Working Document

BEAUFORT SEA INTEGRATED MANAGEMENT PLANNING INITIATIVE (BSIMPI): COASTAL RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The objective of integrated management is to replace the current fragmented approach to ocean management with a more collaborative and coordinated approach. Canada's Beaufort Sea is a high priority area in which to implement oceans management activities because of: the existence of co-management structures under comprehensive land claim settlement with the Inuvialuit; well-established subsistence fish and marine mammal resource harvesting; the Beaufort Sea Beluga Management Plan, and other western Arctic management plans; and significant renewed interest in oil and gas resource development. The existing co-management structures in place provide opportunities to develop or enhance models of oceans governance appropriate to Canada's north.

The Beaufort Sea Integrated Management Planning Initiative (BSIMPI) is being developed with the Inuvialuit in accordance with the Inuvialuit Final Agreement and DFO Integrated Management Planning Framework. The planning process is operating at two levels, the large ocean area scale of the Beaufort Sea and smaller community-based initiatives nested within the larger area. Specifically, the process will focus on initiatives related to the development of a management plan for ocean-related activities in the Inuvialuit Settlement Region. This plan will place particular emphasis on coastal areas in support of the existing Beaufort Sea Beluga Management Plan. The BSIMPI will demonstrate the need for National Integrated Management of Canada's marine waters.

This report represents a first step in the planning process for the Beaufort Sea Integrated Management Planning Initiative. A coastal resource inventory has been compiled synthesizing various sources of information to document environmental, social and cultural, and economic uses within the study area. Each of the discussed resource sectors is visually complimented by maps developed using ArcView GIS. Included in this inventory are existing management plans, such as the Beaufort Sea Beluga Management Plan and community conservation plans. The companion to this report is a digital database compiled in ArcView GIS format.

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BMMDA	Beaufort-Mackenzie Mineral Development Area
BSBMP	Beaufort Sea Beluga Management Plan
BSIMPI	Beaufort Sea Integrated Management Planning Initiative
CAPP	Canadian Association of Petroleum Producers
DEW	Distant Early Warning
DFO	Fisheries and Oceans Canada
DIAND	Department of Indian Affairs and Northern Development (also known as INAC)
DND	Department of National Defence
DOT	Department of Transportation
EIRB	Environmental Impact Review Board
EISC	Environmental Impact Screening Committee
FJMC	Fisheries Joint Management Committee
GNWT	Government of the Northwest Territories
HTC	Hunters and Trappers Committee
IFA	Inuvialuit Final Agreement
IFMP	Integrated Fisheries Management Plan
IGC	Inuvialuit Game Council
IM	Integrated management
INAC	Indian and Northern Affairs Canada (also known as DIAND)
IOS	Institute of Ocean Sciences
IPC	Inuvialuit Petroleum Corporation
IRC	Inuvialuit Regional Corporation

ISR	Inuvialuit Settlement Region
IUCN	International Union for Conservation of Nature and Natural Resources/The World Conservation Union
IWC	International Whaling Commission
MEQ	Marine Environmental Quality
MPA	Marine Protected Area
NCPC/ NWTPC	Northwest Territories Power Corporation
NHS	National Historic Site
NORAD	North American Air Defence System
NTCL	Northern Transportation Company Limited
NWS	North Warning System
NWT	Northwest Territories
PBTC	Federal-Provincial Technical Committee for Polar Bear Research and Management
PBAC	Federal-Provincial Administrative Committee for Polar Bear Research and Management
PAS	Protected Areas Strategy (Northwest Territories)
PCSP	Polar Continental Shelf Project
ROCC	Regional Oceans Coordinating Committee
RWED	Resources, Wildlife and Economic Development (Northwest Territories)
WMAC	Wildlife Management Advisory Council
YT	Yukon Territory

1. *OCEANS ACT* – BACKGROUND

Canada's *Oceans Act* (1997) provides the legislative framework for integrated management. The Minister of Fisheries and Oceans (DFO) is directed to lead and facilitate the development and implementation of plans for the integrated management of all activities or measures in or affecting estuaries, coastal and marine waters of Canada (*Oceans Act*, Part 2, Section 31). Integrated management (IM) is defined as "an ongoing collaborative approach which brings together interested parties to incorporate social, cultural, environmental and economic values in the development and implementation of ocean use plans" (DFO 2000a). The *Oceans Act* (1997) establishes integrated management as the umbrella activity within which other oceans programs are implemented.

There are three parts to the *Oceans Act*:

- Part One recognizes Canada's jurisdiction over the territorial sea, the contiguous zone, the exclusive economic zone and continental shelf;

- Part Two directs that a national strategy for oceans management be developed, based on the principles of sustainable development, integrated management and the precautionary approach; Part 2 also provides a set of tools to be used to implement integrated management: Marine Protected Areas (MPA), the Marine Environmental Quality (MEQ) Program, which can establish standards and guidelines as well as conduct monitoring activities, and the development of integrated management plans; a collaborative approach is to be used, including ministers, boards and agencies of the Government of Canada, provincial and territorial governments and affected aboriginal organizations, coastal communities and other persons and bodies, including those bodies established under land claims agreements;

- Part Three consolidates federal responsibilities for Canada's oceans and identifies Fisheries and Oceans Canada (DFO) as the lead federal agency accountable for oceans management.

The goal of the Oceans Program Division, Fisheries and Oceans Canada, integrated management program is to establish integrated management plans for all of Canada’s marine waters, through two complementary approaches:

1. DFO leading the development of IM plans for Large Oceans Management Areas predominantly located offshore; and

2. DFO facilitating and leading the development of IM plans at the Coastal Community Level located in the nearshore area.

The IM plans for large oceans management areas will address large-scale ecosystem and multiple use issues and overall MEQ issues. This may include: broad ecosystem objectives to be maintained; broad geographic ocean space allocation issues; providing guidance for community-based initiatives nested within the larger area; providing context for MPAs; and assessing broad economic opportunities. At the coastal community level, IM plans will deal primarily with matters of a local nature and address issues at the land-water interface. Such issues may include land-based sources of pollution, habitat degradation and climate change; local ocean space allocation issues; community stewardship initiatives; engagement of regional/local governments and aboriginal groups; and economic diversification opportunities (DFO 2000a).

Integrated management planning initiatives are underway on all three of Canada’s coasts. On the Atlantic Ocean, projects are ongoing for the Eastern Scotian Shelf and Cascapedia Bay, and the Southern Gulf of St. Lawrence. Further inland IM is underway for the St. Lawrence Upper North Shore. Three projects are in progress on the Pacific for the Central Coast, West Coast of Vancouver Island and Clayoquot Sound. In the Arctic, integrated management has been initiated for the southeastern Beaufort Sea and Hudson Bay (DFO 2001a).

2. INUVIALUIT FINAL AGREEMENT – BACKGROUND

The Inuvialuit Final Agreement (IFA) 1984, formalizes the commitment of Canada and the Inuvialuit to a comprehensive land claim settlement to:

- Preserve cultural identity and values;
- Enable equal and meaningful participation in the northern and national economy; and
- To protect and preserve Arctic wildlife, environment and biological productivity (IRC 199-).

The IFA formally established in law co-management and Inuvialuit structures for the management of living resources and economic development.

Objectives are set out in the IFA that support the full participation of Inuvialuit in the northern Canadian economy and the development of an adequate level of economic self-reliance and a solid economic base (Section 16(2) a-b). Socioeconomic measures to assist Inuvialuit in achieving these economic goals are included in the IFA. These measures give priority to Inuvialuit products, resources, employment and services, the best efforts of Government to award contracts to Inuvialuit and an economic enhancement fund to assist in developing Inuvialuit industries and businesses. The IFA sets up a number of corporations, committees and boards including: Inuvialuit Regional Corporation (IRC), Hunters and Trappers Committees, Inuvialuit Game Council, Wildlife Management Advisory Council, Fisheries Joint Management Committee, Environmental Impact Screening Committee, Environmental Impact Review Boards, and Research Advisory Council. The various corporations, committees and boards balance the economic development aspirations of the Inuvialuit with their natural resource management/conservation concerns.

DFO has had active involvement with FJMC as co-managers of the fisheries resource. The FJMC advises both the Minister of Fisheries and Oceans and the Inuvialuit organizations, such as the Game Council. Under the terms of the IFA, where the FJMC advises the Minister, the Minister can accept, request modifications or reject advice/decisions based on conservation, public safety or public health only. DFO's responsibilities for habitat management and its expanded role in oceans management have necessitated involvement with most of the other remaining corporations, committees and boards. However, FJMC remains the only board that advises the Minister of Fisheries and Oceans.

Conservation is one of the basic goals of the IFA. Further, the need for an integrated regime is stated in Section 14(2), "In order to achieve effective protection of the ecosystems in the Inuvialuit Settlement Region, there should be an integrated wildlife and land management regime, to be obtained through various means, including the coordination of legislative authorities."

Within the IFA (s. 14(60b)), provisions are made for the development of a conservation plan, which resulted in the *Inuvialuit Renewable Resource Conservation and Management Plan* (1988). This plan provides direction for resources management initiatives, in the form of principles and goals adapted from both the IFA and the *Report of the Task Force on Northern Conservation* (1984) (WMAC-NWT and FJMC 1988). Specifically, the *Inuvialuit Renewable Resource Conservation and Management Plan* refers to integrated management as one of four goals: "to provide for integrated renewable resource and land management" (WMAC-NWT and FJMC 1988). One objective from this management plan was the development of the document *A Community-based Regional Land Use Plan for the Mackenzie Delta-Beaufort Sea Region* (1991). Subsequently, community conservation plans were produced by the six Inuvialuit Settlement Region (ISR) communities (Figure 2.1). These community conservation plans are intended to provide guidance to those with an interest within the area (terrestrial, freshwater and marine components) by describing current conservation and resources management initiatives, practices and community goals. These plans were first developed in each of the communities between 1990 and 1994, and were reviewed in 1999 (Community of Inuvik and WMAC-NWT 1999).

These community plans define integrated management as a principle that expresses Inuvialuit beliefs and values with regard to conservation and resources management (Community of Inuvik and WMAC-NWT 1999). “Integrated management – all parts of the environment are interconnected, so they must be managed together. Conservation, stable economic development and sound resource management can only be achieved if all parties work toward a common goal. The Inuvialuit community of Inuvik/Aklavik/Tuktoyaktuk recognizes the relationship between direct economic security and resource conservation and the importance of maintaining a spirit of cooperation between all people living in the region” (Community of Inuvik Working Group and WMAC-NWT, p.2-1; Community of Aklavik Working Group and WMAC-NWT, p.2-1; Community of Tuktoyaktuk Working Group and WMAC-NWT, p.2-1).

In terms of management of the marine environment, the *Beaufort Sea Beluga Management Plan* was developed by FJMC, in cooperation with Hunters and Trappers Committees and DFO (FJMC 1998). The purpose of this plan is to ensure the sustainable management of beluga and beluga habitat, and to protect the traditions of the Inuvialuit culture (Fast *et al*. 1998). In order to achieve this, a series of three management zones were created, allowing for varying levels of protection and development activities (Fast *et al*. 1998). This plan was initially developed in 1990, was ratified by the Inuvialuit Game Council in 1991, and has gone through three sets of revisions, with the most recent edition published in 1998 (Fast *et al*. 1998; FJMC 1998). DFO has responsibility for implementation of the plan.

3. Introduction to the Beaufort Sea Integrated Management Planning Initiative (BSIMPI)

Canada's Beaufort Sea is high priority area in which to implement oceans management activities for the following reasons:

- Existence of co-management structures under comprehensive land claim settlement with the Inuvialuit;
- Well-established subsistence fish and marine mammal resource harvesting;
- Beaufort Sea Beluga Management Plan, and other western Arctic fishery management plans; and
- Significant renewed interest in oil and gas resource development.

The existing co-management structures in place provide opportunities to develop or enhance models of oceans governance appropriate to Canada's north.

The objective of integrated management is to replace the current fragmented approach to ocean management with a more collaborative and integrated approach. IM is particularly important in the context of the southeastern Beaufort Sea because of renewed interest by the oil and gas industry in northern energy development. Seismic and drilling exploration activity will significantly increase in the Mackenzie Delta and adjacent Beaufort Sea over the next two to five years. Some thirty to fifty wells will likely be drilled; most of which will be in the marine environment. Pipeline routes have been proposed, including two which would transport oil and gas directly from the Mackenzie Delta south via the Northwest Territories and Alberta or by connecting to the Mackenzie Valley route.

Potential for conflict exists between oil and gas development and the subsistence harvest of fish, birds and marine mammal stocks in the Mackenzie estuary. Of particular importance to the Inuvialuit are the potential impacts on beluga stocks that summer in the area and the subsistence harvest. Conflicts may also arise between proposed pipeline development and the conservation of fish habitat in the Mackenzie Delta and offshore along the Yukon North Slope. Integrated management planning in the Beaufort Sea region will facilitate a coordinated approach to oil and gas development and environmental conservation in marine and coastal waters.

The planning process is operating at two levels, the large ocean area scale of the Beaufort Sea and smaller community-based initiatives nested within the larger area. These initiatives include:

- A Beaufort Sea wide ecological overview, including the following coastal resource inventory;
- An existing and potential use audit which has gathered existing multi-disciplinary knowledge and is being entered into a Beaufort Sea GIS database;
- A survey of oil and gas related 'grey' literature pertaining to the Western Arctic. Much of this information has been catalogued with the goal of making the information accessible to all those with an interest in the Beaufort Sea;
- Community-based MEQ monitoring projects; and
- Development of public education and outreach material.

In addition to providing an information base for the IM planning process, these activities will inform any environmental planning and management decisions associated with current and future northern oil and gas activities.

Figure 2.1:. Site Map: Inuvialuit Settlement Region.

4. PURPOSE OF THE BSIMPI

The purpose of the Beaufort Sea Integrated Management Planning Initiative is to develop a collaborative and integrated approach to ocean management, through implementation of integrated management. Outcomes of the planning process will include:

- Integrated management in a co-management environment;
- Effective oceans governance appropriate to the Inuvialuit Settlement Region;
- Sound integrated management decisions addressing large-scale ecosystem, multiple use, and MEQ issues; and
- Provision of information for planning and decision-making relevant to offshore hydrocarbon exploration and development, other emerging ocean related activities.

Specifically, the process will focus on initiatives related to the development of a management plan for ocean-related activities in the Inuvialuit Settlement Region. This plan will place particular emphasis on coastal areas in support of the existing Beaufort Sea Beluga Management Plan. The BSIMPI will demonstrate the need for National Integrated Management of Canada's marine waters.

The purpose of this document is to inventory present and future coastal activities of environmental, social and cultural, and economic importance. As well, existing management plans are discussed. Each of the resource sectors is visually complimented by maps developed using ArcView GIS. Companion to this report is a digital database of activities in ArcView GIS format.

5. BROAD GOALS OF THE BSIMPI

Broad goals of the Beaufort Sea Integrated Management Planning Initiative are:

1. To guide initiatives related to the development of a management planning processes for ocean-related activities in the Beaufort Sea.

2. To use the National Integrated Management Framework to guide integrated management planning processes in the Beaufort Sea.

3. To develop a multi-level joint management process which will offer lessons for the application of aboriginal rights and the resolution of resource use conflicts elsewhere.

6. BROAD MANAGEMENT FRAMEWORK FOR BSIMPI

The Beaufort Sea Integrated Management Planning Initiative is being developed with the Inuvialuit in accordance with the Inuvialuit Final Agreement and DFO Integrated Management Planning Framework. The planning process will build upon IFA structures and co-management to ensure meaningful engagement. A Senior Management Committee (SMC) has been established which includes seven members representing Inuvialuit, federal government and industry perspectives. The SMC seeks to guide initiatives related to the development of a management planning processes for ocean-related activities in the Beaufort Sea. This planning process will place particular emphasis on coastal areas in support of the existing Beaufort Sea Beluga Management Plan. A Working Group develops and implements work plans in support of Oceans management initiatives. Representation on the Working Group consists of Inuvialuit, federal government (DFO and INAC) and industry. Additional representatives may be added as the process evolves. A DFO Secretariat provides administrative and implementation support. Other key roles of the Secretariat are to act as a federal government consultation forum and to engage all interested parties, including the Territorial government and industries in the planning area.

Within DFO, internal involvement is facilitated through the Regional Management Committee and Coordination with NHQ Oceans Programs and Policy Units. Intersectoral integration occurs through the Regional Oceans Coordinating Committee (ROCC). In addition to engagement by the Secretariat, established federal/territorial/interdepartmental structures are being included in the planning process, such as the NWT Federal Council and the Interdepartmental Committees on Oil and Gas preparedness.

The *Oceans Act* stipulates that DFO will coordinate with federal departments with a role in ocean management. The BSIMPI provides the opportunity to demonstrate the need for National Integrated Management through the review and coordination of federal policies and regulatory instruments affecting northern oil and gas development. In this regard, by engaging other federal/territorial authorities in the planning process, the department is ensuring that future decisions are consistent with the emerging Canadian Oceans Strategy.

7. PHYSICAL SETTING

7.1. Context

The Mackenzie River is the largest north-flowing river in North America, draining $1.787x10^6 km^2$ with a mean annual discharge of $10km^3/s$ and delivering an annual sediment load of $118x10^6$ tonnes to the Arctic Ocean. The Mackenzie River Delta is the largest in Canada, with a span of $12,170km^2$. Annually the delta receives $300\text{-}350km^3$ of water and $120x10^6$ tonnes of suspended sediment, of which two million tonnes are deposited within the delta (Droppo *et al*. 1998). Due to high sediment loads during the open water season, the channels and connected lakes of the delta are highly turbid (Hirst *et al*. 1987). Discharge from the Mackenzie River is of primary importance to the control of waterflow within the delta as a whole (Marsh and Schmidt 1993). Flows typically increase rapidly in May and June, and decline during the period of July to November (Hirst *et al*. 1987).

The Mackenzie Delta covers an area of over $13,000km^2$, making it the second largest river delta in North America (Hirst *et al*. 1987). Formed of a mosaic of low islands, tidal flats, levees, floodplains and channels, the delta is very productive, supporting large numbers of birds, fish, marine and terrestrial mammals (LGL 1982; Environment Canada 2000c; Ferguson and Marsh 1991). As such, the area is of great importance to local people in terms of fishing, hunting and trapping opportunities (Ferguson and March 1991). For the traditional occupants of the land, the Inuvialuit, the area has great social, cultural and traditional significance. The delta is bordered to the west by the Richardson Mountains and to the east by the Caribou Hills, confining its horizontal growth (Swystun 2000).

The delta has formed, and is still forming, from sedimentation filling into a shallow bay. Most of the delta has been built up by sedimentation from the Mackenzie River, while the southwest portion has received extra sediment from the Peel and Rat Rivers (Swystun 2000). Sediment load discharge from the delta comes primarily from the southern regions of the Mackenzie River, and not from the delta itself because of the armoring influence of the permafrost in the river banks (Droppo *et al*. 1998). In terms of sediment loading to the Mackenzie River estuary, both the Mackenzie River and sediments in the nearshore (within 5m) are major particulate sources to the surface layer (Iseki *et al*. 1987).

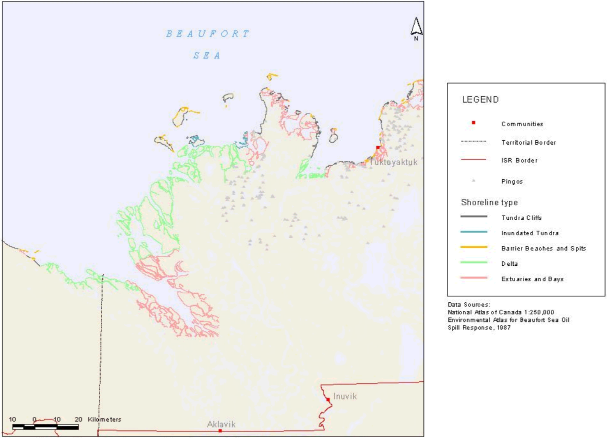
The lower Mackenzie Delta has little relief and low elevation, with an average relief of 15m above sea level (Environment Canada 1992). Providing the only relief in this otherwise flat landscape are pingos (Figure 7.1.1.) (Canadian Heritage 2000). Islands of the outer delta with low relief, not exceeding 30cm above sea level, tend to be unvegetated. Muskeg, underlaid by deltaic and alluvial silts and fine sands (70-150m thick), characterize this area. Numerous lakes and ponds dot the landscape, with the water depth of the delta's braided channels not often exceeding one metre. Mud flats are prominent at low tide (Environment Canada 1992). Away from the waterways and waterbodies, the permafrost is approximately 100m deep. Beneath the main channels and lakes there is no permafrost (Swystun 2000).

The central portion of the Beaufort coast is dominated by the Mackenzie Delta, which is itself dominated by river process inland and wave action in the outer areas (LGL 1982). The coast is composed of eroding bluffs, complex embayments formed by the breaching of thermokarst lakes, and spits and barrier islands which are rapidly eroding (Hequette and Ruz 1991). Generally, the coast is low-lying, less than 10m at the shoreline, with the exception of some sections of the Yukon coast (Figure 7.1.1.) (Jenner and Hill 1991; LGL 1982; Milne and Smiley 1976). The Yukon coast features steep coastal cliffs containing ground ice and fronted by narrow beaches, spits and barrier beaches and partially vegetated deltas of coastal rivers (Milne and Smiley 1976). In contrast, the north shorelines of Richards Island and the Tuktoyaktuk Peninsula have deep embayments caused by the breaching of tundra lakes (LGL 1982; Milne and Smiley 1976). The Beaufort Sea coast is ice-dominated (LGL 1982).

Coastal erosion is extensive due to low shoreline stability, because of the shoreline's formation by unconsolidated sediments discharged from the Mackenzie River

(LGL Limited 1982). Average erosion rates are 30-60cm per year, exceeding 4.6m per year at times (Environment Canada 1992). Measured rates of coastal retreat near Tuktoyaktuk may be up to 8m/year during storm years (Dyke 1991). Erosion rates on the Tuktoyaktuk Peninsula are greater due to lower cliff heights with high ice content. Coastal retreat on the Peninsula is also often a result of the breaching of tundra lakes. Erosion processes take place during the open water season and are dominated by wave action, changing the shoreline rapidly (LGL Limited 1982).

Primary production in the Beaufort Sea, and indeed the Arctic Ocean as a whole, is low compared to that of other oceans and large seas. This is due to the stratification of the water column during the open water season, which prevents the mixing of waters. As a result, nutrient supplies are exhausted in the summer when sunlight is available and not renewed until the winter when water mixing occurs. Light is the limiting factor in winter, limiting primary production in spite of the high availability of nutrients (LGL Limited 1982).



Data Sources:
National Atlas of Canada 1:250,000
Environmental Atlas for Beaufort Sea Oil Spill Response, 1987

Figure 7.1.1.: Shoreline type and locations of pingos.

Fisheries and Oceans Canada Pêches et Océans Canada

Canada

7.2. Vegetation

Two main vegetative communities are prevalent in the integrated management planning area: the tundra zone along the coast of the Beaufort Sea and the taiga (forest-tundra) zone inland and southward (Figure 7.2.1.) (Canadian Heritage 2000; Swystun 2000). The boundary between these two zones may be either sharp or transitional (Swystun 2000). Characteristic of the tundra zone vegetation are dwarf shrubs, sedges and herbs on dry sites, and sedges and willows on wet sites. The forest-tundra is typified by open stands of stunted black spruce, white spruce and tamarack over a cover of dwarf tundra vegetation. In combination, these two vegetation zones provide habitat for many wildlife species, many of which are not typically found at such northern latitudes (Canadian Heritage 2000).

The northern treeline runs through this region, bordering the Yukon North Slope, the northern part of the Mackenzie Delta, the coastal areas around Tuktoyaktuk and the Arctic islands (MDBSRLUPC 1991). The treeline comes further north in this area than anywhere else in the Northwest Territories due to the warming influence of the Mackenzie River. This can be seen from the air as narrow forested bands that grow along the channels in contrast to the willows, alders and sedgy flats of the remainder of the delta. The transitional zone between forest and tundra is scrub vegetation, characterized by willow, ground birch, heaths (cranberry, crowberry, Labrador tea, rhododendron, bog-laurel and heather), lupins, avens, sedges, grasses and lichens (Swystun 2000).

Vegetative communities within the outer delta are the result of both physiographic and climatic factors. Coastal regions (the lower delta) are north of the treeline. Along the banks of some of the watercourses grow tall shrubs (Environment Canada 1992). Muskegs and wet meadows support buckbean, horsetail, sedges and other graminoids, while sedge and willow species are typical of elevated areas (McCormick *et al*. 1984; Environment Canada 1992). The islands of the delta with little relief are characterized by wetlands, vegetated by sedges, grasses, while shrubs populate higher islands (McCormick *et al*. 1984).

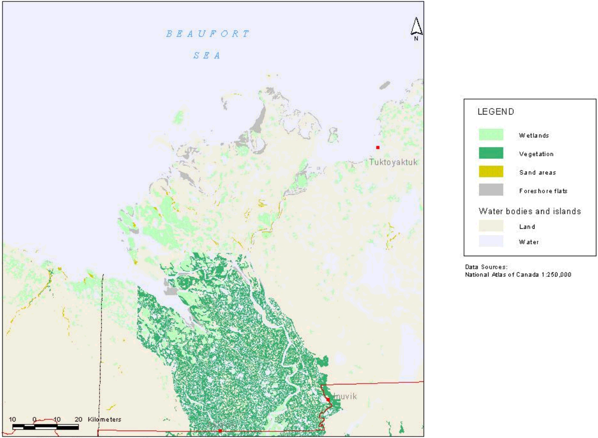


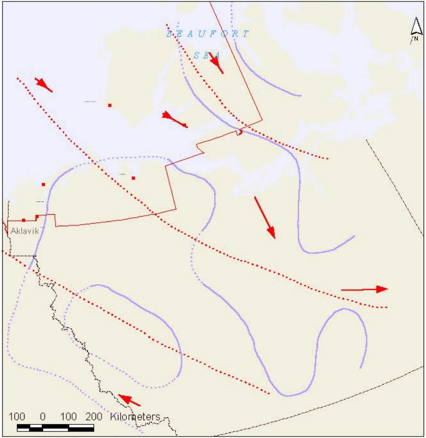
Figure 7.2.1.: Vegetation and wetlands of the Mackenzie Delta.

7.3. Climate

The climate of the Mackenzie Delta and Beaufort coast is dry and cold (Hirst *et al*. 1987). The Marine Tundra Climatic Region (i.e. the outer delta), receives less than 12.5cm of precipitation per year, with summer rainfall comprising 55% of this amount, qualifying the area as an arctic desert (Environment Canada 1992; Swystun 2000). Snow cover generally persists between October to the end of May (Hirst *et al*. 1987). Freezing temperatures are prevalent two-thirds of the year, with above freezing temperatures experienced from June to September (Environment Canada 1992). Ice and snow cover persists for six to eight months of the year (Inuvialuit Environmental Inc. 2000). The average annual mean daily air temperature is approximately -10^{o}C, and average mean daily maximum and minimum temperatures for the year are -7.5^{o}C and -15^{o}C. Temperature extremes range from -57^{o}C to +32^{o}C (Hirst *et al*. 1987). Summer temperatures typically range from 4.5 to 8.5^{o}C and winter mean temperature is –26.5^{o}C. The sun does not rise above the horizon during winter for approximately 3 months (Inuvialuit Environmental Inc. 2000).

During the winter months, relatively strong northwesterly winds dominate the Mackenzie basin. Large, cold high pressure areas migrate over the Beaufort Sea to the mainland, remaining over the region for long periods of time (Figure 7.3.1.). In the summer, warm, southwesterly flows settle over the area, which combined with the presence of the sun, bring warmer temperatures. Low pressure areas dominate in July and August and cyclonic systems are most frequent (Figure 7.3.2.) (Auld 2000).

Weather patterns have been changing in recent years. Annual mean daily surface air temperatures have increased in northwestern Canada by 1.5^{o}C since 1895, the greatest increase of any region in Canada. Pronounced warming in the winter and spring has taken place in the Mackenzie River Basin since the 1970s (Skinner and Maxwell 1994; Maxwell 1999). Projections suggest that Arctic mainland areas may experience temperature increases of up to 5^{o}C, while marine areas may rise 1-2^{o}C. Precipitation may increase up to 25% and spring and autumn snowfall may become rain (Environment Canada 1997). Regional circulation and atmospheric circulation patterns will also be affected by climatic warming. As well, climate warming would impact the ice regime due not only to warmer temperatures, also from associated changes to atmospheric and oceanic circulation patterns. For the Beaufort Sea, it has been predicted that climatic warming could increase the open water season from the present average of 60 days to 150 days. The maximum extent of open water in the summer could increase from its current range of 150-200km to 500-800km. First year ice maximum thickness could decrease by 50-70% (Maxwell 1999).



LEGEND

Seasonal weather January - wind

Seasonal weather January

Sea Level Pressure over land (isobars)

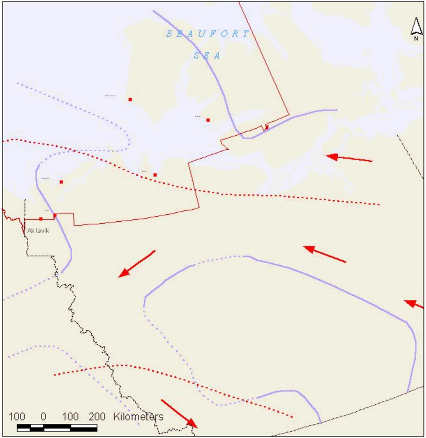
Sea level pressure over water and mountainous regions (isobars)

500mb contour (upper level flows)

Note: During January, the Mackenzie Basin region is dominated by large areas of high pressure formed over the Beaufort Sea.

Data Sources:
National Atlas of Canada 1:250,000
Environmental Atlas of the Beaufort Coastlands,
B. Pelletier (in preparation).

Figure 7.3.1.: Seasonal weather patterns - January.



LEGEND

Seasonal weather July - wind

Seasonal weather July

Sea level presure over land (isobars)

Sea level pressure over water and mountainous regions (isobars)

500 mb contour (upper level flows)

Note: Low pressure areas dominate in July and August, warming the region considerably.

Data Sources:
National Atlas of Canada 1:250,000
Environmental Atlas of the Beaufort Coastlands,
B. Pelletier (in preparation).

Figure 7.3.2.: Seasonal weather patterns - July.

7.4. Southeastern Beaufort Sea

7.4.1. Hydrological Processes – Delta

The Mackenzie River provides the only significant freshwater input to the Beaufort Sea (Giovando and Herlinveaux 1981). Water flow in the Mackenzie Delta is primarily within three channels – two thirds of the flow discharges through the Middle Channel into a large distributary system; one-sixth through the East Channel; and one-sixth through the West Channel. The West Channel is fed by the Peel, Rat and Big Fish Rivers, in which spring/summer break-up occurs earlier than in the rest of the delta (Droppo *et al*. 1998). Water flows into Kugmallit Bay from the east channel, into Beluga Bay through the middle channel and into Mackenzie Bay through the west channel (Figure 7.4.1.) (Carmack *et al*. 1989).

Spring break-up and snowmelt throughout the delta results in ice and logjams, flooding up to 95% of the delta with the highest water levels of the year (Droppo *et al*. 1998; Marsh and Hey 1991; Marsh and Schmidt 1993). This extensive flooding replenishes soil nutrients and creates vast wetlands. Following break-up, water levels in the delta decline, the river's waters recede and the land dries, transforming the landscape to flats, wet meadows and coastal marshes (Environment Canada 2000c). Periodically, there are brief water level rises due to rainstorms in the southern area of the basin and storm surges in the Beaufort Sea. Such variations cease with freeze-up, and water levels remain relatively stable until break-up (Marsh and Schmidt 1993).

Outflow of the Mackenzie River is seasonal in nature, with peak flows attained during mid-May to early June. During this peak, flows may reach 26,000m^3/sec. Between the peak and August discharge may vary by as much as 6,000 to 8,000m^3/sec within a period of days. Such variability is likely caused by the passage of weather systems through the Mackenzie Basin. Starting in August, flow decreases irregularly to reach the winter minimum, 3,000m^3/sec, by the end of December. (Giovando and Herlinveaux 1981).

Data Sources:
National Atlas of Canada 1:250,000

Figure 7.4.1.: Mackenzie River discharge.

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Canada

7.4.2. Oceanic Processes of the Beaufort Sea

In general, the Beaufort Sea includes the waters off the north coasts of Canada and Alaska, bounded in the east by Banks Island and in the west by the Chukchi Sea. The southeastern Beaufort Sea, which encompasses the area of interest for this study, is defined as lying between the Alaska-Yukon border in the west to Cape Dalhousie in the east and northward to 72^{o}N. The southeastern Beaufort Sea may be viewed as a partly estuarine system, with the outflow of the Mackenzie River mixing with the salt water of the Arctic Ocean over much of the continental shelf. The Mackenzie Shelf is the most estuarine of Arctic shelves (Macdonald *et al*. 1987).

There are three main physiographic features present in the southeastern Beaufort Sea: the continental shelf, continental slope and the Mackenzie Canyon. The continental shelf grades gently toward depths of 200m to the shelf break. This area is known as the Mackenzie Shelf and is a partly estuarine environment, greatly influenced by the Mackenzie River, and, with the exception of the Yukon coast, defines the coastal marine zone (Carmack et al. 1989; Carmack and Kulikov 1998; Macdonald *et al*. 1987). The shelf is shallow with a mean depth of 35m and is largely flat (Carmack *et al*. 1989). From the shelf break between the 80 and 120m isobaths (approximately 120km offshore) (Carmack *et al*. 1989), the continental slope falls steeply from the shelf edge and is transected by the v-shaped Mackenzie Canyon (Macdonald *et al*. 1987). Features of the continental shelf are ice scour marks and intermittent underwater pingos or pingo-like structures, with mounds of up to 300m in diameter and 15m in height. Sub-sea bottom discontinuous permafrost underlies the continental shelf (Giovando and Herlinveaux 1981; Milne and Smiley 1976). The Mackenzie Shelf can be characterized into three zones/habitat types: freshwater, estuarine/brackish and coastal marine. Delineation of these somewhat arbitrary zones varies, based on response to season, wind and lunar tides, Coriolis effect, presence of ice and Mackenzie River discharge (Hopky 1988).

Oceanographic processes that impact the Beaufort coast include: surface circulation and the Beaufort Gyre, undercurrents, upwelling along the edge of the

Beaufort Shelf, currents along the shore, tides and storm surges, movement of the Mackenzie River plume, and temperature and salinity of the water mass. In terms of surface circulation, the Beaufort Gyre is the main oceanographic process (Pelletier 2000). The gyre is a huge, clockwise motion of water, that is formed in that area of the Arctic Ocean lying between the northern-most latitudes (85^o) of the Arctic Ocean and North American Arctic mainland (Milne and Smiley 1976; Pelletier 2000). Movement of the gyre is southerly off the Canadian Arctic Archipelago, westerly across the Arctic Basin and edge of the Beaufort Shelf, and northerly along the region of longitude 180^{o}W (Figure 7.4.2.) (Pelletier 2000). There is a strong and persistent undercurrent, known as the Beaufort Undercurrent, located over the continental shelf and slope seaward of the 50m isobath. This current works opposite to the surface drift transporting water from east to west (Carmack *et al*. 1989). Upwelling often occurs at the eastern side of the Mackenzie Canyon, and is probably a result of the interaction of coastal circulation with topography (Figure 7.4.2.) (Macdonald *et al*. 1987). Storm surges (wind tides) are relatively common, up to 1m, and occur an average of once each year (LGL 1982). The Mackenzie plume (discussed in further detail below), is the fresh, turbid outflow of the river, which flows out over the more saline ocean waters. The direction of the plume differs depending on the presence of ice cover and winds (Milne and Smiley 1976).

In the summer months, under non-storm conditions, the surface layer of the Beaufort Sea (5-10m) is strongly stratified as a result of runoff and ice melt (Buckly and Budgell 1988; Carmack and Macdonald *in press*). The surface layer is dominated by outflow from the Mackenzie River, which forms a shallow plume that streams to the east of the river mouth and can at times cover the entire Beaufort Shelf (Buckly and Budgell 1988). Extending from the surface waters to a depth of about 200m is the Arctic water mass, which comes from the seas of the Arctic Ocean and the Bering Sea. Below this layer is the Atlantic water mass, whose source is the North Atlantic surface water, which extends to a depth of approximately 900m. The Atlantic layer is more saline and warmer than the Arctic layer, and it is because of its greater density that it lies below the Arctic layer (Giovando and Herlinveaux 1981). During storm events in the Beaufort Sea, mixing caused by storm generated waves can erode the stratification, making the water essentially homogeneous (Buckley and Budgell 1988). Water mixing occurs throughout the winter as brine rejected during sea ice production mixes convectively with the surface layer (Carmack and Macdonald *in press*; LGL 1982). The degree of winter mixing depends on the barrier that dams the river inflow (Carmack and Macdonald *in press*).

The salinity of the surface waters increases in the winter, though the magnitude of this increase varies. This increase occurs in part as a result of brine rejection during the formation of sea ice. Increasing salinity is also in part associated with the intrusion over the Mackenzie shelf of a water mass with high nutrient and low oxygen concentrations; a feature of the entire western Arctic Ocean (Moore *et al*. 1992). The Beaufort Sea's temperature and salinity fields also result from the modification of offshore water masses by river inflow, ice melting, solar radiation and air-sea exchange (Carmack *et al*. 1989).

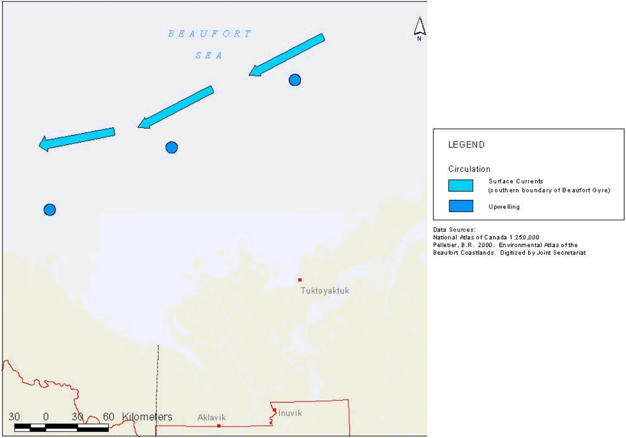

Figure 7.4.2.: Beaufort Sea circulation patterns.

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7.4.3. Oceanic Processes in the Nearshore

Waters of the Mackenzie estuary are strongly influenced by river inflow, especially in terms of temperature and salinity. Offshore waters influence the estuary through ice melting and freezing, solar insolation and air-sea exchange (Carmack *et al*. 1989). During the summer, inshore waters are turbid, fairly warm and brackish due to the flow of the Mackenzie River, while further offshore waters become more cool and saline where the influence of the Arctic Ocean is seen (Milne and Smiley 1976). Generally the summer influx of the Mackenzie River inundates the nearshore and delta out to depths of 3-4m, up to distances of 20km offshore. This water can be forced along the shoreline by winds and currents, or can be forced offshore resulting in upwellings of cold, saline water. In winter, river flows stabilize in the nearshore, as a result of the protection provided by the land-fast ice cover (Hopky 1988).

A freshwater plume from the Mackenzie River flows out over the saline ocean waters (Figure 7.4.3.). In the summer a positive estuary is formed, with the warm freshwater forming a layer over the cold seawater (Macdonald *et al*. 1989). The waters of the plume and those beneath may have very different currents in terms of both direction and speed. In the absence of wind the plume will turn eastward under the influence of the Coriolis effect along the shore of Richards Island and Tuktoyaktuk toward Amundsen Gulf (Milne and Smiley 1976). This estuarine-brackish zone typically extends along the coastal plain and is the most dynamic and unstable area of the coast (Hopky 1988).

The estuary is more stable in winter, forming a reverse estuary in which brine is produced in the surface (Macdonald *et al*. 1989). During winter, the river continues to flow into the estuary, at a reduced rate due to the freezing of many tributaries. This outflow spreads beneath the landfast ice and forms a large pool of fresh or brackish water held in place by the rubble ice field (stamukhi) which defines the outer boundary of landfast ice (Macdonald *et al*. 1999; Carmack and Macdonald *in press*). Locally, this floating, freshwater lake is known as Lake Mackenzie and contains about 70km^3 of water spread over an area of 12,000km^2. Little is known about the ecology of this lake or where the freshwater disperses to during and after breakup (Carmack and Macdonald *in press*).

The fresh, turbid water of the river flows out over the more saline marine waters, creating a brackish environment with important biological implications, in terms of habitat (Hopky 1988; Milne and Smiley 1976). Inflow during the winter and spring results in the brackish, shallow inshore waters east of Richards Island and along Tuktoyaktuk Peninsula. In turn, this creates overwintering habitat in the shallow lagoons, estuaries and breached thermokarst lakes for freshwater and anadromous organisms. The highly turbid outflow of the river inhibits primary production except where river borne nutrients can be utilized outside of the turbid plume (Milne and Smiley 1976). As a result, during the summer months the offshore community is quantitatively more productive than the nearshore (Parsons *et al*. 1988). Distribution of nutrients over the shelf are influenced by the open ocean, the Mackenzie River, ice melt, biological processes and regeneration on the shelf, all of which are seasonal in the upper 50m (Macdonald et al. 1987).

Coastal currents along the shore are complex, their motion responding to wind conditions, discharge of the Mackenzie River and the Coriolis effect (Figure 7.6.1.) (Milne and Smiley 1976; Pelletier 2000). The Coriolis effect causes the residual flow to drift along the coast of the Tuktoyaktuk Peninsula toward the east. Longshore currents have constructed spits and barriers on both sides of the Mackenzie Delta through their influence (Figure 7.4.4.). These currents erode the headlands and islands of the coast direct sediment transport and leeward deposition. Within the coastal flow is the sedimentary discharge of the Mackenzie River. The dispersal direction of this flow is a complex pattern of eddies and contrasting flow directions occurring off the Mackenzie Delta, with a more regular flow off the Tuktoyaktuk Peninsula (Pelletier 2000).

The warm water of the Mackenzie River plume impacts oceanographic process with through temperature and salinity (Pelletier 2000). In the outer region of the delta, water warms above 0^oC by mid-May, reaches a peak of 16^oC in late July and returns to 0^oC by mid-October (Dyke 1991). While variations in river discharge are correlated to oceanographic processes in the nearshore area of the Mackenzie Shelf, this does not extend to the middle and outer portions of the shelf. This indicates that mixing and dispersion of river water eliminates direct discharge effects (Fissel and Melling 1990). Deeper waters may replace the surface waters in an underflow. Alternatively, deep saline waters may be driven offshore as a result of thickness of the freshwater layer. Such counter-currents can create deep-draught floes and thin ice to move in opposing directions (Milne and Smiley 1976).

Tidal currents are minor physical processes affecting the coastal areas of the southern Beaufort Sea, with amplitudes of 10-13cm typically and a maximum of 0.5m during spring tides. As such, the impacts of tidal zone currents are usually negligible, with the exception of storm surges (Pelletier 2000). Generally the gravitational tides are overshadowed by the effects of wind, and during periods of high wind (west or northwest) the Beaufort Sea is prone to large storm surges (also known as wind tides) (Figure 7.6.2.) (Marsh and Schmidt 1993; Milne and Smiley 1976). Surges require fetches of open water in order for the wind to generate energy, and may occur during times of ice cover and open water, with the largest surges taking place during the open water season (Marsh and Schmidt 1993; Milne and Smiley 1976). A storm surge is the result of wind stress on the water surface, causing a strong net displacement of water, which leads to either a rise or fall of the water surface (Marsh and Schmidt 1993). Surge amplitudes may reach 2-3m, with the magnitude accentuated in shallow waters and along shorelines (Marsh and Schmidt 1993; Pelletier 2000). Minor surges are common and occur on average once per year (Milne and Smiley 1976). This has a significant impact on shoreline inundation, erosion and alteration (Pelletier 2000).

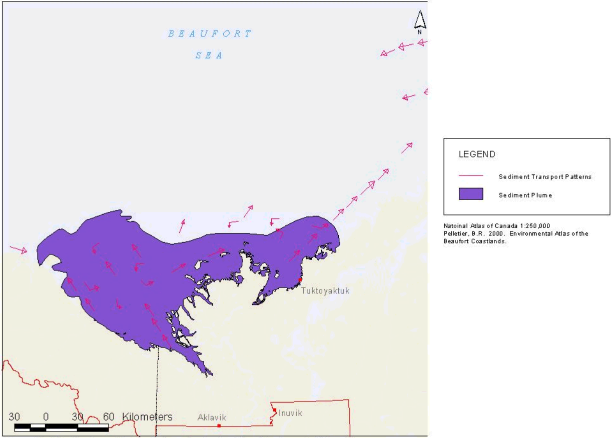
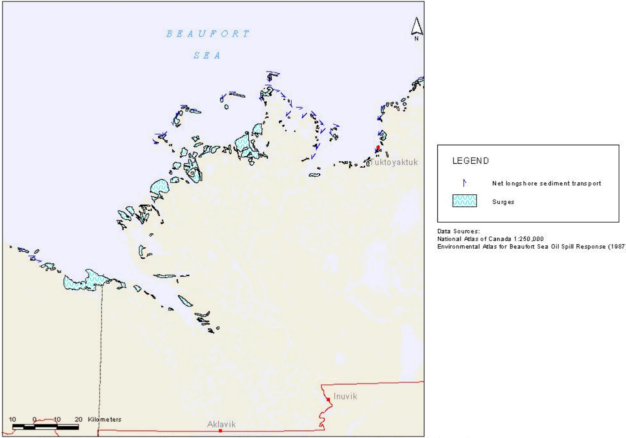


Figure 7.4.3.: Sediment transport and extent of the Mackenzie River plume.



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National Atlas of Canada 1:250,000
Environmental Atlas for Beaufort Sea Oil Spill Response (1987)

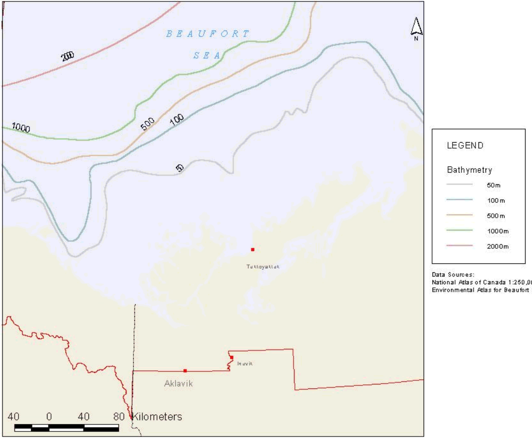
Figure 7.4.4.: Net longshore sediment transport and areas of surges along the Beaufort coast.

7.4.4. Bathymetry

Bathymetrically, the Arctic Ocean is divided into two major sub-basins by an underwater mountain range, the Lomonosov Ridge: the Canadian Basin, with a depth of 3,800m, and the Eurasia Basin, with a depth of 4,200m. Within the Canadian Basin, the bathymetry of the Beaufort Sea is dominated by the shallow continental shelf, which is defined to be the underwater area with depths less than 200m. The shelf extends 70-150km off the coast and the bottom contour generally parallels the coastline (Figure 7.4.5.) (Giovando and Herlinveaux 1981).

The Mackenzie Shelf at the Mackenzie estuary is extremely shallow and flat, with the 10m isobath occurring as far as 35km offshore (Carmack *et al*. 1989; Giovando and Herlinveaux 1981). Discontinuous sub-sea bottom permafrost is found throughout (Giovando and Herlinveaux 1981; Milne and Smiley 1976). The only irregularities in the otherwise regular shelf are ice scour furrows and underwater pingos or pingo-like structures, which occur sporadically off Tuktoyaktuk Peninsula (Carmack *et al*. 1989; Giovando and Herlinveaux 1981; Milne and Smiley 1976). Extending southward from northeast of Herschel Island toward Mackenzie Bay is the deep (500m), V-shaped Mackenzie Canyon, which is the sole exceptional feature of the shelf (Carmack *et al*. 1989; Gilbert and Pederson 1986; Giovando and Herlinveaux 1981). Other lesser features of the shelf include a small deep basin southeast of Herschel Island to the west of Mackenzie Canyon and a minor canyon parallel to Mackenzie Canyon, north of Kugmallit Bay, known as Kugmallit Channel or Kugmallit Canyon (Carmack *et al*. 1989; Giovando and Herlinveaux 1981).

To the north of Mackenzie Shelf, the sea bottom slopes sharply to depths of greater than 3,000m (Giovando and Herlinveaux 1981). This shelf break occurs between the 80 and 120m isobaths, which is approximately 120km offshore (Carmack *et al*. 1989).



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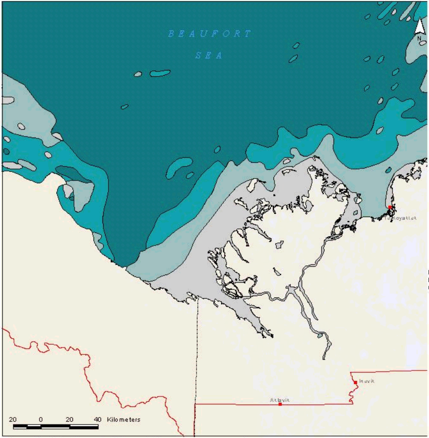
Environmental Atlas for Beaufort Sea Oil Spill Response (1987).

Figure 7.4.5.: Bathymetric contours (metres) of the Beaufort Sea.

7.4.5. Surficial Sediments

At present, the outflow of the Mackenzie River is the only significant source of sediments to the Mackenzie Shelf, although coastal erosion is an important local sediment supply near the shoreline (Carmack and Macdonald *in press*; Giovando and Herlinveaux 1981). This sedimentation combined with the deposition of marine, epicontinental and fluvioudeltaic sediments, during deglaciation periods, has resulted in the current shallow Mackenzie Shelf (Gilbert and Pedersen 1986).

The seabed of the southeastern Beaufort Sea is composed primarily of clay, sand and silt (in order of abundance), with some gravel deposits. Clay substrate is predominant over much of the shelf east of the Mackenzie Delta, with major deposits located in the central portion of the Mackenzie Canyon and on the shelf immediately east. Lowest proportions of clay are found northwest of Herschel Island. Sand is found throughout the area adjacent to the northwestern coast of Herschel Island, with greatest concentrations located in eastern areas of the shelf. Silt is less abundant than either clay or sand and is found in a narrow zone of the shelf directly seaward of the east-central part of the Tuktoyaktuk Peninsula. The lowest concentrations of silt are in the Mackenzie Canyon and east of the central shelf. Gravel is present in various locations, but only in significant concentrations in small areas to the northwest of Herschel Island and north of Cape Bathurst (Giovando and Herlinveaux 1981).



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National Atlas of Canada 1:250,000
Geological Atlas of the Beaufort Sea, Geological Survey of Canada

Figure 7.4.6.: Beaufort Sea offshore clay concentrations.

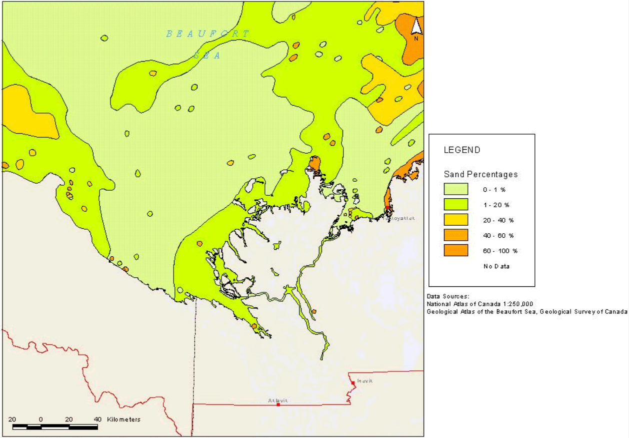

Figure 7.4.7.: Beaufort Sea offshore sand concentrations.

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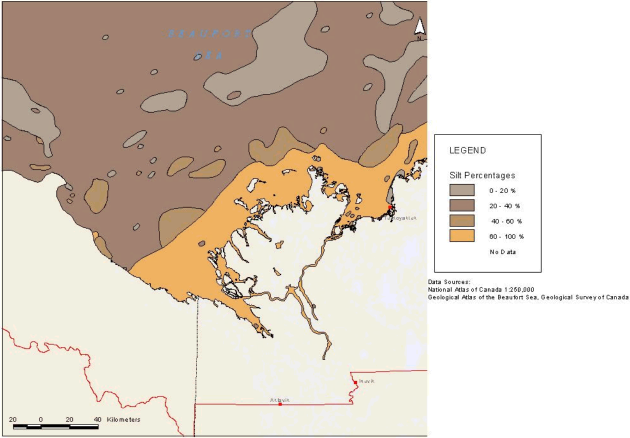

Figure 7.4.8.: Beaufort Sea offshore silt concentrations.

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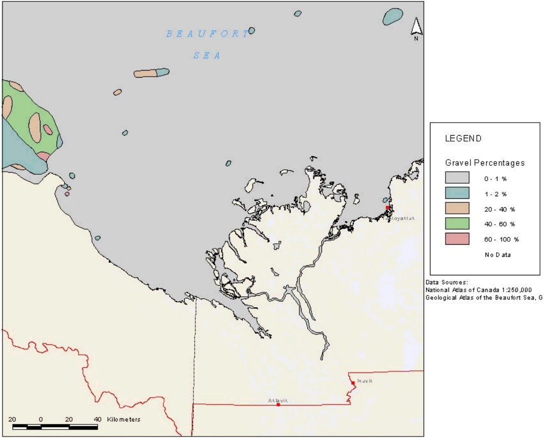

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Geological Atlas of the Beaufort Sea, Geological Survey of Canada

Figure 7.4.9.: Beaufort Sea offshore gravel concentrations.

7.4.6. Ice Scouring

The process of ice scouring occurs when sea ice comes in contact with the seabed and, through grinding, forms long, linear gouges in the seafloor sediments (Gilbert and Pedersen 1986; Myers *et al*. 1996). Scours may result from the onshore or longshore movement of sea ice and by grounding of under ice projections, such as pressure keels. Most scouring occurs during the winter and spring (Giovando and Herlinveaux 1981; Milne and Smiley 1976). There are two morphological types of scours: multiple scours consisting of a series of parallel scours and ridges, and single scours, which are most common in the southeastern Beaufort Sea (Hequette *et al*. 1995).

In the southeastern Beaufort Sea, ice scours may extend linearly for tens of kilometres, with widths of more than 300 metres and incisions of two metres into the seabed (Gilbert *et al*. 1989; Hequette *et al*. 1995). However, mean scour depth and width are 0.3m and 11m respectively. Scours are oriented east or west, which is sub-parallel to the coastline and bathymetric contours. Dominant movement is east to southeast (Hequette *et al*. 1995). The seafloor is virtually saturated with scours at depths of 3 to 50m (Lewis *et al*. 1976). There is a tendency for scours to be deeper and more frequent in water depths 14m to 45m (Hnatiuk and Wright 1983), with scour frequency diminishing rapidly in deeper waters, reaching zero by depths of 80m (Lewis *et al*. 1976). Between depths of 10 and 12m a break in the seabed slope delineates a boundary between the nearshore zone that is moderately affected by ice scouring and the outer zone which is intensely affected. This boundary may be the result of intense erosion caused by keels of pressure ice ridges at the inner edge of a zone of grounded ice ridges. Inshore of the 10m isobath scours are reworked due to frequent bottom disturbance by wave orbital currents and near-bottom currents in the open water season (Hequette *et al*. 1995). Scours in depths of 50m are likely to have occurred at the end of the last glaciation when sea levels were much lower than at present (Giovando and Herlinveaux 1981; Milne and Smiley 1976).

It is difficult to determine which areas of the seabed may be susceptible to ice scouring, since evidence suggests that such disturbances cannot be solely related to any one environmental variable. Documentation from the Beaufort Sea and other high latitude scoured shelves of the world show that scouring effects vary with changes in bathymetry, sea ice zonation patterns, geological and geotechnical relationships and seabed sediment transport variables. It is likely that combinations of these variables result in modern day seafloor scours (Gilbert and Pedersen 1986). Form and intensity of scours are directly affected by ice cover and regime: the fast ice zone, the shear zone and the polar pack (Gilbert and Pedersen 1986; Myers *et al*. 1996). Scours may be affected by the geological and geotechnical nature of the sea floor sediments, with the thickness of sediments influencing scour-depth distributions (Gilbert and Pedersen 1986).

Ice scour has been identified as one of the major constraints to pipeline engineering and petroleum development in the Beaufort Sea, as it is represents a threat to the safe installation of subsea structures (Gilbert and Pedersen 1986; Gilbert *et al*. 1989; Myers *et al*. 1996). Determining the factors affecting the locations, intensity and frequency of ice scour events is critical in defining a safe water depth where a pipeline may rest directly on the seafloor without risk of damage due to ice (Myers *et al*. 1996).

7.4.7. Ice Ecology

7.4.7.1. Sea Ice Zonations

Throughout the winter and early spring, zonation of ice in the southeastern Beaufort Sea features landfast ice, active shear ice, transitional shear ice and the polar pack. Landfast ice, newly formed each year, is found attached to all coasts and is smooth, with a maximum thickness of 2m attained by the end of April, and extends to the 20m isobath (Carmack and Macdonald *in press*; Sobczak and Pelletier 2000). The outer landfast ice is bounded by a rubble ice field (stamukhi) formed when the moving polar pack shears against the inshore ice that is held fast to the coastal seabed and shore

(Carmack and Macdonald *in press*; Sobczak and Pelletier 2000). A long, bow-shaped flaw polynya opens between the rubble ice and polar pack forming an area of open water that expands or contracts based on the prevailing winds. Seaward of the shear zone is the transitional shear zone, which develops additional smaller arcs of open water parallel with the first major arc. The transitional shear zone is composed of large matching fractures in opposite slabs of ice, along with a multitude of huge ice blocks and multi-year floes. This zone extends directly into the polar pack ice, which is comprised of thick multi-year ice, frozen leads, rare ice-island fragments and numerous oblique fractures and open leads. The surface of the polar ice is generally rough, characterized by ridges and hummocks (Sobczak and Pelletier 2000).

7.4.7.2. Sea Ice Cycles

Landfast ice formation in the coastal waters of the southern Beaufort Sea occurs between late September and mid-October and is generally complete by November (Figures 7.4.10. and 7.4.11.) (Marko 1975; Spedding and Danielewicz 1983). The date of new ice formation is influenced by factors such as: summer open water extent, meteorological conditions (i.e. air temperature) and location of the polar pack. Ice first forms along the edge of the polar pack, followed by growth in the sheltered coastal waters (Spedding and Danielewicz 1983).

Within coastal waters, new ice forms first around Richards Island, because water is less saline in this area due to discharge from the Mackenzie River. This is followed by ice formation in other sheltered bays and coastal shallows. After new ice formation has begun, a duration of two weeks is typically required for the entire Beaufort Sea to become ice covered (Spedding and Danielewicz 1983).

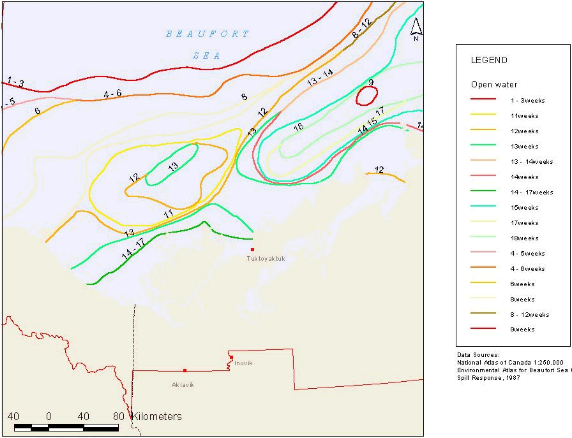
During the winter, landfast ice progresses seaward in a stepwise manner as ice in the shear zone becomes compacted against the edge of the landfast ice (Figure 7.4.12.) (Milne and Smiley 1976; Spedding and Danielewicz 1983). Thin ice forms grounded pressure ridges, helping to stabilize the landfast ice edge. Shear ice is moved away from the landfast ice edge by easterly or offshore winds, with no advancement of the landfast ice (Spedding and Danielewicz 1983).

The rate of landfast progression varies on a yearly basis, due to meteorological conditions and late summer ice conditions. As a result, maximum winter extent can be reached any time between mid-November and March. Generally, the 20m isobath marks the seaward limit of landfast ice (Carmack and Macdonald *in press*). Few changes in the landfast ice occur once the maximum extent has been reached, though flaw leads and thin ice extensions may be found along the edges (Spedding and Danielewicz 1983). During the winter, a system of shore leads, which open and close, and a polynya, which forms in the vicinity of Cape Bathurst, run parallel to the mainland coast and the west coast of Banks Island (Figure 7.4.13.) (Smith and Rigby 1981).

Break-up begins offshore in late April or early May, precipitated by the development of flaw leads along the landfast ice edge. Flooding over the fast ice occurs in early May, with the commencement of the Mackenzie River spring run-off. The floodwaters melt the ice in situ, and form melt lagoons at the channel mouths, which expand via melting at the ice-water interface to the 5-6m depth (Spedding and Danielewicz 1983). This influx of warm river water advances the melting of ice in the delta and estuary by as much as two months (Carmack and Macdonald *in press*). Landfast ice barriers in Mackenzie and Kugmallit Bays melt and fracture between mid-June and mid-July (Figure 7.4.14.). The fracturing of the ice barrier is followed by the disintegration of the ice sheet north of Pullen and Richards Island, resulting in these areas typically remaining ice covered later. In addition to the major influence the Mackenzie River has on break-up, solar radiation plays a role by causing structural weakening of the ice, destroying bonds with shorelines and grounded ridges. The ice sheet fractures into floes, which may be tens of kilometres in diameter, which then drift offshore under the influence of easterly winds (Spedding and Danielewicz 1983). The shelf is usually completely clear of ice by the end of September (Carmack and Macdonald *in press*).

7.4.7.3. Sea Ice Movement

Ice movement is controlled by atmospheric systems and oceanographic circulation. Atmospherically in the southeastern Beaufort Sea, surface winds blow the sea ice forward (Sobczak and Pelletier 2000). In terms of oceanographic processes, the Beaufort Gyre, a huge, clockwise motion of water, is the primary mechanism moving the ice canopy (Milne and Smiley 1976; Pelletier 2000; Sobczak and Pelletier 2000). When the wind blows in the direction of the gyre, ice movement is enhanced, while the wind blowing in the opposite direction to the gyre may retard or reverse ice movement. Regardless, the ice pack will always resume its circulation based on the gyre, under the influence of the prevailing winds, and continue to travel around the Arctic Ocean (Sobczak and Pelletier 2000).



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Environmental Atlas for Beaufort Sea Oil Spill Response, 1987

Figure 7.4.10.: Periods of open water.

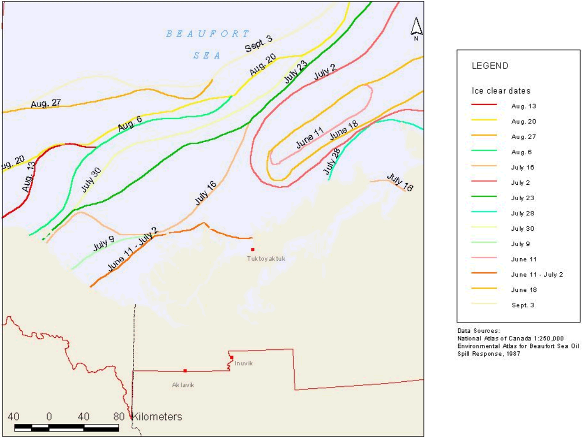

Figure 7.4.11.: Ice clear dates.

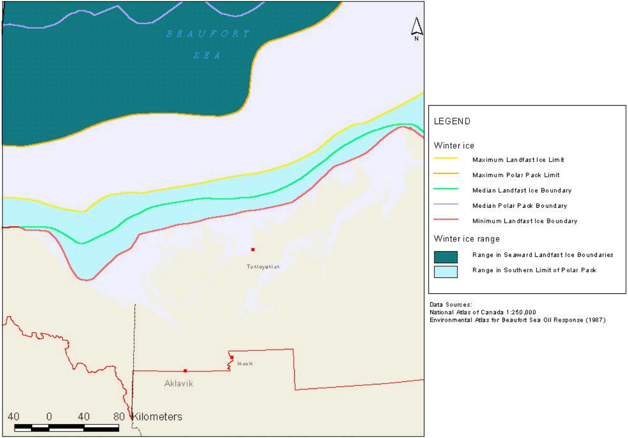

Figure 7.4.12.: Sea ice positions and ranges in the Beaufort Sea - winter.

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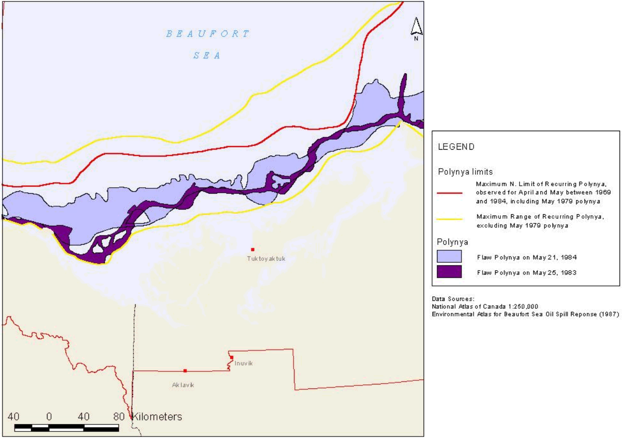
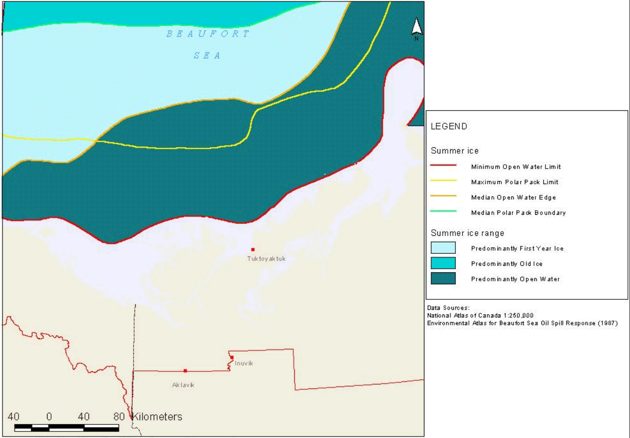


Figure 7.4.13.: Cape Bathurst Polynya limits and ranges.



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National Atlas of Canada 1:250,000
Environmental Atlas for Beaufort Sea Oil Spill Response (1987)

Figure 7.4.14.: Beaufort Sea ice positions and ranges - summer.

8. Resource Sectors - Biological

8.1. Fish

8.1.1. Introduction

Freshwater discharge from the Mackenzie River supplies great amounts of freshwater to the outer delta, while the Beaufort Sea provides salt water (Environment Canada 1992). This brackish estuarine environment is able to support populations of anadromous, marine and freshwater fish species (Figure 8.1.1.). A total of sixty-three species have been reported for the Mackenzie Delta and Beaufort Sea (Table 8.1.1.) (Corkum and McCart 1981). Of these, thirty-two freshwater and anadromous species having been recorded in the delta, with 20-24 of these species commonly encountered (Chang-Kue and Jessop 1991; Environment Canada 1992). Coregonids, such as broad whitefish, lake whitefish (*Coregonis clupeaormis)* and inconnu *(Stenodus leucichthys)* are the most common species in the lakes and streams of the delta. The most abundant fish in coastal waters are Arctic cisco (*Coregonis autumnalis*) and least cisco (*Coregonis sardinella*) (Environment Canada 1992). The following is a discussion of the most common/important (socioeconomically and ecologically) species found in the Mackenzie Delta/Southeastern Beaufort Sea area.

8.1.2. Anadromous Species

8.1.2.1. Coregonids

Five species of anadromous coregonids (whitefish) are found in the estuary. The degree of anadromy varies based on the ability of a species to inhabit brackish waters for prolonged periods and the general distribution in the nearshore environment. Arctic cisco is the most saline tolerant whitefish, followed by least cisco, broad whitefish, lake whitefish and inconnu (Chang-Kue and Jessop 1991).

Broad Whitefish (Whitefish)

Broad whitefish *(Coregonus nasus)*, known locally as whitefish, is the main migratory fish species sought in the ISR's subsistence fishery, for both human and dog-team consumption (Chang-Kue and Jessop 1991; Chang-Kue and Jessop 1997). Commercial fisheries for this species have been attempted sporadically since the mid-1900s (Reist and Treble 1998). Export fisheries existed between 1960-66, 1972-75 and 1989-93 (Reist and Treble 1998). Each of these attempts collapsed, due to factors such as technical problems, poor market conditions and competition with whitefish taken in southern fisheries (Chang-Kue and Jessop 1991; Reist and Treble 1998).

As the result of traditional knowledge and research efforts during the past 25 years, more is known about broad whitefish than any other species within the Mackenzie Delta area (Reist and Treble 1998). It has been established that large schools of broad whitefish migrate annually through the Mackenzie Delta and lower Mackenzie River on late summer and fall spawning routes. Significant numbers of broad whitefish have also been documented in the coastal bays and small watersheds of the Tuktoyaktuk Peninsula (Chang-Kue and Jessop 1997).

Within the lower Mackenzie River, there are two broad whitefish life history types, each with a number of biological populations possessing different characteristics and spawning locations (Reist 1997; Reist and Treble 1998). The first is partially anadromous, meaning that adults annually spend summers in brackish estuarine or marine areas (Reist and Chang-Kue 1997; Reist and Treble 1998). The second is lacustrine, in which adults are lake dwelling (Reist and Treble 1998).

Anadromous

The various stages of the broad whitefish's life history (egg, fry, juvenile and adult), as with most species, are separated into spatially distinct areas. Semi-anadromous fish spawn as adults, and hatch and feed as fry in freshwater, spending the remainder of their lives in brackish (typically waters with less than 20% salinity) coastal waters (Reist and Chang-Kue 1997). Adults of the semi-anadromous populations migrate, in alternate years or longer, between upstream spawning habitats in the Gwich'in and Sahtu Settlement Regions, and coastal feeding and overwintering areas in the nearshore Beaufort Sea (Reist 1997; Reist and Chang-Kue 1997; Reist and Treble 1998).

Spawning takes place primarily in the gravel substrate of the mainstem and major tributaries of the Mackenzie River under the ice during late October and early November when water temperatures are near 0^{o}C. These eggs hatch during the early spring (April/May). Fry emerge from the spawning bed and migrate or are flushed downstream under the ice during May and June with the spring floods (Reist and Chang-Kue 1997).

Once the freshwater creeks become ice-free in June-July, young-of-the-year and juveniles migrate up the creeks to feed and overwinter in the warm and productive lakes of the Tuktoyaktuk Peninsula (Reist and Chang-Kue 1997; Reist and Treble 1998). Four primary nursery systems on the Tuktoyaktuk Peninsula are known: McKinley, Kukjuktuk, Freshwater, Mayogiak and Canyanek Creeks (Reist 1997). There is a relatively low abundance of predatory fish, such as northern pike, lake trout and burbot, in the lakes of the Tuktoyaktuk Peninsula, adding to the importance of this habitat (Reist and Chang-Kue 1997). Some juvenile fish may also overwinter in the Mackenzie River or coastal bays of the estuary (Reist and Chang-Kue 1998). Large juveniles are distributed throughout the Mackenzie River and in lakes of the delta and Tuktoyaktuk Peninsula (Reist and Chang-Kue 1997). At sexual maturity, 7-9 years of age, during the summer prior to spawning, these individuals join the adult population (Reist and Treble 1998).

Adults spend the summer prior to spawning (which takes place every two years or more) feeding in the delta and peninsula lakes or nearshore estuarine waters. During late July and early August adult fish move toward pre-spawning aggregation sites in the Inner Delta at major eddies, until the water drops to a temperature near 0^{o}C. The fish migrate upstream during early November to a number of spawning sites in the Mackenzie River mainstem and tributary rivers (Reist and Chang-Kue 1997). Mature adults spawn only in upstream riverine locations in the Gwich'in and Sahtu Settlement Areas (Reist and Chang-Kue 1997; Reist and Treble 1998). It is likely that individuals from several populations intermingle within the delta area, and may therefore be exploited by numerous fisheries during the fall migration (Reist and Treble 1998).

Lacustrine

Less is known of the life history of lacustrine populations of broad whitefish (Reist and Treble 1998). Evidence of its existence comes from traditional knowledge, physiological and genetic differences, but definitive scientific studies of lacustrine populations are lacking (Reist and Chang-Kue 1997). It appears that these populations are restricted to the larger inland lake and river systems on the east side of the Mackenzie River (Reist and Chang-Kue 1997; Reist and Treble 1998). At least two different populations exist, one in Campbell Lake and the other in Travaillant Lake (Reist 1997; Reist and Chang-Kue 1997). Populations may also be present in the Outer Delta, such as in the Ya Ya Lakes. While it is suspected that these populations do migrate seasonally between different habitats, these distances are much shorter than those of semi-anadromous fish and never involve marine waters or coastal environments. In terms of the subsistence fishery, the lacustrine forms support only local fisheries (Reist and Chang-Kue 1997).

Lake Whitefish (Humpack/Crooked Back)

Lake whitefish (*Coregonus clupeaformis*), locally known as humpack or crooked back, in the Mackenzie Delta may exhibit different life history types: anadromous, lacustrine or riverine. In terms of the anadromous forms, spawning usually takes place in lakes with gravel or boulder substrate, though it may also take place in major rivers and tributaries. Fry are moved downstream in the spring floods to the Mackenzie Delta. Juveniles forage in coastal habitats near the mouth of the Mackenzie River, while adults are less saline tolerant and tend to occupy the delta lake systems. Overwintering takes place in the channels of the Mackenzie River for juveniles and in the delta/inner estuary for adults (MacMillan *et al*. 1992).

Arctic Cisco (Herring)

Arctic cisco (*Coregonus autumnalis*), locally known as herring, are anadromous residents of the Mackenzie River Delta and estuary. These fish migrate annually upstream to spawn during July-September over a gravel substrate in fast water. Following spawning, cisco migrate downstream from the time of freeze-up to December, where they typically spend the remainder of the year in the lower reaches of the turbid waters of the Mackenzie Delta and the brackish waters of the estuary (McPhail and Lindsey 1970; MacMillan *et al*. 1992). Tuktoyaktuk Harbour is known to be a major overwintering site (Bond 1982). The population range is international since some young-of-the-year fish that spawn in the Mackenzie River migrate westward to the Colville River, Alaska via wind-driven longshore currents (Fechhelm and Fissel 1988).

Least Cisco

Least cisco (*Coregonis sardinella*) are anadromous coregonids found throughout the lower Mackenzie River and coastal waters of the Beaufort Sea. Coastal watersheds of the Tuktoyaktuk Peninsula are used widely by least cisco, as well as the other coregonids, for summer foraging and overwintering activities (Jessop and Chang-Kue 1993). Spawning takes place during the fall (September to October) in delta lakes and rivers, eggs hatching in late May or early June, with lower delta streams and shallow nearshore coastal waters acting as nursery areas (McPhail and Lindsey 1970). Overwintering takes place in delta lakes and channels, as well as Mallik and Kugmallit Bays (MacMillan *et al*. 1992). A non-anadromous form of the species exists which is usually restricted to lakes (Bond 1982).

Inconnu (Coney)

Inconnu (*Stenodus leucichthys*), locally known as coney, are anadromous in coastal areas of the Mackenzie Delta, and non-anadromous further inland. Anadromous populations migrate from nearshore environments upstream to spawn I the tributaries of the Peel and Arctic Red River, beginning with ice break-up and peaking in June (Corkum and McCart 1981; MacMillan *et al*. 1992). Large number of inconnu have been found in turbid lakes on Richards Island at break-up and during the summer, as well as in Mallik and Mason Bays during the open water season (Percy *et al*. 1974) and Shingle Point. These fish do not stray far from the mouth of the Mackenzie River, and are thought to be the least saline tolerant member of the coregonids (Chang-Kue and Jessop 1991; McPhail and Lindsey 1970). Feeding and overwintering takes place along the coast in close proximity to river and channel mouths, as well as in lakes and channels of the lower delta (Corkum and McCart 1981). A subsistence fishery exists for inconnu in the autumn and winter, with catches primarily going to feed dog teams (Chang-Kue and Jessop 1991; McPhail and Lindsey 1970; Percy *et al*. 1974).

8.1.2.2. Dolly Varden Char

Dolly Varden char (*Salvelinus malma*) are found from the Mackenzie River west through Alaska; east of the river, char are considered to be Arctic Char (*S. alpinus*). Specifically, riverine char in the area are Dolly Varden, while lacustrine forms are relict Arctic char (Reist *et al*. 1997). Multiple populations exist along the coast, organized by major river systems, though more than one population may occur within a system (Everett *et al*. 1997).

Dolly Varden are anadromous, summering and feeding in the nearshore areas of the Beaufort Sea and annually migrating to freshwater for spawning, rearing and overwintering (Everett *et al*. 1997; Gillman *et al*. 1985). Migration begins during early August and is finished by mid-September (Gillman *et al*. 1985). Spawning takes place every second or third year in streams with gravel substrate (MacMillan *et al*. 1992). In the Big Fish River, char spawning tends to take place in the fish holes area of Cache Creek, an area characterized by gravel substrates and alternating riffles and pools (Gillman *et al*. 1985). By late October spawning is complete, with fish remaining in their selected freshwater systems until freeze-up (Gillman *et al*. 1985). The large pools in the fish holes area are used for overwintering and rearing of fry (Gillman *et al*. 1985; MacMillan *et al*. 1992). At Fish Hole and Rat River, the Dolly Varden population is currently at risk due to physical changes in water quality (Community of Inuvik and WMAC-NWT 1999).

8.1.2.3.Rainbow Smelt

Rainbow smelt (*Osmerus mordax*) are found throughout the lower delta, particularly offshore in Kugmallit Bay and congregating in coastal waters near the mouths of rivers. By March, prior to spring break-up, the smelt migrate into the Mackenzie Delta to spawn within the river and its tributaries (MacMillan *et al*. 1992; Percy *et al*. 1974). Following spawning, adults return to the sea to forage by July. Emergent fry are carried out of the Mackenzie River with the spring flood, remaining in coastal waters as juveniles (MacMillan *et al*. 1992).

8.1.3. Marine Species

8.1.3.1. Pacific Herring (Blue Herring)

Pacific herring (*Clupea pallasi*), locally known as blue herring, inhabit salt and brackish waters of the Beaufort Sea (Community of Inuvik and WMAC-NWT 1999). Spawning takes place June-July at spring break-up in shallow brackish waters and at the mouths of tributaries (Corkum and McCart 1981; Tanasiuchuk *et al*. 1993). Nursery and overwintering areas are located along the Tuktoyaktuk Peninsula and Inner Shallow and Kugmallit Bays (Corkum and McCart 1981). Following spawning, herring disperse throughout the Beaufort coast to feed, with individuals found at Shingle Point, Richards Island and the Tuktoyaktuk Peninsula (Community of Inuvik and WMAC-NWT 1999; Tanasiuchuk *et al*. 1993). Offshore waters of the Beaufort Sea are though to be the most important feeding areas for the species (Corkum and McCart 1981). A test fishery for the species was conducted during the 1980s, but no commercial fishery has been implemented.

8.1.3.2. Arctic Cod

Arctic cod (*Boreogadus saida*) is a key species in the Arctic marine ecosystem because of its wide distribution, abundance and importance in the diet of marine mammals, birds and other fish (Craig *et al*. 1982). The species is primarily found in the offshore environment, where they spawn offshore between November and February, feed and overwinter. There is an association between the distribution of Arctic cod and the marine water mass, with the fish moving inshore and offshore in response to its presence. Coastal waters are used as nursery areas and feeding areas, to which adults migrate in late summer (Craig *et al*. 1982; Moulton and Tarbox 1987).

8.1.3.3. Fourhorn Sculpin

Fourhorn sculpin (*Myoxocephalus quadricornis*) is widely distributed throughout the Beaufort Sea, with larvae and fish of all ages reported along the coasts of Alaska, Yukon and the Northwest Territories. In the southeastern Beaufort Sea, the species is particularly abundant along the Tuktoyaktuk Peninsula and tends to avoid the Mackenzie River Plume. Fourhorn sculpin have been found to travel up to 1km inland in coastal streams, but not beyond the area of tidal influence. Overwintering takes place in bays and inlets along the coast in areas free of landfast ice (Houston 1990). Spawning likely takes place in mid to late winter under the ice, with eggs hatching before break-up in May to June (Bond and Erickson 1989; Houston 1990). Larvae are abundant in shallow pelagic areas and along the coast by July. Little is known about the movements of fourhorn sculpin, but it is thought that they move to the coast from offshore areas in the spring, returning offshore in the fall (Houston 1990).

8.1.4. Freshwater Species

8.1.4.1.Northern Pike (Jackfish)

Northern pike (*Esox lucius*), locally known as jackfish or jacks, are freshwater fish, typically found where salinity levels are negligible (Percy *et al*. 1974; Scott and Crossman 1998). Large turbid lakes in the lower delta are used extensively by pike for feeding (Percy *et al*. 1974). In these lakes pike concentrate to feed on the variety of juvenile coregonids that enter the lakes via the spring floods (Chang-Kue and Jessop 1991). They migrate upstream to spawn immediately after ice break-up, which is completed within several weeks (MacMillan *et al*. 1992; McPhail and Lindsey 1970; Scott and Crossman 1998). Pike inhabit shallower waters during the spring and fall, but move to deeper cooler waters in the summer (Scott and Crossman 1998). Northern pike are an economically important sport fish within the ISR.

Table 8.1.1.: Major fish species of the Mackenzie Delta and southeastern Beaufort Sea (modified from Community of Inuvik and WMAC-NWT 1999; Corkum and McCart 1981).

Common Name(s)	Scientific Name
Marine/Anadromous Species	
Dolly Varden Char	*Salvelinus malma*
Arctic Cod	*Boreogadus saida*
Broad Whitefish	*Coregonus nasus*
Lake Whitefish	*Coregonus clupeaformis*
Arctic Grayling	*Thymallus arcticus*
Fourhorn Sculpin	*Myoxocephalus quadricornis*
Starry Flounder	*Platichthys stellatus*
Arctic Flounder	*Liopsetta glacialis*
Greenland Cod	*Gadus ogac*
Arctic Cod	*Boreogadus saida*
Saffron Cod	*Elegiums navaga*
Pacific Herring/Blue Herring	*Ceupea spp.*
Capelin	*Mallotus villosus*
Pink Salmon	*Oncorhynchus gorbuscha*
Chum Salmon	*Oncorhynchus keta*
Tom Cod	*Microgadus proximus*
Sand Lance	*Amodytes spp.*
Rainbow Smelt	*Osmerus mordax*
Arctic Lampry	*Lampetra japonica*
Boreal Smelt	*Osmerus eperlanus*
Freshwater Species	
Arctic Char	*Salvelinus alpinus*
Inconnu/Coney	*Stenodus leucichthys*
Round Whitefish	*Prosopium cylindraceum*
Broad Whitefish	*Coregonus nasus*
Lake Whitefish	*Coregonus clupeaformis*
Arctic Grayling	*Thymallus arcticus*
Lake Trout	*Salvelinus namaychus*
Walleye	*Stizostedion vitreum*
Northern Pike	*Esox lucius*
Burbot/Loche	*Lota lota*
Trout Perch	*Percopsis omiscomaycus*
Least Cisco	*Coregonus sardinella*
Arctic Cisco	*Coregnous autumnalis*
Pond Smelt	*Hypomesus olidus*
White Sucker	*Catostomus commersoni*
Longnose Sucker	*Catostomus catostomus*
Finescale Dace	*Phoximus neogaeus*
Longscale Dace	*Rhinichthys cataractae*
Flathead Chub	*Platygobio gracilis*
Lake Chub	*Couesius plumbeus*
Nine-spine Stickleback	*Pungitius pungitius*
Spoonhead Sculpin	*Cottus ricei*
Slimy Sculpin	*Cottus cognatus*
Deepwater Sculpin	*Myoxocephalus quadricornis*

Table 8.1.2.: Overview of some fish activities in the Mackenzie Estuary and Beaufort Sea (modified from: Bond 1989; Chang-Kue and Jessop 1991; Community of Inuvik and WMAC-NWT 1999; Corkum and McCart 1981; Jessop and Chang-Kue 1993; Gillman *et al*. 1985; MacMillan *et al*. 1992; McPhail and Lindsey 1970; Percy *et al*. 1974; Reist and Chang-Kue 1997; Reist and Treble 1998; Tanasichuk *et al*. 1993)

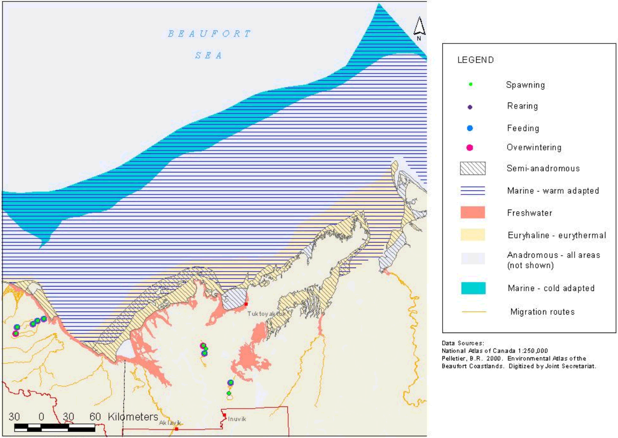
Species	Spawning Period	Spawning Location	Nursery Areas	Feeding Areas	Wintering Areas
Anadromous Species					
Broad whitefish – semi-anadromous	August – September	Upstream in mainstem and major tributaries	Delta lakes, lagoons and shallow nearshore coastal waters of the Mackenzie Delta and Barrier Islands	Adults: nearshore coastal regions of Beaufort Sea and Tuktoyaktuk Peninsula Juveniles: warm and productive lakes of Tuktoyaktuk Peninsula	Adults: nearshore coastal regions of Beaufort Sea and Tuktoyaktuk Peninsula Juveniles: warm and productive lakes and rivers of Tuktoyaktuk Peninsula
Arctic cisco	August – October	Tributaries of the Mackenzie River, Mackenzie River and Arctic Red River	Embayments, lagoons and shallow nearshore waters along the coastline of the outer Mackenzie Delta and Barrier Islands	Nearshore reaches of the outer Mackenzie Delta	Deep brackish water areas along the outer Mackenzie Delta, estuary and turbid waters of lower Delta
Least cisco	September – October	Delta lakes, Peel Channel, Husky Channel, Red River and in the Mackenzie River near Arctic Red River	Lower delta streams and lakes along the shallow nearshore coastal waters of the outer Mackenzie Delta	Shallow nearshore coastal waters of the outer Mackenzie Delta, including Barrier Islands and freshwater lakes and streams in the lower delta; coastal watersheds of the Tuktoyaktuk Peninsula	Delta lakes and channels, Mallik and Kugmallit Bays; coastal watersheds of the Tuktoyaktuk Peninsula
Inconnu	September – October	Outer Mackenzie Delta	Tributaries of the Peel and Arctic Red River	Adults: coastal areas of Beaufort Sea Juveniles: coastal habitats within Mackenzie estuary	Coastal regions of outer Mackenzie Delta; Kugmallit Bay and Tuktoyaktuk Harbour and in river
Dolly Varden char	Autumn	Cache Creek fish holes area	Cache Creek fish holes area	Estuary, nearshore waters	Mackenzie Delta streams and rivers

Table 8.1.2. (continued): Overview of some fish activities in the Mackenzie Estuary and Beaufort Sea.

Species	Spawning Period	Spawning Location	Nursery Areas	Feeding Areas	Wintering Areas
Anadromous Species (cont'd)					
Boreal smelt	April – March	East Channel, mouth of Holmes Creek	Shallow nearshore and inshore coastal waters along the Mackenzie Delta and Beaufort Sea coastline	Throughout the brackish and freshwater regions of the outer Mackenzie Delta and Beaufort Sea coastline; Kugmallit Bay	Deep water regions beyond the Barrier Islands, Kugmallit Bay and waters along the Beaufort Sea coastline
Rainbow smelt		Mackenzie River and tributaries		Lower delta; Kugmallit Bay; Beaufort Sea coastal waters	Adults: Lower delta; Kugmallit Bay; Beaufort Sea coastal waters Juveniles: coastal waters
Freshwater Species					
Broad whitefish – lacustrine	August – September	Lakes and rivers of Mackenzie Delta	Lakes and rivers of Mackenzie Delta	Lakes and rivers of Mackenzie Delta	Lakes and rivers of Mackenzie Delta
Lake whitefish	August – September	Mackenzie Delta lakes and major rivers and tributaries	Delta lakes, lagoons and shallow nearshore coastal waters of the Mackenzie Delta and Barrier Islands	Adults: Lakes and channels of the Mackenzie Delta; remain within close proximity to river and channel mouths Juveniles: coastal habitats near mouth of river	Adults: Mackenzie Delta and inner estuary; Tuktoyaktuk Peninsula Juveniles: channels of the Mackenzie River
Northern pike	Spring, after ice break up	Upstream Mackenzie Delta		Large turbid lakes of Mackenzie Delta	

Table 8.1.2. (continued): Overview of some fish activities in the Mackenzie Estuary and Beaufort Sea.

Species	Spawning Period	Spawning Location	Nursery Areas	Feeding Areas	Wintering Areas
Marine Species					
Fourhorn sculpin	January – March	Widespread over winter range	Nearshore brackish waters, Barrier Islands and along Beaufort Sea coastline	Widespread throughout brackish water regions of the outer Mackenzie Delta and Beaufort Sea coastline	Deep water embayments and inshore waters along the outer Mackenzie Delta and Beaufort Sea coastline
Arctic flounder	February – March	Inshore brackish and offshore marine waters of Mackenzie Bay	Brackish coastal waters of the outer Mackenzie Delta	Brackish waters along the northeast coastline of Richards Island	Throughout the inshore and offshore wasters of Mackenzie Bay and Kugmallit Bay, and the deepwater embayments of Richards Island
Arctic cod	December – February	Offshore marine waters; possibly nearshore waters	Inshore waters of Kugmallit Bay and the Beaufort Sea	Offshore marine waters	Deeper offshore waters
Pacific Herring	June – July at spring break-up	Mouths of tributaries to Mackenzie River	Inner Shallow Bay and Kugmallit Bay; Tuktoyaktuk Peninsula	Coastal bays and lagoons along Richards Island; principal feeding area is offshore waters	Inner Shallow Bay and Kugmallit Bay



Data Sources:
National Atlas of Canada 1:250,000
Pelletier, B.R. 2000. Environmental Atlas of the Beaufort Coastlands. Digitized by Joint Secretariat.

Figure 8.1.1.: Fish habitat.

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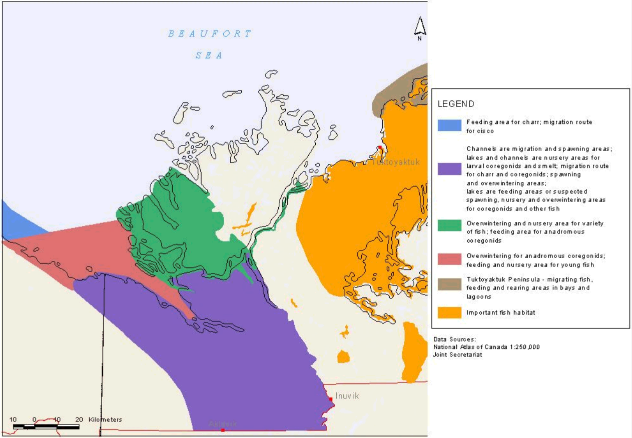

Figure 8.1.2.: Important fish habitat, as identified in the Community Conservation Plan.

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8.2. Marine Mammals

8.2.1. Beluga

The Beaufort stock of beluga (*Delphinapterus leucas*) winters in the Bering Sea and summers in the Beaufort Sea and Amundsen Gulf (Marko and Fraker 1980). Each spring, following east-west offshore shear zone leads, the Beaufort stock migrates through the Chukchi Sea, past Point Barrow, Alaska and reaches the Beaufort Sea (Marko and Fraker 1980; Seaman *et al*. 1986, as cited in Wong 1999). The Mackenzie estuary is home to many beluga from late June to late July or early August, with densities generally peaking in the first half of July (Norton and Harwood 1985). Other beluga aggregations occur offshore, and by August most of the Beaufort stock has moved offshore (Figure 8.2.1.) (Fraker and Fraker 1979). Beluga are capable of making repeated deep dives of over 1,000m and move hundreds of kilometres away from their early summer estuarine concentrations (Richard *et al*. 1997).

Within the Mackenzie estuary, beluga concentrate around the northward extension of the delta that Richards Island provides (Weaver 1991). The estuary, with its warm, turbid, low salinity, shallow waters, is utilized primarily for socializing behaviour and moulting (Norton and Harwood 1986). Concentration areas are located at Niakunak Bay, Kendall Island and Kugmallit Bay. These areas coincide with the focus of the annual subsistence harvest of the Inuvialuit and hunting camps are located adjacently along the coast (Weaver 1991).

The prey of beluga includes fish, such as pacific herring and least cisco, and crustaceans, such as squid (Byers and Roberts 1997; Sergeant and Hoek 1974). Conservative estimates of the Beaufort Sea beluga stock are around 15,000 individuals, though it is likely that this number underestimates the actual population due to limitations in survey techniques (Harwood *et al*. 1996; Richard *et al*. 1997).

Table 8.2.1.: Seasonal beluga habitat in the Western Arctic (modified from Harwood *et al*. 1996; Wong 1999).

Season/Date	Location	Activity
Spring	▪ Migrate through the Chukchi Sea, pass Point Barrow, Alaska and proceed eastward to the Beaufort Sea following east-west offshore shear zone leads	Migration
Late June	▪ Migration into Mackenzie estuary via leads off the Tuktoyaktuk Peninsula	Migration
Summer	▪ Within the Mackenzie estuary beluga concentrate in Niakunak Bay, Kendall Island and southwest Kugmallit Bay around Hendrickson Island ▪ Estuary is used for socializing and moulting	Socializing and moulting
July	▪ Aggregation offshore in the Beaufort Sea and Amundsen Gulf	Feeding
Late August	▪ Move across the Beaufort Sea along the Alaskan coastal waters to the Bering Sea ▪ Some beluga migrate across the Arctic Ocean, reaching the East Siberian Sea or western Chukchi Sea before arriving at the Bering Sea	Migration
Winter	▪ Bering Sea	Overwintering

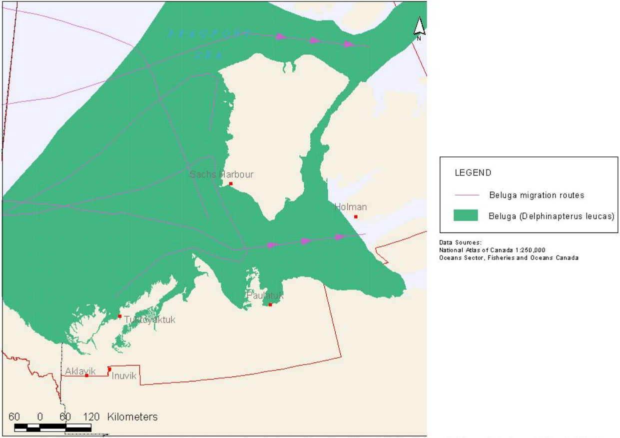

Figure 8.2.1.: Simplified beluga range and migration routes in the southeastern Beaufort Sea (currenlty the only data available to DFO).

8.2.2. Bowhead

In the past, the Western Arctic bowhead stock was distributed in the Beaufort, Chukchi and Bering Seas as far west as Mys Billingsa and as far east as Amundsen Gulf. Because of this distribution, the stock is also known as the Bering/Chukchi/Beaufort Sea stock. The bowhead range is bounded to the north by the permanent pack ice and to the south in the area of St. Lawrence and St. Matthew Islands of Alaska (DFO *et al*. 1991). The population is classified as endangered, however it is generally considered to be a healthy population with numbers between 6,600 and 6,900 (Silva *et al*. 2000).

Bowhead whales (*Balaena mysticetus*) migrate to the Canadian Beaufort Sea from Alaska along the Yukon North Slope through leads in the pack ice in spring, departing westward in open water in September (Aklavik HTC 1988; Sergeant and Hoek 1974). Feeding by sub-adults (10-12m in length) occurs in large numbers at Shingle Point and King Point in August and September (Figure 8.2.2.). Adults and calves travel to deeper waters to feed (Aklavik HTC 1988). Movements of bowhead during the summer and fall appear to correspond to the availability of their main prey, zooplankton. Zooplankton productivity is influenced by the Mackenzie River plume; when the influence of the plume is strong zooplankton biomass is low; when Arctic water is at the surface, zooplankton biomass is high (Bradstreet *et al*. 1987). Summering (May to September) takes place in the southeastern Beaufort Sea and wintering in the Bering Sea (Brueggeman 1982; DFO *et al*. 1991). Bowhead have been found to frequently aggregate offshore of Tuktoyaktuk Peninsula, especially in the area north and northwest of Cape Dalhousie. This area is associated with the winter location of the Bathurst polynya, a particularly productive area in winter and spring, as well as with aggregations of ringed and bearded seals (Harwood 1989).

Table 8.2.2.: Seasonal bowhead whale habitat in the Western Arctic (modified from Wong 1999).

Season/Date	Location	Activity
January to March	▪ Bering Sea – from St. Lawrence Island to St. Matthew Island ▪ In years of extensive ice pack as far south as the Pribilof Islands	Overwintering
Spring – dependent on ice conditions; generally late April and May	▪ Starts from the northwestern Bering Sea along the western areas of St. Lawrence Island and north through western Bering Straight into the Chukchi Sea ▪ Head northeast following leads along the northwest coast of Alaska ▪ Follow easterly offshore leads in Beaufort Sea to reach Banks Island ▪ Bowhead break heavy pack ice using their heads to push the ice from underneath to breath	Spring migration
June and July	▪ Concentrate in Amundsen Gulf or as far east as Victoria Island	Feeding
August	▪ Move into Mackenzie delta and Yukon zone ▪ Sub-adults feed at Shingle Point and King Point	Feeding
August and September	▪ Variable ▪ Bowhead are known to concentrate in three main areas, segregated by age: 1. Yukon coast between Kay and Shingle Point and Herschel Island (immatures, particularly yearlings; adults with calves in deep waters of Herschel Island canyon and further offshore) 2. North of the eastern Tuktoyaktuk Peninsula between McKinley Bay and Cape Dalhousie (adults and sub-adults) 3. Amundsen Gulf (adults and sub-adults)	Feeding
Fall	▪ Move from offshore toward continental shelf waters (<50m) ▪ Head toward Point Barrow, Alaska; travel either across the northern Chukchi Sea or southwestward across Chukchi Sea	Fall migration
November to December	▪ Enter Bering Sea	Overwintering

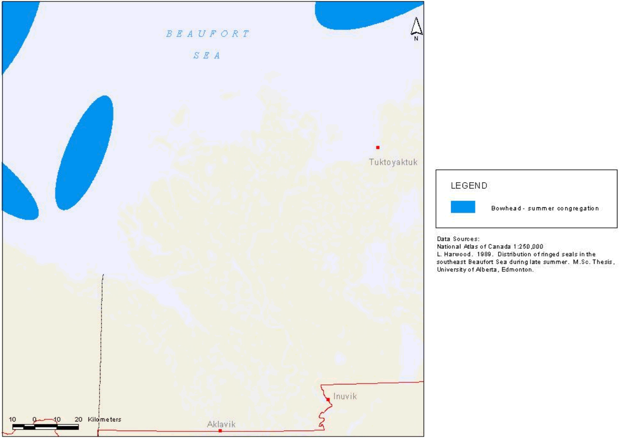

Figure 8.2.2.: Beaufort Sea bowhead summer congregation areas.

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8.2.3. Ringed Seal

Within the southeastern Beaufort Sea area, ringed seals (*Phoca hispida*) tend to aggregate most frequently and in the greatest numbers in waters offshore of the Tuktoyaktuk Peninsula (Harwood 1989). This area, particularly north and northwest of Cape Dalhousie, corresponds to the winter location of the Bathurst polynya (Harwood 1989; Harwood and Stirling 1992).

Ringed seas are the primary prey of the polar bear (*Ursus maritimus*) and an important prey for the arctic fox (*Alopex lagopus*) (Smith 1987). As for the prey of the seals themselves, they feed from several trophic levels, affected by season and age. During the winter months, the seals feed within or near their territories and are dependent on spawning arctic cod. Less feeding takes place during spring haul-out and summer, but food intake increases again in late summer and fall (Harwood 1989), with prey species shifting from fish to crustaceans, especially mysids, amphipods and euphausiids (Harwood and Stirling 1992; Wong 1999).

In the Beaufort Sea, the ringed seal population is present throughout the year (Figure 8.2.3.), though local and large-scale movements may take place (Harwood 1989). These movements are likely in relation to food availability or ice conditions (Smith 1987). In the open water period, the seals are found in large groups, more concentrated than during ice-covered periods (Harwood 1989; Harwood and Stirling 1992). During moulting (June), ringed seals can be found most anywhere that stable landfast ice occurs. Following this period, ringed seals are distributed throughout the region until late August. In the fall, ringed seal aggregations are sometimes seen in association with seabirds and bowhead whales, likely due to the availability of zooplankton food sources (Harwood 1989).

Table 8.2.3.: Seasonal ringed seal habitat in the Western Arctic (modified from Harwood 1989; Smith 1987; Stirling *et al*. (1) 1981; Wong 1999).

Season/Date	Location	Activity
Late June	▪ Throughout the southeastern Beaufort Sea haul out around holes in the sea ice ▪ Widely distributed throughout areas of stable ice ▪ Prefer waters of moderate depths (50-100m), avoiding deepest waters of the Beaufort Sea	Moulting
Summer	▪ Ringed seals are widely distributed throughout the Beaufort region until late August	
Late summer and fall	▪ Aggregations located in nearshore waters north of Tuktoyaktuk Peninsula and the western Yukon coast	Feeding
Fall	▪ Adolescents found mainly in open water and pack ice	Feeding
Fall	▪ When landfast ice starts to form, adults found in areas of stable ice along coastline, particularly complex coastlines such as fjords and islands	Feeding
Early January	▪ Haul-out lairs constructed	Resting
mid-April	▪ Land-fast coastal ice	Birth of pups
Early fall	▪ Groups of adults occupy areas of land-fast coastal ice	Feeding
Late summer-early fall	▪ Young of the year and adolescent seals begin a westward migration along the coast	Feeding
Spring – mid-May to mid-June	▪ Adults occupy areas of land-fast coastal ice	Breeding
Winter	▪ Breeding adults establish territories in stable landfast ice areas ▪ Immature seals are at the periphery of the prime breeding areas where fast ice is less stable	

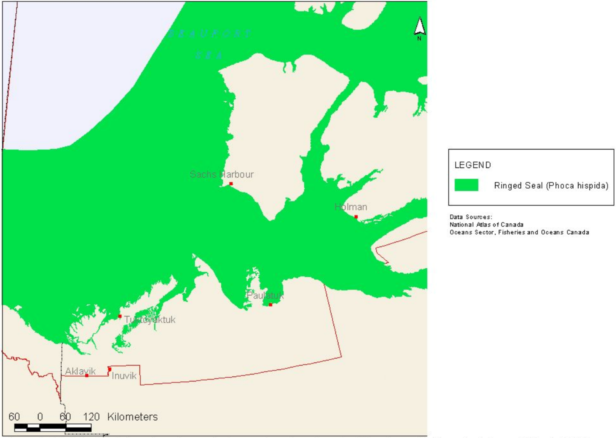

Figure 8.2.3.: Simplified ringed seal range in the southeastern Beaufort Sea (currenlty the only data available to DFO).

8.2.4. Bearded Seal

Bearded seals (*Erignathus barbatus*), though much less common than ringed seals in the southeastern Beaufort Sea area, are resident in the Mackenzie estuary region throughout the year. These seals are benthic feeders, and as such are most often found over shallow depths where food is more accessible and abundant. Feeding takes place throughout the year (Harwood 1989).

The shallow waters (<50m) offshore of the Tuktoyaktuk Peninsula (especially north and northwest of Cape Dalhousie) is a preferred habitat for bearded seals, which is the only area where they appear to aggregate (Harwood 1989). Bearded seal stocks are largely sedentary, with little change in distribution either seasonally or annually (Figure 8.2.4.) (Harwood 1989). These animals are generally found as solitary individuals associated with moving pack ice, such as leads and polynyas (InfoNorth 2000).

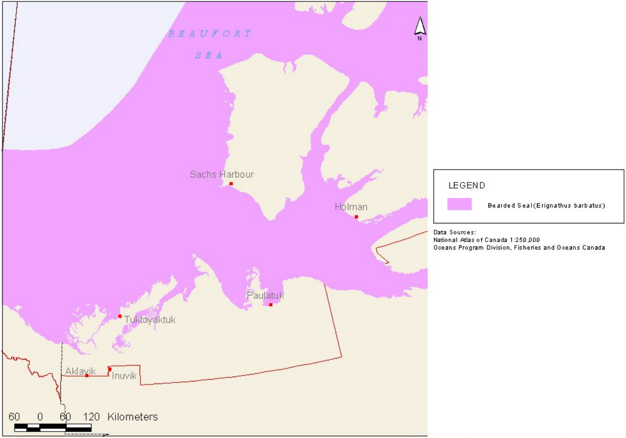

Figure 8.2.4.: Simplified bearded seal habitat and range in the southeastern Beaufort Sea (currently the only data available to DFO).

8.2.5. Polar Bear

The main prey of polar bear in Canada's western arctic is ringed seal. Seals are preyed upon after ice freeze-up in offshore areas of moving ice pack and along the edges of fast ice or floes (Smith 1980). Both polar bears and pack ice retreat in late summer and fall, and predation ceases (Harwood 1989).

Habitat preferences of polar bears vary based on sex and age (Figures 8.2.5. and 8.2.6.). Adult males strongly prefer the floe edge and areas of moving ice. Sub-adult males also show preference for these areas, to a less significant extent. Adult females with cubs of the year strongly prefer stable fast ice with deep snowdrifts along the pressure ridges. It is likely that females with young cubs choose this habitat due to the fact that few adult males are found in such areas. Sub-adult females also show preference for this habitat type, while lone females and those with older cubs appear to have no preference (Stirling *et al*. (2) 1981).

Based on Stirling *et al*. (2) 1981, the most important feeding area for polar bears from winter to early summer is adjacent to the Cape Bathurst polynya. This area is of particular importance to adult and sub-adult males, as it is usually characterized as their preferred habitat type. For adult females with cubs of the year and sub-adult females, the most important habitat tends to be distributed along the west coast of Banks Island and the northern half of Amundsen Gulf (Stirling *et al*. (2) 1981).

The polar bears that inhabit the Beaufort Sea are divided into two components: those associated with the west coast of Banks Island and those associated with the mainland coast. Those of the mainland coast are part of a larger population shared with Alaska. Seasonal migrations take place between the west coast of Banks Island and the Cape Bathurst polynya or Amundsen Gulf. Those bears associated with the offshore of the mainland seasonally migrate east or west along the coast. Bears tend to move with the permanent pack ice, so that when it is blown south towards the mainland more bears are sighted on the coast and islands, such as Herschel Island. When the ice is blown back toward the north, so are the bears. Occasionally polar bears spend the summer on land on the southern end of Banks Island or on the Baillie Islands and mainland coast, but this is uncommon and likely accidental (Stirling *et al*. (2) 1981). It has been estimated that the eastern Beaufort Sea-Amundsen Gulf polar bear population totals 1,200 individuals (Stirling 1998).

Table 8.2.4.: Seasonal polar bear habitat in the Western Arctic (modified from Harwood 1989; Stirling *et al*. (2) 1981).

Season/Date	Location	Activity
Late summer - early fall	▪ Polar bears retreat with the pack ice	Migrate
Freeze-up	▪ Southern migration, following the ice as it freezes up	Feeding
Winter to early summer	▪ Cape Bathurst polynya – male adults and sub-adults	Feeding
Freeze-up to break-up	▪ Bears are distributed over the ice of the southeastern Beaufort Sea and Amundsen Gulf	Feeding
Break-up	▪ As open water develops, first at the Cape Bathurst polynya and extending east, bears move ahead of the advancing floe edge ▪ Amundsen Gulf and Banks Island bears move north along the west coast of Banks Island ▪ Bears on the mainland move west along the coast ▪ Both groups move north as far as necessary to remain with the edge of the permanent ice pack	Migrate
Spring	▪ Western and southern coasts of Banks Island	Maternity denning

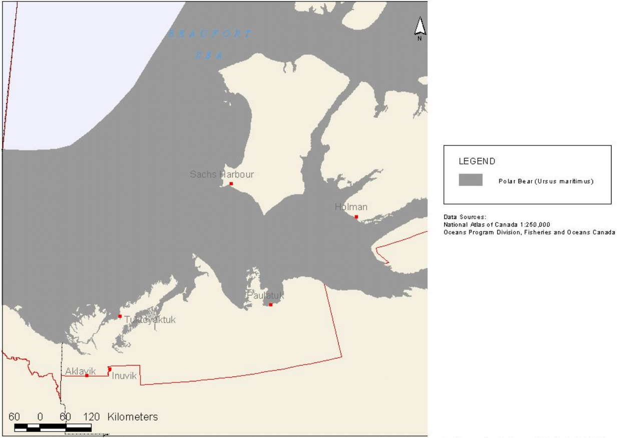

Figure 8.2.5.: Simplified polar bear habitat and range in the southeastern Beaufort Sea (currently the only data available to DFO).

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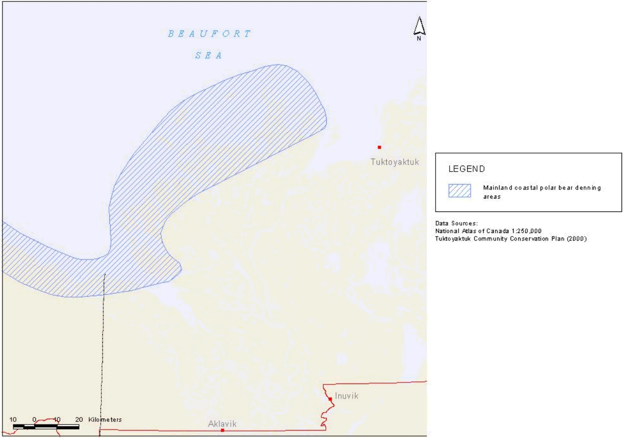

Figure 8.2.6.: Mainland coastal polar bear denning areas in the southeastern Beaufort Sea.

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8.3. Terrestrial Mammals

8.3.1. Bluenose Caribou

The Bluenose caribou (*Rangifer tatandus*) herd is primarily found east of the Mackenzie Delta. During the summer the herd is found within the Brock, Hornaday and Horton River area for calving. The herd migrates north and northeast to the treeline and coastal areas of the Tuktoyaktuk Peninsula for the winter (Figure 8.3.1.) (Community of Tuktoyaktuk and WMAC-NWT 1999; LGL Limited 1982).

8.3.2. Grizzly Bear

Grizzly bears (*Ursus arctos horribilis*) are found in terrestrial mainland habitats, utilizing lowland wetlands in early summer and upland areas later in the summer. Lowland areas are occupied only when located near uplands (LGL Limited 1982). Richards Island and the Mackenzie Delta provide important grizzly habitat (Figure 8.3.2.) (Community of Tuktoyaktuk and WMAC-NWT 1999; LGL Limited 1982). Breeding takes place during June and July, and denning from October to May (Community of Tuktoyaktuk and WMAC-NWT 1999).

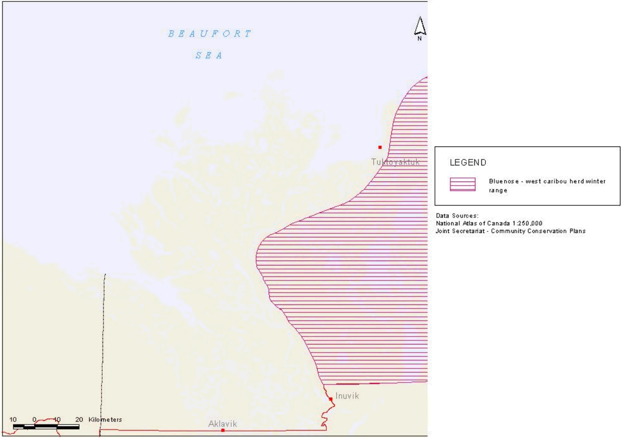

Figure 8.3.1.: Bluenose-west caribou herd winter range.

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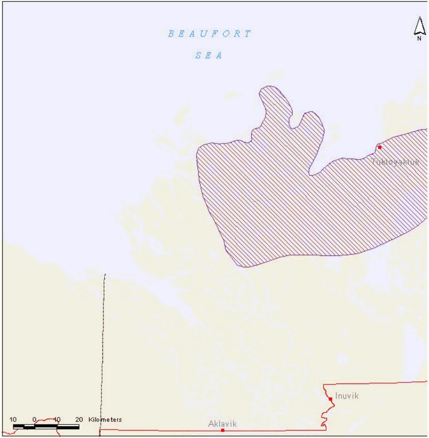


LEGEND

Critical grizzly bear denning areas

Data Sources:
National Atlas of Canada 1:250,000
Joint Secretariat - Community Conservation Plans

Figure 8.3.2.: Critical grizzly bear denning areas.

Fisheries and Oceans Canada Pêches et Océans Canada

Canada

8.4. Shorebirds

Over 130 bird species have been identified in the Mackenzie Delta region (MDBSRLUPC 1991). The southeastern Beaufort Sea coastal zone provides marine and littoral habitat for hundreds of thousands of migrating, breeding and moulting birds (Tables 8.3.1., 8.3.2. and 8.3.3.) (Alexander *et al*. 1988). Of these, priority species for management are the Hudsonian godwit (*Limosa haemastica*), whimbrel (*Numenius phaeopus*), stilt sandpiper (*Calidris himantopus*), long-billed dowitcher (*Limnodromus scolo paceus*) (Dickson and Smith 1991). Endangered species are the Eskimo curlew and peregrine falcon (MDBSRLUPC 1991).

The Mackenzie Delta coastal area is an important staging and nesting area for hundreds of thousands of migratory waterfowl, seabirds and other birds (Figures 8.3.1., 8.3.2. and 8.3.3.). Approximately one-fifth of the world's population of whistling swans nest along the Yukon coast and Mackenzie Delta, as well as the entire Canadian breeding populations of yellow-billed loon, yellow wagtail and blue throat (MDBSRLUPC 1991). The islands of the delta provide important staging grounds during the fall migration, with up to 375,000 lesser snow geese, 23,700 white-fronted geese, 12,200 brant, 1,065 Canada geese and 3,400 tundra swans previously observed. Such great numbers of these migratory birds represent large percentages of the total Canadian populations for these species (McCormick *et al*. 1984). Coastal areas of the delta act as important flyways for birds that follow open ice leads in the spring (MDBSRLUPC 1991).

Table 8.4.1.: Avian activities in the Mackenzie Delta, early June to mid-July (* = significant population) (modified from Alexander *et al*. 1988).

Area	Species	Activity	Location
Southwest of Shallow Bay	Tundra swans* (*Cygnus columbianus*)	Nesting, moulting	**Late May-early June**: open areas along river channels **Late June**: Floodplain grass-sedge meadows and on lakes and ponds
	Dabbling ducks (*Anas* sp.)	Nesting, moulting	Ponds, channels, marshes and grass-sedge delta flats
	Arctic terns (*Sternus paradisaea*)	Nesting	Ponds, channels, marshes and grass-sedge delta flats
	Pacific loons (*Gavia pacifica*)	Nesting	Ponds, channels, marshes and grass-sedge delta flats
	Red-throated loons (*Gavia stellata*)	Nesting	Ponds, channels, marshes and grass-sedge delta flats
	Scaup (*Aythya* sp.)	Nesting	Ponds, channels, marshes and grass-sedge delta flats
	Oldsquaw (*Clangula hyemalis*)	Nesting	Ponds, channels, marshes and grass-sedge delta flats
East of Ellice Island to east edge of Kendall Island Bird Sanctuary	Pacific loons	Nesting	Low lying coastal tundra vegetation and wetlands
	Red-throated loons	Nesting	Low lying coastal tundra vegetation and wetlands
	Tundra swans	Nesting	Low lying coastal tundra vegetation and wetlands
	Dabbling ducks	Nesting	Low lying coastal tundra vegetation and wetlands
	Scaup	Nesting	Low lying coastal tundra vegetation and wetlands
	Shorebirds	Nesting	Low lying coastal tundra vegetation and wetlands
	Arctic terns	Nesting	Low lying coastal tundra vegetation and wetlands
	Long-billed dowitchers (*Limnodromus scolopaceus*)	Nesting – limited breeding range	Low lying coastal tundra vegetation and wetlands
	Stilt sandpipers (*Micropalama himantopus*)	Nesting – limited breeding range	Low lying coastal tundra vegetation and wetlands
	Hudsonian godwits (*Limosa haemastica*)	Nesting – limited breeding range	Low lying coastal tundra vegetation and wetlands
	Whimbrel (*Numenius phaeopus*)	Nesting – limited breeding range	Low lying coastal tundra vegetation and wetlands
Garry Island	Glaucous gulls (*Larus hyperboreus*)	Nesting, feeding (marine waters)	Low, gravel and sand spit at the northeast end of the island
	Arctic terns	Nesting, feeding (marine waters)	Low, gravel and sand spit at the northeast end of the island
	Tundra swans	Unknown	Entire island
	Brant (*Branta bernicla*)	Nesting	Low, gravel and sand spit at the northeast end of the island

Table 8.4.1. (continued): Avian activities in the Mackenzie Delta, early June to mid-July (* = significant population) (modified from Alexander *et al*. 1988).

Area	Species	Activity	Location
Pelly Island	Tundra swans*	Nesting, moulting	Entire island
	Brant	Nesting	Sand spit extending eastward from the northeast edge of the island
	Glaucous gulls	Nesting, feeding (shoreline and offshore waters)	Sand spit extending eastward from the northeast edge of the island
	Arctic terns	Nesting, feeding (shoreline and offshore waters)	Sand spit extending eastward from the northeast edge of the island and spit along the north end of the island
	Dabbling ducks	Nesting	Entire island
Island west of Kendall Island	Glaucous gulls	?	Sand and gravel island
South and west of Kendall Island	Tundra swans	Nesting, moulting	South and west of Kendall Island
	Brant	Nesting	South of Kendall Island
	Lesser snow geese* (*Chen caerulescens caerulescens*)	Nesting, preening and bathing (marine waters)	South of Kendall Island (one of 2 major colonies in the southeastern Beaufort Sea)
Rae Island	Brant	Nesting	Entire island
	Glaucous gulls	Nesting	Entire island
	Arctic terns	Nesting	Entire island
Spit south of Hooper Island	Glaucous gulls*	Nesting	Entire spit
	Arctic terns	Nesting	Gravel spit off northeast end of island
West side of Mallik Bay	Tundra swans*	Nesting, moulting	Coastal tundra vegetation
	Greater white-fronted geese* (*Anser albifrons*)	Nesting, moulting	Parts of area; these birds are rarely found in marine waters
	Dabbling ducks	Moulting	Entire area
	Shorebirds	Nesting	Entire area
Pullen Island spit	Brant	Nesting	Gravel spit and associated mudflat
	Glaucous gulls	nesting	Gravel spit and associated mudflat
Small island in Kidluit Bay	Brant	Nesting	Entire island
	Common eiders (*Somateria mollissima*)	Nesting	Entire island
	Glaucous gulls*	Nesting, feeding (surrounding waters and coastal wetlands)	Entire island

Table 8.4.2.: Avian activities in the Mackenzie Delta, mid-July to mid-August (* = significant population) (modified from Alexander *et al*. 1988).

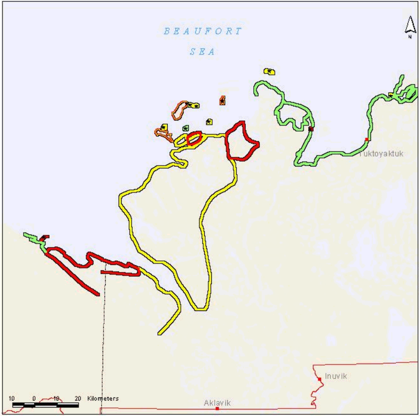
Area	Species	Activity	Location
South of Shallow Bay	Tundra swans*	Moulting, broodrearing	Coastal tundra vegetation, channels and wetlands
	Dabbling ducks	Continued use	N/A
	Arctic terns	Continued use	N/A
	Pacific loons	Continued use	N/A
	Red-throated loons	Continued use	N/A
Northwest Shallow Bay to east of Ellice Island	Tundra swans	Moulting, broodrearing	Low lying sedge/grass marsh
	Dabbling ducks	Broodrearing	Low lying sedge/grass marsh
	Shorebirds	Broodrearing	Low lying sedge/grass marsh
	Arctic terns	Broodrearing	Low lying sedge/grass marsh
	Snow geese	Moulting, staging	Low lying sedge/grass marsh
Ellice Island to Mallik Bay	Tundra swans*	Moulting, broodrearing	Wetlands, lakes, channels southwest of Mallik Bay; Kendall Island; Swan Channel area
	Brant	Moulting, broodrearing, feeding (coastal salt marshes)	Kendall Island; Swan Channel area
	Greater white-fronted geese	Moulting and broodrearing	Wetlands, lakes, channels southwest of Mallik Bay; Mallik Bay Area; Swan Channel area; Denis Lagoon
	Lesser snow geese*	Moulting	Langley Island to Swan Channel
	Canada geese (*Branta canadensis*)	Moulting	Mallik Bay area; Swan Channel area
	Dabbling ducks	Moulting	Wetlands; Mallik Bay area; Swan Channel area
	Scaup	Moulting	Swan Channel area
	Shorebirds	Broodrearing, fall staging	Swan Channel area
	Arctic terns	Broodrearing	Swan Channel area
East of Ellice Island to east edge of Kendall Bird Sanctuary	Pacific loons	Broodrearing	West side of Kendall Island Bird Sanctuary
	Red-throated loons	Broodrearing	West side of Kendall Island Bird Sanctuary
	Tundra swans	Moulting, broodrearing	West side of Kendall Island Bird Sanctuary
	Arctic terns	Broodrearing	West side of Kendall Island Bird Sanctuary
	Shorebirds	Broodrearing, fall staging	West side of Kendall Island Bird Sanctuary

Table 8.4.2. (cont'd): Avian activities in the Mackenzie Delta, mid-July to mid-August (* = significant population) (modified from Alexander *et al*. 1988).

Area	Species	Activity	Location
Garry Island	Tundra swans	Moulting, broodrearing	Entire island
	Brant	Moulting, broodrearing	Entire island, coastal salt marshes
	Glaucous gulls	Broodrearing	Low, gravel and sand spit at the northeast end of the island
	Arctic terns	Broodrearing	Low, gravel and sand spit at the northeast end of the island
Island east of Garry Island	Glaucous gulls	Feeding, resting	Entire gravel island
Pelly Island	Tundra swans*	Moulting, broodrearing	Entire island
	Brant	Moulting, broodrearing	Entire island; lagoon system and spit
	Dabbling ducks	Moulting	Entire island
Spit south of Hooper Island	Glaucous gulls	Nesting	Large mudflat with a small gravel spit
Hansen Harbour to Kidluit Bay	Red-throated loons	Feeding	Entire area
	Scaup*	Moulting	Entire area
	Oldsquaw	Moulting	Entire area
	Red-breasted merganser* (*Mergus serrator*)	Moulting	Entire area
	Scoters (*Melanitta* sp.)	Moulting	Entire area
	Greater white-fronted geese	Staging	Mason Bay
	Brant	Moulting	Bay south of Summer Island
Small island in Kidluit Bay	Brant	Moulting, broodrearing	Salt marsh areas along the shoreline of the island
	Glaucous gulls	Broodrearing; feeding (surrounding waters and terrestrial areas)	Island
Hendrickson Island	Shorebirds*	Brooding, staging	Entire island
	Glaucous gulls	feeding	Entire island
South of Tuktoyaktuk	Tundra swans	Moulting	Entire upland area
Tuktoyaktuk to Hutchinson Bay	Brant	Moulting	Tidal marsh areas
	Pacific loons	Feeding	Offshore areas
	Red-throated loons	Feeding	Offshore areas
	Shorebirds	Staging, broodrearing	Coastal and tidal marsh areas
	Glaucous gulls	feeding	Entire area
	Dabbling ducks	Moulting	Offshore areas
	Diving ducks	Moulting	Offshore areas

Table 8.4.3.: Avian activities in the Mackenzie Delta, mid-August to late September (* = significant population) (mod. from Alexander *et al*. 1988).

Area	Species	Activity	Location
Shallow Bay to Mallik Bay	Lesser snow geese*	Staging	Entire area
	Glaucous gulls	Staging	Entire area
	Pacific loons	Broodrearing	Northwest and southwest Shallow Bay
	Tundra swans	Moulting, broodrearing, staging	Northwest and southwest Shallow Bay; southeast Shallow Bay; Northeast Shallow Bay; west side Kendall Island Bird Sanctuary to Swan Channel; Mallik Bay area
	Greater white-fronted geese*	Staging	Northwest and southwest Shallow Bay; southeast Shallow Bay; northeast Shallow Bay; Olivier Islands; Ellice Island area; Mallik Bay area
	Brant*	Staging	Northwest Shallow Bay; southeast Shallow Bay; northeast Shallow Bay; Olivier Islands to west side Kendall Island Bird Sanctuary; Ellice Island area; to Swan Channel; Mallik Bay area; north of Mallik Bay
	Canada geese*	Staging	Southeast Shallow Bay
	Dabbling ducks	Staging	East of Kendall Island Bird Sanctuary
	Shorebirds	Staging	West side of Kendall Island Bird Sanctuary to Swan Channel
South Garry Island	Brant	Staging	Entire island
	Greater white-fronted geese*	Staging	Entire island
Pelly Island	Tundra swans*	Moulting, broodrearing	Entire island
	Brant	Staging	Lagoon system and spit
	Dabbling ducks	Staging	Lagoon system and spit
	Shorebirds	Staging	Lagoon system and spit
	Glaucous gulls	Staging	Entire island
Hansen Harbour to south of Summer Island	Red-breasted merganser	Staging	Protected bays
	Glaucous gulls	Staging	Protected bays
South of Kidluit Bay	Tundra swans	Moulting, broodrearing	Wetlands
Kittigazuit Bay area	Tundra swans	Broodrearing	Low-lying areas of coastal tundra vegetation
	Canada geese	Staging	Low-lying areas of coastal tundra vegetation
	Brant	Staging	Low-lying areas of coastal tundra vegetation
	Greater white-fronted geese*	Staging	Low-lying areas of coastal tundra vegetation
	Lesser snow geese	Staging	Low-lying areas of coastal tundra vegetation



LEGEND

- Communities
- Shorebird colonies - early June to mid-July

Shorebird habitat - early June to mid-July

- high use
- high use - based on 1 year of data only
- low use
- moderate use
- variable use

Data Sources:
National Atlas of Canada 1:250,000
Alexander, et al. 1988. Key coastal areas for birds in coastal regions of the Canadian Beaufort Sea.
Canadian Wildlife Service, Environment Canada, Edmonton.

Figure 8.4.1.: Coastal shorebird habitat, mid-June to early July.

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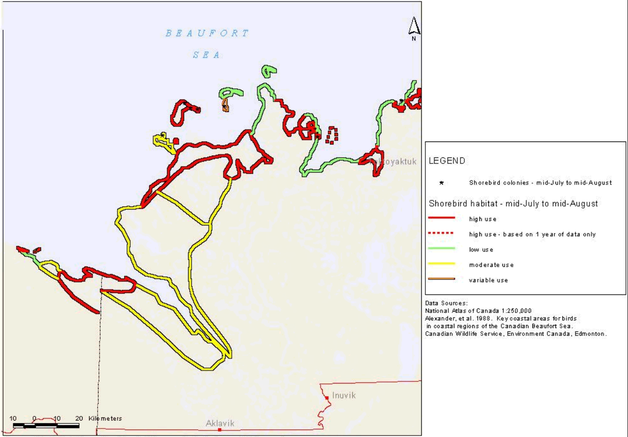

Data Sources:
National Atlas of Canada 1:250,000
Alexander, et al. 1988. Key coastal areas for birds in coastal regions of the Canadian Beaufort Sea. Canadian Wildlife Service, Environment Canada, Edmonton.

Figure 8.4.2.: Shorebird habitat, early July to mid-August.

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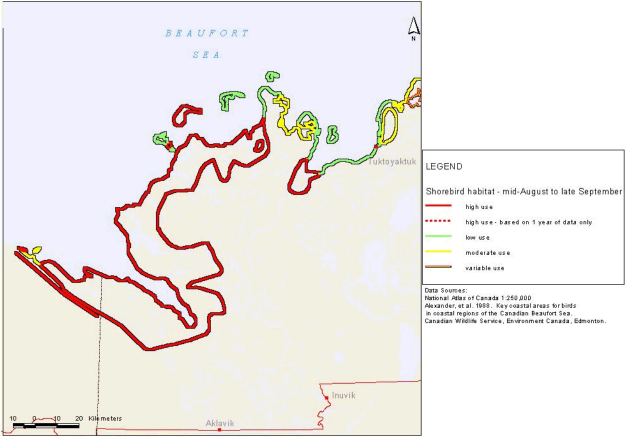

Figure 8.4.3.: Shorebird habitat, mid-August to late September.

9. RESOURCE SECTORS – SOCIAL/CULTURAL

9.1. Fishing Areas

The specific locations of fishing camps for the communities of Tuktoyaktuk, Aklavik, and Inuvik are confidential. However, the Community Conservation Plans document where important areas for subsistence harvesting of fish takes place (Table 9.1.1.). There is some overlap between the communities, with each of them utilizing the Mackenzie Bay and Shallow Bay area. In addition, the communities, with the exception of Inuvik, appear to exclusively use certain fishing areas, such as Toker Point by Tuktoyaktuk and the Inner Mackenzie Delta by Aklavik (Community of Tuktoyaktuk and WMAC(NWT) 1999; Community of Aklavik and WMAC(NWT) 1999; Community of Inuvik and WMAC(NWT) 1999). The Tuktoyaktuk Community Conservation Plan best identifies where subsistence fishing takes place by documenting the areas used during each season. No large scale commercial fisheries are operating at present in the area, though there are some small, local, independent fisheries.

Table 9.1.1.: Subsistence fish harvesting areas, as documented by Community Conservation Plans.

Community	Locations of subsistence fish harvesting
Tuktoyaktuk	▪ Figures 9.1.1., 9.1.2., 9.1.3. and 9.1.4. ▪ Toker Point (Figure 9.1.5.) – important for subsistence harvesting of inconnu, whitefish, loche and herring (spring, summer and fall) ▪ Fish Lakes and Rivers (Figure 9.1.6.) – important fish habitat; important historic and present subsistence harvest area for people of Tuktoyaktuk and Inuvik ▪ Mackenzie Bay and Shallow Bay (Figure 9.1.7.) – important traditional fishing area
Aklavik	▪ Mackenzie Bay and Shallow Bay (Figure 9.1.7.) – important traditional fishing area ▪ Inner Mackenzie Delta (Figure 9.1.8.) – subsistence fishing all year, especially summer and fall; channels are zoned for commercial fishing
Inuvik	▪ Fish Lakes and Rivers (Figure 9.1.6.) – important fish habitat; important historic and present subsistence harvest area for people of Tuktoyaktuk and Inuvik ▪ Mackenzie Bay and Shallow Bay (Figure 9.1.7.) – important traditional fishing area

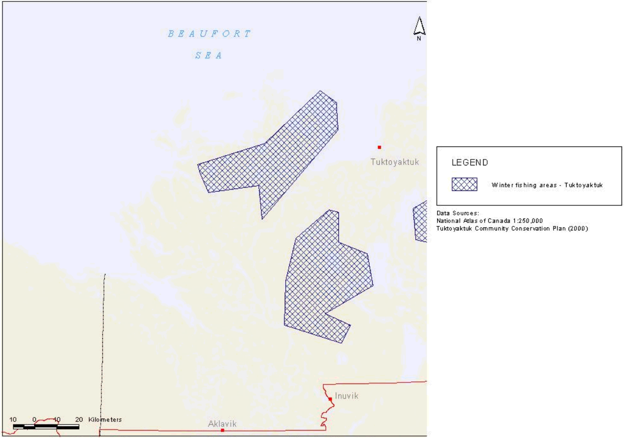

Figure 9.1.1.: Winter fishing areas utilized by the community of Tuktoyaktuk.

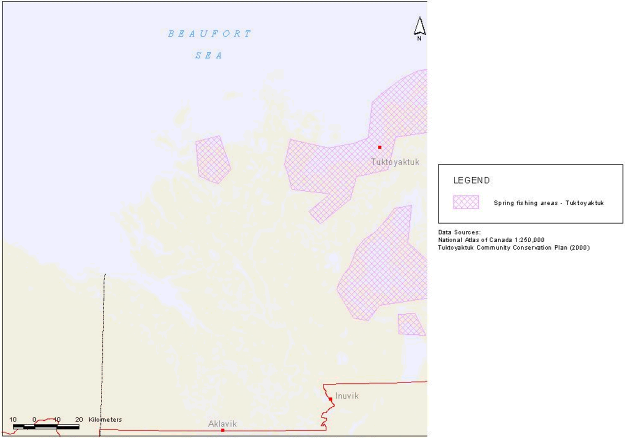

Figure 9.1.2.: Spring fishing areas utilized by the community of Tuktoyaktuk.

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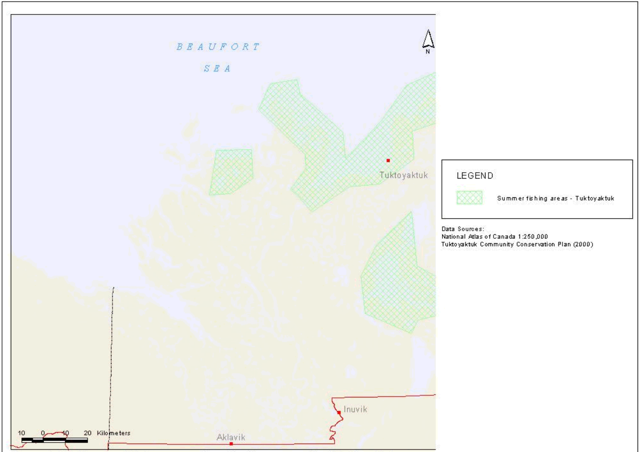
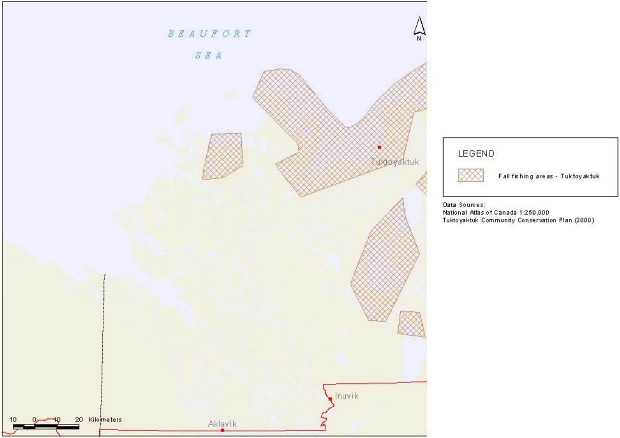


Figure 9.1.3.: Summer fishing areas utilized by the community of Tuktoyaktuk.



Data Sources:
National Atlas of Canada 1:250,000
Tuktoyaktuk Community Conservation Plan (2000)

Figure 9.1.4.: Fall fishing areas utilized by the community of Tuktoyaktuk.

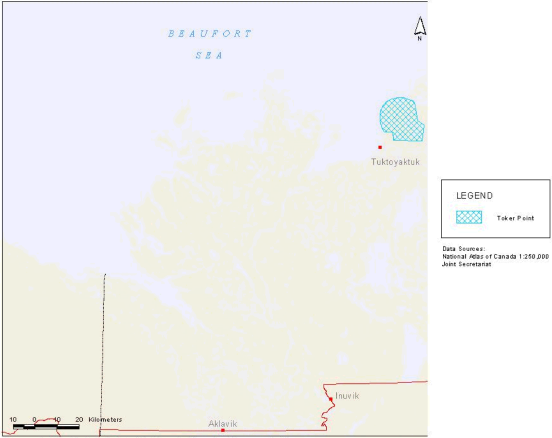


Figure 9.1.5.: Toker Point - Tuktoyaktuk subsistence fishing.

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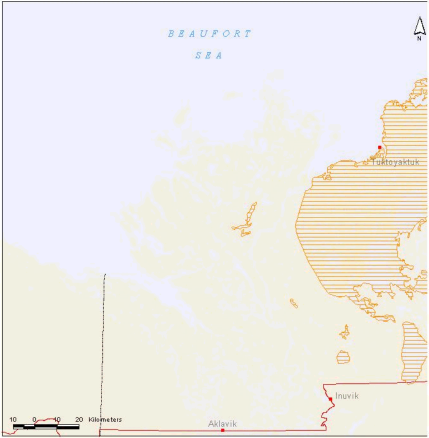
Canada



LEGEND

Fish Lakes and Rivers

Data Sources:
National Atlas of Canada 1:250,000
Joint Secretariat

Figure 9.1.6.: Fish Lakes and Rivers - subsistence fishing by Tuktoyaktuk and Inuvik.

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

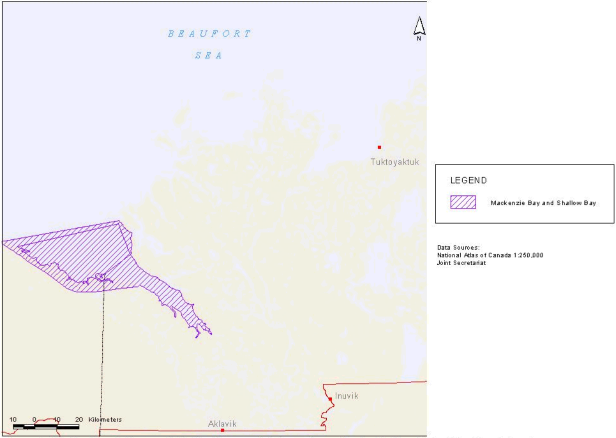


Figure 9.1.7.: Mackenzie Bay and Shallow Bay - subsistence harvesting by Tuktoyaktuk, Aklavik and Inuvik.

Fisheries and Oceans Canada Pêches et Océans Canada

Canada

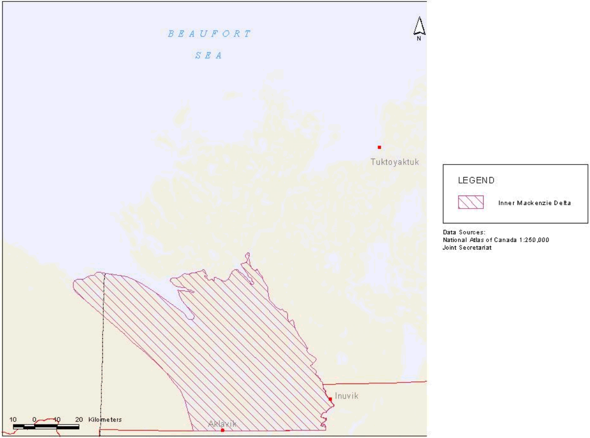


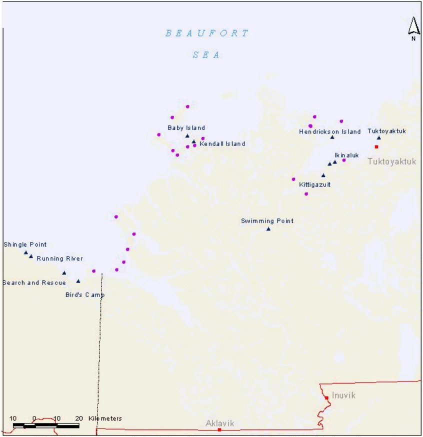
Figure 9.1.8.: Inner Mackenzie Delta - subsistence fishing by Aklavik.

9.2. Hunting

9.2.1. Beluga Hunting Camps & Traditional Hunting Areas

Residents of Inuvik, Aklavik and Tuktoyaktuk traditionally hunt beluga for subsistence purposes. Subsistence harvesting by Inuvialuit is not subject to quota (Weaver 1991). The majority of whales are landed in July, over a 4-6 week period, though occasionally hunts take place in late June and early September as well (Norton and Harwood 1986; Weaver 1991). Non-aboriginal people may hunt whales when in possession of a licence issued by the Fisheries and Oceans Canada (Weaver 1991).

Beluga harvesting takes place in coastal waters bounded to the west by Shingle Point, to the north by Gary, Pelly and Hooper Islands and to the east by the Hamlet of Tuktoyaktuk. Discrete concentration areas are located at Niakunak Bay, Kendall Island and Kugmallit Bay, and traditional hunting camps are located adjacently on the shore (Figure 8.5.1.) (Weaver 1991). During the 1990s, it has been estimated that an average of 110 beluga were taken annually, which is a decrease from the 1970s and 1980s in which an average of 131.8 and 124.0 beluga, respectively, were taken annually. Of the 110 beluga landed in the 1990s, 91.8% were taken from the Mackenzie estuary; 17.0% by Aklavik, 34.7% by Inuvik and 40.1% by Tuktoyaktuk. An average of 124.9 beluga were struck annually in the 1990s, signifying that 11.2% were struck but lost (Harwood *et al.* 2000).



LEGEND

▲ Whaling camp

● Traditional beluga harvesting area

Data Sources:
National Atlas of Canada 1:250,000
Beaufort Sea Beluga Management Plan: Tourism Guidelines within the Inuvialuit Settlement Region. Revised April 27, 1994.
Weaver, P.A. 1991. The 1987 beluga (Delphinapterus leucas) harvest in the Mackenzie River estuary, NWT. Canadian Manuscript Record of Fisheries and Aquatic Sciences, No. 2097.

Figure 9.2.1.: Locations of whale hunting camps and traditional beluga harvesting areas.

9.2.2. Bowhead

The Inuvialuit of Aklavik successfully hunted and landed a bowhead whale (*Balaena mysticetus*) in September 1991 at Shingle Point. Due to the endangered status of this whale, the licence issued for the hunt was the first in more than 25 years, and the whale itself was the first landed in an even longer period of time (Freeman *et al*. 1992). A second licenced hunt took place in July 1996, also struck and landed at Shingle Point (Figure 9.2.2.) (Wong 1999).

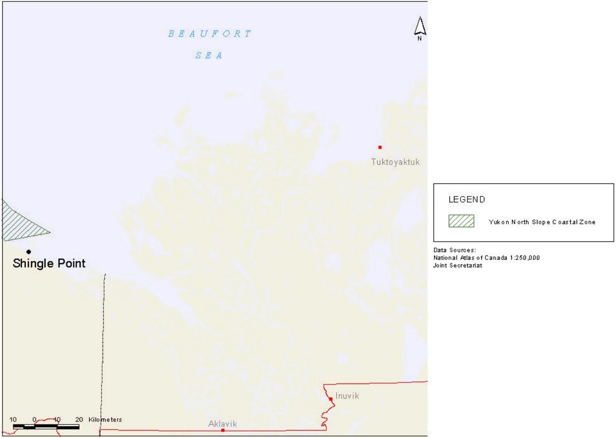


Figure 9.2.2.: Traditional bowhead harvesting area.

9.2.3. Geese and Waterfowl

Geese and waterfowl are hunted for subsistence purposes during spring, summer and fall throughout the coastal areas and islands of the Mackenzie estuary (Figure 9.2.3.). Canada goose, snow goose, white-fronted goose, brant and tundra swan are harvested in the spring as an important traditional food source for the community. As well, the down from these species is traditionally used in pillows and blankets. During the spring and fall, waterfowl species such as king eider, common eider, mallards, scoters, wigeon, old squaw and pintail are harvested as a subsistence food source (Community of Aklavik and WMAC-NWT 1999; Community of Inuvik and WMAC-NWT 1999; Community of Tuktoyaktuk and WMAC-NWT 1999). The majority of spring hunting is conducted from camp sites located within 150km of the community. Spring harvesting tends to occur at or near the end of the spring migration and continues until travel conditions deteriorate. Fall harvesting levels are smaller than those of the spring (Bromely 1996).

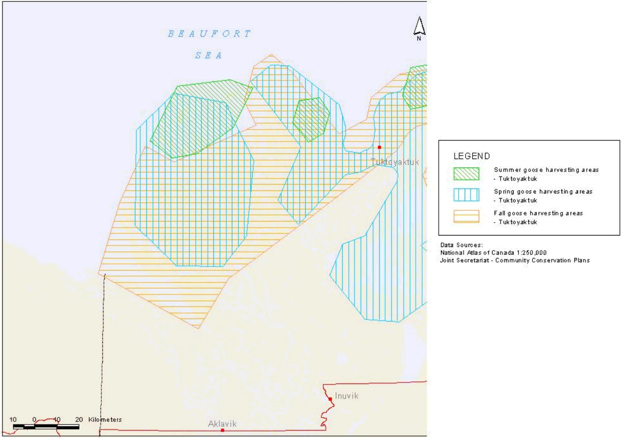


Figure 9.2.3.: Goose harvesting areas utilized by the community of Tuktoyaktuk.

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Canada

9.2.4. Ringed Seal

Seals are harvested primarily for use in making clothing, such as boots and mittens. Occasionally, seal meat is used as a food source. Harvesting of seals takes place during the fall and winter on shorefast ice and stable offshore ice, which are the preferred ice conditions of the species (Figure 9.2.4.). Spring seal harvesting (not shown on map) takes place at Husky Lakes (Community of Aklavik and WMAC-NWT 1999; Community of Inuvik and WMAC-NWT 1999; Community of Tuktoyaktuk and WMAC-NWT 1999).

9.2.5. Polar Bear

Polar bear is harvested during the winter from the same areas that sub-adult seals are found, particularly the moving ice of the transition zone (LGL Limited 1983). Adult seals are also hunted in their shorefast ice and stable offshore ice habitats. Traditionally polar bear has been utilized as a source of fur and occasionally as a food source (Community of Aklavik and WMAC-NWT 1999; Community of Inuvik and WMAC-NWT 1999; Community of Tuktoyaktuk and WMAC-NWT 1999).

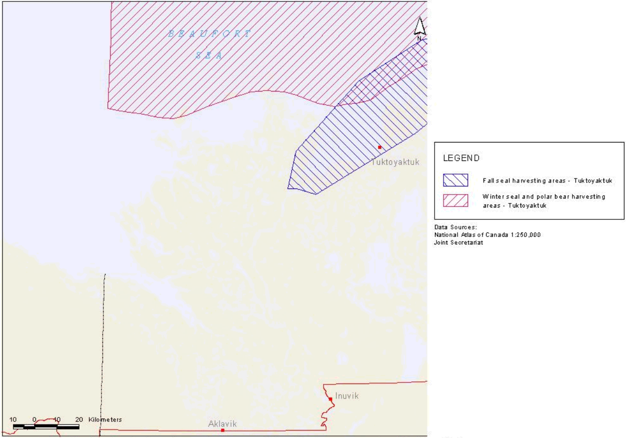

Figure 9.2.4.: Seal and polar bear harvesting areas utilized by the community of Tuktoyaktuk.

Fisheries and Oceans Canada   Pêches et Océans Canada

Canada

9.2.6. Bluenose Caribou

Bluenose caribou are harvested year round in coastal areas east of Richards Island. The meat is highly valued as a food source, and traditionally the animals have been used to make clothing and tools (Community of Tuktoyaktuk and WMAC-NWT 1999).

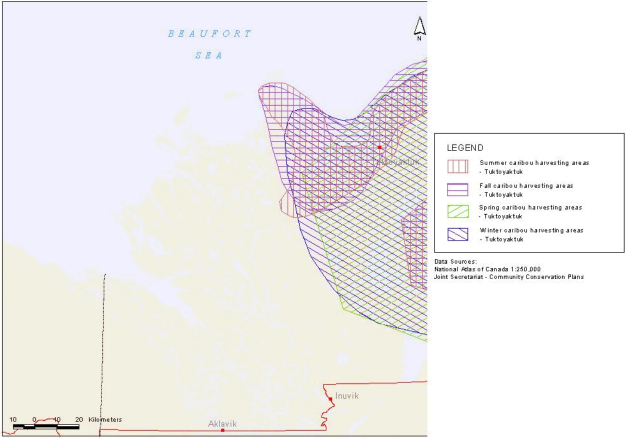

Figure 9.2.5.: Caribou harvesting areas utilized by the community of Tuktoyaktuk.

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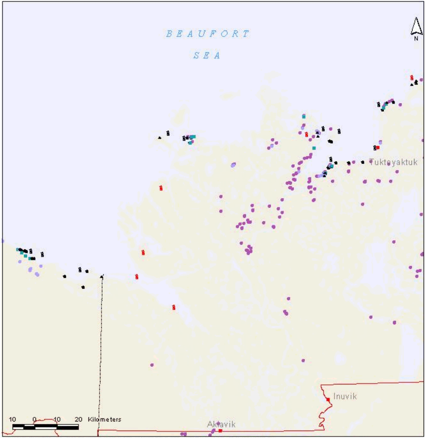
Canada

9.3. Historical Sites

9.3.1. Archeological Sites

Archeological sites across the ISR (Figure 9.3.1.) are protected from disturbance under both federal and territorial legislation, which require that land use activities not disturb remains. Land use activities that result in the finding of artifacts must be reported to the Senior Archeologist, Prince of Wales Northern Heritage Centre, Yellowknife, and safeguarded (IRC 2000). Within the coastal areas of the Mackenzie estuary, a number of cultural and archeological sites exist, ranging from burial sites to prehistoric camp and hunting areas.



LEGEND

Land use

Highly Important

Important

Archaeological Site

Heritage Site

Major Resource Harvesting Camp

Other Resource Harvesting Camp

Archeological Sites (Prince of Wales)

Data Sources:
National Atlas of Canada 1:250,000
Environmental Atlas for Beaufort Sea Oil
Spill Response, 1987
Prince of Wales Heritage Centre

Figure 9.3.1.: Cultural land use and archeological sites.

9.4. Military Activities

9.4.1. Distant Early Warning Line

As part of the North American Air Defence (NORAD) System, Canada and the United States agreed in 1940 to the construction and operation of three radar lines, including the Distant Early Warning (DEW) line (DND 2000a). The DEW line was constructed across Canada's Arctic in 1955, and operated by the United States, to provide radar surveillance of airborne threats (Fletcher 1989). In 1988 the DEW line was partially deactivated and ceased operation (Fletcher 1989; DND 2000a).

Along the coast of the Mackenzie estuary are the remains of two stations, at Shingle Point and Tuktoyaktuk (Table 9.4.1. and Figure 9.4.1). Clean-up and decommissioning of these sites is ongoing, with specific attention to limiting environmental contamination, particularly of PCBs. A military waste site is located near the Tuktoyaktuk station, with several other sites further inland.

Table 9.4.1.: Distant Early Warning (DEW) Line sites located within the integrated management area (modified from: Wilson 2000).

DEW Line Site	Location	Description	Date of Deactivation
Bar-2	Shingle Point	Auxiliary site	June 1989
Bar-3	Tuktoyaktuk	Auxiliary site	September 1993

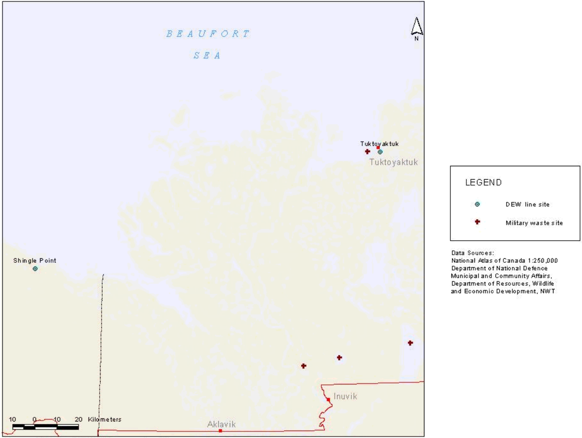


Figure 9.4.1.: DEW Line and military waste sites.

9.4.2. North Warning System

An agreement to replace and modernize the DEW Line system was signed by Canada and the United States in 1985, with the signing of the North American Defence Modernization Agreement (DND 1992; DND 2000a; Wilson 2000). Within Canada this system is operated by the Canadian military and is made up of a series of long range radar sites and unattended short range radar sites, situated approximately every 80.5km along the Arctic coastline, supported by logistical support sties (MDBSRLUPC 1991). Across Canada a total of eight DEW Line sites were modified to become Long Range Radar sites, with three new sites constructed, and thirty-six short range radar sites were built along the old DEW Line (DND 2000a).

Located on the coast of the Mackenzie estuary are one short range radar site and one long range radar site (Table 9.4.2. and Figure 9.4.2.). Another short range site exists further inland at North Storm Hills and a station at Inuvik acts as the logistical support site for the region (DND 1992; Wilson 2000).

Table 9.4.2.: North Warning System (NWS) sites located within the integrated management area (modified from DND 1992; Wilson 2000).

NWS Site	Location	Description	Date of Activation
Bar-2	Shingle Point	Long range radar	June 1989
N/A	Inuvik	Logistical support site	N/A
Bar-BA3	North Storm Hills	Short range radar	November 1990
Bar-3	Tuktoyaktuk	Short range radar	September 1990

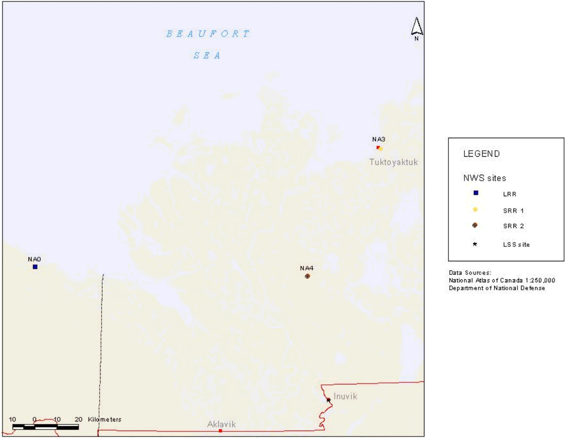


Figure 9.4.2.: North warning system (NWS) and logistical support sites (LSS).

9.4.3. Current Military Activities

Within Canada's arctic are four military bases; within Nunavut at Iqaluit and Rankin Inlet, and within the Northwest Territories at Inuvik and Yellowknife (Capt. P. Beaulieu, pers. comm.). Inuvik is the location of a Forward Operating Line (FOL) for aircraft support (Capt. P. Beaulieu, pers. comm.; MDBSRLUPC 1991; DND 2000b). Until 1986, Inuvik was the site of a major military base, run by the Department of National Defence (MDBSRLUPC 1991). At present, this site is periodically used for land-based military and flight training exercises by the Canadian Armed Forces take place, as well as occasional cruise missile training by the United States (MDBSRLUPC 1991). Infrastructure at the base includes hangars for six aircraft (Capt. P. Beaulieu, pers. comm.).

9.5. Municipal Activities

9.5.1. Water

Table 9.5.1.: Municipal water sources for communities of the Mackenzie Delta (modified from: CBC 2000; Fehr *et al*. 1997; GNWT 1998; Town of Inuvik 2000).

Community	Water Source	Comments
Inuvik	Winter: East Channel of Mackenzie River Summer: Water piped three miles from Lake B to Hidden Lake, which acts as a natural reservoir	Mackenzie not used in the summer due to high silt concentrations.
Aklavik	Peel Channel of the Mackenzie River	Silt is filtered out; drinking water is trucked from the water treatment plant on Peel Channel to utilidors
Tuktoyaktuk	Kudluk Lake, northeast of the community	Lake is currently down to 2 feet in depth from 8 feet three years ago due to the formation of an overflow creek; repairs to the lake needed.

9.5.2. Sewage Sites

Table 9.5.2.: Sewage and grey water effluent disposal sites for communities of the Mackenzie Delta (Figure 8.12.1.) (modified from: Adams 1997; Bachmayer *et al*. 1978; Fehr *et al*. 1997; Henry and Prasad 1986).

Community	Sewage Disposal	Comments
Inuvik	East Channel of the Mackenzie River	Wastewater is collected in utilidors and then flows by gravity through a collecting sewer to the primary cells of the sewage lagoon (approx. 17 days); effluent from the primary cells enters the secondary cell where it is held for 10 months (November to August); during early winter (September and October) the secondary cell is drained and discharged into the East Channel of the Mackenzie River.
Aklavik	Clearing Lake, a natural lake adjacent to Aklavik; locally known as Sewage Lake	Trucks pump sewage and wastewater from buildings and dump it into the lake; Clearing Lake is part of a system of interconnected lakes and creeks that ultimately drain via Six-Mile Creek into Peel Channel; sewage goes through a natural process of sedimentation, precipitation and uptake by organisms
Tuktoyaktuk	Honey bags are disposed of at the southern edge of the municipal landfill	Septic tank and honey bag system; collected by sewage disposal contractor – currently E. Felix Enterprises Limited

9.5.3. Solid Waste Sites

Table 9.5.3.: Solid waste sites within the region (Figure 9.5.1.) (modified from: Adams 1997; Government of Canada 1984).

Site	Location	Agency	Purpose
Kittigazuit	69°29'25" N 133°41'10" W	DIAND	Waste metal depot
Tuktoyaktuk Solid Waste Disposal Site	69°25'N 133°02'W 3km south of the hamlet on the Tuktoyaktuk Peninsula; 20ha in area; western side of the site in use since 1984	Hamlet of Tuktoyaktuk	Municipal landfill, in operation since early 1970s; There is little separation of wastes, with the entire facility covered in litter and debris; little to no soil cover and little waste compaction
Tuktoyaktuk	End of community airstrip	Hamlet of Tuktoyaktuk	Former municipal dump

Sites that have been identified as requiring immediate waste clean-up in the Mackenzie Delta region include the 6-mile area in the West Channel of the Mackenzie River, Richards Island and the DEW Line. Land-based waste disposal options are preferred over marine disposal and are being developed. Together with federal and territorial waste management agencies, Inuvialuit land management authorities have the responsibility of developing a comprehensive waster management strategy (MDBSRLPC 1991).

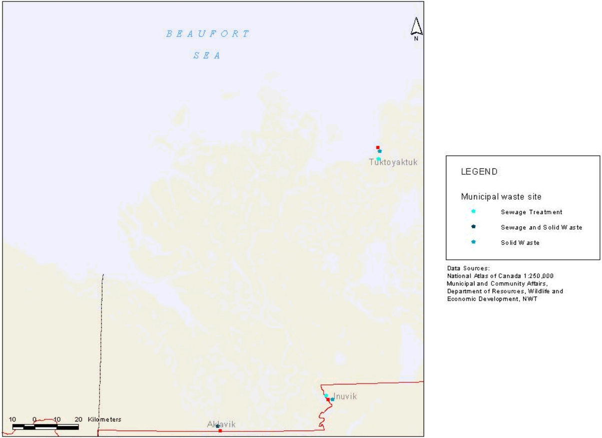


Figure 9.5.1.: Municipal sewage and waste sites.

9.6. Research

9.6.1. Scientific research stations

Table 9.6.1.: Sites of scientific research stations in the Mackenzie River estuary study area (list is not complete) (modified from Nettleship and Smith 1975;

Name	Location	Facilities	Comments
University of British Columbia (UBC)	Garry Island	Not an official research station?	Garry island has been a focal of UBC's geomorphological research in the Mackenzie Delta since 1958
University of British Columbia Field Station No.2	Williams Island	Unknown	Near Caribou Hills

9.6.2. Permanent camps

Table 9.6.2.: Permanent research stations located in the Mackenzie River estuary study area (modified from Government of Canada 1984; PCSP 2000a; PCSP 2000b; PCSP 2000c; PCSP 2000d; CPC 2000a; CPC 2000b; CPC 2000c).

Name	Location	Facilities	Comments
Aurora Research Institute (formerly Science Institute of the Northwest Territories – West)	Inuvik 68-21N 133-43W	▪ Provides technical and logistical support to researchers ▪ Licences and coordinates research ▪ Maintains Inuvik Research Centre ▪ Two story complex with lab and office ▪ Three unheated warehouses ▪ Five labs ▪ Research library ▪ Accommodations for 24 people ▪	▪ Works to improve the quality of life for NWT residents by applying scientific, technological and indigenous knowledge to solve northern problems and advance social and economic goals ▪ Open all year, summer is busiest
Western Arctic Area Office	Inuvik 68-0N 134-0W	▪ Permanent structure with wet lab and workshop area	▪ Operated by Fisheries and Oceans Canada

Table 9.6.2. (continued): Permanent research stations located in the Mackenzie River estuary study area (modified from Government of Canada 1984; PCSP 2000a; PCSP 2000b; PCSP 2000c; PCSP 2000d; CPC 2000a; CPC 2000b; CPC 2000c).

Name	Location	Facilities	Comments
Polar Continental Shelf Project	Tuktoyaktuk 69-30N 133-0W	▪ Accommodations for 36 people ▪ Library ▪ Main garage, stores and working building located on airport apron ▪ Warehouse	▪ Operated by Natural Resources Canada ▪ Facility will only open if demand is sufficient to be economical
Tuktoyaktuk Field Station	Tuktoyaktuk 69-30N 133-0W	▪ Permanent structure with wet lab, warehouse and storage area	▪ Operated by Fisheries and Oceans Canada ▪ Facility has not been used for a number of years ▪ At present station is open only to government researchers, though there is potential for graduate research
Inuvik Research Lab	Ya Ya Lake	▪ Still in operation?	▪ Operated by DIAND

10. Resource Sectors – Economic

10.1. Oil and Gas Industry

10.1.1. Leases and Wells

The Beaufort-Mackenzie Basin possesses large volumes of discovered oil and gas resources, with high potential for future discoveries. Exploration in this region began in the mid-1960s, with the majority of exploration drilling occurring between 1970 and 1989. During this period, a total of 183 exploration wells and 66 development wells were drilled, resulting in the discovery of 53 oil and/or gas fields – 20 gas, 13 oil and 20 oil and gas (Figures 10.1.1. and 10.1.2) (Dietrich and Dixon 2000; NEB 1998). Onshore, the largest gas field Taglu, which was discovered in 1971 and has an estimated marketable gas resource of $58.6 \times 10^9 m^3$. Offshore, the largest field is Amauligak, discovered in 1984, which has an estimated recoverable oil resource of $37.3 \times 10^6 m^3$ (NEB 1998).

It is estimated that total discovered petroleum resources are between $186 \times 10^9 m^3$ and $349 \times 10^9 m^3$ of recoverable gas and between $93 \times 10^6 m^3$ and $229 \times 10^6 m^3$ of recoverable oil (NEB 1998). The total petroleum resource reserve (discovered and undiscovered) is estimated at $1.9 \times 10^{12} m^3$ of recoverable gas and $1.1 \times 10^9 m^3$ of recoverable oil (Dietrich and Dixon 2000). These estimates add to the possibility that several major fields have yet to be discovered in the region, and the potential for new discoveries of oil and gas is high both on- and offshore (Dietrich and Dixon 2000; INAC 1995). Likely areas include the Oligocene Kugmallit sequence in the shallow-shelf and offshore Mackenzie Delta, the Lower Cretaceous strata in the southern Mackenzie Delta area (Dietrich and Dixon 2000) and along the Tuktoyaktuk Peninsula (INAC 1995).

To date, within the Mackenzie Delta-Beaufort Sea region, no oil or gas fields have been developed, other than the onshore Ikhil field (Brackman 2000; Dietrich and Dixon 2000). Ten new exploration parcels were nominated during summer 2000, with the close of bidding on August 14, 2000. As well, the IRC recently put some of their subsurface lands out for bids, resulting in two parcels being allocated to Chevron Canada Resources, and one each to Petro-Canada and Anderson Resources (Brackman 2000).

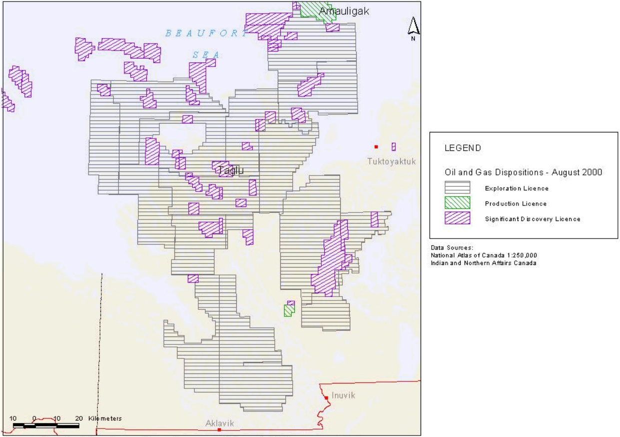


Figure 10.1.1.: Oil and gas dispositions as of August 2000.

Fisheries and Oceans Canada
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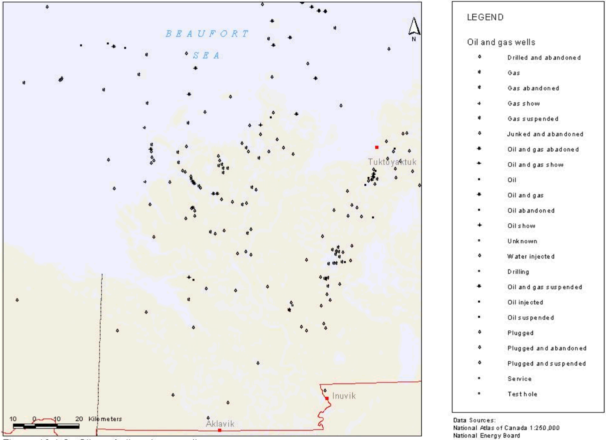


Figure 10.1.2.: Sites of oil and gas wells.

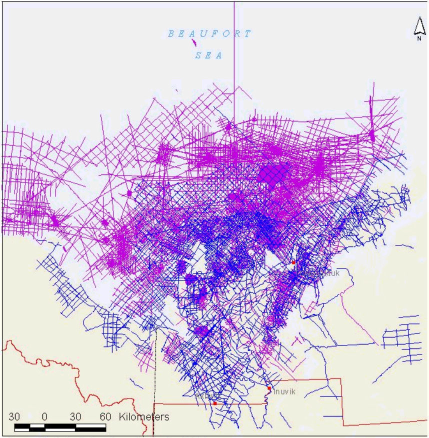
Fisheries and Oceans Canada Pêches et Océans Canada

Canada

10.1.2. Seismic Activity

Seismic activities, to determine the location and extent of petroleum resources, were conducted during the 1970s and 1980s in the Mackenzie Delta and Beaufort sea, fluctuating in response to increasing and decreasing demands for northern oil and gas resources. During the 1980s, most seismic work was done north of Richards Island and the western Tuktoyaktuk Peninsula, as far west as the Alaska-Yukon border and as far east as the Baillie Islands (Figure 10.1.3.). Lengths of seismic lines shot ranged from a minimum of 15km to a maximum of 48km (Brouwer *et al*. 1988).

Seismic work began again in the 1999/2000 season with renewed interest in the Mackenzie-Beaufort region. During the winter 2000/2001 (January to April) season, 2D seismic activities were conducted by AEC Limited over 4,800km^2 located north of Inuvik to Kugmallit Bay, including part of Richards Island. Twenty lines were planned, varying in length from 14 to 47km, spaced at 2km intervals. Burlington Resources Canada Energy Limited and Petro-Canada also conducted 2D seismic activities west of the AEC area. Depending on the results of these surveys, further in depth seismic and drilling explorations will be planned (Inuvialuit Environmental Inc. 2000).



LEGEND

Seismic work - pre-1975

Seismic work - post-1975

Data Sources:
National Atlas of Canada 1:250,000
Joint Secretariat

Figure 10.1.3.: Seismic work, up to 1992.

10.1.3. Oil and Gas Industry Infrastructure

The first base camp near Tuktoyaktuk was built in 1969 by Imperial Oil, located on the opposite side of the harbour from the hamlet. During the early 1970s Gulf Oil, Sun Oil and companies serving the oil industry, such as Kaps Transport, established small operations adjacent to Tuktoyaktuk Harbour. At that time, companies were focussed on hydrocarbon exploration in the onshore areas of the Mackenzie Delta (MacEachern *et al*. 1983).

Offshore exploration of the Beaufort Sea began in 1973, led by Esso Resources Canada. Most of the company's artificial island building and offshore drilling activities were staged and supplied out of its Tuktoyaktuk base camp. In 1976 Dome/Canmar gained approval for exploration in the deeper waters of the Beaufort Sea, resulting in the construction of shorebase facilities located away from the townsite, but on the same side of the harbour (Figure 10.1.4.). With increased interest in the Beaufort Sea area, in 1979-1980 Esso Resources Canada expanded and modernized its base. During 1982-83 Gulf Canada Resources re-entered the area and built a shorebase south of Dome/Canmar. During the early 1980s, the Esso, Dome/Canmar and Gulf/Beaudrill camps had a regular seasonal staff complement of over 600 personnel. These personnel in turn supported the operations of offshore drilling ships and construction vessels with an even larger seasonal staff. The movement of personnel into and out of the Tuktoyaktuk area and supplying of the shorebases and offshore activities resulted in heavy usage of the airport and harbour by industry and the service companies (MacEachern *et al*. 1983). Supplemental wintering bases built at McKinley Bay and Pauline Cove on Herschel Island (Dome Petroleum Limited 1980) have since been demolished.

These facilities, and others, remain and are likely to be utilized in future hydrocarbon exploration activities as staging and supply bases. In fact, some shorebases have already been brought back into service with the recent interest in the hydrocarbon resources of the Beaufort Sea.

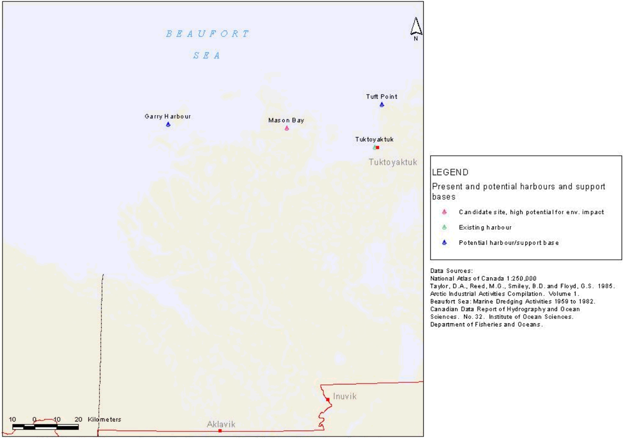


Figure 10.1.4.: Existing and potential harbour sites for the oil and gas industry.

10.1.4. Artificial Islands

Artificial islands were first constructed in the Beaufort Sea beginning in 1972, in order to provide safe bottom-founded drilling platforms. Initially, islands were built in the nearshore waters of the Mackenzie Shelf. However, starting in 1980 offshore islands were constructed in water depths greater than 20 metres, into progressively deeper waters (Figure 10.1.5.) (Taylor *et al*. 1985).

Dredged materials from the seabed are typically used to create artificial islands, though early islands were built with gravel from terrestrial sources in the Mackenzie Delta, such as the Ya Ya Lakes area. During the time period of 1972 to 1985, the number of dredges in the Beaufort Sea increased from one to seven. This was due to the greater distances that the dredge had to travel to get good construction material, the increased volume of material required to construct deepwater islands and the more difficult construction environment. Technology has moved from constructing islands built exclusively of dredged material to the use of caisson-retained designs, whereby a steel or concrete structure rings the island. This design has made platforms viable all year round and more resistant to ice damage (Taylor *et al*. 1985).

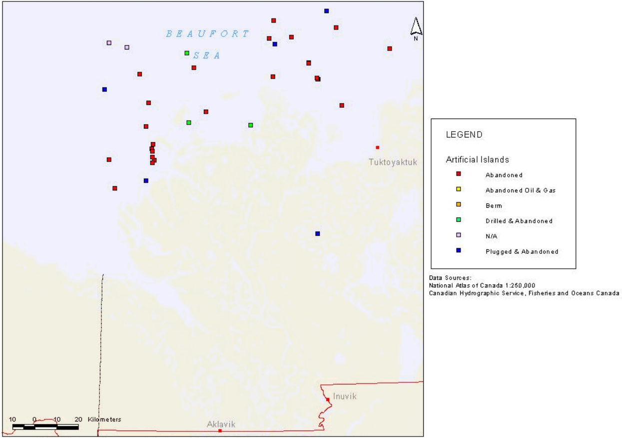


Figure 10.1.5.: Locations and status of artificial islands.

10.1.5. Ikhil Gas Pipeline to Inuvik

The Ikhil gas field has been developed by the Inuvialuit Petroleum Corporation, and was originally discovered and capped by Gulf Canada. Central to this project is the development of a pipeline to bring the gas to Inuvik, with the potential to generate electricity and significantly reduce costs for businesses and consumers (Figure 10.1.6.) (NWT Economic Strategy Panel 2000). Petro-Canada Limited did seismic work for this project in summer 2000 (Petro-Canada 2000).

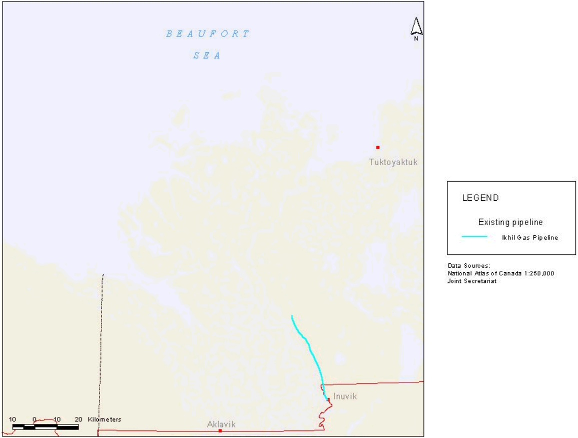
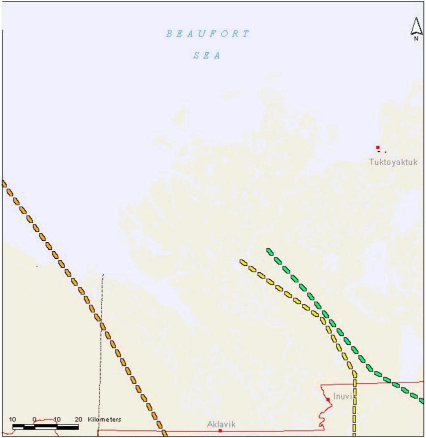


Figure 10.1.6.: Location of Ikhil gas pipeline to Inuvik.

10.1.6. Potential Pipelines

The potential exists for an extension of the Norman Wells oil pipeline to the Mackenzie Delta. In order for this to become economically feasible, several of the existing onshore discoveries in the Delta would need to be developed and produced within a few years of each other. Additionally, the development of the offshore Amauligak oil field in conjunction with several small onshore developments could make an offshore extension of the pipeline feasible (Brackman 2000).

Currently, three possible gas pipeline routes to the delta are under consideration, as well as one that would connect the existing pipeline to the Yukon/Alaska (Figure 10.1.7.). The possibility exists for one or two of these pipelines to be constructed – in the second scenario, one pipeline would connect to the Yukon and one to the Mackenzie Delta.



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Proposed pipeline route

- Dempster Lateral (Foothills)
- Mackenzie Valley to Beaufort Sea/Alaska (Arctic Resources Co.)
- Mackenzie Valley to Delta (TransCanada Pipelines)

Data Sources:
National Atlas of Canada 1:250,000
Foothills Pipeline Limited Transportation Systems Report, 2000.

Figure 10.1.7.: Proposed gas pipeline routes.

10.2. Ecotourism Industry

10.2.1. Introduction

Tourism is the third leading export of the NWT, ranking behind minerals and oil and gas, and is considered to be a growing sector (Hinch 1995). The industry has evolved from a focus on big game hunting to tourism that combines natural and cultural elements of the local landscape and communities (Notzke 1995). ISR tourism activities include: observing wildlife, hiking, rafting, sports hunting, visiting whaling and fishing camps, boating and attending community/cultural activities (MDBSRLUPC 1991).

The Dempster Highway, linking with the Alaska Highway in Whitehorse and ending in Inuvik, makes the Western Arctic the only area of Canada’s north that is accessible by road (Notzke 1995). Inuvik acts as the major transportation hub and staging point for tourism in the rest of the Western Arctic (MDBSRLUPC 1991; Notzke 1995). Evidence of this fact is illustrated by the 1994 statistics of the Northwest Territories Exit Survey. Based on this study, over 6,300 people visited Inuvik from July to September 1994, primarily via the highway. This number represents 19% of all the visitors to the NWT in 1994 (Notzke 1995).

Visitors to the Beaufort-Delta fit into three general categories, in terms of expectations, demographics and activities (Dressler 1999). These categories are: cultural tourism, ecotourism and adventure travel. Cultural tourism generally consists of tours of local communities, interaction with Inuvialuit through lectures, conversation, cultural activities and visits to bush and whaling camps. Tourists in this category are motivated by a wish to experience the ways of a culture different from their own. Ecotourism activities may consist of wildlife viewing tours, particularly whale and bird watching, via air or boat (RT and Associates 1990, as cited in Dressler 1999). Adventure tourism tends to be undertaken in remote wilderness locations and involves unconventional means of transportation, such as kayaking and hiking (Canadian Tourism Commission 1995, as cited in Dressler 1999).

10.2.2. Boat Tours

In recent years, cruise ship tours to Arctic destinations have increased in popularity. Ships typically carry 50 to 300 passengers at once, originating from various ports in the United States, Russia, northern Japan and Greenland (Denmark) (Marsh and Staple 1995). Touring the ISR area currently are three ships: the Russian Ice Breaker *Kaptain Khlebnikov*, from Germany the *MS Haneseatic* and from Florida the *Frontier Spirit*. During 1998, the *Kaptain Khlebnikov* and *MS Haneseatic* brought 250 and 68 passengers, respectively (Dressler 1999). Russian ships must remain 40 miles offshore, bringing tourists to the mainland by helicopter and zodiac boats (Fast *et al*. 1998).

Boat tours are run within the estuary by local operators, and primarily tour the Mackenzie River and coastal areas from Herschel Island to Tuktoyaktuk (Figure 10.2.1.). Visitors are taken wildlife viewing, fishing, scenic tours and, in some cases to whaling and/or bush camps, although this practice has become less prevalent in recent years. Boat tours run by local operators to the Pingo Canadian Landmark are popular, making this an important tourism destination for visitors to Tuktoyaktuk. Tours of the Mackenzie River are also popular, with approximately 200 individuals per year taking the trip with one company alone (Notzke 1995).

A growing awareness of the potential for conflict between tourism activities and beluga harvesting has emerged. There are concerns about the use of hovercraft, small aircraft and zodiacs in close proximity to whaling camps and their impacts on beluga, both in terms of the health and well-being of the animals, and the disruption of hunting activities. Beaufort Sea Beluga Management Plan tourism guidelines are in place to control these activities, but enforcement is problematic and difficult. It has been suggested that the only way that these activities may be effectively controlled is through informal pressure on the operators exerted by the HTCs (Fast *et al*. 1998).

Kayaking is increasingly becoming a popular activity. The destination of most kayakers is along the Yukon North Slope to Kaktovik on the Alaskan North Slope.

Along this route, tourists often stop off at the Aklavik whaling camps of Running River and Shingle Point, and then Herschel Island. This creates difficulties, as independent tourists tend to arrive at camps unannounced, which may create safety issues and cause disruptions during whaling season (Dressler 1999). Existing visitor guidelines for the ISR fail to address independent adventure travelers, thereby not regulating environmental impacts, such as litter and waste disposal, theft of artifacts, nor the cost of search and rescue operations. New legislation that will penalize travelers for such impacts is pending (Johnston 1998).

10.2.3. Flight Tours

Flight tours are an important component of tourism in the Western Arctic, given the distances to be traversed between destinations (i.e. communities, parks, islands, fishing, hunting and bird-watching tours) and their popularity for guided tours, scenic flights and wildlife viewing. Many of the charter plane companies work together with, or are owned by, tour companies, emphasizing the importance of flight to tourism (Notzke 1995).

Flights are often chartered by tourists to view wildlife, especially whales, flying at low levels to better accommodate viewing (Figure 10.2.1.). As a result, the activities of whaling camps along the route may be disrupted, with some Inuvialuit suggesting that these planes scare off beluga and interrupt processing. Specifically, a survey conducted by Dressler (1999) found that elders from Aklavik were concerned about planes flying very low over the Running River and Shingle Point whaling camps. Elders from Inuvik and Tuktoyaktuk were concerned about disturbances at the Kugmallit Bay, East Whitefish Station and Hendrickson Island whaling camps (Dressler 1999).

The most regularly utilized flight path for chartered planes is from Inuvik to Herschel Island and Tuktoyaktuk (Dressler 1999). Small aircraft, such as one propeller airplanes, and helicopters are typically employed.

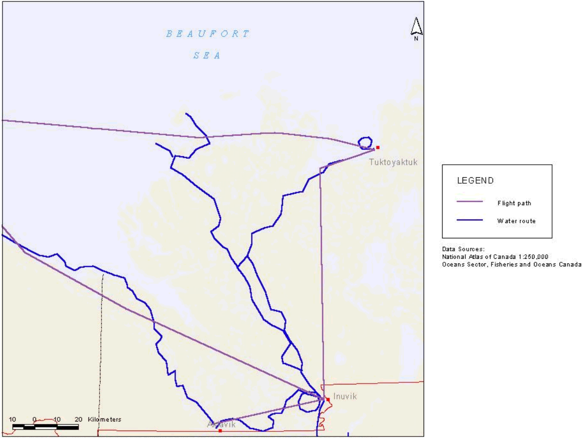


Figure 10.2.1.: Flight paths and water routes used by ecotourism operators.

Fisheries and Oceans Canada Pêches et Océans Canada

Canada

10.2.4. Hunting

Tourism in the Western Arctic has traditionally focussed on big game hunting. In 1995, fishing and hunting comprised the NWT's single largest tourism product based on annual revenues. In terms of per capita spending by individual tourists, trophy hunters have the greatest impact on community economies and have the least demands for tourism infrastructure (Table 10.2.1.). Within the Mackenzie Delta, Tuktoyaktuk has the longest sport hunting tradition, and receives the greatest proportion of tourists within the ISR as a whole, totaling 3,500 compared to 100 in Aklavik in 1994. Tourism in Tuktoyaktuk is supported by the community's proximity to Inuvik and the existence of infrastructure and established tour and outfitting companies (Notzke 1995).

Trophy hunting is an important industry, with hunters seeking polar bear (*Ursus maritimus*), muskox (*Ovibos moschatus*), barren ground grizzly bear (*Ursus arctos horribilis*) and caribou (*Rangifer tatandus*). Quotas for the Inuvialuit Settlement Region are set by WMAC-NWT in consultation with the IGC and the territorial department of Resources, Wildlife and Economic Development. Tags are then allocated by the HTCs for commercial sports hunting and subsistence use, split equally between general licence holders and Inuvialuit beneficiaries (Dressler 1999). The HTCs subsequently act as licenced outfitters, sub-allocating hunting tags to individual hunters, guides and outfitters; in Tuktoyaktuk, a panel is responsible for allocating tags. Within some communities, allocation of clients to individual guides is to occur on a rotational basis (Notzke 1995). Many HTCs have incorporated their sport hunting business to aid in financial management and marketing; for example, the Tuktoyaktuk HTC is known as "Beaufort Outfitting and Guiding Services (Notzke 1995).

Table 10.2.1.: 1995 Sport hunting statistics for Tuktoyaktuk (monetary values are in Canadian dollars) (modified from Notzke 1995).

Species	Number Allocated	Comments	Approximate $ Value/Hunt
Polar Bear	26 total (Maximum 50% allocated to sport hunters)	▪ Hunts may only be conducted with a dog team	$23,000
Muskox	25	▪ Hunts must take place in the spring or fall ▪ May take place from a boat or snowmobile, but last 1.5km stalk must be on foot	$3,800
Caribou	175 commercial tags	▪ Only bulls may be taken ▪ Commercial tags = the meat may be sold ▪ "No wastage" rule is enforced	$3,800
Tundra Grizzly	12	▪ Geographical limitations may be placed upon the hunters	$5,200

10.2.5. Fishing

Guided fishing tours have long been a mainstay of the Northwest Territories tourism industry (Hinch 1995). In 1994, 8,902 visitors came to the NWT to sport fish. Together, sport hunting and fishing make up the single largest tourism sector in the NWT (Notzke 1995). Sport fishing is offered as part of boat tours, bush camps and in the winter from the ice. Lodge accommodations are also available at the Sitidgi Lake Fishing Lodge located 52km from Inuvik (NWT Travel 2000b). The most popular sport fish species found in the Mackenzie Delta include inconnu (large whitefish), lake trout among the lakes and tundra rivers and char along the coast (Table 10.2.2.) (NWT Travel 2000a).

Sport fishing licences are required by everyone to sport fish in the Northwest Territories, and additional validations are required to fish in the ISR (GNWT-RWED 2000a). Within the ISR, sport fishers must obtain validation from the GNWT RWED office and must register with either the local HTC or the FJMC, in order to cross onto Inuvialuit private lands (GNWT-RWED 2000a). Currently only one river in the

Mackenzie estuary area is restricted – in the Big Fish River, a river which is classified as "restricted waters" by the FJMC (FJMC 2000).

Table 10.2.2.: Sport fishing catch and possession limits per species in the ISR (modified from GNWT-RWED 2000b). DCL = Daily Catch Limits; PCL = Possession Limits.

Species	Waters	DCL	PCL	Size limits
Arctic Char	Most NWT waters	4	7	None
Arctic Grayling	All waters within the ISR	5	10	None
Lake Trout	Most NWT waters	3	5	None
Northern Pike	All waters within the ISR	5	10	None
Walleye	All waters within the ISR	5	10	None
Cisco/Suckers	Most NWT waters	No limit	No limit	None
Dolly Varden	All NWT waters	4	7	None
Goldeye/Inconnu	All NWT waters	5	10	None
Whitefish (all species)	All waters within the ISR	10	20	None

10.3. Transport Industry

10.3.1. Shipping Routes

Transportation of bulk cargo relies on barge shipments run by the Northern Transportation Company Limited (NTCL) from late May to mid-October (MDBSRLUPC 1991). Cargo travels to the ISR beginning at the end of the railway at Hay River, crosses Great Slave Lake, then proceeds down the Mackenzie River to the communities of Aklavik and Inuvik (Figure 10.3.1.) (MDBSRLUPC 1991; NTCL 2000a). Cargo is distributed to coastal areas, such as Tuktoyaktuk and North Warning System sites, by arctic sealift ships (MDBSRLUPC 1991). NTCL operates a coastal vessel through the Mackenzie River East Channel and Kugmallit Bay every other day, between July 1 and October 1, bringing supplies to various communities (Fast *et al*. 1998).

The Northern Transportation Company Limited (NTCL), Canada's only pan-Arctic marine transportation provider, has two offices and terminals within the Western Arctic, at Inuvik and Tuktoyaktuk (NTCL 2000a; NTCL 2000b). Tuktoyaktuk is NTCL's primary arctic staging and trans-shipment point. Beginning at this point, tugs travel as far west as Point Hope, Alaska and as far east as Taloyoak, Nunavut (NTCL 2000a).

Ship traffic occurs throughout the Beaufort Sea, primarily for purposes related to the oil and gas industry, whaling and tourism activities (MDBSRLUPC 1991). During the height of the oil and gas industry activities, an average of 100 vessels of all types could be seen in Kugmallit Bay at one time – including barges, platforms and supply ships. Local whaling boat traffic tends to take place in 18' boats with 40hp motors, from late June through July. In terms of tourism activities, zodiacs, canoes and kayaks are the primary boat types utilized. Three times per season Coast Guard ships move though the area to set, check and retrieve navigation buoys (Fast *et al*. 1998).

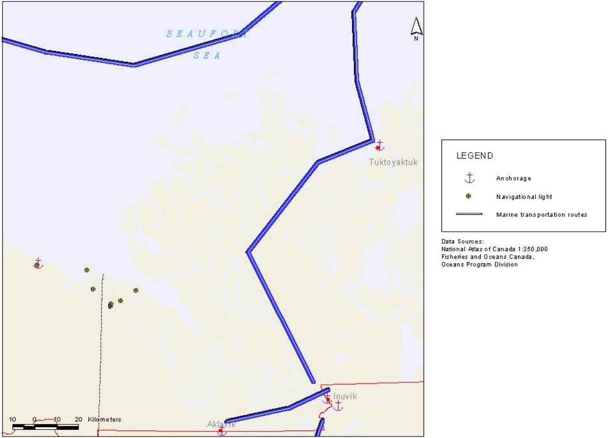


Figure 10.3.1.: Marine transportation routes.

10.3.2. Dredged Channels

During the height of oil and gas development in the southern Beaufort Sea, a great deal of marine sea bottom dredging took place, under the commission of companies such as Dome Petroleum Limited, Esso Resources Canada Limited and Gulf Canada Resources Limited. Dredging was conducted for the construction of harbours and anchorages, breakwaters and piers, navigational channels, artificial islands for drilling and glory holes for wellhead protection. Communities also commissioned dredging projects, primarily to provide landfill for community development (Taylor *et al*. 1985). In the past, Public Works Canada led the dredging of the east Mackenzie River channel at the mouth to accommodate shipping (Fast *et al*. 1998). The majority of this activity took place around the mouth of the Mackenzie River during the open water season, with offshore dredging in water depths of 30 to 60 metres increasing during the 1980s. Between 1959 and 1982, a total of 46,533,800m^3 of marine sediment was removed via dredging (Taylor *et al*. 1985).

In terms of the oil and gas industry, future exploration, production and shipping activities will require dredging and the loading and subsequent disposal or placement of spoils. Dredging is needed to (Taylor *et al*. 1985, p.10):

1. Construct and maintain harbours and approaches of appropriate depth and configuration to accommodate present and future marine fleet;

    Marine dredging activities are usually required to provide:

    a) good sea access;
    b) adequate areas for large dock, storage and lay-up areas plus associated workshops, accommodations and support facilities;
    c) capability to handle deep draft vessels and drilling systems and aircraft larger than the jets in use in 1982.

    Marine dredging activities may be required to provide:

    d) good access to Mackenzie River system;
    e) capacity to receive medium- to long-range heavy aircraft;
    f) potential overland access by winter or permanent road;
    g) capability to fuel and service all types of marine traffic on a year round basis;

2. Provide materials used in the construction of artificial islands (foundation pads, berms and relief well spurs) for offshore platforms and ballast for caisson platforms;

3. Excavate glory holes at well sites for drilling from conventional drill ships and conical drilling units in less than 54 metres of water;

4. Provide ice scour protection required for production trees, subsea pipelines and other possible seafloor systems;

5. Provide material used for landfills and land reclamation.

Significant finds of oil and gas offshore may result in a network of small-diameter, subsea pipelines being developed for oil gathering and gas re-injection. Dredged trenches would be dug to bury and subsequently protect these pipelines against ice scouring. It has been estimated that trenches would need to be dug to a maximum depth of five metres below the sea floor, and a maximum width of 20 metres (Taylor *et al*. 1985). Materials dredged for this purpose may be used to construct or revamp artificial islands, for terrestrial uses (see below) or the spoils may be deposited offshore (Taylor *et al*. 1985; Fast *et al*. 1998).

Materials dredged from the seabed may be used as terrestrial landfill, as in some cases it is considered as the best and economic source. This is true for Tuktoyaktuk, which is located on a peninsular gravel bar bordered by small lakes and tundra. As a result of this environment, the town has a shortage of land available for community development and lacks terrestrial landfill sources. Sand, silt and gravel dredged from the Tuktoyaktuk harbour in the past have been used as fill on which to develop subdivisions, a potable water reservoir, dock construction and airport expansion (Taylor *et al*. 1985).

10.3.3. Harbour infrastructure

Natural harbours and channels are rare in the southern Beaufort Sea region, particularly in the area of the Mackenzie estuary. This is due to the heavy silt loads of the river, storm surges and coastline erosion. Few harbours in the area have protection from winds and sea ice or have passages of sufficient depth and width for even shallow vessels. The only acceptable harbour site has been judged to be Tuktoyaktuk harbour. Mason Bay (Richards Island) and King's Point, Yukon were past candidate sites, but were determined to have too high a potential for environmental impact (Taylor *et al*. 1985).

Tuktoyaktuk Harbour, located on the eastern edge of the Mackenzie Delta within Kugmallit Bay, is approximately 6.5km long and up to 1.8km wide, totaling a surface area of 942ha (Thomas *et al*. 1981, as cited in Berkes 1999). The harbour has two distinct, relatively shallow entrances, the Eastern and Western channels, separated by Tuktoyaktuk Island. Depths are less than 10m in most areas of the harbour, with maximum depths reaching 26m (Bond 1982). As the result of isostatic rebound, sedimentation, erosion, and storm surges, the shoreline of the harbour is dynamic and continually changing (Kovacs and Mellor 1971, as cited in Berkes 1999).

During the period of intense survey activity in the Beaufort Sea (late 1970s to early 1980s), Tuktoyaktuk Harbour became a focal point for hydrocarbon exploration (Thomas *et al*. 1986, as cited in Berkes 1999). Large supply bases were operated by Esso Resources Canada Limited, Dome Petroleum Limited and Gulf Canada Resources Incorporated, smaller bases were operated by Transport Canada and Arctic Transportation Limited. The harbour also contained a floating dry-dock (Berkes 1999).

Department of Public Works began dredging Tuktoyaktuk Harbour in 1959 for to maintain navigational safety. The majority of dredging activities took place during 1980-1982. The GNWT dredged 80,000m^3 of material from the harbour in 1979 to use for landfill. During 1981 GNWT dredged 750,000m^3 to construct a water reservoir and the

Arctic Transportation Company Limited dredged 250,000m^3 of granular material for dock construction and landfill. During 1981 and 1982, Esso Resources of Canada dredged over 250,000m^3 of material in the harbour, for use in a land reclamation project (Taylor *et al*. 1985). The harbour has not been dredged during the past ten years.

The primary marine harbour within the ISR is located at Tuktoyaktuk, which has served as the primary support and supply base for oil and gas activities (MDBSRLUPC 1991; Taylor *et al*. 1985). Increased oil and gas exploration and production may require additional marine infrastructure, such as a deep-water port, likely to be developed from the existing facilities at Tuktoyaktuk (MDBSRLUPC 1991). Additionally, it has been proposed that artificial harbours may be constructed on the Yukon coast to accommodate future developments on the Mackenzie shelf. Since new harbours developed in the southern Beaufort Sea would be artificial considerable dredging for the construction and maintenance of both the harbours and their approach channels would be required (Taylor *et al*. 1985). McKinley Bay, out of the geographic scope of this discussion, located east on the Tuktoyaktuk Peninsula, in the past served as an oil and gas base.

10.3.4. Proposed Highways

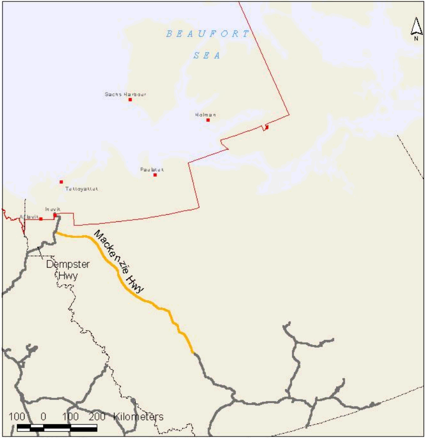
10.3.4.1. Mackenzie Highway

Currently, the only land route to the ISR community of Inuvik is the Dempster Highway, via the Yukon (at Whitehorse) (MDBSRLUPC 1991). This roadway operates year round with the exception of freeze-up and break-up, during which time the ferries/ice bridges at Arctic Red River at Tsiigehtchic and Fort McPherson on the Mackenzie River are unable to operate (Rescan Environmental Services Limited 1999; MDBSRLUPC 1991).

In 1972 route studies began to extend the Mackenzie Highway north, from its existing terminus at Wrigley, to the Dempster Highway (DOT 1989). Currently under consideration by the GNWT DOT is an 804 km extension that would join the Dempster

Highway south of Inuvik (Figure 10.3.2.). This extension has not been formally proposed, but is being evaluated in terms of economic, social, cultural and environmental impacts, as well as through benefit-cost analysis, engineering and financing studies (GeoNorth Limited and Golder Associates 1999).

Though because of its distance from the coast, this highway extension may not directly impact the coastal zone, it is likely to directly impact the economies, communities and environment of the Mackenzie Delta region. In terms of the local economy and employment, it is expected that the road will promote the resource industry and generate additional tourism business. From a community and social well-being perspective, residents recognize that the road may increase social problems related to increased access to alcohol and drugs. Environmentally, access may have negative effects on fish and wildlife habitat and populations, in terms of legal and illegal overexploitation from hunters and fishers. As well, the highway may be an impediment to the movements and migrations of fish, wildlife and bird species and mortality may increase as a result of collisions and disturbances. Overall, the communities of the Mackenzie Valley, including Inuvik, all support the highway extension, believing that its benefits will outweigh the costs (GeoNorth and Golder Associates 1999).



LEGEND

Existing Highways

Proposed Mackenzie Highway extension

Data Sources:
National Atlas of Canada 1:250,000
Department of Transportation - Highways and Engineering Division. 1999. Mackenzie Highway Extension Wrigley to the Dempster Highway. June 1999.

Figure 10.3.2.: Proposed Mackenzie Highway extension.

10.3.4.2. Inuvik to Tuktoyaktuk Highway

Since 1968 there has been interest amongst community and government stakeholders in developing a road between the communities of Inuvik and Tuktoyaktuk (Figure 10.3.3.). Initially, this road was viewed as part of a Mackenzie Delta community road network, however it has since been construed as an extension of the existing Dempster Highway system and potentially part of the proposed Mackenzie Highway extension. Feasibility studies and route surveys of possible road locations took place in 1977, 1985 and 1986 (DOT 1989; Ferguson Simek Clark 1997). In recent years, interest in the project has again risen among the communities of Tuktoyaktuk and Inuvik, precipitating detailed studies on the economics, social, cultural and environmental impacts of a road.

Tuktoyaktuk community members are very supportive of the project, citing various economic and social benefits that it may provide. Potential benefits that improved access to the region may provide include: reduced resupply costs, increased tourism and associated employment opportunities, reduced isolation, increased access to sand and gravel resources and potential development of resource industries (Nichols Applied Management 1999). As well, local employment opportunities are likely to arise for construction and maintenance of the road. During consultation, Tuktoyaktuk residents identified some concerns in terms of potential social costs and benefits (access to alcohol and drugs), financial costs (to pay for the road), land claims and regulatory issues (passing through Gwich'in and Inuvialuit Settlement Regions), and the effects of the project on fish, wildlife habitat (exploitation, disruption, barriers to movement) and traditional land uses (Rescan Environmental Services Limited 1999).

The initial road survey completed in 1977 is the preferred route, based on consultations with all stakeholders. This path is the shortest and the most economical, as well as being routed in terms of possible sources of granular materials available for road construction (Ferguson Simek and Clark 1997). The two alternative routes, surveyed in 1985 and 1986, were designed to be further away from Husky Lakes, due to community opposition to the road's close proximity to this ecologically significant area (DOT 1989; DOT 1999; Ferguson Simek and Clark 1997). However, at this time the communities support the original design as the most efficient route between Inuvik and Tuktoyaktuk and no longer oppose its positioning in regards to Husky Lakes (DOT 1999; Ferguson Simek and Clark 1997).

Based on stakeholder consultations, it has been determined that the road design should be an all-weather standard, capable of providing year-round, dependable use by passenger vehicles, recreational vehicles and transport trucks. Two road standards have been identified: an all-weather road designed for 60km/hour and a higher standard all-weather road designed for 80km/hour (DOT 1999). The road will cover a distance of 140km with a 60m right-of-way, to cover 840ha of land, 65% of which will be on Inuvialuit owned lands (Terriplan Consultants Limited 1999). Between the two communities, this route is fairly direct, except for the northern section, which veers to the east following the Husky Lakes coastal plain. This design avoids the rolling topography and remains close to granular sources for construction. An alternative alignment under consideration is to utilize 5km of existing roadway from Inuvik to the Department of National Defence (DND) Receiver site. In the past DND would not consider a road through this site, however since defence activities have declined in recent years, this may be a viable alignment (DOT 1999). It has been suggested that due to the high cost of constructing this road (estimated at $100,000,000 -$135,000,000), construction take place over a 5-10 year period to spread out the costs and to train and provide the maximum level of employment for community residents (Ferguson Simek and Clark 1997; Nichols Applied Management 1999). As of yet, no formal plans have been made as to if and how the project should proceed.

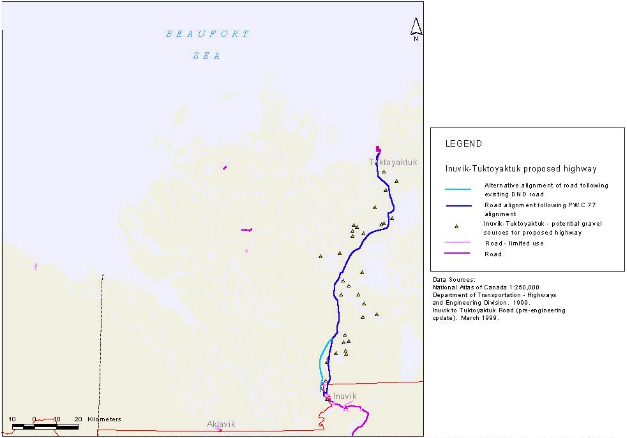


Figure 10.3.3.: Locations of existing highway and roads and proposed Inuvik-Tuktoyaktuk all season highway with potential gravel sources for construction.

10.3.5. Winter Road Route

Within the Mackenzie Delta region, the existing terrestrial transportation infrastructure is limited to seasonal ice roads between Inuvik and Tuktoyaktuk (194km) and Inuvik to Aklavik (112km) (Figure 10.3.4.) (Rescan Environmental Services Limited 1999; Town of Inuvik 2000). These ice roads generally operate for three months each year (January to April) (Rescan Environmental Services Limited 1999).

Figure 10.3.4.: Winter/ice road routes.

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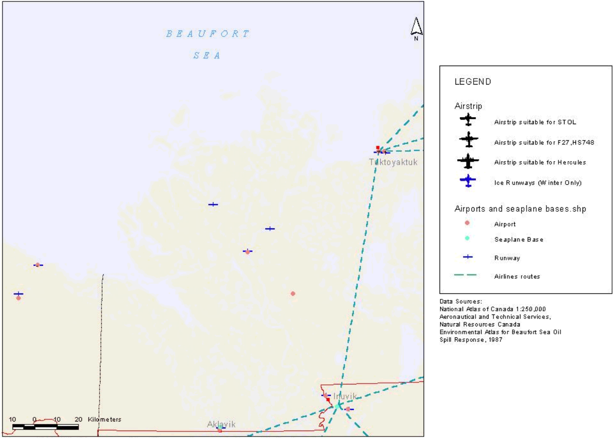
10.3.6. Air Transportation

Air service, of varying degrees of frequency and equipment, connects each of the communities within the study region (Figure 10.3.5.). In terms of large-scale airlines with regular flight schedules, Inuvik can be reached via First Air and Canadian North. Connections to Aklavik and Tuktoyaktuk are provided by small-scale operators, via regularly scheduled flights.

Flight frequency increases during the summer months, from approximately June 1 to August 31, corresponding with the tourism season. During this time period, daily scheduled flights connect Inuvik, Aklavik and Tuktoyaktuk, departing seven days per week, with approximately two flights per day. Air travel from Tuktoyaktuk to Inuvik is a combination of scheduled and chartered flights (Dressler 1998). Flight movements are frequent within the study region. Aircraft movements in 1998 at Tuktoyaktuk totaled 4,272, of which 193 (5%) were for sight seeing. A total of 1,831 flights departed from Aklavik in 1998 and from Inuvik, 14,869 (Transport Canada 1998, as cited in Dressler 1999).



Data Sources:
National Atlas of Canada 1:250,000
Aeronautical and Technical Services,
Natural Resources Canada
Environmental Atlas for Beaufort Sea Oil
Spill Response, 1987

Figure 10.3.5.: Commercial airline routes and airport infrastructure.

10.4. Mining

10.4.1. Minerals

As a whole, the ISR is a relatively unexplored area in terms of mineral potential (IRC 2000). The only active mining interests in the ISR are located outside of the BSIMPI area of interest at Darnley Bay, the site of a magnetic anomaly and North America's strongest isolated gravity anomaly. The economic mineral potential of the area is centred on minerals such as nickel, copper and platinum/palladium group elements, and diamonds may be present as well (Darnley Bay Resources Limited 2000). Known deposits of iron, coal, copper, lead and zinc exist within Mackenzie estuary area, but have yet to be developed (MDBSRLUPC 1991).

Mineral rights are held by the Inuvialuit Land Corporation, as per the IFA (Figures 10.4.1., 10.4.2., 10.4.3. and 10.4.4.) (IRC 2000):

- Section 7(1)(a)(i) lands (totaling 11,000km^2) – all minerals and granular materials;

- Section 7(1)(a)(ii) lands (totaling 2,000km^2) – Cape Bathurst;

- Section 7(1)(b) lands (totaling 78,000km^2) – excluding oil, gas, related hydrocarbons, coal, native sulphur and minerals, but including granular materials;

- Section 7(2) lands (all lakes, rivers and other water bodies found on Inuvialuit-owned 7(1)(a) or 7(1)(b) lands) – sub-surface rights held by Inuvialuit on 7(1)(a) lands and by the federal Crown on 7(1)(b) lands.

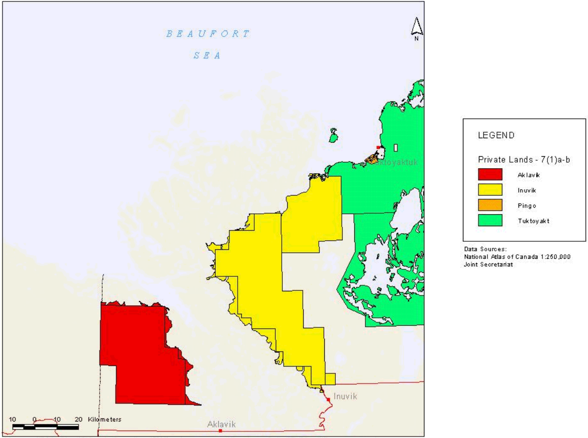


Figure 10.4.1.: Private lands, 7(1)a-b, as per the Inuvialuit Final Agreement.

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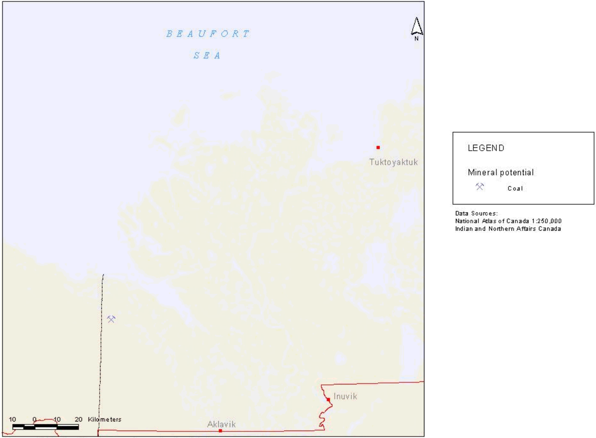


Figure 10.4.2.: Onshore mineral potential.

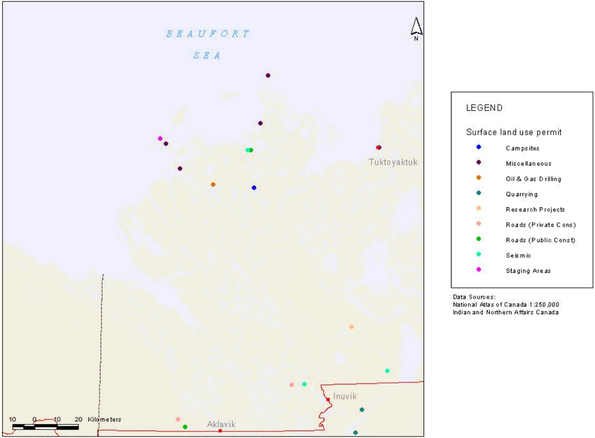
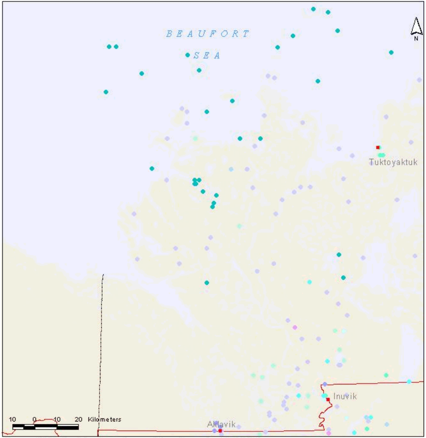


Figure 10.4.3.: Surface land use permits (as of Fall 2000).



LEGEND

Surface disposition

- Commercial
- Government
- Industrial
- Institutional
- Land Claims
- Oil and Gas
- Private/Recreational
- Private/Residential
- Public/Recreational
- Utility

Data Sources:
National Atlas of Canada 1:250,000
Indian and Northern Affairs Canada

Figure 10.4.4.: Surface disposition (as of Fall 2000).

10.4.2. Sand and Gravel

In the Inuvialuit Final Agreement, provisions are made in Section 7 for the reservation of granular and sand resources for community needs (Government of Canada 1984). Sand and gravel supplies within the southern Beaufort Sea and Mackenzie Delta region are generally in short supply, with demand for community requirements, maintenance and upgrading of transportation facilities, military activities and the oil and gas industry (MDBSRLUPC 1991). The IFA outlines priority use for sand and gravel resources as (Government of Canada 1984):

1. The Inuvialuit shall reserve supplies of sand and gravel in order to meet public community needs in the Western Arctic Region;

2. The Inuvialuit shall reserve adequate supplies of sand and gravel for the direct private and corporate needs of the Inuvialuit; and

3. The Inuvialuit shall make available sand and gravel for any project approved by an appropriate government agency.

Terrestrial sand and gravel deposits are primarily located at the Ya Ya Lakes eskers. This area, according to the IFA, is to be dedicated to sand and gravel development, “subject to normal pit development, restoration measures and laws of general applications” (Government of Canada 1984, s.7 (32)). Marine deposits of gravel are found northwest of Herschel Island and north of Cape Bathurst. Sand concentrations on the Mackenzie Shelf are located on eastern portions of the shelf and west of Herschel Island (Giovando and Herlinveaux 1981).

10.5. Reindeer

Approved by the Environmental Impact Review Board in November 2000, and forwarded to INAC for licencing (since received), Kuññek Resource Development Corporation (KRDC) plans to revitalize the historic reindeer herding operation. The current herd of 6,500 individuals is to be increased to 10,000 wintering and 12,000 summering reindeer. Presently, the herd is located on the Tuktoyaktuk Peninsula, but is to be moved back to the traditional ranges to summer on Richards Island and winter in an area between Inuvik and Tuktoyaktuk (Figure 10.5.1.). Travel between the mainland and the island will take place at Swimming Point when ice conditions allow in the spring and fall. Reindeer are to be monitored and tagged to prevent cross over with the caribou herd. The herd will be harvested for antlers, and at a later date an application will be submitted for meat production and tourism (EIRB 2000).

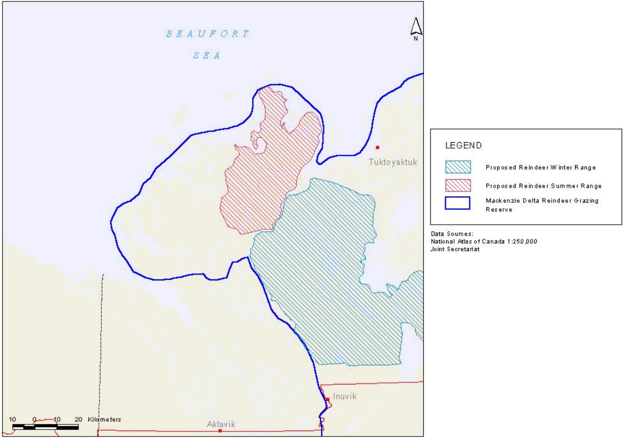


Figure 10.5.1.: Proposed reindeer summer and winter ranges.

11. PROTECTED AREAS

11.1. Migratory Bird Reserves

11.1.1. Kendall Island Bird Sanctuary

The Kendall Island Bird Sanctuary, located east of Mackenzie Bay on the outer margin of the Mackenzie Delta, was established by the Canadian Wildlife Service (CWS) in 1961 (Figure 11.1.1.). This designation was made to provide long-term protection to the colony of lesser snow geese (*Anser caerulescens caerulescens*), as well as the staging and breeding grounds of many migratory waterbird and shorebird species (Environment Canada 1992; Environment Canada 2000a; Environment Canada 2000b). The sanctuary encompasses 606km^2 of delta, made up of many flat islands and part of Kendall Island, bordering on the Beaufort Sea (Environment Canada 2000b). The flats, wet meadows and coastal marshes characteristic of the Kendall Island area provide important habitat to waterfowl and shorebirds. Ponds and lakes found on the flat islands offer further nesting and feeding habitat (Environment Canada 2000c). Tuktoyaktuk is the closest community, located approximately 120km to the east, and Inuvik is found approximately 140km to the south (Environment Canada 2000b).

The presence of more than 84 bird species has been recorded within the sanctuary. Perching birds, waterfowl and shorebirds inhabit the sanctuary from May to November (Environment Canada 1992). Lesser snow geese constitute a large proportion of the waterfowl population, up to 8,000 individuals, using the area for nesting in the spring and occasionally staging in the fall. Tundra swans (*Cygnus columbianus*), brant (*Branta bernicla nigricans*) and greater white-fronted geese (*Anser albifrons*) nest and moult in and around the site. Two shorebird species that have limited breeding distribution within Canada, Hudsonian godwits (*Limosa haemastica*) and long-billed dowitchers (*Limnodromus scolopaceus*), nest in and around the sanctuary. Dowitchers also traverse the area during fall migration. An endangered species, Eskimo curlew (*Numensius borealis*), was recorded in the sanctuary in 1985. In addition, thousands of other shorebirds nest and stage during migration periods throughout the sanctuary, and indeed throughout much of the Mackenzie Delta (Environment Canada 1992).

Kendall Island Bird Sanctuary is managed by the Canadian Wildlife Service in cooperation with local communities and regional aboriginal organizations. Management policies undergo review every five years. As stipulated in the IFA, beneficiaries may access the sanctuary and hunt and trap wildlife within in accordance with the terms of the Agreement (Environment Canada 2000e). Other types of land use are subject to approval and require a Sanctuary Permit, issued on an individual case basis, taking the type of activity, seasonal timing and the potential for damage to birds and their habitat under consideration. Activities are only permitted if they are of limited impact and undertaken under certain conditions. Proposals for activities are screened by the Environmental Impact Screening Committee (EISC) and may go onto the Environmental Impact Review Board (EIRB). Final approval is given by CWS under the sanctuary regulations of the *Migratory Birds Convention Act* (IRC 2000).

In 1990, CWS began studying the distribution and abundance of migratory birds within the sanctuary and adjacent areas in order to determine whether the size of the sanctuary should be increased (Environment Canada 1992). A proposal has been made by CWS to expand the boundaries of the sanctuary to include a 431km^2 area of high use by geese and waterfowl west of Shallow Bay (Community of Tuktoyaktuk and WMAC-NWT 1999). At this time, expansion has not proceeded.

11.2. National Historic Sites

11.2.1. Pingo Canadian Landmark

Located six kilometres south-southwest of Tuktoyaktuk, covering 16.4km^2 of land, is the Pingo National Historic Site (NHS) and Canadian Landmark (Figure 11.1.1.) (Canadian Heritage 1997a). This site is of international significance as it is home to Canada's largest pingo (Iluyk Pingo), which is the second largest in the world (Notzke

1995). Also at this site is the world's largest concentration of pingos, at various stages of evolution (Canadian Heritage 1997a; Notzke 1995). Creation of this NHS was agreed to in the Inuvialuit Final Agreement in 1984, with final legislation passing in 1996 (Canadian Heritage 1997a). National Park status for the site is pending (IRC 2000).

Management of this site is under the *National Parks Act* in a joint management regime in consultation with the Inuvialuit Land Administration and the people of Tuktoyaktuk (Notzke 1995; IFA Section 7[73]). Currently, funding sources are being sought to support the development and presentation of the site (Canadian Heritage 1997a). Land use activities are prohibited (IRC 2000).

11.2.2. Kitigaaryuit (Kittigazuit)

In 1978 the Inuvialuit community of Kitigaaryuit (also known as Kittigazuit) was declared to be of national historic significance, but was never officially commemorated as a National Historic Site (NHS) (Figure 11.1.1.). Work is currently ongoing to map and document the oral history and archeology of the area (Canadian Heritage 1997b), known as an important ceremonial and whaling centre up until the early 1900s (PWNHC 2000). This work may lead to a Cultural Resource Management Plan, making NHS status possible (Canadian Heritage 1997b).

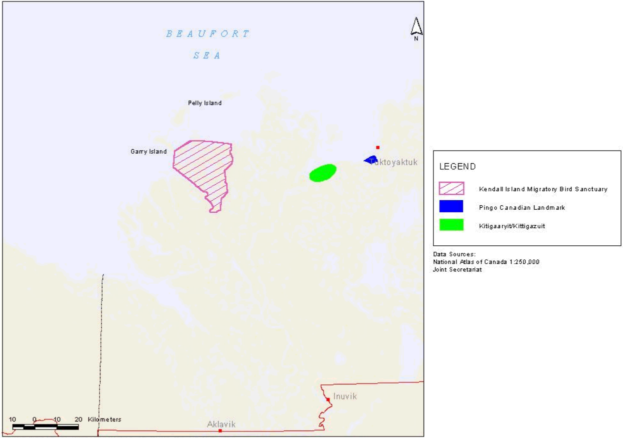


Figure 11.1.1.: Areas with special designations.

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11.3. Northwest Territories Protected Areas Strategy

Beginning in 1996, the governments of Canada and the Northwest Territories (NWT) began overseeing the development of the Northwest Territories Protected Areas Strategy (PAS). The purpose of this strategy is to set the framework, goals and guidelines for the establishment of protected areas across the NWT, recognizing social, cultural, economic and environmental components of the landscape (GNWT 2000; IRC 2000). Identification of candidate sites and specific implementation procedures are the responsibility of each region, to be determined with full stakeholder participation (GNWT 2000; IRC 2000).

The overall guiding goal of the PAS is the protection of core representative areas within each ecoregion, in terms of natural and cultural areas, though as of yet no sites have been selected (Figure 11.3.1.) (GNWT 2000). This indicates that at least one such area may be identified in the Mackenzie Delta, which encompasses the Tuktoyaktuk Coastal Plain ecoregion. However, the Kendall Island Migratory Bird Sanctuary already exists in this ecoregion, and as such is considered to be part of the NWT protected areas network (NWT Protected Areas Strategy Advisory Committee 1999). Therefore, it is unlikely that another protected area will be implemented in this region until the network has grown in the rest of the NWT. If another area is selected within this ecoregion, it will represent different characteristics than the bird sanctuary. It has been recommended that while proposals for protected areas are being evaluated, the proposed area should at a minimum be protected from mineral activities, and for those sites nominated for the highest level of protection, all industrial activities should be prohibited (IRC 2000).

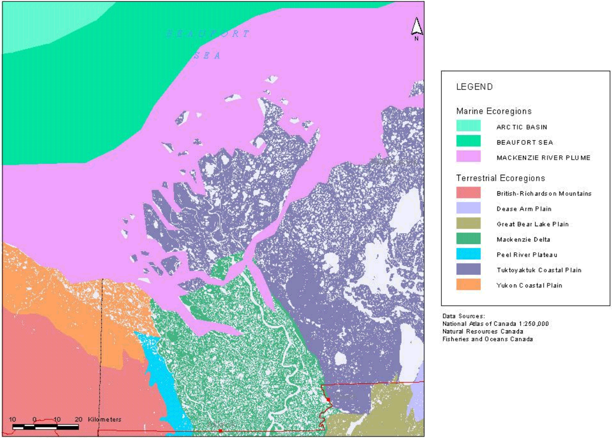

Figure 11.3.1.: Marine and terrestrial ecoregion boundaries.

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11.4. Areas with Special Status

11.4.1. Key Migratory Bird Terrestrial Habitat Site

The Canadian Wildlife Service (CWS) has identified a list of key migratory bird habitat sites throughout the ISR, in addition to Migratory Bird Sanctuaries. These sites have been identified because they represent special or significant bird habitat, and special care is required (IRC 2000).

Within the study area, one such site has been identified – the Mackenzie River Delta (Figure 11.4.1.) (McCormick *et al*. 1984; IRC 2000). This area encompasses 1,037km^2, including the islands of the outer delta, including Kendall Island (overlapping with the Kendall Island Bird Sanctuary and the Reindeer Grazing Reserve), Pelly Island and part of Richards Island. The Mackenzie River Delta has been identified for the significant numbers of waterfowl species and individuals that utilize the area for staging, nesting and moulting. This site has been recognized by both the CWS and the Community Conservation Plans (land management category D) as critical migratory bird habitat for nesting, staging and moulting waterfowl and their sensitivities to disturbances and the degradation of these low-lying habitats (Community of Tuktoyaktuk and WMAC-NWT 1999; McCormick *et al*. 1984).

These islands provide important staging grounds during the fall migration, with up to 375,000 lesser snow geese, 23,700 white-fronted geese, 12,200 brant, 1,065 Canada geese and 3,400 tundra swans previously observed. Such great numbers of these migratory birds represent large percentages of the total Canadian populations for these species. The small islands south of Kendall Island support nesting and moulting populations of lesser snow geese, tundra swans, sandhill cranes, brant, white-fronted geese, dabbling ducks and sea ducks annually (McCormick *et al*. 1984).

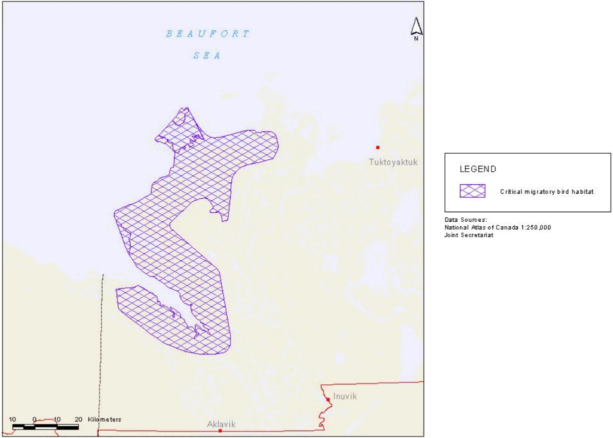

Figure 11.4.1.: Critical migratory bird habitat.

11.4.2. Area Ratings Identified in Community Conservation Plans

Land Management Categories for Community Conservation Plans (Table 11.4.1. and Figure 11.4.2.).

Category A = lands where there are no known significant and sensitive cultural or renewable resources; lands shall be managed according to current regulatory practices

Category B = lands where there are cultural or renewable resources of some significance and sensitivity, but where terms and conditions associated with permits and leases shall assure the conservation of these resources

Category C = lands where cultural or renewable resources are of particular significance and sensitivity during specific times of the year; lands shall be managed so as to guarantee the conservation of resources

Category D = lands where cultural or renewable resources are of extreme significance and sensitivity throughout the year; lands shall be managed so as to guarantee the conservation of resources

Category E = lands where cultural or renewable resources are of extreme significance and sensitivity; there shall be no development on these lands; these lands shall be managed to guarantee absolutely no damage or disruption; this category offers the highest degree of protections, short of legal designation

Category H = harvesting (Tuktoyaktuk category only)

Table 11.4.1.: Area ratings identified by the Tuktoyaktuk, Inuvik and Aklavik Community Conservation Plans, within the integrated management planning area (1999).

Site No.	Identified by…	Land Mgmt	Description
Tuk202h: Spring Caribou Harvesting Area	Tuktoyaktuk HTC	H	Tuktoyaktuk Peninsula
Tuk204h: Spring Goose Harvesting Area	Tuktoyaktuk HTC	H	Coastal areas
Tuk205h: Spring Fishing Area	Tuktoyaktuk HTC	H	Tuktoyaktuk Peninsula
Tuk207h: Summer Fishing Area	Tuktoyaktuk HTC	H	Coastal areas
Tuk208h: Summer Goose Harvesting Area	Tuktoyaktuk HTC	H	Coastal areas
Tuk209h: Fall Caribou Harvesting Area	Tuktoyaktuk HTC	H	Coastal areas near Tuktoyaktuk
Tuk210h: Fall Fishing Area	Tuktoyaktuk HTC	H	Coastal areas
Tuk211h: Fall Sea Harvesting Area	Tuktoyaktuk HTC	H	Coastal area surrounding Tuktoyaktuk
Tuk212h: Fall Goose Harvesting Area	Tuktoyaktuk HTC	H	Coast
Tuk213h: Winter Seal and Polar Bear Harvesting Area	Tuktoyaktuk HTC	H	Offshore
Tuk215h: Winter Caribou Harvesting Area	Tuktoyaktuk HTC	H	Area surrounding Tuktoyaktuk
Tuk216h: Winter Fishing Area	Tuktoyaktuk HTC	H	Coast at estuary
Tuk218e: Beluga Management Plan Zone 1a Sites – Kugmallit Bay, near Kendall Island, Shallow Bay	FJMC	E	
Tuk220b: Beluga Management Zone 3	FJMC	E	Waters greater than 20m deep in the Canadian Beaufort Sea and Amundsen Gulf to permanent pack ice,
1: Culturally Important Sites	Inuvik Community Working Group	D (cabins); E (all other sites)	Cabins, camps, archeological sites, burial grounds, old forts, trading posts, etc.
70: Fish Lakes and Rivers	Inuvik and Tuktoyaktuk Community Working Groups	C	Site includes rivers along the shoreline west of Tuktoyaktuk, inland to their headwaters
71: Bluenose Caribou Herd Winter Range	Inuvik Community Working Group	B	Extends from the Mackenzie Delta to the Anderson River, south to the headwaters of the Anderson River and Kugaluk River, and north to the coast
72: Caribou Hills	Inuvik Community Working Group	B	West bank of Mackenzie River including Williams Island (Caribou Hills)

Site No.	Identified by…	Land Mgmt	Description
74 : Caribou Hills, Middle Mackenzie Delta	International Biological Programme	Part or all of site should be candidates for ecological reserve	Upland area west of Parsons Lake and paralleling East Channel of Mackenzie River
79: Pingos Canadian Landmark	Canadian Parks Service	Will be legislatively protected under *National Parks Act* and IFA	
83: Beluga management plan zone 2 (Mackenzie shelf waters shallower than 20m)	FJMC	C	Includes the Mackenzie Shelf waters shallower than 20 metres that are not already in Zone 1
84 : Kugmallit Bay	Inuvik, Aklavik and Tuktoyaktuk Community Working Groups	C	Includes waters of Kugmallit Bay, Pullen Island, Hendrickson Island, the shorelines beginning at Hansen Harbour and extending south to the mouth of the Mackenzie River and west to the community of Tuktoyaktuk to Toker Point
85a: Mackenzie Estuary, Richards Island	Inuvik, Aklavik and Tuktoyaktuk Community Working Groups	C	Includes Kendall Island, Pelly Island, Garry Island, Beluga Management Plan Zone 1a waters, the existing and proposed Kendall Island Bird Sanctuary boundaries, nearby waters and onshore areas
85b: Critical Grizzly Bear Denning Areas	Tuktoyaktuk Community Working Groups	C	Includes Kendall Island, Pelly Island, Garry Island, Beluga Management Plan Zone 1a waters, the existing and proposed Kendall Island Bird Sanctuary boundaries, nearby waters and onshore areas
85c: Mainland Coastal Polar Bear Denning Area	Tuktoyaktuk Community Working Groups	C	Includes Kendall Island, Pelly Island, Garry Island, Beluga Management Plan Zone 1a waters, the existing and proposed Kendall Island Bird Sanctuary boundaries, nearby waters and onshore areas
86: Mackenzie Bay and Shallow Bay	Inuvik, Tuktoyaktuk and Aklavik Community Working Groups	C	Extends from the Blow River in the Yukon along the edge of Shallow Bay and up into Mackenzie Bay; includes the ocean, river water and adjoining shoreline.
88: Garry and Pelly Islands	International Biological Programme	Part or all should be candidate for ecological reserve status	

Site No.	Identified by…	Land Mgmt	Description
89: Kendall Island Bird Sanctuary and Mackenzie River Delta key migratory bird terrestrial habitat	Canadian Wildlife Services	Bird Sanctuary: legislatively protected under *Migratory Birds Convention Act*; Key habitat: D	
90: Kugmallit Bay, Whitefish Bay, Tuktoyaktuk	DFO	E	
91: Central Mackenzie Estuary	DFO	E	
92: Shallow Bay	DFO	E	FJMC Beluga Management Plan Zone 1a
95: Inner Mackenzie Delta, including Peel, Inuvik, Husky and West Channels	Inuvik Community Working Group	C	Consists of the part of the Mackenzie Delta bounded by the head of Shallow Bay in the north, the edge of the Delta at the foot of the Richardson Mountains in the west, the extent of Inuvik's traditional land use are to the southern boundary with the Gwich'in Settlement Region, and the Middle Channel of the Mackenzie River to the east
98: Culturally Important Sites	Aklavik Working Group	D (cabins) E (all other sites)	Sites include cabins, camps, archeological sites, burial grounds, old forts, trading posts, etc.
105: Canoe Lake	International Biological Programme	Part or all of site should be a candidate for an ecological reserve	
107: Mackenzie Delta Channels and Lakes	DFO	E – lakes and channels, including Rat River D – lakes	
127: Yukon North Slope Coastal Zone	DFO	C	Nearshore areas along north coast of Yukon to Shallow Bay
129: Critical Bowhead Whale Habitat	Aklavik Working Group	D	Boundary extends from the shoreline to 10km offshore and spans from the Yukon/Alaska border to the eastern boundary of Escape Reef

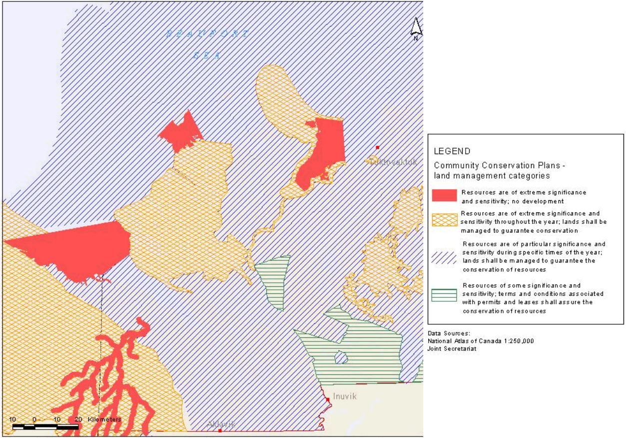

Figure 11.4.2.: Community Conservation Plans - land management categories.

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11.5. Sites Identified by International Biological Programme

11.5.1. Garry and Pelly Islands

Garry and Pelly Islands, both outer islands of the Mackenzie River Delta, have been identified by the International Biological Programme as sites that are biologically important to Canada's north (Figure 11.5.1.). As a result, it has been proposed that these islands be given a high level of consideration for protection, special management or study (Nettleship and Smith 1975). To date, it appears that these recommendations have not been formally acted upon, though the Community Conservation Plans recommend the areas be considered for ecological reserve status (Community of Tuktoyaktuk and WMAC-NWT 1999).

Both islands are small, at less than 10km in length and 5km wide, and low-lying, with Garry Island rising to 69m and Pelly to 38m. The islands are unique as they are composed of Pleistocene deposits and are remnants of the Mackenzie River's Pleistocene delta. Vegetation at these sites is representative of the delta's tundra, with twelve plant communities having been identified on Garry Island. In terms of biological importance, each of the islands provides important habitat to waterfowl for nesting as well as for small mammals (Nettleship and Smith 1975).

11.5.2. Caribou Hills

Located on the eastern side of the Mackenzie Delta, 24km northeast of Inuvik, are the Caribou Hills. Specifically, the area identified by the International Biological Programme as being of biological importance is a 56km long section of the Hills and two adjacent delta islands, Williams and Harrison Islands (Figure 11.5.1.). The area is made up of consolidated gravels and sands, and rises up abruptly from the delta to level off into a rolling plateau at 150-060m above the river (Nettleship and Smith 1975).

The west-facing slopes of the Caribou Hills are very sensitive, containing unique plant and animal assemblages. A diverse variety of plant communities are found at the site, including delta, scrub, boreal, tundra and post-fire associations, with the tree-line occurring altitudinally. Due to the warming effects of the Mackenzie Delta, several southern plant species are found in the area. Habitat is provided for both boreal and tundra fauna, and the diverse bird population is large, with significant populations present. The remains of a settlement established as the centre of reindeer herding operations, Reindeer Station, are located on the west side of the Hills (Nettleship and Smith 1975).

The International Biological Programme recommended management or protection for this area, because human impacts in the past have been great, including seismic activity, drilling, road construction and mining of gravel (Nettleship and Smith 1975). Such activities have the potential to endanger the vulnerable and unique populations of Caribou Hills (Nettleship and Smith 1975). To date, it appears that this area does not possess any protective status. The Community Conservation Plans recognize the area as land management category B (Community of Tuktoyaktuk and WMAC-NWT 1999).

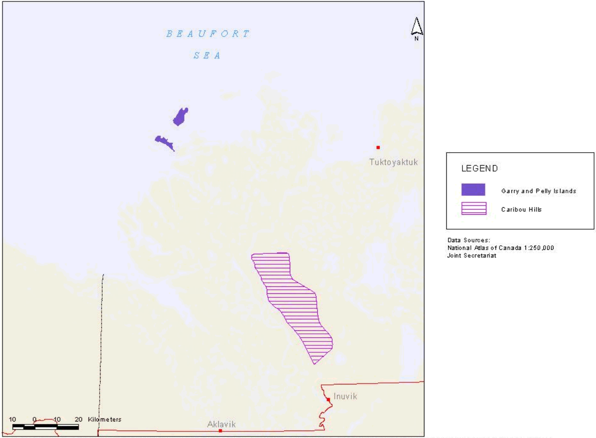

Figure 11.5.1.: International Biological Programme identified sites - Garry and Pelly Islands, and Caribou Hills.

12. EXISTING MANAGEMENT REGIMES

12.1. Inuvialuit Renewable Resource Conservation and Management Plan

The Inuvialuit Renewable Resource Conservation and Management Plan, in keeping with the principles and goals of the IFA and *Task Force on Northern Conservation*, defines a long-term strategy for the conservation and management of renewable resources within the ISR (WMAC-NWT and FJMC 1988). The principles, goals and objectives listed here were ultimately incorporated into *A Community-based Regional Land Use Plan for the Mackenzie Delta-Beaufort Sea Region* (1991), and thus the community conservation plans.

Principles (WMAC-NWT and FJMC 1988, p.6):

1. Diversity – maintaining the great variety of animals and plants will ensure the stability and productivity of the arctic ecosystem.

2. Productivity and culture – maintenance of productive arctic ecosystems is essential for the survival of Inuvialuit cultural values, social systems, local economy and sense of well-being.

3. Communication cooperation – long-term protection of ecosystems can best be achieved through active communication and cooperation of all parties concerned, including the combination of renewable resource and land management activities.

4. Future options – maintenance of the renewable resource base and its enhancement, where appropriate, will maximize Inuvialuit future options.

5. Protection – special conservation measures, including new legislation, may be necessary from time to time, to protect the renewable resource base.

6. Population management – management of fish and wildlife resources as discrete populations, where these can be identified, is essential to their conservation.

7. Habitat – careful management of habitat is vital to the maintenance of abundant fish and wildlife populations.

8. Resource Use – subsistence and recreational use of well managed renewable resources is desirable and consistent with their conservation.

9. Participation – participation of the Inuvialuit in renewable resource and land management is essential for the conservation of Arctic plants and animals and the habitats on which they depend.

10. Indigenous knowledge – Inuvialuit knowledge and experience are essential elements in the proper management of renewable resources in the Settlement Region.

Goals (WMAC-NWT and FJMC 1988, p.8):

1. Conserve resource base – to conserve arctic animals and plants and their associated ecosystems within the Inuvialuit Settlement Region.

2. Integrated management – to provide for integrated renewable resource and land management.

3. Cooperation – to cooperatively manage shared renewable resources.

4. Enhance understanding – to enhance understanding and appreciation of arctic ecosystems.

Objectives (WMAC-NWT and FJMC 1988, p.10-14):

1. Produce and implement community conservation plans.

2. Encourage active involvement of the Inuvialuit in renewable resource management and generate public support for conservation.

3. Integrate renewable resource management and regional land use planning.

4. Determine allowable harvests and quotas.

5. Assess local potential for renewable resource based economies.

6. Protect important natural resources from the negative impacts of development.

7. Develop and maintain a renewable resource information system

8. Support renewable resource research.

9. Develop appropriate legislation and conservation agreements.
10. Establish critical levels for different populations and emergency management procedures.

11. Prepare an annual report on renewable resource conservation, research and management activities.

12.2. Beaufort Sea Beluga Management Plan

Management of the Beaufort stock of beluga has been carried out under several federal acts and regulations: *Fisheries Act*, the Marine Mammal Protection Regulations, the *Oil and Gas Production and Conservation Act*, the *Canadian Environmental Protection Act*, the *Arctic Waters Pollution Prevention Act* and the Inuvialuit Final Agreement. Subsistence harvesting of beluga by Inuvialuit has been self-limited. In order to ensure that beluga resources continue to be sustainable, the Beaufort Sea Beluga Management Plan was developed with the participation of both the Inuvialuit (HTCs, IGC), FJMC and DFO (FJMC 1998).

Goals of the plan are (FJMC 1998, p.3):

1. To maintain a thriving population of beluga in the Beaufort Sea.
2. To provide for optimum sustainable harvest of beluga by Inuvialuit.

Components and associated objectives of the plan are (FJMC 1998, p.5, 9, 10, 19, 21, 23):

i) Sustainable harvests

   a) to provide for a level of harvest that generates the greatest net benefit to the Inuvialuit while ensuring the long-term sustainability of beluga in the Canadian Beaufort Sea;

   b) to ensure an efficient harvest and low loss rates.

ii) Conservation and protection

   a) to protect beluga, beluga habitat and beluga harvesting;

   b) to provide guideline and information to assist government, the environmental impact screening and review processes and the Inuvialuit Land Administration in their evaluation of development proposals which may affect beluga, beluga habitat or beluga harvesting;

c) to provide information in a format that will assist the Mackenzie Delta-Beaufort Sea Regional Land Use Planning Commission in developing its comprehensive land use plans;

d) to provide guidelines to assist industry in preparing developmental proposals.

iii) Tourism, belugas and beluga hunting

a) to facilitate tourism opportunities associated with belugas while minimizing the impacts of such activities on beluga and beluga harvesting.

iv) By-laws and regulations

a) to protect the Beaufort Sea beluga resources and the harvest of that resource;
b) to formulate, amend and implement guidelines, bylaws and regulations necessary to protect the beluga, beluga habitat and the beluga harvest.

v) Supporting programs

a) to provide the necessary biological information for the conservation, management, protection and optimal utilization of Beaufort Sea beluga;

b) to provide the new biological information about the Beaufort Sea beluga required for the implementation of this management plan.

vi) Education and public awareness

a) to initiate school and hunter education programs.

Table 12.2.1.: Beluga management plan zones (Figure 12.2.1.) (Muir 1997, p.33).

Zone	Description of Zone	Guidelines for Zone
Zone 1a Traditional Harvesting Concentration Areas	1800km^2 of shallow waters at the mouth of the Mackenzie River, including summer concentration area of Shallow Bay, east Mackenzie Bay and Kugmallit Bay. Beluga harvested by Inuvialuit from Inuvik, Tuktoyaktuk and Aklavik.	Zone 1 is a Protected Area according to guidelines in the Inuvialuit Renewable Conservation and Management Plan. No oil and gas exploration, production or related construction in this area. No mining activities (e.g. gravel removal) from break-up until August 15. All shipping activities (including dredging) should be confined to designated routes. Passage outside these routes should be avoided from break-up to August 15. No port development within or on the shores of Zone 1. Development activities outside Zone 1 should be evaluated for potential deleterious effects on water quality, quantity or on stability and integrity of Zone 1 ice. Commercial fishing proposals in Zone 1 evaluated for impact on beluga food species. Developers, regulators and other interested parties should consult with HTCs.
Zone 1b Occasional or Potential Harvesting Areas	Areas where beluga harvested by Inuvialuit of Paulatuk and occasionally by Holman, and where Sachs Harbour residents may harvest.	
Zone 2	Mackenzie shelf waters shallower than 20m that were not included in Zone 1. Extends from Cape Bathurst in east to Kay Point on the Yukon coast to the west. Major travel corridor used by beluga to move into, out and among various bays of Mackenzie estuary.	Development permitted if does not adversely affect the conservation of the beluga, protection of beluga habitat and hunting, and conducted in controlled and responsible manner. Assessment of development must consider direct effects on beluga (contamination, ISR disruption and displacement) as indirect effects (stability and integrity of ice, timing of break-up and food availability). Assessments must consider potential for cumulative impact and long-term effects. Commercial fishing proposals are evaluated with respect to beluga food species. Developers, regulators and other interested parties should consult with HTCs.
Zone 3	Remaining range of beluga in Beaufort Sea and Amundsen Gulf (waters greater than 20m deep). Bounded by Victoria Island on east, permanent pack ice on north and Alaska-Yukon border on west.	
Zone 4 International Waters	Winter range of beluga population and outside Canadian waters. Includes Alaskan Beaufort Sea, Chukchi Sea and Bering Sea.	An international agreement should be developed to ensure beluga are managed and protected throughout the range. Exchange of information between Canada and Alaska on industrial activities that could affect well being of beluga.

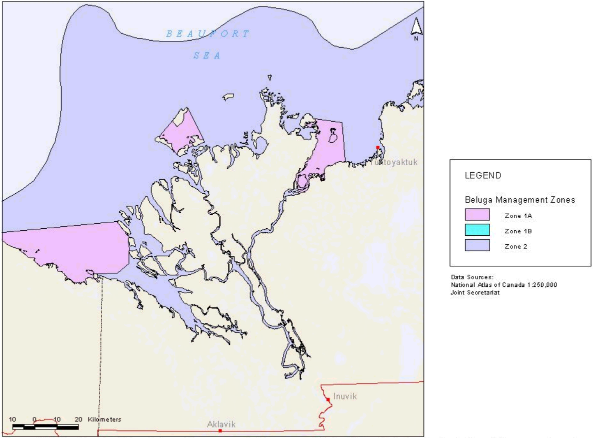

Figure 12.2.1.: Beaufort Sea Beluga Management Plan zones (Note: Zone 1B is located outside of the area shown)

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12.3. Western Arctic Bowhead Management

Resulting from the 1988 proposal of the Aklavik Hunters and Trappers Committee to gain a licence to land a bowhead, the Western Arctic Bowhead Management Plan is developed and updated each time a hunt is proposed (P. Hall, pers. comm.). Due to past commercial overexploitation of the Western Arctic bowhead stock, the International Whaling Commission (IWC) has classified it as a “protection stock”, prohibiting commercial harvest. The Inupiat of Alaska harvest from this same stock based on subsistence needs and subject to a quota issued by the IWC (DFO *et al*. 1991).

The management plan is implemented to “ensure a healthy, productive bowhead stock in the Western Arctic that will complement international conservation and aboriginal need, and support a sustainable harvest by Inuvialuit in Canada” (DFO *et al*. 1991, p.2). The plan is based on five components: 1) stock information; 2) fishing plan; 3) compliance and harvest statistics plan; 4) research and monitoring plan; and 5) communication and education plan. Information collected in each of these categories led to the Minister of Fisheries and Oceans issuing a permit for the hunting and killing of one or the striking of two bowhead for local consumption in 1991. The FJMC then allocated this quota to the Aklavik HTC, which was responsible for the coordination of the hunt. Details as to the manner in which the hunt was to be carried out were outlined in the plan, with regards to fishing equipment and crew, the role of fisheries officers, research and monitoring requirements, and communication procedures to occur between the HTC, IGC and DFO (DFO *et al*. 1991).

12.4. Community Conservation Plans

Within the IFA (s. 14(60b)), provisions are made for the development of a conservation plan, resulting in the *Inuvialuit Renewable Resource Conservation and Management Plan* (1988). This plan provides direction for resources management initiatives, in the form of principles and goals adapted from both the IFA and the *Report of the Task Force on Northern Conservation* (1984) (WMAC-NWT and FJMC 1988).

One objective from this plan was the development of community conservation plans by the six Inuvialuit Settlement Region (ISR) communities, based on information contained in the document *A Community-based Regional Land Use Plan for the Mackenzie Delta-Beaufort Sea Region* (1991). These Community Conservation Plans are intended to provide guidance to those with an interest within the area by describing current conservation and resources management initiatives, practices, and community goals and concerns. Each community plan provides a detailed overview of land uses within each specific area. These plans were first developed in each of the communities between 1990 and 1994; the plans undergo a stringent review and potential revisions every two years (Community of Inuvik and WMAC-NWT 1999).

12.5. Kendall Island Migratory Bird Sanctuary

The Kendall Island Migratory Bird Sanctuary was established in 1961 to provide long-term protection to the colony of Lesser Snow Geese (Environment Canada 1992). Management of the sanctuary is such that no activity that could harm migratory birds or their habitat is allowed, except when authorized by a permit issued by the Canadian Wildlife Service of Environment Canada. Such a permit outlines various restrictions on the timing, location and intensity of the proposed activities so that negative impacts on birds are minimized. Individuals who are not beneficiaries of the IFA are required to obtain a special permit to hunt or trap migratory birds or other wildlife (Environment Canada 2000d). Management is undertaken in cooperation with local communities and regional aboriginal organizations. Consultation with stakeholders is ongoing and management policies are reviewed every five years (Environment Canada 2000d).

12.6. Fish Management Plans

Fisheries and Oceans Canada (DFO) is working together with other boards, wildlife bodies and users to develop integrated fisheries management plans (IFMP) as part of the co-management of northern fisheries (IRC 2000). Within the Mackenzie Delta/southern Beaufort Sea area, one fish management plan currently exists, the *Integrated Fisheries Management Plan for Coney (*Stenodus leucichthys*) in the Gwich'in Settlement Area, Inuvialuit Settlement Region and the Sahtu Settlement Area, Northwest Territories*. Coney (also known as inconnu or sheefish) is a migratory species in the lower Mackenzie River basin, spawning in upstream in the Peel, Arctic Red and Mackenzie Rivers and major tributaries, and inhabiting the lower Mackenzie Delta and coastal Beaufort Sea. As a result of these migrations, coney stocks are shared by resource users from the three land claims areas in the communities of Fort Good Hope, Tsiigehtchic, Fort McPherson, Inuvik, Aklavik and Tuktoyaktuk. Within the ISR, residents of Tuktoyaktuk harvest the majority of the fish (approximately 5,150 annually in the ISR) (DFO 2000b, p.6).

The IFMP is a joint effort of all agencies with mandates to manage to coney within their waters – the Fisheries Joint Management Committee, the Inuvialuit Game Council, the Gwich'in Renewable Resources Board (GRRB), the Sahtu Renewable Resources Board (SRRB) and the Department of Fisheries and Oceans. Other groups that play a role in coney management are the Hunters' and Trappers' Committees, land and water boards and environmental impact screening and review boards. The management plan is integrated in nature since it utilizes both scientific and traditional knowledge for the management of coney (DFO 2000b). The overall goal of this management plan is "to manage the migratory coney stocks in the Lower Mackenzie River and the inshore marine waters of the Beaufort Sea in the Mackenzie Delta Area" (DFO 2000b, p.1).

Specific goals for coney management are (DFO 2000b, p.1):

1. to determine the current stock size and health;

2. to maintain or enhance the size of coney stocks through management practices (such as using closed seasons or quotas);

3. to identify, protect and manage critical coney habitats.

Specific goals for resource users are (DFO 2000b, p.2):

1. to protect and maintain traditional fishing activities and areas;

2. to encourage conservation, efficient and responsible fishing practices for coney;

3. to work to increase the knowledge of coney ecology by promoting research and exchanging traditional and scientific knowledge;

4. to ensure that management decisions and study results are communicated back to communities and other users/groups in a timely manner and in a meaningful way; and

5. to ensure that all decisions that may effect the status of coney stocks and their habitats, and thus the well being of those who utilize coney, are based on the best available information.

These goals are to be met via specific solutions and actions, outlined under the two categories of: 1) coney and 2) resource users. Categories to be addressed in this manner are (DFO 2000b, p.7-14):

1. Coney:
    a) stock status/biological features;
    b) traditional ecological knowledge;
    c) harvest management; and
    d) habitat use/management.

2. Resource users:
    a) Co-management; and
    b) culture and education.

12.7. Polar Bear Management

12.7.1. International

In response to concerns about the conservation of polar bear, representatives from the five polar bear countries (Canada, Denmark, Norway, the United States of America and the Union of Soviet Socialist Republics) met in 1965. A group of polar bear scientists from each of the nations organized themselves into what is now known as the International Union for the Conservation of Nature Polar Bear Specialist Group to discuss research and management strategies. As a result on November 15, 1973 the *International Agreement on the Conservation of Polar Bears and Their Habitat* was signed in Oslo, Norway. Each country agreed to undertake national research programs on polar bears, emphasizing the conservation and management of the species, and to exchange data from such studies (Stirling 1998). As well, the agreement states: “each Contracting Party shall take appropriate action to protect the ecosystems of which polar bears are a part, with special attention to habitat components such as denning and feeding sites and migration patterns, and shall manage polar bear populations in accordance with sound conservation practices based on the best scientific data” (Article II).

12.7.2. Canada

Within Canada exist two committees responsible for making recommendations as to polar bear management: the Federal-Provincial Technical and Administrative Committees for Polar Bear Research and Management (PBTC and PBAC, respectively). These committees meet annually and are composed of representatives from the federal government, the territories (Yukon, Northwest Territories and Nunavut) and four provinces (Manitoba, Newfoundland, Ontario and Quebec). Four Inuit user groups (Inuvialuit Game Council, Nunavut Wildlife Management Board, Makivik Corporation and the Labrador Inuit Association) have been invited to participate as members on both these committees. One of the functions of these committees is to make recommendations on sustainable annual quotas across Canada’s arctic (Lunn *et al*. 1998).

12.7.3. Northwest Territories

Within the Northwest Territories, the sustainable quotas for each population of bears are divided amongst the communities that hunt them. In terms of polar bear management within the Northwest Territories, a draft management plan was drafted and reviewed by both the PBTC and the territorial biological staff, but has not been updated nor agreed upon. Any such management plan must be consistent with the Inuvialuit Final Agreement legislation and will likely be based on the cooperative development of Population Management Agreements with the communities. As such, a polar bear management plan for the ISR must come from the appropriate Land Claims boards (i.e. the Wildlife Management Advisory Council), rather than the territorial government (Lunn *et al*. 1998).

Polar bear management within the communities of the ISR currently starts with community meetings and concludes with Population Management Agreements, signed by the communities sharing the bear populations and the Minister of Resources, Wildlife and Economic Development (RWED). All agreements are reviewed by the Land Claim Boards and are then given to the Minister of RWED as recommendations for regulation changes to enable the agreements. Agreements such as these have led to increased protection for females and family groups (all family groups are now protected) and a lowering of quotas in order to ensure sustainable harvesting. Population Management Agreements may be changed with new information or with the preferences of local hunters, but only with consultation with all affected communities and jurisdictions sharing a population (Lunn *et al*. 1998). An overview of the regulations covering polar bear management in the Northwest Territories is presented in Table 9.7.1.

Table 12.7.1.: Summary of regulations covering polar bear management in the Northwest Territories as of 31 December 1996 (Lunn *et al*. 1998, p.52-53).

Category	Northwest Territories
Hunting	Varies between NWT Wildlife Management Polar Bear Areas; longest season 1 August to 31 May; shortest season 1 January to 31 May
Who can hunt	Inuit residents and non-residents with Wildlife Certificate if HTA provides necessary tag
Quota	By settlement; 1996-1997 quota was 531 (including Nunavut)
Females and cubs protected by law	Yes
Bears in dens protected by law	Yes
Proof of origin of untanned bear	Seal on hide and export permit
Export permit required and cost (out of territory of origin)	Required: no coast. There is a $750 Trophy Fee for non-residents and non-resident aliens
Export permit out of Canada	Required by CITES for all polar bears or parts thereof exported out of Canada; obtained from Territory/Province in which port of export
Scientific licences	Discretion of Director of Wildlife and Fisheries, Department of Resources, Wildlife and Economic Development
Selling of hide by hunter	Yes; must be sealed
Basis of regulation	Wildlife Act and Regulations; 1960 Order in Council (Endangered Species)
Fur dealer authority	$150 Fur Dealer's Licence for each of the first 2 consecutive years, then $10 for each year after $200 Travelling Fur Dealer's Licence for each of the first 2 consecutive years, then $25 for each year after
Taxidermy	$25 Taxidermist Licence
Tanner's authority	$25 Tanner's Licence
Live animal capture	$5 licence to capture live wildlife
Live animal export	Licence to Export Live Wildlife, $3,000/polar bear

12.7.4. Southern Beaufort Sea

In January 1988, the Inuvialuit (represented by the Inuvialuit Game Council, Inuvik) and the Inupiat of Alaska (represented by the North Slope Borough Fish and Game Management Committee of Barrow, Alaska) signed the *Management Agreement for polar bears in the southern Beaufort Sea*. This agreement covers the area of the southern Beaufort Sea from approximately Baillie Islands, Canada in the east to Icy Cape, USA in the west. The communities that this agreement may impact are Barrow, Nuiqsut, Wainwright, Atqasuk and Kaktovik in the United States and Inuvik, Aklavik, Tuktoyaktuk and Paulatuk in Canada. This agreement is non-binding since the Alaskan representatives do not possess the authority to sign such an agreement, but rather are acting as representatives of the local traditional user group (Inuvialuit Game Council and North Slope Borough Fish and Game Management Committee 1988).

From this agreement, two committees were convened to ensure the annual review of harvest data, research results and management recommendations: the Joint Commissioners, chosen from the Inuvialuit and Inupiat, and a Technical Committee to be composed of scientists from government agencies and hunters (Lunn *et al*. 1998). These committees are to determine the annual sustainable harvest, to be divided between Canada and the USA based on an annual review of scientific evidence (Inuvialuit Game Council and North Slope Borough Fish and Game Management Committee 1988). The Technical Committee is also responsible for producing an annual report, on behalf of the Inuvialuit and Inupiat that accounts for the manner in which the quota was taken and other matters of interest or concern (Lunn *et al*. 1998).

Objectives of the agreement are (Inuvialuit Game Council and North Slope Borough Fish and Game Management Committee 1988, Article II):

a) to maintain a healthy viable population of polar bears in the southern Beaufort Sea in perpetuity;

b) to provide the maximum amount of protection to female polar bears;

c) to minimize detrimental effects of human activities, especially industrial activities, on important polar bear habitat;

d) to manage polar bears on a sustained yield basis in accordance with all the best information available;

e) to encourage the collection of adequate technical information on a timely basis to facilitate management decision;

f) to further refine the eastern and western boundaries of the population of polar bears;

g) to encourage the wise use of polar bear products and by-products within the context of management on a sustained yield basis;

h) to facilitate the exchange of polar bear meat and products between traditional users in Alaska and Canada (enabling legislation required);

i) to legalize the sale of polar bear hides and by-products by the traditional Alaskan users in Alaska (enabling legislation required);

j) to facilitate the export of polar bear hides and other polar bear products from the Western Arctic of Canada into the USA (enabling legislation required); and

k) to consider at a later date a limited legalized Alaskan sport harvest of polar bears which emphasizes benefits to local hunters of the area (enabling legislation required).

The Inuvialuit Game Council has expressed concern recently over the proportion of female bears taken in the harvest. Although the proportion of female bears is not to exceed one-third of the harvest, because the total quota of bears has not been filled in past years, the number of female bears exceeds one-third of the total harvest. This issue is being addressed by the IGC and the Hunters' and Trappers' Committees within the communities, and an educational program is to be implemented (Lunn *et al*. 1998).

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14. Personal Communications

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APPENDIX 1: PROPOSED THREE-YEAR WORKPLAN AND TIMELINE

Beaufort Sea Integrated Management Planning Working Group

PROPOSED THREE-YEAR WORKPLAN

Meeting in Inuvik, NT, Jan.17 and Jan.18, 2001

Purpose: Develop a workplan including timeframe and geographic scope.

1. Integrated Management Planning Process on Beaufort Sea Beluga Management Plan (BSBMP) Zones 1a for potential MPA

Focus on Beaufort Sea Beluga Management Plan

a) Community Consultation on Zones 1a (as per BSBMP) research needs
-Identify issues/concerns and prioritize
-Identify research needs, gaps and priorities

b) Conduct research to Meet Community and DFO Needs
-Ecological Assessment Report (TK/Scientific)
-Technical Assessment Report (is a MPA feasible, practical, regulations, community support, is it necessary etc.) compensation, if necessary
-Social/Economic Assessment Report (costs and benefits of MPA)

c) Implication of Activities outside 1a area
(need for looking at matters outside Zones 1a that impact these zones e.g. Disturbance of beluga by seismic which may occur outside Zones 1 a 1) Initially the Working Group will focus on activities inside Zones 1a and subsequently consider impacts farther out.
- identify activities
- assess the impacts on Zones 1 a
- provide recommendations to SMC Senior Management Committee (SMC) on how to address impacts.

d) Develop recommendations on management needs in Zones 1a and whether to proceed with a potential MPA or not and refer to SMC for decision
- proceed or not as per SMC decision

2. Marine Environment Quality (MEQ)

Completed activities: Community workshops held in both Aklavik and Tuktoyaktuk. (Two members of MEQ working groups have been identified, no dates set yet for meetings.)
Draft reports have been circulated to the respective organizations. They will be circulated to workshop participants for information.

a) MEQ Working Group meetings in Aklavik and Tuk (community working group to assist in implementing monitoring program at community level)
b) Workshop(s) to develop indicators for MEQ
c) Monitoring to Support Zones 1a and community areas of influences that impact on Zones 1a
d) Community ocean monitoring training of local community members
e) Linking with other monitoring programs and agencies [e.g. EMAN (Ecological Monitoring and Assessment Network); Arctic Knowledge Co-op, MVCIMP (Mackenzie Valley Cumulative Impacts Monitoring Program), FJMC-DFO (Fisheries Joint Management Committee and Department of Fisheries and Oceans)] spell out these acronyms.

3. Husky Lakes: (Andrea Hoyt)
IM research in support of ILA management plan.

Completed: community interviews to document community wishes concerning the management plan for Husky Lakes 2000
a) Review results with ILA and communities and obtain feedback
b) Report including maps and community presentation (Timeframe: completion summer 2001)
c) Other support pending ILA needs

4. GIS support and Information gathering
Contract with Joint Secretariat – year one near completion 2000/2001

a) Year two: Joint Sec. Contract to be renewed for 2001/2002
Mapping (as required) to meet the WG needs re Zones 1a
b) Information gathering from Integrated Management Planning Resource Person position.
c) Winnipeg GIS support
d) Data gathering, exchange and coordination with other agencies and groups:
- Arctic Institute
- Environmental Studies Research Fund (ESRF), Program of Energy Research Development (PERD)
- Inuvialuit Cultural Society
(relate to workplan 1(b) Zones 1a)
e) Draft Ecological overview report of Beaufort Sea by March 31/2001.
f) Cataloguing of gray and published literature
g) Magdalena Muir: regulatory review, re: Marine Protection
h) Jesse Sloan report on regulatory process A “Road Map”

5. Secretariat incl. Technical Support
    a) Select Chair of Working Group
    b) Fill Integrated Management Planning Resource Person in Inuvik
    c) Secretariat functions – see Appendix A

6. Communications Strategy

    Target and prioritize audiences, timing and messages

    a) Develop a strategy, first priority is communities in the ISR, co-management bodies and organizations
    b) Develop a communications plan which provides continuous updates/communication with the communities etc
    c) Implement communications plan
    d) Articles in IRC newsletter to introduce Working Group activities and provide updates on a regular basis.

Beaufort Sea Integrated Management Planning Working Group Proposed Three-Year Workplan

SMC = Senior Management Committee

Workplan Activity	**2001/2002**	**2002/2003**	**2003/2004**
1. Integrated Management Planning Process on Beaufort Sea Beluga Management Plan (BSBMP) Zones 1a for potential MPA			
a) Community consultation on Zones 1a research needs			
Identify issues/concerns and prioritize			Assumes that new issues/concerns will arise over time and need to be addressed
Identify research needs, gaps and priorities and identify existing information			
b) Conduct research to meet community/DFO research needs		May be adjusted to meet changing needs	
Ecological Assessment Report focusing on the estuary and Zones 1a.			
Technical Assessment Report			
Social/economic Assessment Report			
c) Implications of activities outside Zones 1 a area			

Workplan Activity	**2001/2002**	**2002/2003**	**2003/2004**
Identify activities We know most of them already: shipping; food for beluga; subsistence hunting and fishing; ecotourism; oil and gas; research. It is hard not to look at the estuary. The focus is on Zones 1a but look at the whole.		May be adjusted to meet changing needs	
Assess the impacts on Zones 1a			May be adjusted to meet changing needs
Provide recommendations to SMC on how to address impacts			
d) Develop recommendations on management needs in Zones 1a and whether or not to proceed with MPA and refer to SMC for decision			
Proceed as per SMC advice			
2. Marine Environmental Quality			
a) MEQ Community Working Group meetings in Aklavik and Tuk			
b) Workshop(s) to develop indicators or MEQ			
c) Monitoring to support Zones 1a and community areas of influences that impact on Zones 1a			

Workplan Activity	**2001/2002**	**2002/2003**	**2003/2004**
d) Community ocean monitoring training			
e) Linking with other monitoring programs			
3. Husky Lakes IM research in support of ILA Management Plan			
a) Review results with ILA and communities and obtain feedback			
b) Report including maps and community presentation			
c) Other support pending ILA needs?			
4. GIS Support and Information Gathering			
a) Joint Secretariat Contract Year 2			
b)Information gathering from ISR Liaison position			
c) Winnipeg GIS support			

Workplan Activity	**2001/2002**	**2002/2003**	**2003/2004**
d) Data gathering, exchange and coordination with other agencies and groups			
e) Ecological overview of the Beaufort Sea			
f) Cataloguing of published and grey literature			
g) Regulatory Review: Muir			
h) Regulatory Process: Sloan – Road Map			
6. Secretariat incl. Technical Support			
a) Select Chairman of Working Group	To be completed before Apr 1/2001		
b) Fill ISR Integrated Management Planning Resource Person	To be completed before Apr 1/2001		
c) Secretariat functions as per Appendix A			
7. Communications Strategy			
a) Develop a strategy; first priorities is communities in the ISR, co-management bodies, organizations			

Workplan Activity	2001/2002	2002/2003	2003/2004
and communities			
b) Develop a plan			
c) Implement plan			
d) Articles in IRC Newsletter to introduce Working Group activities and provide regular updates			

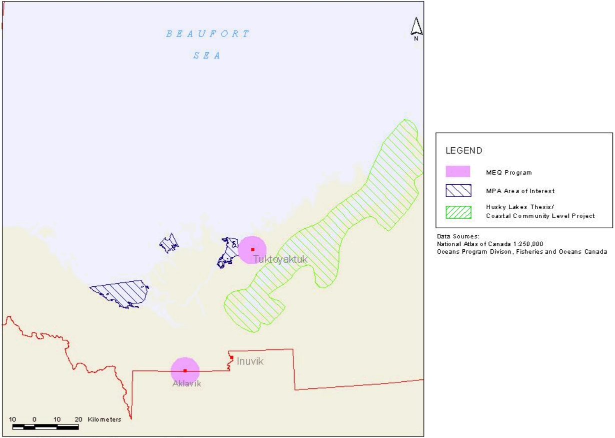

Figure A1.: On-going Oceans activities.