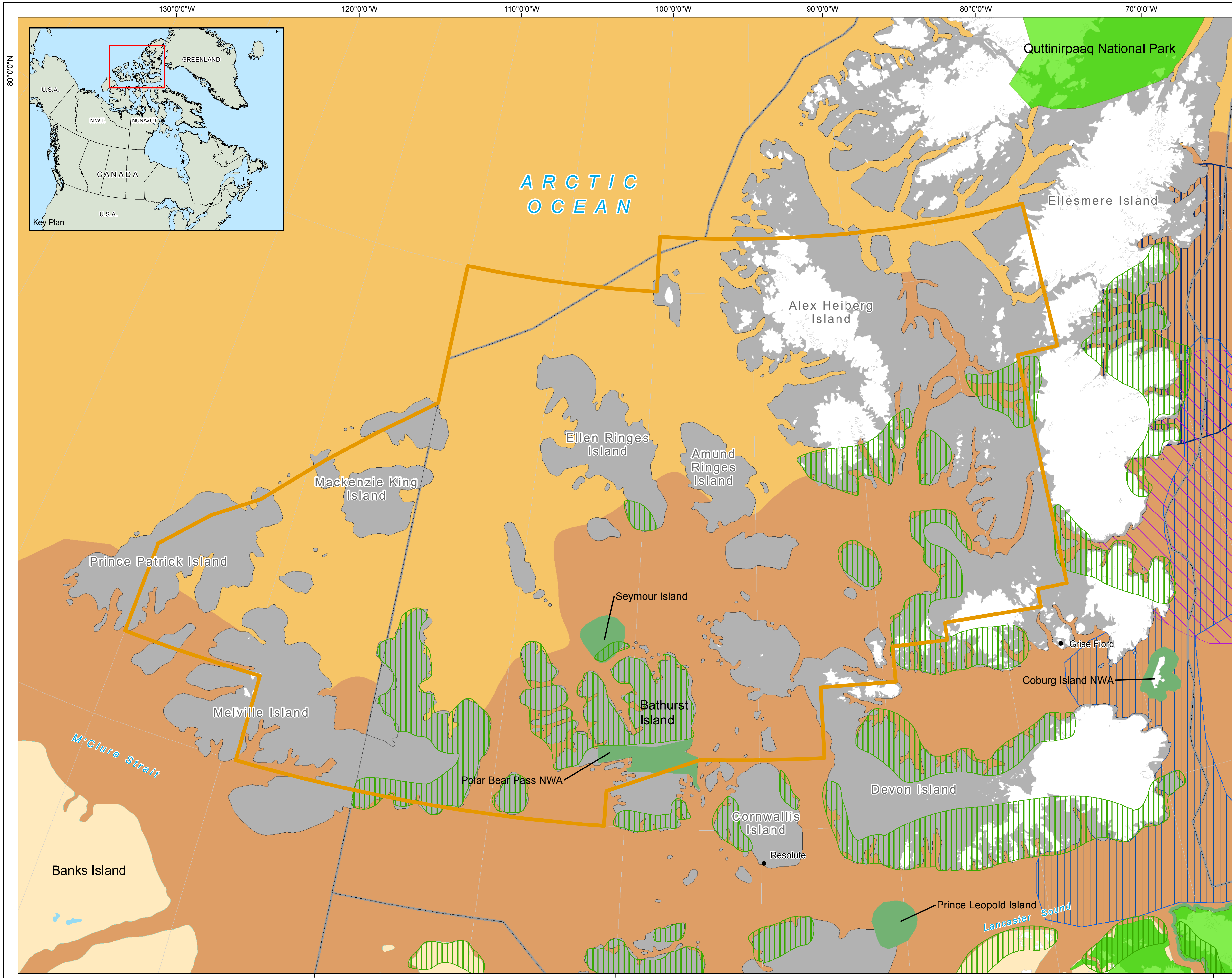
Peary Caribou

Peary caribou are the smallest subspecies of caribou, and are found in the Canadian Arctic archipelago, where they number approximately 10,000 animals.

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 (COSEWIC 2006b). 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.* 2008), 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.* 2008). 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.* 2008). The colonies on eastern Devon Island were always relatively small, and have also been largely abandoned (Latour, *et al.* 2008).

The wintering population distribution is poorly known but are known to winter 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).



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

Fig 4-9

- Beluga Winter Range [5]
- Narwhal Winter Concentration [1]
- Bowhead Wintering Area [4,6,8]
- Walrus Winter Distribution [3]
- Walrus Winter Concentration Area [7]
- Polar Bear Denning Area [7,9]
- Core Polar Bear Range [6]
- Lower Density Polar Bear Range [6]
- Peary Caribou Range [2]

Base Features

- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120

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. 2004. COSWEIC assessment and update report on the Peary caribou Rangifer tarandus pearyi and the barren-ground caribou Rangifer tarandus groenlandicus (Dolphin and Union population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 91 pp.
*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. 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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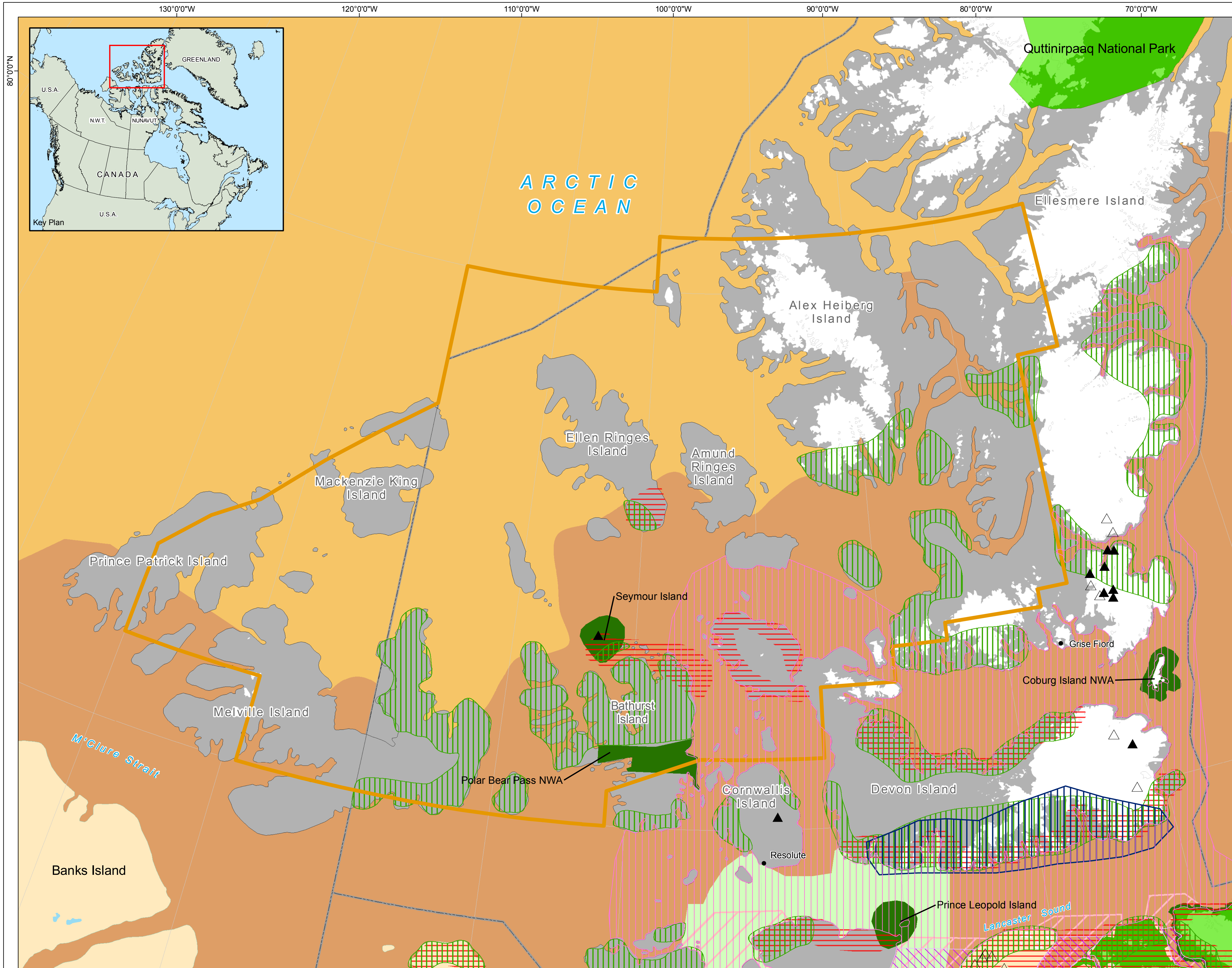

High Arctic, Nunavut, Canada Species Of Conservation Concern Summer Distribution

Fig 4-10

- ▲ Known Ivory Gull Colony [5]
- △ Potential Ivory Gull Colony [5]
- Bowhead Summer Aggregation Areas [6]
- Walrus Summer Distribution [4]
- Walrus Summer Concentration Area [8]
- Polar Bear Denning Area [8,10]
- Narwhal Summer Concentrations [2]
- Summer Retreat [8]
- Beluga Summer Core Area [1,7]
- Core Polar Bear Range [9]
- Lower Density Polar Bear Range [9]
- Peary Caribou Range [3]

Base Features

- ● Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Reg. Boundary
- Conservat'n Area
- National Park

1:4,000,000

30 15 0 30 60 90 120

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. 2004. COSWEIC assessment and update report on the Peary caribou Rangifer tarandus pearyi and the barren-ground caribou Rangifer tarandus groenlandicus (Dolphin and Union population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 91 pp.
*Digitized by Nunami Stantec 2010

[4]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

[5]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

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

[8]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

[9]Stirling, I. 1998. Polar Bears. The University of Michigan Press. Ann Arbor, Michigan.
*digitized by Nunami Stantec 2010

[10]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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Ecology

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 (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 (COSEWIC 2006a).

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).

Peary Caribou

Ground and tree lichens are the primary winter food of caribou. After the snow melts, caribou switch to green vegetation; sedges, willow and other shrubs, and flowers. Caribou are considered migratory and often travel long distances between wintering and calving grounds. Although caribou often return to the general area for both winter and calving grounds, there is no indication of fidelity to specific ranges (Miller 2003). Depending upon winter conditions, Peary caribou will generally space themselves in smaller groups (Miller ,*et al.* 1982).

Peary caribou are small caribou found only in the islands of the Canadian Arctic archipelago, where they number approximately 10,000 animals. Peary caribou do not normally have significant migrations,

[2] Males mate with more than one female

although many move among islands during summer and, especially if hard icing conditions force them from their normal ranges (COSEWIC 2004b)

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 (COSEWIC 2006b). 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 (Gilchrist and Mallory 2005; 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 (COSEWIC 2006b).

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 (COSEWIC 2006b). They are known to remain close to the pack ice or close to polynyas, scavenging on carrion on the ice (COSEWIC 2006b).

4.4.2.2 Key Habitat

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.

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.

Peary Caribou

Peary caribou use poorly to moderately vegetated dry to moist habitats (Miller 1991). Ground and tree lichens are the primary winter food of caribou. After the snow melts, caribou switch to green vegetation; sedges, willow and other shrubs, and flowers. Caribou are vulnerable when they congregate for calving and rutting and therefore these areas are likely critical habitat (COSEWIC 2004b). In addition, uninterrupted foraging in these areas is important to the cyclical growth and increase in quality of physical condition and calf growth.

Ivory Gull

The Ivory Gull requires nesting sites that are free from predators and in close 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).

4.4.2.3 Sustainability Factors

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).

Peary Caribou

Caribou are susceptible to and recover slowly from population declines because of their low rate of reproduction. The main factors leading to caribou declines are habitat loss, degradation, and fragmentation, as well as predation and disease. Wolves are considered the major predators of caribou. Some wolf packs will follow migrating herds of caribou year round. Other predators of caribou include grizzly and black bears, wolverines, lynx, and golden eagles (Miller 2003).

The availability of wintertime forage is the main limiting factor for Peary caribou. Deep snow, ground-fast ice, and wind-packed snow can make food difficult to reach; thus snow and ice conditions have a direct influence on mortality, nutrition and productivity (Gunn, *et al.* 2000). The uncertainty of climate trends for the western High Arctic population is a current cause for concern. Both summer and winter inter-island movements need to be identified and documented. Hunting is considered a potential limiting factor. Wolf predation and disturbances by humans may also be contributing to the population declines. In the Arctic, the limiting factors are compounded: a series of disturbances, insufficient forage supply, or increased hunting following a severe winter could have drastic effects on the populations of Peary caribou.

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).

4.4.2.4 Susceptibility to Oil and Gas Activities

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. It is possible that commercial fisheries may compete for resources, potentially damaging seabed and causing temporary disturbances to habitats (COSEWIC 2006a). Ship noise and oil and gas exploration could displace walruses from their haul-outs and interfere with their communication (Stewart 2002).

Peary Caribou

Disturbances such as the movement of low level aircraft and ground vehicles and construction of ground installations may hamper movement to better feeding grounds. Increasing human disturbance in the high Arctic, through ice breaking activities and increased shipping traffic will have an impact on the Peary caribou populations.

Ivory Gull

Industrial activities are a threat to the nesting areas of Ivory Gulls on the Brodeur Peninsula, Baffin Island. Diamond exploration and associated activities have been taking place since 2002 and their effects on nesting Ivory Gulls are undocumented (COSEWIC 2006b). Most breeding colonies are remote and undisturbed, but on the Brodeur Peninsula of Baffin Island there has recently been a considerable increase in diamond mine exploration, coincident with a significant decline in colony occupation (COSEWIC 2006b). 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).

4.4.2.5 Potential Effects of Climate Change on Species of Conservation Concern

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 and development pressure on walruses will likely increase as the amount and duration of ice cover in the Arctic declines (Marine Mammal Commission 2009). 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).

Peary Caribou

For Peary caribou, climate change will potentially result in deeper snow, faster spring melt, warmer summers, and freezing rain. High annual variability of all these factors may have an impact on the ability of caribou to thrive in its environment.

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).

4.4.3 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 4-11 (winter) and Figure 4-12 (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)

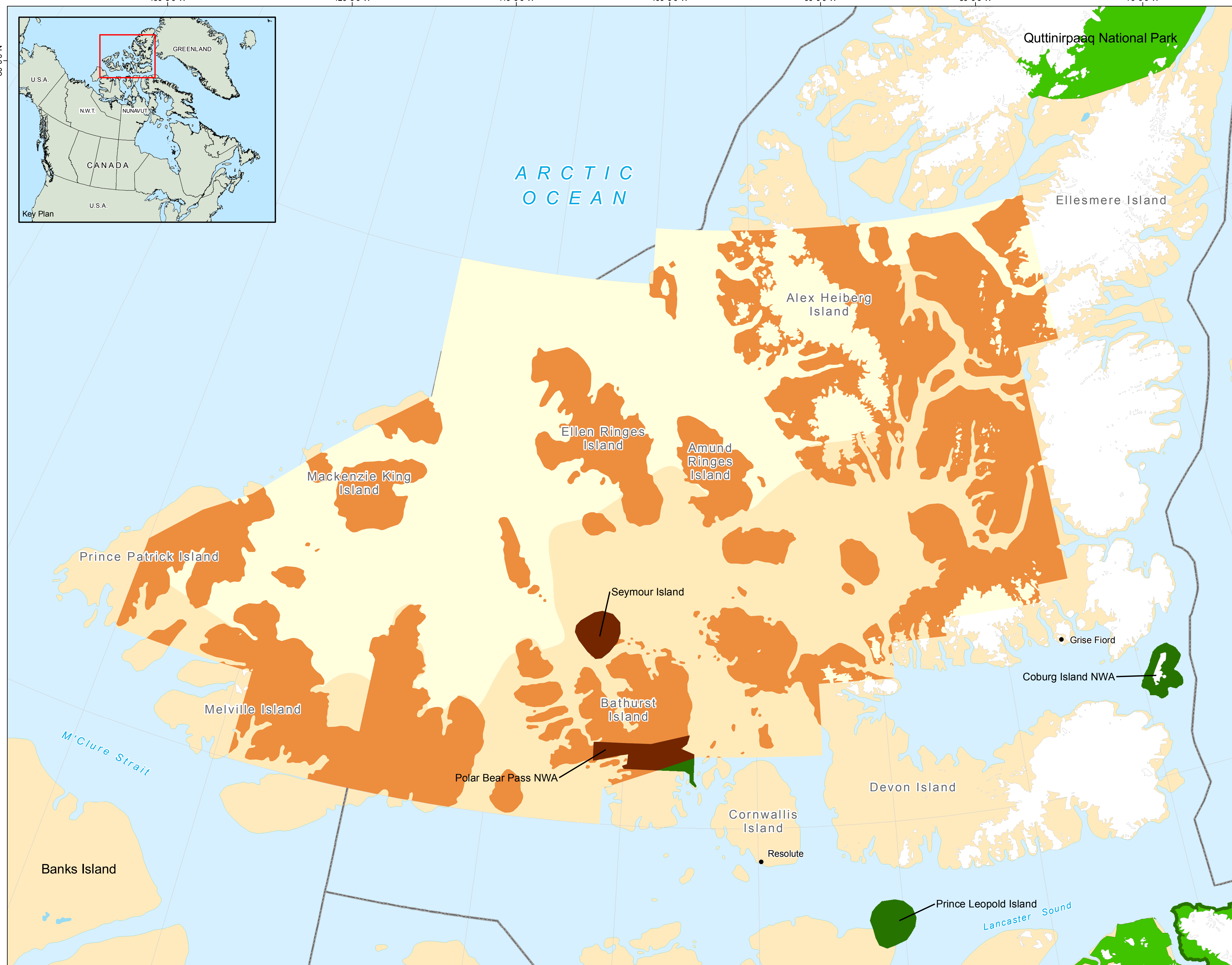
A rating of moderate sensitivity represents areas that overlap with the range of any species identified as ‘Threatened’ under SARA or COSEWIC or ‘Vulnerable’ under IUCN.

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.



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

Fig 4-11

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

Base Features
- Community
- Grid Line
- Ice Cap
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120
Kilometres

Prepared By:
Nunami - Stantec

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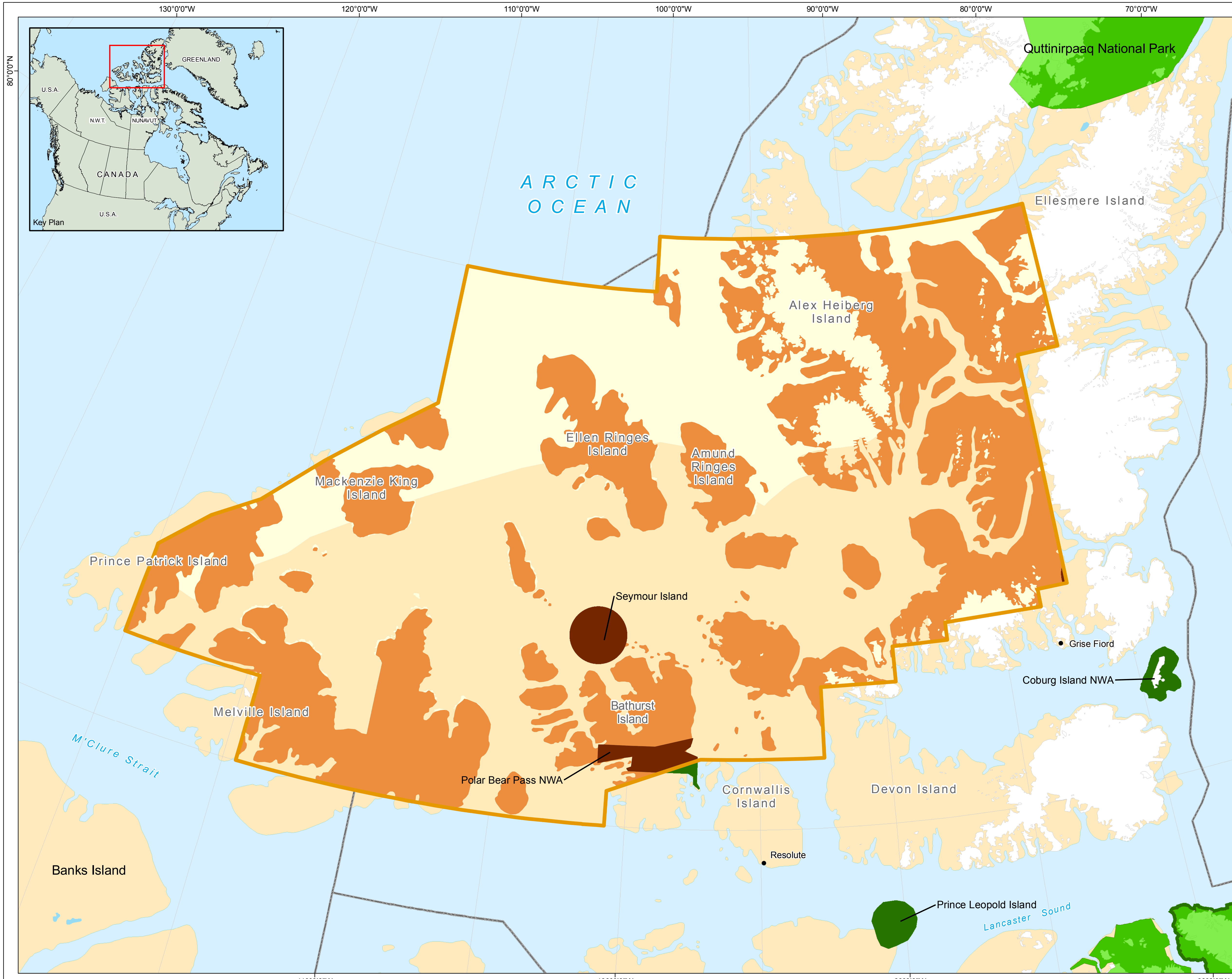

High Arctic, Nunavut, Canada Species Of Conservation Concern Summer Sensitivity

Fig 4-12

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

Base Features
- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120

Kilometres

Prepared By:
Nunami - Stantec

References:

1. Van De Velde et al., 2003
2. Freshwater institue. 1994.
3. Nunavut Planning Commission,

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4.4.4 Mitigation

Species specific mitigation strategies are summarized in Sections 4.1.4 (polar bear), 4.2.4 (narwhal) and 4.3.4 (ivory gull). Additional mitigation required for walrus include vessel speed restrictions, noise restrictions, and minimum aircraft altitude restrictions around known haul-out sites. Any development within the range of the Peary caribou will need to be mitigated to avoid sensitive life stages and noise disturbance from aircraft, land vehicles, and construction activities. As specific seasonal habitat use of Peary caribou in the arctic islands is poorly understood, additional studies would be required to address these knowledge gaps.

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.

4.4.5 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.

4.4.6 Summary

Species of conservation concern often have additional ecological, cultural and/or economic importance. There are three species of conservation concern with ranges that overlap with the High Arctic Study area. High sensitivity areas for species of conservation concern include Seymour Island (an ivory gull breeding colony) and Polar Bear Pass National Wildlife Area. Moderate to high sensitivity areas include terrestrial and coastal habitat where Peary Caribou are distributed. Low to moderate sensitivity rating was given to marine and sea ice habitat in the southern portion of the study area which includes the core range of the polar bear. Marine and sea ice habitat that overlaps with areas of lower polar bear density was given a low sensitivity rating.

4.5 Traditional Harvesting

4.5.1 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 (Nunavut Planning Commission 2000). The availability of traditionally harvested foods lowers the demand for imported food which is both costly and often less nutritious. Additionally, the harvesting of wildlife and subsequent distribution and use of the harvest provides important opportunities to maintain and enhance Inuit culture.

4.5.2 Traditional Harvest Summary

4.5.2.1 Background

Traditional harvesting is how the Inuit have provided for their families. According to the 2001 Aboriginal Peoples Survey, approximately seven out of ten Inuit still participate in traditional harvesting across Nunavut (Buell 2006). Within the ISR, traditional renewable resource harvest in the Olokhatomiut traditional harvest area includes fish, seals, caribou, Muskox, fox, wolf, polar bear, Arctic hare, ptarmigan and waterfowl (OCCP 2000). Primary economic activities in Uluhaktok include hunting, trapping, fishing and arts and crafts (OCCP 2000).

Further details of harvesting activities within various community areas within the study area can be found in Section 4.5.2.2.

The following is a list of species which are documented as harvested in the High Arctic study area:

- Polar Bear
- Caribou
- Arctic Char.

4.5.2.2 Description of Traditional Harvesting Activities by Community Areas in the Nunavut Settlement 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. The information in the Nunavut Atlas is dated; however, it is the most comprehensive record of harvesting areas 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 4-1. Traditional harvest sites are summarized in Figures 4-13 (winter) and 4-14 (summer).

Bache Peninsula

There is a major travel route between Ellesmere Island and Axel Heiberg Island, through Eureka Sound. This is a snowmobile travel route used occasionally by Grise Fiord hunters to travel between Grise Fiord and Eureka. The intensity of land use in this area is rated as medium. Caribou are occasionally hunted along the east side of Eureka Sound.

Raanes Peninsula and Svendsen Peninsula on the east side of Ellesmere Island as well as Baumann Fiord were reported to be used by Grise Fiord hunters during winter and spring to hunt for polar bears and caribou. The intensity of land use in this area is rated as high. Most caribou are taken along the shores of Blind Fiord, while Baumann Fiord is where polar bears are often found.

Sverdrup Islands

The southern portion of Axel Heiberg Island, along the coast and in Norwegian Bay, has a reported high level of Inuit land use. There are about several camping sites present and Grise Fiord hunters were reported to use this area every year during spring and winter to hunt for polar bears.

King Christian Island

Penny Strait and Queens Channel, east of Bathurst Island as well as the eastern coastline of Bathurst Island are rated as having a medium intensity level of Inuit land use. There are camping sites present on the eastern coastal side of Bathurst Island. This area was used for caribou hunting by Resolute hunters until 1974; however, due to a rapid decrease in population the Resolute Hunters and Trappers Association (HTA) declared a moratorium on caribou hunting here. Penny Strait and Queens Channel have been occasionally used in March and April by the Resolute hunters for polar bears.

Norwegian Bay

Part of Norwegian Bay has an Inuit land use intensity rating of high. There are several camping sites in the area, as well as a few fishing sites.

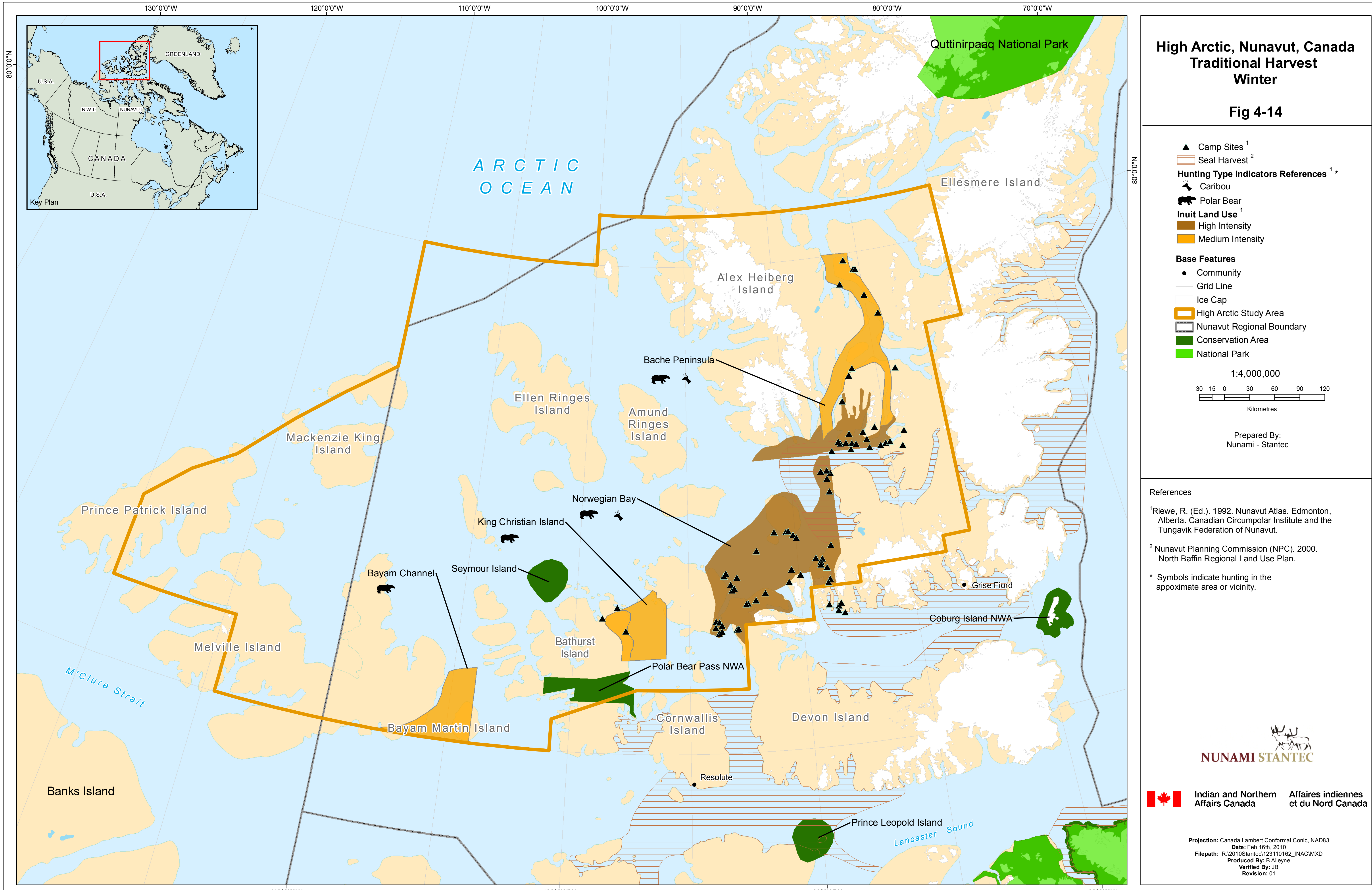
Norwegian Bay was reported to be used annually for polar bear hunting during the spring by hunters from Grise Fiord.

Grise Fiord residents conduct caribou hunting on Graham Island, Buckingham Island and the western portion of Ellesmere Island in the spring, and occasionally during the fall.

The northern portion of Devon Island which falls within this study area is used to hunt caribou in August, by hunters from Grise Fiord. There are also some fishing sites in this area where Arctic char are fished for during summer.

Byam Channel

Byam Channel, which lies between Melville Island and Byam Martin Island, has been rated as having a medium intensity level of Inuit land use. This area has been used by Resolute hunters to hunt for polar bears (also in Byam Martin Channel and on the southeast coast of Melville Island).


High Arctic, Nunavut, Canada
Traditional Harvest
Winter
Fig 4-14
Camp Sites 1
Seal Harvest 2
Hunting Type Indicators References 1 *
Caribou
Polar Bear
Inuit Land Use 1
High Intensity
Medium Intensity
Base Features
Community
Grid Line
Ice Cap
High Arctic Study Area
Nunavut Regional Boundary
Conservation Area
National Park
1:4,000,000
30 15 0 30 60 90 120
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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Revision: 01
Key Plan
GREENLAND
U.S.A.
N.W.T.
NUNAVUT
CANADA
U.S.A.
130°0'0"W
120°0'0"W
110°0'0"W
100°0'0"W
90°0'0"W
80°0'0"W
70°0'0"W
80°0'0"N
ARCTIC
OCEAN
Quttinirpaaq National Park
Ellesmere Island
Alex Heiberg Island
Bache Peninsula
Ellen Ringes Island
Amund Ringes Island
Mackenzie King Island
Prince Patrick Island
Norwegian Bay
King Christian Island
Seymour Island
Bayam Channel
Grise Fiord
Coburg Island NWA
Melville Island
Bathurst Island
Polar Bear Pass NWA
M'Clure Strait
Bayam Martin Island
Cornwallis Island
Devon Island
Resolute
Prince Leopold Island
Lancaster Sound
Banks Island
110°0'0"W
100°0'0"W
90°0'0"W
80°0'0"W

4.5.2.3 Description of Traditional Harvesting Activities by Inuvialuit from the Inuvialuit Settlement Region (ISR)

The following information has been obtained from the Olokhaktomiut Community Conservation Plan (OCCP 2000). Traditional harvesting activities by residents of Uluhaktok which occur in the study area are described below. For a summary of this information, see Table 4-1.

Within this area, the OCCP (OCCP 2000) describes special designation areas. Those which fall into the study area include: 502B, 503B, 504E and 505E. Harvesting activities are described below for each of these special designated areas.

502B – Emangyok Sound Coastline over to Byam Martin Island

This area includes the south-eastern coastline of Melville Island and Byam Channel, which also includes harvesting by Resolute hunters as indicated in Section 4.5.2.2. The people of Uluhaktok and Sachs Harbour also use this area for subsistence hunting from November to May. Year-round, this area provides important habitat for polar bears, ringed seal, and bearded seal and is an important feeding area for beluga. The area has been used by Inuvialuit for generations and is, therefore; an important traditional and cultural site. The OCCP (2000) raises concern that marine traffic would have a negative impact on traditional harvesting in the area.

503B – Coastline, Kangikhokyoak (Liddon)

This area includes the south side of Melville Island, north of Liddon Gulf, as well as the southern portion of Byam Martin Island. This area falls partially in the study area. This area is noted as being important for traditional harvesting from November to May. The OCCP also reports concerns about negative effects of petroleum industry activity on wildlife habitat.

504E – Ibbett Bay to McCormick Inlet

This designated site includes a section of Melville Island inland from the mouth of Ibbett Bay inland heading east to the mouth of McCormick Inlet. The Dorset encampment site, located here, is most north-westerly known Inuit site in the Canadian Arctic.

505E – Prince Patrick – Key Bird Habitat

This area includes the area on the south-eastern part of Prince Patrick Island in the study area. It is important polar bear habitat and for subsistence harvesting.

Table 4-1: Harvested Species by Community and Time of Year – High Arctic Study Area (Riewe 1992; OCCP 2000)

Location	Community	Harvested Species	Harvesting Season	
			Winter (Sept. – June)	Summer (July – Aug.)
Bache Peninsula	Grise Fiord Hunters	Polar Bear	✓	
		Caribou	✓	
Sverdrup Islands	Grise Fiord	Polar Bear	✓	
King Christian Island	Resolute hunters	Polar Bear	✓	
Norwegian Bay	Grise Fiord	Caribou	✓	✓
		Arctic Char		✓
		Polar Bear	✓	
Byam Channel	Resolute and Holman hunters	Polar bears	✓	
Holman Planning Area	Holman and Sachs Harbour hunters	Polar Bear	✓	

Readers are cautioned that most of 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.

4.5.2.4 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. The study area includes both terrestrial and marine areas, providing for both land based and marine oil and gas activity.

Harvested species and their habitats sensitivity to oil and gas activity will affect the presence and abundance of the species and therefore its availability to be harvested. Sensitivity of wildlife 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, support base) providing opportunities for a number of different direct interactions with traditional harvesting such as disturbance to harvesting areas, physical barriers, noise propagation breaking of ice, visual disruption, etc., which can potentially negatively affect harvesting.

Seismic Exploration

Seismic activity in the study area could occur on land during winter and summer while marine seismic would be conducted during the summer open water season. Terrestrial seismic activity has the potential to affect wildlife presence and limit access to harvesting opportunities. Within the marine environment, seismic surveys may interfere with migration of marine wildlife and potentially affect the availability of species for harvesting.

Ice-based Activities

Drilling and drilling support activities may be conducted on the ice. Under routine conditions these activities would generate noise under ice and above the ice. This may result in avoidance by wildlife and reduce harvesting opportunity. Depending on the length and timing of drilling season ice breaking by ship may be undertaken. In addition to noise generated by ice breaking, 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.

4.5.2.5 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 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.

4.5.3 Sensitivity Ranking

In developing a sensitivity layer for traditional harvesting, consideration was given to the Areas of Importance identified in Appendix G of the NBRLUP, the land use categories presented in the Olokhaktomiut Community Conservation Plan (OCCP 2000) 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. Five categories of lands are designated in the Olokhaktomiut Community Conservation Plan. The Areas of Importance presented in the NBRLUP and the land use categories included in the Olokhaktomiut Community Conservation Plan cover part of the current study area. For that portion of the study area not covered by the NBRLUP or the Olokhaktomiut Community Conservation Plan, sensitivity is considered to be low. Sensitivity ranking for traditional harvest in the high arctic study area is summarized in Figure 4-15.

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 Lands and waters where cultural or renewable resources are of extreme significance and sensitivity and no development should be allowed (OCCP).

Moderate/High Sensitivity (4)

Areas of great importance to the community and where much of the community's harvest comes from the area are rated moderately to highly sensitive. This rating also applies to areas that provide important wildlife habitat (however, alternate habitat is available) (NBRLUP), and lands and waters where cultural or renewable resources are of particular significance and sensitivity throughout the year (OCCP).

Moderate Sensitivity (3)

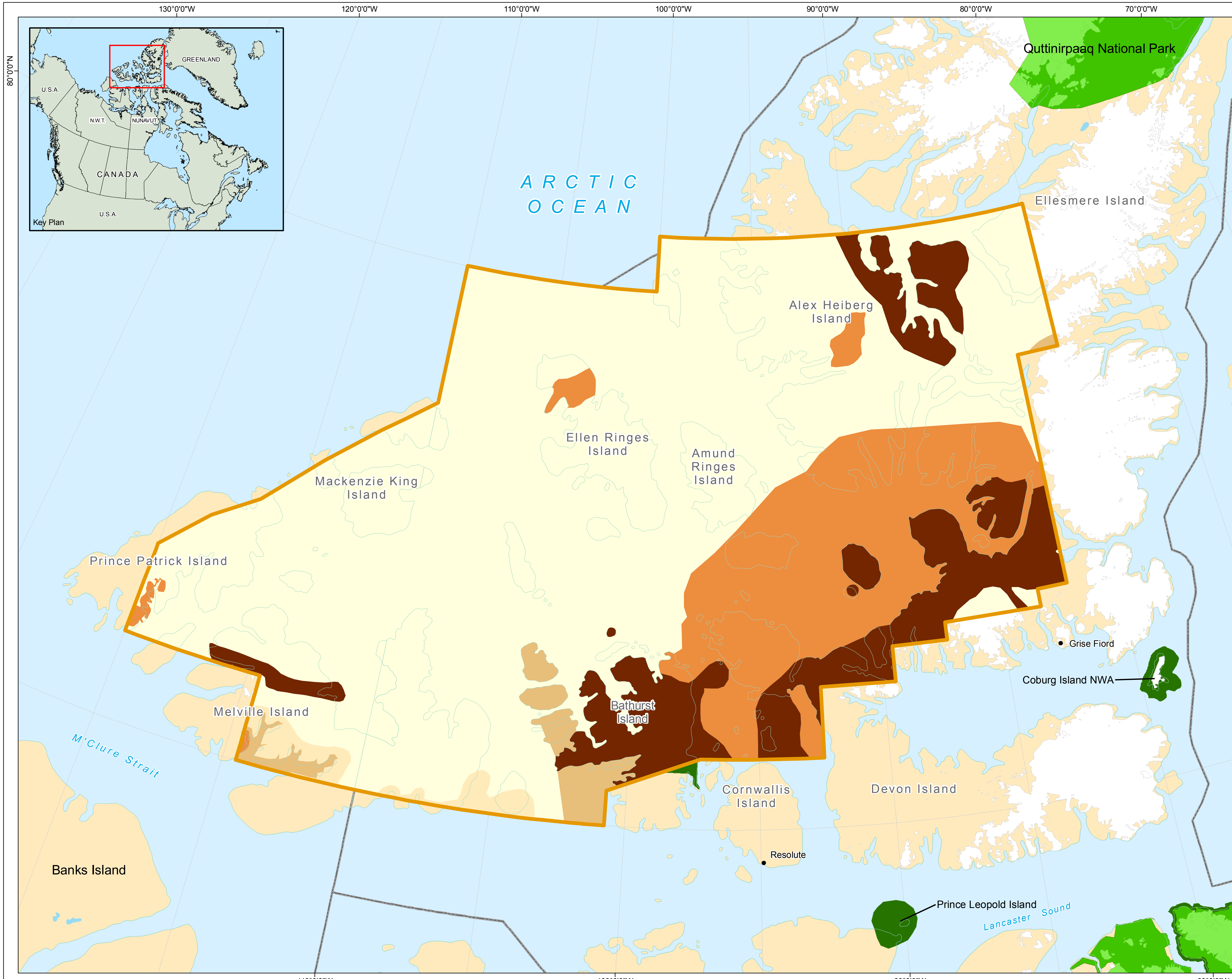
Moderate sensitivity was applied to areas of general harvesting use by the community or where a smaller proportion of harvest comes from these areas than more important areas. Generally there are fewer species present, key habitat for harvested species is not present, and alternate habitat is available (NBRLUP). This rating also applies to lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year (OCCP).

Low/Moderate Sensitivity (2)

This rating applies to lands where there are cultural or renewable resources of some significance and sensitivity (OCCP), 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). This includes lands where there are no known significant or sensitive cultural or renewable resources (OCCP)



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

Fig 4-15

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

Base Features
- Community
- Grid Line
- Ice Cap
- High Arctic Study Area
- Nunavut Regional Boundary
- Conservation Area
- National Park

1:4,000,000

30 15 0 30 60 90 120

Kilometres

Prepared By:
Nunami - Stantec

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4.5.4 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 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.

4.5.5 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.

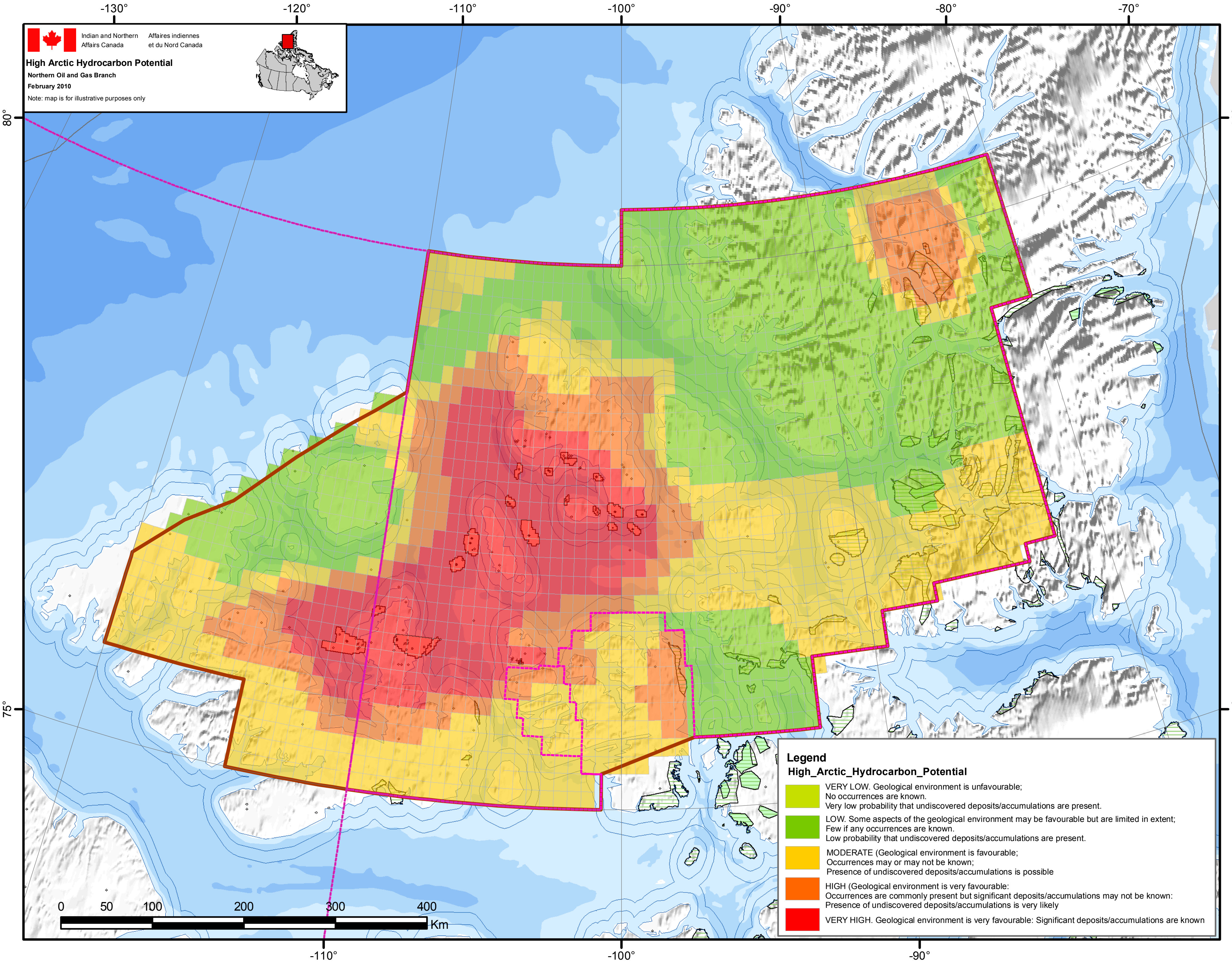
4.5.6 Summary

Traditional harvesting has high social, cultural and economic value to the Inuit in the study area. Approximately seven out of ten Inuit still participate in traditional harvesting across Nunavut (Buell 2006). Traditional harvesting occurs in both the marine and terrestrial environment and includes harvesting of fish, seals, caribou, Muskox, fox, wolf, polar bear, Arctic hare, ptarmigan and waterfowl. Major travel routes, camping sites and harvesting areas occur in Byam Channel, Norwegian Bay, King Christian Island, Sverdrup Islands, Bache Peninsula, Bathurst Isand, Melville Island and Prince Patrick Island. 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 based on the definitions of the Areas of Importance in the NBRLUP and land use categories presented in the Olokhaktomiut Community Conservation Plan. 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.

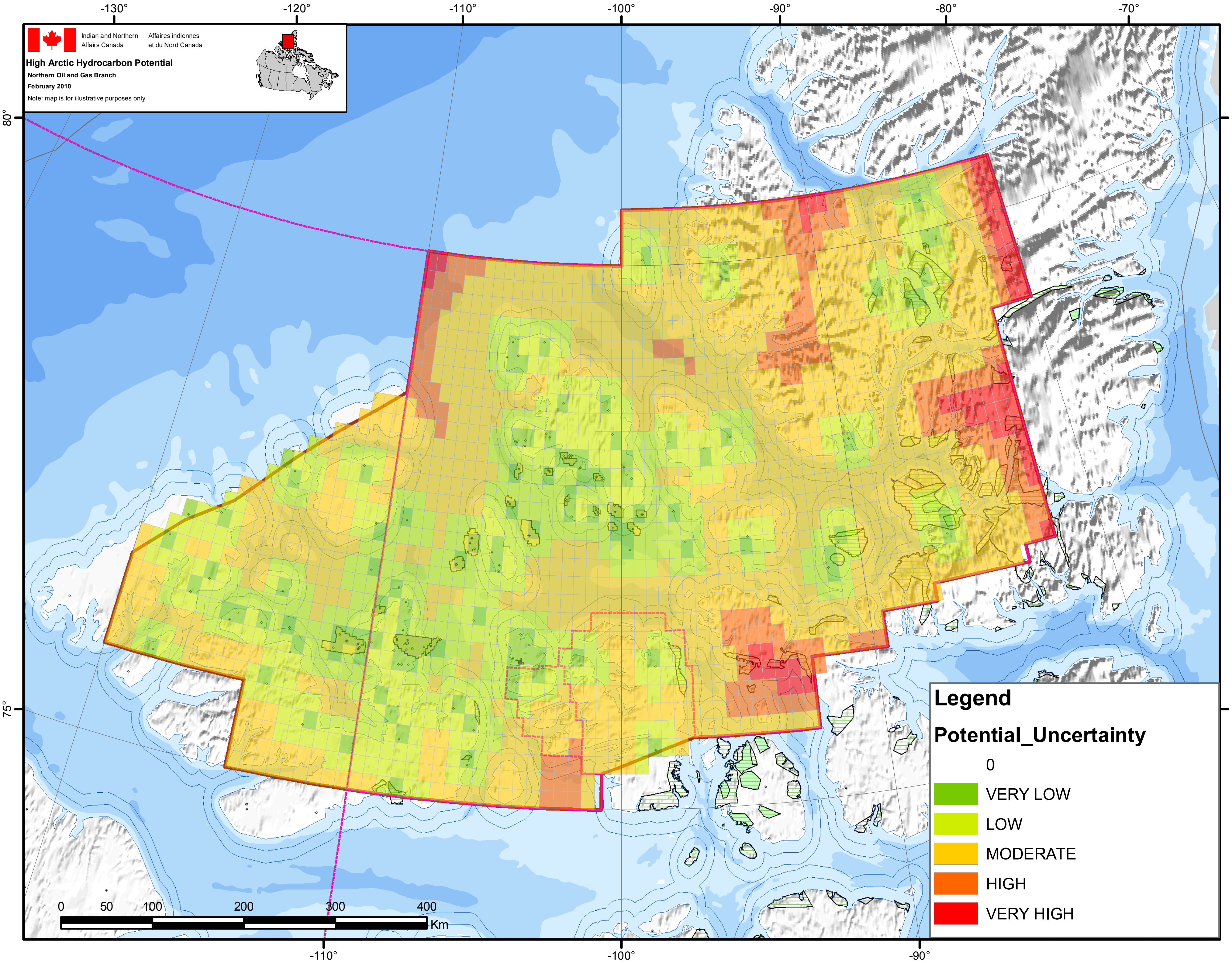
5 GEO-ECONOMIC LAYERS

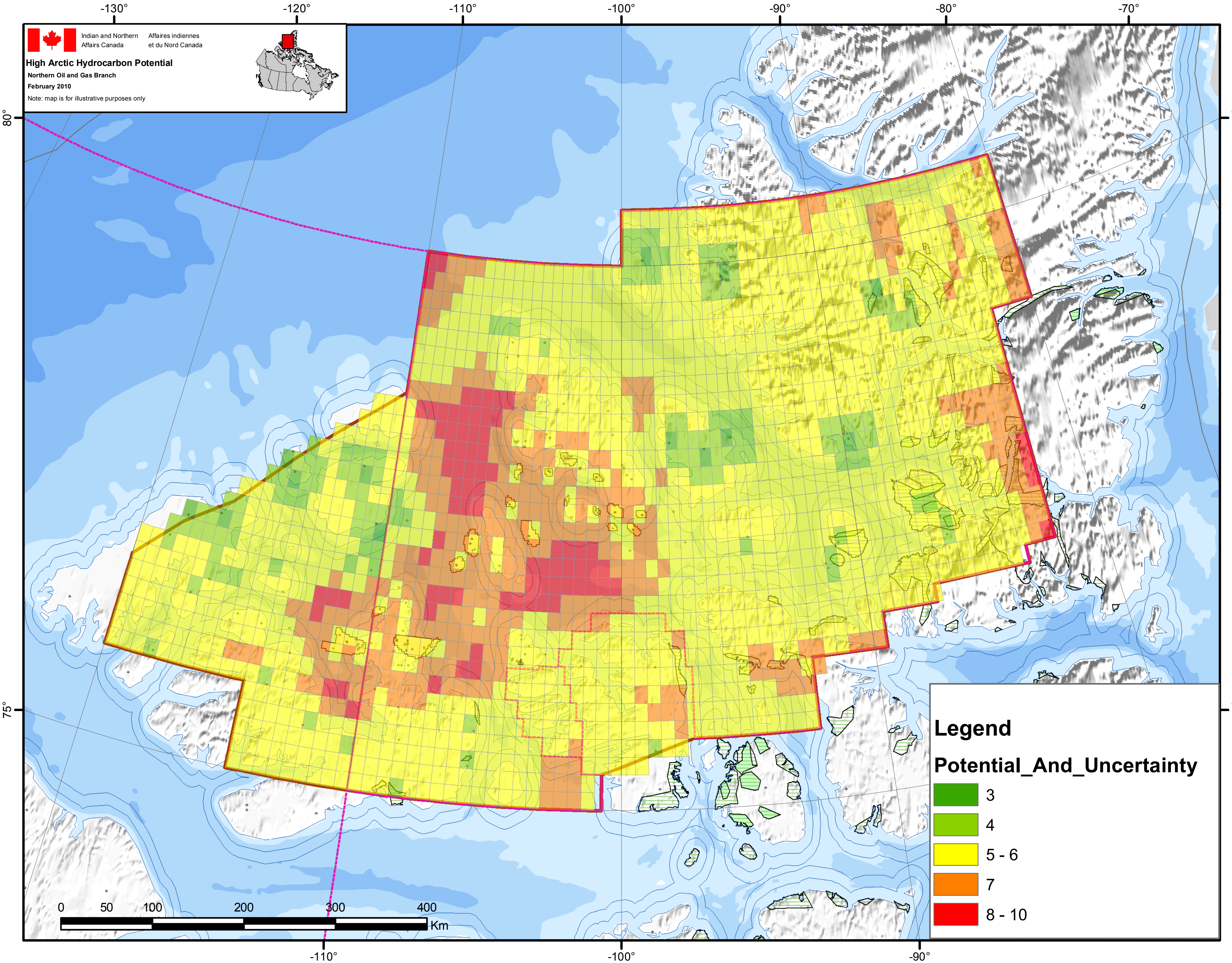
Figure 5.1 summarizes the variations in hydrocarbon potential throughout the region in qualitative terms. The potential of the central part of the Sverdrup Basin is qualified as ‘very high’, indicating that the geological environment is very favorable and significant accumulations are known. Hydrocarbon potential in the southern margin of the Sverdrup Basin and areas of the bordering Arctic Platform ranges from ‘high’ to ‘moderate’. In the northern and northeastern Sverdrup Basin (with some local exceptions) the potential is generally low. While some aspects of the geological environment may be favorable in these areas, few if any occurrences are known and there is a low probability that undiscovered accumulations are present.

The relatively sparse exploration that has occurred across much of the region, including in those areas ranked as ‘low’, indicate a lack of geological knowledge and some uncertainty as to the petroleum potential. This uncertainty can represent opportunity for those interested in exploration. Although admittedly a crude parameter, uncertainty of subsurface geology is represented in this study by mapping distance from well control (Figure 5.2). Figure 5.3 combines petroleum potential qualified by state of knowledge points to greater opportunity for new exploration across much of the region than might be concluded from the map of inferred potential alone.



Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada
High Arctic Hydrocarbon Potential
Northern Oil and Gas Branch
February 2010
Note: map is for illustrative purposes only
Legend
High_Arctic_Hydrocarbon_Potential
VERY LOW. Geological environment is unfavourable;
No occurrences are known.
Very low probability that undiscovered deposits/accumulations are present.
LOW. 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.
MODERATE (Geological environment is favourable;
Occurrences may or may not be known;
Presence of undiscovered deposits/accumulations is possible
HIGH (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
VERY HIGH. Geological environment is very favourable: Significant deposits/accumulations are known
0 50 100 200 300 400 Km
-130° -120° -110° -100° -90° -80° -70°
80° 75°


Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada
High Arctic Hydrocarbon Potential
Northern Oil and Gas Branch
February 2010
Note: map is for illustrative purposes only
Legend
Potential_Uncertainty
0
VERY LOW
LOW
MODERATE
HIGH
VERY HIGH
0 50 100 200 300 400 Km
-130° -120° -110° -100° -90° -80° -70°
80° 75°



Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada
High Arctic Hydrocarbon Potential
Northern Oil and Gas Branch
February 2010
Note: map is for illustrative purposes only
Legend
Potential_And_Uncertainty
3
4
5 - 6
7
8 - 10
0
50
100
200
300
400
Km
-130°
-120°
-110°
-100°
-90°
-80°
-70°
80°
75°

6 CONCLUSIONS AND RECOMMENDATIONS

The practical utility of the Petroleum and Environmental Management tool is dependent on the availability and quality of available spatial data on habitat use for each of the VEC's and VSEC's. 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 VEC's and VSEC's for this analysis were chosen based partially on the 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.

7 REFERENCES

7.1 Literature Cited

Alexander, S.A., R.S. Ferguson and K.J. McCormick. 1991. *Key migratory bird terrestrial habitat sites in the Northwest Territories.* Can. Wildl. Serv. Occas. Pap. No. 71, Ottawa.

Born, E.W., S. Rysgaard, G. Ehlmé, M. Sejr, M. Acquarone and N. Levermann. 2003. Underwater observations of foraging free-living Atlantic walruses (*Odobenus rosmarus rosmarus*) and estimates of their food consumption. *Polar Biology* 26:348–357.

Buell, M. 2006. *Resource Extraction Development and Well-Being in the North – A Scan of Unique Challenges of Development in Inuit Communities.*

CEC. 1999. *North American Important Bird Areas.* Commission for Environmental Coorporation, Montreal. 359 pp

Chen, Z. and K.G. Osadetz. 2006. Geological risk mapping and prospect evaluation using multivariate and Bayesian statistical methods, western Sverdrup Basin of Canada. *AAPG Bulletin* 90(6):859-872.

COSEWIC. 2002. *COSEWIC assessment and update status report on the Polar Bear Ursus maritimus in Canada.* Ottawa. vi + 29p pp. (Canadian Wildlife Service, Environment Canada)

COSEWIC. 2004a. *Assessment and update status report on the narwhal Monodon monoceros in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. vii + 50p pp. (Canadian Wildlife Service, Environment Canada)

COSEWIC. 2004b. *COSEWIC assessment and update report on the Peary caribou Rangifer tarandus pearyi and the barren-ground caribou Rangifer tarandus groenlandicus (Dolphin and Union population) in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. x + 91 pp.

COSEWIC. 2006a. *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.

COSEWIC. 2006b. *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

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

Derocher, A.E., N.J. Lunn and I. Stirling. 2004. Polar bears in a warming climate. *Integrative and Comparative Biology* 44:163-176.

Dewing, K. 2010. Carbonate Stratigrapher, Natural Resources Canada.

DFO. 1998a. *Baffin Bay Narwhal.* (Stock Status Report No. E5-43 (1998)). Department of Fisheries and Oceans

DFO. 1998b. *Hudson Bay Narwhal.* (Stock Status Report No. E5-44). Department of Fisheries and Oceans

DFO. 2002. Narwhal Whale. *Department of Fisheries and Oceans. Underwater World Series*.

DFO. 2008. *Recovery strategy for the Atlantic walrus (Odobenus rosomarus rosomarus), Northwest Atlantic population, in Canada.* Species at Risk Recovery Strategy Series. Ottawa. x + 11 pp

Dietz, R., M.P. Heide-Jorgensen, P.R. Richard and M. Acquarone. 2001. Summer and fall movement of narwhals (*Monodon monoceros)* from northwestern Baffin Island towards northern Davis Strait. *Arctic* 54(3):244-261.

Evans, P.G.H. and J.A. Raga. 2001. *Marine Mammals: Biology and Conservation*. Kluwer Academic/Plenum Publishers. New York.

Ferguson, S.H., M.K. Taylor, E.W. Born, A. Rosing-Asvid and F. Messier. 2001. Activity and movement patterns of polar bears inhabiting consolidated versus active pack ice. *Arctic* 54(1):49-54.

Ferguson, S.H., M.K. Taylor and F. Messier. 2000a. Influence of sea ice dynamics on habitat selection by polar bears. *Ecology* 81(3):761-772.

Ferguson, S.H., M.K. Taylor, A. Rosing-Asvid, E.W. Born and F. Messier. 2000b. Relationships between denning of polar bears and conditions of sea Ice. *Journal of Mammalogy* 81(4):1118-1127.

Finley, K.J. and C.R. Evans. 1983. Summer diet of the bearded seal (*Erignathus barbatus*) in the Canadian High Arctic. *Arctic* 36(1):82-89.

Finley, K.J. and W.E. Renaud. 1980. Marine Mammals inhabiting the Baffin Bay Northwater in winter. *Arctic* 33:724-738.

Gartner Lee Limited. 2008. *Development of a Decision Support Tool for Resource Management in Support of a Strategic Envrionmental Assessment for the Canadian Beaufort Sea.* Prepared for the Department of Indian Affairs and Northern Development

Gilchrist, H.G. and M.L. Mallory. 2005. Declines in the abundance and distribution of the ivory gull (*Pagophila eburnea*) in Arctic Canada. *Biological Conservation* 121(2):303-309.

Gilchrist, H.G. and G.J. Robertson. 2000. Observations of marine birds and mammals wintering at polynyas and ice edges in the Belcher Islands, Nunavut, Canada. *Arctic* 53(1):61-68.

Gunn, A., F.L. Miller and J. Nishi. 2000. Status of endangered and threatened caribou on Canada's Arctic Islands. *Rangifer Special Issue* 12:39-50.

Hay, K.A. and A.W. Mansfield. 1989. Narwhal *Monodon monoceros* Linneaus, 1758. In S. H. Ridgway & R. Harrison (Eds.), *Handbook of Marine Mammals*. London, UK: Academic Press. pp. 145-176.

Hovelsrud, G.K., M. McKenna and H.P. Huntington. 2008. Marine mammal harvests and other interactions with humans. *Ecological Applications* 18(sp2):S135-S147.

Huntington, H.P. in press. A preliminary assessment of threats to arctic marine mammals and thier conservation in the coming decades. *Marine Policy (2008)* doi:101016/j.marpol.2008.04.003.

Laidre, K.L. and M.P. Heide-Jorgensen. 2005. Arctic sea ice trends and narwhal vulnerability. *Biological Conservation* 121: 509-517.

Laidre, K.L., M.P. Heide-Jorgensen, O.A. Jorgensen and M.A. Treble. 2004. Deep-ocean predation by a high Arctic cetacean. *ICES Journal of Marine Science* 61: 430-440.

Laidre, K.L., M.P. Heide-Jørgensen and J.R. Orr. 2006. Reactions of Narwhals, *Monodon monoceros*, to Killer Whale, *Orcinus orca*, attacks in the eastern Canadian Arctic. *Canadian Field Naturalist* 120(4):457–465.

Laidre, K.L., I. Stirling, L.F. Lowry, Ø. Wiig, M.P. Heide-Jørgensen and S.H. Ferguson. 2008. Quantifying the sensitivity of arctic marine mammals to climate-induced habitat change. *Ecological Applications* 18(Supplement: Arctic Marine Mammals):S97-S125.

Latour, P.B., J. Leger, J.E. Hines, M.L. Mallory, D.L. Mulders, H.G. Gilchrist, *et al.* 2008. *Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut.* 3rd ed. Canadian Wildlife Service Occasional Paper No. 114

Lunn, N.J., S. I., D. Andriashek and E. Richardson. 2004. Selection of maternity dens by female polar bears in western Hudson Bay, Canada and the effects of human disturbance. *Polar Biology* 27(6):350-356.

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 Paper. (No. 109)

Mansfield, A.W. and D.J. St. Aubin. 1991. Distribution and abundance of the Atlantic walrus, *Odobenus rosmarus rosmarus*, in the Southampton Island-Coats Island Region of northern Hudson Bay. *Canadian Field Naturalist* 105(1):95-100.

Marine Mammal Commission. 2009. *Annual Report to Congress 2008.* Marine Mammal Commission. Maryland. 269 pp

McCracken, A.D., T.P. Poulton, E. Macey, J.M.M. Gray and G.S. Nowlan. 2007. *Arctic Oil and Gas*. Natural Resources Canada.

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.

Miller, F.L. 1991. *Peary caribou calving and postcalving periods, Bathurst Island complex, Northwest Territories, Canada, 1990* Tech. Rep. Ser. No. 151. W. a. N. R. canadian Wildlife Service. Edmonton, Alberta. 87 pp.

Miller, F.L. 2003. Caribou (*Rangifer tarandus*). In G. A. Feldhammer, B. C. Thompson & J. A. Chapman (Eds.), *Wild Animals of North America: Biology, management and economics*. Baltimore: The Johns Hopkins University Press.

Miller, F.L., E.J. Edmonds and A. Gunn. 1982. *Foraging behaviour of Peary caribou in response to springtime snow and ice conditions* 48. Canadian Wildlife Service Occassional Papers No. 48. 41 pp.

Montevecchi, W.A. 1993. Birds as indicators of change in marine prey stocks. In R. W. Furness & J. J. D. Greenwood (Eds.), *Birds as Monitors of Environmental Change*. London, pp. 217-266: Chapman and Hall.

Moore, S.E. and H.P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience *Ecological Applications* 18(sp2):S157-S165.

Morrell, G.R., M. Fortier, P.R. Price and R. Polt. 1995. *Petroleum exploration in northern Canada: a guide to oil and gas exploration and potential.* Northern Oil and Gas Directorate, Indian and Northern Affairs Canada. Ottawa, ON

NAMMCO. 2006. *NAMMCO (North Atlantic Marine Mammal Commission) Scientific Committee Working Group on the stock status of walruses in the North Atlantic and adjacent seas, Final Report.* Copenhagen. 27 pp pp

Nettleship, D.N. 1980. *A guide to the major seabird colonies of eastern Canada: identity, distribution, and abundance.* Unpublished report, Canadian Wildlife Service, Ottawa. 133 pp.

Nunavut Planning Commission. 2000. *North Baffin regional land use plan.*

OCCP. 2000. *Olokhaktomiut (Holman) Community Conservation Plan. A plan for the conservation and management of renewable resources and lands within the Inuvialuit Settlement Region in the vicinity of Holman, NWT.* Prepared by the Community of Holman, the Wildlife Management Advisory Council (NWT) and the Joint Secretariat,

Priest, H. and P.J. Usher. 2004. The Nunavut Wildlife Harvest Study. *Nunavut Wildlife Management Board* Final Report: 822p.

Ray, G.C., J. McCormick-Ray, P. Berg and H.E. Epstein. 2006. Pacific walrus: Benthic bioturbator of Beringia. *Journal of Experimental Marine Biology and Ecology* 330:403-419.

Richard, P. 2001. *Marine Mammals of Nunavut*. Teaching and Learning Centre, Qikiqtani School Operations, Department of Education. Iqluit, Nunavut.

Richard, P., P. Weaver, L. Dueck and D. Barber. 1994. Distribution and numbers of Canadian High Arctic narwhals (*Monodon monoceros*) in august 1984. *Meddr Gronland Bioscience* 39:41-50. Copenhagen 1994-1904-1922.

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.

Richardson, J., C.R. Greene Jr, C. Malme and D. Thomson. 1995. *Marine Mammals and Noise*. Academic Press. San Diego.

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

Shapiro, A.D. 2006. Preliminary evidence for signature vocalizations among free-ranging narwhals (*Monodon monoceros*). *Journal of the Acoustical Society of America* 120(3):1695-1705.

Sivummut Economic Development Strategy Group. 2003. *Nunavut Economic Development Strategy-Building a Foundation for the Future.*

Smith, M. and B. Rigby. 1981. Distribution of polynyas in the Canadian Arctic: Pages 7-28 In I. S. a. H. Cleator (ed.), *Polynyas in the Canadian Arctic*. Can. Wildl. Serv. Occas. Pap. No. 45, Ottawa.

Springer, A.M., J.F. Piatt and G. Van Vliet. 1996. Seabirds as proxies of marine habitats in the western Aleutian Arc. *Fisheries Oceanography* 5:45-55.

Stenhouse, I.J., G.J. Robertson and H.G. Gilchrist. 2004. Recoveries and survival rates of Ivory Gulls banded in Nunavut, Canada, 1971-1999. *Waterbirds* 27:486-492.

Stewart, D.B. 2002. Review of Atlantic walrus (*Odenbenus rosmarus rosmarus*) in Canada. *Candaian Science Advisory Secretariat* Research Document 2002/092.

Stirling, I. 1980. The biological importance of polynyas in the Canadian Arctic. *Arctic* 33:303-315.

Stirling, I. 1990. Polar bears and oil: ecologic perspectives. In J. R. Geraci & D. J. St. Aubin (Eds.), *Sea Mammals and Oil: Confronting the Risks*. San Diego, CA: Academic Press. 223-234.

Stirling, I. 1998. *Polar Bears*. The University of Michigan Press. Ann Arbor, Michigan.

Stirling, I. and A.E. Derocher. 2007. Melting Under Pressure the real Scoop on Climate Warming and Polar Bears. *The Wildlife Professional* 1(3):24-27.

Stirling, I., A.E. Derocher, W.A. Gough and K. Rode. In press. Response to Dyck *et al.* (2007) on polar bears and climate change in the western Hudson Bay. *Ecol. Complex. (2008), doi: 101016/j.ecocom.2008.01.004*.

Stirling, I., N.J. Lunn, C. Elliot and M. Obbard. 2004. Polar bear distribution and abundance on the southwestern Hudson Bay coast during open water season, in relation to population trends and annual ice patterns. *Arctic* 57(1):15-26.

Stirling, I. and N.A. Øritsland. 1995. Relationships between estimates of ringed seal (*Phoca hispida*) and polar bear (*Ursus maritimus*) populations in the Canadian Arctic. *Canadian Journal of Fisheries and Aquatic Sciences* 52:2594-2612.

Stirling, I. and C.L. Parkinson. 2006. Possible effects of climate warming on selected populations of polar bears (*Ursus maritimus*) in the Canadian Arctic. *Arctic* 59(3):261-275.

Taylor, M.K., S. Akeeagok, D. Andriashek, W. Barbour, E.W. Born, W. Calvert, *et al.* 2001. Delineating Canadian and Greenland polar bear (*Ursus maritimus*) populations by cluster analysis of movements. *Canadian Journal of Zoology* 79:690-709.

Taylor, M.K., J. Laake, H.D. Cluff, M. Ramsay and F. Messier. 2002. Managing the risk from hunting for the Viscount Melville Sound polar bear population. *Ursus* 13:185-202.

Taylor, M.K., J. Laake, P. MCloughin, D. Cluff and F. Messier. 2008a. Mark-recapture and stochastic population models for polar bears of the high Arctic. *Arctic* 61(2):143-152.

Taylor, M.K., J. Laake, P.D. McLoughlin, H.D. Cluff and F. Messier. 2008b. Mark-recapture and stochastic population models for polar bears of the high arctic. *Arctic* 61(2):143-152.

Taylor, M.K., J. Laake, P.D. McLoughlin, H.D. Cluff and F. Messier. 2009. Demography and population viability of polar bears in the Gulf of Boothia, Nunavut. *Marine Mammal Science* 25(4):778-796.

Terriplan Consultants. 2008. *Socio-Demographic and Economic Sector Analysis*. Prepared for: Nunavut Planning Commission.

Van De Velde, F., I. Stirling and E. Richardson. 2003. Polar bear (*Ursus maritimus*) denning in the area of the Simpson Pennisula, Nunavut. *Arctic* 56(2):191-197.

Wiig, O., V. Berg, I. Gjertz, D.J. Seagars and J.S. Skaare. 2000. Use of skin biopsies for assessing levels of organochlorines in walruses (*Odobenus rosmarus*) *Polar Biology* 23(4):272-278.

Zöckler, C. 1998. *Patterns in Biodiversity in Arctic Birds.* World Conservation Monitoring Centre

7.2 Internet Sites

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

DFO. 2010. *Statement of canadian practice with respect to the mitigation of seismic sound in the marine environment statement of canadian practice with respect to the mitigation of seismic sound in the marine environment* Available at: http://www.dfo-mpo.gc.ca/oceans-habitat/oceans/im-gi/seismic-sismique/index_e.asp. Accessed: March 9, 2010.

Government of Nunavut Department of the Environment (Avatiliqiyikkut). 2005. *Wildlife management.* Available at: http://env.gov.nu.ca/programareas/wildlife. Accessed: February, 2010.

IBA Canada. 2009. Important Bird Area. Available at: http://www.ibacanada.com/. Accessed: July, 2010.

IUCN. 2009. *IUCN Red List of Threatened Species. Version 2009.2.* Available at: www.iucnredlist.org. Accessed: Accessed January 25, 2010, 2010.