Development of a Decision Support Tool for Resource Management in Support of a Strategic Environmental Assessment for the Canadian Beaufort Sea

Prepared for
Department of Indian Affairs and Northern Development

Submitted by
Gartner Lee Limited

March 2008

Gartner Lee

Development of a Decision Support Tool for Resource Management in Support of a Strategic Environmental Assessment for the Canadian Beaufort Sea

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Dear Mr. Duncan:

Gartner Lee Limited (GLL) is pleased to provide an amended report on the *"Development of a Decision Support Tool for Resource Management in support of a Strategic Environmental Assessment for the Canadian Beaufort Sea."* This report should be reviewed in concert with the Geographic Information System (GIS) decision-support tool and database, also developed by GLL as part of standing offer agreement # 00-04-6004-2. Gartner Lee Limited is confident that this report and accompanying GIS decision support tool will be valuable in meeting that objective.

If you have any question regarding this report, please do hot hesitate to contact GLL at the number below. Thank you for the opportunity to participate in this exciting project.

Yours very truly,
GARTNER LEE LIMITED

Heidi Klein, BSc., MES
Senior Environmental Planner, Principal

HK:g

(80197_Fnl Decision Support Tool Rpt_31March2008_R12JSD.doc)

Executive Summary

This report accompanies a GIS-based decision support tool and database that are intended to facilitate the Strategic Environmental Assessment (SEA) of oil and gas leasing options for a portion of the Beaufort Sea. These products were produced for the Department of Indian and Northern Affairs Canada (INAC) - Northern Oil and Gas Branch (NOGB) to aid the NOGB in meeting their commitments associated with management of oil and gas resources on federal land and the provision of hydrocarbon development opportunities in the North, while ensuring environmental protection. The SEA will assist managers and decision-makers in choosing appropriate processes and actions to responsibly manage the opening of offshore areas petroleum industry activities. The study area and analytical resolution was defined using the oil and gas leasing grid within the Beaufort Sea.

The study area has been the scene of oil and gas exploration activity since 1957. Oil was first discovered at Atkinson Point in 1969 and major gas fields in the early 1970's. Such finds spurred the proposal of the Mackenzie Valley Pipeline in 1974 and the addition of exploration and investment offshore. Exploration and drilling continued both onshore and offshore until the mid 1970's with the release of the Berger Report, which recommended a 10-year moratorium on the construction of the pipeline. After the release of the Berger Report, the pace of onshore activity declined but offshore exploration escalated in the 1980's. Offshore exploration was facilitated with innovative operating techniques and new offshore platforms that extended the ability to operate in the short open-water season and ice. With the minor exception of the small onshore gas field at Ikhil, no oil or gas has been commercially produced in the area.

The preparation of the GIS-based decision-support tool for the study area required the completion of a series of inter-related steps. The steps included:

1. identification and review of potential and final valued ecosystem components (VEC) and valued socio-economic components (VSEC);
2. the review of past, present and potential oil and gas development activities in the region, and the residual effects of these activities;
3. the preparation of sensitivity layers for the VEC and VSEC;
4. the preparation of the geo-economic layer; and
5. the development of decision-rules around the sensitivity layers.

A key aspect of the decision-support tool development was the selection of Valued Ecosystem Components (VECs) and Valued Socio-Economic Components (VSECs). Following a review of selected literature, Community Conservation Plans, the VECs chosen for this project include polar bear, beluga whale, ringed seal and migratory birds. When choosing the particular VECs, the project team identified species at risk or species that had high ecological, social, cultural or economic value. All the VECs selected also play an important social, cultural and economic role for the Inuvialuit Settlement Region (ISR) communities, which include Aklavik, Inuvik, Tuktoyaktuk, Ulukhaktok, Sachs Harbour, and Paulatuk.

The hunting and trapping of polar bears, beluga whales, ringed seals and migratory birds were identified as the crucial socio-economic and cultural component. To sustainably manage their resources, the Inuvialuit communities designated special areas and recommend land use practices in their community conservation plans (CCPs), depending on the significance and sensitivity of cultural or renewable resources. The VSEC of hunting was selected to be included in the decision support tool because the activity of hunting and the species hunted are susceptible to changes in association with oil and gas activities. The CCPs were used as the basis of the VSEC sensitivity scores.

The geo-economic layer components of the decision-support tool were based on an INAC-developed scorecard rating system for each grid cell in the study area. Each grid cell was scored based on geological factors, economic factors, and uncertainty.

The sensitivity layers are a composite of various pieces of relevant ecosystem (habitat use and availability) and socio-economic information. In their compiled state, they form a sensitivity layer. In some situations there was an intersection of more than one sensitivity ratings within a single grid cell. Decision rules were developed to assign the overall sensitivity rating for those grid cells. The rules allow for various levels of conservativeness to be considered related to the sensitivity ratings for a grid cell. Three decision rules were applied in calculating a grid rating, (grid assigned maximum score of scores present, grid assigned mean score of scores present, and grid assigned max value of scores present if 90% of the area of the grid is covered by the max score). This report presents the most conservative scores for the grids. The ability to compare conservativeness is embedded within the decision support tool options.

A sensitivity map was developed for each VEC and VSEC. The sensitivity scores provide a relative appreciation of the biological (highlights the most vulnerable and sensitive areas, seasonal distribution, and provides information on the potential response to change resulting from hydrocarbon development), social or economic values within grid. This information can be used by INAC-NOGB as well as other users to manage activities within that grid by providing a better understanding of the sensitive areas within a region. Management options to be applied by NOGB are yet to be determined. The Strategic Environmental Assessment process that is to be undertaken by the Branch will involve the development of leasing management options.

This decision-support tool has been designed to eventually support the inclusion of more VEC's and VSEC's as the geographic information becomes available. The tool could also be used to evaluate potential cumulative effects resulting from oil and gas activity in the region at strategic level. Preliminary work was completed on a summary of residual effects associated with offshore oil and gas activity (effects that persist after the application of mitigation) that could act in a cumulative fashion to impact the environment and social structure of the region. This work needs to be further refined and confirmed but has been included in an appendix of this document.

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Acronyms

BBOE	Billions of Barrels of Oil Equivalent
CCP	Community Conservation Plan(s)
CEAA	Canadian Environmental Assessment Agency
COGOA	Canada Oil and Gas Operations Act
COSEWIC	Committee on the Status of Endangered Wildlife In Canada
CPRA	Canada Petroleum Resources Act
CWS	Canadian Wildlife Service
DST	Decision Support Tool
EIRB	Environmental Impact Review Board
EISC	Environmental Impact Screening Committee
ESRI	Environmental Systems Research Institute
FEARP	Federal Environmental Assessment and Review Process
GIS	Geographic Information system
GLL	Gartner Lee Limited
GNWT	Government of the Northwest Territories
IBA	Important Bird Area
IBP	International Biological Programme
INAC	Indian and Northern Affairs Canada
MGP	Mackenzie Gas Project
NEP	National Energy Program
NOGB	Northern Oil and Gas Branch
OGMD	Oil and Gas Management Directorate
SARA	Species At Risk Act
SEA	Strategic Environmental Assessment
UGI	Unique Grid Identifier
VEC	Valued Ecosystem Component
VSEC	Valued Socio-Economic Component
WMAC	Wildlife Management Advisory Council

Glossary of Terms

Active ice	Ice that forms open water leads that expand and contract due to the pressures of wind and pack ice movement (also see Flaw Leads)
Anadromous	Living in marine water, while breeding in fresh waters.
Annual ice	The ice that forms on the ocean surface annually in late fall and melts in late spring
Anthropogenic	Effects of processes derived by human activities or actions.
Base Layer	A base layer is the electronic representation of geographic information that applies to the entire study area i.e., maps of the coast line, river systems, etc.
Benthic	The bottom of a sea, lake or river.
Component Layer	A component layer is electronic geographic information that is specific to valued ecosystem components (VECs) or valued socio-economic components (VSECs) and necessary to developing a sensitivity layer.
Country Food	Food derived or gathered from non-domestic sources (i.e., wild game)
Critical Habitat Area	As defined by the Species at Risk Act, the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.
Critical Habitat Area	As defined by the Species at Risk Act, the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.
Decision-support tool	The geographic information system (GIS) that contains a series of sensitivity layers generated for each valued ecosystem component (VEC), valued socio-economic component (VSEC) and the geo-economic potential in the study area, which can be manipulated to generate a picture of potential change, should an area be opened to exploration and development.
Estuary	(1) The lower course of a river where its current is met by the tides and fresh and salt water mix. (2) An arm of the sea that extends inland to meet the mouth of a river.
Flaw leads	Productive areas of an open area of water that separates the central Arctic ice pack from landfast ice.
Geo-economic Layer	The geo-economic layer developed was based on INAC-developed scorecard rating system for each unique grid cell in the Study Area that was scored based on geological, economic, and uncertainty factors.
Geographic Information System (GIS)	A GIS is a computer-based system for capturing, storing, analyzing and managing data and associated attributes, which are spatially referenced to the earth.
Grid	The grid is the predetermined set of coordinates used by the

	Department of Indian Affairs and Northern Development.
Grid Layer	The grid layer is the visual categorization of the sensitivity rating to the grid.
Ice lead	Any fracture or passageway through sea ice, which is navigable by surface vessels. If the passageway lies between drift ice and the shore, it is termed a shore lead. If it lies between drift ice and fast ice it is called a flaw lead
Land fast ice	The ice that forms between the shore and sina (ice edge)
Moult	The periodic shedding of the outer skin layer.
Multi-year pack ice	Large area of floating ice that perennially covers the ocean surface.
Polynya	An area of thin ice (surrounded by sea ice) that melts early in spring, creating open water. Usually formed due to upwelling of relatively warm, nutrient-rich seawater.
Primary Productivity	Primary productivity is the accumulation of biomass, primarily through photosynthesis, In ocean environments, algae supports most primary production.
Secondary Productivity	Secondary productivity is the accumulation of biomass by heterotophs; such as the shrimp-like crustaceans, small fish and zooplankton that make up ringed seal diets.
Sensitivity Layer	A sensitivity layer is a visual representation of the rating gradient developed (1 to 5, whereby 1 is the least sensitive and 5 is the most sensitive), featuring the susceptibility of a VEC or VSEC to change. It is developed from a composite of component layers.
Shore lead	An area of open water between pack ice and fast ice or between floating ice and the shore.
Subsistence Harvesting	Hunting for wildlife to provide essential food and clothing
Surrogacy	The ability for a VEC/VSEC to act on behalf of other components of the environment.
Valued ecosystem component (VEC)	Any part of the biophysical environment that is considered important. Importance may be determined on the basis of cultural values or scientific concerns.
Valued socio-economic component (VSEC)	Those aspects of the socio-economic environment considered to be of vital importance to a particular region or community, including components relating 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.
Zone of Influence	The area surrounding a feature or activity in which animal abundance, distribution or health is impacted.

1. Introduction

In July 2006, the Department of Indian and Northern Affairs Canada (“INAC”) - Northern Oil and Gas Branch (“NOGB” or “Branch”), contracted Gartner Lee Limited (“GLL”) to develop a geographic information system (GIS) based decision-support tool (“DST”) that would facilitate the completion of a Strategic Environmental Assessment (“SEA”) for a discrete area of the Beaufort Sea.

The NOGB is responsible for the management of oil and gas resources in the Northwest Territories, Nunavut and the northern offshore. The Branch[1], through the *Canada Petroleum Resources Act* (CPRA) provides access to federal Crown lands, issues rights, sets and collects royalties, while the National Energy Board, regulates petroleum industry activities in the North under the CPRA and the *Canada Oil and Gas Operations Act* (COGOA).

In seeking the creation of a decision-support tool to facilitate a SEA, the NOGB is advancing their commitment to sustainable development associated with management of oil and gas resources in the North, while ensuring environmental protection. The decision-support tool and SEA will assist managers and decision-makers in choosing appropriate processes and actions to responsibly manage the opening of offshore areas.

This contract work includes the following:

- a summary of information relating to the biophysical, social and economic environment;
- a summary of information on past and present offshore oil and gas activities in the region;
- a web accessible and GIS-based decision support tool (and supporting database); and
- a report summarizing the above work.

1.1 Objectives

The objectives for this program are twofold:

The first objective was to define sensitively layers for a series of Valued Ecosystem Components (VEC’s) and Socio-economic Components (VSECs) so that parts of the study area that have greater susceptibility to development are identified. A series of VECs and VSECs were chosen to represent a variety of ecological and social components that were of value.

The second objective was to amalgamate the sensitivity layers using a GIS tool so that the combined results of sensitivity to development results among VECs and VSECs can be viewed holistically and support future decisions regarding areas available for lease, for oil and gas exploration and development. The sensitively layers would be applied to the Northern Oil and Gas Branch’s Leasing Grids (termed herein Grid Sensitivity), and the combination could simultaneously

[1] *http://www.ainc-inac.gc.ca/oil/vision_e.html*

identify areas of high or low sensitivity among several VECs/VSECs, and corresponding high and low values of geo-economic potential.

Additionally, these objectives are meant to contribute to the ability of INAC to complete strategic level environmental assessment and support long-term planning. By developing an understanding of where multiple environmental and socio-economic sensitivities are, and where the greatest and least economic potential lies (and where uncertainties exist), INAC can use that information in planning and evaluating future leasing scenarios.

1.2 Study Area Description

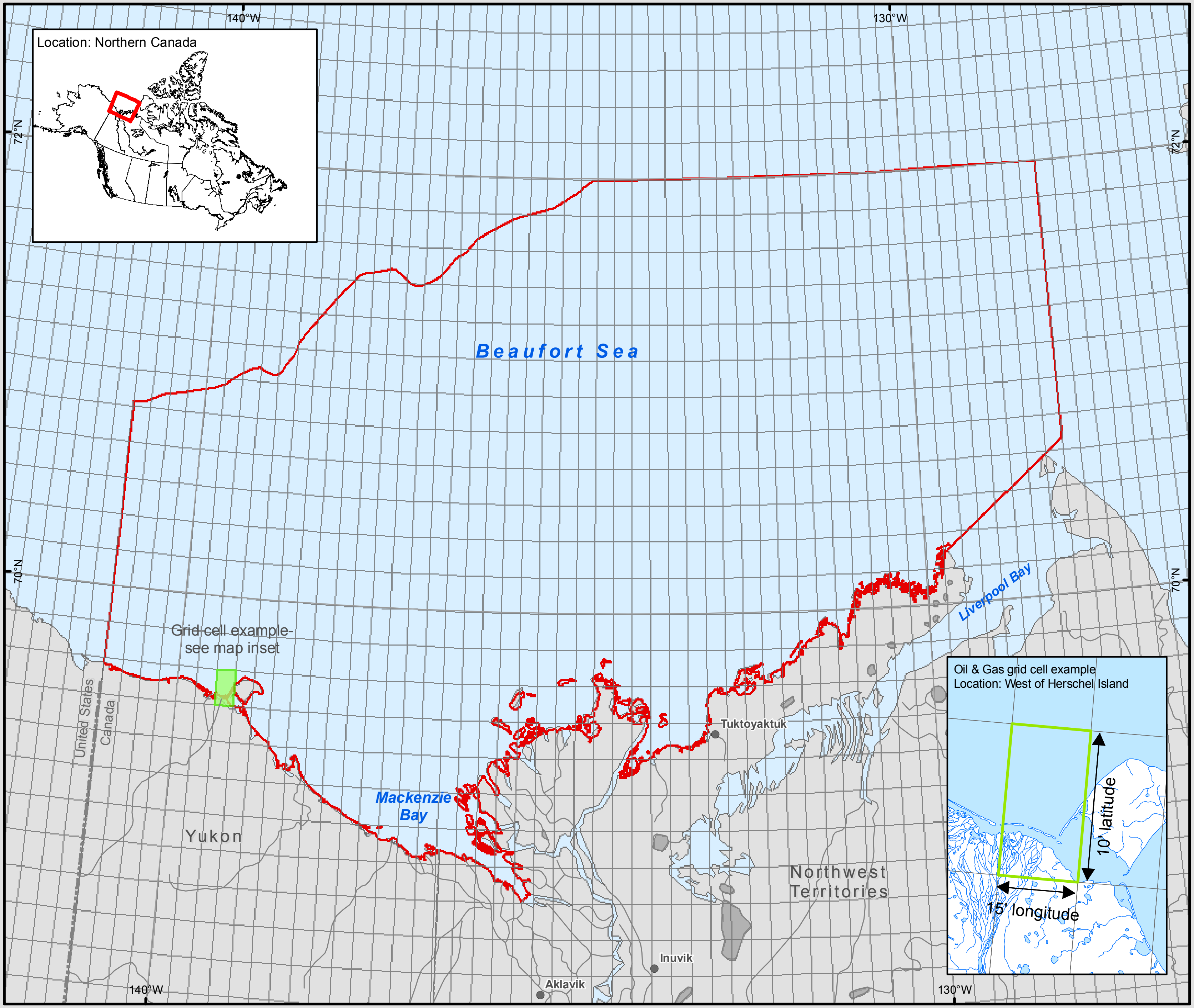
The study area lies immediately north of Inuvik and Tuktoyatuk in the Beaufort Sea, and borders the Canada-United States border to the west (141° W), approximately the mainland coast to the south, the 128° W longitude to the east, and 72°N latitude to the north (Figure 1-1). Bounds of the study area were based on the NOGB leasing grids used in the Beaufort Sea, as those grids units in which the potential leasing of oil and gas exploration and production areas are issued. The study area was defined by INAC as part of the terms of the project, the Beaufort Sea area that Decision Support Tool was to be applied within.

1.2.1 Unique Grid Identifiers

The study area was divided according to a pre-defined grid used by the NOGB to issue oil and gas exploration rights. For the purposes of this exercise, discrete grid cell identifiers were assigned to the cells in the grid so that cells could be distinguished. The unique grid identifier (UGI) was linked to the northeast corner coordinates for each grid cell. Using this naming convention for the UGI, the grid whose northeast corner is 70 degrees, 00 minutes North, 120 degrees 00 minutes West, had a UGI of "700012000". The use of the UGI allowed for linkages to other project information in the decision-support tool (i.e., area calculations were done for each unique grid cell). The typical area of the individual grid cells was between 160-182 km^2 with distortion due to the map projection (i.e., going northward from the 60-degree latitude, parallel towards the poles).

Note: To simplify the grid definition, no change in grid size was applied at 70° North as prescribed by the *Territorial Lands Act.*

File: 60866_O1_Fig_1-1_StudyArea_11May07.mxd



Legend

- Community point
- Grid cell
- Grid cell - UGI 694013915
- Study area

Map Sources/Notes:

Study area provided by INAC

Oil & gas grid provided by INAC

N E S W

10 5 0 10 20 30 40 Km

1:2,750,000

Lambert conformal conic projection

Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Study Area

16 May 2007

Gartner Lee

Figure 1-1

Version 1

1.2.2 Environmental Setting

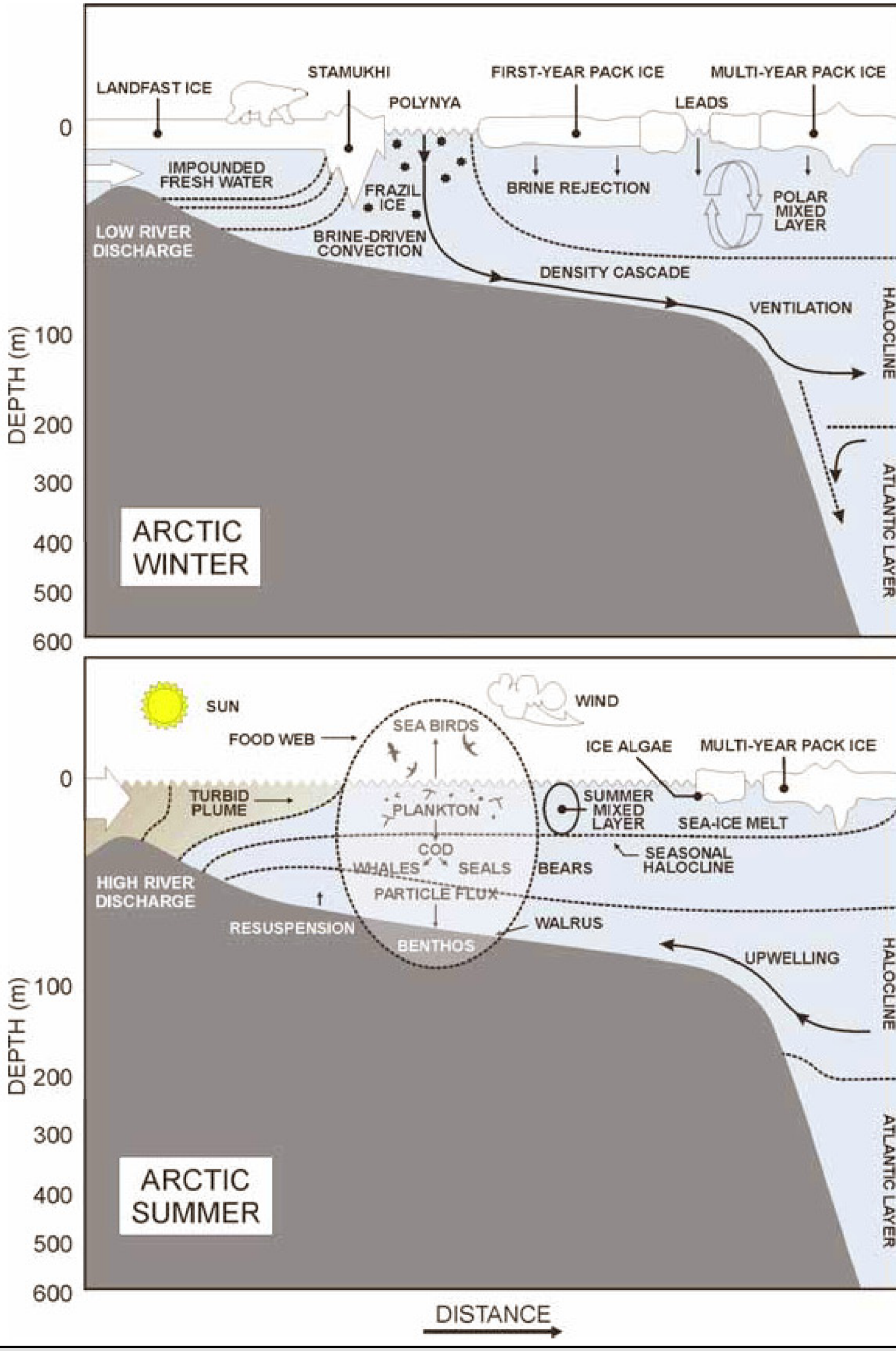
Seasonal ice cover characterizes the region with multi-year ice to the north of the study area. Freeze-up starts in October and is generally complete by November (Figure 1-2). The landfast ice extends outward from the coast to the point at which water depth is approximately 20 m, after which rubble ice is formed. Beyond the rubble ice, on the seaward side is a flaw polynya, and beyond that there is drifting polar pack ice (DFO 2007).

Typically, in April, break-up of the nearshore ice begins. Freshwater from the Mackenzie River and sea-ice melt create circumstances not dissimilar to an estuary. The area becomes dominated by freshwater and allows freshwater biota to temporarily inhabit the nearshore waters. In the fall, autumn storms force an upwelling bringing off-shore waters to mix with the nearshore waters.

The trophic relationships in the Beaufort are driven by light and nutrients absorbed by phytoplankton (primary producer). Phytoplankton growth is driven by light and nutrient availability in the Beaufort Sea. Zooplankton creates the link between phytoplankton and larger organisms (Figure 1-3). Fish species closely occupy the same points in the water column as zooplankton. Of primary importance are arctic cod (*Boreogadus saida*). Arctic cod are consumed by bowhead whales (*Balaena mysticetus*), beluga whales (*Delphinapterus leucas*) and seals (*Phoca* sp.). At the top of the trophic scale, seals are consumed by polar bears (*Ursus maritimus*) (DFO 2007).

1.2.3 Background of Oil and Gas Development in the Beaufort Sea

The Beaufort Sea-Mackenzie Delta has been the scene of extensive oil and gas exploration activity including both onshore and offshore drilling activities. Oil and gas activity north of 60° extends back to the discovery of the fields in Norman Wells in 1919 (Morrell *et al.* 1995). Exploration activity in the area began onshore in 1957 with the first reconnaissance-level ground and air studies taking place in the Mackenzie Delta region by major industry corporations such as Dome, Chevron, Gulf, Esso and others (GNWT 2006). The discovery of oil at Atkinson Point in 1969 and discover of major gas fields at Taglu (1971), Parsons Lake (1972) and Niglintgak (1973) resulted in the proposal of the Mackenzie Valley Pipeline in 1974 and the addition of exploration and investment offshore (Morrell 2003). Offshore exploration began in the Beaufort Sea region in the early 1970's with the use of artificial islands in shallow water (up to 12 metres) (Timco and Johnston 2002). These islands were constructed by either dredging the local sea bottom or by trucking gravel from shore. The first of the islands was constructed in 1972, followed by the completion of 23 more before 1984 (FEARP 1984).



Map Sources/Notes:
Figure reproduced upon permission from Fisheries and Oceans Canada.

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Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Winter and Summer Sea Ice Dynamics and Influence of the Mackenzie River

01 May 2007

Gartner Lee

Figure 1-2
Version 1

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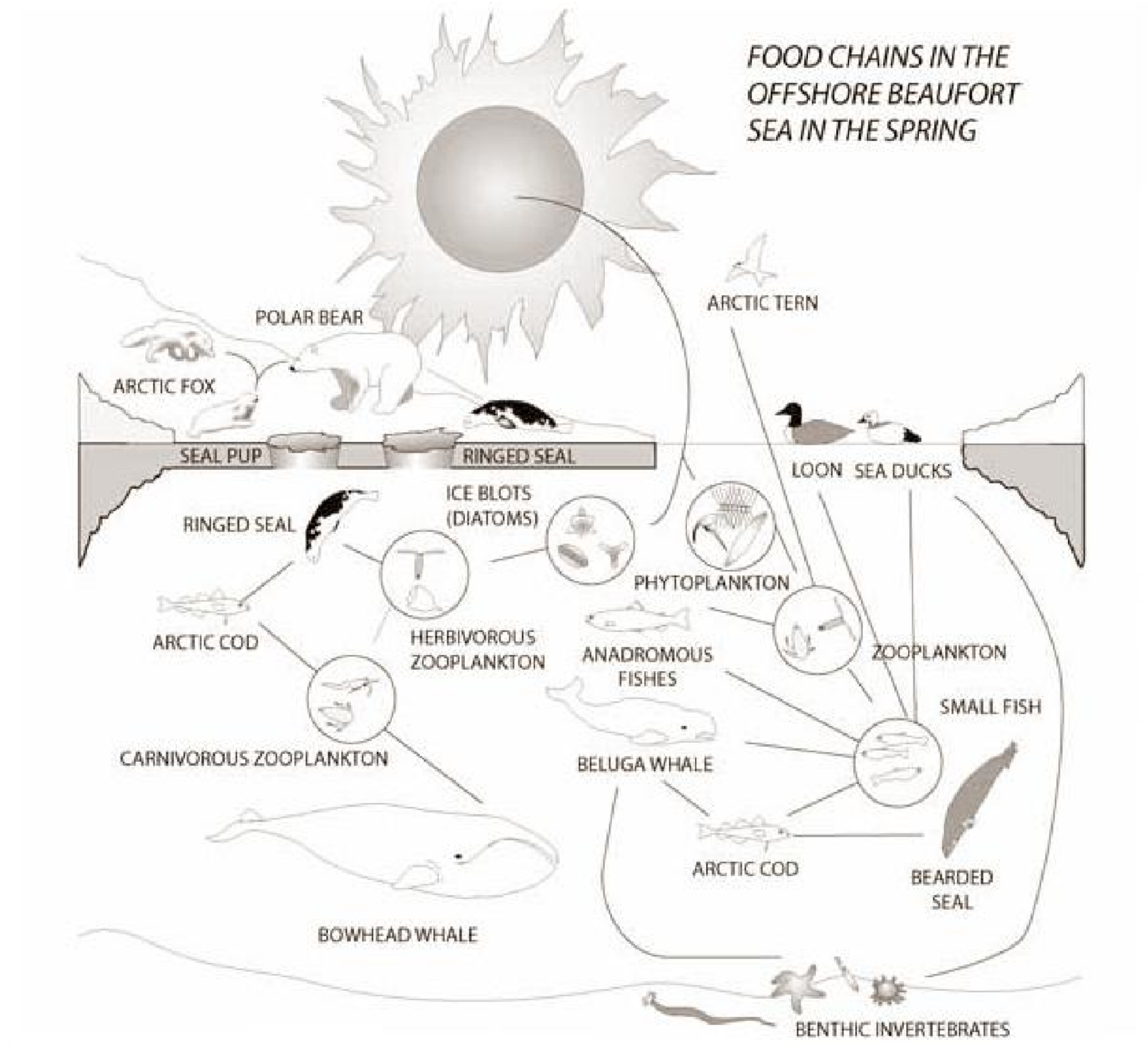
File: 60866_C1_Fig_1-3_FoodWeb_01May07.mxd



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Map Sources/Notes:
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Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Trophic Relationships of Species in the Beaufort Sea Region

01 May 2007

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Figure 1-3
Version 1

Exploration and drilling continued, both onshore and offshore, until the mid 1970's and the release of the report on the inquiry for the Mackenzie Valley pipeline by Justice Berger. This report recommended a 10-year moratorium on the construction of a pipeline up the Mackenzie Valley in order to settle land claims with aboriginal groups and address environmental concerns (GNWT 2006). This prompted the federal government to institute a freeze on the issuance of new exploration rights in the Mackenzie Valley until land claims were settled (Morrell *et al.* 1995). At the same time, the National Energy Program (NEP) was initiated in 1980 to continue to promote activity in the Beaufort Sea – Mackenzie Delta region.

Offshore exploration escalated in the 1980's. Seismic exploration found numerous large structures and potential for "oil-prone source rocks". This precipitated additional offshore exploration with success at Kopanoar in 1976, and culminating with Amauligak, which was considered among the largest discoveries, in 1983 (Morrell *et al.* 1995). The success of this exploration has led to the issuing of numerous exploration and significant discovery licences (Figure 1-4). Offshore exploration was facilitated with innovative operating techniques and new offshore platforms that extended the ability to operate in the short open-water season and ice. Offshore petroleum discoveries continued each year until 1989 (Table 1-1). A total of 83 offshore wells had been drilled in the Beaufort-Mackenzie Basin (62 exploratory and 21 delineation). With the settlement of land claims in the Beaufort-Delta, rights issuance was again initiated in 1989 but it was not until 1999-2000 that companies took up extensive petroleum exploration rights both onshore in the Mackenzie Delta and in the Beaufort Sea (INAC 2001).

Table 1-1. Offshore Oil Discoveries in the Beaufort-Mackenzie Region from 1976-1989 (mmbls)

500-100 mmbls	100-25 mmbls	25-10 mmbls	<10 mmbls
Amauligak (1983)	Tarsiut (1978)	Nektoralik (1976)	Nerlerk (1977)
Adlartok (1985)	KoaKoak (1979)	W. Atkinson (1982)	Itiyok (1982)
Kopanoar (1976)	Issungnak (1980)	Amauligak (1988)	Arnak (1986)
	Havik (1983)	Nipterk (1989)	
	Pitsiulak (1983)		
	Nipterk (1984)		
	Kingark (1987)		

Note: mmbls = million barrels (Morrell et al. *1995)*

With the minor exception of the small onshore gas field at Ikhil, no oil or gas had been commercially produced, despite all of the exploration and monetary investment in the 1970s and 80s. Ikhil was put on-stream in the Mackenzie Delta in 1999 and currently supplies the town of Inuvik with energy for power generation and domestic use (Morrell 2003). In 2004, the Delta gas fields discovered at Taglu, Parsons Lake, and Niglintgak were proposed for development (Mackenzie Gas Project 2004). Offshore exploration was again revived with the 2005 drill program by Devon Canada. The drilling of the Paktoa well site was the first to be drilled offshore in the Beaufort Sea in sixteen years (Indian and Northern Affairs Canada 2005). At the end of 2005, although six gas fields were in production in the Northwest Territories only one gas field was producing the Mackenzie Delta (Ikhil) and none from the offshore Beaufort Sea (INAC 2006c).

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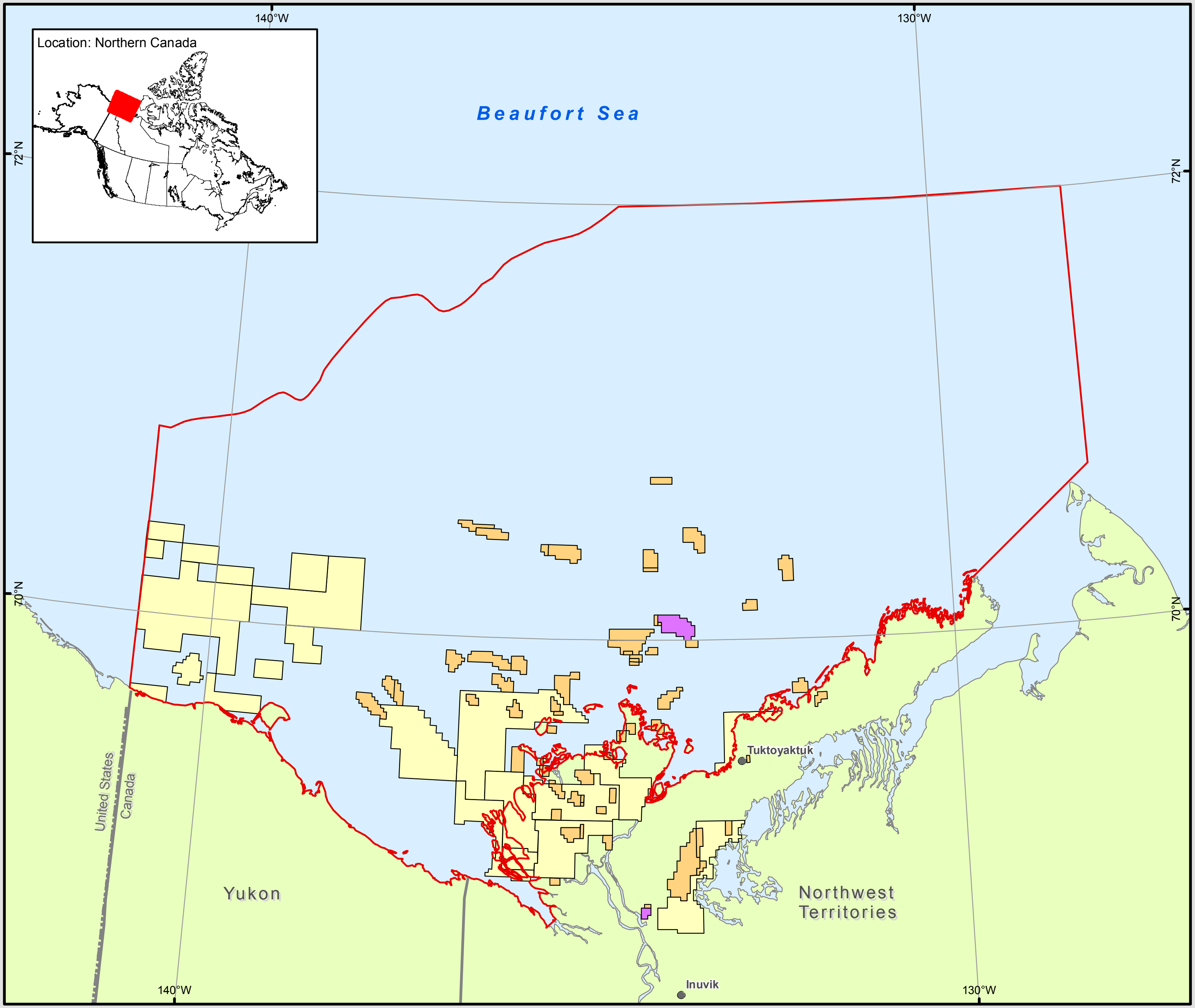

Legend

- Community point
- Study area
- NorthernBorders
- International

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:

GeoEcon & VEC data compiled by GLL & INAC
Study area provided by INAC
Oil and Gas dispositions provided by INAC

1:2,750,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Location of Exploration and Significant Discovery Licences

07 October 2008

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Figure 1-4
Version 1

2. Approach and Methods

This section provides an overview of the methods to defining sensitivity layers for the selected VECs and VSECs, the development of the Geo-Economic layer, and how that information was used in building the decision support tool.

2.1 VEC/VSEC Layer Development

2.1.1 Selection of Valued Ecosystem and Socio-Economic Components

A key aspect of the decision-support tool development was the selection of VECs and VSECs. It was critical that the VECs and VSECs be scientifically defensible and broadly accepted. In addition, consideration was given to whether or not a VEC or VSEC could be representative of components other than themselves (i.e., were they capable of acting as a surrogate for other components).

Identifying the candidate VECs and VSECs for this exercise was completed in the following manner:

- the development of a preliminary list of VEC/VSEC was based on a review of selected literature, including previously completed environmental assessments, research reports related to the Beaufort Sea Region, and the Community Conservation Plans (CCP) for the Inuvialuit Settlement Region (Appendix A);
- determination of which potential VECs and VSECs were associated with the study area for at least a portion of their annual life cycle;
- confirmation of the availability of information for the potential VECs and VSECs;
- determination of a potential relationship between the VECs and VSECs; and
- determination of whether the VECs/VSECs displayed sensitivity to change.

A further step included consideration of VEC/VSEC responses to possible environmental effects related to oil and gas projects and discussions with regulators familiar with the Beaufort Sea region.

When considering candidate species of mammals, migratory birds and fish, the project team also identified species at risk and those components with a high ecological, social, cultural or economic value.

2.1.1.1 Surrogacy

In selecting VECs and VSECs, surrogacy, or the ability for the VECs/VSECs to act on behalf of other components, was also considered and actively sought. It is important to note; however, that there are limitations to using a VEC as a surrogate. Surrogacy needs to be interpreted on points of commonality as VECs will never fully equate to another in terms of habitat area-values, life history strategies, or potential response and sensitivity to development. In some cases though, there are common elements of habitat use that can be interpreted, and for example, some of the shallow waters and marine estuaries used as migratory areas for beluga corresponds well to those areas where Arctic cod and rainbow smelt concentrate. As most digital spatial layers were not available for all potential VECs identified, we have identified those VECs that may act as surrogates for other species.

2.1.1.2 Selected Valued Ecosystem Components

The VECs selected for this project include:

- polar bear (*Ursus maritimus*);
- beluga whale (*Delphinapterus leucas*);
- ringed seals (*Phoca hispida*); and
- migratory birds.

A large list of candidate VECs was considered; and is summarized in Appendix B. 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 sensitive areas associated with VECs. It is intended that additional VECs/VSECs will be mapped in future, as additional spatial datasets become available. The mapping of subset of the candidate VECs/VSECs and the subsequent review of the sensitivity layers will allow for modification to the mapping and processes in future (if necessary) as additional VECs/VSECs are mapped.[2]

2.1.1.3 Valued Socio-Economic Components

All the VECs selected play an important social, cultural and economic role for the Inuvialuit Settlement Region (ISR) communities. The ISR Community Conservation Plans identify important wildlife habitat and seasonal harvesting areas, population goals and conservation measures appropriate for each species of concern, and make recommendations for their management. After a review of the CCPs, and a consideration of petroleum industry activities likely to take place in the study area, hunting and trapping was selected as the final VSEC. In reviewing all of the plans for the ISR communities it was determined that communities of Paulatuk, Sachs Harbour and Ulukhaktok (Figure 2-1) did not identify lands within the study area which were used for hunting and trapping, therefore, the review of CCP information focused on the communities of Aklavik, Inuvik and Tuktoyaktuk. Additional details on the hunting and trapping VSECs is provided in Section 4.

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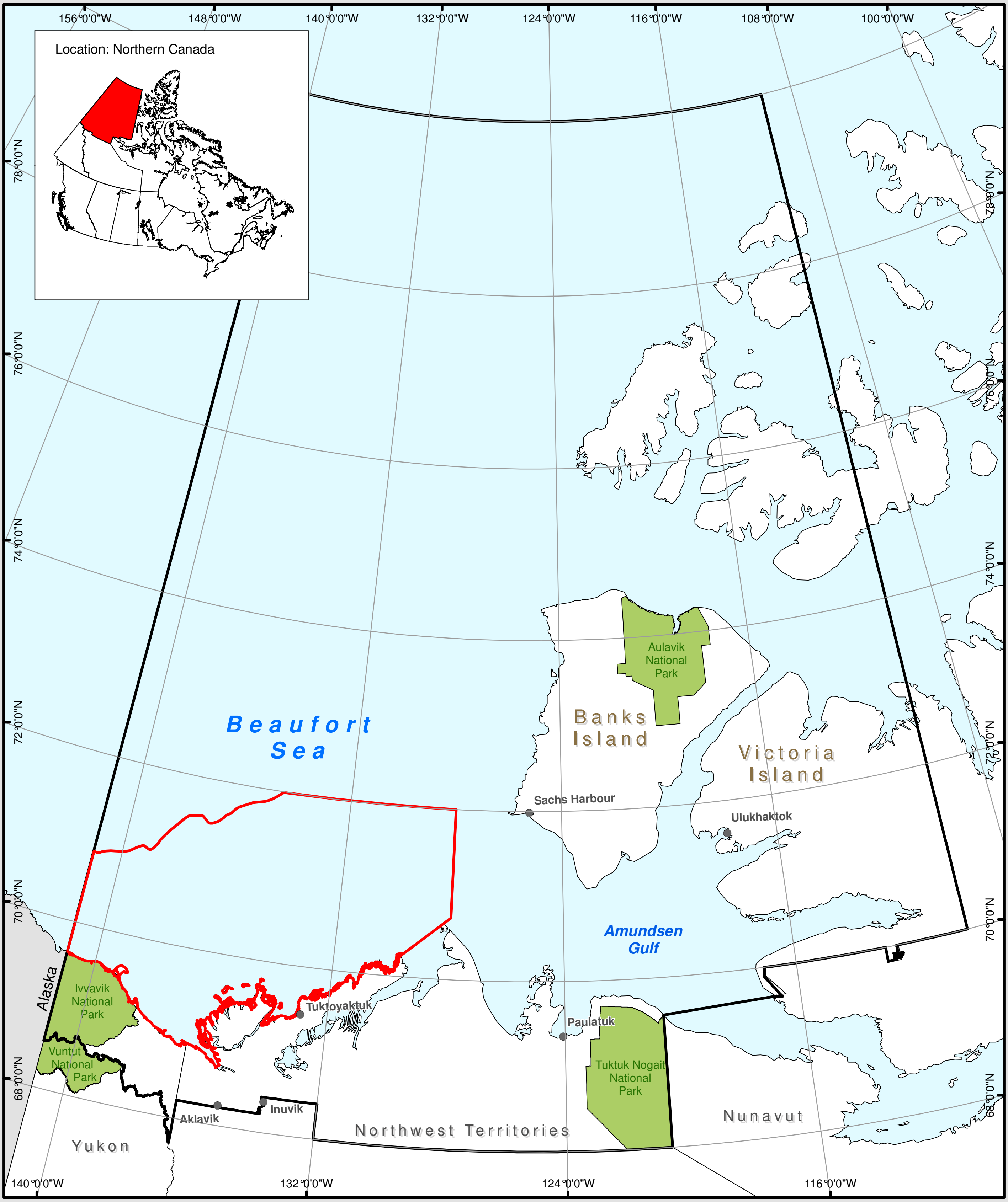
[2] *It is NOGB's hope to further develop the list of VEC's and VSEC's as spatial information becomes available. The department of Fisheries and Oceans recently provided information on Ecologically and Biologically Significant Areas in the Beaufort Sea, which will be a priority for future integration into the tool.*



Map Sources/Notes:
Inuvialuit settlement region boundary obtained from Her Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.
Study Area delineated by Gartner Lee Ltd.

N W E S

50 25 0 50 100 150 200 Km

1:7,000,000
Lambert conformal conic projection
Standard parrallels at 60°N and 75°N,
Central meridian at -125°W

Legend

- Community
- National Park
- Inuvialuit Settlement Region Boundary
- Study Area

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Inuvialuit Settlement Region

25 June 2007

Gartner Lee

Figure 2-1
Version 1

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2.1.2 VEC/VSEC Sensitivity Layer Development

Sensitivity layers were developed for each selected VEC/VSEC were a composite of various pieces of relevant ecosystem (habitat use and availability) and socio-economic information. Establishing the appropriate rating and distributing it spatially across the study area was dependent on data availability. Therefore, while the VEC/VSEC information is comprehensive, the spatial distribution may vary substantially on an annual basis, and is dependent upon environmental conditions at the time. Given this variability, it is recommended that conservative interpretations of potential impacts for projects among seasons be considered, rather than less conservative. A component sensitivity layer was made up of from 1 to 20 information layers (Figure 2-2).

2.1.2.1 Sensitivity Ranking Methodology

The process of developing sensitivity ranking was a process that linked ecological factors and habitats associated with individual species, and the nature of potential impacts for VECs and VSECs. The concepts considered in developing the rating included the sensitivity to development, the susceptibility to habitat change for VECs, the life cycle and occurrence in the study area, and the importance to Inuvialuit. A five-level rating scale was applied to allow for amalgamation of VEC and VSEC rating that included:

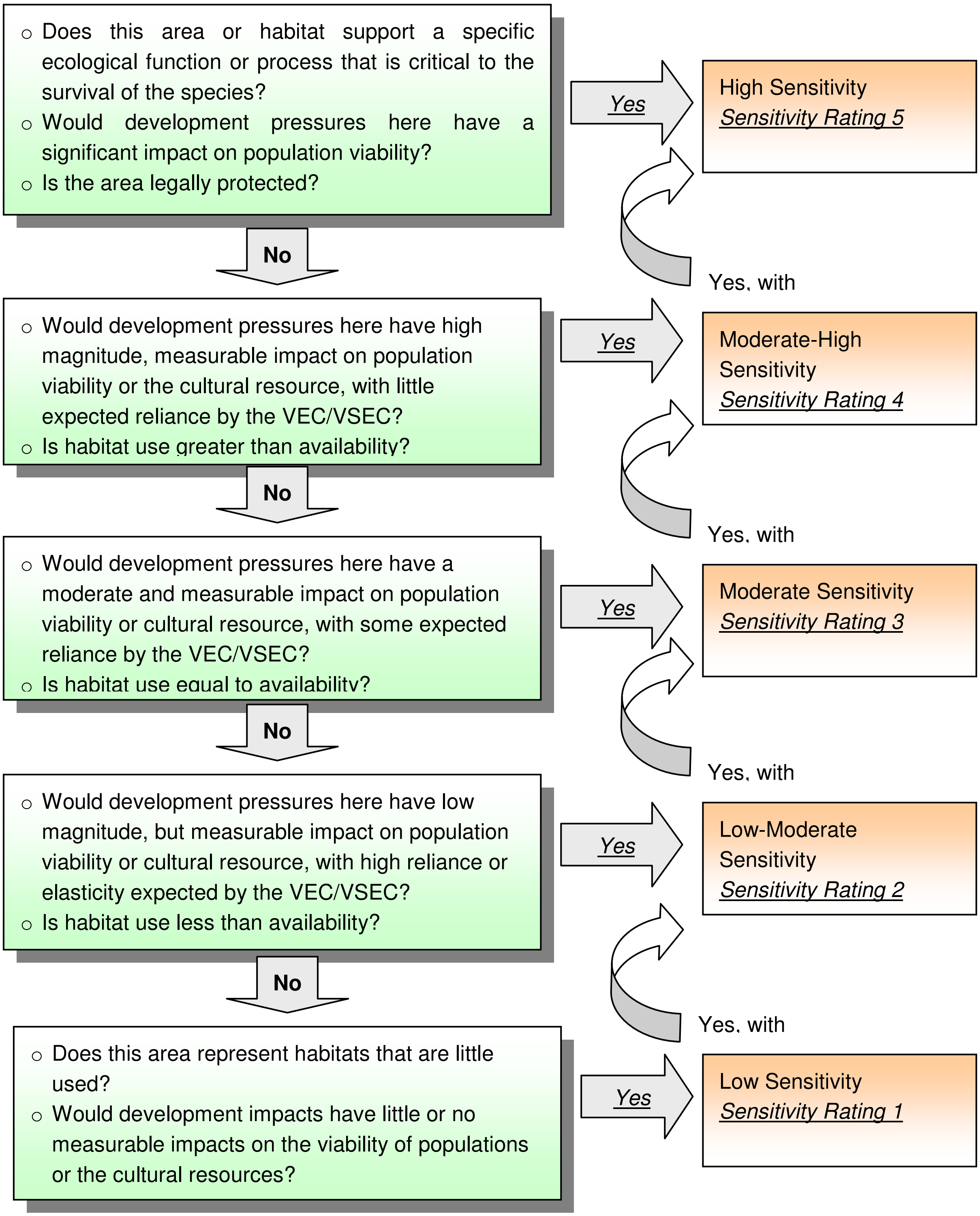
1. Low Sensitivity
2. Low/Moderate Sensitivity
3. Moderate Risk Sensitivity
4. Moderate/High Sensitivity
5. High Sensitivity

Each species and VSEC is unique. The process of assigning a rating to a sensitivity layer was, in part, a subjective and individual method. However, there were several guiding principles that were common to the process of sensitivity ranking for all VSECs and VECs. For biophysical VECs, the ranking system applied a combination of habitat value and the susceptibility of habitat values to developments. The implication of that combination to the population for individual VECs to the loss of habitats was then used to assign a sensitivity rank. The principles that guided this process were, in summary:

- habitats that have specific values for the a suite of VECs were incorporated and mapped;
- the ecological value of habitat that support the viability of the population of a VEC were positively reflected in the sensitivity rating for a individual VEC;
- the cultural value of areas to local and indigenous people was positively related to the sensitivity rating of a VSEC; especially in regard to the ability of the area to support culturally significant activities, history, or education;

Figure 2-2. Creation of the Geo-economic Sensitivity Layer

Sensitivity Rating Decision Process (Top Down Process)



- the greater the ability of a given area to respond to development pressures (including accidents) with elasticity and less functional change were given a lower sensitivity rating, and conversely, those areas that had less capacity to absorb changes due to development pressures were given higher sensitivity ratings; and
- 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.

These principles have been established through the development of similar Sensitivity Atlases, such as those used for preventing and responding to ecological disasters (primarily oil spills) in marine environments. Examples include the Sensitivity Atlas of Peatlands to Climate Change (Tarnocia *et al.* 2000) and the Arctic Environment Sensitivity Atlas (Environment Canada 2003). Sensitivity atlases for the Beaufort Sea produced by Environment Canada focused in detail on inshore areas, and overall sensitivity ranks were based on 20 sensitivity elements among 3 categories (human use sensitivity, biological sensitivity, and shore zone or marine oil residence). That process of sensitivity rankings was described as a distillation of the sensitivities to compile one rank. Sensitivity atlases have also been developed for other natural processes, such as Wolfe and Nickling's atlas (1997) that mapped the combined risks of wind erosion with climate sensitivity. In that atlas, similar to the approach used here, two variables (eolian and climatic risk) were combined to produce one sensitivity rating.

Principles used in the creation of the sensitivity layer can be applied and repeated should additional VECs be included within the decision-support tool, and should be utilized in re-valuating the layers if new data becomes available for VECs and VSECs. Thus, the overall sensitivity rating of individual layers was assigned to five categories, where the highest ratings was meant to document those habitats or areas that support a specific ecological function or process that is critical to the survival and reproduction of the species at a population-level and/or those areas that have the highest vulnerability to development pressures (specific to the individual VEC). These areas rated highest included "Critical Habitat" as defined by the *Species at Risk Act.* The lowest sensitivity rankings, conversely, included habitats that are little used and of relatively low value to the viability of the populations, and in which the receiving environment may show limited functional change with the addition of oil and gas developments. Moderately-Low, Moderate, and Moderately-High ranking reflect intermediate stages between areas that are critical to the viability of species' populations, and those areas that have very limited value to the viability of the population.

The VECs and VSECs selection all have unique life histories. Differing sensitivities to development pressures, and differing histories of population growth or decline, make standardizing the ratings for the five rating classes among each VEC/VSEC difficult to quantitatively defend. In most cases, the distinction between Moderate-Low through Moderate-High was based on professional judgement. However, classification to the Low or High sensitivity ratings was easier to define because those areas of very high or very low value were better defined with the existing literature (for example, for the migratory birds VEC, defined areas are known to support a significant portion of the world' s population during a time of specific ecological function). The rating system and the principles for that can be described using as decision process diagram.

While it could be argued that the approach of sensitivity mapping lacks scientific rigour and quantitative habitat assessment, it is important to recognize that the roots of this method lie in practicality, and providing a relatively simple approach to amalgamate several ecological and cultural values together, so that decision makers can have a support tool to help evaluate the implications of opening areas of the Beaufort to exploration and development. Moreover, many rigorous scientific studies have resulted in detailed and accurate spatial definition of habitat values, and that rigour is thus inherent in resulting sensitivity layers.

This sensitivity is expressed as a rating for each polygon from 1 through 5, representing the utility of the area to the species, and the value of the area to the viability of the population(s). Ratings of class 1 represented the least utility and values (to which development impacts would be least apparent in the population, while areas ranked 5 are the most used and/or critically important to the survival of the species (and could be most affected by development). Areas of higher sensitivity were typically those that support potential denning and successful reproduction, as well as feeding areas necessary to support year-over-year survival.

Seasonality

In ranking sensitivity, the seasonality of occurrence of potential development impacts was identified, as were the value of the area or habitat that may only be used seasonally for each VEC. As the overall objective of this work was to facilitate a decision-support tool for the potential issuance of oil and gas exploration (and ultimately production permits with the Study Area [i.e., the Northern Oil and Gas leasing grid]), the sensitivity rating was built to incorporate data from all seasons (i.e., it was seasonal). The main rationale for this approach is that development activities that may occur in one season often result in impacts that persist across other seasons (i.e., habitat loss that occurs in mid-winter may not have immediate impacts to the moulting areas of migratory birds, but those impacts will persist to result in habitat loss across all seasons, including during the moulting periods). Furthermore, as ecologically specific seasons exist for individual VECs, such as denning, migratory movements, nesting, moulting, spring feeding, etc., then delineating the model by season would result in potentially dozens of separate decision-support tools. This would largely defeat the purpose of amalgamating sensitive areas together to best gain an overall picture of the sensitivity of the Beaufort Sea.

Confidence in Data Layers

The accuracy in which sensitivity layers are delineated in the model, the true value of habitats, and the true nature of how areas may respond to industrial disturbance is likely variable among VECs. Those underlying spatial data were treated more conservatively when it was suspected that limited confidence existed for the mapping of habitat values (such as the case with polar bears). It is hoped that use of this decision-support tool will ultimately spur primary researchers to better define and categorize the habitat values in the study areas, and the potential consequences of development. In such cases, as new data becomes available this tool had the inherent capability to respond to such changes, by simply updating the base layers used in the sensitivity layer development.

2.2 Geo-Economic Layer Development

The geo-economic layer scoring in the decision-support tool was developed based on an INAC-developed scorecard rating system for each unique grid cell in the Study Area. A spreadsheet was created to hold the scores for all grid cells in the study area, based on a sample scorecard and rating system developed for individual UGI cells.

Essentially, each individual cell was scored based on the following three main categories:

- Geological Factors
- Economic Factors
- Uncertainty

2.2.1 Geological Factors Score per UGI

The Beaufort-Mackenzie Basin is known for its proven and potential oil and gas resources. The discovered quantities of conventional oil and gas resources are estimated to be 277.3 x 10^6 m^3 recoverable crude oil, and 332.4 x 10^9 m^3 recoverable natural gas. This assessment of resource potential was based on research completed by the Geological Survey of Canada, which identified 18 plays. The Basin itself has been organized into six distinct play groups. Geological scores were derived from the mean oil resource estimate for the following:

- Deep Water (outboard of the contemporary shelf edge);
- Basinal Facies (inboard of the contemporary shelf edge);
- West Beaufort Sea;
- Taglu Delta;
- Kugmallit Delta; and
- Rifted Margin.

These potential estimates were taken from Chen *et al.* (2006).

The allocation per grid was determined by dividing the mean potential estimate in Billions of Barrels of Oil Equivalent (BBOE), by the number of grids in the play group.

The mean oil score was multiplied by a gas/oil factor based on discovered resources in each play group, to determine a mean gas endowment per play group (Table 2-1). This factor was estimated from Dixon et al. (1994). No gas was assigned to the Deep Water play group.

Table 2-1. Beaufort and Mackenzie Basin Total Gas and Oil based on BBOE

Play Group	Total Gas + Oil (BBOE) Per Grid cell
Taglu Delta	33
West Beaufort Sea	25
Rifted Margin	11
Kugmallit Delta	36
Basinal Facies	29
Deep Water	31

Overlapping play areas (some grid cells have more than one play) had to be combined for each grid cell, so that percent coverage for each play in each grid cell could be calculated. The BBOE values inside each grid cell were added to get a total BBOE for that grid cell.

Totals per grid in BBOE (i.e., for oil and gas) were presented as the geo-potential map. There was a five-fold classification applied, with 5 indicating relatively high potential, and 1 indicating relatively low potential (Table 2-2). It should be noted that this was an indication of relative potential within the Beaufort-Mackenzie basin, as the entire basin has a high to very high potential for hydrocarbons.

Table 2-2. Geology Scores Classification

Score Range (BBOE)	Geology Score
0.03 – 7.02	1
7.021 - 18.07	2
18.071 - 29.15	3
29.151 - 47.44	4
47.441 - 80.00	5

2.2.2 Economic Factors Score per UGI

The economic score per grid was a simplistic indication of the cost of exploration and development. It was based on a number of objective factors such as distance from infrastructure (anticipated from the Mackenzie Gas Project), water depth, etc. Many other factors could be added to further refine the economics score. Table 2-3 shows a sample economics score card for a grid cell. Only a selected number of economic factors identified have been populated for the purpose of this exercise. Spatial calculations used in Economics worksheet include distance from planned infrastructure and geographic location.

Table 2-3. Economic Factors Score Card Example

Factors	Components	Score	Tick	Weight Factor	Points	Comment
Existing Commitments	Active Exploration License	5	No	1	0	
	Development Plan	10	No	1	0	
Distance From Planned Infrastructure	> 100 Km	1		3	0	
	>25 Km And < 100 Km	2		1	0	
	< 25 Km	3	Yes	1	3	
Target Pool Size	Pool Size Bboe Medium And Larger (=>4)	1		1	0	200 Bcf
	Pool Size Bboe Smaller Than Medium (<4)	1	Yes	1	1	Consider If Onshore
Potential Grouping	Discoveries Within 2 Grids (Number)	1	Yes	1	1	
Geographic Location	Slope	1		1	0	
[Proxy For Cost]	Deep Shelf	2		1	0	
	Shallow Shelf >10 M < 30 M	3		1	0	
	Shallow Shelf < 10 M	4		1	0	
	Nearshore <5 Km	5		1	0	
	Onshore	6	Yes	1	6	
Hydrocarbons	Heavy Oil	1	Yes	1	1	Consider If Onshore
	Non-Conventional Gas	1		1	0	Consider If Onshore
	Oil	1		1	0	
Or	Oil Or Gas/Associated Oil/Gas	2		1	0	
Or	Gas	3		1	0	
Or	Oil & Gas (Separate Reservoirs)	4	Yes	1	4	
Development Risks	Ice Shear	0	Yes	1	0	Not Relevant If Onshore
	Ice Scour	0	Yes	1	0	
	Other Development Risk	1		1	0	
		Total Points For Grid			**16**	

2.2.2.1 Distance from Planned Infrastructure

Different scores were required depending on the proximity to the Mackenzie Gas Project (MGP) infrastructure. The MGP layer (line) was buffered at 25 km and 100 km. Grid cells within 25 km of the MGP infrastructure were given a score of 3 for the distance from planned infrastructure portion of the economics score i.e., most favourable from an economic standpoint. Cells within 100 km were given a score of 2, and cells greater than 100 km were given a score of 1.

2.2.2.2 Geographic Location

The seabed contours of 200, 30, and 10 m depths were combined with a 5 km coastline buffer and all onshore areas. The area north of the 200 m-depth line (Slope) was given a score of 1 i.e., least favourable. The area between the 200 m and 30 m depth lines (Deep shelf) was given a score of 2. The area between the 30 m and 10 m depth lines (Shallow shelf) was given a score of 3. The area between the 10 m depth line and a 5 km distance from shore (Shallow shelf <10 m) was given a score of 4. The area between the coast and a 5 km distance offshore (Nearshore) was given a score of 5 and the onshore areas were given a score of 6.

The 1 to 5 scale depicts relative cost of development, with 5 representing a low cost and 1 representing a high cost (Table 2-4).

Table 2-4. Economics Scores Classification

Points Range	Economics Scores
2.0 – 4.0	1
4.1 – 7.0	2
7.1 – 11.0	3
11.1 – 15.0	4
15.1 – 25	5

2.2.2.3 Uncertainty/Standard Deviation

Associated with the geological score was an uncertainty score. This was an indication of the possibility of making a large discovery whose size alone would make it more economic to develop. The standard deviation of the probability curve for each play group (Table 2-5) was chosen as the proxy statistic for uncertainty. A high uncertainty score meant that there was a larger spread in the curve of potential estimates. Two play groups may have had the same mean potential, but one may have had a possibility of a much larger field. For a basin in the early stages of exploration and development, the allure of the elephant is a key driver for exploration investment. The uncertainty score per grid was scaled from 1 to 5, with the high number indicating the largest standard deviation, and hence, the possibility of larger discoveries (Table 2-6).

Table 2-5. Summary of Standard Deviation Values

Play Group	Standard Deviation
Taglu Delta	58
West Beaufort Sea	120
Rifted Margin	112
Kugmallit Delta	135
Basinal Facies	142
Deep Water	285

Each play was assigned a standard deviation (SD) value. The maximum value in each grid cell was used.

Table 2-6. Uncertainty Score Classes

SD Value	Uncertainty Score
112	1
120	2
135	3
142	4
285	5

The individual scores for the geological, economic and uncertainty factors are then added together into a total score for each individual grid cell/UGI, called the Overall Development Likelihood Score (Table 2-7).

Table 2-7. Example of a Development Likelihood Score for a Grid Cell

Geological Score	2
Uncertainty Score	4
Economics Score	2
Overall Development Likelihood Score	**8**

The final score for each grid was given a key and split into five main categories for analysis and mapping them as follows (Table 2-8):

Table 2-8. Final Scores and Key

Score	Description
<6	Relatively low prospect for exploration and very low for development within 25 years
6	Relatively moderate prospect for exploration and low prospect for development within 25 years
7 - 8	Relatively good prospect for exploration and moderate prospect for development within 25 years
9 - 10	Relatively good prospect for exploration and development within 15 years
11 - 12	Active or imminent interest in exploration and development

Note: These scores are approximate indications of the relative likelihood of exploration and development and are based on opinion. Scores may be modified following consultation or as new information becomes available. Users are advised that they should be clear as to the limitations of the approach used in this study should any decision be contemplated on the basis of these representations.

2.3 Decision-Support Tool

As already mentioned, this work is intended to facilitate the commitment of INAC to complete a Strategic Environmental Assessment of potential development within the Beaufort Study Area. The decision-support tool's function is to allow users to overlay VSEC and VEC attributes on a grid thereby allowing comparison on an overall average rating of sensitivity, as well a maximum sensitivities, and with an overlay of geo-economic potential. The strength in this method is in understanding the relative values of leasing grids among a suite of VECs and VSECs, and for identifying those areas where leasing activities may be more or less favourable to consider by decision and management agencies. For example, the tool allows for identification of those areas that have high sensitivities and low geo-economic potential, or low areas with low sensitivities and high geo-economic potential. The tool eventually will be accessed on the web to users outside of INAC.

2.3.1 Steps for Developing the Decision-Support Tool

The preparation of the GIS-based decision-support tool required the completion of a series of inter-related steps. The steps included the following:

1. Identification and review of potential and final valued ecosystem components (VEC) and valued socio-economic components (VSEC);
2. the review of past, present and potential development activities in the region, and the residual effects (Appendix A) of these activities;
3. the preparation of sensitivity layers for the VEC and VSEC;
4. the preparation of the geo-economic layer; and
5. the development of decision-rules around the sensitivity layers.

2.3.2 Application of Grid Sensitivity

When applied to a particular Oil and Gas Leasing Grid, sensitivity ratings provide a relative appreciation of the biological values (highlights the most vulnerable and sensitive areas, seasonal distribution, and provides information on the potential response to change resulting from hydrocarbon development), social or economic values within grid.

2.3.3 Application of Grid Sensitivity

Establishing the appropriate rating and distributing it spatially across the study area was dependent on data availability. Therefore, while the VEC/VSEC information is comprehensive, the spatial distribution may vary substantially on an annual basis, and is dependent upon environmental conditions at the time. Given this variability, it is recommended that conservative interpretations of potential impacts for projects among seasons be considered, rather than less conservative. As an example, areas within a given grid may include portions with Class 4 and Class 3 Sensitivity, but it is recommended that the entire grid be considered Class 4, because of the inherent variability in the natural system and to reflect uncertainties in spatial data. A component sensitivity layer was made up of from 1 to 20 information layers.

In some situations, there was an intersection of one or more sensitivity ratings within a single grid cell. Decision rules were developed to assign the overall sensitivity rating for those grid cells. The rules allow for various levels of conservativeness to be considered related to the sensitivity ratings for a grid cell. Three decision rules were applied for comparison purposes to calculate a grid rating, (1) grid assigned maximum score of scores present, (2) grid assigned mean score of scores present, and (3) grid assigned max value of scores present if 90% of the area of the grid is covered by the max score. This report presents the most conservative scores for the grids. The ability to compare the implication of these decision rules is embedded within the decision-support tool options.

The information within a sensitivity map may be used by INAC-NOGB, as well as, other users to manage activities within that grid by providing a better understanding of the sensitive areas within a region. Management options to be applied by NOGB are yet to be determined. The Strategic Environmental Assessment process that is to be undertaken by the Branch will involve the development of leasing management options.

3. Polar Bear Sensitivity

Data sources for the decision-support tool were publicly available regional and local environmental and ecological data and maps provided by the communities, municipal, territorial and federal government agencies, scientific reports and peer-reviewed journal publications.

3.1 Description

Polar bears are the top carnivore within the Arctic ecosystem. Among the 14 recognized populations in Canada, the South Beaufort Sea and North Beaufort Sea populations occur within the study area (Figure 3-1). The North Beaufort Sea population is associated with the west coast of Banks Island, and the South Beaufort Sea population is associated with the mainland coast (COSEWIC 2002). The estimated number of bears within those populations totals approximately 3000 individuals and the current populations are believed to be stable or slightly increasing (COSEWIC 2002).

Distribution in the Beaufort Sea (and elsewhere) is influenced primarily by the type and distribution of sea ice, as well as the density and distribution of their primary food source – ringed seals (Stirling and Øritsland 1995). Northerly and southerly movements of bears (Figure 3-2) coincide with seasons and appear to be dependent on seasonal melting and refreezing of ice near shore and the distribution of suitable ice for hunting seals (Stirling and Øritsland 1995).

In winter (i.e., ice-covered season from approximately October through May), most bears are actively hunting seals on areas of annual ice (ice that forms and melts annually). Areas of annual ice within the Beaufort Sea that are most utilized for hunting include areas of inter-island channels, and areas where ‘active ice’ occurs, such as polynyas and landfast shore leads. Pregnant female bears may retire to maternity dens in late October to early November. These dens are found in snowdrifts on multiyear pack ice, but primarily on small islands near the western and southern shores of Banks Island, and to a lesser extent on islands and coastal areas from Tuktoyaktuk east to Alaska. Herschel Island appears to be the most important maternal denning area on the mainland coast (Stirling and Andriashek 1992). Cubs are usually born in late November to January, and are nursed within the den. During periods of particularly cold or inclement weather, solitary males and females with cubs, may also shelter in dens on multiyear pack ice, within several hundred kilometres of the southern extent of pack ice (Stirling 2002). Females with cubs often leave the dens in March or April to actively hunt seals. Breeding occurs over relatively short periods in April and May. In spring, most bears retreat off ice to denning locations on the North Slope of the Beaufort Sea and Banks Island, to den during the ice-free periods when prey is unavailable, or retreat northward to multi-year pack ice.

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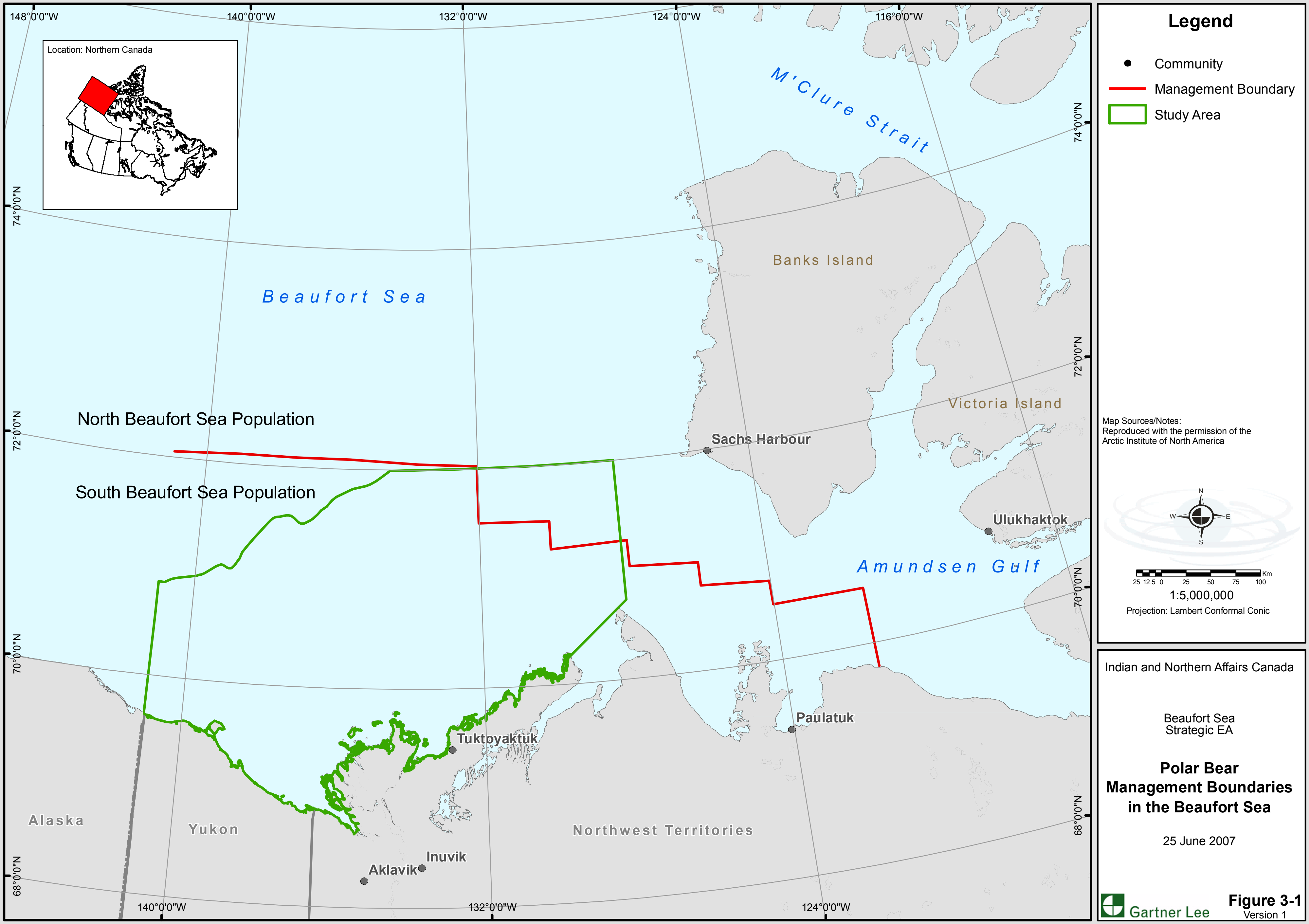


Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

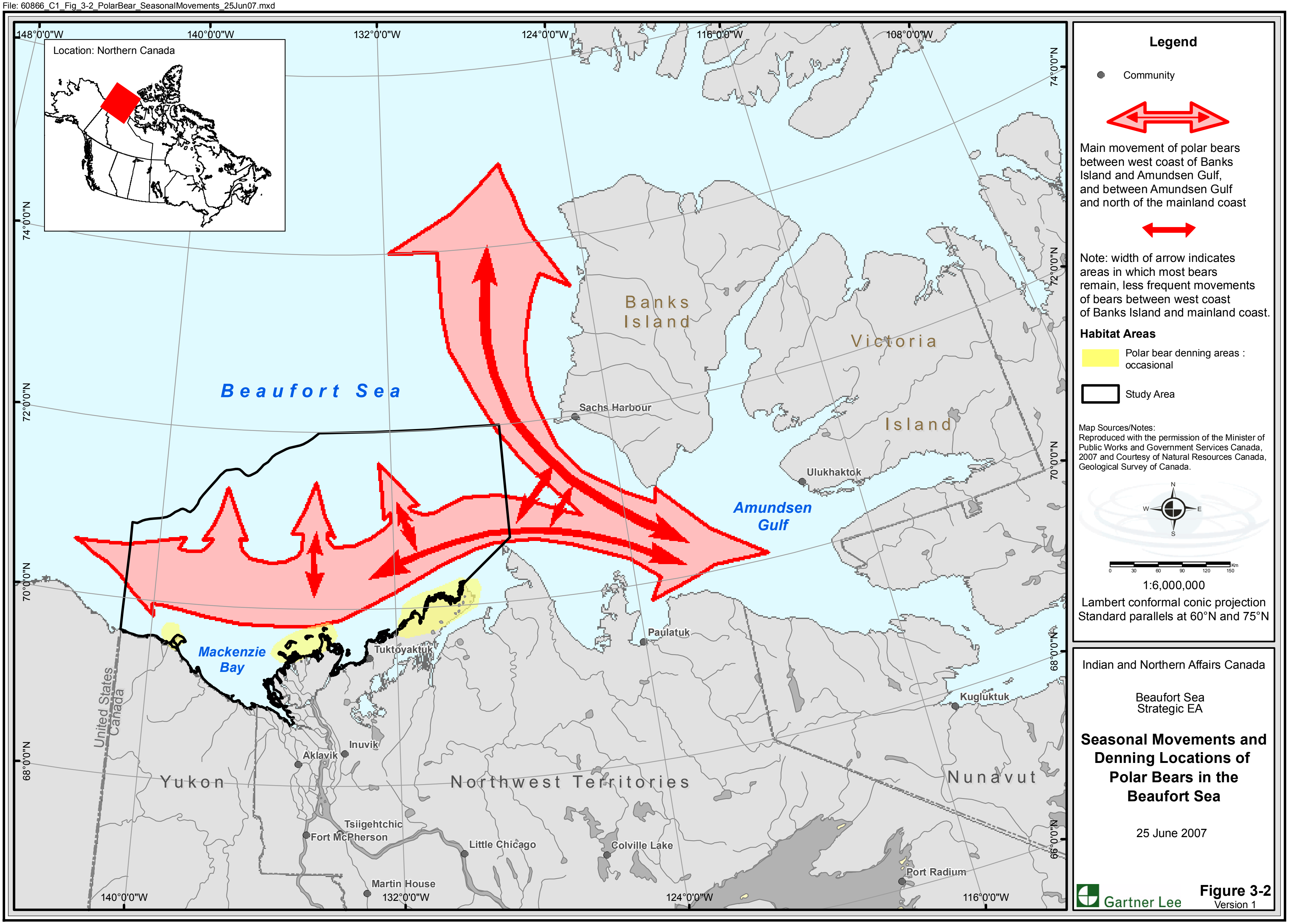
Polar Bear Management Boundaries in the Beaufort Sea

25 June 2007

Gartner Lee

Figure 3-1
Version 1

File: 60866_C1_Fig_3-2_PolarBear_SeasonalMovements_25Jun07.mxd



3.1.1 Rationale for Selection

Polar bears are a high profile species for several reasons – they are a potential indicator species for measures of climate change, they provide social and economic benefits, and they are identified as a potential A*t-Risk Species* (i.e., the area listed as Special Concern by COSEWIC). Canada supports a majority of the world's polar bear population and under the *International Agreement on the Conservation of Polar Bears* the conservation of species is mandated. Additionally, the polar bear has previously been identified as an important component of the Nearshore Marine Valued Component in the recent Beaufort Delta Cumulative Effects Project (Dillon Consulting Limited and Salmo Consulting Limited 2005), the Marine Mammal Valued Component of the Northwest Territories Cumulative Impacts Monitoring Program, and within the Community Conservation Plans within the study area. Polar bears also provide direct economic support to the communities that provide consumptive (hunting) and non-consumptive (tourism and wildlife viewing) use of the bears. Thus, concerns about the status of the species exist at both regional and national levels.

Polar bears may act as a surrogate during portions of the winter season for ringed or bearded seals, may be considered a surrogate for some scavenging wildlife species (Arctic and red foxes, wolverine) that may scavenge on seal carcasses killed by polar bears. In general, polar bears are relatively unique in their life history and habitat uses, and the potential for surrogacy is limited to late winter seasons, and generally near shore areas.

Polar bear habitat in the Northwest Territories lies within the Inuvialuit land claim settlement area. Both the Government of the Northwest Territories (GNWT) and the Inuvialuit Final Agreement requires a review process for exploration, development, and research activities, which includes a consideration of impact on polar bear populations and other wildlife.

3.1.2 Sustainability

The viability of polar bears is closely linked to availability of food sources at key times of the year, and suitable denning habitats. Both of these factors are associated with the pattern and timing of ice features in the Beaufort Sea. The greatest overall threat to polar bears may be large-scale ecological change resulting from climatic warming (Stirling and Derocher 1993), which may change characteristics of sea ice. Polar bears are closely tied to the presence of sea-ice from which they hunt, mate, and carry on other life functions. Continuing declines in ice coverage will restrict their productivity and could ultimately threaten their survival.

Evidence of climatic conditions that impact ringed seal populations (the polar bear's primary food source) is strong. In particular, potential changes in populations due to the availability of prey have been evidenced when heavy ice cover in the Beaufort Sea resulted in declines in seal populations in the mid- 1970s and 1980s, and subsequent declines in the natality and survival of sub-adult bears (Stirling 2002). In recent years, there has been a greater abundance of open water (circa 1989) due to changes in mean air temperature and shifts in wind patterns (Macdonald *et al.* 1999), which has resulted in increased seal production, and combined with regulated hunting, stable bear populations. However, climatic warming and early rain (rather than snows) may expose ringed seal birth lairs, resulting in predation on seal pups at substantially higher predation rates (Stirling and Smith 2004), ultimately reducing the prey base for bears.

Similarly, the low reproductive potential of bears means that the survival of juveniles and adult females is especially important to the viability of these populations. Thus, maternal denning sites are a key element of bear ecology, potentially reducing the vulnerability of the cubs and nursing females to hunters and intraspecific predation. Historically, female polar bears were often hunted in maternal dens on Banks Island and the mainland, prior to protection of such dens approximately 30 years ago. The historic hunting of such bears may have contributed to the higher proportion of maternal denning sites currently found on multi-year pack ice off shore (Stirling 2002).

In addition to habitat conditions, the harvesting of bears by Inuvialuit and sport hunters influences the sustainability of populations. Currently, most polar bears are harvested through a managed quota system. Sport hunters, accompanied by Inuit, take most bears, although subsistence hunting also occurs. The total harvest is governed by a quota system that allocates bears to each community in the Study Area, but the demographic parameters of the populations make polar bear populations very sensitive to over harvest. Prior to the establishment of quotas, populations were in decline (Stirling 2002), but have recovered since the imposition of quotas and are currently considered stable (COSEWIC 2002).

3.1.3 Susceptibility to Development

3.1.3.1 Linkages to Development

In recent history (i.e., in the past 50 years), industrial activity in the Arctic has been increasing, although the level of industrial activity and the number of ongoing projects are still very low in the Beaufort Sea. Much of the activity has been associated with petroleum exploration, mineral exploration, and marine shipping traffic. Given the relatively low amount of industrial activity in the Arctic, there is little empirical evidence to strongly associate project-specific impacts, or impacts from multiple industrial projects, to population parameters for polar bears. However, there are likely two means whereby the viability of polar bear populations can be linked to project-specific impacts:

- industrial activities may reduce the quality and amount of suitable habitat available to polar bears, especially for feeding and denning, and
- industrial activities may increase the risk of mortality to individual bears in proximity to developments.

3.1.3.2 Habitat Susceptibility

The potential disturbance of denning and feeding areas could seriously affect the individual populations of polar bears (COSEWIC 2002). Industrial activity may produce residual effects (as summarized in Section 3.2) that either result in a complete loss of habitat, as is common with the 'footprint' of industrial developments, or effective habitat loss, whereby polar bears avoid habitat in proximity to development. Depending upon the seasonality of occurrence of bears, and the timing of impacts, the habitat loss or avoidance that results from a specific project may be limited to specific seasons.

In the context of petroleum development and exploration, the maximum extent of predicted disturbance may extend up to 50 km from a point source impact (e.g., ice road construction and operations (Devon Canada Corporation 2004). Other oil and gas related projects would likely have more localized habitat impacts; flaring, drilling, and ice pad construction, may result in avoidance within approximately 1 km of a specific site. These localized disturbances may also result in avoidance of the site by two to seven seals (Devon Canada Corporation 2004), thus reducing foraging value for polar bears. Seismic activities that occur in open water are unlikely to directly affect polar bears in any measurable amount. The extent to which habitat losses from petroleum exploration and development may affect polar bear populations are uncertain, and will vary the amount, season, and duration of activities. In general though, it is unlikely that habitat loss from petroleum activity alone will directly influence populations, as mortality rate, and climate-induced habitat changes will most directly contribute to overall population trends.

The presence of oil or other contaminants resulting from accidents and malfunctions associated with petroleum exploration and fuel transfer also have the potential to reduce habitat availability. Contact with spilled oil may directly affect the health of individual bears, and/or reduce the availability of ringed seals. The population impacts that may result from such accidents would depend largely on the season, amount and type of contaminants released, climatic factors and the responses initiated. While the likelihood of serious accidents increases with increased exploration and development, no condensate or oil spills have occurred during the 85 offshore drilling programs that have been completed in the Beaufort Sea since 1990 (Devon Canada Corporation 2004). One shallow gas blowout occurred in the Beaufort Sea in 1989 (reported in Devon Canada Corporation 2004). The chance of large oil spills or blowouts occurring on any given wellsite is very small (1 in 12,000; Devon Canada Corporation 2004) and is further reduced by modern technology and operational standards in use today.

3.1.3.3 Mortality Risk

Human-wildlife conflicts have occurred with regularity in areas where humans and bears coexist, including in northern areas, such as Churchill, Manitoba. For species such as polar bears, the loss of adult females in such conflicts poses a particular risk to the population. This is because polar bears have low reproductive rates, exist at low densities, and reproduce relatively late in life. Thus, each individual adult female is important to the entire population's viability, as there are relatively few reproducing females, and the loss of individual bears substantially reduces the reproductive potential of the entire population. High mortality rates of adult females would result in a relatively rapid population decline.

Risk of mortality to bears is greatest where bears may interact with project facilities (on ice in particular) and bears could be killed to maintain the safety of humans. Polar bears, because of their highly investigative behaviour, may be attracted to project facilities (Stirling 1988), which could result in defensive kills if not properly monitored and mitigated. Mortality risk also extends to near shore developments that are in close proximity to denning locations (especially during freeze up) where bears initiate offshore hunting on areas of active and annual ice. In general, the frequency with which polar bears come into contact with people and structures is undoubtedly a function of the amount of activity in their habitats, and mortality risk increases in relation to human activity even when the best mitigation measures are put in place.

In the Beaufort Sea study area, the mortality risk that is directly associated with oil and gas projects has not been quantified. However, strict bear monitoring, waste management deterrence measures, and encounter protocols have reduced the mortality risks to bears (Devon Canada Corporation 2004).

3.1.3.4 Seasonality of Development Impacts

In general, those activities that occur outside the seasons where polar bears are present (i.e., in open water periods throughout much of the study area) are unlikely to result in direct impacts to polar bears. That is, polar bears in denning locations not within a Zone of Influence of project impacts situated over open water will almost certainly not be affected. This may include activities such as shipping, seismic exploration, and island or platform drilling. However, contaminant spills (particularly hydrocarbon spills) remain a potential risk that could have direct consequences to seal populations in the Beaufort Sea, and subsequently, to polar bear populations. This risk can be managed appropriately through prevention measures, and it can be considered to have a relatively low probability of occurrence. On-ice activities such as ice-platform based drilling, ice road construction, and flaring have the greatest potential for direct impacts to bears, either through habitat loss or increased mortality risk.

3.1.3.5 Population vs. Individual Level Impacts

Impacts from individual projects would likely be most measurable at the individual or family group level (such as an adult female with cubs may avoid habitats near an operating drill site). However, all such impacts ultimately have population-level consequences. The intent to which they are apparent at the population level (such as reduced ranges, or lower population numbers or overall density) will depend on the magnitude to which impacts to the individual occur. In particular, bears killed in human-wildlife conflicts certainly result in an individual level impact (individual mortality), but the reproductive potential for the entire population is also impacted with the loss of individuals.

Additionally, because both the North and South Beaufort Populations' range boundaries extend beyond the Study Area boundaries, impacts to the population that occur outside the study area may act in a cumulative fashion with impacts within the study area to influence the populations.

3.1.3.6 Sensitivity Layers

The sensitivity layers established for polar bears reflect the environmental sensitivity of an area should development (primarily petroleum exploration and production, but also marine transportation and other human impacts) occur within the area. This sensitivity is expressed as a rating for each polygon from 1 through 5, representing the utility of the area to the species, and the value of the area to the viability of the population(s). Ratings of class 1 represented the least utility and values (to which development impacts would be least apparent in the population, while areas ranked 5 are the most used and/or critically important to the survival of the species (and could be most affected by development). Areas of higher sensitivity were typically those that support potential denning and successful reproduction, as well as feeding areas necessary to support year-over-year survival.

Polar bears are present in the study area year round, although different areas are used for different purposes among seasons. Particular seasonal uses (spring foraging and denning) have greater or lesser implications to the viability of the species than most other uses (such as foraging in non-critical times). The rating system below was based on the period that polar bears are present and use the areas for either foraging or denning. Potential residual effects from development would be most detrimental to the population viability in areas of annual ice that supports foraging activities, and areas that support denning. Thus, higher risk categories are associated with these features.

As with other VECs, when assessing a grid cell for sensitivity to development during a specific time period, all time periods should be considered. Habitats that support key life stages are important to identify, regardless of the season in which it is most used, because habitat loss that occurs in one season may have impacts that extend beyond that season of impact. As an example, denning habitats are important to conserve in periods when bears are not actively denning, as they will return during the denning season, and as such, these habitats are key elements that support the species survival.

There are a wide variety of potential project types that vary in spatial extent, duration, and intensity, with a corresponding range in magnitude of impacts that may occur in the project area. Given that such activities may occur among the several hundred leasing grids in the study area, it is impossible to recommend specific mitigations and/or limitations (i.e., whether certain grids should have seasonal restrictions on specific activities or not) for each grid. Such considerations should be a component of project-specific mitigation planning for individual projects and/or grids. However, there are several principles that can be applied based on the summary of project- specific residual effects, the seasonality of polar bear movements, and the criteria used to define the grid rating. Such principles are as follows:

- Maternal denning areas are key areas that are important to the viability of the species, and therefore, impacts here should be avoided. Should development be initiated in areas where maternal dens are present, timing should coincide with the spring period when female bears are foraging away from maternal dens (from April to late Spring). Females may occupy such dens during the open water season and during the birthing period (late October through to March or April).

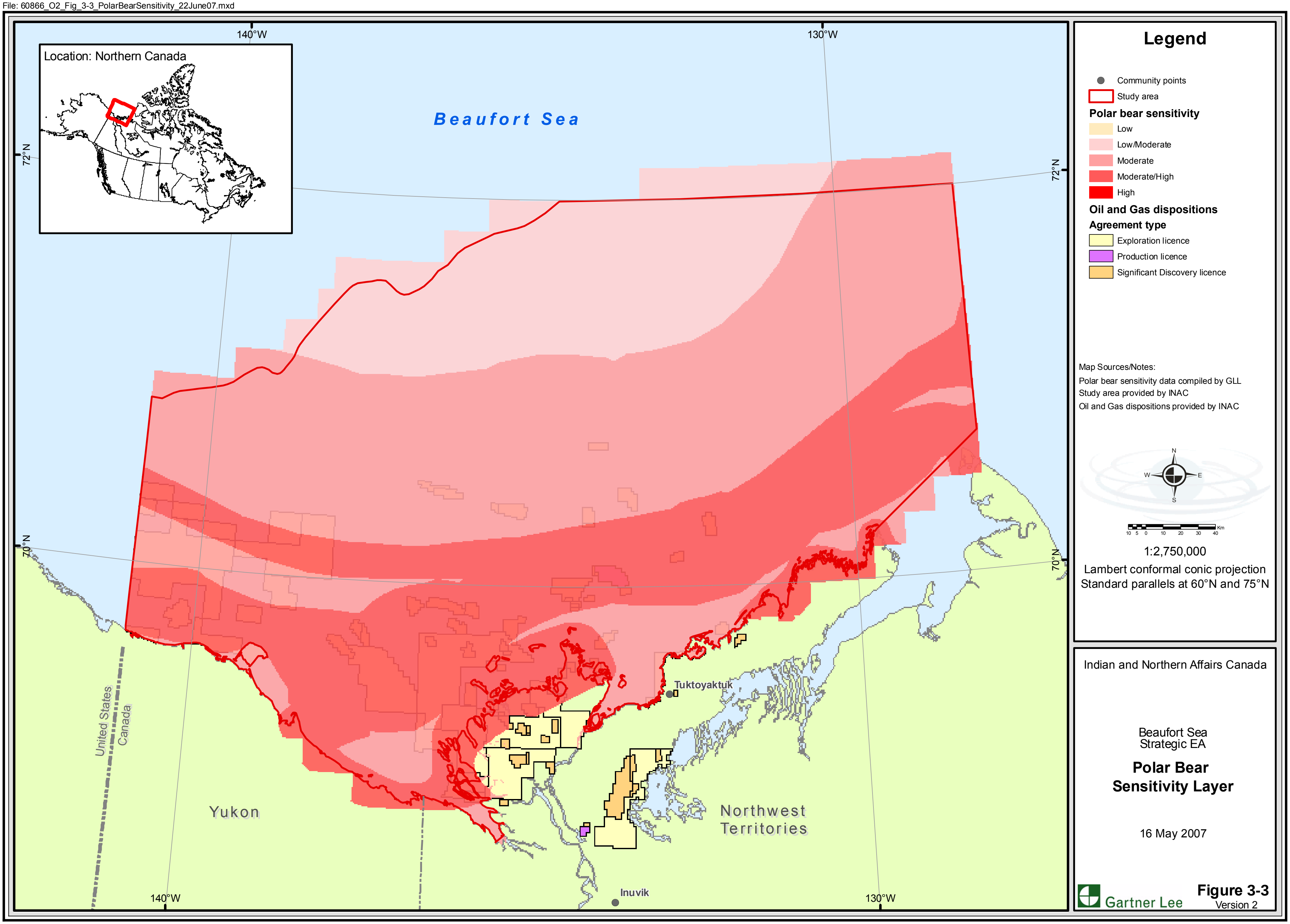
- Areas of spring feeding are also especially important to both male and female bears, and as such, on-ice activity near areas of active ice and annual ice should be limited to levels to which the population level impacts are not apparent. In particular, mitigation planning to reduce mortality risk is especially important where defence kills are a possibility.
- On ice activities (such as exploration drilling) in areas lesser used for foraging and denning are less likely to result in population level impacts, but mitigation planning with respect to defence kills remains important.
- Open water activities are generally unlikely to produce residual effects beyond the open water season, especially if accidents and hazards are controlled.

3.1.3.7 Sensitivity Layer Ranking

- **Low Sensitivity (1):** This rating reflects areas that have very limited use year round, and thus, do not contribute substantially to the viability of the species in the area, in that the areas have little value for reproduction (denning) or survival (limited use for foraging). These areas are greater than 300 km beyond (i.e., northward) the summer extent of pack ice.
- **Low/Moderate Sensitivity (2):** These areas represent parts of multiyear pack ice that have limited use as denning areas (during the open water period primarily), and are found within a 300 km buffer north of the extent of summer pack ice. Since use of these areas is limited, population impacts resulting from development are expect to be low, although uncertainty exists in this regard, and they have been designated as low/moderate to reflect that uncertainty.
- **Moderate Sensitivity (3):** These areas represent foraging areas in non-critical time periods and include the summer limit of pack ice to flow edge/moving ice area. Forage value of these areas is associated with the mid and early winter periods. These areas are associated with non-critical mid-winter and early winter. The magnitude of development impacts in this location were considered moderate, and sensitivity rating of moderate was applied.
- **Moderate/High Sensitivity (4):** These areas represent foraging areas in critical time periods of spring and early fall (area of moving ice/flow edges, polynyas), as well as extensively used areas nearshore denning areas (used during early winter to early spring for birthing and during open water times of limited prey availability). As polar bears have a preferential selection for these areas and these areas have moderate to high foraging potential in critical time periods, a value of moderate/high was applied.
- **High Sensitivity (5):** Critical Habitat Areas are legally defined areas under the *Species at Risk Act* that represent habitats critically important to the survival of the species. No such areas are known in the study area.

The sensitivity layer (Figure 3-3) that was developed was based on underlying spatial layers that are imprecise (spatial variability) and are subject to variability among years (temporal variability). Given this variability, it is recommended that conservative interpretations of potential impacts for projects among seasons be considered, rather than less conservative.

File: 60866_O2_Fig_3-3_PolarBearSensitivity_22June07.mxd



Polar Bear Sensitivity Layer

16 May 2007

Figure 3-3
Version 2

3.1.3.8 Climate Change

Global circulation models predict substantial decreases in both thickness and coverage of arctic sea ice due to increased atmospheric CO_2. Present climate models are insufficient to predict regional ice dynamics. Changes that are likely to occur, but are difficult to model, include reduced total sea ice area, reduced sea ice duration, thinner ice, smaller floe sizes, more open water, altered snow cover, and increased rates of ice drift. However, we can speculate on the potential impacts of observed trends in Arctic climate on wildlife. Most of the characteristic mammals in the arctic marine ecosystem are specifically adapted to the sea ice environment. Changes to its distribution, characteristics, and timing will fundamentally alter the marine arctic ecosystem. The presence of sea ice is critical to polar bears because it provides the platform from which they hunt seals (Stirling and Archibald, 1977**;** Smith, 1980), seek mates and breed (Ramsay and Stirling 1986, Stirling *et al.* 1993), provides access to terrestrial maternity denning areas or as maternity denning habitat (Stirling and Andriashek 1992), and is used to make long-distance movements. Polar bears show a marked preference for sea ice but quickly abandon the ice for land once the sea ice concentration falls below 50% (Mauritzen *et al.* 2003, Stirling *et al.* 1999). Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and the abundance and structure of some species.

Reduced sea ice duration (earlier break-up and later freeze-up) shortens the amount of time that bears are able to feed on seals and prolongs the fasting period (Derocher *et al.* 2004, Stirling *et al.* 2008). Declining body mass, reproductive rates, and subadult survival are the potential effects of earlier spring break-up (Stirling and Derocher 1993, Derocher *et al.* 2004).

Female polar bears show fidelity to specific den areas, many of which are inland within a few km of the coast (Harington 1968; Ramsay 1990). If the extent of the polar pack is reduced and freeze-up is delayed, it may become difficult for pregnant females to reach coastal areas for denning. Under these conditions, more females may choose to den on the multiyear ice, as many already do in the Beaufort Sea population (Stirling and Andriashek 1992), or they may come ashore at break-up in the summer and attempt to fast until entering a maternity den in autumn, similar to pregnant females in Hudson Bay (Ramsay and Stirling, 1988).

3.1.3.9 Recommendations and Data Certainty

Ecological attributes that polar bears are dependant on have been well researched, and it is known that conservation of areas used for denning, and spring, fall, and winter feeding, in addition to regulated hunting, are necessary for population viability. However, uncertainties do exist on several fronts, as the bounds of where such feeding or denning areas occur is not exact, nor do habitat selection models exist that demonstrate the relative value of such off-shore habitats for polar bears. Furthermore, the impacts associated with development are not well documented in the Beaufort Sea (as little development beyond exploration projects has taken place), so the reliance and susceptibility of polar bears to respond to developments is uncertain. More pressing uncertainties relate to climate change, including how the locations of areas mapped herein may change with a warming climate, and if the susceptibility of polar bears to development will subsequently change. Hence, the recommendations for updating the polar bear sensitivity rating include research to document the habitat selection of bears within the Beaufort and identification of habitat values among scenarios for climate change.

3.1.3.10 Summary

Polar bears were considered a VEC because of their high public profile, economic importance, and importance within the food chain as the top predator in the Beaufort Sea. Polar bears have several seasonal-driven habitat uses, and the sensitivity ranking often reflected attributes such as important denning areas or spring or fall feeding areas. The ecology of polar bears (including factors that may limit population growth, susceptibility to development impacts and climate change) meant that sensitivity ranking was relatively conservative for this VEC. There are some uncertainties associated with the currently mapped areas for habitat use and their value, and it is anticipated that as new data becomes available, the sensitivity layer can be updated to refine habitat values and potential risks from development.

The sensitivity layer can be interpreted to mean that areas with the greatest inherent biological value should be subject to greater caution for activity, and implies that greater risk exists to polar bears from habitat loss and mortality risk in such areas. A higher sensitivity rating was most often associated with denning areas and foraging in critical time periods. Due to seasonal changes in polar bear distribution and habitat uses, it is recommended that a long-term view of the potential activities be considered when evaluating individual grids. Although oil and gas exploration activities may be limited to seasons when bears are not present (such as open water seismic), the potential petroleum production infrastructure associated with such exploration – which is the ultimate goal of exploration activities – may ultimately persist year round, and could impact polar bear populations beyond the season(s) of exploration.

Specific recommendations regarding project seasonality and other mitigation measures should be a component of project-specific planning and/or impact assessment. Ongoing efforts to identify and map areas where polar bears are most likely to den and forage should also improve the ability of regulators and industry to reduce disturbance of denned bears (effective habitat loss) and reduce the likelihood of conflict-related bear kills (mortality risk).

4. Beluga Whales

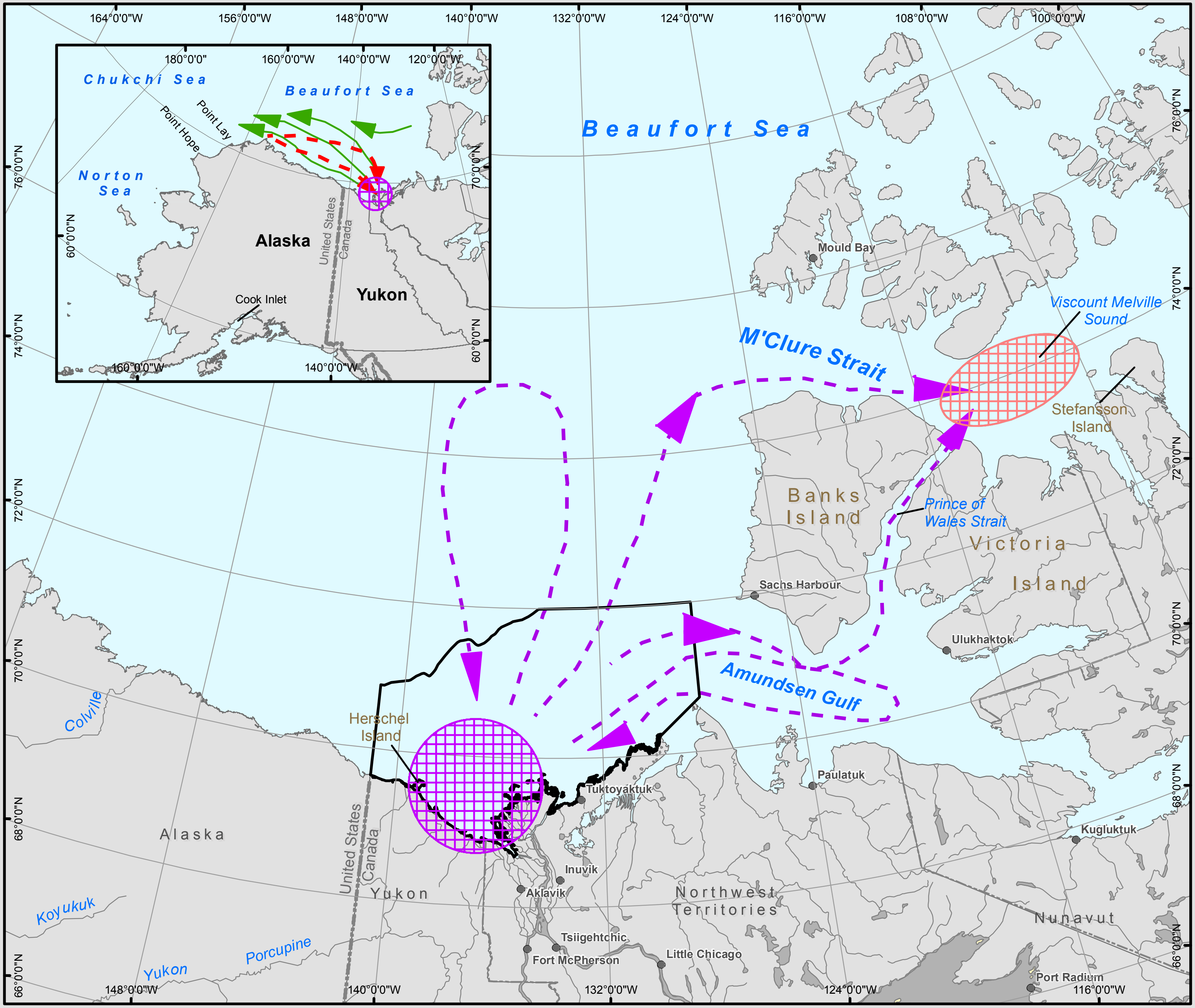
Data sources for the decision-support tool were publicly available regional and local environmental and ecological data and maps provided by the communities, municipal, territorial and federal government agencies, scientific reports and peer-reviewed journal publications.

4.1 Description

The beluga whale (*Delphinapterus leucas)* belongs to the family Monodontidae, which includes the narwhal (*Monodon monoceros)* (COSEWIC 2004). These two species lack dorsal fins, a common characteristic thought to be an adaptation to life in ice-filled Arctic waters. Adult belugas can be distinguished by their pure white coloring, while juveniles are slightly grey in appearance. Belugas are long-lived with life spans that can exceed 63 years (COSEWIC 2004). Many harvested whales have been estimated to be over 40 years old (Harwood and Smith 2002). Females mature sexually between four to seven years and males reaching sexual maturity between six to seven years (COSEWIC 2004). Mating occurs during late winter to early spring with the peak of mating occurring before mid April. Gestation is estimated at 12 to 14 months with peak calving occurring during the late spring in offshore areas. Diet varies according to seasonal availability and consists of fish such as capelin, Arctic cod and herring, and invertebrates such as shrimp, squid and marine worms.

The Eastern Beaufort Sea beluga population winters in the Bering Strait and migrates eastward through the Alaskan Beaufort Sea during April and May, arriving off the west coast of Banks Island in late May and early June (Figure 4-1; Moore *et al.* 1993). Offshore leads are important during this portion of their spring migration (Barber *et al.* 2001, Richard *et al.* 2001, Harwood and Smith 2002). Depending on ice conditions, they may first appear near Herschel Island in late April or early May, and come to the shallow waters of the Mackenzie Delta in June to early July. They then move in a southwestward direction along the landfast ice edge off the Tuktoyaktuk Peninsula and into Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay and the Kendall Island area where they aggregate for much of July (Harwood and Smith 2002). These areas are presumed to be of considerable importance to beluga because they return to these areas each summer despite significant hunting pressures (North/South Consultants Inc. 2003). The reasons why belugas come into estuaries were not well understood until recently. Earlier theories included a thermal advantage for calves and food availability. More recently, it has been shown that occupation of these warm, less saline waters is related to their annual moult and is connected with significant hormonal changes correlated with new skin growth (Harwood and Smith 2002). Mother-calf pairs are believed to spend longer periods in shallow water than other age or gender classes.

File: 60866_C1_Fig_4-1_BelugaSeasonal_Movements_25Jun07.mxd



Legend

- Community
- Beluga Spring Movements
- Beluga Mid-to-Late Summer Movements
- Beluga Fall Movements
- Summer Concentration Areas
- Late Summer Concentration Areas (males)
- Study Area

Map Sources/Notes:
Figure reproduced upon permission from Fisheries and Oceans Canada.

N
W E
S

50 25 0 50 100 150 200 Km

1:8,000,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Seasonal Movements and Concentration Areas of East Beaufort Sea Beluga Whales

25 June 2007

Gartner Lee

Figure 4-1
Version 1

Belugas also aggregate offshore in the Beaufort Sea, Amundsen Gulf and Viscount Melville Sound where it is presumed they engage in feeding activities prior to the fall migration (Harwood and Smith 2002; Barber *et al*. 2001, Richard *et al.* 2001, DFO 2000). Belugas from the Mackenzie Estuary use deep offshore areas on their way to M'Clure Strait rather than using the shallower waters near Banks Island (Barber *et al.* 2001). In late August, the return migration consists of a variety of routes, varying from 100 to 400 km offshore of northern Alaska (Harwood and Smith 2002). During their migration to the wintering areas in the autumn, belugas feed heavily on schools of Arctic cod building up an accumulation of a thick layer of blubber, which acts both as insulation and a large reserve of energy in preparation for winter.

4.2 Rationale for Selection

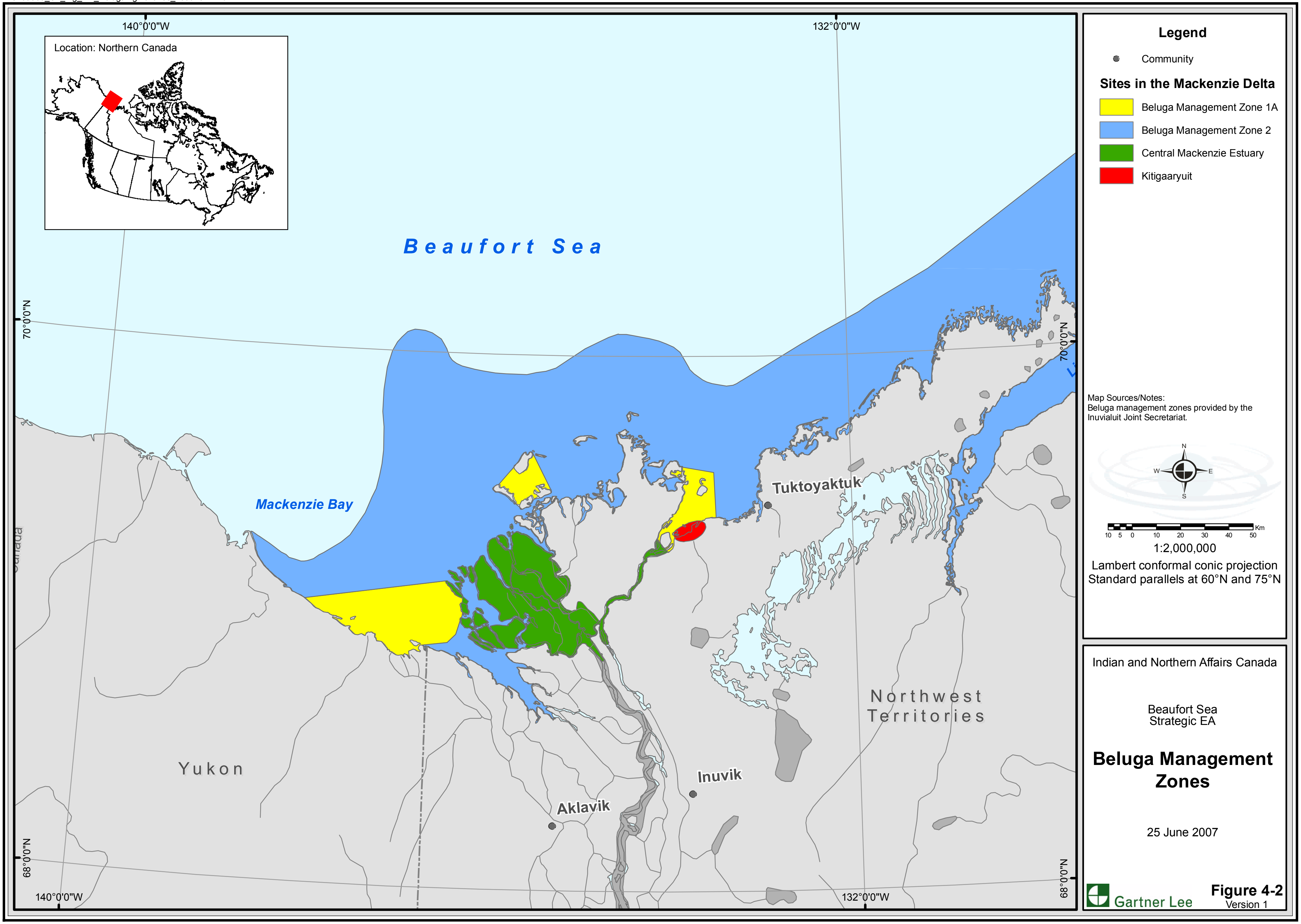
The beluga whale was selected because the species was previously cited as a VEC for the Beaufort region (GNWT 2005) and because information was available for this work, such as Beluga Management Zones identified in the Community Conservation Plans (Figure 4-2). Additionally, beluga whales are an important link in the arctic food web as both a predator and as prey. Belugas are known to feed on many species of fish species in the Beaufort Sea and Amundsen Gulf, including Arctic cod (*Boreogadus saida*), cisco (*Coregonus artedii*) and halibut (*Reinhardtius hippoglossoides*) (COSEWIC 2004). Benthic invertebrates are also frequently found in the stomachs of belugas (COSEWIC 2004).

4.2.1 Description of Key Marine Beluga Whale Habitat

4.2.1.1 Beaufort Sea

- The Beaufort Sea provides important spring and fall migration corridor habitat, including marine waters up to and including 400 km north of the Northwest Territories, Yukon and Alaskan coasts.
- The Beaufort Sea, between the Bering Strait and Banks Island, provides important spring migration habitat, where belugas follow leads in the ice to reach the shallow waters, bays and river estuaries. During August, belugas are widely distributed in the area and feeding is probably their most important activity. During the fall migration in mid-August, belugas leave the shallow waters, bays and river estuaries and return to the Bering Strait for the winter. Few whales remain in the area past early September.
- The shallow waters, bays and river estuaries of the Beaufort Sea described above are recognized as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans as 712C – Beluga Management Zone 2 (WMAC 2000 a,b,c). Zone 2 extends from Kay Point on the Yukon coast to Baillie Islands (Cape Bathurst) in the east, and includes waters shallower than 20 m. Category C comprise lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year.

File: 60866_C1_Fig_4-2_BelugaMgmtZones_25Jun07.mxd



4.2.1.2 Mackenzie Delta

The landfast ice edge off the Mackenzie Delta provides important spring migration habitat as belugas move into Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay and the Kendall Island area.

Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay, Kendall Island Area

- Kugmallit Bay, east and west Mackenzie Bays, Shallow Bay and the Kendall Island area provides important summer habitat. This area, which encompasses approximately 1800 km2 , comprise the only known traditional summer concentration areas for the Beaufort Sea beluga stock from late June to early August. Belugas use these areas for moulting, calving and feeding. Feeding is not always observed and empty stomachs in belugas landed in the subsistence hunt are common. Belugas in these traditional summer concentration areas are harvested by Inuvialuit from Aklavik, Inuvik and Tuktoyaktuk.
- These areas are recognized as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plan as 711E, 714E and 716E – Beluga Management Zone 1A (WMAC 2000a, b, c). Category E comprise lands and water where cultural or renewable resources are of extreme significance and sensitivity. The CCPs recommend the highest degree of protection of category E lands and there shall be no development in these areas (WMAC 2000a,b,c).

4.2.1.3 Surrogate for Fish

The Beaufort Sea study area provides important habitat for the many fish species. These fish species include Arctic cod, burbot (*Lota lota*), char (*Dolly Varden*) (*Salvelinus malma*), cisco, halibut, inconnu (*Stenodus leucichthys*), Pacific herring (*Clupea pallasi*), rainbow smelt (*Osmerus mordax*) and whitefish (*Coregonus* spp.) (Byers 1993; DFO 2004). Anadromous fish species such as char (Dolly Varden), cisco and inconnu spawn in the Mackenzie River system, as well as in freshwater streams and rivers located west of the Mackenzie River system (Craig 1984; Reist *et al*. 1997). Offshore waters are used throughout the year by marine species and provide migration corridors for anadromous fish species (DFO 2004). Arctic cod and rainbow smelt provide links in the food chain, and may be important food sources for other fish, as well as beluga whales and other marine mammals

In the absence of precise digital and/or spatial fish-habitat data, and because belugas and some fish species present in the Beaufort Sea both utilize some of the same habitats, belugas may act as a surrogate for some fish species present within the Beaufort Sea. In particular, belugas use shallow waters and river estuaries areas in the study area in the period of May to mid-August (DFO 2004; Harwood and Smith 2002), during the same period in which anadromous fish such as cisco, rainbow smelt, char, and inconnu are also present in marine waters. As Arctic cod are traditionally more associated with deep waters, and Pacific herring occur in shallow estuaries only during late season spawning, beluga may not be as suitable as a surrogate for those fish species.

4.2.1.4 Sustainability

The Eastern Beaufort population of beluga is considered *Not At Risk* (COSEWIC 2004). Population surveys in 1992 estimated the population at 19,629 (95% C.L. = 15,131 to 24,125) (Harwood *et al.* 1996) and in 2002 the estimate placed the population at 39,258 individuals when corrected for sightability (COSEWIC 2004).

Conserving habitat is fundamental to the viability of the Eastern Beaufort Sea beluga whale population. Belugas occur most often in the Mackenzie Estuary and within a deep trench in M'Clure Strait and Viscount Melville Sound during the summer. In the fall, the whales occur in the Mackenzie Estuary and Amundsen Gulf and north along the Yukon Coast (Barber *et al.* 2001). Presently, approximately 1716 km^2 of shallow waters, including Mackenzie Bay at 1160 km^2, the Kendall Island area at 193 km^2, and Kugmallit Bay at 363 km^2 has been identified as important beluga habitat. These areas are being considered for Protected Area status with the protection of the eastern Beaufort Sea beluga stock one of its primary objectives (North/South Consultants Inc. 2003; Fast *et al.* 1998). These same areas have already been recognized as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans and have been identified as 711E – Beluga Management Zone 1A or as 712C – Beluga Management Zone 2.

Offshore areas in the Beaufort Sea, both within and beyond the Study Area, have also been identified as important, since belugas congregate in these areas and engage in feeding activities from the sea floor before they migrate back to their wintering areas (Harwood and Smith 2002; DFO 2000). The migration routes followed by belugas vary and extend up to 400 km from the shoreline (Barber *et al.* 2001, Richards *et al.*. 2001), and these areas will also need to be protected and kept unobstructed if the belugas are expected to continue to use these routes (Harwood and Smith 2002).

4.2.1.5 Susceptibility to Development

The level of industry activity and the number of ongoing projects that may impact beluga populations in the Beaufort Sea is very low. Given the relatively low occurrence of industrial activity in the Arctic, there is little empirical evidence to strongly associate project-specific impacts, or impacts from multiple industrial projects, to population parameters for beluga whales. However, there are two likely means that viability of beluga whale populations can be linked with project-specific impacts:

- industrial activities may reduce the quality and amount of suitable habitat available to beluga whales, especially for feeding, moulting, mating and calving, and
- industrial activities may increase the risk of mortality to individual beluga whales in proximity to developments.

Belugas are vulnerable to anthropogenic threats, such as industry activities because of their strong tendency to return to specific sites of summer aggregation to moult, feed, calve, socialize, rest and avoid predators (COSEWIC 2004; Pippard 1983). They continue to return to traditional areas of aggregation, even in the face of disturbance and harvesting pressures.

Habitat Susceptibility

Residual effects from industrial activity (as summarized in Section 3.2) may result in either complete loss of habitat, as is common with the 'footprint' of industrial developments, or effective habitat loss, whereby beluga whales avoid habitat in proximity to development. Depending upon the seasonality of occurrence of beluga whales, and the timing of impacts, the habitat loss or avoidance that results from a specific project may be limited to specific seasons.

Development activities to which beluga may be susceptible include:

- industrial pollution and miscellaneous spills;
- noise due to seismic activities and vessel movement; and
- island building or temporary drilling platforms.

Industrial pollution and miscellaneous spills that are discharged have the potential to result in either complete or effective habitat loss. Beluga whale habitats most susceptible to these releases are the shallow waters and river estuaries. The effects have been studied in the St. Lawrence beluga population where their critical shallow water and river estuaries habitat has been reduced as a result of extensive damming along the Manicouagan and Outardes rivers (Pippard 1983). Their habitat has also been reduced as a result of municipal, agricultural and industrial pollution discharged in the St. Lawrence and Saguenay rivers and their tributaries (Pippard 1983). Explanations for belugas abandoning these areas include:

- altering the heat budget making the water temperatures too low or unreliable for calving, and
- affecting fish and invertebrate reproduction, thereby reducing the number of prey species.

The population impacts that may result from an oil spill would depend largely on the season, amount and type of contaminants released, climatic factors and response initiated. An oil spill within the shallow waters and river estuaries identified as critical beluga habitat would be the most sensitive and could produce major site-specific impacts. An oil spill further offshore within the feeding, movement and migratory areas and corridors may produce fewer impacts because the beluga can navigate around the spill in these greater water depths. Contact with spilled oil may directly affect the health of individual whales, and/or reduce the availability of food, such as fish and invertebrates.

Noise from marine vessels movements or seismic activities may potentially affect belugas by displacing belugas from the area. The maximum extent of avoidance was predicted to be 50 km in a recent regulatory impact assessment (Devon Canada Corporation 2004). Marine vessels may have the greatest impact (in terms of habitat avoidance) in open water periods when aggregated belugas are feeding in shallow offshore waters. At its most extreme, noise can potentially also affect beluga whales by interfering with mating behaviours, communication and even cause damage to ears or other organs (Erbe and Farmer 1999).

Island building or the installation of temporary drill platforms in shallow waters identified as critical beluga habitat could potentially affect belugas and their habitat by competing with the belugas for space during the summer when they are congregating the shallow waters or by disrupting the habitat during the winter and rendering it unusable.

Seasonality of Development Impacts

Beluga whales that migrate into the Beaufort Sea during open water periods over-winter in waters outside of the study area. Therefore, industrial activities such as ice-platform based drilling, ice road construction, and flaring that occur outside the seasons when beluga whales are present (i.e., in frozen water periods throughout much of the study area) are unlikely to result in direct impacts to beluga whales. Open water industrial activities such as seismic, shipping and other marine vessel transport have the greatest potential for direct impacts to beluga whales. Potential accidents from these activities, such as contaminant spills (particularly hydrocarbon spills), have potential for direct impacts. These industrial activities and potential accidents also have a great potential for indirect impacts to belugas via food sources such as fish and invertebrates. If risk has been managed appropriately through prevention measures, and use of these measures is continued, the probability of occurrence of impacts remains low.

Population vs. Individual Level Impacts

Impacts from individual projects would likely be most measurable at the individual or family group level (such as an beluga cow with a calf). However, all such impacts ultimately have population-level consequences. The extent to which they are apparent at the population level (such as lower population numbers) will depend upon the magnitude to which impacts to the individual occur.

Additionally, because the Eastern Beaufort Sea beluga whales utilize waters beyond the Study Area boundaries (e.g., Amundsen Gulf and Viscount Melville Sound), impacts to the population that occur outside the study area may act in a cumulative fashion with impacts within the study area to influence the populations.

4.2.1.6 Sensitivity Layers

The sensitivity layers established for beluga whales reflect the sensitivity of environmental components (important to beluga whales) to development. This sensitivity is expressed as a rating for each polygon from one through five, representing the utility of the area to the species for a variety of life history purposes, and the value of the area to the viability of the population(s). Ratings of class one represented the least utility and values (to which development impacts would be least apparent in the population), while areas ranked five are the most used and/or critically important to the survival of the species (and could be most affected by development). Areas of higher sensitivity were typically those that support moulting, successful reproduction and feeding areas, as well as movement and migratory corridors necessary for year-over-year survival.

Beluga whales are present in the study area during open water periods and different areas are used for different purposes. Belugas select particular classes of sea ice concentration and water depth, presumably because both relate to factors such as prey distribution, predation, weather, moulting, and the rearing of young (Barber *et al.* 2001). The rating system below was based on the period that beluga whales are present and use the areas for moulting, feeding and calving, as well as for movement and migration. Potential residual effects from development would be most detrimental to the viability of the population in shallow water and river estuaries that support theses activities. Thus, higher risk categories are associated with these important habitats.

As with other VECs, when assessing a grid cell for sensitivity to development, all time periods should be considered. Habitats that support key life stages are important to identify regardless of the season at which it is most used, because habitat loss that occurs in one season may have impacts that extend beyond that season of impact. As an example, moulting habitats are important to conserve in periods when beluga whales are not actively moulting, as they will return during the moulting season, and such habitats are key elements that support the species survival.

There is a variety of potential project types that vary in spatial extent, duration, and intensity, with a corresponding range in magnitude of impacts that may occur in the project area. Given that such activities, over time, may occur anywhere within the several hundred leasing grids in the study area, it is impossible to recommend specific mitigations and/or limitations (i.e., whether certain grids should have seasonal restrictions on specific activities or not) for each grid. Such considerations should be a component of project-specific mitigation planning for individual projects and/or grids.

However, there are several strategies that can be applied to project-specific mitigation planning, based on the summary of project specific residual effects, the seasonality of beluga whale movements, and the criteria used to define the grid rating. These considerations should not be interpreted as a prescription for actions imminently required; rather, they are strategies that may be valuable in project planning.

- Moulting, feeding and calving areas are key areas that are important to the viability of the species, and therefore impacts here should be mitigated and/or avoided where possible. These areas include the shallow waters and river estuaries within Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay and around Kendall Island. Should development be initiated in such areas, timing should attempt to coincide with periods when belugas are not present (from September to April). .
- In areas of beluga spring and fall migration, marine vessel movement activities within these areas should be limited to levels to which the population-level impacts are not apparent.
- On-ice activities are generally unlikely to produce residual effects beyond the frozen water season, and may be a preferable option to open water activities, especially if accidents and hazards are controlled.

4.2.1.7 Sensitivity Layer Ranking

Populations that are concentrated for any part of the year (e.g., staging, moulting, and foraging areas) are vulnerable to site-specific threats because a significant proportion of the population could be affected. As well, populations that occupy geographically restricted habitats (rare, threatened or endangered species) are vulnerable if their habitats are threatened.

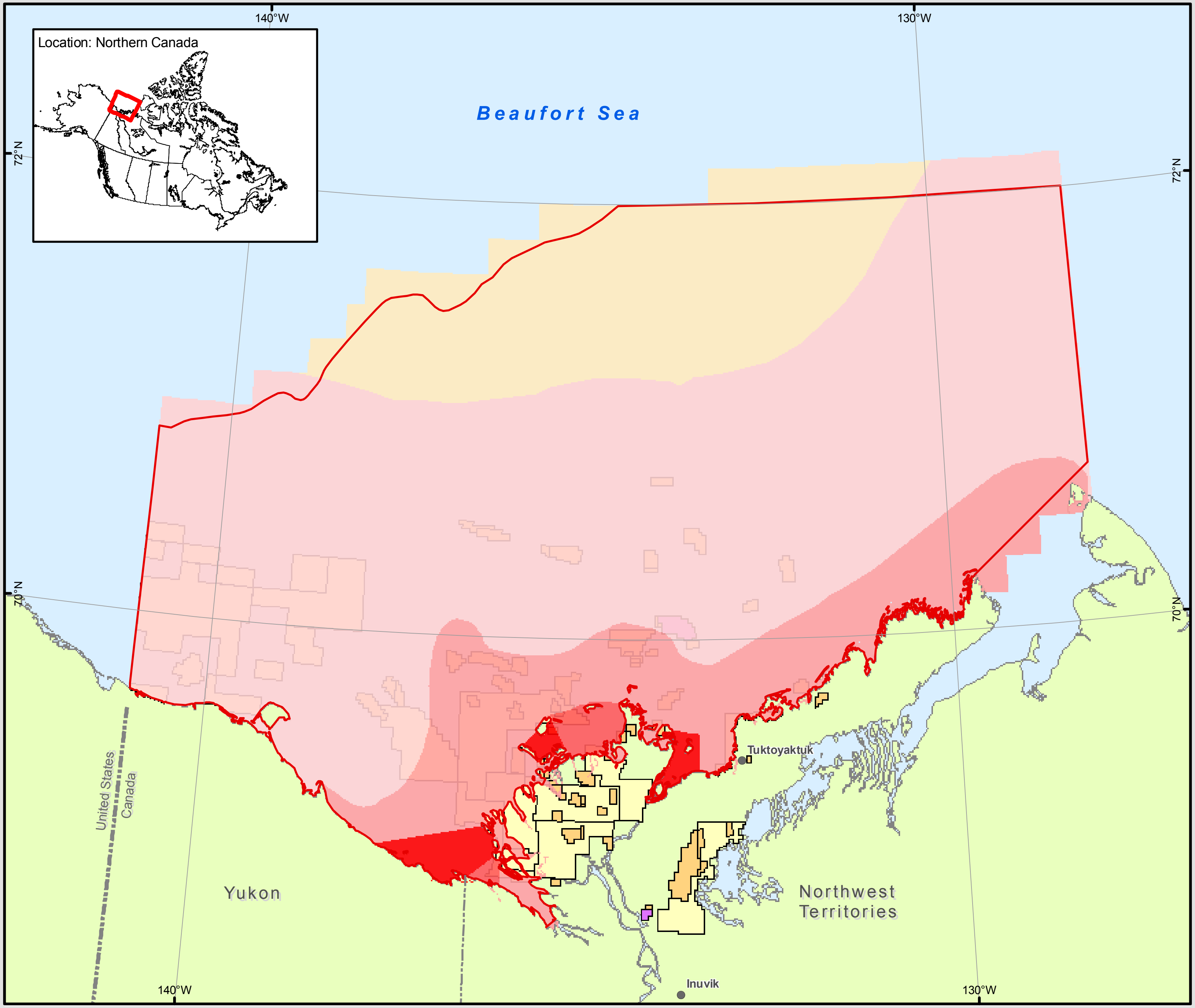
The concepts considered in developing the sensitivity rating included the following:

- life cycle and occurrence in the study area;
- susceptibility to habitat change;
- sensitivity to development; and
- importance to Inuvialuit (VSEC).

- **Low Sensitivity (1):** Northward from the summer extent of pack ice, using the approximate summer extent of pack ice (defined in Stirling 2002).
- **Low/Moderate Sensitivity (2):** The offshore area northward of the Beluga Management Area Zone 2 Boundary (as defined in Community Conservation Plans as area 712C), but excluding areas of multi-year pack ice. This area is considered seasonal migratory route habitat.
- **Moderate Sensitivity (3):** The Beluga Management Area Zone 2 (as defined in Community Conservation Plans as area 712C). The total of this area includes the areas designated as Sensitivity Layer 4 and 5; therefore, the areas that are overlapped carry the higher designated Sensitivity Layer.
- **Moderate/High Sensitivity (4):** Polygons include the areas identified as important summer mating, moulting and feeding habitat. The total of these areas include the areas designated as Sensitivity Layer 5, therefore the areas that are overlapped carry the higher designated Risk Layer.
- **High Sensitivity (5):** The Beluga Management Area Zone 1(a) (as defined in Community Conservation Plans as area 711E). These areas are also being considered for status as a Protected Area.

The sensitivity layer (Figure 4-3) developed was based on underlying spatial layers are that are imprecise (spatial variability), and subject to variability among years (temporal variability). Given that variability, it is recommended that conservative interpretations of potential impacts for projects among seasons be considered, rather than less conservative.

File: 60866_O2_Fig_4-3_BelugaSensitivity_25June07.mxd



Legend

- Community point
- Study area

Beluga sensitivity

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

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:
Beluga sensitivity data compiled by GLL
Study area provided by INAC
Oil and Gas dispositions provided by INAC

1:2,750,000
Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Beluga Sensitivity Layer

26 June 2007

Gartner Lee

Figure 4-3
Version 2

4.2.1.8 Climate Change

Global circulation models predict substantial decreases in both thickness and coverage of arctic sea ice due to increased atmospheric CO_2. For cetaceans, the potential detrimental effects of decrease ice extent is more indirect than the loss of ice habitat (Tynan and DeMaster 1997). In the case of the beluga whale, this indirect effect is the potential loss of its predominant prey, the arctic cod (*Boreogadus saida*) which is intimately associated with ice-edge habitats (Bradstreet 1982). The arctic cod is dependent on the secondary production in these habitats with the latter being sustained by ice algae. Ice algae form a thin, dense layer on the underside of ice at the ice-seawater interface and is well recognized as very important in the food web of marine mammals in the high Arctic (Bradstreet 1982, Tynan and DeMaster 1997).

Retreating ice extent would have an impact on the annual spring and fall migration of the belugas which timed these movements on the opening of ice leads in spring and advancing ice in fall. In summer the pack ice in the Northwest Passage has been the physical barrier separating the western and eastern stocks of belugas. If opening this passage for 100 days in summer comes to pass as predicted, then there is the potential of the mixing of these two stocks leading to reduce genetic diversity across the Arctic (Tynan and DeMaster 1997).

4.2.1.9 Summary

Beluga whales were considered a VEC because of their important link in the food web of Arctic waters, and because they have been previously selected as a VEC in the Beaufort region. Additionally, the Inuvialuit have long relied on them for subsistence.

Beluga whales are present in the study area during open water periods. In June to early July, belugas are found along the coastlines and in relatively shallow waters of the Mackenzie Delta including Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay and the Kendall Island area. These areas are important as moulting, calving and feeding areas. Beginning in mid-August, belugas move away from the estuarine areas to feed in the deeper waters, and move west towards their winter areas in the Bering Strait and Chukchi Sea in mid-to-late September. Waters near the coastline and extending up to 400 km offshore are important as feeding areas and as spring and fall migration corridors.

Beluga whale habitats most sensitive to industrial activities in the Study Area are the shallow waters and river estuaries. Potential impacts from industrial pollution, miscellaneous spills, and noise are important to mitigate in these areas where possible. Beluga whales that migrate into the Beaufort Sea during open water periods over-winter in waters outside of the study area. Therefore, industrial activities that occur outside the seasons when beluga whales are present (i.e., in frozen water periods throughout much of the study area) are unlikely to result in direct impacts to beluga whales.

Numerous fish species present in the Beaufort Sea share and utilize many of the same shallow water and deep water beluga habitats. The sensitivity layers established for beluga whales reflect the environmental sensitivity of an area should development occur and could encompass the various fish species that occupy the same habitat.

5. Ringed Seals

Data sources for the decision-support tool were publicly available regional and local environmental and ecological data and maps provided by the communities, municipal, territorial and federal government agencies, scientific reports and peer-reviewed journal publications.

5.1 Description

The ringed seal (*Phoca hispida*) is a relatively small marine mammal that serves as a critical ecological link in the food chain within the Canadian Arctic marine environment. Populations of ringed seals are strongly linked to polar bear population numbers (Stirling 2002).

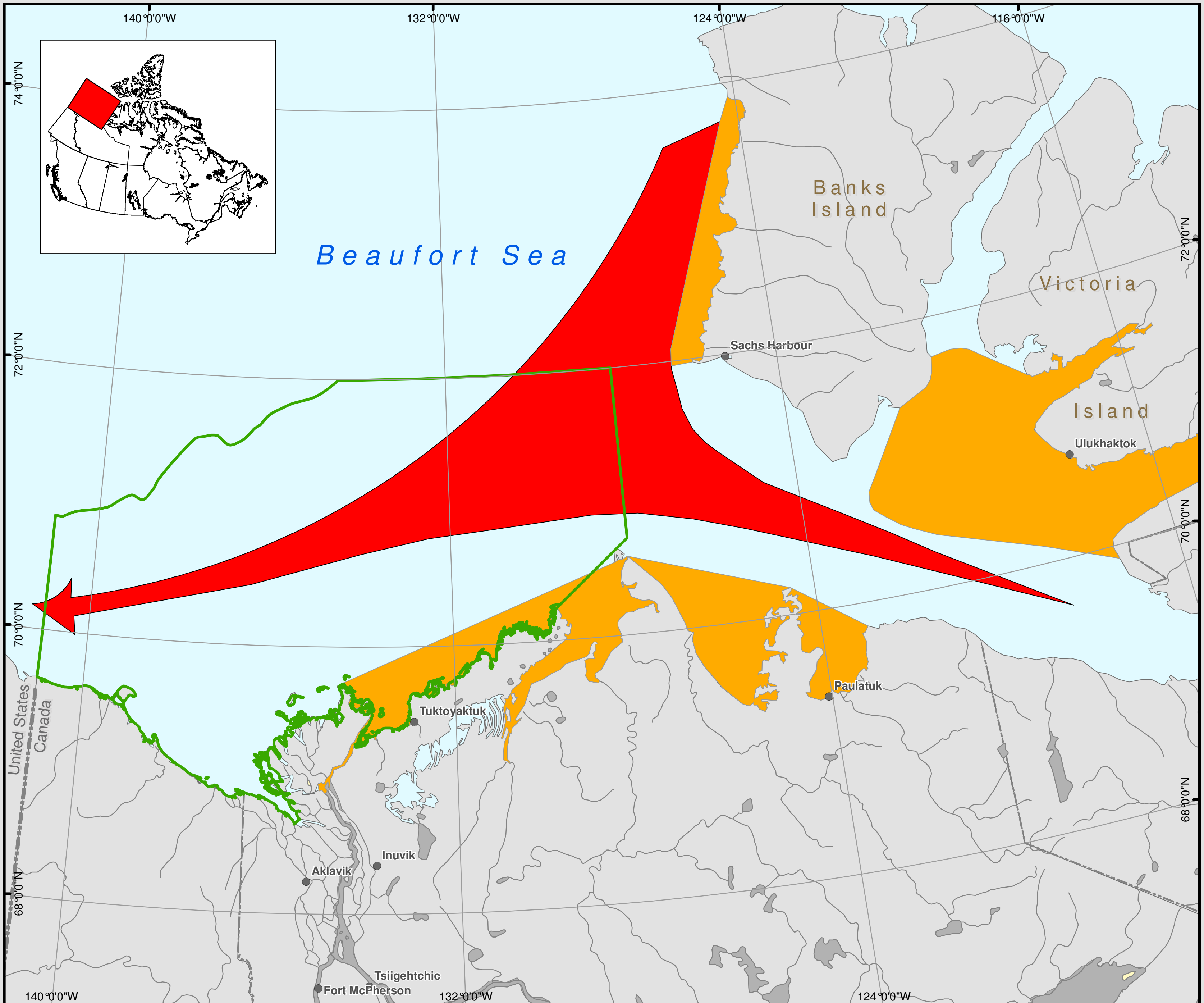
This seal is found throughout the circumpolar regions of the Northern Hemisphere, and the population of ringed seals in the Western Arctic is approximately 650 thousand seals (GNWT 2007a). In the southern Beaufort Sea, the estimates of population size are dated, but range from 41,200 in 1982 (open water surveys; Harwood and Stirling 1992), to a low of 2,900 in 1997 (spring surveys; Stirling *et al.* 1982). Estimates from open water surveys in 1986 were 14,300 (Harwood and Stirling 1992). The populations of seals observed are highly variable, and are influenced by ice conditions and prey availability (Stirling 2002). Sharp population declines in observed populations are closely associated with ice cover, which reduces primary and secondary productivity (Stirling 2002).

Preferred ringed seal habitat consists of flaw leads, pressure ridges and polynyas in the land-fast ice of the Arctic Ocean. Offshore pack ice is used irregularly. Very deep water areas appear less used than shallower depths (i.e., less than 100 m), but ringed seals are found throughout the Beaufort Sea (Stirling *et al.* 1982).

Ringed seals have a varied diet composed primarily of larger shrimp-like crustaceans, small fish and zooplankton. These food sources occur in open ocean areas, and in greater concentrations in areas where upwelling of currents or nutrient inputs occur. In late summer, prior to freeze up, the importance of foraging is heightened, as seals build up fat reserves for the winter.

Seasonally, there are some evident patterns that are associated with breeding, birthing, and summer feeding activities, although ringed seals are present in the study area on a year-round basis (Figure 5-1). During much of the winter, and until break up in June, adult seals maintain established territories around breeding areas and are generally solitary. Adult ringed seals maintain lairs and breathing holes beneath the snow throughout the winter (Smith and Stirling 1975), and females give birth in mid-March to mid-April in birthing lairs. Prior to ice break-up in late June, ringed seals are distributed throughout the southern Beaufort Sea and can be easily observed hauling out on the ice to moult. Seals appear to prefer areas where water is 75 to 100 m deep for

60866_C1_Fig_5-1_SealMovements_25Jun07.mxd



Legend

- Community
- Seal Breeding Area
- Seal Migration Route
- Study Area

Map Sources/Notes:
Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2007 and Courtesy of Natural Resources Canada, Geological Survey of Canada.

N E S W

30 15 0 30 60 90 120 Km

1:4,500,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Seasonal Movement Patterns of Ringed Seals in the Beaufort Sea

25 June 2007

Gartner Lee

Figure 5-1
Version 1

haul out locations (Stirling *et al.* 1982). During the open water periods, seals forage and build up fat reserves for the coming winter. Seals may aggregate in groups of up to 21 members in areas where greater food abundance is located during late summer (L. Harwood, pers. comm 2007; Harwood and Stirling 1992). The location of aggregations within the Beaufort Sea varies between years, but such areas appear to be most common north of the Tuktoyaktuk Peninsula (Harwood and Stirling 1992), and are very similar to the areas where bowhead whales concentrate and forage (L. Harwood, pers. comm 2007). Seal density within the aggregations can be 6 to 13 times higher than regional mean densities (Harwood and Stirling 1992). As freeze up commences in late autumn, adult seals move into coastal areas of stable, landfast ice and establish breeding territories. Although still solitary, seal concentrations may be higher along complex shorelines (such as those with fjords and islands), as compared to more simple coastal areas (Smith 1987). Also at this time, there is a general westward movement of adolescent and young of the year seal pups through the study area from the Amundsen Gulf to the Chukchi Sea. This migration and segregation of age classes is thought to be in response to food availability and population pressures (GNWT 2007a).

In the Beaufort Sea, predators of ringed seals are primarily polar bears, arctic foxes, wolves, and wolverine; Arctic foxes in particular, eat a high proportion of the pups in ringed seal dens. Ringed seals are however, the main prey of polar bears. Polar bears catch and consume about one seal every six and a half days (GNWT 2007b), or about an average of 43 seals per year (Stirling and Øritsland 1995). Given the current populations of ringed seals in the Beaufort Sea, there are likely not enough seals to support much more growth in polar bear populations, the latter of which have grown over the past 20 years.

5.1.1 Rationale for Selection

The ringed seal was selected primarily for two reasons – its important role within the food chain, and its economic importance as a hunted and cultural resource. Within the food chain, seals are a key prey item in the Beaufort Sea for large and medium- sized predators; in particular, polar bears, fox, and wolverine. There are strong associations in particular between the population of polar bears and ringed seals (Stirling 2002). Cultural and economic value of seals is also clearly evident, as seals have been a reliable source of heating oil, meat and skins for coastal Inuit. Sealing continues to be important for its nutritional and cultural values to northerners.

The ringed seal is somewhat unique, in that its habitat associations are fairly general (with the exception of some smaller areas where foraging at key times takes place), thus resulting in a Sensitivity Layer for ringed seals that reflects a species that can be considered a habitat generalist. This is in contrast to other VECs, such as migratory birds that may have very site-specific requirements, and thus, helps to represent the range of ecological attributes that different species rely on in the study area.

As a habitat generalist, the ringed seal helps to represent many species within the study area, such as foxes, that scavenge polar bear predation sites. The ringed seal (or any other VEC chosen) can be considered a surrogate for other species that have similar habitat uses and that use the same key habitat areas. As an example, the ringed seal is a reasonable surrogate for the bowhead whale during the late summer feeding period, as similar oceanographic features (such as canyons and continental shelf breaks) that are important habitat characteristics for ringed seals are also important for bowhead whales during this time (L. Harwood, pers. comm., 2007). This is not to suggest that bowhead whales have exactly the same habitat requirements as seals at all times of the year, or that the sensitivity to development that ringed seals may experience would be the same sensitivity that bowhead whales would experience. It does suggest though, that mitigation measures or development limitations designed specifically for ringed seals might have additional benefits to other species, in particular bowhead whales, when applied to areas where those species overlap in habitat use.

5.1.1.1 Sustainability

The viability of ringed seals is most closely associated with ice cover that provides suitable denning habitat and the productivity of and the rate of predation on pups by polar bear and foxes. Ice cover is impacted primarily by climatic conditions (wind, ambient air temperature, and solar radiation). Currently, ringed seals are not threatened in the Beaufort Sea, but they have undergone substantial fluctuation in abundance due to long-term changes in ice characteristics. Heavy ice years in the 1970's and 1980's were closely linked with a decline in food availability and the decline of populations (Stirling *et al.* 1982, Stirling 2002). During periods of heavy ice cover (such as 1974), decreased primary and secondary productivity alters prey availability for ringed seals, such that body condition declines and the ovulation rate can be reduced to <50% (Stirling *et al.* 1977, Stirling 2002). The opposite has been found to be true when there is early melting of landfast ice and later freeze up i.e., better body condition and a higher ovulation rate (Harwood and Smith 2001).

Hunting and predation rates also have the potential to limit populations. Here too, climatic conditions may influence susceptibility to predation, as early spring rains can expose birth lairs, resulting in high levels of predation on pups (Stirling and Smith 2004). Independent from climatic factors, human hunters may also take a significant proportion of animals, primarily for their pelts, oils, and as food for domestic dogs.

5.1.1.2 Susceptibility to Development

Linkages to Development

Given that ice characteristics are the greatest influence on population viability, potential impacts from industry that most influences ice cover in the study area would have the greatest affect on impacts to populations. However, widespread changes in ice cover (such as thickness and timing of freeze up and break up) are unlikely to be affected by most oil and gas projects. There are potential project impacts though, that may be apparent in a more localized nature. The extent to which such localized impacts influence population dynamics will depend on the number and extent of projects. Most project activities have potential impacts that can be grouped into three categories: Ice-Based Activities, Open-Water Activities, and Hydrocarbon Releases.

Ice-Based Activities

On-ice activities have several potential effects. Activities that are in close proximity to denning seals have the greatest potential to disturb birthing or rearing. Studies have shown displacement of ringed seals from areas close to artificial islands in the central Beaufort Sea and abandonment of breathing holes close to seismic survey lines (Frost and Lowry 1988; Kelly *et al.* 1988). Monitoring studies for the Alaskan Northstar and Liberty projects suggest minor effects on ringed seals from ice road construction and seismic exploration (Harris *et al*. 2001), as den locations are relatively ubiquitous throughout the study area. Ice-pad and ice-road construction also have the potential for disturbance due to noise and other human activity (Zwanenburg *et al*. 2006). Impact predictions associated with the Voisey's Bay Nickel Mine (CEAA 2007) also suggested that seals may suffer temporary hearing loss near vessels traveling through ice, and that they display avoidance behaviour at 500 to 700 m from such shipping activities. Devon Canada Corporation (2004) identified potential habitat alienation due to platform structures, ice pads and ice roads. It should be noted though, that there is no strong evidence to suggest that changes in densities of seals will result from oil and gas activities. In particular, Moulton *et al.* (2003) found no changes in seal densities in relation to an ice bound drilling operation in Alaska.

Open Water Activities

In open water, the presence of shipping activities, offshore facilities (such as drilling rigs), and open water exploration activities (primarily seismic exploration) can be expected to result in relatively short-term displacement of seals (Zwanenburg *et al.* 2006). The presence of open water production wells in areas where concentrated foraging takes place may reduce habitat use in such areas, potentially reducing overall body condition, ultimately resulting in decreased production of pups over a relatively short term. Seals are generally well known to habituate to development, human activities, and infrastructure (the abundance of harbour seals in most coastal city harbours are a good example of such habituation), and as such, long term impacts on seals exposed to open water activities is likely minimal.

Hydrocarbon Releases

As discussed in Section 3 (polar bears), contaminant spills (particularly hydrocarbon spills) remain a potential risk that could have direct consequences to seal populations in the Beaufort Sea. Open water hydrocarbon spills are one of the largest longer-term threats to populations, as a large spill would be expected to disrupt the food availability for seals, potentially decimating the population. It seems likely that an oil spill would affect ringed seals in the same way that the Exxon Valdez spill affected Harbour seals (*Phoca vitulina*) in Alaska (Frost *et al.* 1994). Seal habitat may be affected by contaminant spills, as contaminant presence may reduce the prey base for seals. A large-scale oil spill may also directly impact the health of individual seals. The risk of large-scale spills, however, is very low (Devon Canada Corporation 2004).

Seasonality of Development Impacts

There are three relatively distinct time periods in which development activities may impact aspects of seal ecology. Those include the open water, birthing, and winter periods. Seals are present throughout the study area on a year round basis. Open water impacts to seals would likely be limited to activities such as platform-based drilling, open water seismic, and marine transportation activities. Activities that may affect the winter and birthing ecology of seals would include all ice-bound exploration and drilling, ice road related operations and construction, and low-level aircraft flights.

Population vs. Individual Impacts

Projects may result in several key distinct residual effects to ringed seals, such as habitat avoidance, and contaminant exposure risk. These impacts are generally apparent at an individual level, such as localized and/or temporary avoidance of infrastructure. Overall, threats to the viability of populations are most closely associated with ice features that support successful denning and reproduction, and the productivity of waters in the Beaufort Sea for foraging. In most cases, the impact of project-related residual effects is limited to relatively short term time periods and small areas, which will not affect such parameters as ice features and marine productivity. However, there is the potential for population-level impacts to occur in the following two ways: cumulative effects due to multiple projects, and through large hydrocarbon spills or accidents.

Multiple projects, especially those that may occur in areas of concentrated late summer feeding, may have the potential to reduce habitat suitability on a broad scale, if there are enough projects acting in concert to do so. Similarly, a large hydrocarbon release also has the potential to reduce marine productivity, which would in turn result in lower populations and likely a reduced range that will reflect the location of greatest contaminant concentrations.

5.1.1.3 Sensitivity Layers

In developing a sensitivity layer for ringed seals, the sensitivity rating was dependent on the physical attributes that are crucial to the growth and viability of the population. In particular, areas for denning and pupping, areas of feeding (for both young seal pups and adults), and movement or migratory corridors were considered of importance. Typically these areas were related to distances from shore and seasonal ice patterns. The abundance and distribution of seals may vary in response to ice conditions, and the spatial representation of these areas may thus change over time. Additionally, oceanographic features that support greater congregations of seals were identified and included the Mackenzie and Kugmallik Canyons, and areas near the mouth of the Mackenzie River. These same features provide similar habitat values as those selected by Bowhead whales. These areas are considered of greater value due to the upwelling of ocean currents and the influx of nutrients create areas of greater forage concentrations (crustaceans and zooplankton; L. Harwood, pers. comm, 2007).

Thus, the sensitivity layer developed reflected the following:

- areas used for denning and successful reproduction; and
- feeding areas necessary to support year-over-year survival.

Similar to those factors developed for polar bears, the risk layer reflects a combination of habitats necessary for the viability of the population and the risk to the sustainability of those areas given the potential impacts for development.

5.1.1.4 Sensitivity Layer Ranking

As described in Section 2, a sensitivity layer was produced with sensitivity ratings from 1 through 5 (Figure 5-2).

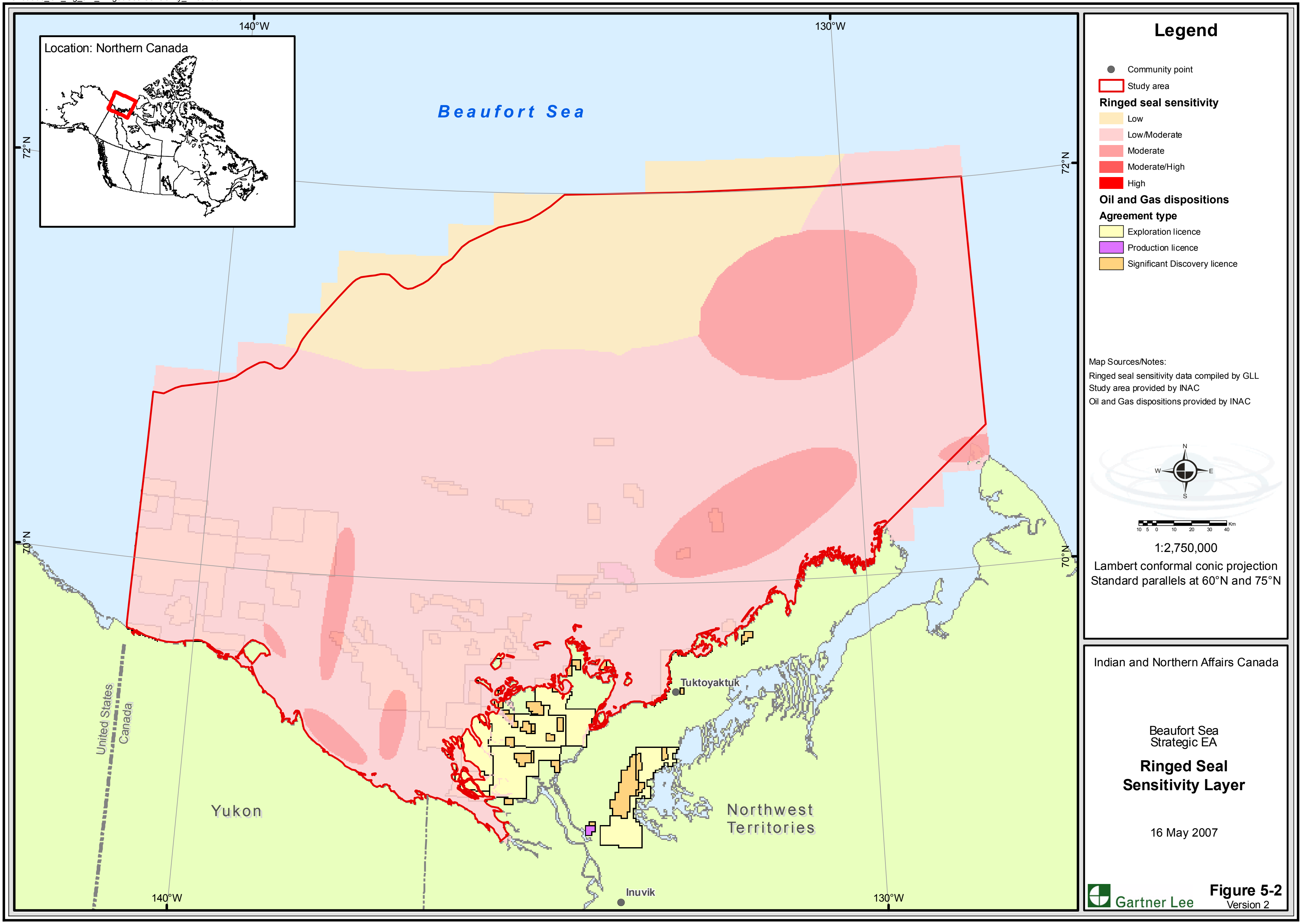
- **Low Sensitivity (1):** This rating reflects areas that have very limited use or selection. Such areas do not contribute substantially to the viability of the species and these areas have little value for reproduction (denning) or survival (limited use for foraging). Such areas are generally identified as areas of multi-year pack ice.
- **Low/Moderate Sensitivity (2):** This rating reflects all areas of the Beaufort Sea, with the exception of multi-year pack ice, and areas classified as moderate or greater risk. These areas have low density, uniform use for foraging, and have moderate, but low-density use as denning areas.
- **Moderate Sensitivity (3):** These areas represent foraging areas that may result in aggregates of seals during late summer feeding periods. They are associated with oceanographic features and include the Mackenzie Canyon, Kugmallit Canyon, and areas of the coastal shelf (these areas are also typical areas of summer bowhead whale aggregation).
- **Moderate/High Sensitivity (4):** These areas represent extensively used near shore denning areas. There are no such areas existing in the study area, although some exist near Banks Island.
- **High Sensitivity (5):** Critical Habitat Areas, as defined by SARA; none exist in the study area.

A note of importance is that the potential impact of short-term, localized disturbance, and potential hydrocarbon spills to ringed seals was considered greater in the areas of late summer foraging, rather than on multi-year pack ice, and thus, higher sensitivity ratings were applied to those key foraging areas. Similar to the sensitivity layer developed for polar bears, the underlying spatial layers are imprecise and subject to spatial variability among years. Thus, it is recommended that conservative interpretations of potential impacts for projects among seasons be considered, rather than less conservative.

5.1.1.5 Climate Change

Seals, especially ringed seals which are the main food source for polar bears, depend on the sea ice to provide a platform for resting, foraging, birthing and nursing pups, and moulting. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and abundance of ringed seals.

File: 60866_O2_Fig_5-2_RingedSealSensitivity_22June07.mxd



Ringed seals rely on both the duration of the ice cover and the total precipitation to create sufficient snow depth for the building of subnivean birthing lairs. If snow decreases in depth and melts earlier, pups may be exposed at an earlier age to freeze-thaw cycles and predators such as the polar bear.

The arctic cod is a pivotal species in the arctic food web, as a prey item to belugas, ringed seals, bearded seals, and other species (Bradstreet *et al.* 1982). The productivity of the arctic cod is dependant upon algal blooms that occurs at the ice-edge every spring. Reduction in the extent of the ice edge, and its associated community, may have harmful consequences for marine mammals that have evolved with these unique systems (Tynan and DeMaster 1997).

Another consequence of increased atmospheric CO_2 would be increased precipitation and continental runoff. Increase discharge from the Mackenzie River would increase the regional ice extent in the Beaufort Sea, and dramatic declines in polar bear and ringed seals population in 1974-75 and 1984-85 were associated with the heavy ice conditions during those years (Stirling *et al.* 1977, Harwood and Stirling 1992, Stirling and Parkinson 2006).

5.1.1.6 Summary

Ringed seals were considered a VEC because of their important economic role, as well as their role in the food chain in supporting several predators, in particular, polar bears. Ringed seals are unique in that they are habitat generalists, and are ubiquitous throughout the area, with some spatial ties to feeding areas such as in under sea canyons and upwellings. Ringed seals have relatively low susceptibility to impacts of development impacts, such as short term, localized displacement, but much greater vulnerability to natural occurrences in ice characteristics. The sensitivity categories developed herein reflect relatively limited potential for significant residual impacts due to development, but do identify increased risk associated with key foraging areas.

6. Migratory Birds

Data sources for the decision-support tool were publicly available regional and local environmental and ecological data and maps provided by the communities, municipal, territorial and federal government agencies, scientific reports and peer-reviewed journal publications.

6.1 Description

The Beaufort Sea supports over 65 species of breeding and non-breeding migratory birds which rely on the area for breeding, feeding, moulting, and staging during spring and fall migrations (Alexander *et al*. 1997). Virtually, the entire western Canadian Arctic population of some species, including king (*Somateria spectabilis*) and common eiders (S*omateria mollissima*) and red-throated loons (*Gavia stellata*), migrate through the Beaufort Sea area (Alexander *et al*. 1988, 1997; Dickson *et al*. 2005). These marine habitats support considerable diversity and abundance of migratory birds and include coastline, open sea (inshore, near shore and offshore sites) and polynyas. Starting in late May, hundreds of thousands of birds migrate across the Beaufort Sea, travelling north and east following a series of open leads and polynyas, to breeding grounds in Arctic Canada. Birds remain in the ice leads for two to four weeks until breeding areas are available for nesting (Alexander *et al*. 1997). From June to freeze-up, coastal lagoons, bays, barriers islands and tidal marshes along the Beaufort Sea coast are all important bird nesting, moulting and staging areas. Most nesting occurs from mid-June to mid-July, and brood rearing and moulting from mid-July to mid-August. Many species are flightless for two to three weeks during the moulting period.

6.2 Rationale for Selection

Migratory birds are regulated under the *Migratory Birds Convention Act*, and several species that inhabit the Beaufort Sea area have significant portions of the entire Canadian or global populations occur within the region. Concerns about the status of several species exist at regional and national levels. Available regional and continental data from waterfowl breeding population and habitat surveys suggest that 10 of 15 sea duck species have declined over the long term, including long-tailed duck (*Clangula hyemalis*), king, spectacled (*Somateria fischeri*), common and Stellar's eider (*Polysticta stelleri*), surf (*Melanitta perspicillata*), white-winged scoter (*Melanitta fusca*), and gray-bellied and black brant (*Branta bernicla nigricans*) (Sudyam *et al*. 2000; Bowman and Koneff 2002; Dickson and Gilchrist 2002; Haszard 2002). Of the 42 shorebird species that breed in Canada, 26 breed exclusively at or above treeline, and most of their habitat is in NWT and Nunavut. Out of the 26 NWT/Nunavut-nesting species that were analysed, 21 show persistent, negative trends regarding their respective populations (Environment Canada 2001).

Adequate habitat is fundamental to the conservation of wildlife. Habitat provides the needs for species' survival and reproduction. Habitat loss and degradation are the leading causes of species endangerment. Sites were considered to be key terrestrial and marine migratory bird habitat if they met the following criteria:

- support at least 1% of the Canadian population (Mallory and Fontaine 2004; Latour et al. 2006) (Figures 6-5 through 6-7). This criterion has been used extensively in the selection of sites of international importance under the Convention on the Conservation of Wetlands of International Importance (aka Ramsar Convention), and meets the criteria established by the CWS Executive Committee;
- support populations that occupy geographically restricted habitats;
- sites that are of exceptional species diversity; and
- have a conservation area status or designation (e.g., Canadian Important Bird Area (IBA) or International Biological Programme (IBP) sites). There are no regulatory controls in place for protecting IBA or IBP sites, but the designation serves to highlight the ecological importance of particular areas (Figure 6-8).

6.3 Description of Key Terrestrial and Marine Migratory Bird Habitat

Populations that are concentrated for any part of the year (e.g., staging, moulting, and foraging areas) are vulnerable to site-specific threats because a significant proportion of the population could be affected. As well, populations that occupy geographically restricted habitats (rare, threatened or endangered species) are vulnerable if their habitats are threatened.

Three broad "habitat zones" support considerable diversity and abundance of migratory birds in the Canadian Beaufort Sea and include the following: (1) coastline, (2) open sea (including inshore, near shore, and offshore components), and (3) polynyas. Coastline habitats include wetlands, salt marshes, mudflats, and estuaries and are important as nesting and brood-rearing areas. Inshore, nearshore, and offshore open sea habitats are important as feeding, spring migration staging, and moulting areas. Polynyas and shore leads provide the open water required as feeding sites for migrating birds and they form important migration corridors and staging areas.

Within these "habitat zones", 11 key terrestrial and marine migratory bird habitat sites have been identified, based on certain criteria. Each site identified:

- supports at least 1% of the Canadian population of a migratory bird species during some part of its life cycle (nesting, moulting, staging);
- occupies geographically restricted habitat for a population; or
- has an exceptional species diversity.

These sites are recognized for their unique physical or ecological characteristics and as such, will have a conservation designation such as the following: International Biological Programme Site

(IBP), Canadian Important Bird Area (IBA), Migratory Bird Sanctuary, National Park, Territorial Park, Canadian Wildlife Service (CWS), Key Migratory Bird Terrestrial or Marine Habitat site, special designated land in Community Conservation Plans). Migratory Bird Sanctuaries, National and Territorial Parks give birds' full protection, while IBP, IBA, CWS Key Habitat, and CCP designations do not.

As a signatory to the *Convention on the Conservation of Wetlands of International Importance, Canada* participated in the International Biological Program. Under the Convention, Canada has obligations to identify and adequately protect wetlands of international importance. There are no regulatory controls in place for protecting IBP sites but the designations serves to highlight the importance of these areas.

The Important Bird Areas (IBA) program has two complementary goals: 1) to identify those sites most critical for the protection of birds in North America; and 2) to take positive and coordinated action to promote the conservation of these sites. The criteria for what qualifies as an IBA fall into four basic categories:

- those protecting globally or nationally threatened species;
- those protecting species with restricted ranges (such as many endemic species);
- those protecting species which breed only or primarily in a single biome; and
- those protecting congregations of species, such as nesting colonies of seabirds.

The IBAs represent sites which include both terrestrial and non-terrestrial habitats that are critically important for bird species not just during the breeding and wintering seasons but also during migration. They are intended to be large enough to support self-sustaining populations of those species for which they are important.

The Canadian Wildlife Service (CWS) catalogues, protects and manages Key Migratory Bird Terrestrial or Marine Habitat sites that are essential to the welfare of a large number of migratory birds. These sites serve as a statement of CWS interest in lands where special conservation measures may be required.

Community Conservation Plan land management categories A through E were developed to recognize priority land uses and activities, as well as areas of special ecological and cultural importance (see section 2.1.1.3).

The Cape Bathurst Polynya is a recurrent crack and lead system, coinciding with the 30 m water depth contour that develops in the Beaufort Sea between the landfast ice and the Arctic pack ice (Figure 6-1). The open water is continuous from Mackenzie Bay to Cape Bathurst, north around the west side of Banks Island, and east into Amundsen Gulf, and is the largest polynya in the western Arctic (Smith and Rigby 1981). This area is of critical importance, for it provides feeding sites, migration corridors and staging areas and supports up to 2%, 36% and 1% of the Canadian populations of king eiders, common eiders and long-tailed ducks, respectively (Alexander *et al.* 1997; Mallory and Fontaine 2004). It has been recognized as a Canadian Important Bird Area

(NT039, IBA Canada 2004) and a Key Migratory Bird Marine Habitat site by the Canadian Wildlife Service (Site 19, Mallory and Fontaine 2004).

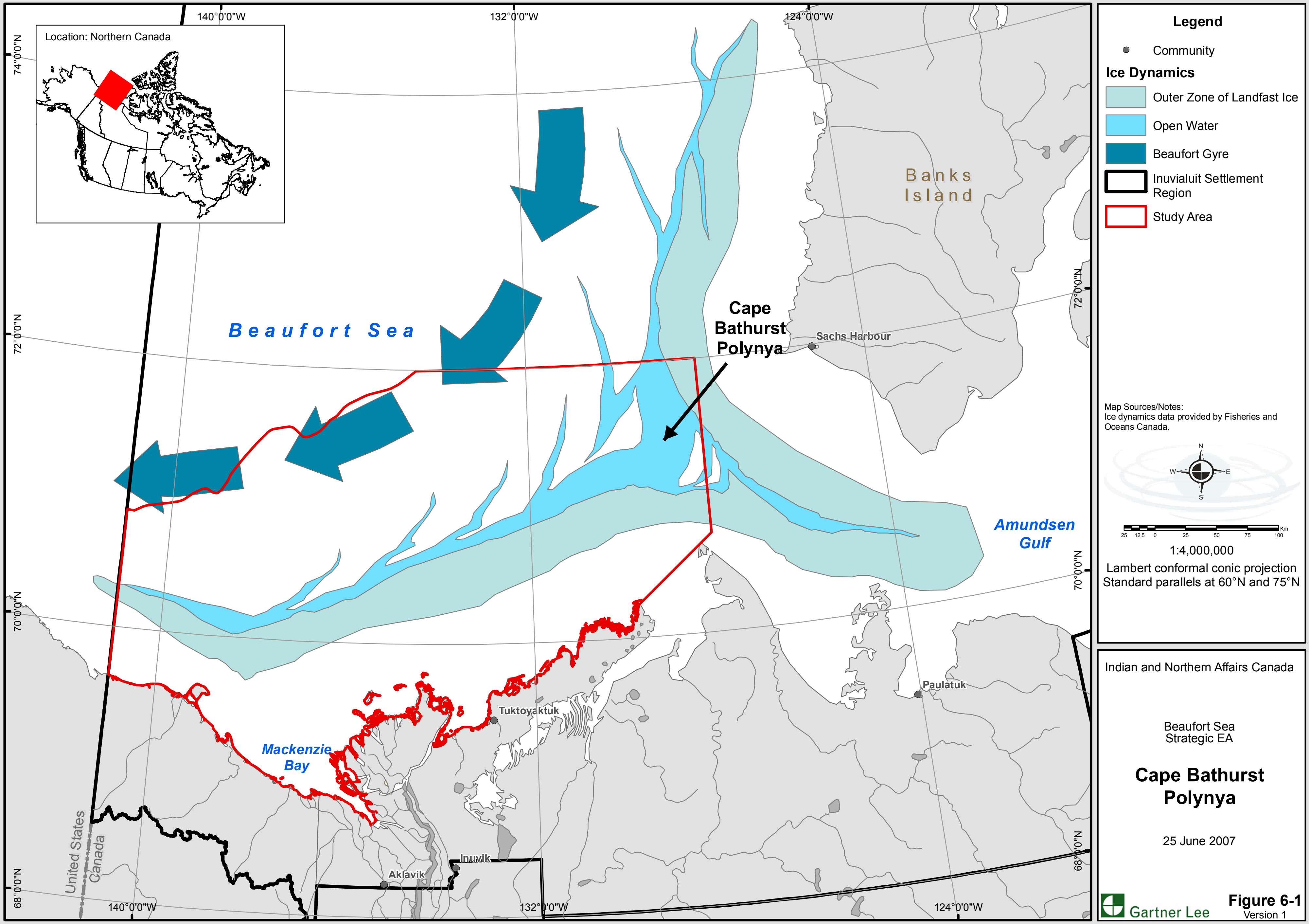
6.3.1.1 Yukon North Slope

The area known as the Yukon North Slope (Figure 6-2) was designated under the IFA as a Special Management Area. All development proposals relating to the Yukon North Slope are screened to determine whether they could have a significant negative impact on the wildlife, habitat or ability of the aboriginals to harvest wildlife. Development proposals that may have a significant negative impact are subject to a public environmental impact assessment (EIA) and review process.

The Blow River Delta, located on the northeast Yukon Coast, extends about 35 km in length, starting in the west with Shingle Point and Escape Reef, through Whitefish Station, Shoalwater Bay, and finally, to Tent Island on the east (Figure 6-2). The inland eastern part of this site includes Moose Channel, which is the extreme northwestern arm of the massive Mackenzie River delta system to the east. The site extends inland from the coast up to 15 km to include areas of channels, ponds, and salt marshes. Storm tides can inundate a large part of the grass-sedge flats; hence, a wide band of land is considered to be influenced by the sea. Most of the coastline that is not delta habitat consists of gravel and sand beaches.

The delta is especially important for the habitat it provides to shorebirds, supporting 4% of the global population of American golden plover (*Pluvialis dominica*), 12% of the global population of pectoral sandpiper (*Calidris melanotos*) (Alexander *et al*. 1988) and 6% of the Western Central Flyway population of Snow Geese (*Chen caerulescens caerulescens*) during the fall migration (Alexander *et al*. 1988). Escape Reef supports a substantial nesting colony of Glaucous gulls (*Larus hyperboreas*) in the Beaufort Sea region (Alexander *et al*. 1988). Generally, this site has been recognized as a Canadian Important Bird Area (YK008, IBA Canada 2004), and a special designated land (725D Aklavik and Inuvik Community Conservation Plan (CCP), WMAC 2000a, b).

File: 60866_C1_Fig_6-1_CapeBathurstPolynya_25Jun07.mxd



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Beaufort Sea Strategic EA

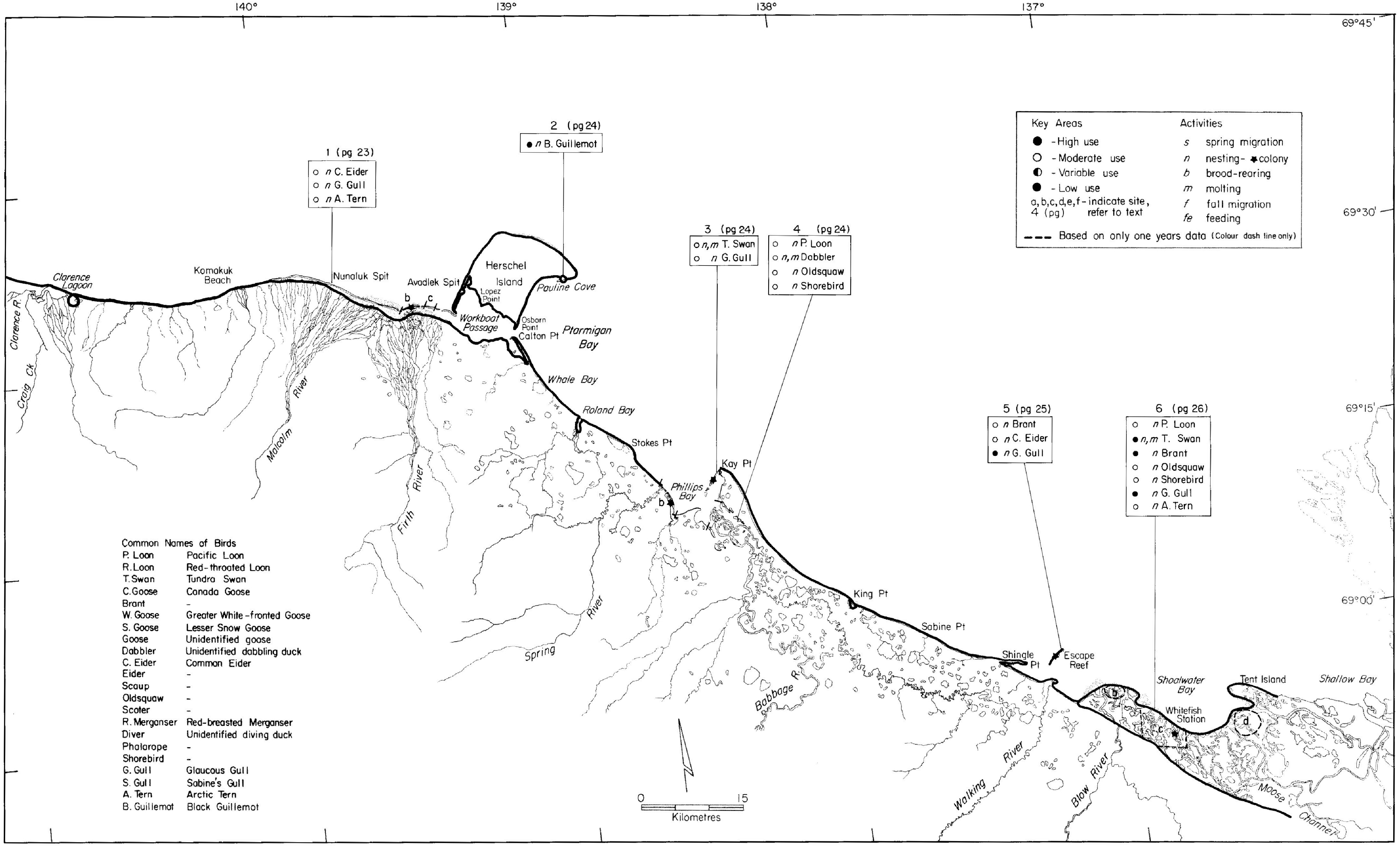
Cape Bathurst Polynya

25 June 2007

Gartner Lee

Figure 6-1
Version 1

Key areas for birds during early June to mid-July: Yukon Coast.



Legend

Location: Northern Canada

Map Sources/Notes:
Reproduced from S.A. Alexander, et al. March 1988. Key Areas for Birds In Coastal Regions of the Canadian Beaufort Sea.

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Yukon North Slope

25 June 2007

Gartner Lee

Figure 6-2
Version 1

File: 60866_C1_Fig_6-2_YukonNorthSlope_25Jun07.mxd

Nunaluk Spit, Workboat Passage and Herschel Island are remote areas on the Beaufort Sea along the Yukon coast (Figure 6-2). The site encompasses about 45 km of coastline extending from the base of Nunaluk Spit at the west end, to Calton Point at the east end. The site also includes the open waters of Workboat Passage, which lies between Herschel Island and the coast. The site extends inland approximately 1 km (and occasionally up to 4 or 5 km) to the higher coastal plain. Dwarf shrubs, sedges, and herbs typify low Arctic tundra vegetation. The coast is composed of sandy spits and deltaic wetlands.

- Pauline Cove on Herschel Island is the only site in the Beaufort Sea region supporting a substantial nesting colony of black guillemot (Cepphus grylle) (Alexander et al. 1988).
- The area provides moulting habitat in August for 12% and 3% of the Canadian populations of long-tailed duck and white-winged scoter, respectively, and significant numbers (52,000) of red-necked phalaropes (Phalaropus lobatus) (Alexander et al. 1988).
- This site has been recognized as a Canadian Important Bird Area (YK005, IBA Canada 2004) and as special designated lands in the Aklavik and Inuvik Community Conservation Plans (726D, 730E WMAC 2000a, Herschel Island is a Territorial Park and is protected under the Yukon Territorial Act).

Babbage and Spring River Deltas (Figure 6-2) are located on the Beaufort Sea along the Yukon coast. The site encompasses about 15 km of coastline and extends out 12 km into the Beaufort Sea to include Kay Point and Phillips Bay. The site continues about 1 km inland, except at the Babbage River delta, where it continues up to 5 km inland. The dominant habitats include ponds, channels, grass-sedge wetlands, salt marshes, and tidal mudflats. Along the coast, gravel and sand beaches dominate, while further inland, Arctic tundra consists of dwarf shrubs, sedges, and herbs.

- The area is important for brood-rearing and staging shorebirds from late July to early September. Breeding birds recorded in the area in late summer include Pacific loon (*Gavia pacifica*), northern pintail (*Anas acuta*), American wigeon (*Anas americana*), northern shoveler (*Anas clypeata*), green-winged teal (*Anas crecca*), long-tailed duck, red-breasted merganser (*Mergus serrator*), and shorebirds, such as semipalmated sandpiper (*Calidris pusilla*) and red-necked phalarope (Alexander et al. 1988).
- This site has been recognized as a Canadian Important Bird Area (YK007, IBA Canada 2004) and as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans (725D, 726D WMAC 2000a, b, c).

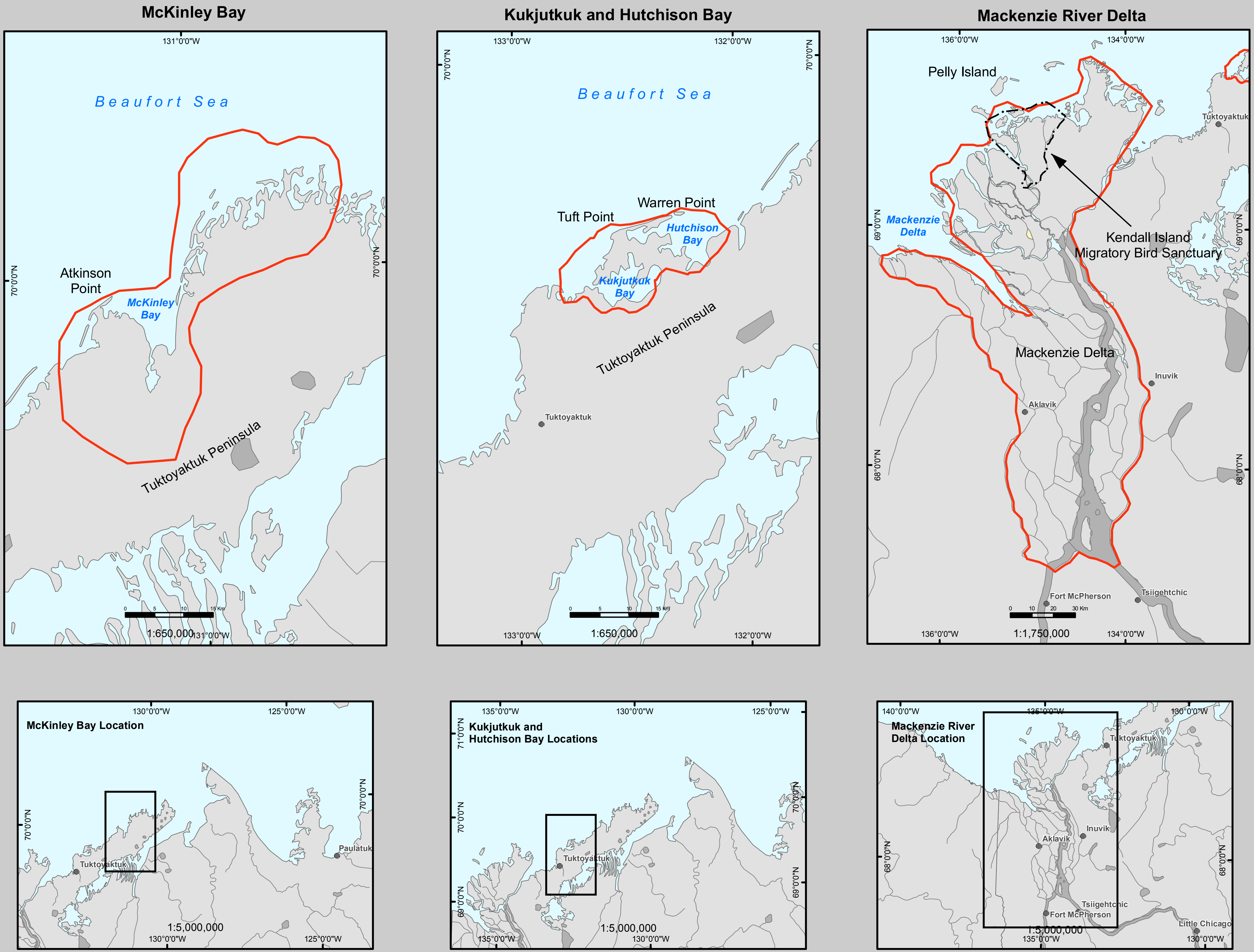
Yukon Coastal Plain. The Yukon coastal plain (Figure 6-2) extends from the Alaska-Yukon border to the Mackenzie Delta and varies in width from approximately 5 km near the Alaskan border, to 30 km at the Babbage River. Spits and lagoons, sand and shingle beaches, and areas of steep cliffs characterize the coastline. Vegetation consists of shrubby tundra vegetation: dwarf birch (*Betula glandulosa*), willow (*Salix* spp.), northern Labrador tea (*Ledum groenlandicum*), *Dryas* spp., and tussock-forming sedge (*Carex* spp.) in Arctic coastal habitats.

- Important staging grounds from late August to late September for 6% of the Canadian population of lesser snow geese (Alexander et al. 1988).
- Ivvavik National Park occurs within the site and is protected under the National Parks Act, and is recognized as special designated lands in the Aklavik and Inuvik Community Conservation Plans (727E, WMAC 2000a, b).

6.3.1.2 Mackenzie Delta

The Mackenzie River Delta includes Shallow Bay, Olivier, Ellice, Garry, Pelly and Kendall Islands, as well as part of Richards Island (Figure 6-3). The islands are generally marshy and covered in sedges, grasses (*Eriophorum* spp.), and horsetail (*Equisetum* spp.), with shrubs in higher areas. The lowlands of Richards Island are dotted with numerous lakes and ponds.

- It provides important nesting habitat for several bird species from May through August and supports up to 2%, 10%, and 1% of the Canadian populations of white-fronted goose (*Anser albifrons*), tundra swans (*Cygnus columbianus*), and dabbling ducks, respectively (Hines et al. 2006; Latour et al. 2006).
- It provides important nesting/brood-rearing habitat for several shorebird species from May through August, and supports up to 1% of the Canadian populations of American golden plover, Hudsonian godwit (*Limosa haemastica*), pectoral sandpiper, red-necked phalarope, stilt sandpiper (*Micropalama himantopus*) and whimbrel (*Numenius phaeopus*) (Gratto-Trevor, 1996; Environment Canada 2006).
- Kendall Island Migratory Bird Sanctuary (KIBS) is a site for one of the two major nesting colonies for snow geese in the southeastern Beaufort Sea (the other site is in the Anderson River Delta). It supports 1% and 4% of the Canadian populations of Hudsonian godwit and whimbrel, respectively (Environment Canada 2006). It is legislatively protected under the Migratory Birds Convention Act, 1994.
- Short-eared owls (*Asio flammeus*), a species listed under SARA (Special Concern, Schedule 3), have been recorded at various locations throughout the outer Delta, including KIBS.
- The coastal tundra vegetation, channels and wetlands provides key moulting habitat for several species. Lesser snow geese, tundra swans, white-fronted geese, sandhill cranes (*Grus canadensis*), Pacific brant, glaucous gulls, Arctic terns (*Sterna paradisaea*), dabbling ducks, and shorebirds nest and moult in the area.
- The islands of the outer delta are important staging grounds from late August to late September for geese (>1% of the Canadian populations of lesser snow geese, white-fronted geese and dabbling ducks; 5% of the Canada goose population (*Branta canadensis*), 20% of the Pacific brant population and 10% of the tundra swan population (Latour et al. 2006).



Legend

- Community
- Bird Migratory Areas

Map Sources/Notes:
Reproduced from Latour et al, 2006; Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut.

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Key Migratory Bird Habitats: Tuktoyaktuk and Mackenzie River Delta

25 June 2007

Gartner Lee

Figure 6-3
Version 1

File: 60866_C1_Fig_6-3_KeyBirdAreas_Tuktoyaktuk_25Jun07.mxd

- This site has been recognized as an International Biological Programme Site (Sites 8 and 42, Beckel 1975), a Canadian Important Bird Area (NT016, IBA Canada 2004), as special designated lands (715C, 716CE, 717B Aklavik, Inuvik and Tuktoyaktuk CCPs, WMAC 2000a, b, c), and a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (NT Site 12, Latour *et al*. 2006).

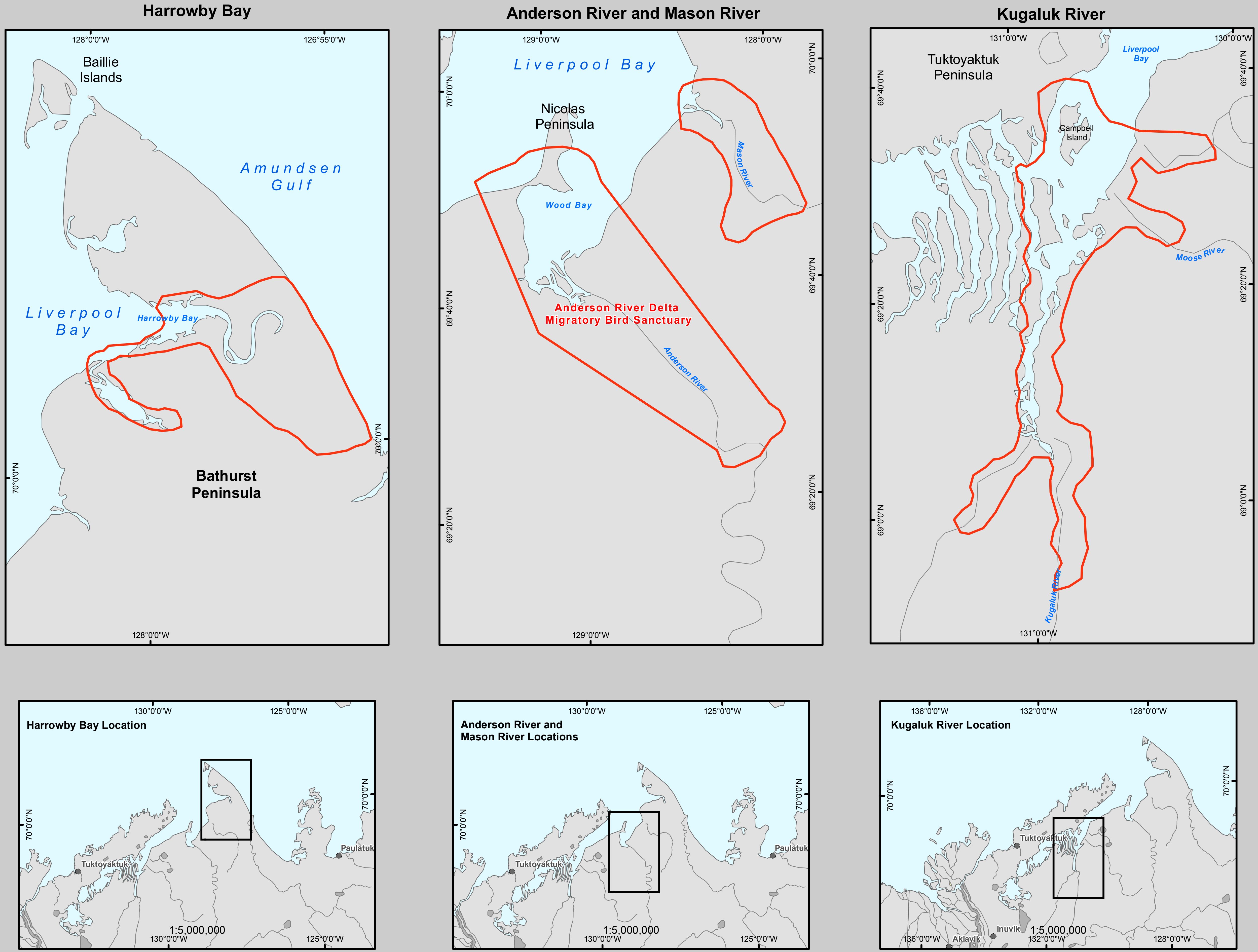
6.3.1.3 Tuktoyaktuk Peninsula

The Kugaluk, Moose and Smoke River Deltas cover about 40 km of the Kugaluk River, the lower 10 km of both the Moose and Smoke Rivers and the upper reaches of Liverpool Bay (Figure 6-4). Two large islands in the bay, one of which is Campbell Island, are also included. The site is extremely flat and the vegetation is primarily sedge and grass, marsh and meadow. Shorelines are non-vegetated tidal sand flats.

- This is one of the most important breeding areas for Pacific brant, supporting 10% of the Canadian population (Latour et al. 2006; Hines et al. 2006).
- The sedge marshes and sandflats are important moulting areas for several species of waterfowl: 10%, 3% and 1% of the Canadian populations of Canada geese (short grass prairie population), white-fronted geese and tundra swans, respectively.
- This site has been recognized as an International Biological Programme Site (IBP Site 44, Beckel 1975), a Canadian Important Bird Area (NT037, IBA Canada 2004), a special designated land (703D Aklavik, Inuvik and Tuktoyaktuk CCP, WMAC 2000a, b, c) and a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (NT Site 9, Latour et al. 2006).

Lower Anderson River Delta (and Mason River) follows the lower 50 km of the Anderson River and includes most of Wood Bay and the lower 20 km of the Mason River (Figure 6-4). The land is low-lying, lakes and ponds are common in the surrounding area and the river breaks up into several channels at the delta. At the highest reaches of the site, the surrounding land is spruce forest. *Dryas* tundra is found a little farther down, and at the river delta, the vegetation is made up of grasses, sedges and willows. Many species of waterfowl use the area for breeding, moulting and staging.

- In the 1970s, the area provided nesting habitat from late May through August for 1%, 1% and 6% of the Canadian populations of lesser snow geese, tundra swans, and Pacific brant, respectively, but numbers of snow geese and brant have declined since then (Latour et al. 2006; Wiebe Robertson and Hines 2006).
- The Eskimo Curlew (*Numenius borealis*) used to breed here. This shorebird is globally listed as critical and nationally listed as endangered (Schedule 1, SARA), but may now be extinct. The bird was last seen somewhere along the Anderson River in 1989 (Latour et al. 2006).
- About 2% of the Canadian population of Pacific brant moult in the inner delta area, and 6% of the Canadian population of long-tailed ducks, scaup (*Aythya spp.*) and scoters use Wood Bay and the Mason River delta for moulting (Alexander et al. 1988; Latour et al. 2006).

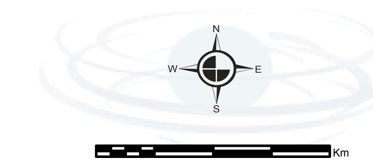


Legend

Community

Bird Migratory Area

Map Sources/Notes:
Reproduced from Latour et al, 2006; Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut.



1:650,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Key Migratory Bird Habitats: Bathurst Peninsula & Liverpool Bay Areas

25 June 2007

Gartner Lee

Figure 6-4
Version 1

File: 60866_C1_Fig_6-4_KeyBirdAreas_HarrowbyBay_25Jun07.mxd

- Most of the site is within the Anderson River Delta Migratory Bird Sanctuary and is legislatively protected under the *Migratory Birds Convention Act, 1994.* This site has been recognized as an International Biological Programme Site (IBP Site 43, Beckel 1975), a Canadian Important Bird Area (NT038, IBA Canada 2004), a special designated land (707D Aklavik, Inuvik and Tuktoyaktuk CCP, WMAC 2000a, b, c) and a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (NT Site 8, Latour *et al*. 2006).

Harrowby Bay is a deep bay in the centre of the Bathurst Peninsula (Figure 6-4). The site contains the open sea of Harrowby Bay, Ikpisugyuk Bay, and the area around the Old Horton River bed. The north shores of Harrowby Bay are composed of low bluffs and sand and gravel beaches and spits. The south shore is marshy and leads to a series of terraces and finally to a plateau surrounding the muddy Ikpisugyuk Bay. The oxbow lakes of the Old Horton Channel are surrounded by lush sedge-grass vegetation.

- From mid-summer through to autumn, 2 to 4% of the Canadian populations of Canada goose and white-fronted goose spend about a month and a half moulting in the Old Horton Channel area. Thousands of long-tailed ducks, scoters, and scaup moult in the waters of Harrowby Bay.
- This site has been recognized as a special designated land (321D Tuktoyaktuk CCP, WMAC 2001c) and a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (NT Site 7, Latour et al. 2006).

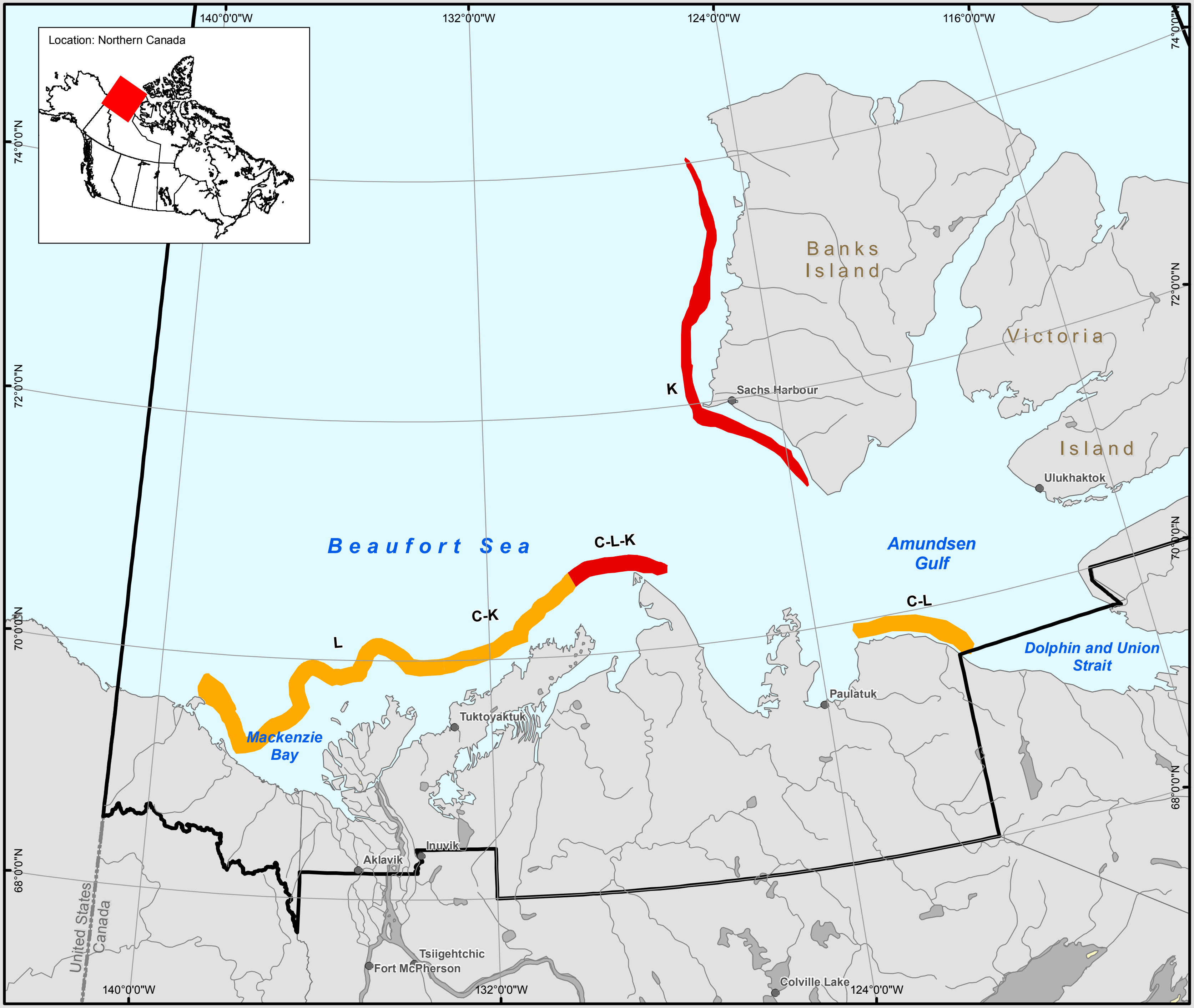
Kukjutkuk and Hutchison Bay The sandy barrier islands, sand spits, sheltered bays and lagoons of Kukjutkuk and Hutchison Bays provide moulting habitat for diving ducks, loons, white-fronted geese, Pacific brant, and tundra swans (Figure 6-3). Inland areas are characterized by numerous ponds and lakes, wetlands and tundra polygons, and lowland tundra.

- The area provides moulting habitat for 1% of the Canadian populations of long-tailed duck, surf and white-winged scoter (Latour et al. 2006).
- This site has been recognized as a special designated land (308C Tuktoyaktuk CCP, WMAC 2000c) and as a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (Latour et al. 2006).

McKinley Bay-Phillips Island The sandy barrier islands, sheltered bays and lagoons of the McKinley Bay-Phillips Island area are characterized by numerous ponds and lakes, extensive wetlands dominated by grasses and sedges, and lowland tundra (Figure 6-3). The area is heavily used by moulting and pre-moulting diving ducks (primarily long-tailed ducks, surf and white-winged scoters), white-fronted geese, red-throated loons, and dabbling ducks.

- The area provides moulting habitat for 1% of the Canadian populations of long-tailed duck, surf and white-winged scoter, and white-fronted geese (Latour et al. 2006).
- This site has been recognized as a special designated land (308C Tuktoyaktuk CCP, WMAC 2000c) and a Key Migratory Bird Terrestrial Habitat site by the Canadian Wildlife Service (NT Site 10, Latour et al. 2006).

File: 60866_C1_Fig_6-5_StagingAreasSeaDucks_25Jun07.mxd



Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

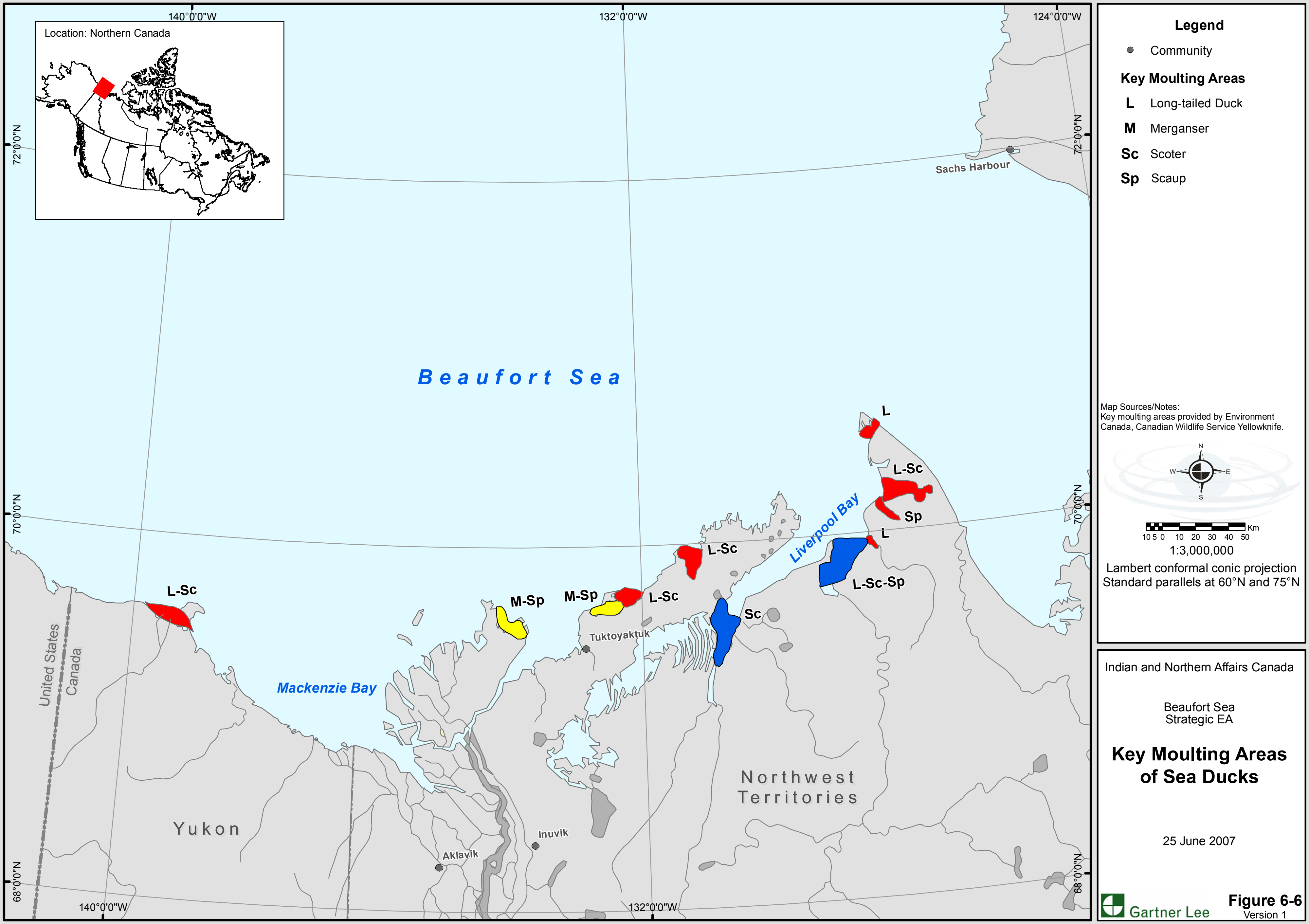
Major Spring Migration Staging Areas of Sea Ducks

25 June 2007

Gartner Lee

Figure 6-5
Version 1

File: 60866_C1_Fig_6-6_MoultingAreasSeaDucks_25Jun07.mxd



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Beaufort Sea
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Key Moulting Areas of Sea Ducks

25 June 2007

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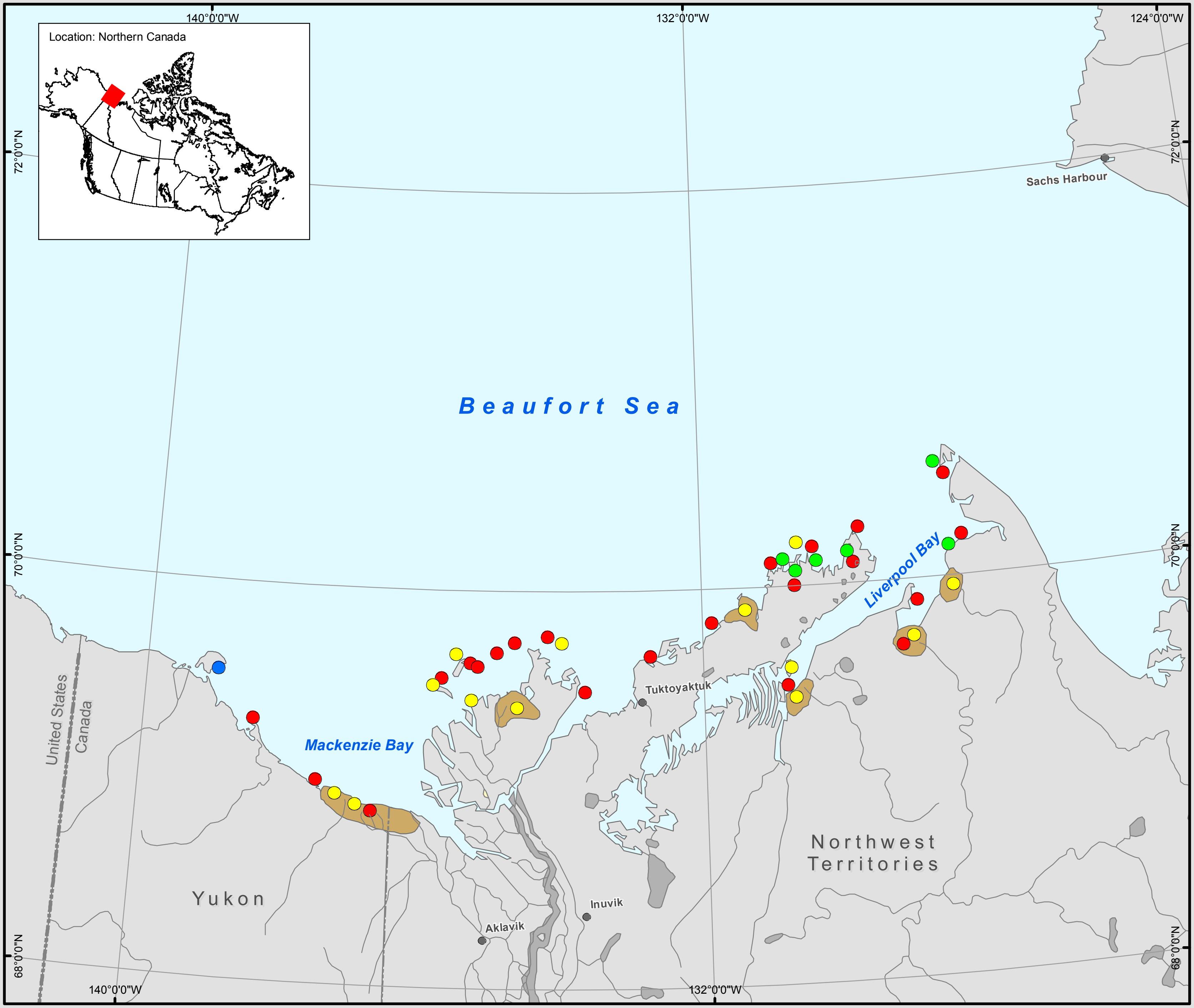
Figure 6-6
Version 1

File: 60866_C1_Fig_6-7_NestingAreasMarineBirds_25Jun07.mxd



Legend

Community

Key Nesting Areas

- Black Guillemot
- Common Eider
- Geese
- Gulls and Terns

Key Nesting Areas

Map Sources/Notes:
Key nesting areas provided by Environment Canada, Canadian Wildlife Service Yellowknife.

N E S W

10 5 0 10 20 30 40 50 Km

1:3,000,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

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Beaufort Sea
Strategic EA

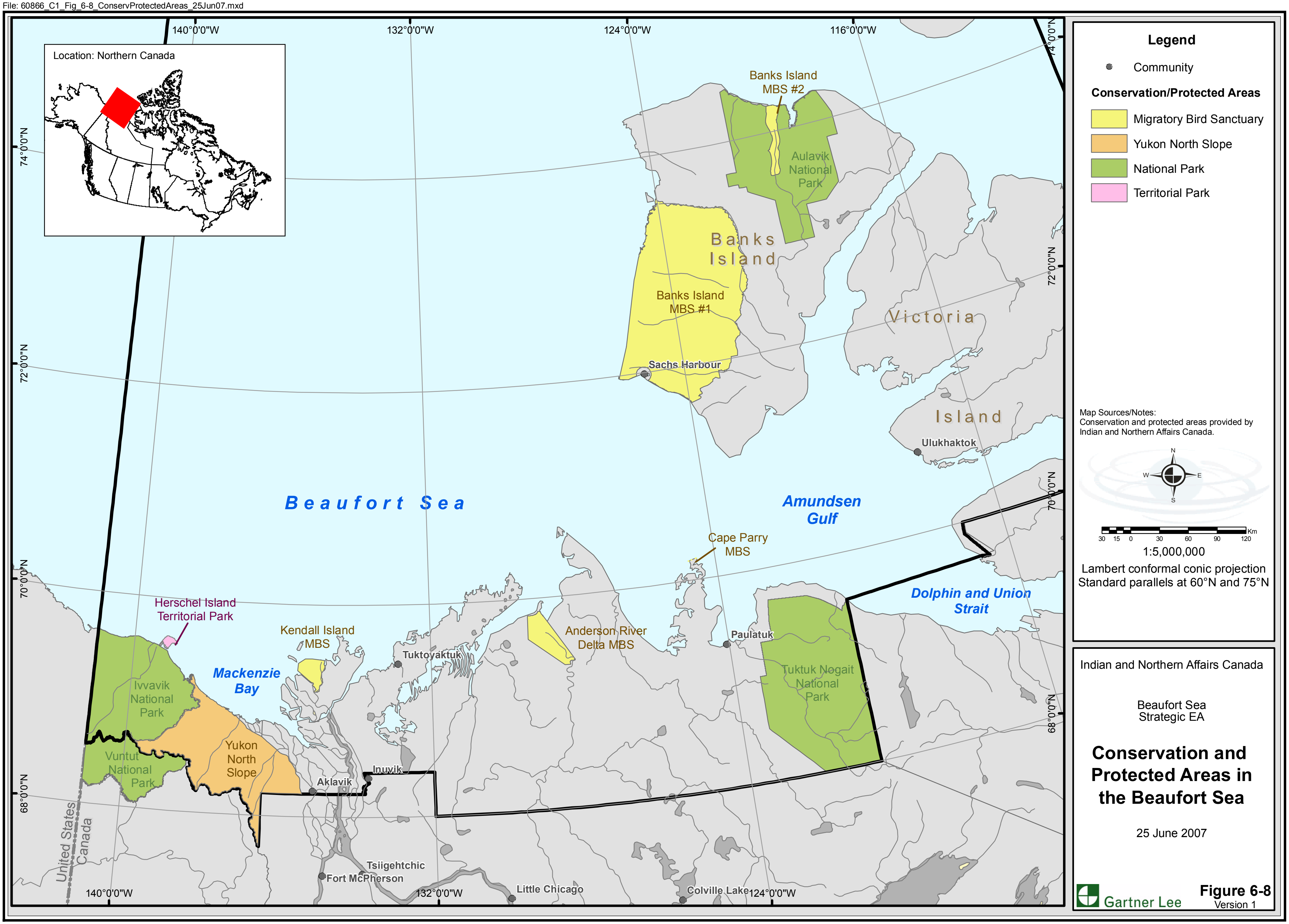
Key Nesting Areas of Marine Birds

25 June 2007

Gartner Lee

Figure 6-7
Version 1

File: 60866_C1_Fig_6-8_ConservProtectedAreas_25Jun07.mxd



6.3.1.4 Sustainability

The most effective way to conserve species diversity is to conserve the ecosystems and habitats that permit this diversity. In the event of population fluctuations, or even local extinctions, the ecosystem would still be able to support the recolonization and success of its plants and animals. In order to be protected, key migratory bird terrestrial and marine habitat must first be identified. Protection of these key areas will play an important role in maintaining the integrity of the terrestrial and marine ecosystem and in preserving marine birds and waterfowl.

Thousands of migrating birds stop temporarily in off-shore areas to feed, rest and court and are dependent on open-water leads and polynyas during the spring migration. Factors that might affect the suitability of staging areas include the annual recurrence of open water, availability of shallow water feeding areas, and water turbidity. Regardless of ice conditions, open water between Cape Dalhousie and the Baillie Islands is extremely important to eiders and long-tailed ducks. Water turbidity reduces visibility and hampers foraging.

Spring weather and timing of snowmelt are critical factors limiting the reproductive success of Arctic waterfowl. Reproductive success of all species is highest during earlier springs and lowest during the coolest springs (Newton 1977). Offshore open water leads and clear-water bays and lagoons which are sheltered from the Mackenzie River plume, are important for spring staging, nesting, brood-rearing, moulting, feeding and fall staging.

6.3.1.5 Susceptibility to Development

Bird species that frequent sea coasts and marine waters in the Beaufort Sea have the potential to be impacted by oil and gas activities. Degradation or destruction of habitat could have a significant impact on a particular population. The importance of a particular terrestrial or marine habitat depends on the size of the population that it supports during any part of the species' life cycle. Activities such as dredging, shore-based staging areas and offshore platforms could alter valuable coastal bird habitat and may cause displacement. Flare stacks, staff quarters, gas conditioning facilities and other tall structures could increase bird mortality by direct strikes.

The impacts of a major oil spill will vary depending on the location, size, timing and clean-up of the spill. During certain life-cycle phases (e.g., nesting, brood-rearing, moulting), bird species are relatively sedentary and oil spills can have catastrophic site-specific effects. Sea ducks and sea birds are especially vulnerable to oil spills, because they tend to congregate in such large numbers that even a small spill can affect a large number of birds (Dickson and Gilchrist 2002). Polynyas and associated lead systems are important spring feeding and staging areas for migrating sea ducks and serve as major feeding areas for substantial numbers of seabirds during the summer months. Oil pollution in offshore areas in the southern Beaufort Sea during spring migration could be devastating to several populations. Nesting and moulting seabirds and waterfowl concentrate in nearshore sheltered bays from late July to mid-August. Since they are flightless during the moult, they are susceptible to disturbance and vulnerable to oil spills during this period.

Birds may be disturbed by aircraft overflights between shore-bases and offshore platforms. Negative effects of noise (e.g., flushing, displacement, or abandonment of key areas) are species dependent, as well as being dependent on the life history stage of the birds (nesting vs. staging) (Bunnell *et al.* 1981; Belanger and Bedard 1989). Birds that are colonial nesters are especially vulnerable, due to their clumped nature. Birds are also vulnerable during the sedentary moulting and brood-rearing periods, as well as during the fall. In 1997, the Wildlife Management Advisory Council in the NWT concluded that a flight altitude of 650 m was appropriate to minimize disturbance to birds under normal conditions, and that a minimum flight altitude of 1100 m should be adhered to in areas where birds were known to concentrate (sanctuaries, colonies, and moulting areas). The Inuvialuit Environmental Impact Screening Committee (EISC) has adopted these flight height criteria (Inuvialuit Joint Secretariat 2002). In addition, Environment Canada has recommended avoidance of concentrations of migratory birds by a distance of 1.5 km during the nesting, breeding and moulting seasons, and a distance of 3 km during the spring and fall staging periods (Belanger and Bedard 1989; Environment Canada 2006).

Drilling programs may involve summer drilling in the area as they have in the past. Unless adequate measures are taken, the discharge of drilling muds, cuttings, and other fluids and solids (e.g., grey water, sewage, reverse osmosis reject water, miscellaneous wash water) has the potential to affect birds. Exploration wells could be drilled during the winter within the landfast ice zone and the preferred method of disposal of drilling waste is under-ice (Environment Canada 2006). Most birds are not present in the study area during the ice-covered winter period. Since the drilling waste will be discharged under the ice, there will be no opportunity for overwintering birds such as ravens to interact with the waste.

6.3.1.6 Sensitivity Layers

The rating system below is assigned to the key migratory bird terrestrial and marine habitat which includes spring and fall migration areas, nesting, brood-rearing, and moulting habitat.

Most birds are not present in the study area during the ice-covered winter period. However, their absence during the winter does not diminish the significance of the identified key migratory bird terrestrial and marine habitat. These habitats provide the needs for a species' survival and reproduction and are fundamental to the conservation of many species.

6.3.1.7 Sensitivity Layer Ranking

Populations that are concentrated for any part of the year (e.g., staging, moulting, and foraging areas) are vulnerable to site-specific threats because a significant proportion of the population could be affected. As well, populations that occupy geographically restricted habitats (rare, threatened or endangered species) are vulnerable if their habitats are threatened.

As described in Section 2, a sensitivity layer was produced with sensitivity ratings from 1 through 5 (Figure 6-9). The sensitivity layer and spatial grid layer developed was based on underlying spatial layers that are imprecise (spatial variability) and are subject to variability among years (temporal variability). The concepts considered in developing the sensitivity rating included the following:

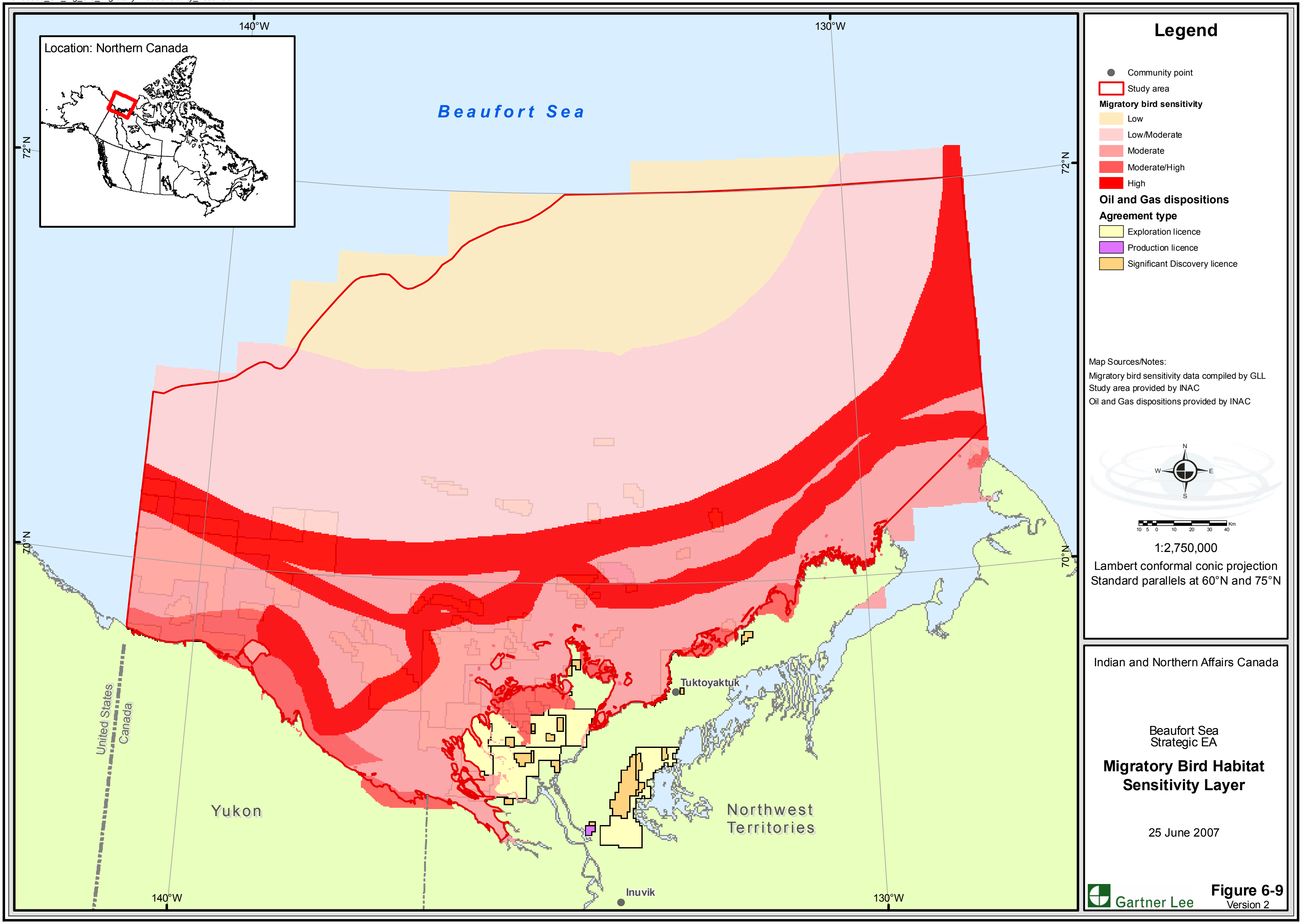
- life cycle and occurrence in the study area;
- susceptibility to habitat change;
- sensitivity to development; and
- importance to Inuvialuit (VSEC).

- **Low Sensitivity (1):** areas that have very limited use year round and include the area beyond the summer extent of pack ice (approximate summer extent of pack ice as defined in Stirling 2002).
- **Low/Moderate Sensitivity (2):** areas where populations are geographically widespread or widely dispersed throughout a variety of habitats. These populations are less vulnerable to site-specific threats, as only a small portion would be affected. Includes coastal and offshore areas to the limit of summer pack ice and upland and floodplain.
- **Moderate Sensitivity (3):** areas where populations are concentrated in a habitat site for any part of the year including staging areas, nesting colonies, moulting and feeding areas. Includes sites with moderate to high densities, but <1% of the Canadian population, and coastal and offshore areas to the limit of summer pack ice and upland and floodplain.
- **Moderate/High Sensitivity (4):** populations that occupy geographically restricted habitats and sites that support at least 1% of the Canadian population and/or have a conservation area status or designation. This includes key areas along the Yukon North Slope (Blow River delta, Nunaluk Spit, Workboat Passage, Herschel Island, Babbage and Spring River deltas), the Yukon Coastal Plain, the Mackenzie River Delta, and areas along the Tuktoyaktuk Peninsula (Kugaluk, Moose, and Smoke Rivers; lower Anderson and Mason River deltas; Harrowby Bay, Kukjutkuk and Hutchinson Bay, McKinley Bay and Phillips Island) Also includes sites of exceptional species diversity, and includes coastal and offshore areas to the limit of summer pack ice and upland and floodplain
- **High Sensitivity (5):** sites that support 50% of the Canadian population. This includes the Cape Bathurst polynya and includes critical habitat as defined by the *Species At Risk Act* (SARA)

6.3.1.8 Climate Change

Birds are potentially useful as indicators of broader ecological effects of climate change because they occupy a wide range of habitats. Climatic variables most often identified as influencing bird responses include a rise in air and sea surface temperatures, rising sea levels, drying of wetlands, and sea ice variability. In northern regions, warming may extend nesting periods, provide more food for young and decrease chick mortality. However, warming may reduce breeding and foraging habitats, sea level rise may damage important shoreline nesting areas, and increasing storms during nesting season could destroy essential nesting effort, eggs, and chicks (UNEP 2005).

File: 60866_O2_Fig_6-9_MigratoryBirdsSensitivity_25June07.mxd



Climate change may lead to alterations in location, timing and length of migration routes. Spring migration of birds is generally considered more important than autumn migration because it determines their arrival timing at breeding grounds, which is crucial for mating and territory choice. There is concern some long distance migrant bird species may not be able to alter their migratory behaviour sufficiently to match shifts in the availability of important food sources such as insects, flowers and berries (Climate Risk 2006, Tulp and Schekkerman 2008). These timing shifts are a threat when they force birds' life cycles out of synchrony with plants and insects upon which they depend.

6.3.1.9 Summary

The NWT coastal and marine zones support a considerable diversity and abundance of migratory birds which use coastline, open sea (inshore, nearshore and offshore sites) and polynyas during some part of their life cycle (nesting, moulting, staging). Species that use the offshore waters include the red-throated, Pacific and yellow-billed loons, common eiders, long-tailed ducks, Sabine's gulls and glaucous gulls. Bird species that depend on the nearshore waters include the red-throated loon, Pacific loon, brant, tundra swan, glaucous gull, Arctic tern, lesser snow geese, black guillemots, common eiders and thick-billed murres. Most birds are not present in the Project area during the winter ice-covered period; therefore, interactions are only likely to occur during the pre-operations mobilization period and at spring breakup, following winter drilling operations.

Key terrestrial and marine habitat for birds exists in both offshore and coastal areas. Polynya and lead habitats off Cape Bathurst, Banks Island and the Mackenzie Delta are critically important to sea ducks (king and common eiders and long-tailed ducks) during spring migration. Birds arrive on their nesting grounds in the Beaufort Sea in late May to early June. From late July to early August McKinley Bay–Phillips Island, the Kukjuktuk and Hutchison Bay area, and Workboat Passage at Herschel Island are key habitats for >100,000 moulting and pre-moulting ducks. Due to the fact that migratory birds concentrate to feed at ice edges and in open leads, and during breeding, nesting, moulting and migration periods, they are particularly vulnerable to oil. Oil spills could seriously reduce or even eliminate some of these birds in areas of concentration, and have a lasting impact on the entire population of migratory birds in the region. Concern over this potential threat has resulted in research that has vastly improved our knowledge of the location, size, breeding success, feeding habits, and migration patterns of many migratory bird species in the Beaufort Sea (Alexander *et al*. 1988; Gratto-Trevor 1996; Dickson 1997; Hines and Wiebe Robertson 2006).

Eleven key terrestrial and marine migratory bird habitat sites have been identified. Each site selected supports at least 1% of the Canadian population of a migratory bird species during some part of its life cycle (nesting, moulting, staging), or a population that occupies geographically restricted habitat, or is a site of exceptional species diversity. These sites are recognized for their unique physical or ecological characteristics and as such, have a conservation designation (International Biological Programme Site, Canadian Important Bird Area, Migratory Bird Sanctuary, National Park, Territorial Park, Canadian Wildlife Service Key Migratory Bird Terrestrial or Marine Habitat site, special designated land in Community Conservation Plans). Migratory Bird Sanctuaries, National and Territorial Parks give birds full protection, while IBP, IBA, CWS Key

Habitat, and CCP designations do not. Their identification is intended to raise awareness and draw attention to activities that may threaten an area.

Additionally, key migratory bird terrestrial and marine habitat extends beyond the study area boundary (e.g., west and south coast of Banks Island). Impacts to certain migratory bird populations (e.g., king eiders) outside the study area, may act in a cumulative fashion with impacts within the study area to influence the populations.

It is possible to make some general predictions regarding the effects of the petroleum industry on seabirds and other marine life in the Canadian Arctic. Despite the most conscientious efforts by the industry to minimize losses during its day-to-day operations, accidents do occur and there could be low levels of oil pollution in some areas from time to time. There could be extensive mortality in the event of a major spill in any of the areas where large numbers of migratory birds congregate. Accidents arising from equipment failure or human carelessness can be reduced by design, construction and maintenance, and by taking adequate precautionary measures. In the event of a significant accident, human resources and equipment must be made immediately available to contain and clean up the spill to the greatest extent possible.

The presence of additional humans, along with ships, aircraft and other oil and gas project related activities in the region, could result in more extensive disturbance of marine life, including migratory birds. It is possible through diligent project design, construction and maintenance to minimize the impact of oil and gas exploration and development. For instance, it is possible to reduce the level of disturbance from aircraft and ships by identifying and avoiding sensitive areas at certain times of the year.

7. Valued Socio-Economic Component

7.1 Description

For the purpose of developing the decision-support tool, hunting of polar bears, beluga whales, ringed seals, and migratory birds was selected as the VSECs. The information for this VSEC is based primarily on the Community Conservation Plans for the Inuvialuit communities of Aklavik, Inuvik and Tuktoyaktuk (WMAC 2000a, b, c), and on a study prepared by Usher (2002) on the Inuvialuit use of resources in the Beaufort Sea during the 1960s and 1990s. As mentioned earlier, the CCPs for Sachs Harbour, Ulukhaktok, and Paulatuk were not considered in this research because the Plans do not overlap with the study area.

Polar bears, beluga whales, ringed seals, and migratory birds were examined from a socio-economic and cultural perspective because of the important role they play in subsistence economies and cultural sustainability.

7.2 Rationale for Selection

The Inuvialuit of the Beaufort Sea coastal area have relied upon the area's wildlife for many years. Hunting (and trapping) continues to be of cultural, social and spiritual importance for Inuvialuit communities, as well as, economic importance. The CCPs were developed to help protect the environment in the Mackenzie Delta / Beaufort Sea coastal, onshore and offshore areas to ensure cultural survival of the Inuvialuit Community. One of the goals of the CCP is to identify important wildlife habitat, seasonal harvesting areas and cultural sites (e.g., cabin sites) and make recommendations for the conservation and management of the resources on which priority lifestyles depend. The total area used for hunting by the Inuvialuit has not changed much since the 1960s, but there has been a decline in the number of harvesters and a shift from full-time to part-time harvesting (Usher 2002). Many of the people are tied to the community by some form of wage employment and travel only on weekends and holidays. Their dependence on nearby areas is now even more acute.

The mean annual harvest of country food has declined from the 1960s to the 1990s (Table 7-1). There are several reasons for the decline; principally, the abandonment of dogs as the principal means of transportation (which were primarily fed marine species of seal and whitefish); the increased use of snowmobiles and the shift from full-time to part-time harvesting. These changes in lifestyle have led to an overall shift from marine to terrestrial country food sources. While the total amount of country food produced has declined, the amount consumed by Inuvialuit has increased. Subsistence harvesting thus continues to persist as significant economic and cultural practices in the region (Usher 2002).

Table 7-1. Mean Annual Inuvialuit Harvest of Selected Species, 1960-65 and 1988-97

Species	1960-65	1988-97
Marine mammals		
■ beluga	83	117
■ ringed seals	4,900	1,085
■ polar bear	68	56
Terrestrial mammals		
■ caribou	1,300	3,114
■ muskoxen	0	327
■ moose	60	28
■ muskrat	98,000	10,019
■ arctic fox	5,300	1,384
Marine and anadromous fish (kg)	400,000	92,034
Freshwater fish (kg)	40,000	17,450

Source: Usher 2002.

7.2.1.1 Polar Bears

Currently, polar bear sport hunts account for half of the total polar bear harvests in the Inuvialuit Settlement Area, mainly in Sachs Harbour, Holman (now Ulukhaktok), Paulatuk, and Tuktoyaktuk (Usher 2002) (Figure 7-1). The polar bear harvest is managed via a quota system that allocates bears to each community in the study area. Prior to the establishment of quotas, populations were in decline (Stirling 2002), but have recovered since that time and are considered stable (COSEWIC 2002). Traditional uses of polar bears in the three communities include the occasional consumption of their meat and the use of their fur for clothing (WMAC 2000a, b, c).

7.2.1.2 Beluga Whales

The Inuvialuit have a long history of hunting beluga and rely on them for subsistence (Fast *et al.* 1998; Harwood and Smith 2002, Harwood *et al.* 2002). Beluga whales remain a highly valued food source in the three communities under study (WMAC 2000a, b, c). Hunters and their families from Inuvik, Aklavik, and Tuktoyaktuk travel to traditional whaling camps along the Beaufort Sea coast each summer. The beluga whale hunt is usually conducted during the month of July, while the belugas are aggregated in the warm waters of the Mackenzie River estuary, and lasts for four to six weeks (Harwood *et al.* 2002). Table 7-1 shows that the mean annual beluga harvest has increased from 83 in the 1960s to 117 (nearly 50% higher) in the 1990s. This harvest effort is supported by the Inuvialuit Joint Secretariat, which states that the difference in numbers is not significant and that the beluga harvest has not increased significantly over the years (Richard Binder, *pers. comm.*, 2007). The current annual harvest varies with between 100-130 animals taken.

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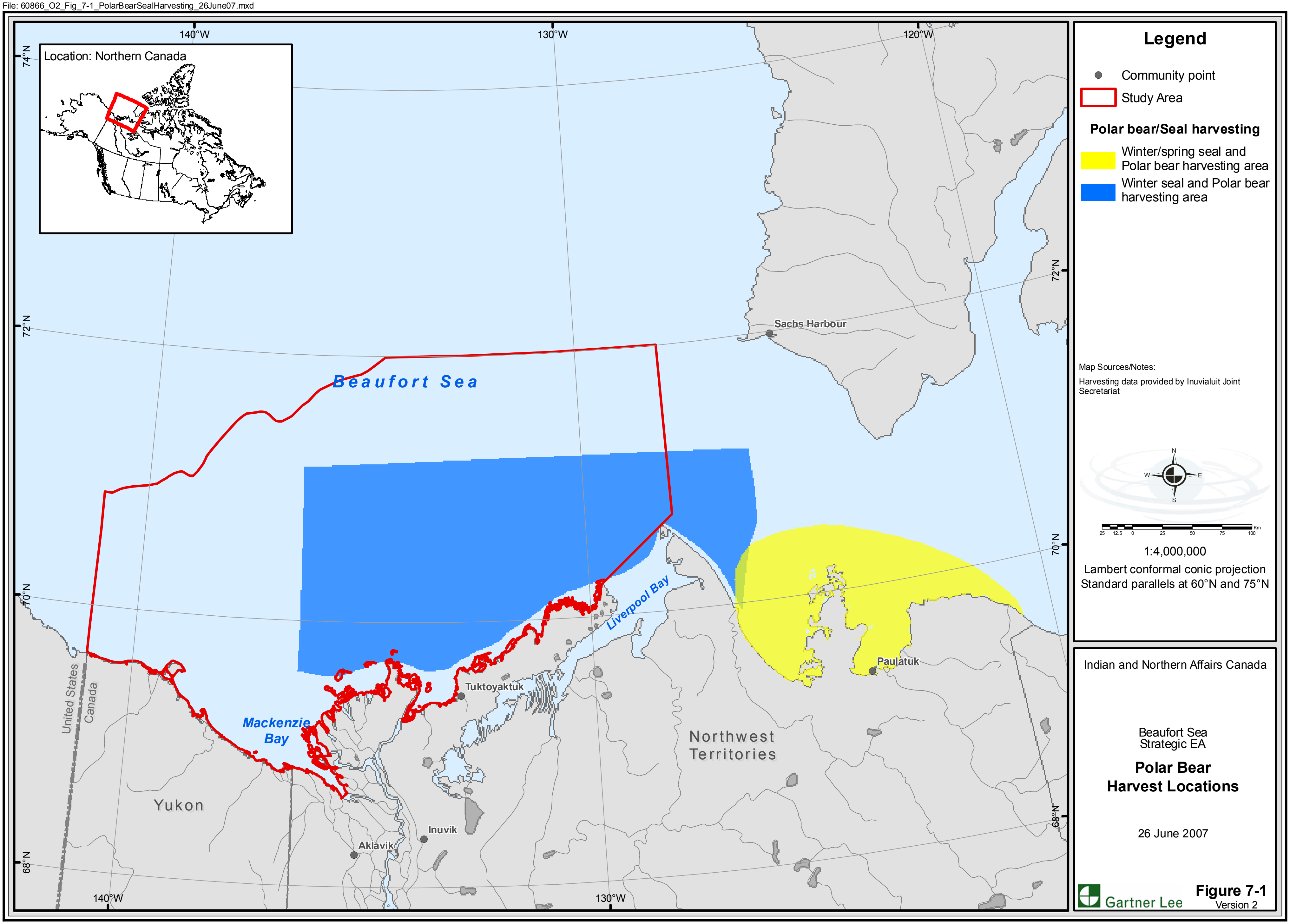

Figure 7-1
Version 2

7.2.1.3 Ringed Seals

Seals have been a reliable source of heating oil, meat and pelts for Inuvialuit hunters for generations. The ringed seal is an important species in the subsistence harvest and economy of the three communities, particularly in Tuktoyaktuk, but it is shifting due to changes in technology. Seals were the primary source of dog feed in the 1960s and their harvest declined between the 1960s and the 1990s, due to the shift towards snowmobiles for transport rather than dog teams. A secondary factor in reduced harvests was the decline in pelt prices due to European and American import bans (Usher 2002). Seals continue to be harvested for consumption by humans and dogs. They are also harvested for their pelts, which are used in handicrafts and clothing (i.e., boots and mittens) (WMAC 2000a, b, c).

7.2.1.4 Migratory Birds

Many species of waterfowl in the Beaufort Sea are harvested for subsistence purposes including ducks, geese and tundra swan. Waterfowl have cultural, social and spiritual well-being importance (Usher 2002). The Inuvialuit are concerned about the regional management of waterfowl as some of their populations are declining, in particular king eider, common eider and black brant (WMAC 2000a, b, c).

<u>Ducks:</u> *King eider and common eider* – The Inuvialuit traditionally consume the king eider and common eider in the spring and fall. King eiders comprise 96% of the total eider harvest with the majority of the harvest occurring in June (Fabijan *et al.* 1997; WMAC 1999; Byers and Dickson 2001).

<u>Geese and Tundra Swan:</u> *Canada goose, snow goose, white-fronted goose, Brant and Tundra Swan* - Geese and swans are important food sources and as a source of feathers for pillows and blankets. Over one-third of Inuvialuit harvesters hunt snow geese (Usher 2002). Lesser snow geese comprise approximately 70% of the goose and swan harvest, with the majority of the harvest occurring in the spring (Bromley 1996).

7.2.1.5 Sustainability

Hunters typically show an affinity for particular harvesting areas (Bromley 1996; Byers and Dickson 2001). Much of the terrestrial wildlife harvesting occurs near the coast, due to the ease of transport and accessibility. Beluga whale hunting is concentrated around the mouth of the Mackenzie River during the open water season, while the seaward limit of harvesting of polar bears and seals by Aklavik, Inuvik and Tuktoyaktuk communities are associated with the normal maximum extent of fast ice (Usher 2002). To sustainably manage their resources, the Inuvialuit have designated special areas and recommended land use practices for their planning areas. In designating land management categories, the communities have prioritized land uses and activities, in addition to denoting areas of special ecological and cultural importance. The CCP provides each area of importance with a management designation corresponding i.e., A to E with A being the least sensitive and E being the most sensitive.

- **Category A:** represents lands and waters where there are no known significant and sensitive cultural or renewable resources.
- **Category B:** represents lands and waters where there are cultural or renewable resources of some significance and sensitivity.
- **Category C:** represents lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year.
- **Category D:** represents lands and waters where cultural or renewable resources are of particular significance and sensitivity throughout the year.
- **Category E:** represents lands and waters where cultural or renewable resources are of extreme significance and sensitivity. This category recommends the highest degree of protection; there shall be no development on these areas.

By creating a management system that recognizes that some areas are more important to hunting than others, the Inuvialuit have created a system that allows them to protect areas of greatest importance while not limiting the potential for development in areas of less harvesting importance. The goals of the planning process are summarized below.

- To identify and protect important habitats and harvesting areas, including wildlife habitat, seasonal harvesting areas and cultural sites and make recommendations for their management.
- To describe the community process for making land use decisions and managing cumulative impacts, which will protect community values and conserve the resources on which priority lifestyles depend.
- To identify educational initiatives for Inuvialuit and others interested in the area which will promote conservation, understanding and appreciation.
- To describe a general system for wildlife management and conservation and identify population goals and conservation measures appropriate for each species of concern in the planning area.
- To enhance the local economy by adopting a cooperative and consistent approach to community decision-making and resource management.

7.2.1.6 Susceptibility to Development

Hunting is susceptible to development in the following ways: loss of access to hunting areas, loss of the species being pursued, change in technology, and loss of hunting time to employment. For example, as already mentioned earlier in this paper, there has been a shift from dogs for transportation to snowmobiles and the attendant reduction in the seal hunt. This shift took place in association with changing values in seal pelts. The result at that time was an overall reduction in seal hunting.

Changes in technology and loss of time to employment have had an impact on the cultural role of hunting. Hunting, while still a family event is compressed in time to weekends or days off and renewing contact with the land, as well as the passing of knowledge and skills of a traditional lifestyle are affected. Accelerated oil and gas exploration may result in further declines in hunting activities (Byers and Dickson 2001).

The harvest of large marine mammals and migratory waterfowl is highly restricted in time and space (Usher and Wenzel 1987). Inuvialuit consistently harvest in the same areas for reasons of access and known congregation of animals. Many of these harvest areas are seasonally important for wildlife species (e.g., migration, nesting, denning). The coastal and offshore regions of the study area overlap much of the area where Inuvialuit hunters harvest polar bears (Figure 7.1). Oil and gas activities related to petroleum development might affect the movements of polar bears and make them less available for hunting, or interfere with their denning sites (Perham 2005). Polar bears are also susceptible to any changes in their food supply due to tainting, spills and disruption due to noise (Report of the Scientific Review Panel 2002). This may cause polar bears to move from an area of disturbance and ultimately affect hunting activities or success.

Seals and whales may be affected by changes to their food supply such as tainting. Both seals and whales do not immediately avoid oiled areas. Increases in seal pup mortality have been observed in contaminated areas, in addition to eye and brain damage (Report of the Scientific Review Panel 2002). Whales may avoid areas where there are explosions by seismic airgun arrays, either by moving away or simply avoiding an area (Report of the Scientific Review Panel 2002). Persistent and intense activity within traditional hunting areas could limit the ability to harvest whales or seals in such areas, and spills. Spills or contaminated areas could affect hunting and access to hunting areas, at least temporarily.

Migratory birds are an integral part of the food chain. They consume vegetation, zooplankton, shellfish and fish. Changes in food supply and oiling has been shown to result in mortality, reduced reproduction, growth and distribution. Each of these activities interferes with hunting.

Harvesting activities have an economic role, providing food and cash income, and a cultural role, as a family event and renewing contact with the land and passing on the knowledge and skills of a traditional lifestyle. Accelerated oil and gas exploration may result in significant changes to employment and income patterns, which has the potential of replacing a predominantly subsistence economy with an increasingly dominant wage economy resulting in a decline in fishing and hunting activities (Byers and Dickson 2001).

7.2.1.7 Sensitivity Layers

Community Conservation Plans were developed to help protect the environment in the Mackenzie Delta area and onshore and offshore areas of the Beaufort Sea. Within the CCPs, important wildlife habitat and/or harvesting areas have been identified. These areas were assigned management categories according to ecological and cultural importance, need to conserve a renewable resource, and need to protect priority activities (Table 7-2). As the Inuvialuit had already created a five-part classification system consistent with the classification system being used in developing the decision-support tool, their system of classification was adopted for the purposes of this project.

Table 7-2. Summary of Inuvialuit Community Values Used to Develop Conservation Plans Land Use Classifications

- **Conservation is First Priority** – All renewable and non-renewable development must recognize conservation of the renewable resource base as the foremost priority.
- **Integrated Management** – All parts of the environment are interconnected and must be managed comprehensively.
- **Maximize Community Benefit** – Renewable and non-renewable resource development should be of maximum benefit to community residents, with priorities for Inuvialuit.
- **Protect Priority Community Activities** – Priority activities to be protected by the three CCPs are hunting, fishing, guiding, trapping, tourism and arts and crafts manufacturing.
- **Cooperative Management of Shared Resources** – The three Plans recognize the need for cooperation with respect to the management of migratory species, which are also used by other Inuvialuit and non-Inuvialuit.
- **Maintain a Healthy Environment** – The Inuvialuit of the three communities place a high priority on maintaining air and water quality and the health of natural resources.
- **Consistency** – The three CCPs should be consistent with the Principles of Wildlife Harvesting and Management from the Inuvialuit Final Agreement, the goals and principles of the Inuvialuit Renewable Resource Conservation and Management Plan (1988), the goals of the North Slope Wildlife Conservation and Management Plan (1993), the Regional Land Use Plan for the Mackenzie Delta-Beaufort Sea Region (1991), the Arctic Environmental Strategy (1991), and other conservation plans or agreements endorsed by the Community's representatives.

7.2.1.8 Sensitivity Layer Ranking

Populations that are concentrated for any part of the year (e.g., staging, moulting, and foraging areas) are vulnerable to site-specific threats because a significant proportion of the population could be affected. As well, populations that occupy geographically restricted habitats (rare, threatened or endangered species) are vulnerable if their habitats are threatened.

The concepts considered in developing the sensitivity rating included the life cycle and occurrence in the study area, the susceptibility to habitat change, the sensitivity to development; and the importance to Inuvialuit as a VSEC.

- **Low Sensitivity (1):** lands and waters where there are no known significant and sensitive cultural or renewable resources i.e., limited hunting interest. These were identified as Category A lands in the CCPs.
- **Low/Moderate Sensitivity (2):** lands and waters where there are cultural or renewable resources of some significance and sensitivity i.e., some hunting interest. These were identified as Category B lands in the CCPs.
- **Moderate Sensitivity (3):** lands and waters where cultural or renewable resources are of particular significance and sensitive to change during specific times of the year. These were identified as Category C lands in the CCPs.

- **Moderate/High Sensitivity (4):** lands and waters where cultural or renewable resources are of particular significance and sensitivity throughout the year. These were identified as Category D lands in the CCPs.
- **High Sensitivity (5):** represents lands and waters where cultural or renewable resources are of extreme significance and sensitivity. These were identified as Category E lands in the CCPs. This category recommends the highest degree of protection; there shall be no development on these areas.

A sensitivity layer for the combined VSEC attributes was produced with sensitivity ratings from 1 through 5 (Figure 7-2).

7.2.1.9 Climate Change

Despite changes in today's world, the importance of wildlife to Inuit remains as true as it ever was as a food source, a cultural source, a knowledge source, a spiritual and inspirational source, and a livelihood source. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and the abundance and population structure of some species. Because of the importance of belugas, migratory birds, and ringed seals as a principal food source or resource, there is concern regarding climate change and the resultant changes in sea ice and coastal habitat, which may eventually change animal movements, breeding and feeding behaviour, geographic ranges, and hunter access to the resource. Any reduction in abundance and distribution of these species would also lead to a change in dietary habits and cultural practices.

7.2.1.10 Summary

The hunting of polar bears, beluga whales, ringed seals, and migratory birds were identified as key socio-economic and cultural components within the study area. Hunting for these species continues to provide food and clothing for the three Inuvialuit communities in the study area. Thus, industrial development, such as oil and gas activity, must take all necessary steps to ensure that potential activity impacts do not interfere with the ability of northern aboriginal peoples to harvest wildlife.

File: 60866_O2_Fig_7-2_VSECSensitivity_4July07.mxd

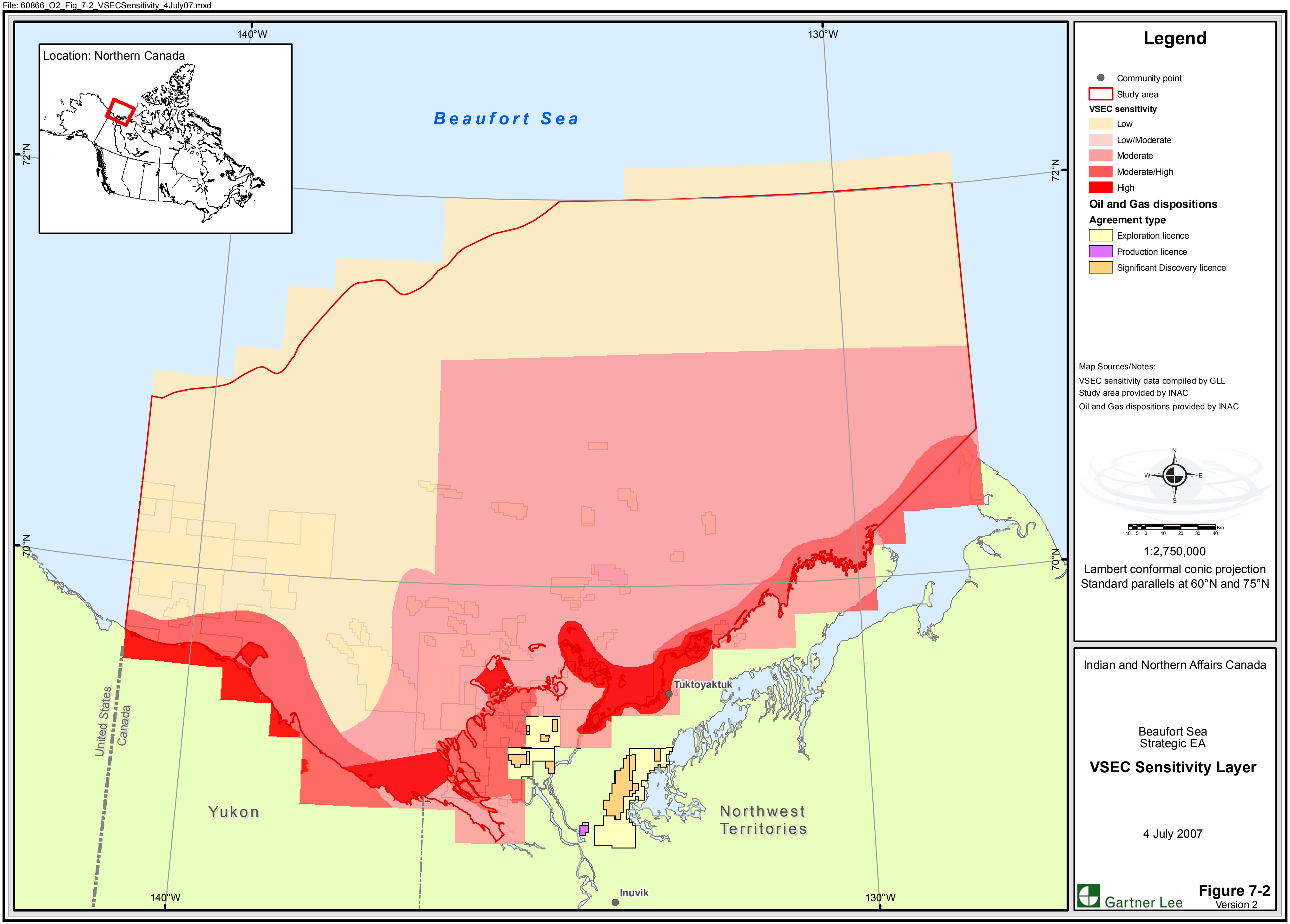

Figure 7-2
Version 2

8. Geo-Economic Layers

The geo-economic layer that resulted from the compilation of the development potential and uncertainty is depicted in Figure 8.1. The combined three scores for geological, economic, and uncertainty factors into five classes indicated that the eastern portions of the study area generally contained grid cells with the lowest development potential, and those cells just offshore and in the western portion of the study area below multi year pack ice were also rated low. Conversely, south-central areas (those areas directly north of and adjacent to the Mackenzie Delta) had the highest development potential, and much of the off-shore areas of multi-year pack ice were rated as Class 4.

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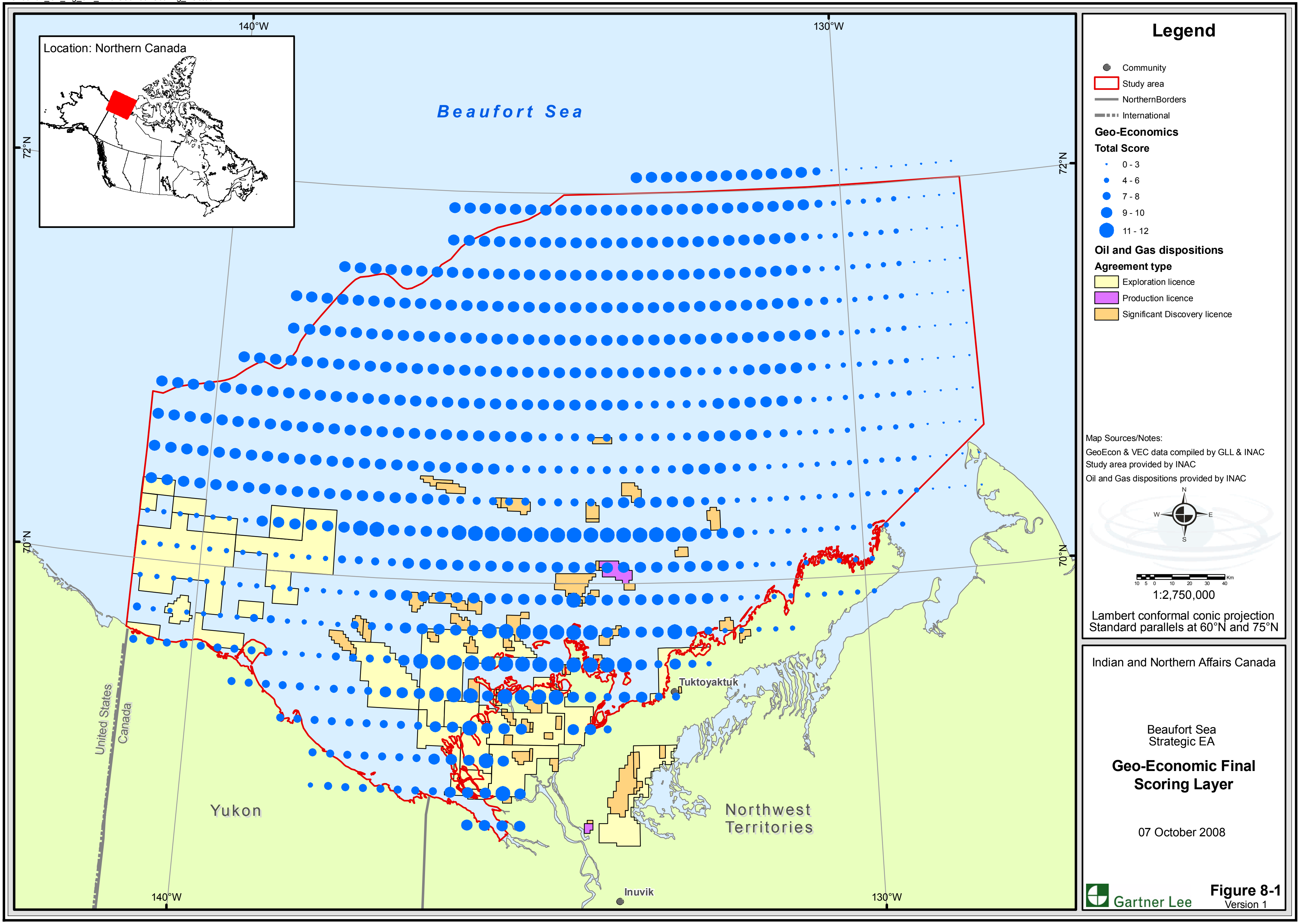

9. Development of Decision-Support Tool

9.1.1 Introduction

The decision support tool was developed as a means to amalgamate the attribute data for VEC/VSEC sensitivity and the geo-economic potential that underlies grid cells. The tool was built as a means to evaluate the extent and manner in which co-existing geological and environmental values occur in the oil and gas leasing framework in the Beaufort Sea. The tool is designed to be web-accessible to INAC users, and is built such that individual VEC and VSEC attributes can be evaluated solely or in with any combination of VECs, VSECs, or the geo-economic layer.

The development of the decision-support tool required that spatial and attribute information in digital format was first gathered and compiled. Following a review of project requirements and data inputs, internally-used study area data GIS layers were gathered from the NOGB project team. Data for the identified VEC and VSEC came from other known or identified sources held in various government departments and agencies, as well as from the Inuvialuit Joint Secretariat. A complete listing of data sources is available in Appendix B of this report. Where the information was not available electronically, it was digitized from published literature (listed in Table C-2 in Appendix C). The goal was to gather publicly available data layers and any associated attribute information from existing resources.

The overall steps involved in this preparation of data layers included the following:

- acquisition of base data and grid layer;
- acquisition of VEC and VSEC specific data;
- creation of sensitivity layers for VEC and VSECs;
- formula development to define grid layers from sensitivity layers; and
- creation of the geo-economic layer.

For the purpose of this project, the oil and gas leasing grid was used as the foundation for data summary and for the creation of the VEC, VSEC risk and geo-economic potential layers. The grids were prescribed in the *Canada Oil and Gas Land Regulations*, Section 4. Generally, the grids are spaced at an interval of 10 minutes of Latitude and 15 minutes of Longitude.

9.2 Grid Sensitivity Rating

9.2.1 Grid Application of VEC and VSEC Sensitivity Ratings

Sensitivity layers that had been developed for each of the VECs and VSEC were applied to the oil and gas leasing grids used by the NOGB. Grid sensitivity ratings provide a relative appreciation of the biological (highlights the most vulnerable and sensitive areas, seasonal distribution, and provides information on the potential response to change resulting from hydrocarbon activity), social or economic values within grid. As grid boundaries were based on latitude and longitude though, the resulting grid cells may have included portions of multiple sensitivity ranked layers (i.e., Class 4 and Class 3).

It was generally the intent to assign grid classifications using conservative criteria, due to the inherent variability in the natural system and to reflect uncertainties in spatial data. However, three alternate means of transferring a sensitivity layer values within a grid cell to an overall gird cell rating were prepared, so that the ratings may be manipulated to reflect more or less conservative approaches to the inherent variability of the sensitivity layer. Grid cells were made available to manipulations that reflected a scale of conservatism according to the percentage occurrence of a given sensitivity layer rating within each grid (defined as a maximum value, mean value, and ninety percent (90%) interval value, using the following sensitivity layer manipulations:

1. **Most Conservative** = The highest rating of sensitivity that occurs within the grid was selected to represent the entire grid, regardless of the percentage that that sensitivity layer occurs within the grid (so long as it does occur in the grid).

2. **Conservative** = Each grid was assigned the average value if more than one sensitivity rating falls inside the cell. The average value was not proportional to area. For example, if ratings 3, 4, and 5 were present in one cell, the average risk value was 4, with no consideration given to how much more of one risk layer is present over another.

3. **Least Conservative** = 90% interval calculation of the ratings for the grid generally assumes that a sensitivity rating must cover at least 90% of the grid; else the next lowest rating applied

Using the ‘Conservative’ option (i.e., the average value of sensitivity ratings with a grid cell ultimately produced the most practical outlay of grid ratings that reflected differentiation of sensitivity layers. That is, that option most closely mirrored the sensitivity layer. Figures 9-1 through 9-5 show the grid sensitivity rankings for each VEC and VSEC.

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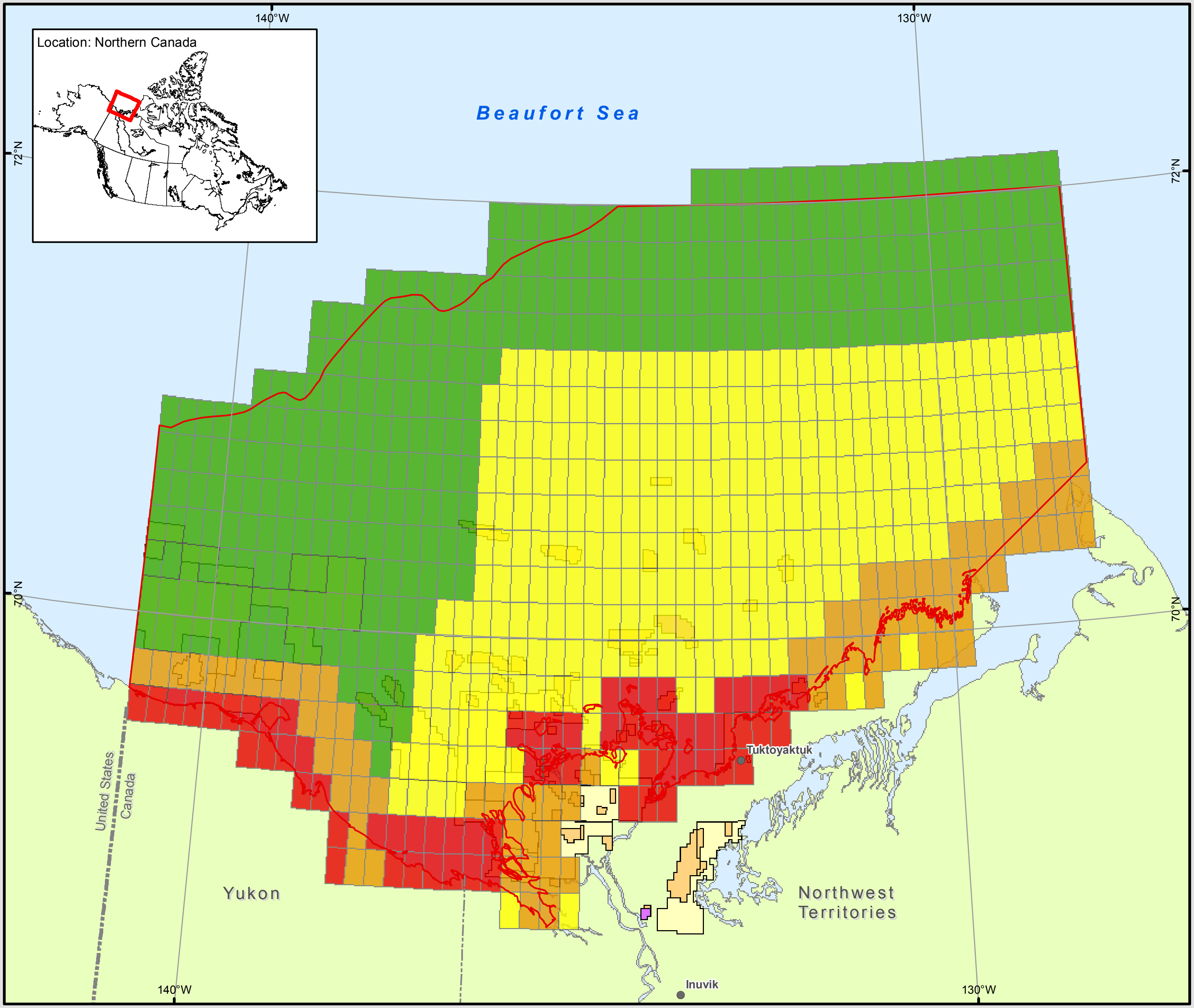


Legend

- Community point
- Study area

VSEC sensitivity

MAX value

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

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:
VSEC sensitivity data compiled by GLL
Study area provided by INAC
Oil and Gas dispositions provided by INAC

1:2,750,000
Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

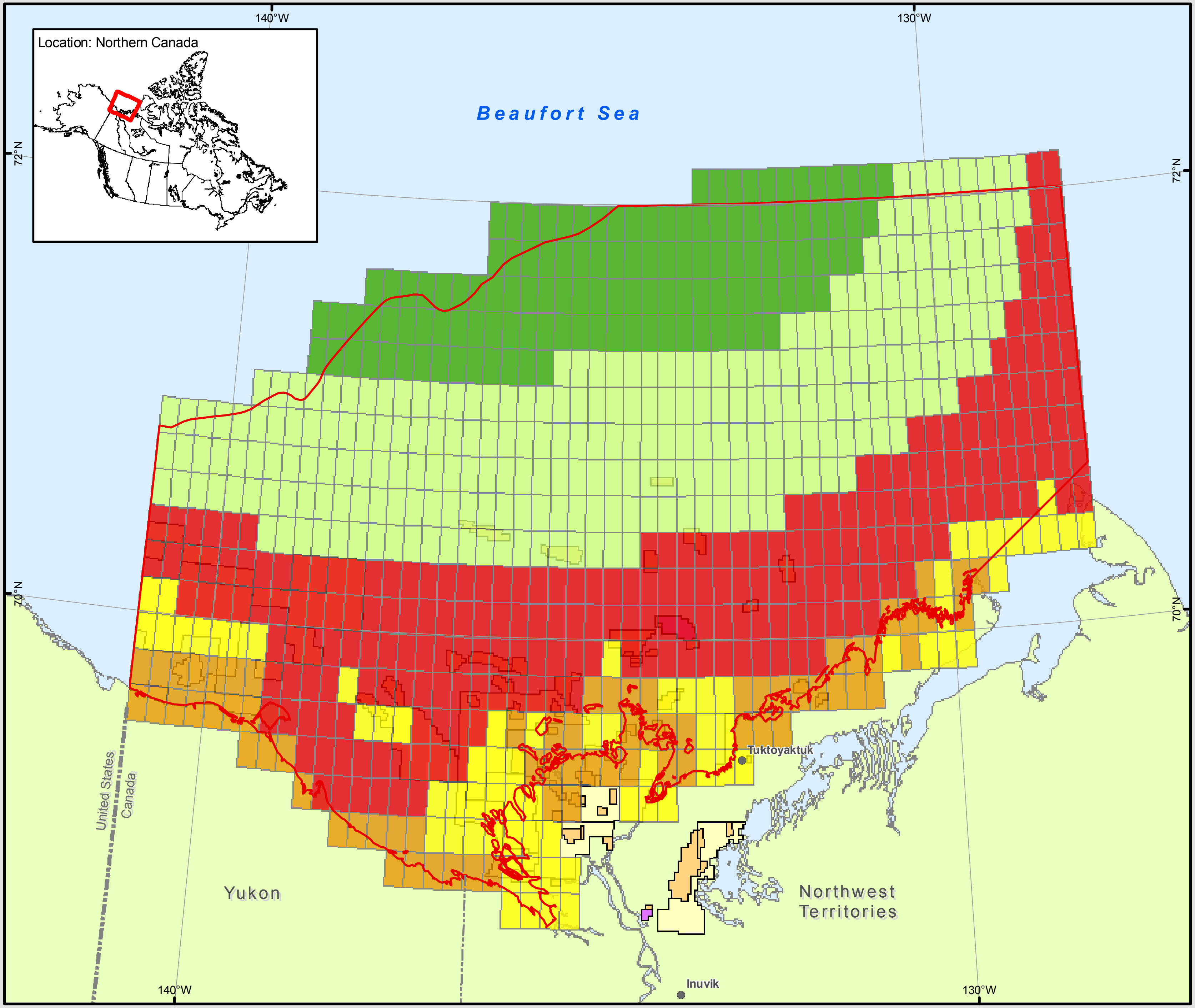
Grid Sensitivity Rating for VSECs

4 July 2007

Gartner Lee

Figure 9-5
Version 2

File: 60866_O2_Fig_9-4_RingedSealSensitivityMAX_22June07.mxd



Legend

- Community point
- Study area

Migratory bird sensitivity

MAX value

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

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:
Migratory bird sensitivity data compiled by GLL
Study area provided by INAC
Oil and Gas dispositions provided by INAC

1:2,750,000
Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

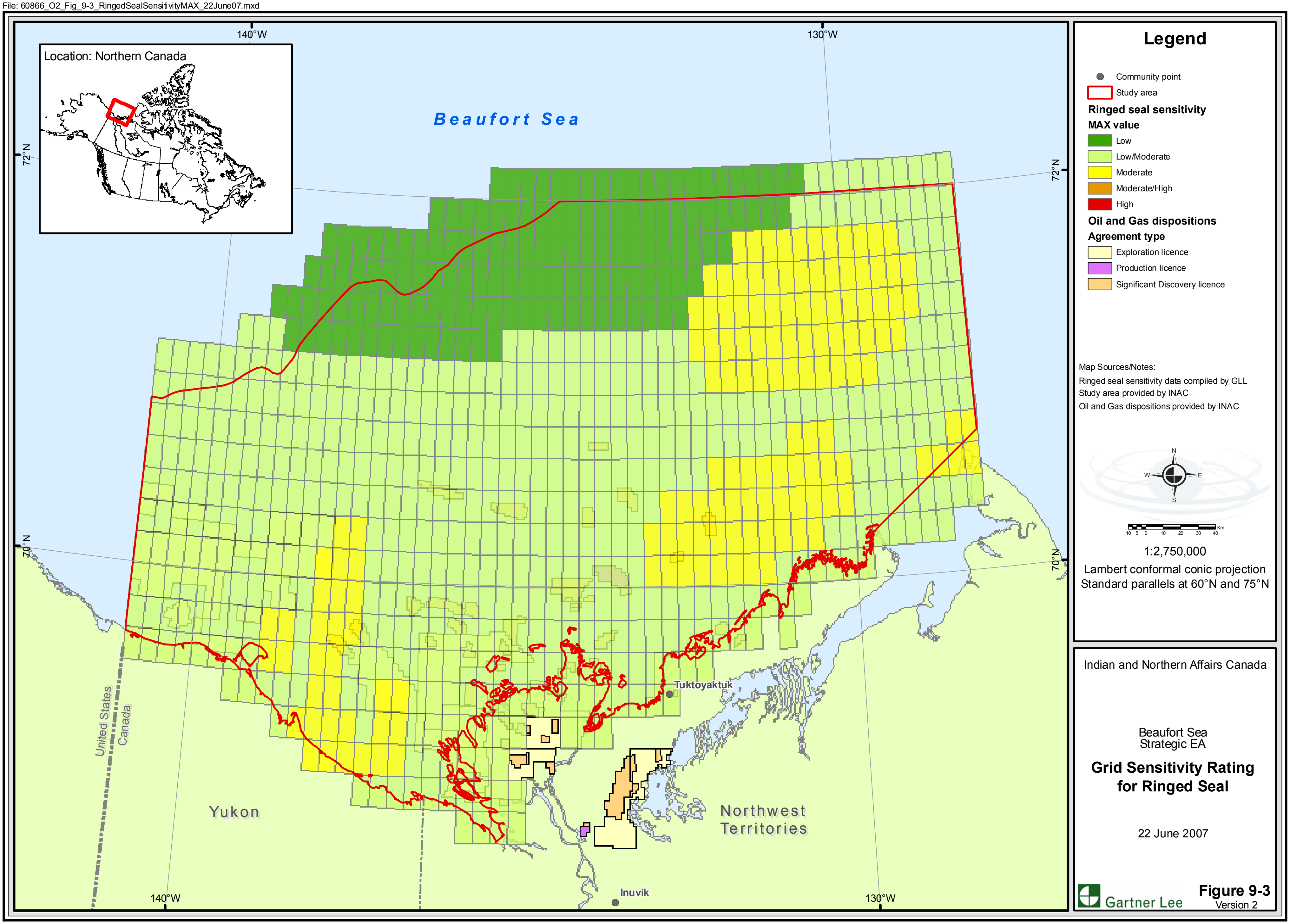
Grid Sensitivity Rating for Migratory Birds

25 June 2007

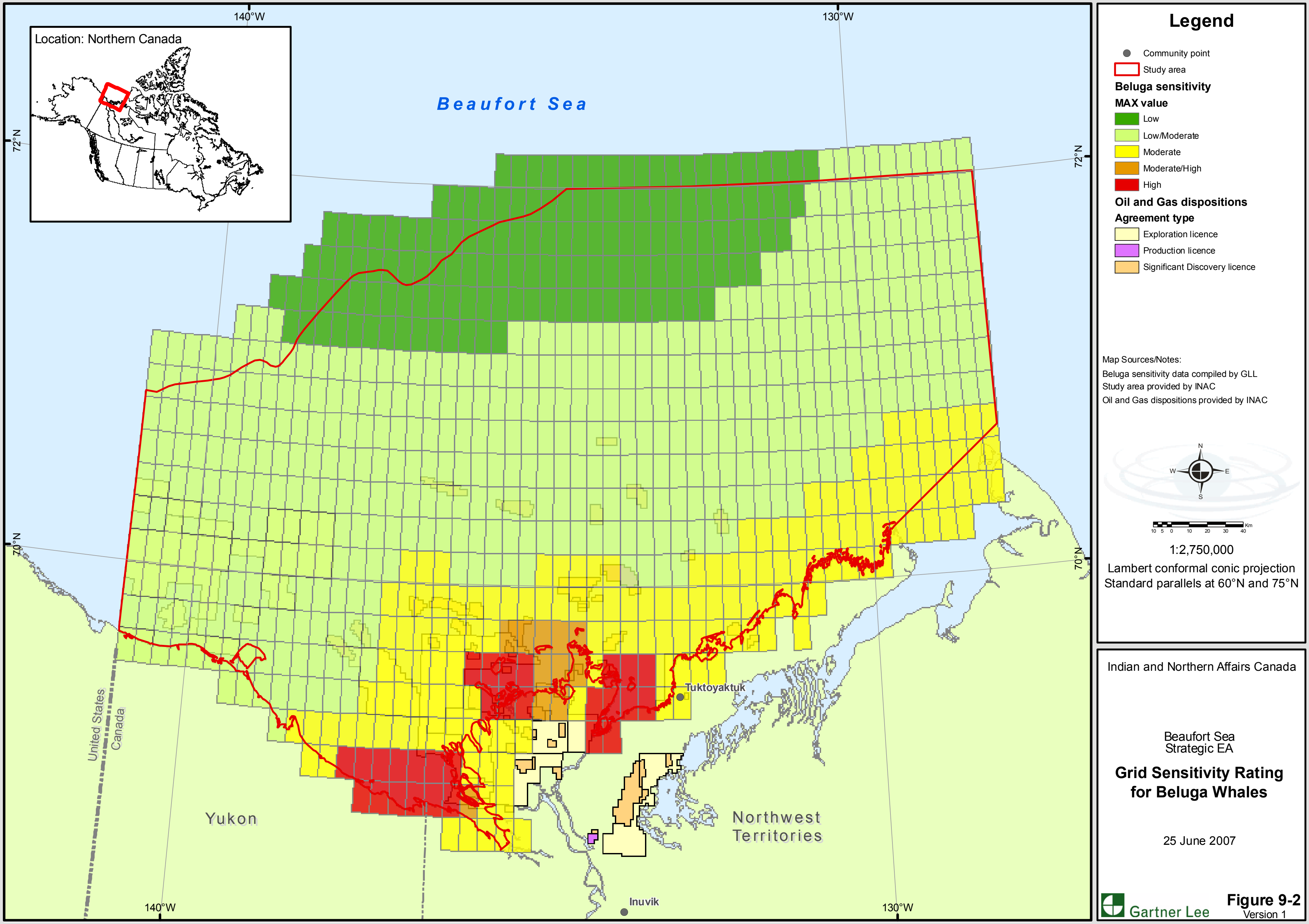
Gartner Lee

Figure 9-4
Version 2

File: 60866_O2_Fig_9-3_RingedSealSensitivityMAX_22June07.mxd



File: 60866_O2_Fig_9-2_BelugaSensitivityMAX_25June07.mxd



Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

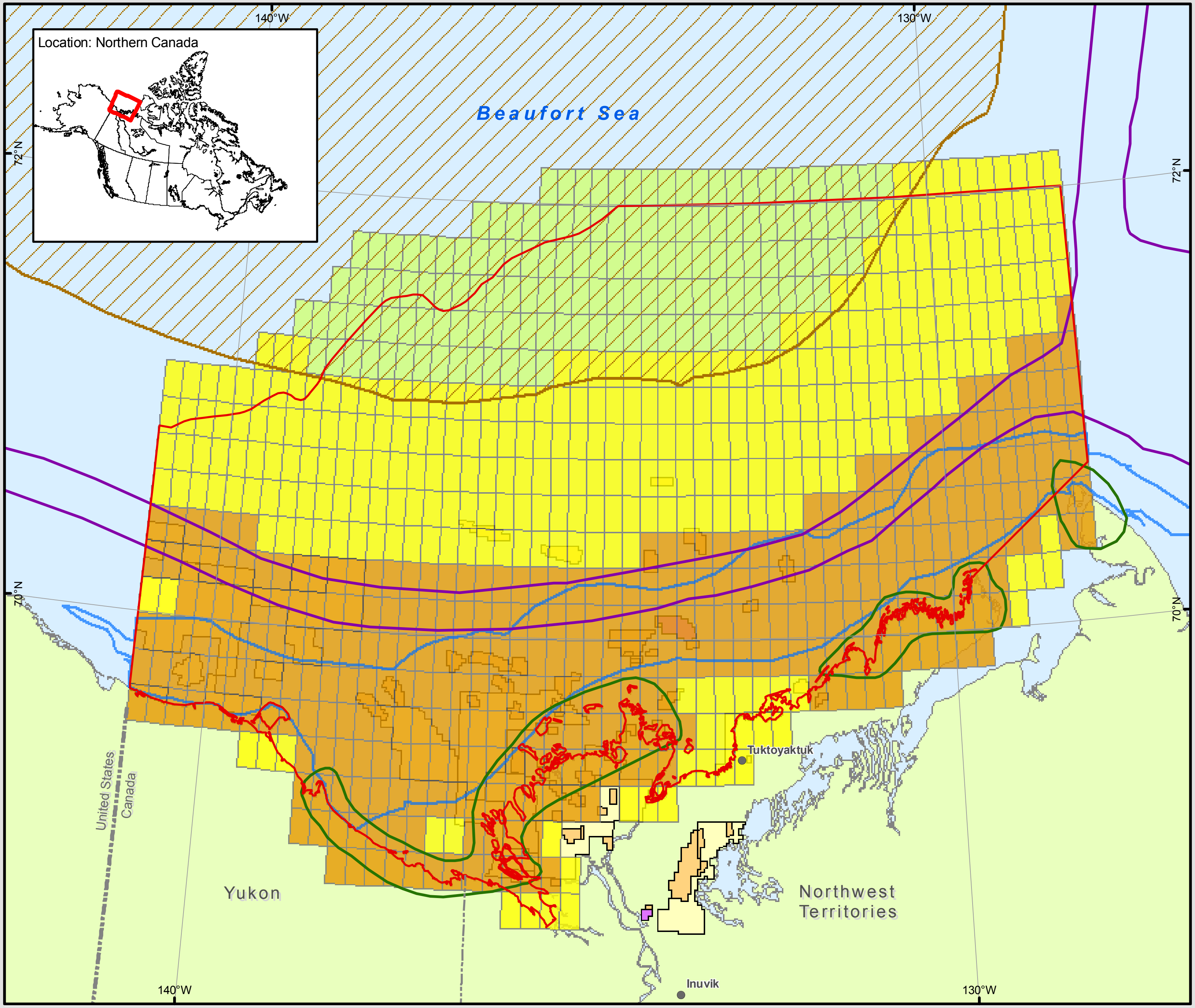
Grid Sensitivity Rating for Beluga Whales

25 June 2007

Gartner Lee

Figure 9-2
Version 1

File: 60866_O2_Fig_9-1_PolarBearSensitivityMAX_21June07.mxd



Legend

- Community point
- Study area
- Polar Bear Denning
- Cape Bathurst Polynya
- May Fast Ice
- Pack Ice Summer Limit, 300km North

Polar bear sensitivity

MAX value

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

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:

Polar bear sensitivity data compiled by GLL

Study area provided by INAC

Oil and Gas dispositions provided by INAC

N
W E
S

1:2,750,000

Lambert conformal conic projection

Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Grid Sensitivity Rating for Polar Bears

21 June 2007

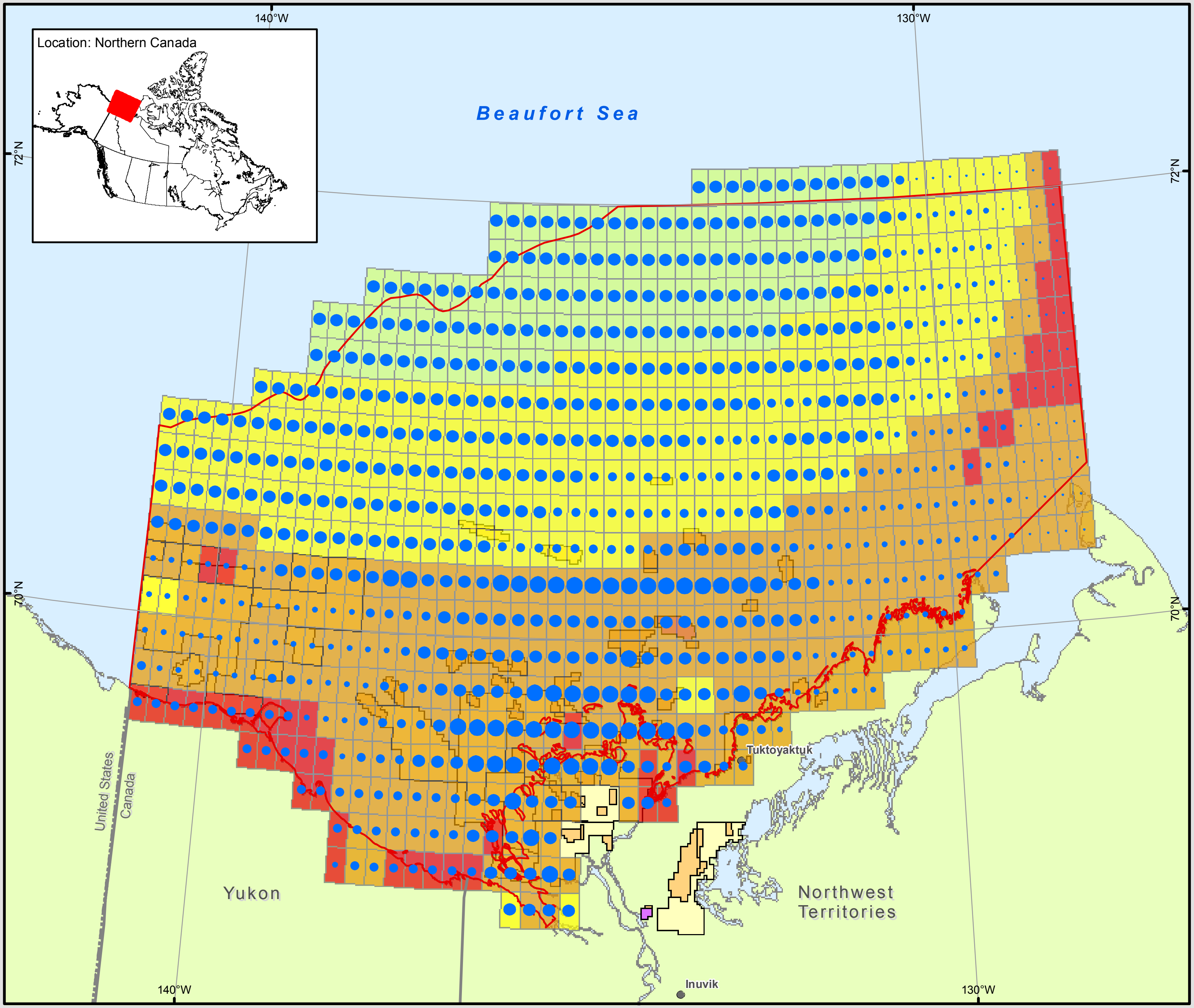
Gartner Lee

Figure 9-1

Version 2

The strength in the DST lies with the inclusion of geo-economic data and environmental sensitivity rating overlay. An example of the how the DST can be viewed is provided in Figure 9-6, whereby the VEC/VSEC layer was prepared using the average value for sensitivity rating of VECs/VSECs using the most conservative ranking of individual grid cells and an overlay of the geoeconomic layer. It is evident from that figure that more northern areas of the Beaufort Sea have higher geo-economic potential with relatively low environmental sensitivity, while the reverse is true for areas in the eastern areas of the study area.

File: 80197_C1_Fig_9-6_GeoEconVec_7Oct08.mxd



Legend

- Community point
- Study area
- NorthernBorders
- International

Geo-Economics

Total Score

- 0 - 3
- 4 - 6
- 7 - 8
- 9 - 10
- 11 - 12

VEC/VSEC Combined

MAX of AVG Scores

- 1 or less
- 1.01 - 2
- 2.01 - 3
- 3.01 - 4
- > 4

Oil and Gas dispositions

Agreement type

- Exploration licence
- Production licence
- Significant Discovery licence

Map Sources/Notes:

GeoEcon & VEC data compiled by GLL & INAC

Study area provided by INAC

Oil and Gas dispositions provided by INAC

1:2,750,000

Lambert conformal conic projection
Standard parallels at 60°N and 75°N

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Combined Grid Sensitivity Rating for VECs/VSECs and Geo-Economic Potential

09 October 2008

Gartner Lee

Figure 9-6
Version 1

10. Conclusion

The decision-support tool was developed to assist in the evaluation of options for oil and gas rights issuance in the Beaufort Sea for input into a Strategic Environmental Assessment (SEA). The tool allows the user to consider options for leasing areas to exploration after considering environmental sensitivities along with economic potential.

The development of the tool is a first step in a Strategic Environmental Assessment process. With added information, the tool could be used in cumulative effects assessment and further scenario development.

10.1 Cumulative Effects

Cumulative effects are the effects that remain after a change has occurred. Cumulative effects result from several projects and/or multiple activities taking place in the same time and space. Whether an activity takes place is dependent on economic conditions, government programs or policies (i.e., hunting regulations), etc. Contributors to cumulative effects are climate change, non-point source contaminants, and other trans-boundary effects. This tool has been designed to eventually contribute to CE evaluation.

Using the decision support tool in cumulative effects evaluation begins with gathering and building the VEC and VSEC data base. Concurrently, other layers may be added that reflect the sensitivity of the VEC/VSEC to oil and gas activity. This work begins with residual effects analysis.

10.1.1 Residual Effects

Project-level residual effects were considered in the development of the sensitivity layers. Based on what is known of project effects, the residual effects that are likely to span grids include spills and accidents, noise, and habitat change. Information on program and policy effects or trans-boundary effects was not collected.

10.2 Scenario Building

Once the appropriate information has been collected and there is broad agreement on the veracity of the residual effects information, then residual effect scenarios can be applied to a grid to gain an understanding of the changes that may occur to a sensitivity layer. The capacity to create different scenarios will require multi-party input on the exact nature of effects. Once there is agreement on the residual effects then the decision-support tool can be programmed for different scenarios to evaluate the sensitivity of VECs and VSECs to alternate development scenarios.

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Appendices

Appendix A

Summary of Residual Effects

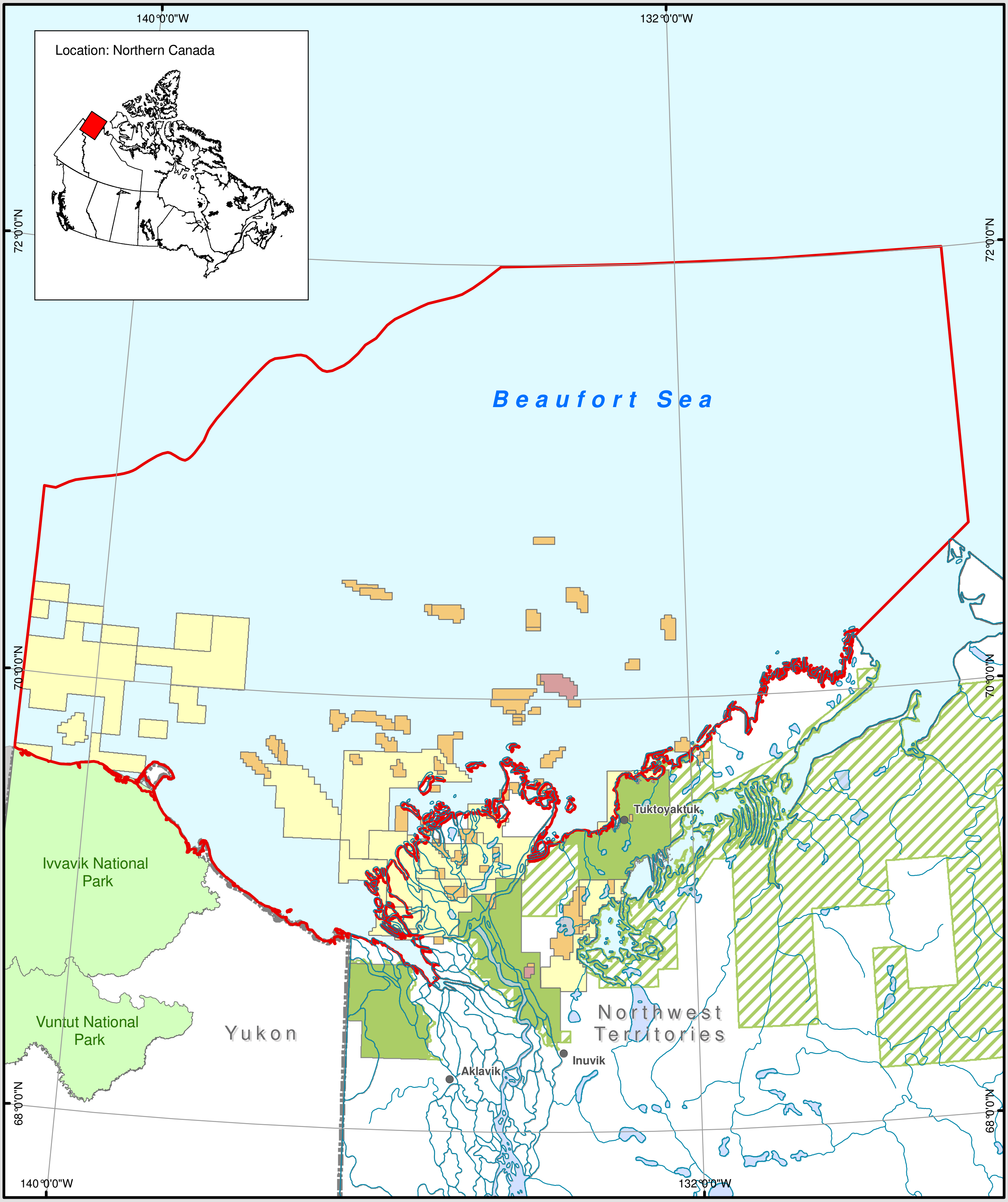
Appendix A

Summary of Residual Effects

Introduction

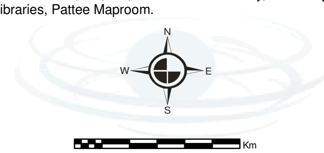
Numerous exploration projects have been completed in the Beaufort Sea – Mackenzie Delta region since oil and gas resources were first discovered over 40 years ago. The current oil and gas dispositions in the study area are shown in Figure A-1. An understanding of the residual effects (spatial and temporal) associated with these exploration projects will provide the opportunity to look at multiple activities in the study area in relation to important VEC habitat and asses whether special management action is needed. This will increase our ability to complete strategic level cumulative effects assessments, as well as improve leasing plans and resource management. In an effort to establish zones of influence for the environmental effects of offshore projects, several projects in the Beaufort Sea – Mackenzie Delta region were reviewed, as well as material from other regions where off-shore drilling has taken place. These include:

- Devon Canada Corporation regarding the *Comprehensive Study Report Devon Beaufort Sea Exploration Drilling Program* (Devon Canada Corporation 2004).
- The Federal Environmental Assessment Panel regarding the *Beaufort Sea Hydrocarbon Production and Transportation* proposal (FEARP 1984).
- The Environmental Impact Review Board regarding the *Public Review of the Esso Chevron et al Isserk I-15 Drilling Program* (EIRB 1989).
- The Institute of Ocean Sciences regarding the Review of Models in Support of Oil and Gas Exploration off the North Coast of British Columbia (Foreman *et al*. 2005).
- Dome Petroleum Ltd, Esso Resources Canada Ltd and Gulf Canada Resources Inc., regarding *Hydrocarbon Development In The Beaufort Sea – Mackenzie Delta Region* (Dome *et al*. 1982).
- Fisheries and Oceans Canada regarding the Implications of Ecosystem Dynamics for the Integrated Management of the Eastern Scotian Shelf (Zwaneburg *et al*. 2006).
- Environmental Impact Review Board regarding the *Public Review of the Gulf Canada Resources Limited Kulluk Drilling Program 1990 – 1992* (EIRB 1993).
- Stanislav Patin book regarding *Environmental Impact of the Offshore Oil and Gas Industry* (Patin 1999).
- Northern Oil and Gas Directorate regarding the Economic and Strategic Significance of Petroleum Resources Potentially Affected by a Marine Protected Area in the Beaufort Sea (Morrell 2003).
- Department of Fisheries and Oceans (DFO) regarding the Review of Scientific Information on Impacts of Seismic Sounds on Fish, Invertebrate, Marine Turtles and Marine Mammals (DFO 2004).



Map Sources/Notes:

Oil and gas rights obtained from Indian and Northern Affairs Canada.
Base data 1:2,000,000; Penn State University, University Libraries, Pattee Maproom.



1:2,750,000

Lambert conforal conic projection
Standard parallels at 60°N and 75°N

Legend

Oil and Gas Rights

- Exploration Licence
- Significant Discovery Licence
- Production Licence
- Surface owners are First Nations
- Subsurface and surface owners are First Nations

Other Features

- Community
- Watercourse
- Waterbody
- National Park
- Provincial Boundary
- Study Area

Indian and Northern Affairs Canada

Beaufort Sea
Strategic EA

Oil and Gas Dispositions in the Beaufort Sea

25 June 2007

Gartner Lee

Figure A-1
Version 1

File: 60866_C1_Fig_A-1_OilGasDepositions_25Jun07.mxd

Although numerous reports and sources were reviewed, information regarding development-related residual effects in the Beaufort Sea was limited. As a result, zones of influence for potential residual effects were largely based on estimates provided in the Devon Canada Corporation Comprehensive Study Report of the Beaufort Sea Exploration Drilling Program. As such, this summary of residual effects in the Beaufort Sea is intended as first step towards a larger and more comprehensive study.

For the purposes of this report, information regarding residual effects was identified, analyzed and categorized based on disturbance type. The Devon Canada Corporation (2004) report included potential effects to several animals that were not listed as VECs in this report, including Arctic fox, benthic invertebrates, humans, plankton, reefs and water quality. The information is summarized in Table A-1.

Table A-1. Potential Residual Effects, Sources and Categories Related to Oil and Gas Development

Potential Residual Effects Category	Potential Source of Residual Effects	Potential Residual Effect
Drilling Waste Products	Drilling Muds (Oil & Water-based) Produced Water Cuttings Toxins (heavy metals, barium, hydrocarbons, etc.)	Poisoning Tainting Smothering
Other Miscellaneous Releases	Food Waste Sewage Disposal Spills (oil, organochlorines, ethylene glycol)	Animal Attractant Poisoning
Seismic Activity	Seismic Waves / Energy Pulses	Pressure Differentials Sound Bursts Mortality (i.e., fish)
Localized Disturbances	Drill Platform (Staging, Mobilizing, Set Down, Storage) Drill Ships Ice Pad & Ice Road Construction Pipe-laying Support Facilities Construction	Localized Disturbance of on-ice and underwater habitat Animal avoidance
Noise	Drilling Flaring Construction (Ice Pad, Ice Road, Pipe-laying, Support Facilities) Marine Transport Air Transport (Landings, Takeoffs, Flyovers) Road Transport	Noise Disturbance Animal avoidance
Light	Fixed & Portable Lights Flaring	Animal Attractant Chemical Residues

Drilling Waste Products

Various types of drilling fluids (i.e., mud) can be used for offshore operations, including oil-based, synthetic based and water-based[3] fluids (Table A-1). It's predicted that oil-based drilling muds will have no residual effects beyond a 1.5 km radius from the discharge source that would affect fish and fish habitat, and the effects are expected to persist for less than three years (Devon Canada Corporation 2004). The Department of Fisheries and Oceans (DFO) found various re-suspended drilling mud up to 10 km from the discharge source (Zwanenburg *et al.* 2006). The effect of smothering from various drilling muds was found to be proportionate to the size of the release (DFO 2004).

Toxins from cuttings have been found up to 10 km from the discharge source in benthic invertebrate samples (Patin 1999). Heavy metals and barium distribution in bottom sediments was found to result in concentrations 100 to 1000 times higher than background levels characteristic in benthic invertebrate communities (Patin 1999). Tainting was observed up to 500 m from the discharge source and the potential residual effects to fish and fish habitat are predicted persist for less than one year (Devon Canada Corporation 2004; Zwanenburg *et al.* 2006).

Produced water, which can include metals and hydrocarbons, are predicted to produce no residual effects beyond a 1.5 km radius that would affect fish and fish habitat and these effects are expected to persist for less than three years (Devon Canada Corporation 2004).

Other Miscellaneous Releases

Other miscellaneous releases that have been known to be associated with offshore oil and gas activities include food waste, sewage discharge, ethylene glycol, organochlorines and other typical household wastes (e.g., plastics, paper, glass) (Table A-1). Oil spills are discussed separately below. These compounds can potentially be consumed either directly or indirectly by polar bears or other species (Perham 2005). The release of sewage waste into the aquatic environment has been shown to stimulate algae growth (Devon Canada Corporation 2004; Patin 1999). It's predicted that they will not produce any residual effects beyond a 1 km radius from the discharge source and that these effects would persist less than one year (Devon Canada Corporation 2004). Flaring activities have been found to produce residual chemical effects, whereby ice surfaces around flaring sites tended to be polluted by atmospheric fallout of heavy oily residue (Patin 1999).

Oil Spills

Oil spills and other hydrocarbon releases can have similar potential effects as other miscellaneous releases discussed above (Table A-1). Oil Spills and other hydrocarbon releases can be lethal to species exposed through consumption of contaminated prey, grooming and inhalation of vapours. These releases can also have indirect effects such as a loss of or redistribution of prey species. Finally, spills may affect species movements; such that there could be increased bear-human interactions (Devon Canada Corporation 2004; Perham 2005). The potential residual effects

[3] To date, not all of these have been used in the Beaufort off-shore.

associated with a tanker spill vary greatly and are dependent on many variables (Devon Canada Corporation 2004; Patin 1999). The composition and size of the release, distance from shore, ocean currents, response time and time of year all influence the potential for a tanker spill to produce measurable effects on its surrounding environment (Patin 1999). One ton of released oil can disperse over a 50 m radius with a 10 mm thick film in 10 minutes, and can eventually cover a 12 km^2 area with a 1 mm thick film (Patin 1999). Studies on the residual effects of a tanker spill on marine birds and mammals show that optimal population abundances can be restored several years following a spill (Patin 1999). Although large catastrophic spills have occurred, the risk is greatly reduced with appropriate mitigation.

Seismic

Available information regarding the potential biological effects of seismic activities on marine organisms was limited and somewhat contradictory, and quantitative assessments of such impacts on the total stock and reproduction of fish populations are not available (Patin 1999). Norwegian research results indicated that school pelagic fish (especially herring) responded to a seismic signal 100 km from the discharge source (Dalen and Knutsen 1997), while studies found a 90% mortality of larvae, fry and adult fish within a radius of 2 m from the seismic wave (Matishov 1992). However, other research has found that seismic activity has not produced effects beyond an 8 m radius from the waves that would adversely affect fish and fish habitat (Patin 1999). Due to the incomplete and contradictory nature of the available information, a more comprehensive study is required.

Localized Disturbance

Localized disturbances linked to oil and gas development include drill platforms, ice pads and ice roads (Table A-1). Drill ships are discussed separately below. These activities can result in smothering, localized changes in habitat and displacement. The effects of these activities vary with the receiving VEC. The extent of the effects is dependent on the size and scale of the operation under consideration. Activities from drill platforms are predicted to produce no residual effects to habitat beyond a 1 km radius that would fish and fish habitat, beluga whales or sea birds (Devon Canada Corporation 2004). The effects to fish and fish habitat are expected to persist for less than three years, while the effects to beluga whales and sea birds are expected to persist for less than one year. The construction of ice roads is predicted to produce no residual effects beyond a 50 km radius that would affect polar bears and ringed seals and beyond a 1 km radius that would affect fish and fish habitat (Devon Canada Corporation 2004). The effects to polar bears, ringed seals, and fish and fish habitat are expected to persist for less than one year. Potential residual effects associated with seabed heating from pipelines include accelerated biological processes that could potentially lead to reductions in dissolved oxygen. However, studies have not been conducted to determine the magnitude of any impacts from seabed heating (Patin 1999).

Drill Ships

In areas where floe ice and icebergs present dangers, mobile drilling platforms are used to avoid ice collisions. Platforms include drilling ships or semi submersible rigs (i.e., platforms mounted on submerged, neutrally buoyant pontoons, which are anchored or positioned by motors over the drill site). Starting in the mid 1976, Dome Petroleum (Canmar) utilised floating drill ships during summer months in the Beaufort Sea (Timco and Johnston 2002). In 1983, Gulf Canada Resources Ltd. designed and built an inverted cone shaped floating structure (the “Kulluk”) that allowed drilling later into the winter season (Timco and Johnston 2002). These impacts are associated with drilling activities such as drilling waste products and potential oil spills, as well as those associated with movement to and from the drilling site such as noise from marine vessels. Localized disturbance impacts are similar to those from drill platforms discussed above.

Noise Sources

Noise sources from oil and gas development include ice pad, ice road, pipe-laying and support structure construction, drill rig operations, flaring, marine transport activities and air and road transport activities (Table A-1). Effects associated with noise are often temporary (i.e., marine transport activities) but can also be persistent (Devon Canada Corporation 2004; citations within Moulton *et al.* 2003; Erbe and Farmer 1998; Fast *et al.* 1998; Harwood and Smith 2002; Perham 2005; Richardson *et al.* 1995). In either case, behavioural adjustments of different magnitudes are observed and can range from avoidance to habituation. Devon Canada Corporation (2004) predicted that noise from marine transport activities would produce no residual effects beyond a 50 km radius from the marine transport vessel that would affect beluga whales or ringed seals. The effects to beluga whales are predicted to persist for less than one year, while the effects to ringed seals are predicted to persist for less then two days. At its most extreme, noise can potentially affect beluga whales by interfering with mating behaviours, communication and even cause damage to ears or other organs (Erbe and Farmer 1998).

Light Sources

Light sources from oil and gas development include portable and fixed lights, as well as flaring (Table A-1). Light sources are predicted to have limited residual effects beyond a 1 km radius, for no longer than two days, for temporary operations (Devon Canada Corporation 2004). Facility lights were identified as a potential attractant for polar bears; however, studies conducted in Canada indicated that bears were not attracted to areas lit with high intensity lights. Thus the evidence of impacts of the facility lights is limited and unclear (Perham 2005).

Biodiversity Changes

Residual effects associated with the exploration, development and production phases of oil and gas reserves have the potential to produce changes in biodiversity (Devon Canada Corporation 2004; Patin 1999). These effects can potentially reduce productivity in benthic invertebrate communities and may persist for several years (Devon Canada Corporation 2004). This can potentially produce a shift in plankton and algae towards waste tolerant species (Devon Canada Corporation 2004).

Appendix B

Selected Literature Reviewed for VEC Selection

Appendix B

Selected Literature Reviewed for VEC Selection
All Documents Reviewed

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Appendix C

Valued Ecosystem Components and Socio-Economic Components Selection Process

Appendix C

Valued Ecosystem Components and Socio-Economic Components Selection Process

VEC's and VSEC's historically identified and used within the Mackenzie Delta and Beaufort Sea Region

Mammals

- Polar Bears
- Grizzly Bears
- Black Bears
- Reindeer
- Caribou
- Moose
- Muskrat
- Arctic Fox
- Wolf
- Marten
- Lynx
- Dall Sheep
- Ringed Seal
- Bowhead Whale
- Bearded Seal
- Narwhal
-

Birds

- Lesser Sow Goose
- Greater White Fronted Goose
- Common Eider
- King Eider
- Oldsquaw (long-tailed duck)
- Glaucous Gull
- Arctic Term
- Brant Goose
- Red Throated Loon
- Scoter
- White Winged Scoter
- Long Tailed Duck
- Lesser Scaup
- Pacific Common Eider
- Jaeger
- Murre
- Common Raven

Fish

- Arctic Cisco
- Lest Cisco
- Fourhorn Sculpin
- Arctic Char
- Arctic Cod
- Broad Whitefish
- Lake Whitefish
- Pacific Herring
- Inconnu
- Rainbow Smelt
- Blackline Prickleback
- Arctic Flounder
- Starry Flounde

Geographic Feature

Polyna

Socio-Economic

Economic Potential
Hunting
Trapping
Fishing
Transportation / Access

<u>VECs and VESCs Selected for the Beaufort Sea Study Area</u>

- Polar bear
- Beluga whale
- Ringed seal
- Migratory birds
- Hunting

Geo Referencing Parameters

Geographic coordinates were referenced to North American Datum 1927, Clark 1866 using a Lambert Conformal Conic Projection (INAC 2006d, detailed in Appendix D).

Projected Coordinate System:	North_America_Lambert_Conformal_Conic
Projection:	Lambert_Conformal_Conic
False_Easting:	0.00000000
False_Northing:	0.00000000
Central_Meridian:	-134.00000000
Standard_Parallel_1:	60.00000000
Standard_Parallel_2:	75.00000000
Latitude_Of_Origin:	50.00000000
Linear Unit:	Metre
Geographic Coordinate System:	GCS_North_American_1983
Datum:	D_North_American_1983

Acquisition of Electronic Data

All spatial data was requested in a format compatible with commonly used GIS software programs (i.e., ESRI ArcGIS shapefile format). Where the data requested was not available in digital format, or were not accessible within the timeline of this project, the information was digitized where possible and appropriate (Table C-1). This was done in a desktop GIS environment. Some spatial information was not geo-referenced (i.e., CorelDraw file had to be manually geo-referenced for use).

Table C-1. Electronic Data Acquired for the Bequfort Sea Strategic Environmental Assessment Project

Source	Contact	Data Supplied	No. of layers
INAC – NOGB	Anthony Tucker and INAC website download	Oil and gas grid Study area baseline Oil and gas dispositions/existing licenses Settled land claims Economics/Socio-Economic	8+
National Energy Board	Via Anthony Tucker	Wells (current and historic)	1
Environment Canada Canadian Wildlife Service	Samuel Kennedy	Migratory bird habitat layers	10
Department of Fisheries and Oceans	Humfrey Melling Pierre Richard	Seasonal limits of landfast ice Beluga tracking data	3
Natural Resources Canada	Walta-Anne Rainey Scientific Technical Support	Coastline detail Artificial islands Pingo-like formations (mud volcanoes)	3
INAC Yellowknife - Geomatics	Anthony Tucker: INAC NOGB	1:250 NTDB** CANMATRIX CANIMAGE orthophotos	194
Inuvialuit Joint Secretariat	Public web site download www.jointsecretariat.com	All CCP GIS layers	122

*** Note: 1:50K data received but only 1:250K data was used.*

Table C-2. Digitized Data and Source

Source of Digitized Data	Data Supplied	No. of Layers	Layers
Figure 1 in the proposed MPA for the southeastern Beaufort sea	Beluga Mating/Moulting (Sens 4)	1	BelugaMatingMoulting
Figure1 in *Arctic* Vol. 55, p. 61, Ian Sterling	Average summer limit of pack ice	1	PackIceSummer Limit
Figure 1 in *Arctic* Vol. 55, p. 61, Ian Sterling	Cape Bathurst Polynya (Sens 4)	1	PolarBearPolynya
Figure 3 in Areas of Summer bowhead whale concentration	Seal Foraging (Sens 3)	1	Seal Foraging
F.3 Figure MB4, Modified from Dixon et al 1994	Anomalies data (Undrilled, Oil&Gas, Dry and Abandoned, Wells, Beaufort Regions	5	AnomaliesAbandoned Dry, AnomaliesOilGas, AnomaliesUndrilled, BeaufortRegions, WellsAnomaliesMap

Challenges with Acquiring Data

Acquisition of data for this project commenced in September 2006 and continued to March 2007. The majority of data was collected in January and February 2007. The difficulty in obtaining data included the need to develop intra-departmental data sharing agreements, availability of data during the timeframe of the project and the nature of the data (digital or not digital). Overall, the constraints in accessing data slowed the development of the decision-support tool and limited the number of sensitivity layers that could be created. Some data requested was available during the time frame needed to complete the decision-support tool. This information was recorded and can be used for any updates to the tool.

Base and Grid Layers

The development of the decision-support tool began with the compilation of base data relevant to each sensitivity layer (Table C-3). These data included coastline information, location of protected areas, location of communities, etc.

Table C-3. Base Layers Used

Layer Name	Source	Description
Beaufortcoast.shp	INAC -NOGB	Beaufort Sea Coastline
Study_area.shp	INAC -NOGB	Study area boundaries
communities.shp	INAC -NOGB	Communities in the Study Area
NWT_protected_areas.shp	INAC -NOGB	NWT Protected Areas
territorial_parks.shp	INAC -NOGB	Territorial Parks
nwtwellscurrent.dbf	INAC -NOGB	NWT current wells
FreshSalt_boundary.shp	INAC -NOGB	Freshwater/saltwater boundary line
settled_land_claims.shp	INAC -NOGB	Settled land claims
area_subject_to_work_prohibitions.shp	INAC -NOGB	Areas subject to work prohibitions
10lat15long.shp	INAC -NOGB	Oil and Gas Grid - original, no UGI, no area

Valued Ecosystem and Valued Socio-Economic Data

The data acquired for the development of the sensitivity layer is summarized in Table C-4.

Table C-4. Data Acquired to Develop the Sensitivity Layers

Layer Name	Source	Description
seal_foraging.shp	(Digitized)	Seal Foraging (areas of summer bowhead concentration)
Average_sum_ice_pack_limit.shp	Sterling (Digitized)	Average summer pack ice southern extent
323c.shp	Inuvialuit Joint Secretariat	Mainland Coastal Polar Bear Denning Areas
fasticeedge1may1980-2003.shp	DFO British Columbia	Land fast ice edges Northern and southern most extents May 1980-2003
polynya.shp	Sterling (Digitized)	Cape Bathurst Polynya
711e.shp	Inuvialuit Joint Secretariat	Beluga Management Zone 1A
beluga_risk4_digitizedbySK.shp	Digitized by GLL	Beluga mating and moulting
712c.shp	Inuvialuit Joint Secretariat	Beluga Management Zone - Mackenzie Shelf Waters < 20m
keynestingareas_pnts.shp	EC-CWS Yellowknife	Migratory birds- Key nesting points
710cd.shp	Inuvialuit Joint Secretariat	Coastal Zones of the Tuktoyaktuk Peninsula, Liverpool Bay, Wood Bay, Baillie Islands
KeyMoltingAreas.shp	EC-CWS Yellowknife	Migratory birds - Key molting areas
kibs_boundary.shp	EC-CWS Yellowknife	Migratory birds – KIBS Boundary
726d.shp	Inuvialuit Joint Secretariat	Yukon North Slope Coastal Zone
keynestingareas.shp	EC-CWS Yellowknife	Migratory birds – Key nesting areas

Layer Name	Source	Description
CWS_Key_Terrestrial_Habitat_Sites_NWT.shp	EC-CWS Yellowknife	Key migratory bird terrestrial sites - NT and NU
Key Marine Areas_NT-NU.shp	EC-CWS Yellowknife	Migratory birds Key marine areas - NT
KeySpringStagningAreas_poly.shp	EC-CWS Yellowknife	Migratory birds - Key spring staging areas
beaufort_seabed_morphology_5m.shp	NRCan	Beaufort Sea seabed morphology in 5m isobaths
301c.shp	Inuvialuit Joint Secretariat	Spring Seal Harvesting Areas
311c.shp	Inuvialuit Joint Secretariat	Fall Seal Harvesting Area
313c.shp	Inuvialuit Joint Secretariat	Winter Seal and Polar Bear Harvesting Area
403c.shp	Inuvialuit Joint Secretariat	Spring Seal and Polar Bear Harvesting Area
414c.shp	Inuvialuit Joint Secretariat	Winter Seal and Polar Bear Harvesting Area

Creation of the Geo-Economic Layer

The data acquired for the development of the geo-economic layer is summarized in Table C-5.

Table C-5. Data Acquired for the Geo-Economic Layer

Layer Name	Source	Description
BasinalFaciesPlay.shp	INAC -NOGB	Basinal Facies play boundary
DeepWaterPlay.shp	INAC -NOGB	Deep Water play boundary
KugmallitDeltaPlay.shp	INAC -NOGB	Kugmallit Delta play boundary
RiftedMarginPlay.shp	INAC -NOGB	Rifted Margin boundary
TagluDeltaPlay.shp	INAC -NOGB	Taglu Delta boundary
WestBeaufortPlay.shp	INAC -NOGB	West Beaufort Sea boundary
pipe_2001_macdel_jfs.shp	INAC -NOGB	Mackenzie gas pipeline
0506c.shp	INAC -NOGB	Oil and Gas Dispositions

Appendix D

List of Contacts and Data Sources

Appendix D

List of Contacts and Data Sources

Government of Canada departments and agencies contacted to supply data and GIS layers included the following:

Department of Fisheries and Oceans
Humfrey Melling
Arctic Aquatic Research Division
Central & Arctic Region
Fisheries and Oceans Canada
501 University Crescent, Winnipeg, Manitoba R3T 2N6
Government of Canada

Institute of Ocean Sciences
Pierre Richard
State of the Ocean
Pacific Region
9860 West Saanich Road
PO Box 6000
Sidney, British Columbia V8L 4B2

Fisheries and Oceans Canada
Lois Harwood
Yellowknife Office
Central & Arctic Region
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Natural Resources Canada
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Natural Resources Canada
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Geologic Survey of Canada
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National Energy Board
Lori-Ann Sharp
444 7th Avenue SW
Calgary AB, T2P 0X8
1-800-899-1265

Indian and Northern Affairs Canada, Gatineau
Northern Oil and Gas Branch
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Gatineau, Quebec
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Ottawa, Ontario, K1A 0H4