PETROLEUM AND ENVIRONMENTAL MANAGEMENT TOOL

High Arctic Study Area

2011 UPDATE



Prepared for:

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Project No.:

1231-10432

August 2011





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EXECUTIVE SUMMARY

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

Information on several Valued Ecosystem Components (VECs) and Socio-economic Components (VSECs) presented in the web based geographic sensitivity analyses tool for the 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).

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 VECs and VSECs presented in the PEMT. 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 NOGB'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 are 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 VSEC) are included. Oil and gas activities examined include exploration (seismic activities, exploration drilling), production (field development), transportation, and decommissioning and abandonment.

The VECs and VSEC selected for the High Arctic study area are:

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

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- 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 VSEC. Moderate-Low, Moderate, and Moderate-High rankings indicate intermediate levels of sensitivity. Sensitivity layers accounted for variability in habitat usage and development activities in the openwater 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 southwest 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 in 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 VSEC. 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.

This report was initially submitted in 2010. This 2011 Update Report includes updates to the geographical extent of the High Arctic Study Area (extended west to the 2000 m bathymetric contour), and associated extension and revision of VEC and VSEC sensitivity ratings in the larger Study Area. Information on petroleum potential in the expanded study area is currently unavailable, therefore the analysis and figures remain unchanged.



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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
НТА	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 provide 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 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 Valued 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 NOGB'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. Multiyear ice is found throughout the High Arctic. In the winter it is usually entrapped in landfast ice and in the summer it is 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.



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 and development of the Geo-Economic layers.

3.1 VEC/VSEC Layer Development

3.1.1 Selection of Valued Ecosystem and Socio-Economic Components

The VECs and VSEC were chosen based on their cultural, ecological and economic 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 VSEC involved developing a preliminary list of VECs and VSECs based on their association and relative importance to the cultural and ecological value of the study area. This list was further refined based on the availability of spatial data required for assessing sensitivity of habitat in the region.

3.1.2 Literature Review

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

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

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 VSEC was selected for the High Arctic 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 is 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/VSEC is comprehensive, much of the habitat usage by VECs and the VSEC 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 VSEC. 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 was 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 rating (1) includes areas that are infrequently used and of relatively low value to the VECs' and VSEC's viability. Moderate-Low (2), Moderate (3), and Moderate-High (4) 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, 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?

Moderate-Low 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 the sensitivity layers, the potential effects of these interactions were considered.

3.1.8.1 Seismic Survey

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

3.1.8.2 Exploration Drilling

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

- Physical presence of equipment
- Aircraft support
- Ice platforms and roads.

3.1.8.3 Field Development

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

3.1.8.4 Production

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

3.1.8.5 Decommissioning

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

3.2 Geo-Economic Layer Development

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 as they are the top predator within the food web. Polar bears also have significant cultural and economic importance to the Inuit and Inuvialuit, and they 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 in Nunavut 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 and Inuvialuit guided hunting is a source of income from the tourist industry, and polar bear watching tours have also become popular.



4.1.2 Polar Bear Summary

4.1.2.1 Life History

Conservation Status

Polar bears were classified as 'Special Concern' by COSEWIC in 1991, and their status was reexamined and confirmed in 1999, 2002 and 2008 (COSEWIC 2008). They have not yet been assessed under the *Species at Risk Act* (SARA). Polar bears are protected under Appendix II of the Convention on International Trade in Endangered Species (CITES) and are classified under the International Union for Conservation of Nature (IUCN) as Lower Risk: Conservation Dependent. Polar bear policy and management in Canada is complicated by the fact that polar bear populations inhabit multiple territories and provinces. As such, management authority rests with federal, territorial, and provincial jurisdictions as well as with wildlife management boards established under land claims (e.g., the Nunavut Land Claims Agreement [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 the Northwest Territories 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 four of the thirteen Canadian subpopulations of polar bears (from COSEWIC 2008): the Viscount Melville Sound subpopulation (215 ± 116 bears [1996 estimate]) (Taylor *et al.* 2002), the Lancaster Sound subpopulation ($2,541 \pm 782$ bears [1998 estimate]) (Taylor *et al.* 2008b), the Norwegian Bay subpopulation (203 ± 44 bears) (Taylor *et al.* 2009), and just the northeastern most extremity of the Northern Beaufort Sea subpopulation ($1,200 \pm 375$ [2006 estimate]). Estimated total population numbers for all sub-populations in Canada is approximately 15,000 (COSEWIC 2008).



Ecology

Habitat requirements for polar bears include ice, open water, coastal areas and land. Their distribution on ice is closely linked to the distribution of ringed seals (their preferred prey) and to a lesser degree bearded seals (Stirling 1980). Specific ice habitat selection by polar bears seems to be complex. 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 season (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 et al. (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 the 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 gestation period is only two months and females cannot breed more often than once 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 continuously 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 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 (e.g., 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 Axel Heiberg Island (see Figure 4-1). In portions of the High Arctic, polar bears are forced onto the land in the summer as the ice recedes. They may spend several months in summer retreat areas while they wait for the ice to return. These areas have been identified on Bathurst Island and northwestern Devon Island (Figure 4-1).

4.1.2.3 Sustainability Factors

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

Female polar bears have low reproductive rates, which make 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 bioaccumulation¹ 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).

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 predominately 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 maternity 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 becomes oiled, and when oil is 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 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 (i.e., 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 for 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-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 (IBP) 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 (i.e., on southern Axel Heiberg Island; see Figure 4-1).

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.

Moderate-Low 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 and the Northwest Territories as they are the top predator within the food web. The High Arctic study area overlaps with four of the thirteen Canadian subpopulations of polar bears.

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 Axel Heiberg Island. In portions of the High Arctic, polar bears are forced onto the land in the summer as ice recedes. They may spend several months in summer retreat areas while they wait for the ice to return. These areas have been identified on Bathurst Island and northwestern Devon Island (Figure 4-1).



Habitat rated as moderate-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-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 threat to polar bears because they rely on the ice for traveling, feeding habitat, and denning.



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 Ellesmere 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.




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 sp.*) 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 km²) 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.





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 the Northwest Territories due to the often prolific numbers that occur in both terrestrial and marine habitats throughout the High Arctic region. They are most abundant during breeding periods, when food abundance is high, breeding sites are accessible and weather conditions are favourable. However, local abundance may be even higher for species that congregate at stopover sites during the spring and fall migratory periods or in open marine waters during the winter.

The sensitivity of migratory birds to anthropogenic disturbance is highly linked to their use of Arctic habitats throughout the annual cycle. Key marine-linked migratory birds in the study area include three closely-related groups: (1) seabirds, (2) waterfowl, and (3) shorebirds. Migratory birds such as shorebirds and waterfowl are sensitive to large-scale climatic fluctuations and habitat changes at migratory stopover sites. Seabirds have strong cultural significance and are often featured in carvings. Subsistence harvest of seabirds is conducted by residents of coastal villages (Meehan et al 1998). Seabirds are also a key offshore indicator of anthropogenic disturbance.

4.3.2 Migratory Birds Summary

4.3.2.1 Description

The marine and terrestrial areas of Nunavut and the Northwest Territories support 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 habitat site as an area that supports at least 1% of the Canadian population of at least one migratory species.

Within the marine ecosystem, there are three important habitat types or zones that are essential to migratory birds: (1) the coastline, (2) the open sea, and (3) 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 during the winter months. 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.

Terrestrial ecosystems in Nunavut and the Northwest Territories consist of six ecozones. In the High Arctic, two ecozones predominate: Northern Arctic and the Arctic Cordillera. The Northern Arctic is typified by barren plains interspersed with well-vegetated wetlands and rocky outcrops and cliffs, while the Arctic Cordillera consists of mostly precipitous peaks, permanent ice caps, and multiple glaciers. These terrestrial habitats are important 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*), and red phalarope (*Phalaropus fulicaria*). A number of shorebirds that nest in the Arctic depend heavily on Canadian habitat, as much of their global population is found here. For example, 41% of red knot, 45% of pectoral sandpiper, and 80% of Baird's sandpiper breeding populations occur in Canada (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 and five in the Northwest Territories. 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 that is often 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 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 a 1994 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 areas of high productivity, with high species diversity and/or high species abundance. A second workshop was conducted in 2010, organized by the Oceans Programs Division of Fisheries and Oceans Canada (Stephenson 2010). The goal of this workshop was to update the results of the 1996 workshop and identifying areas of High Biological Importance (HBI) to wildlife. While detailed information is not available for each hotspot identified, for the purposes of this report, HBIs were treated as important to migratory birds.

4.3.2.3 Key Terrestrial and Marine Sites

Seymour Island

The key migratory bird habitat identified at Seymour Island has a marine and terrestrial component. 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 the ivory gull, which is listed as Endangered under SARA. 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 Gate and Cardigan Strait

The 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*) occur in this area. Common eider (*Somateria mollissima borealis*), glaucous gull (*Larus hyperboreus*), Thayer's gull (*Larus glaucoides thayeri*), Arctic tern (*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 northwestern Devon Island and contains two important terrestrial habitat sites that support seabird colonies within the marine region (Alexander et al. 1991).

The Cheyne Islands represent one of only four known breeding colonies of Ross's gull (*Rhodostethia rosea*) (listed as 'Threatened' under the SARA) in Canada (IBA Canada 2009, Internet site). These three islands of similar size are located on the west side of Penny Strait. They have a low relief (up to 3 m above sea level) and are composed of alluvial material. The Cheyne Islands are considered a nationally significant IBA because terrestrial habitat may support about 40% (or 8 pairs) of Canada's Ross's gull breeding population, although recent surveys have not found any individuals here (Mallory et al. 2006). Other occurring species include common eider (almost 1% of the Canadian population), black-legged kittiwake (almost 1% of the Canadian population), king eider, black guillemot.

Surveys conducted in 2005 identified Ross's gulls nesting on an unnamed island in the Penny Straight (proposed name Nasaruvaalik Island), approximately 80 km from the Cheyne Islands. Consequently, Environment Canada has now identified this island as an important migratory bird site for Ross's gull and other key species including Arctic tern and common eider.

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).

Eastern Axel Heiberg Island and Fosheim Peninsula

The lowland valley associated with the Chain of Three Lakes supports rich sedge meadow vegetation and supports a high density of shorebirds including the red knot and the ruddy turnstone as well as numerous nesting shorebird species such as sanderling, purple sandpiper, and red phalarope. Other migratory bird species present in this area include greater snow goose, re-throated loon, and two species of jaeger (CWS 2008, pers. comm.). Fosheim Peninsula, on the western side of Ellesmere Island adjacent to Eureka Sound provides high quality and extensive Arctic wetland habitat for shorebirds such as red knot and ruddy turnstone (CWS 2010, pers. comm.).

Sabine Peninsula

Sabine Peninsula on the northeast tip of Melville Island contains rich, expansive wetlands that provide habitat for high numbers and diversity of migratory birds during the summer months (CWS 2008, pers. comm.).

Eastern Prince Patrick Island Coast

Prince Patrick Island is located in the western high Arctic and features numerous expansive cliffs (up to 80 m high) as well as coastal lowland areas (Latour et al. 2008). Brant make 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 goose (lesser and greater), king eider, common eider, long-tailed duck, Pacific loon, glaucous gull, peregrine falcon, and black-legged kittiwake.

Brant 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 IBA in Canada (Latour et al. 2008). This IBA is considered globally significant for congregatory species (IBA Canada 2009, Internet site).

Amundsen Gulf and Cape Bathurst Polynya (key marine habitat site)

This marine area is defined by a reoccurring polynya that forms in the western Amundsen Gulf and the associated leads that extend northward along the west coast of Banks Island and Prince Patrick Island and eastward along the southern coast of the Amundsen Gulf. The characteristic form of this polynya coincides with the 30-m depth contour and changes position very little from year to year (Mallory and Fontaine 2004). Freeze-up of the polynya occurs between mid-October and mid-November and by mid-May open water develops and progressively widens along the lead systems.

While some seabirds use this marine region, Arctic waterfowl are heavily dependent on open water for feeding and resting, and this polynya area is critical to them during migratory periods. In particular, 16,000 king eiders were observed in the shore leads off Banks Island (Mallory and Fontaine 2004).

4.3.2.4 Sustainability Factors

Migratory 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. Population size of some migratory species may be regulated by singular events affecting individual survival during congregatory periods, such as at stopover sites, nesting colonies, or polynyas. For example, mass starvation of adult king eiders occurs occasionally, due to lack of open water or adverse weather. An estimated 100,000 died in the Beaufort Sea in 1964 because of these factors (Dickson et al. 1997).

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 colonies to be abandoned (IBA Canada 2009, Internet site). This threat is potentially important for bird species that are concentrated into relatively small areas or for species that 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 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 migratory birds that use marine areas for part or all of their annual cycle 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.

Seabirds are good indicators of change in the marine food web because they are dependent on the marine environment for high quality prey (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. Species that are more reliant on the presence or amount of ice and snow are expected to be more negatively impacted 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 season).

High Sensitivity (5)

Habitat given a rating of high sensitivity includes areas globally important to 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 lvory 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 during the summer season these areas include: Seymour Island, North Kent Island and Eastern Prince Patrick Island Coast. In the winter, Seymour Island and Polar Bear Pass NWA are rated as high sensitivity areas in winter and summer given their legal protection status.

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 during the summer season these areas include Cheyne Islands, Nasaruvaalik Island, key migratory bird marine and terrestrial habitat sites, and biological hotspots. In the winter season, the Amundsen Gulf and Cape Bathurst polynya are given moderate/high sensitivity rating given the value of this open water area to migratory birds in the spring and fall.

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.

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).







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, as can migratory waterfowl and shorebirds during stopover periods.

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 species of conservation concern refer to species that are: (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. Species of conservation concern with ranges that overlap with the High Arctic study area are summarized in Table 4-1.

Common Name	Scientific Name	Protection Status (SARA Schedule 1) ¹	Population Status Designation		Seasonal Use of	Critical	Important Habitat
			IUCN ²	COSEWIC ¹	High Arctic Habitats	Habitat defined?	Identified in Study Area
lvory gull	Phagophila eburnean	Endangered	Near Threatened	Endangered	B (S), M, W	Yes	Yes
Ross's gull	Rhodostethia rosea	Threatened	Least Concern	Threatened	B (S), M	No	Yes
Red knot	Calidris canutus islandica	No Schedule, No Status	Least Concern	Special Concern	B (S), M	No	No
Polar bear	Ursus maritimus	No Schedule, No Status	Vulnerable	Special Concern	S,W	No	Yes
Narwhal	Monodon monoceros	No Schedule, No Status	Near Threatened	Special Concern	S, W	No	No
Walrus	Odobenos rosmarus rosmarus	No Schedule, No Status	Data deficient	Special Concern	S, W	No	No
Bowhead whale	Balaena mysticetus	Special Concern	Least Concern	Special Concern	R	No	No
Peary caribou	Rangifer tarandus pearyi	Endangered	Least Concern (subspecies <i>pearyi</i> not assessed)	Endangered	S, W	No	No

Table 4-1: Species of Conservation Concern in the High Arctic Study Area

NOTE:

B = Breeding M = Migration

S = Summer R= Range overlap only

W = Winter

1) Species' SARA and COSEWIC status taken from http://sararegistry.gc.ca/ in August 2011

2) Species' IUCN status taken from http://www.iucnredlist.org/ in August 2011

4.4.2 Species of Conservation Concern Summaries

Although bowhead whale, beluga whale, and walrus may be present in the study area, their use of habitat is expected to be relatively uncommon and information on specific habitat use (breeding, moulting, feeding, etc.) within the study area is very limited. The red knot is distributed throughout the High Arctic and although suitable breeding habitat occurs along the western coastline of the Arctic islands, they have not been recorded breeding within the High Arctic study area (COSEWIC 2007). However, eastern Axel Heiberg Island has been identified as a key migratory bird site that supports high densities of red knots (CWS 2008, pers. comm.) (Section 4.3.2). For the purposes of the sensitivity ranking, it is conservatively assumed that the range for these species may extend throughout the study area, but specific information on the ecology and important habitat of these species in the study area is not summarized below or included in the sensitivity ranking analysis due to limited data availability.

See Section 4.1.2 for a summary of the polar bear and section 4.2.2 for a summary of the narwhal. Migratory birds (including Ross's gull, red knot and ivory gull) are discussed in Section 4.3.2. Additional Information on species listed as endangered under the *SARA* (Peary caribou and ivory gull) is summarized below.

4.4.2.1 Life History

Conservation Status

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 the High Arctic study area was assessed as endangered by COSEWIC and is on Schedule 1 of SARA as an endangered species (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 2006) and is listed as Endangered on Schedule 1 under SARA. In Nunavut, it may be at risk 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 2006). 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

Important identified habitat of Species of Conservation Concern is summarized in Figure 4-9.

Peary Caribou

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

Ivory Gull

The ivory gull breeding population has a circumpolar, patchy distribution in the Arctic. The Canadian breeding population is restricted to 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 the Nunavut landmass 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 and off the northern coast of Bathurst Island (COSEWIC 2006). 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 defined 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 2006).

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Ecology

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).

Ivory Gull

lvory gull requirements for breeding sites are highly restrictive. Isolation from terrestrial predators (particularly the Arctic fox, *Alopex lagopus*) appears to be important and ivory gull will select areas that are located near marine waters 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 2006). Nests are generally located within 100 km of nearby polynyas and/or recurring leads (COSEWIC 2006). Nest sites on Ellesmere and southeast Devon Island were found 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 lemmings and foxes are largely absent (Gilchrist and Mallory 2005; COSEWIC 2006). Individuals reach breeding maturity in their second year, laying one or two eggs per clutch (COSEWIC 2006). Both parents incubate the eggs alternately for about 25 days. Chick survival is dependent on weather conditions, predation and human disturbance (COSEWIC 2006).

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

4.4.2.2 Key Habitat

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

lvory gull require nesting sites that are free from predators and in close proximity to early season open water areas for foraging. These requirements greatly restrict possible breeding locations in the Canadian Arctic. For example, much of the western Arctic and Ellesmere Island are unsuitable for nesting because



there is no ice-free ocean regularly available during the breeding season (late May – early June). In addition, ivory gull tend to avoid areas with vegetation where Arctic fox occur (COSEWIC 2006).

Two predominant habitat types are consistently used for breeding locations. The first type is sheer granite cliffs amidst glacial terrain, represented by the southeast of Ellesmere and Devon Islands. These sheer cliffs eliminate predation by Arctic fox and are far enough inland to avoid t coastal avian predators (COSEWIC 2006). 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 2006). Again, these areas are generally free of vegetation and therefore Arctic fox, the main nest predator. Nesting further inland lowers the probability of predation by Arctic fox or polar bear, which forage along the coast (COSEWIC 2006). 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 during the early part of the breeding season (COSEWIC 2006).

4.4.2.3 Sustainability Factors

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, groundfast 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 eggs 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 2006). 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 ivory gull sensitivity 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 gull may be more tolerant of disturbance than other seabirds (COSEWIC 2006). Further research is required to determine sensitivity to anthropogenic factors.

lvory gull 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 2006). 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 2006).

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

4.4.2.4 Susceptibility to Oil and Gas Activities

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 threaten ivory gull nesting areas 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 2006). Most breeding colonies are remote and undisturbed, but on the Brodeur Peninsula of Baffin Island there has been a considerable increase in diamond mine exploration, coincident with a significant decline in colony occupation (COSEWIC 2006). 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 2006).

All seabirds, in particular gulls, are considered to be highly vulnerable to oil pollution. The ivory gull populations may be particularly susceptible to oil spills since they are more pelagic 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 2006).

4.4.2.5 Potential Effects of Climate Change on Species of Conservation Concern

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 impact ivory gull populations depending on how it affects the distribution of open water and the persistence of polynyas early in the breeding season (COSEWIC 2006).



Because ivory gull is associated with pack ice year-round an increase in the extent or thickness of ice cover would reduce their foraging capabilities during the non-breeding season 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 2006).

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 similar throughout the year and are presented in Figure 4-10.

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. A rating of high sensitivity also represents areas that overlap with the range of any species classified as 'critically endangered' by the IUCN or habitat that is legally protected as a park or conservation area. High sensitivity areas in the High Arctic study area include Polar Bear Pass NWA and Seymour Island Migratory Bird Sanctuary.

Moderate/High Sensitivity (4)

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

Moderate Sensitivity (3)

A rating of moderate sensitivity represents areas that overlap with the range or important habitat of any species identified as 'Threatened' under SARA or COSEWIC or 'Vulnerable' under IUCN. This includes breeding habitat identified for the Ross's gull (Cheyne Islands and Nasaruvaalik Island)

Low/Moderate Sensitivity (2)

A rating of low/moderate sensitivity represents areas that overlap with the range or important habitat of any species Identified as 'Special Concern' under SARA or COSEWIC or 'Near Threatened' under IUCN. This includes the potential distribution of bowhead whale, beluga whale, narwhal, polar bear (including identified denning and summer retreat areas), walrus, and red knot.

Low Sensitivity (1)

A rating of low sensitivity represents areas that overlap with the range or important habitat of any species Identified as 'data deficient' under SARA, COSEWIC or IUCN, 'least concern' under IUCN or areas with limited habitat suitability for species of conservation concern (terrestrial areas with permanent ice caps).



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, bowhead whale and beluga whale 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 4-2. Traditional harvest sites are summarized in Figures 4-11 (summer) and 4-12 (winter).

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).





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High Arctic Study Area Traditional Harvest Summer Fig 4-11 • Fishing Sites ¹ ▲ Camp Sites Hunting Type Indicators ¹ * ➤ Arctic Char 👗 Caribou Community Inuit Land Use High Intensity Medium Intensity **Base Features** Community High Arctic Study Area Ice Cap Nunavut Regional Boundary National Park Conservation Area Depth (m) <200 200-499 500-999 1000-1999 2000-2999 >3000 1:4,000,000 25 12.5 0 25 50 75 100 Kilometres Prepared By: Nunami - Stantec References ¹Riewe, R. (Ed.). 1992. Nunavut Atlas. Edmonton, Alberta. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. * Symbols indicate hunting in the appoximate area or vicinity. W. KTREM NUNAMI STANTEC Indian and Northern Affaires indiennes * Affairs Canada et du Nord Canada Projection: Canada Lambert Conformal Conic, NAD83 Date: Sept 27th, 2011 Filepath: R:\2010Stantec\123110162_INAC\MXD Produced By: B Alleyne Verified By: JB Revision: 01



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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 4-2.

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.


(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	\checkmark	
King Christian Island	Resolute hunters	Polar Bear	✓	
Norwegian Bay	Grise Fiord	Caribou	✓	✓
		Arctic Char		\checkmark
		Polar Bear	✓	
Byam Channel	Resolute and Holman hunters	Polar bears	✓	
Holman Planning Area	Holman and Sachs Harbour hunters	Polar Bear	~	

Table 4-2:Harvested Species by Community and Time of Year – High Arctic Study Area
(Riewe 1992; OCCP 2000)

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 4-13.



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)



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.



-90°





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 VECs and VSECs. As additional information becomes available, it is important that the tool is updated to reflect the most recent knowledge on the biophysical or cultural components of interest. As the VECs and VSEC 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, caribou and tourism) are recommended for inclusion to the PEMT tool once data become available.

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



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