High Arctic PEMT Layers

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General Sensitivity Notes

Sensitivity layers were organized according to summer (May to October) and winter (November to April) unless otherwise noted, which correspond with seasons for sea ice concentrations (Barber and Hanesiak 2004). Sensitivity layers were extended to include the NOGB onshore grid network. The onshore sensitivity layers include an evaluation of onshore polar bear denning habitat, and staging, feeding, nesting, brood-rearing and moulting habitats for offshore (seabirds), and onshore (shorebirds, ducks and geese) migratory bird species. The concepts considered in developing the sensitivity rating included the following:

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

Sensitivity Layers

Sensitivity layers were developed based on a composite of various pieces of relevant ecosystem (habitat use and availability) and socio-economic information. Grid sensitivity ratings provide a relative appreciation of the biological (highlights the most vulnerable and sensitive areas, seasonal distribution, and provides information on the potential response to change resulting from hydrocarbon development), social or economic values within grid. A consistent rating scale was applied to allow for comparison, as outlined below.

Grid Cell Sensitivity Rating

1 - Low Sensitivity

2 - Low/Moderate Sensitivity

3 - Moderate Risk Sensitivity

4 - Moderate/High Sensitivity

5 - High Sensitivity

Polar Bear

Rationale for Selection

Polar bears are an integral component of the Arctic ecosystem in Nunavut as they are the top predator within the food web. Polar bears also have significant cultural and economic importance to the Inuit and are hunted by almost all communities (Priest and Usher 2004). Over a five year period from 1996 to 2001 the mean number of polar bears taken from hunting was approximately 1339 (Priest and Usher 2004). Hides are sold commercially as luxury items and may bring high prices in the fur market. Inuk guided hunting is also a source of income from the tourist industry and polar bear watching tours have also become popular (COSEWIC 2002).

Key habitat

Polar bears rely on sea ice habitat for survival as it provides them access to the seal species that make up the majority of their diet. For this reason, Polar bear habitat shows the same variability from year to year as the sea ice. When this variability is compounded with the uncertainty of the effects that climate change has on arctic ice patterns, it becomes very difficult to accurately identify the spatial boundaries of polar bear key habitat as they are changing from year to year and decade to decade. Key habitat for polar bears includes areas of active ice (leads, polynyas) in the spring and early summer when access to prey is most critical.

Polar bears prefer productive waters near shorelines, the edge of the pack ice and polynyas as these areas provide access to the seals that they prey on. Landfast ice also provides important foraging habitat for polar bears in the spring when seals and their pups are in their birth lairs. Polar bears tend to return to the same denning area year after year or an area of similar habitat quality (Lunn, et al. 2004; Stirling, et al. 2004). Denning areas in the high arctic study area are concentrated along the coastal regions of Melville Island, Bathurst Island, Ellesmere Island, and Alex Heiberg Island. In portions of the high arctic, polar bears are forced onto the land in the summer as the ice recedes and spend up to several months in summer retreat areas while they wait for the ice to return. These areas have been identified on Bathurst Island and northeastern Devon Island.

Sustainability Factors

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

Female polar bears have low reproductive rates, which makes them vulnerable to any threat that could impact health and population abundances (COSEWIC 2002).

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

Susceptibility to Oil and Gas Activities

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

Seismic Exploration

Marine based seismic exploration can only proceed in areas of open water. Although it is not uncommon to see polar bears swimming in open water, adverse interactions with polar bears would be unlikely and effects would be limited. The impact of land-based activities on maternal denning has not been studied.

Ice-based Activities

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

Shipping

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

Hydrocarbon Release

Physiological studies on the effects of oil on polar bears show there is a high probability that a single major oil spill in a critical habitat area for polar bears may have a significant effect on the population (COSEWIC 2002). Polar bears have been shown to be extremely sensitive to the toxic effects of oil and quickly succumb to kidney failure and death when exposed to situations where their fur became oiled, and oil was ingested while grooming (Stirling 1998).

Potential Effects of Climate Change

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

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

Sensitivity Ranking

High Sensitivity (5)

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

Moderate/High Sensitivity (4)

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

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

Areas identified as important polar bear habitat under the Government of Nunavut's Wildlife Areas of Special Interest, or under the international Biological Program are also given a rating of moderate/high sensitivity for the summer and winter seasons. There is only one IBP site that falls within the high Arctic Study area.

Moderate Sensitivity (3)

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

Low/Moderate Sensitivity (2)

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

Low Sensitivity (1)

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

Mitigation

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

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Narwhal

Rationale for Selection

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

Key habitat

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

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

Sustainability Factors

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

Susceptibility to Oil and Gas Activities

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

Increased land development along the coast may cause negative effects on narwhals. Potential increases in shipping and offshore oil and gas development may induce temporary or long term changes in habitat, distribution and migration (Richard 2001; Huntington in press).

Increased vessel traffic and offshore oil development may also negatively affect the narwhal populations through habitat displacement and/or ship strikes (though strikes are less likely with fast moving whales such as the narwhal). Behavioral studies of narwhal reaction suggest narwhals "freeze"(seek shallow water and remain immobile) when approached by vessels (Finley and Evans 1983; COSEWIC 2004c). As well, some Inuit hunters suggest that narwhals are sensitive to and avoid noise from industrial machines and explosions (COSEWIC 2004c).

Potential Effects of Climate Change

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

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

Sensitivity Ranking

Sensitivity rankings for narwhal habitat in the High Arctic study area were developed using two primary types of information: i) known and likely range/distribution of this species (as determined from available literature sources [e.g., COSEWIC status reports]; and ii) ecological sensitivity described recently by Laidre, et al. 2008. Hence, application of the ecological sensitivity components included by Laidre, et al. 2008 may not always be consistent with known locations of narwhal habitat. For example, COSEWIC (2004) states that narwhals are likely found as far north and west (within the Canadian high Arctic region) as ice conditions permit. Thirty year median ice charts, produced by the Canadian Ice Service, were used in applying the ecological sensitivities (as described by Laidre, et al. 2008, and others) and known ice distribution.

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

High Sensitivity (5)

Areas identified as highly sensitive for toothed whales includes areas designated as critical for narwhals and a spatially limited area (< 100 km2) during the summer months that provides specific ecological function essential to narwhals. In the winter months this rating was also given to that provide core overwintering habitat or where very large concentrations of narwhals are known to occur.

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

Moderate/High Sensitivity (4)

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

Moderate to highly sensitive summer narwhal habitat was identified primarily for those regions of loose pack ice in July – September. These regions include waters near King Christian Island and Penny Strait; as well as south of Prince Patrick and Melville Island (though narwhals have not been observed in these last two western regions). No moderate to highly sensitive narwhal habitat was identified in the High Arctic study area.

Moderate Sensitivity (3)

Moderate sensitivity during the summer months was given to areas of open water, shelf-break, and the ice-edge (pack ice next to open water). This rating would also apply to areas that contain moderate to large numbers of narwhals. Moderate sensitivity during the winter months was given to areas that contain low to moderate sized concentrations of narwhal, deep water, the shear zone, or leads and polynyas.

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

Low/Moderate Sensitivity (2)

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

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

Low Sensitivity (1)

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

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

Mitigation

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

Migratory Birds

Rationale for Selection

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

Key habitat

Key Migratory Bird Marine and Terrestrial Habitat Sites

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

Migratory Bird Sanctuaries

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

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

Important Bird Areas

Important Bird Areas (IBAs) are created to identify, conserve, and monitor a network of sites that provide essential habitat for threatened birds, birds restricted by range or by habitat, and congregatory species. The IBA program is an international conservation initiative coordinated by BirdLife International. The Canadian co-partners for the IBA program are Bird Studies Canada and Nature Canada (Formerly the Canadian Nature Federation). A short description of each IBA featured can be found below. Each IBA is also identified as being either globally, continentally or nationally significant.

Biological Hotspots

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

Key Terrestrial and Marine Sites

Seymour Island

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

The Sverdrup Basin has a high future potential for oil drilling and associated spills or exploration could further endanger the seabirds and pollute their feeding areas.

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

North Kent Island, Hell's Gate and Cardigan Strait

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

(Larus glaucoides thayeri), Arctic Terns (Sterna paradisaea) and the High Arctic Brant (Branta bernicla) all occur in the area.

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

Queen's Channel

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

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

Cheyne Islands

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

Eastern Prince Patrick Island Coast

Prince Patrick Island is located in the western high arctic and features numerous expansive cliffs of up to 80 m high as well as coastal lowland areas (Latour, et al. 2006b). The Brant makes extensive use of the coastal lowland areas for nesting and moulting. This location could service as much as 50% of the

Western High Arctic Brant population (Latour, et al. 2006b). Additional species that use this important terrestrial site include Snow Geese (Lesser and Greater), King Eider, Common Eider, Long-tailed Ducks, Pacific Loons, Glaucous Gulls, Peregrine Falcons, Black-legged Kittiwakes.

The Brants and their associated habitat are particularly sensitive to disturbance during the summer. Prince Patrick Island has potential for hydrocarbon deposit and is listed as an Important Bird Area in Canada (Latour, et al. 2006b). This IBA is considered globally significant for congregatory species (IBA Canada 2009).

Sustainability Factors

Birds are susceptible to loss of habitat (through either the conversion of natural areas for development or by avoiding areas disturbance that experience disturbance because of human activity) and direct mortality.

Susceptibility to Oil and Gas Activities

Migratory birds occurring on open water can general avoid the routine effects of hydrocarbons development (for example, by moving to avoid passing ships). Human disturbance (such as low-flying aircraft) can affect nesting colonies, in the most extreme case causing them to be abandoned (Important Bird Areas Canada). This is a potentially important for bird species that are either concentrated into relative small areas or are —at risk (such as the endangered Ivory Gull).

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

Potential Effects of Climate Change

Climate changes will affect seabirds in a variety of ways both directly and indirectly. Direct effects include a rise in air and sea temperatures, changing ice distribution and rise in sea levels, while indirect effects include changes in prey distribution. A rise in sea level may damage essential shoreline nesting areas. Direct mortality from predation and storms are the two primary natural threats to seabirds.

Increasing temperature may bring increasing storms which could increase general mortality and during the breeding season could inhibit nesting effort or destroy eggs and chicks. Climatic changes will affect the habitat of seabirds which may shift their distribution and abundance.

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

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

Sensitivity Ranking

High Sensitivity (5)

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

- Supports 1% of the North American population (following the IBA guidelines)
- Supports a very significant (i.e., 10%) portion of the Canadian population of a migratory bird species at any time during the year and/or an endangered species (e.g., breeding areas for the endangered Ivory Gull).
- Has been identified as being either globally or continentally significant Important Bird Area.
- Is legally protected (e.g. national or territorial park, marine protected area, migratory bird sanctuary, critical habitat for VEC under the Species at Risk Act).

In the study area these areas include: Seymour Island, North Kent Island, Eastern Prince Patrick Island Coast, Key Terrestrial Habitat Sites (e.g. Queen‘s Channel).

Moderate/High Sensitivity (4)

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

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

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

Moderate Sensitivity (3)

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

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

- coastal areas
- offshore areas to the limit of summer pack ice
- floodplains
- upland areas
- areas within the known range migratory birds whose populations are heavily dependent on the Canadian Arctic (the PEMT uses the summer range of Baird's Sandpiper).

Low/Moderate Sensitivity (2)

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

Low Sensitivity (1)

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

Mitigation

Key mitigation measures limit human disturbance to key areas for migratory birds, particularly for species that congregate in large numbers and/or are —at risk. Mitigation measures include (but are not limited to):

- placing flight restrictions over bird colonies;
- adopting measures to reduce the volume, duration and frequency of noise-producing activities;
- where possible, scheduling activities that may cause disturbance when most birds are absent (e.g. from October to April);
- when possible, siting activities away from the most sensitive areas for birds; and
- routing marine traffic to avoid concentrations of birds, especially molting or brood-rearing flocks, where practical.

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Species of Conservation Concern

Rationale for Selection

Regulators, First Nations, and other stakeholders are particularly concerned about Species at Risk. For the purposes of this report they are considered species:

- listed on Schedule 1 of SARA;
- assessed by COSEWIC as endangered, threatened, or special concern; and,
- categorized by the IUCN as critically endangered, endangered, vulnerable, or near threatened.

Species of conservation concern often have additional ecological, cultural and/or economic importance. In the high Arctic Study area, species of conservation concern include polar bear, narwhal, walrus, Peary caribou, and ivory gull.

Key habitat

Walrus

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

Land and marine based conservation for this species should focus on areas where it is found to haul-out in large numbers.

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

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

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

Peary Caribou

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

Ivory Gull

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

Two predominant habitat types are consistently used for breeding locations. The first type is represented by the southeast of Ellesmere and Devon Islands provides sheer granite cliffs amidst glacial terrain. These sheer cliffs eliminate predation by arctic foxes and are too far inland and so high that avian predators are likely few (COSEWIC 2006a). The second type is the vast vegetation-free gravel limestone plateaus on the Brodeur Peninsula of Baffin Island, parts of Cornwallis Island, west of Devon Island, and northeast Somerset Island (COSEWIC 2006a). Because these plateaus lack vegetation, the arctic fox is absent from these areas. Their location far inland lowers the probability of predation by arctic fox or polar bear that are foraging along the coast (COSEWIC 2006a). Other parts of the Canadian Arctic offer similar nesting habitat, but appear unsuitable as they are over 100 km from polynyas, which provide critical foraging habitat for Ivory Gull during the early part of the breeding season {COSEWIC, 2006 #4628}.

Sustainability Factors

Walrus

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

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

Peary Caribou

Caribou are susceptible to and recover slowly from population declines because of their low rate of reproduction. The main factors leading to caribou declines are habitat loss, degradation, and fragmentation, as well as predation and disease. Wolves are considered the major predators of caribou.

Some wolf packs will follow migrating herds of caribou year round. Other predators of caribou include grizzly and black bears, wolverines, lynx, and golden eagles (Miller 1982).

The availability of wintertime forage is the main limiting factor for Peary caribou. Deep snow, ground-fast ice, and wind-packed snow can make food difficult to reach; thus snow and ice conditions have a direct influence on mortality, nutrition and productivity (Gunn 1998; Toews, et al. 2007). The uncertainty of climate trends for the western High Arctic population is a current cause for concern. Both summer and winter inter-island movements need to be identified and documented. Hunting is considered a potential limiting factor. Wolf predation and disturbances by humans may also be contributing to the population declines. In the Arctic, the limiting factors are compounded: a series of disturbances, insufficient forage supply, or increased hunting following a severe winter could have drastic effects on the populations of Peary caribou.

Ivory Gull

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

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

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

Susceptibility to Oil and Gas Activities

Walrus

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

At present levels of industrial activity, potential threats to walruses are low. It is possible that commercial fisheries may compete for resources, potentially damaging seabed and causing temporary disturbances to habitats (COSEWIC 2006b). Ship noise and oil and gas exploration could displace walruses from their haul-outs and interfere with their communication (Stewart 2002).

Peary Caribou

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

Ivory Gull

Industrial activities are a threat to the nesting areas of Ivory Gulls on the Brodeur Peninsula, Baffin Island. Diamond exploration and associated activities have been taking place since 2002 and their effects on nesting Ivory Gulls are undocumented (COSEWIC 2006a). Most breeding colonies are remote and undisturbed, but on the Brodeur Peninsula of Baffin Island there has recently been a considerable increase in diamond mine exploration, coincident with a significant decline in colony occupation {COSEWIC, 2006 #4628}. In addition to the physical and sensory disturbance associated with human activities, they may attract previously scarce or absent mammalian and avian predators that will also prey on other local sources of food including gull colonies {COSEWIC, 2006 #4628}.

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

Potential Effects of Climate Change

Walrus

It is possible that direct effects of climatic warming or cooling on walruses are likely limited and not necessarily negative (Moore and Huntington 2008). Born, et al. (2003) hypothesized that a decrease in the extent and duration of Arctic sea ice in response to warming might increase food availability for walruses by increasing bivalve production and improving access to feeding areas in shallow inshore waters {COSEWIC, 2006 #3666}. Others have suggested that walrus populations will decline in recruitment and body condition as a result of climate change because they rely on sea ice as a platform for hunting, breeding, and resting (Moore and Huntington 2008). Laidre, et al. (2008) demonstrated that walrus fitness was positively correlated to sea ice. As well, North American Marine Mammal Commission (NAMMCO) (2006) noted that hunting pressure on walruses will likely increase as the amount and duration of ice cover in the Arctic declines (COSEWIC 2006b). Predation by killer whales and polar bears may also increase in the absence of ice as walrus are forced to use terrestrial sites (COSEWIC 2006b).

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

Peary Caribou

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

Ivory Gull

Climate change may also have an impact on Ivory Gull depending on how it affects the distribution of open water early in the breeding season {COSEWIC, 2006 #4628}. Because the Ivory Gull is associated with pack ice year-round an increase in the extent or thickness of ice cover would reduce their foraging capabilities and have potential effects on reproductive productivity. Alternatively, a decrease in ice cover or thickness may increase available habitat for foraging and have a positive effect on reproductive productivity in the breeding season (COSEWIC 2006a).

Sensitivity Ranking

Sensitivity ranking for species of conservation concern is based on the presence or absence of populations, colonies or important seasonal habitat of any species identified as sensitive by COSEWIC, SARA, or IUCN.

High Sensitivity (5)

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

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

Moderate/High Sensitivity (4)

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

Moderate Sensitivity (3)

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

Low/Moderate Sensitivity (2)

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

Low Sensitivity (1)

A rating of low sensitivity represents areas that overlap with the range of any species Identified as 'data deficient' under SARA, COSEWIC or IUCN or 'least concern' under IUCN.

Mitigation

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

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

Traditional Harvesting

Rationale for Selection

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

Traditional Harvesting Activities

Nanavut Settlment Area

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

Bache Peninsula

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

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

Sverdrup Islands

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

King Christian Island

Penny Strait and Queens Channel, east of Bathurst Island as well as the eastern coastline of Bathurst Island are rated as having a medium intensity level of Inuit land use. There are camping sites present on the eastern coastal side of Bathurst Island. This area was used for caribou hunting by Resolute

hunters until 1974; however, due to a rapid decrease in population the Resolute Hunters and Trappers Association (HTA) declared a moratorium on caribou hunting here. Penny Strait and Queens Channel have been occasionally used in March and April by the Resolute hunters for polar bears.

Norwegian Bay

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

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

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

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

Byam Channel

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

Inuvialuit Settlement Region

The following information has been obtained from the Olokhaktomiut Community Conservation Plan (OCCP 2000). Traditional harvesting activities by residents of Uluhaktok which occur in the study area are described below.

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

Emangyok Sound Coastline over to Byam Martin Island

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

Coastline, Kangikhokyoak (Liddon)

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

Ibbett Bay to McCormick Inlet

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

Prince Patrick - Key Bird Habitat

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

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

Susceptibility to Oil and Gas Activities

The analysis of susceptibility of traditional harvesting to oil and gas activity is restricted to consideration of routine exploration and development activities. As such, the potential effects of a catastrophic event such as an oil spill are not considered. The study area includes both terrestrial and marine areas, providing for both land based and marine oil and gas activity.

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

Seismic Exploration

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

Ice-based Activities

Drilling and drilling support activities may be conducted on the ice. Under routine conditions these activities would generate noise under ice and above the ice. This may result in avoidance by wildlife and reduce harvesting opportunity. Depending on the length and timing of drilling season ice breaking by ship may be undertaken. In addition to noise generated by ice breaking, resulting ship tracks can present a safety hazard as a result of open water and rough ice when the tracks freeze.

Shipping

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

Potential Effects of Climate Change

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

Sensitivity Ranking

In developing a sensitivity layer for traditional harvesting, consideration was given to the Areas of Importance identified in Appendix G of the NBRLUP, the land use categories presented in the Olokhaktomiut Community Conservation Plan (OCCP 2000) and the frequency and amount of documented harvesting activity. Four levels of importance are defined for areas in the NBRLUP, based on a combination of importance to community harvesting and wildlife productivity. Five categories of lands are designated in the Olokhaktomiut Community Conservation Plan. The Areas of Importance presented in the NBRLUP and the land use categories included in the Olokhaktomiut Community Conservation Plan cover part of the current study area. For that portion of the study area not covered by the NBRLUP or the Olokhaktomiut Community Conservation Plan, sensitivity is considered to be low.

Sensitivity levels for traditional harvesting are defined as follows:

High Sensitivity (5)

Highly sensitive ratings are given to those areas deemed essential harvesting locations (community cannot survive without the area), an area that provides essential habitat with no alternative available, or an area that supports rare, threatened or endangered species or is protected or proposed for legislative protection (NBRLUP). This rating is also given to Lands and waters where cultural or renewable resources are of extreme significance and sensitivity and no development should be allowed (OCCP).

Moderate/High Sensitivity (4)

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

Moderate Sensitivity (3)

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

Low/Moderate Sensitivity (2)

This rating applies to lands where there are cultural or renewable resources of some significance and sensitivity (OCCP), areas where species of harvest interest may be present, but there is limited documented harvesting.

Low Sensitivity (1)

These areas are not used much by the community and little information exists to assess its importance to wildlife (NBRLUP). This includes lands where there are no known significant or sensitive cultural or renewable resources (OCCP).

Mitigation

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

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Geo-Economic Layer Development

The geo-economic layers are based on qualitative ranking. Three layers were developed as follows:

- Petroleum Potential
- Geological Uncertainty
- Economics of development

Petroleum Potential

Petroleum potential was ranked using the following qualitative scale. It is based on the presence of known oil and gas discoveries, and, in the absence of discoveries, on the inferred presence of geological factors favorable to oil and gas accumulation. This is approach has been used previously by the Geological Survey of Canada in making general assessments of petroleum potential (e.g. Jefferson C.W., R.F.J. Scoates and D.R.Smith,, 1988. Evaluation of the regional non-renewable resource potential of Banks Island and Northwestern Victoria Islands, Arctic Canada. Geological Survey of Canada Open File 1695.)

- Rank 1. VERY LOW POTENTIAL. Geological Environment is unfavorable. There are no known petroleum occurrences are known and a very low probability that undiscovered accumulations are present.
- Rank 2 LOW. Some aspects of the geological environment may be favorable but are limited in extent. Few if any occurrences are known and there is a low probability that undiscovered accumulations are present.
- Rank 3. MODERATE. Geological environment is favorable. Occurrences may or may not be known and the presence of undiscovered accumulations is possible.
- Rank 4. HIGH. Geological environment is very favorable. Occurrences are commonly present but significant accumulations may not be known. Presence of undiscovered accumulations is very likely.
- Rank 5. VERY HIGH POTENTIAL. Geological environment is very favorable. Significant accumulations are known.

These rankings are assigned to each grid area covered by the PEMT.

Note that quantitative estimates of petroleum potential are available for some areas covered by the PEMT. For reasons of consistency across the Arctic, and recognizing that a quantitative approach is not necessary for the purposes of this tool, qualitative assessment based on expert judgement is preferred.

Geological Uncertainty

Large areas of the Arctic have seen little exploration for oil and gas. Consequently, there can be considerable uncertainty as to whether oil and gas accumulations are present and to their potential size. An exploratory well is the most direct way to collect subsurface information and to prove the presence or absence of an accumulation or favorable geological factors. Proximity of a well is therefore taken as a proxy for uncertainty. A simple uncertainty ranking was developed using distance from a well as a measure of overall uncertainty as follows:

- Rank 1. VERY LOW UNCERTAINTY. Grid has one or more exploratory wells within it.
- Rank 2. LOW. The grid is within 25 km of an exploratory well.
- Rank 3. MODERATE. The grid is between 25 and 75 km from an exploratory well.
- Rank 4. HIGH. The grid is between 75 and 100 km from an exploratory well.
- Rank 5. VERY HIGH UNCERTAINTY. The grid is further than 100 km from an exploratory well.