Eastern 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. Landfast ice on the eastern coast of Baffin Island 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 den year after year or an area of similar habitat quality (Lunn, et al. 2004; Stirling, et al. 2004). In the eastern Arctic Study area, these denning areas are concentrated along the eastern coast of Baffin Island, Devon Island and Ellesmere 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.

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 Eastern 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

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)

Multiyear pack ice provides limited denning or foraging use for polar bears in the Davis Strait/Baffin Bay region but may be utilized by bears for foraging in early summer before the sea ice recedes completely.

Low Sensitivity (1)

Low sensitivity areas include offshore regions of open water during the summer and areas outside of the core 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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Bowhead Whale

Rationale for Selection

The bowhead whale is a culturally and ecologically important species. The present significance of bowheads to humans can be expressed in terms of their future potential as a renewable subsistence and aesthetic resource (Reeves and Mitchell 1990). Bowheads are low-level trophic feeders and filter large amounts of zooplankton from the sea to feed. This makes the bowhead whale essential to the ecosystem as a major consumer of primary and secondary productivity. They are heavily influenced by ice distribution all year round which offers primary productivity and protection from killer whale predation (Finley 2001). Bowhead whales are also known to be preyed upon by killer whales but to what degree is uncertain (i.e., calves taken, mortalities, injuries) (Burns, et al. 1993; Higdon 2007).

Commercial whaling of the bowhead whale was extensive during the 1600s to the 1900s and was highly profitable. The Inuit hunt of the bowhead in Nunavut is a historic event and embedded in their culture. Inuit of Nunavut presently harvest one bowhead every two to three years and still represents a notable economy in these communities of Nunavut. Four out of 28 communities participated in the hunt over a five year period from 1996 to 2001 and the mean number of bowhead whales taken was approximately one (Priest and Usher 2004). The whale muktuk is widely distributed and consumed.

Key habitat

Critical sensitive bowhead whale habitats, as articulated by Laidre, et al. (2008), are regions of shallow water/continental shelf. Important bowhead habitat includes dense annual pack ice, shear zone/leads, polynyas, open water, and ice edges (pack ice and open water). Loose annual pack ice and shelf break regions are also used by bowhead whales (Laidre, et al. 2008).

Sustainability Factors

Threats to bowhead whales include predation, accidental ingestion, environmental contamination, disease, offshore oil and gas exploration, shipping, illegal hunting and tourism.

The severe depletion of the bowhead population by commercial whalers is the main reason that the species is listed as endangered in several parts of its range. Recent reports suggest that killer whales may be the primary threat to bowheads in the eastern Canadian Arctic (Finley 2001; Moshenko et al. 2003; Higdon 2007). Ingestion of foreign material through the process of skim feeding is also a possible threat (Finley 2001). Bowheads can live >100 years and therefore are susceptible to the accumulation of toxins over a long period of time.

Susceptibility to Oil and Gas Activities

An additional concern comes with increased interest in offshore developments and tourism, which could possibly affect whale populations with associated traffic, underwater noise and possible oil spills. Bowhead whales use long-range communication and are sensitive to low-frequency industrial sounds (Burns, et al. 1993). At Isabella Bay, bowheads react strongly at far distances to outboard-powered boats and ships and attempt to flee either by moving into shallow waters or traveling long distances away (Finley 2001). Migrating bowheads have been reported to stay 20 km from seismic, ice-breaking and support vessels and drilling ships (Finley 2001).

Seismic Exploration

Potential effects to bowhead whales relating to underwater seismic sound are relatively well documented for the western Arctic, Beaufort Sea and similar effects should be expected for the eastern Canadian Arctic. Such effects to bowhead whales include habitat avoidance, temporary reductions in feeding, socializing and other behaviors. Low frequency communication masking is also a potential effect on this species, more so given such frequencies have been shown to travel longer distances in/near ice environs. Current understanding suggests that effects on temporary or permanent hearing to bowhead whales are unlikely but supporting evidence is lacking.

Ice-based Activities

For the most part, ice-based activities are not likely to notably influence bowhead whale habitat; however note is made that bowheads regularly occur in regions considered as heavy ice (10/10ths ice) hence this general conclusion may not always be accurate.

Shipping

The primary effects on bowhead whales relating to shipping are vessel-strikes (resulting in injury or mortality) and underwater noise. Vessel – bowhead whale strikes can partially be avoided by implementation of vessel-speed restrictions (typically less than 14 knots or 10 knots). Ice-breaking, for example is known to produce underwater sound sufficient to displace bowhead whales from preferred habitat up to 30 km away.

Hydrocarbon Release

Potential effects to bowhead whales from a hydrocarbon release relate primarily to chronic effects such as contamination and toxicity. Acute effects (direct exposure) include baleen (hair like apparatus the bowhead uses to filter prey from water) fouling, eye irritation and possibly vapor inhalation.

Potential Effects of Climate Change

Tynan and DeMaster (1997) list the bowhead as a possible indicator species for climate change in the north, making the species of special interest for scientific reasons. Climate change is likely to cause changes in ice distribution and condition, surface temperatures, currents and mixing. Such changes in Nunavut could alter the bowhead whales' migration patterns, feeding locations and make

it more susceptible to predation and hunting. Such changes will have direct and indirect effects on bowhead health, population and distribution.

For example continued increases of killer whales in Nunavut as described by Higdon (2007) could result in elevated levels of bowhead predation. This may have detrimental effects on the population especially because killer whale predation has been noted as the major cause of bowhead mortality in Nunavut (Finley 2001). As well, primary productivity is highly variable and dependent on nutrient availability. Such processes are greatly influenced by climate change and therefore, feeding habitat of bowheads may be altered (Finley 2001). Bowhead fecundity is probably related to zooplankton production

(Calanus) therefore, climatic change is likely to have an impact on population growth (negative or positive) through changes in the extent of sea ice (Finley 2001).

Laidre, et al. (2008) indicate that three types of sensitivities by bowhead whales are likely to be influenced by climate change: narrowness of distribution and specialization in feeding; seasonal dependence on ice; and, reliance on sea ice as a structure for access to prey and predator avoidance.

Sensitivity Ranking

Sensitivity rankings for eastern arctic bowhead whales 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 professional experience in this region); 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 bowhead habitat. It is important to note that the definition of winter (November – June) and summer (including July – October) heavily influences the sensitivity layers given the very large influence of ice in this region. To address and incorporate the extreme variability imposed by the dynamic ice regime, 30 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 sensitive bowhead whale 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)

Isabella Bay, and the proposed Ninginuaik National Wildlife Area, is a well-known critical bowhead whale feeding habitat and hence designated as highly sensitive.

Highly sensitive habitat for bowhead whales also includes important summer feeding areas and areas that have been identified as primary over-wintering habitat.

Though bowhead whales of the eastern Canadian Arctic are known to occur in the NOW polynya this region likely cannot be considered as primary over-wintering habitat – Hudson Strait is such an area but does not fall within the study area for this project, and hence no highly-sensitive habitat is designated here.

Moderate/High Sensitivity (4)

Moderate to high sensitivity rating was given to areas that provide valued seasonal habitat for bowhead whales. This includes shallow water (approximately 10 m to 100 m depth) and the continental shelf (approximately 100 m to 300 m depth)which provides habitat year round and the shear-zone, leads, polynyas and open water next to pack ice that provides habitat for bowhead whales in the winter. Areas adjacent to over-wintering habitat are also considered moderately to highly sensitive.

Much of the summer continental shelf and shallow-water habitat within the Eastern Arctic study area is classified as moderate to high bowhead whale habitat sensitivity. The Lancaster Sound region was designated as moderate to highly sensitive summer bowhead whale habitat for the increased number of animals in this region during July. Four types of moderate to highly sensitive bowhead habitat were identified within the Eastern Arctic study area:

- Those regions approximating the main shear-zone/lead off the coast of Baffin Island
- Two regions adjacent to known bowhead whale over-wintering areas (Cumberland Sound and Frobisher Bay)
- Lancaster Sound and northern Baffin Bay. Large numbers of bowhead whales are well-known to use Lancaster Sound in June and evidence exists to suggest open-water regions next to pack-ice in northern Baffin Bay are used by numerous whales in late winter (June).
- The NOW polynya.

Moderate Sensitivity (3)

Moderately sensitive bowhead whale habitat includes areas of dense annual pack-ice and summer habitat where shear zones, leads, open water and open water adjacent to pack-ice are present.

In the summer (July primarily) the offshore region within the study area joining Baffin Bay and Davis Strait contains dense annual pack-ice, and hence this is the basis for the ranking of moderate sensitivity in this region. Winter habitat ranked as moderately sensitive bowhead whale habitat includes much of the Eastern Arctic study area and is based primarily on the presence of dense annual pack-ice in these regions.

Low/Moderate Sensitivity (2)

Areas that overlap with known bowhead whale habitat, or adjacent to known bowhead whale habitat were rated as low to moderately sensitive. This rating was also given to areas with loose annual pack-ice in the summer and winter, and shelf break habitat in the summer.

In the summer, bowhead whale habitat ranked with low to moderate sensitivity (4) was defined to represent the loose off-shore annual pack-ice in southern Baffin Bay and northern Davis Strait. This would be primarily for July and August given that ice is largely absent in this region (30 year median) in September and October. Ice median charts indicate that, for most of the winter, loose annual pack-ice and low-moderate sensitive habitat is lacking.

Low Sensitivity (1)

Low sensitivity was given to areas where the bowhead whale is not known to inhabit, but potential habitat exists. This includes areas in the summer months such as shore-fast ice, deep ocean basins, estuaries, and lagoons. It also includes waters less than 5m in depth and land fast ice in winter.

In the summer, low sensitivity habitat in northern Baffin Bay was defined primarily on the basis of the deeper water and distance from pack-ice. Presence of offshore open-water in July in north-western Baffin Bay therefore was designated with low sensitivity. Though much of the coastal (within 30 km) region within the Eastern Arctic study area has land/shore-fast ice for most of the winter (and hence could be considered with low sensitivity) 30-year ice median charts indicate that this is not the case in November.

Mitigation

The most effective available mitigation tool is planning to avoid spatial and seasonal bowhead whale habitat where possible. Other common mitigations include the use of dedicated Marine Mammal Observers aboard related vessels, designation of a marine mammal exclusion zone around active seismic arrays, vessel speed restrictions, and minimum aircraft altitude restrictions. Unfortunately, in the Eastern 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.

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Toothed Whales

Rationale for Selection

Toothed whales were chosen as a VEC to represent the species known to occur in the Eastern Arctic study area. Available information on killer whales is notably limited (but growing); hence this species was not included in the designation of sensitive toothed whale habitat (but is included below for context).

Beluga whales and narwhals are both culturally and ecologically important species in the eastern Canadian Arctic. Over a five year period from 1996 to 2001 the total annual mean number of belugas taken from hunting was approximately 1339 and are hunted by many communities (20 out of 28) (Priest and Usher 2004). Inuit knowledge suggests that belugas are easier to hunt than other marine mammals (walruses) because they are not as suspicious of humans and are easily approached (Richard 2001). It is used for its meat, which is mostly used for dog food and skin which is desirable and profitable to Inuit (Richard 2001). Narwhals are hunted in Nunavut by several communities (18 out of 28) for subsistence use (Dietz, et al. 2001; Priest and Usher 2004). Over a five year period from 1996 to 2001 the total annual mean number of narwhal taken from hunting was approximately 734 (Priest and Usher 2004).Their skin and underlying fat is consumed and the tusks are sold and are quite valuable (DFO 1998a, b).

Ecologically, belugas and narwhals are relatively different though both are likely preyed upon by various marine mammals of the Arctic including polar bears (COSEWIC 2004b) and killer whales (Higdon 2007). Belugas in the Eastern Arctic appear to frequent shallow-water environs whereas narwhals prefer deeper waters. Beluga whales are known to travel in large groups whereas narwhals are found in groups of two to 12 (DFO 2005, internet site). Stomach content analyses imply that both species differ in prey species: arctic cod as the primary beluga whale prey and squid/turbot for narwhals. Both species use underwater noise for communication and prey detection (echolocation).

Key habitat

Beluga

Belugas do not rely directly on land for any part of their life cycle. Generally, they inhabit shallow coastal areas and estuarine environments in the summer; thus coastal development (i.e., marine terminal construction and especially vessel traffic) may deter beluga from preferred habitat (avoidance behavior) and could cause increased environmental contamination. Planning could consider sensitive times of year for belugas, site-fidelity, migration routes and local concentration areas (e.g., estuaries).

Critical physical and biotic habitat factors for beluga whales include regions of loose pack-ice, polynyas, shallow water/continental shelf, interactions between polynyas and shallow water and estuaries/lagoons. Important areas to belugas whales include shear zones/leads, open water, the shelf break and the interface between pack-ice and open water. Belugas are also known to use multiyear pack-ice (Laidre, et al. 2008). Areas not categorized as important, or used, by beluga whales include shore-fast ice, dense annual pack-ice, deep ocean basins and where pack ice and shallow continental shelf regions interact (Laidre, et al. 2008).

Narwhal

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, and 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).

Killer whale

While habitat use likely varies between each population, killer whales generally appear to use and tolerate wide habitat variability (depth, size of water body, water temperature) (COSEWIC 2001). It is generally believed that killer whales do not range into regions of pack ice (due to their large dorsal fin) but this assumption has not been verified. Killer whales occasionally move into freshwater, though usually only for short periods (hours or days) (Higdon 2007).

Sustainability Factors

Beluga

Threats to beluga whales include predation, environmental contamination, offshore oil and gas development, shipping, hunting and commercial fisheries (Huntington in press).

Polar bears and killer whales are known predators of belugas (Smith and Sjare 1990; Reeves and Mitchell 1989 in COSEWIC 2004b) however; walruses also injure or kill beluga whales (Reeves and Mitchell 1989 in COSEWIC 2004b).

The ability for contaminants to accumulate in the tissue of beluga whales has been widely studied in the St. Laurence population. Such contamination is linked to reproductive impairment, immunosuppression, and tumour incidence (Becker 2000; Hickie, et al. 2000).

Beluga whales exhibit strong site-fidelity, making them easy targets for commercial and subsistence hunters (Francis 1977; Reeves and Mitchell 1987 in COSEWIC 2004b). With the introduction of new hunting technologies, Inuit have expressed an increase in competition during the beluga hunt and suggest this may result in larger harvest numbers (Kilabuk 1998).

Narwhal

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

Killer Whale

A likely natural source of mortality is the propensity for this species to mass strand (infrequent) or become entrapped in ice (Newfoundland and the Canadian Arctic) (COSEWIC 2001). Since population sizes are generally small, even infrequent occurrences of such events may have dramatic impacts on populations (COSEWIC 2001).

The largest source of killer whale mortality is hunting, mostly by Greenland Inuit. Killer whales have been sporadically hunted by Canadian Inuit historically but takes are likely non-existent at present (Higdon 2007).

In the Pacific, killer whales are among the most heavily contaminated marine mammals on earth (Ross 2006 in Higdon 2007); however, studies of contaminant levels in Arctic killer whales are still in initial stages. The effects of contaminants on Arctic killer whales have been identified as a research priority (Higdon 2007).

Susceptibility to Oil and Gas Activities

Beluga

Reaction of beluga whales to offshore oil and gas exploration and to vessels range from great tolerance to extreme sensitivity (Richardson, et al. 1995). Sensitive reactions involve short-term displacement and may change local distribution (Richardson, et al. 1995). The relative broad range of reactions from belugas may be a result of their ability to adapt to repeated ongoing man-made noises (Richardson, et al. 1995). However, belugas often flee from fast and erratically traveling vessels and have been reported to displace up to 2.4 km away (Richard 2001). As well, belugas have been observed by Inuit to react negatively (avoidance behavior) to noisy anthropogenic sources (boats) and suggested to have caused declines in abundances at Pangnirtung (Kilabuk 1998 in COSEWIC 2004b). Inuit also suggest that avoidance behavior caused belugas to be less healthy (skinnier) (Kilabuk 1998).

Narwhal

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

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, et al. 1983; 1984; 1990; Miller and Davis 1984 in COSEWIC 2004a). As well, some Inuit hunters suggest that narwhals are sensitive to and avoid noise from industrial machines and explosions (Remnant and Thomas 1992; Stewart, et al. 1995; Gonzalez 2001 in COSEWIC 2004a).

Killer Whale

Killer whales do not rely on land for any component of their life history or for habitat requirements. However, they are extremely susceptible to bioaccumulation of contaminants, hence coastal development inducing marine discharges from land based activities need to be taken into account.

Susceptibility of toothed whales to specific oil and gas activities is similar to those described for Bowhead whale.

Potential Effects of Climate Change

Beluga

The effects of climate change on beluga whales are uncertain. They are highly adapted to Arctic seas, yet capable of survival far from sea ice, and sometimes select open-water habitats at least for part of the year (Moore and Huntington 2008). It is likely that climate change will result in changes in the extent and duration of sea ice (Huntington in press). This may alter beluga migrations and may cause them to penetrate further into the Arctic environment possibly allowing new feeding habitat to be exploited (Huntington in press).

Changes in sea ice regimes with climate change will impact the timing and extent of primary production (Moore and Huntington 2008). This may have negative effects on the beluga whale prey or could cause shifts in the location of prey (Moore and Huntington 2008).

Climate change has also been attributed to increases in the number of killer whales along the coasts of Nunavut (Higdon 2007). Such changes in the range of killer whales may cause increased predation on belugas resulting in higher incidences of mortality, injury and avoidance behavior (Higdon 2007). This coupled with decreases in available ice refuge may result in negative effects on beluga population (Higdon 2007; Moore and Huntington 2008; Huntington in press).

Narwhal

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 to climate change (primarily based on their reliance on sea ice and specialized feeding).

Killer Whale

In recent years Inuit hunters have noted that killer whales are increasing throughout Nunavut, particularly Hudson Bay, where they were unknown prior to the mid-1900s (Reeves and Mitchell 1988). This increase has been related to a decline in sea ice in Hudson Strait, suggesting that declining ice cover has influenced killer whale movements and distribution; allowing them to both extend their range and stay longer in Arctic regions (Higdon 2007). This has implication on the arctic ecosystem as increases in killer whale numbers in Nunavut will likely increase predation rates (Higdon 2007).

Sensitivity Ranking

Sensitivity rankings for Eastern Arctic toothed whales 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 professional experience in this region); 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 toothed whale habitat. It is important to note that the definition of winter (November – June) and summer (July – October) heavily influences the sensitivity layers given the very large influence of ice in this region. To address and incorporate the extreme variability imposed by the dynamic ice regime, 30 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 sensitive toothed whale 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 any of the toothed whale species and a spatially limited area (< 100 km) during the summer months that provides specific ecological function essential to toothed whales. In the winter months this rating was also given to the following:

- Areas known to consistently contain large concentrations of toothed whales
- Full winter polynyas
- Areas that have been identified as core overwintering habitat for belugas
- Areas within Davis Strait or Baffin Bay with limited open water throughout the winter for narwhals.

Highly sensitive summer toothed whale habitat was not identified in the Eastern Arctic study area. However, highly sensitive winter habitat was described to represent known beluga whale over-wintering areas near Cumberland Sound and mouth of Frobisher Bay; as well as Lancaster Sound and northern Baffin Bay (where large numbers of toothed whales are found in June).

Moderate/High Sensitivity (4)

Areas with moderate to high sensitivity in the summer includes habitat with loose (beluga) or dense annual pack ice (narwhal), shallow continental shelf, estuaries, lagoons and fjords for belugas and shear-zone/leads, fjords, shelf-break, deep ocean basins for narwhals. In winter, areas where large concentrations of beluga or narwhals are known to occur, polynyas, shallow or coastal areas with light and highly moveable ice cover for belugas or habitat next to known beluga over-wintering sites.

Moderate to highly sensitive areas in the winter include deep offshore, continental slope regions of Davis Strait and Baffin Bay for narwhals (with limited open water for a portion of the winter).

Summer toothed whale habitat of moderate to high sensitivity was determined primarily to reflect known ranges of beluga and narwhals (north eastern coast of Baffin Island, Lancaster Sound and Devon Island region), their preference for fjords (both beluga and narwhal), shallow continental shelf regions (belugas within their range) and areas of ‘shelf break' (for narwhals).

Two areas of moderate to highly sensitive toothed whale winter habitat were identified: i) the NOW polynya (where belugas have been recorded in March) and, ii) the continental shelf region in the south western portion of the study area which is adjacent to known beluga overwintering habitat (and which may also entail June shear-zones and limited open water for a portion of the winter).

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 toothed whales and shear zones and leads that are utilized by belugas.

Moderate sensitivity during the winter months was given to areas that contain moderate sized concentrations of narwhal or beluga whales, coastal leads (<50 km from shore), in or near (<20 km) coastal pack ice, and near land-fast ice or the ice edge. Deep water, the shear zone, leads and polynyas are also moderately sensitive for narwhals.

Moderately sensitive toothed whale summer habitat was described primarily to capture the ice edge (pack ice next to open water) region of north western Baffin Bay. Moderate to large numbers of toothed whales may potentially occur in the Lancaster Sound region in July and hence this area has been also designated as moderately sensitive summer habitat.

Toothed whale winter habitat of moderate sensitivity was determined to represent the predominant shear zone/lead area offshore of Baffin Island (presumably important for narwhals) and regions entailing ice-edges (proximity to pack ice) in June in north eastern Baffin Bay.

Low/Moderate Sensitivity (2)

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

Coastal summer toothed whale habitat in the south-western corner of the Eastern Arctic study area was identified as low to moderately sensitive habitat primarily on the reasonable likelihood of beluga whale presence in this region.

Low to moderately sensitivity winter toothed whale habitat was identified in the south-eastern portion of the Eastern Arctic study area, primarily on the basis that this region is far from ice-edges (land fast ice and pack ice) and largely ice-free in November.

Low Sensitivity (1)

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

According to Laidre, et al. (2008) narwhal summer habitat is primarily coastal in nature and important offshore, deep water habitat is primarily during winter months. Similarly, beluga whales prefer coastal environs in the summer. Consequently, low sensitivity summer toothed whale habitat was identified for the majority of the offshore portion of the Eastern Arctic study area. A narrow band of low sensitivity coastal toothed whale habitat, extending south of Clyde River to Cumberland Peninsula, was identified given that narwhal and beluga ranges do not include this region.

In the winter, two regions of low sensitivity were identified: i) a narrow coastal region extending from Pond Inlet to Cumberland Peninsula (to reflect land-fast ice in this region for most of winter); and, ii) offshore regions of Baffin Bay and Davis Strait with consistently high ice concentration for all winter months (according to 30 year median ice charts).

Mitigation

Mitigation measures identified to reduce potential effects to bowhead whales are equally appropriate for toothed whales. Certainty regarding narwhal and beluga whale distribution in the Eastern Arctic is not high. This is in part due to the highly dynamic nature of sea ice in this region and the challenges of studying relatively small marine mammals over large areas which are underwater for more than 90% of the time.

Anadromous Arctic Char

Rationale for Selection

Anadromous Arctic char are an important fish species culturally, nutritionally and economically. Arctic char are well adapted to arctic lakes and rivers and in many cases the only fish species which can inhabit the more northern aquatic systems.

Key habitat

Throughout Nunavut, many arctic char populations experience heavy fishing pressure (Carder and Peet 1983; Carder 1991, 1995; Read 2000; Read 2004). As such, commercial, recreational, and subsistence fisheries for Arctic char should be carefully managed to avoid overexploitation and to ensure the long-term sustainability of harvests. Spawning, rearing and overwintering, critical to maintaining sustainable char populations, all occur in freshwater rivers or lakes. Feeding of adult Arctic char occurs in coastal waters often close to river mouths. Adult Arctic char will obtain most of their annual energy requirements in these coastal waters during the short open water season. Access and maintaining the ecological integrity of these coastal areas are critical to healthy Arctic char stocks. Special management or mitigation measures should be considered on activities and/or timing of these activities in coastal areas utilized by Arctic char.

Sustainability Factors

The primary threat to anadromous Arctic char populations has been from over harvesting. Climate change may also pose a threat. Reduction of river discharges resulting from climate change may restrict Arctic char from moving up river in the fall or lead to failures in spawning or overwintering due to low water conditions. Climate change may also allow new species to occupy areas previously used by Arctic char. This may lead to these new species out competing Arctic char for space and food. Growing interest in hydrocarbon exploration in the Easter Arctic may in the future put new pressure on Arctic char sustainability.

Susceptibility to Oil and Gas Activities

Seismic Exploration

Few studies have been conducted on the effects of seismic operations on salmonids and most of these studies involved the effects of the use of explosives to conduct seismic activities. No studies on the effects of seismic have been conducted specifically with Arctic char. The use of air guns has greatly reduced mortalities in fish during seismic surveys. Mortality is generally restricted to the immediate few meters under the air gun, affecting mainly fish eggs and larval fish. Mortality of fish eggs and larval fish by air guns is far less than natural mortality (Saetre and Ona 1996). Pacific herring have exhibited a number of behavioral responses such as startle response, alarm and avoidance (Schwarz and Greer 1984) during seismic activities however these responses stop shortly after cessation of seismic operations. Seismic operations can also cause declines in catches of fish. Reductions of over 50% in catches of cod (Løkkeborg 1991; Engas, et al. 1996), haddock (Engas, et al. 1996), and rockfish (Skalski, et al. 1992) have been reported.

There is the potential that Arctic char feeding migrations may be disrupted during seismic operations in coastal waters. The disruption of feeding migrations may reduce the amount of energy the Arctic char can obtain during the short feeding season. This could result in reduced survival or reproductive success due to insufficient energy reserves

Ice-based activities

As Arctic char use freshwater lake and river systems during the ice covered season, no effects are expected from ice-based activities in the marine and coastal areas.

Shipping and Related Coastal Infrastructure

Shipping itself is expected to have minimal effects on Arctic char. Coastal infrastructure related to shipping such as docks or causeways may have potential short or long-term effects on Arctic char. The construction of docks would likely only have short-term effects during the period of construction when Arctic char migration may be disrupted. The construction of causeways which extend out from shore may also cause short-term disruptions in feeding migrations. The potential for longer-term effects are unknown but the migrations of adults of similar species such as Dolly Varden char and Arctic cisco do not appear to be affected by causeways constructed in the Alaskan Beaufort Sea (Fechhelm, et al. 1999).

Drilling and Production

Exploration drilling or production activities would likely only have potential effects on Arctic char if these activities occurred in nearshore areas or mouths or rivers containing anadromous char. No data is available on the effects of drilling and production activities on Arctic char however underwater noise created by drilling or production activities may cause disruptions in char migration or lead to reduced catches by local fishermen. Drilling or production in the offshore is unlikely to have effects on Arctic char populations. Ancillary activities related to production such as pipelines from the offshore to land would cause temporary disruption of char migration and feeding during construction of the pipeline in nearshore areas if constructed during the open water season.

Hydrocarbon Release

The accidental release of hydrocarbons into the marine environment could lead to adult Arctic char mortality, reduced health or reduced quality due to tainting. Small releases of hydrocarbons are unlikely to have a significant effect, except perhaps on a few individuals. Chronic small releases of hydrocarbons may lead to reduced health of char populations and/or tainting, which could lead to reduced overwintering and reproductive success. Large releases of hydrocarbons during key periods of Arctic char migration may lead to large scale mortality or reduced health levels, which could lead to reproductive failure of one or more age classes.

Potential Effects of Climate Change

The effects of climate change on Arctic char are unknown. Changes in river discharge may either positively or negatively affect Arctic char populations. Increased discharge may provide easier access to and from the sea as well provide better overwintering habitat. Decreased discharge may lead to blockages occurring where Arctic char cannot return to their natal system to overwinter or spawn. Climate change may also affect sea temperature and currents, thereby changing food availability. This could result in either a benefit if food availability increased or a negative effect if food availability declined. Increased water temperatures may also result in increased competition for space and food by species which were previously limited in their range by temperature. This competition could lead to reduced stocks of Arctic char.

Sensitivity Ranking

Sensitivity ranking is based on the use of marine waters by anadromous adult Arctic char, the size of the aggregations utilizing specific coastal areas and the season. The use of coastal areas by Arctic char for feeding is important for overwintering and reproductive success.

High Sensitivity (5)

There are no high sensitivity areas for Arctic char in marine waters. Spawning, rearing and overwintering all occur in freshwater.

Moderate/High Sensitivity (4)

Moderate to high sensitivity is applied to river mouths and estuaries during the open water season (summer).

The mouths and estuaries of Arctic char rivers are important aggregation areas for feeding and as a gateway for char moving upriver to overwinter and spawn, and downriver to the sea for feeding. Activities or hydrocarbon spills in and around the mouth or estuary of an Arctic char river has the potential to affect a large proportion of the adult population, thereby potentially affecting overwintering or reproductive success of one or more year classes.

Moderate Sensitivity (3)

Moderate sensitivity is applied to habitat between the shore and 0.5 km during the open water season (summer).

Aggregations of adult Arctic char utilize the nearshore coastal areas during the open water season for feeding. A majority of an adult char's energy budget is obtained during this open water period. Activities or spills which may affect their feeding activities could reduce their energy input resulting in reduced overwintering or reproductive success. Arctic char tend to remain close to shore but it is not known how far offshore they move, therefore a precautionary approach was taken in selecting a distance of 0.5 km out from shore to delineate this sensitivity area.

Low/Moderate Sensitivity (2)

This area of sensitivity ranges from 0.5 km to 10 km offshore during the open water season. This range is arbitrary due to the lack of available information on the use of this area by Arctic char however it does attempt to take a precautionary approach in determining the potential use of this area by Arctic char. Although it is suspected that most Arctic char stay relatively close to shore, some Arctic char may venture further offshore. The extent offshore and numbers of char which might utilize these waters, if any, is unknown. Due to the uncertainty of the use of this area by Arctic char the sensitivity ranges from low to moderate.

Low Sensitivity (1)

Arctic char do not utilize coastal or offshore marine waters during the ice covered season. As there is no to minimal risk to species sustainability in these areas during this time period the sensitivity ranking for Arctic char is low.

Although some individuals of Arctic char may venture into offshore waters (> 10 km from shore), Arctic char appear to mainly stay in coastal nearshore areas during the open water season. Arctic char which may use the offshore environment would likely be small in number and widely dispersed. It is unlikely that activities occurring in offshore waters would have any effect on the sustainability of Arctic char populations. The ranking for the offshore during the open water season is low for the VEC Arctic char.

Mitigation

The following mitigation will reduce the potential for negative effects on anadromous Arctic char populations:

- Ramp-up or soft start during seismic operations
- Regular communication with HTO's and local harvesters on timing of seismic or other activities occurring nearshore in order to avoid peak migration periods of Arctic char.
- Timing of construction activities (e.g., pipelines) in the nearshore to avoid major migration periods of Arctic char. Construction where possible is preferable during the ice on period.

Summary

Anadromous Arctic char are an important fish species to local inhabitants having cultural, nutritional and economic benefits. The highest ranked sensitivity areas for anadromous Arctic char in the marine environment are the mouths and estuaries of rivers and adjacent nearshore coastal areas. These areas are critical for adult Arctic char feeding. Although the open water season is short, a majority of the annual energy budget required by an Arctic char is obtained during this period. Mitigation includes ramp-up or soft starts for seismic operations. Regular communications with HTOs and harvesters when activities are planned for river mouths or adjacent coastal areas and ensuring adequate and well maintained spill equipment on board and/or on land.

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 offshore 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 2004b; Latour, et al. 2006b). 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. 2006a). As such, not all sites are targeted to become protected areas (Mallory and Fontaine 2004b). The locations within the study area are described below.

Migratory Bird Sanctuaries

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

There are no Migratory Bird Sanctuaries in the Eastern Arctic study area.

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. Further information on the Canadian IBA Sites Catalogue can be found at http://www.bsc-eoc.org/iba/IBAsites.html.

Biological Hotspots

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

Key Terrestrial and Marine Sites

North Water Polynya

The NOW Polynya is the largest (27,000 km2) polynya in the Canadian Arctic and is located in northern Baffin Bay between Ellesmere Island and Greenland. This polynya remains open water year round and is considered one of the most productive polynyas in the northern hemisphere (Stirling 1980; Hobson, et al. 2002). The NOW Polynya is a key marine habitat site for the millions of seabirds that breed nearby and many of these (about 14 million) migrate north along shore leads in the spring (Renaud et al. 1982). Various important species that using this area include the Black-legged Kittiwakes (Rissa tridactyla) (16% of the Canadian population), Thick-billed Murres (Uria lomvia) (12% of the Canadian population), Northern Fulmar (Fulmarus glacialis) (1% of the Canadian population), Ivory Gulls (Pagophila eburnea) (14 colonies, 30% of the Canadian population), Black Guillemots (Cepphus grille) (2% of the Canadian population) (Mallory and Fontaine 2004a).

Within the NOW Polynya is Coburg Island which is an International Biological Programme site (Nettleship 1980) and has been protected since 1995 as Nirjutiqavvik National Wildlife Area and includes waters within 10 km of the high tide line. Both Coburg Island and the Inglefield Mountain Ivory Gull colonies (Nunataks) are considered Important Bird Areas in Canada (CEC 1999).

Eastern Jones Sound

The Eastern Jones Sound site occurs between southern Ellesmere Island, Coburg Island, and northeastern Devon Island and contains two key terrestrial sites (Coburg Island and eastern Devon Island). Over 500,000 breeding marine birds are found in this area and include Black-legged Kittiwakes (16% of the Canadian population), Thick-billed Murres (12% of the Canadian population), Northern Fulmars (1% of the Canadian population), Ivory Gulls (4 colonies, 4% of the Canadian population), Black Guillemots, Glaucous Gulls (Larus hyperboreus), Long-tailed Ducks (Clangula hyemalis), Common Eiders (Somateria mollissima), and Atlantic Puffins (Fratercula arctica).

Within Eastern Jones Sound, Coburg Island is an International Biological Programme site (Nettleship 1980) and has been protected since 1995 as Nirjutiqavvik National Wildlife Area and includes waters within 10 km of the high tide line. Both Coburg Island and Devon Island contain Ivory Gull colonies (Nunataks) and are considered Important Bird Areas in Canada (CEC 1999). Devon Island is considered globally significant for congregatory species and nationally significant for threatened species and species with restricted ranges (BirdLife International 2008 Internet site).

Eastern Lancaster Sound

Eastern Lancaster Sound site is a completely marine area and often forms as an early, open water feature during spring ice breakup. There are six major breeding colonies in this area and most of the birds inhabiting these colonies use Eastern Lancaster Sound during migration or use it for feeding (McLaren 1982). Large proportions of the Canadian population of Black-legged Kittiwakes (35% of the Canadian population), Northern Fulmars (57% of the Canadian population) and Thick-billed Murres (27% of the Canadian population) occur in this area (Nettleship 1980). In addition to the resident breeding colonies, millions of non-breeding birds spend the summer in the area and numerous migrants pass through on their way to breeding areas in the central Canadian High Arctic and northwest Greenland (McLaren 1982).

Eastern Lancaster Sound is an Important Bird Area in Canada (CEC 1999). This area is considered to be globally significant to congregatory species as well as for concentrations of colonial waterbirds and seabirds (BirdLife International 2008Internet site).

Cape Hay

Cape Hay is located at the eastern entrance to Lancaster Sound and is one of the five largest Thick-billed Murre colonies in Canada (over 10% of the Canadian population). A variety of bird species occur in this area including Black-legged Kittiwakes (over 10% of the Canadian population), Northern Fulmars, Black Guillemots and Dovekies (Alle alle). Cape Hay is an important area for marine birds and significant concentrations of them may be found throughout the region depending on annual fluctuations in ice breakup and distribution of prey (McLaren 1982; Dickins, et al. 1990; Riewe 1992a). According to the coastal atlas of environmental protection, the shoreline around Cape Hay is listed as being ‘highly sensitive' to oil spills from May to October, the offshore area is listed as being ‘highly sensitive' from May through August and ‘moderately sensitive' from September through April (Dickins, et al. 1990).

Cape Hay is a Canadian Important Bird Area (CEC 1999) and an International Biological Programme site (Nettleship 1980). Cape Hay is considered to be globally significant for congregatory species and concentrations of colonial waterbirds and seabirds. It is continentally significant to congregatory species (BirdLife International 2008 Internet site). Additionally, it is part of the Bylot Island Migratory Bird Sanctuary (established in 1965) and the Sirmilik National Park (established in 2001).

Cape Graham Moore

Cape Graham Moore is a completely marine site approximately 70 km north of the Pond Inlet community. Both the Thick-billed Murres and the Black-legged Kittiwakes occur in Cape Graham Moore and their numbers represent more than 1% of the Canadian population (Mallory and Fontaine 2004a). A wide variety of species is drawn to the leads and polynyas in this area during spring break¬up and include fulmars, kittiwakes, murres, and guillemots. Also present are Dovekies and Ivory Gulls.

Cape Graham Moore in an International Biological Programme site (Nettleship 1980) and a Canadian Important Bird Area (CEC 1999). This IBA is considered globally and continentally significant for congregatory species and globally significant for concentrations of colonial waterbirds and seabirds. Since 1965 the Cape has been part of the Bylot Island Migratory Bird Sanctuary and is also located just outside the boundary of Sirmilik National Park which was established in 2001. According to the coastal atlas for environmental protection, the shoreline around the Cape is listed as ‘extreme sensitivity' from May to October for impact of oil spills. The offshore area is listed as being of ‘high sensitivity from May through August and ‘moderate sensitivity' from September through April (Dickins, et al. 1990).

Cape Searle (Qaqulluit) and Reid Bay (Minarets; Akpait)

Cape Searle and Reid Bay are primarily marine sites (2,747 km2 marine vs. 94 km2 terrestrial). Qaqulluit contains Canada‘s largest Northern Fulmar colony at 22 – 27% of the Canadian population (Nettleship 1980; Alexander, et al. 1991). Other numerous birds at this site include Glaucous Gulls, Iceland Gulls (Larus glaucoides) and Black Guillemots (Nettleship 1980). One of Canada‘s largest Thick-billed Murre colonies (about 10% of the Canadian population) occurs at Akpait along with about 4% of the Canadian population of Northern Fulmars (Nettleship 1980; Alexander, et al. 1991). Additionally Black-legged Kittiwakes, Glaucous Gulls and Black Guillemots also nest there. Numerous other species use the area for feeding including Common Eiders, Canada Geese (Branta canadensis) and Common Ravens (Corvus corax).

Cape Serale and Reid Bay are International Biological Programme sites (Nettleship 1980) and Important Bird Areas in Canada (CEC 1999). Cape Serale is recognized as globally significant for congregatory species (BirdLife International 2008 Internet site). Reid Bay is considered globally and nationally significant for congregatory species and globally significant for colonial waterbirds and seabird concentrations (BirdLife International 2008 Internet site).

Cumberland Sound

The Cumberland Sound area contains a recurrent polynya at its mouth and is located approximately 250 km from two major bird colonies; Cape Searle and Reid Bay (see description above). Numerous species occur within the Sound including Common Eiders, Iceland Gulls and Dovekies. The largest breeding colony of Iceland Gulls in Canada occurs on the islands in Cumberland Sound. Additionally, there are Black Guillemots (over 1% of the Canadian population), Black-legged Kittiwakes (1% of the Canadian population), Thick-billed Murres (10% of the Canadian population) and Northern Fulmars (27% of the Canadian population).

Frobisher Bay

Frobisher Bay contains both marine and terrestrial areas. The area contains a large annual polynya and many small polynyas among the islands. Numerous species of birds use this area including Thick-billed Murres (3% of the Canadian population), Black-legged Kittiwakes (1% of the Canadian population), Glaucous Gulls, Northern Fulmars, Razorbills (Alca torda), Dovekies, Black Guillemots, Common Eiders, Iceland Gulls, Ivory Gulls, Harlequin Ducks, Canada Geese, Long-tailed Ducks and various gulls (Larus spp.)

Hantzsch Island within Frobisher Bay is an International Biological Programme site (Nettleship 1980) and a Canadian Important Bird Area (CEC 1999). Hantzsch Island is considered globally and continentally significant for congregatory species and globally significant for colonial waterbirds and seabird concentrations (BirdLife International 2008 Internet site).

Susceptibility to Oil and Gas Activities

Hydrocarbon Release

It has been well documented that seabirds can be dramatically affected by anthropogenic changes in the environment such as oil spills. The Exxon Valdez oil spill in the Gulf of Alaska in 1989 was responsible for the death of an estimated 100,000 to 300,000 birds (Piatt et al. 1990). Those species most severely affected by the spill were murres, other alcids and sea ducks (Piatt, et al. 1990).

The intensity of the effects of an oil spill on seabirds depends on several factors including the size of the local bird population, their foraging behavior, whether these populations are aggregated or dispersed at the time of the spill and on the type and persistence of the oil spilled (NRC 1985). Birds suffer from contact with oil from direct fouling of feathers which reduces their insulative properties in addition to the direct toxicological effects of ingestion. Species that spend a large amount of time swimming on the sea surface and those that form large aggregations are the most vulnerable.

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:

- NOW Polynya
- Eastern Jones Sound
- Eastern Lancaster Sound
- Cape Hay
- Cape Graham Moore
- Cape Searle (Qaqulluit) and Reid Bay (Minarets; Akpait)
- Cumberland Sound
- Frobisher Bay

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 biological hotpots identified by CWS (outside of those areas listed as a 5 above).

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, including:

- 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).

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.

Key habitat

Polar Bear

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. Landfast ice on the eastern coast of Baffin Island 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 den year after year or an area of similar habitat quality (Lunn, et al. 2004; Stirling, et al. 2004). In the eastern Arctic Study area, these denning areas are concentrated along the eastern coast of Baffin Island, Devon Island and Ellesmere Island.

Bowhead Whale

Critical sensitive bowhead whale habitats, as articulated by Laidre, et al. (2008), are regions of shallow water/continental shelf. Important bowhead habitat includes dense annual pack ice, shear zone/leads, polynyas, open water, and ice edges (pack ice and open water). Loose annual pack ice and shelf break regions are also used by bowhead whales (Laidre, et al. 2008).

Beluga

Belugas do not rely directly on land for any part of their life cycle. Generally, they inhabit shallow coastal areas and estuarine environments in the summer; thus coastal development (i.e., marine terminal construction and especially vessel traffic) may deter beluga from preferred habitat (avoidance behavior) and could cause increased environmental contamination. Planning could consider sensitive times of year for belugas, site-fidelity, migration routes and local concentration areas (e.g., estuaries).

Critical physical and biotic habitat factors for beluga whales include regions of loose pack-ice, polynyas, shallow water/continental shelf, interactions between polynyas and shallow water and estuaries/lagoons. Important areas to belugas whales include shear zones/leads, open water, the shelf break and the interface between pack-ice and open water. Belugas are also known to use multiyear pack-ice (Laidre, et al. 2008). Areas not categorized as important, or used, by beluga whales include shore-fast ice, dense annual pack-ice, deep ocean basins and where pack ice and shallow continental shelf regions interact (Laidre, et al. 2008).

Narwhal

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, and 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).

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.

Ivory Gull

The Ivory Gull requires nesting sites that are free from predators and in 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 2006b).

Sustainability Factors

Polar Bear

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).

Bowhead Whale

Threats to bowhead whales include predation, accidental ingestion, environmental contamination, disease, offshore oil and gas exploration, shipping, illegal hunting and tourism.

The severe depletion of the bowhead population by commercial whalers is the main reason that the species is listed as endangered in several parts of its range. Recent reports suggest that killer whales may be the primary threat to bowheads in the eastern Canadian Arctic (Finley 2001; Moshenko et al. 2003; Higdon 2007). Ingestion of foreign material through the process of skim feeding is also a possible threat (Finley 2001). Bowheads can live >100 years and therefore are susceptible to the accumulation of toxins over a long period of time.

Beluga

Threats to beluga whales include predation, environmental contamination, offshore oil and gas development, shipping, hunting and commercial fisheries (Huntington in press).

Polar bears and killer whales are known predators of belugas (Smith and Sjare 1990; Reeves and Mitchell 1989 in COSEWIC 2004b) however; walruses also injure or kill beluga whales (Reeves and Mitchell 1989 in COSEWIC 2004b).

The ability for contaminants to accumulate in the tissue of beluga whales has been widely studied in the St. Laurence population. Such contamination is linked to reproductive impairment, immunosuppression, and tumour incidence (Becker 2000; Hickie, et al. 2000).

Beluga whales exhibit strong site-fidelity, making them easy targets for commercial and subsistence hunters (Francis 1977; Reeves and Mitchell 1987 in COSEWIC 2004b). With the introduction of new hunting technologies, Inuit have expressed an increase in competition during the beluga hunt and suggest this may result in larger harvest numbers (Kilabuk 1998).

Narwhal

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

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).

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

Polar Bear

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).

Bowhead Whale

An additional concern comes with increased interest in offshore developments and tourism, which could possibly affect whale populations with associated traffic, underwater noise and possible oil spills. Bowhead whales use long-range communication and are sensitive to low-frequency industrial sounds (Burns, et al. 1993). At Isabella Bay, bowheads react strongly at far distances to outboard-powered boats and ships and attempt to flee either by moving into shallow waters or traveling long distances away (Finley 2001). Migrating bowheads have been reported to stay 20 km from seismic, ice-breaking and support vessels and drilling ships (Finley 2001).

Beluga

Reaction of beluga whales to offshore oil and gas exploration and to vessels range from great tolerance to extreme sensitivity (Richardson, et al. 1995). Sensitive reactions involve short-term displacement and may change local distribution (Richardson, et al. 1995). The relative broad range of reactions from belugas may be a result of their ability to adapt to repeated ongoing man-made noises (Richardson, et al. 1995). However, belugas often flee from fast and erratically traveling vessels and have been reported to displace up to 2.4 km away (Richard 2001). As well, belugas have been observed by Inuit to react negatively (avoidance behavior) to noisy anthropogenic sources (boats) and suggested to have caused declines in abundances at Pangnirtung (Kilabuk 1998 in COSEWIC 2004b). Inuit also suggest that avoidance behavior caused belugas to be less healthy (skinnier) (Kilabuk 1998).

Narwhal

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

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, et al. 1983; 1984; 1990; Miller and Davis 1984 in COSEWIC 2004a). As well, some Inuit hunters suggest that narwhals are sensitive to and avoid noise from industrial machines and explosions (Remnant and Thomas 1992; Stewart, et al. 1995; Gonzalez 2001 in COSEWIC 2004a).

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. Ship noise and oil and gas exploration could displace walruses from their haul-outs and interfere with their communication (Stewart 2002).

Ivory Gull

Industrial activities are a threat to the nesting areas of Ivory Gulls on the Brodeur Peninsula, Baffin Island. In addition to the physical and sensory disturbance associated with human activities, they may attract previously scarce or absent mammalian and avian predators that will also prey on other local sources of food including gull colonies (COSEWIC 2006b).

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

Potential Effects of Climate Change

Polar Bear

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).

Bowhead Whale

Tynan and DeMaster (1997) list the bowhead as a possible indicator species for climate change in the north, making the species of special interest for scientific reasons. Climate change is likely to cause changes in ice distribution and condition, surface temperatures, currents and mixing. Such changes in Nunavut could alter the bowhead whales' migration patterns, feeding locations and make it more susceptible to predation and hunting. Such changes will have direct and indirect effects on bowhead health, population and distribution.

For example continued increases of killer whales in Nunavut as described by Higdon (2007) could result in elevated levels of bowhead predation. This may have detrimental effects on the population especially because killer whale predation has been noted as the major cause of bowhead mortality in Nunavut (Finley 2001). As well, primary productivity is highly variable and dependent on nutrient availability. Such processes are greatly influenced by climate change and therefore, feeding habitat of bowheads may be altered (Finley 2001). Bowhead fecundity is probably related to zooplankton production (Calanus) therefore, climatic change is likely to have an impact on population growth (negative or positive) through changes in the extent of sea ice (Finley 2001).

Laidre, et al. (2008) indicate that three types of sensitivities by bowhead whales are likely to be influenced by climate change: narrowness of distribution and specialization in feeding; seasonal dependence on ice; and, reliance on sea ice as a structure for access to prey and predator avoidance.

Beluga

The effects of climate change on beluga whales are uncertain. They are highly adapted to Arctic seas, yet capable of survival far from sea ice, and sometimes select open-water habitats at least for part of the year (Moore and Huntington 2008). It is likely that climate change will result in changes in the extent and duration of sea ice (Huntington in press). This may alter beluga migrations and may cause them to penetrate further into the Arctic environment possibly allowing new feeding habitat to be exploited (Huntington in press).

Changes in sea ice regimes with climate change will impact the timing and extent of primary production (Moore and Huntington 2008). This may have negative effects on the beluga whale prey or could cause shifts in the location of prey (Moore and Huntington 2008).

Climate change has also been attributed to increases in the number of killer whales along the coasts of Nunavut (Higdon 2007). Such changes in the range of killer whales may cause increased predation on belugas resulting in higher incidences of mortality, injury and avoidance behavior (Higdon 2007). This coupled with decreases in available ice refuge may result in negative effects on beluga population (Higdon 2007; Moore and Huntington 2008; Huntington in press).

Narwhal

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 to climate change (primarily based on their reliance on sea ice and specialized feeding).

Walrus

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

Ivory Gull

Climate change may also have an impact on Ivory Gull depending on how it affects the distribution of open water early in the breeding season (COSEWIC 2006b). Because the Ivory Gull is associated with pack ice year-round an increase in the extent or thickness of ice cover would reduce their foraging capabilities and have potential effects on reproductive productivity. Alternatively, a decrease in ice cover or thickness may increase available habitat for foraging and have a positive effect on reproductive productivity in the breeding season (COSEWIC 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, or areas where no species of conservation concern are known to inhabit.

Mitigation

Species specific mitigation strategies are summarized in sections 4.1.4 (polar bear), 4.2.4 (bowhead whale), 4.3.4 (beluga and narwhal), and 4.5.4 (ivory gull). Additional mitigation required for walrus include vessel speed restrictions, noise restrictions, and minimum aircraft altitude restrictions around known haul-out sites.

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

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 1992b) 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 currently 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 1992b).

The Nunavut Atlas (Riewe 1992b) provides the following definitions for land use intensities:

- High Intensity – areas used every year
- Medium intensity – areas used (within the last 30 years), but not necessarily used every year
- Low intensity – areas used prior to 1960, but rarely used by hunters in 1987.

Devon East (East side of Devon Island and Lancaster Sound)

Coburg Island is used by Grise Fjord hunters to hunt thick-billed murres and other seabirds and to collect their eggs. They travel there by a combination of snowmobile and boat. There are several campsites present on Coburg Island and has an Inuit land use intensity rating of high.

There are major snowmobile travel routes from Croher Bay south into Lancaster Sound and then east towards Baffin Bay. These snowmobile routes are used in winter and spring by Arctic Bay hunters travelling to the south-eastern Devon Island area where they hunt Muskox and marine mammals. Several campsites exist in the area and the Inuit land use intensity rating of high. Arctic Bay hunters are also reported to hunt polar bear, narwhal, walrus and seal in the Lancaster Sound area in the late winter and spring periods. Narwhals are taken at the floe edge in spring. At the time that the Nunavut Atlas was produced, hunters had been able to hunt polar bears in the south-eastern Devon Island area.

Admiralty Inlet (for southern portion of Lancaster Sound)

There are several camping sites present along the southern portion of Lancaster Sound, and this area is rated as high Inuit land use intensity. Hunters from Arctic Bay use this area for hunting ringed and bearded seals. In the winter, ringed seals are taken at breathing holes in the ice, but in spring, they are hunted when basking on the ice. Bearded seals are hunted mostly in late spring at the floe edge or in open water during the summer. Inuit from Arctic Bay and Pond Inlet use the northern coasts of Borden Peninsula and Navy Board Inlet for seal hunting in open water during the summer and at floe edges in the late spring. Residents of Pond Inlet Inuit hunt walrus in late spring at the floe edges and during summer in the open water or at haul-out sites such as the Wollaston Islands. In the spring and summer, narwhals are hunted in Navy Board Inlet and in southern Lancaster Sound.

Pond Inlet

The area along the coast of Bylot Island and Baffin Island has many camping sites and few fishing sites. There is a major travel route along the coast of Bylot Island, as well as along the coastline of Baffin Island. The Inuit land use intensity directly along the coastline is rated as high. The area further out into Baffin Bay has an Inuit land use intensity rating of medium.

The coastal areas of Bylot Island are an important area for polar bears. This area is reported as the north-eastern limit of travel for Pond Inlet hunters. Seal and narwhal are hunted south of Cape Walter Bathurst. Walrus hunting occurs throughout the entire coastal area in the winter.

Pond Inlet Inuit hunt ringed and bearded seals intensely year-round in all marine areas along Baffin Bay. The marine area by southeast Bylot Island and Guys Bight, Erik Harbour is where duck hunting occurs.

The offshore area of fast ice in Baffin Bay is used for polar bear and seal hunting in some years. This is especially the case in March – April when a combination of grounded icebergs and reduced current allow for the growth of new fast ice.

Clyde River

There are major travel routes along the coastline of Baffin Island with the Inuit land use intensity of this area, which extends into Baffin Bay, rated as high. There are snowmobile and dog team travel routes between Pond Inlet and Clyde River. Several campsites are located along the coastline and offshore in Baffin Bay, as well fishing sites in various locations along the coast. The marine area, including all adjacent fjords, bays and inlets, is reported to be used intensively by Clyde River hunters for polar bears, ringed seals, and bearded seals on the fast ice and at the floe edge from December through June. In Eglinton Fjord and at the mouth of Clyde Inlet, seals are hunted in fall and winter. Cape Christian is a popular sealing area. In Sam Ford Fjord and Scott Inlet, ringed seal pups are hunted in spring. Harp seals are harvested in Clyde Inlet during the summer. The area off the mouth of Clyde Inlet is used year round. During the summer, narwhals as well as some belugas are hunted in this area. In the summer and fall, Eider ducks are hunted in Inugsuin Fjord.

Home Bay

Continuing south along the coast of Baffin Island, the area of Home Bay is also rated as having a high level of Inuit land use. There are various major travel routes in this area, as well as several camping sites. The marine area east of Isabella Bay is intensively used by Clyde River hunters who hunt ringed and bearded seals as well as polar bears during the winter and spring, especially in Isabella Bay. Along the coasts of Isabella Bay and its islands, Arctic foxes are trapped. During summer and fall, narwhals and harp seals are hunted in Clyde Inlet and Inugsuin Fjord. The northern part of Home Bay and the adjacent fjords are used to hunt ringed seals and polar bears during winter and spring. Alexander Bay is noted as a favored location for hunting polar bears, and is also where walrus are hunted in the spring.

Qikiqtarjuaq hunters use Home Bay for ringed seal hunting, especially during the spring. In Ekalugad and Pitchforth fjords, they hunt narwhals during the summer. In the mouth of Alexander Bay, they also hunt walrus, narwhals, harp and bearded seals. Narwhals are pursued at the floe edge in spring and early summer and close to Cape Hooper. Polar bears are hunted throughout the area to the southeast of Cape Hooper during winter and spring. Eider duck and Arctic tern eggs are collected on many of the small outer islands in Home Bay during the summer.

Cape Dyer

There are major travel routes along the coast of Baffin Island, as well as many camping sites. There are also several fishing sites present. This area has a high rating of Inuit land use intensity. Qikiqtarjuaq Inuit hunt in the marine area for marine mammals year round. The fjords, inlets and bays from Broughton Island to Cape Dyer are used intensively year round for hunting ringed seals and during the summer for hunting harp seal and bearded seal. Polar bears are hunted over this entire area during winter and spring and walrus are hunted early during the summer with the breakup of fast ice. During the spring, waterfowl (especially eiders and murres) are shot at the floe edge and during open water season they are shot in the fjords. During late summer, fishing for Arctic char occurs in several of the fjords, especially Padle Fjord. East of Broughton Island, narwhals and ringed seals are hunted during spring at the floe edge and in Merchants Bay, Padle Fjord, around Broughton Island and near Paugnang Island during the summer. In Padle Fjord, Belugas are sometimes hunted during the summer and in the spring at the floe edge. Exeter Sound and Bay are used by Pangnirtung and Qikiqtarjuaq residents to hunt ringed seals each winter and spring.

Hoare Bay

The Hoare Bay area has a high level of Inuit land use. There are several camping sites and fishing sites along the coast of the Cumberland Peninsula of Baffin Island. These hunters hunt ringed seal and walrus in the Hoare Bay area during winter, spring and summer.

Hoare Bay is used infrequently by hunters from Qiktarjuaq

Cumberland Sound

There are several major travel routes present in the area, as well as several campsites and fishing sites. At the mouth of Cumberland Sound, the intensity of Inuit land use has been rated as medium. For the rest of the area, the land use intensity has been rated as high.

Pangnirtung hunters occasionally hunt marine mammals in the offshore area at the mouth of Cumberland Sound.

Some caribou are hunted along the Cumberland Peninsula of Baffin Island. Along the travel routes in this area, from the Ujuktuk Fjord-Kumlein Fjord area, polar bears are occasionally hunted.

Along the east and west coasts of Cumberland Sound as well as amongst the Leybourne Islands, polar bears are hunted in winter.

Walrus are hunted in the Lemieux Islands area during summer.

In Cumberland Sound, part of the Pangnirtung hunter's annual quota of 40 narwhals is taken, as well as about 50 belugas. They also hunt ringed seals and harp seals in this area.

Domestic Arctic char fisheries occur in many coastal areas of Cumberland Sound.

Resolution Island

The intensity of Inuit land use for Resolution Island, as well as the coastline and part of the Davis Strait is rated as high. There are several campsites and fishing sites present on Resolution Island. There are also major travel routes in the area.

Iqaluit hunters use the area just north of Resolution Island (Edgell Island) to hunt harbour seals, although they are quite uncommon in this region. This is often done in conjunction with waterfowl hunting during the summer. Common eiders and other waterfowl as well as their eggs are taken in Gabriel and Graves Straits. Hunting camps are set up in the summer on the northern portion of Resolution Island, Lower Savage Island, and Edgell Island. Both Iqaluit and Kimmirut hunters have historically hunted ringed, bearded, harp and sometimes hooded seals on the coastal area adjacent to Meta Incognita Peninsula, including Annapolis and northern Gabriel Straits.

Kimmirut residents hunt caribou and polar bears at Meta Incognita Peninsula and the adjacent coastal waters.

The southern portion of Resolution Island and further out into the Davis Strait is not used for traditional harvesting.

Frobisher Bay

This area has several camping sites and fishing sites as well as many major travel routes. It is rated as having a high intensity level of Inuit land use.

The portion of the Davis Strait along the coast of Lemieux Islands was used by members of the Allen Island Outpost Camp for ringed, bearded, and harp seal hunting throughout the year. Iqaluit and Pangnirtung hunters also use this portion of the Davis Strait for polar bear hunting.

Iqaluit hunters have used the eastern half of Beekman Peninsula and both Brevoort and Lemieux Islands for caribou and polar bear hunting. Pangnirtung hunters hunt for seals, caribou and walrus in the vicinity of the Lemieux islands.

Previously, there were two families reported as living year round at the Allen Island Outpost Camp, trapping Arctic foxes, hunting waterfowl and fishing for Arctic Char for domestic use close to the camp. From March to May, the portion of the Davis Strait including Robinson Sound and Cyrus Field Bay was used by Allen Island Outpost Camp members for guided polar bear hunts. Walrus are hunted year round in this area, the annual take for which is around 100. Ringed seals are hunted year round, while bearded (hunted on the north and east coast of Loks Land) and harp seals are hunted mostly during the summer. Common Eiders and other waterfowl are also hunted off of Loks Land. Iqaluit residents hunt for harbour seals at Cyrus Field Bay, Lupton Channel, Beare Sound, and the north-west and east coasts of Lok Lands in conjunction with waterfowl hunting.

During the summer, caribou and wolf hunting by the Iqaluit hunters takes place in the coastal region of Hall Peninsula and Blunt Peninsula. On Loks Land during the summer, caribou are occasionally hunted. This area has been used for hunting caribou, waterfowl, Arctic foxes and for Arctic Char fishing.

During summer, waterfowl hunting as well as egg gathering occurs in Kendall Strait and near Gross and Potter Islands. Although fairly uncommon, when harbour seals are seen here during the summer, they are harvested. South from Frobisher Bay including the areas adjacent to Potter, Gross, and Palmer islands, hunting for ringed, bearded, harp and occasionally hood seal and walrus takes place. Residents of Lake Harbour use this area occasionally for caribou and seal hunting.

Readers are cautioned that 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. Most oil and gas activities in the study area will occur in the marine environment; however, shore bases to support activity may be required.

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

Seismic Exploration

Seismic activity in the study area is expected to be conducted by marine vessels during the open water season. As activity is expected to be conducted offshore, direct interaction with traditional harvesting is expected to be limited; however, vessel traffic may interfere with migration of marine wildlife and potentially affect the availability of species for harvesting.

Ice-based Activities

It is likely that drilling in the study area would be undertaken by drill ships or other mobile structures. Therefore oil and gas activities affecting ice in the study area would be expected to be related to ice management and transfer of people and materials to offshore drilling locations. Noise associated with ice breaking may indirectly affect harvesting as species may avoid areas of activity. Depending on the drilling season, location and resupply locations, ice breaking could interact with traditional harvesting. Ice breaking and 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 and may also result in the imposition of and/or reduction in harvest quotas.

Sensitivity Ranking

In developing the sensitivity layer for traditional harvesting, consideration was given to the Areas of Importance identified in Appendix G of the NBRLUP 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. The Areas of Importance presented in the NBRLUP cover most of the Eastern Arctic study area.

For that portion of the study area not covered by the NBRLUP, the presence of species of harvest interest and the intensity of harvesting activity as presented in the Nunavut Atlas was evaluated to determine sensitivity rankings.

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 areas documented as important/intense harvesting area in references, areas where key wildlife habitat documented to be present and areas that are proximate to communities.

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), areas documented as important harvesting area in references, or travel routes to harvesting and/or camping locations.

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) however, some harvesting has been documented to occur.

Low/Moderate Sensitivity (2)

This rating applies to 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). There is little to no documented harvesting and no important habitat for species of traditional harvest interest is known to be present.

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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Commercial Fishing

Rationale for Selection

Commercial fishing is an important and developing sector of the Nunavut economy. The vision of the Nunavut Fisheries Strategy is —to see fisheries emerge as a driving economic catalyst for Nunavut resulting in increasing prosperity for current and future generations of Nunavummiut recognizing the principles of sustainable use and Inuit Quajimajatuqangit (Nunavut Department of Economic Development and Transportation 2009, internet site). Nunavut is currently involved in highly competitive offshore, near shore and inland fisheries (Nunavut Department of Economic Development and Transportation 2009, internet site). The Baffin region, within the Eastern Arctic study area, is where large-scale offshore turbot (Reihardtius hippoglossoides, also known as Greenland Halibut) and shrimp fisheries (Northern or pink shrimp – Pandalus borealis) have been established. There is also an inshore commercial turbot fishery as well as an Arctic Char (Salvelinus alpinus) fishery within Cumberland Sound. It is estimated that the commercial turbot and shrimp fishery contribute a combined $8 million annually to the Nunavut economy. The Nunavut Fisheries Strategy also indicates that there is potential to develop a commercial fishery for clams, scallops and crabs in the future (Nunavut Department of Economic Development and Transportation 2009, internet site). There is a growing expectation for the commercial fishing industry to create meaningful employment opportunities and contribute to economic growth in the region.

After a review of commercial fisheries in the study area and consideration of its current and potential economic importance, commercial fishing was selected as one of the final VSECs.

Commercial Fishing Activities

The North Atlantic Fisheries Organization (NAFO) allows fishing for Turbot (Reihardtius hippoglossoides), also known as Greenland Halibut, in Subarea O (subdivisions OA and OB) of the Northern NAFO Regulatory Area (GS Gislason & Associates Ltd 2002). There are several locations where Turbot fishing occurs along the coast of Baffin Island, in subdivision OA and OB, within the Eastern Arctic Study area (Baffin Fisheries Coalition 2005, internet site). Large-scale offshore turbot fisheries and shrimp fisheries (Northern or pink shrimp – Pandalus borealis) have been established in the Baffin region. There is also an inshore commercial fishery for turbot in Cumberland Sound on south Baffin Island, very close to the southern portion of the Eastern Arctic study area. Nunavut's largest fish processing facility is in Pangnirtung with smaller operations in Iqaluit, both of which are very close to the Eastern Arctic study area (Nunavut Department of Economic Development and Transportation 2009, internet site). Depending on seasonal ice conditions, both fisheries normally operate between April and December (Nunavut Department of Economic Development and Transportation 2009, internet site).

Historically, Nunavut's involvement in offshore turbot and shrimp fisheries has been in the form of royalties paid by outside fishers, thereby causing significant loss of economic development from the territory (Government of Nunavut and Nunavut Tunngavik Incorporated 2005). According to GS Gislason & Associates Ltd., the 2001 Division 0A quota for Canada, all of which was allocated to Nunavut, was 3,500 tonnes of Turbot. The 2001 Division 0B quota of Turbot for Canada was 5,500 tonnes, of which 1,500 tonnes went to Nunavut residents, 2,500 tonnes went to company quotas, and 1,500 tonnes went to a competitive fishery (2002). However, apart from the Turbot fishery in Cumberland Sound, which falls within NAFO subdivision 0B, the entire subdivision 0A and 0B quotas are leased by Nunavut interests to non-Nunavut companies that fish offshore (GSGislason & Associates Ltd. 2002). Some of the turbot caught by the non-Nunavut companies is delivered and processed at the Pangnirtung Fisheries Ltd. plant in Pangnirtung, which is a joint venture between the Government of Nunavut and a local Inuit owned company called Cumberland Sound Fisheries Ltd. In 2001, about 365 tonnes of fish from offshore fisheries were delivered for processing to the Pangnirtung plant, which accounts for less than half of the offshore trawl catch (GS Gislason & Associates Ltd. 2002). In 2002, according to GS Gislason & Associates Ltd, an estimated 20 Nunavut residents worked on offshore trawlers.

None of the offshore shrimp is caught by Nunavut vessels or processed in Nunavut. The product is usually delivered to Newfoundland and Nova Scotia (GS Gislason & Associates Ltd. 2002). In 2002, according to GS Gislason & Associates Ltd., all licences held by Nunavut corporations were leased to and fished by non-Nunavut companies in return for royalty payments and employment and training opportunities. Approximately 55 Inuit were employed on shrimp trawlers in 2002 (GS Gislason & Associates Ltd. 2002).

In the Pond Inlet area of Baffin Island, Arctic Char commercial fishing occurs in the Coutts Inlet area. There is a commercial quota of 910 kg round weight (rnd) of anadromous Arctic Char there. Records have not been kept as to whether the area is actually being used for commercial fishing; however, Pond Inlet residents requested the quota to be opened for fishing during the 1977 – 78, 1979 – 80 and 1980 –

81 seasons. In 1979, the total commercial catch of Arctic char was 2,570 kg rnd. The fish were sold by Toonoonik Sahoonik Co-operative within the community.

According to DFO, the Arctic Char commercial fishery in Cumberland Sound occurs in Kingnait Fjord (2009). In 2000, the Pangnirtung Hunters and Trappers Association noticed a decline in Arctic Char population and requested that Kingnait Fjord be closed to commercial fishing by the Nunavut Wildlife Management Board (NWMB). The NWMB announced closure to commercial fishing for five years, and communities were encouraged to minimize their subsistence fishing in the area to help recover the stocks. The HTA then requested that Kingnait Fjord be reopened for commercial fishing in 2002 and again in 2003. DFO indicated that a total harvest from all sources of 2000 kg (4409 lb) would pose a low level risk to the population. Since the summer 2005/2006, an annual exploratory license with a 2000 kg quota has been established for this fishery (DFO 2009). The Fisheries Management Harvest Information System (FHMIS) is a DFO database which provides information on harvest in kg round weight by DFO fiscal year, April 1 to March 31 (DFO 2009). According to FMHIS, in the summer 2005/2006, 1919 kg round weight was harvested for commercial purposes, in summer 2006/2007 the commercial harvest amount was 1617 kg, in winter 2007/2008 the commercial harvest was 1258 kg and in summer and winter 2008/2009 the commercial harvest was 3129 kg.

There have been reports that subsistence harvesting from this stock have at times been as high, or higher than, the commercial harvest; however, a good record of the subsistence harvest of this stock and the total yearly harvest (both subsistence and commercial) is not available (DFO 2009).

Susceptibility to Oil and Gas Activities

Commercial fishing and oil and gas activity may interact when both activities occur in the same area at the same time. Industry activity may be both mobile (seismic) or stationary (drilling). Direct interactions with commercial fishing may include access restrictions due to presence of vessels or indirect interactions through interactions with species, including sensory disturbance, habitat loss/alteration, direct mortality and changes to the aquatic food web as a result of chemical contaminants.

Seismic Exploration

Seismic activity in the study area is expected to be conducted by marine vessels during the open water season which overlaps with the fishing season. Seismic vessels deploy air guns which produce sound pressure waves under water. The pressure waves have the potential to cause changes in fish behavior, physiological damage and mortalities.

Ice-based Activities

It is likely that drilling in the study area would be undertaken by drill ships or other mobile structures during the open water season. Therefore oil and gas activities affecting ice in the study area would be expected to be related to ice management at the drill site and transfer of people and materials to offshore drilling locations. Some ice breaking may be required during ice management or during transits to a shore base in early or late season. Noise associated with ice breaking may cause sensory effects to fish and the presence of industry vessels may prevent access by fishing vessels.

Shipping

Shipping to support oil and gas activity has the potential to interact with habitat, fish species and fishing activity. Intensive shipping such as regular transits between a shore base and an offshore location may increase the interaction and result in effects to the VSEC.

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, increased inputs of fresh water to the marine environment and changes in ocean currents all have the potential to effect habitat and species abundance and distribution.

Sensitivity Ranking

In developing a sensitivity layer for commercial fishing, the sensitivity rating was dependent on the presence of commercial species and the frequency and amount of documented commercial fishing activity. Currently the commercial fishing season coincides with the open water season which is likely when oil and gas activities would be expected to occur in the study area.

Determination of sensitivity for Commercial Fishing is based on:

High Sensitivity (5)

High sensitivity areas include those where commercially fished species present in area, there is a commercial quota established, and there is active commercial fishing in area.

Moderate/High Sensitivity (4)

Moderate to high sensitivity applies to areas where commercially fished species are present a commercial quota is established, but there is no current commercial fishing activity during open water season.

Moderate Sensitivity (3)

Moderate sensitivity was given to areas were commercially fished species are present in area and traditional subsistence fisheries are known to occur.

Low/Moderate Sensitivity (2)

Areas where limited information is available but suggests that commercial fish species and habitat may be present were given a low to moderate sensitivity rating.

Low Sensitivity (1)

Low sensitivity applies to areas where there is no documented information on presence of commercial fish species and no documented information about habitat for commercial fish species.

Mitigation

Commercial fishing is dependent on the presence of commercial fish species, the allocation of commercial quota and the opportunity to conduct fishing operations. Species presence depends on the availability of habitat and healthy and viable populations. Avoidance of important fish habitat and fishing areas will reduce the potential for sensory disturbance, habitat change and the potential to affect food sources through the release of contaminants. Avoidance can be accomplished through physically avoiding an important area or by conducting operations when species are not present (e.g., winter when anadromous Arctic char are in inland waters). Seismic operations present a potential for direct impact to fish and their availability for harvest. Options to mitigate the impact on fish from seismic operations include reducing the energy level in the seismic guns and/or ramping up energy levels whereby the intensity is gradually increased to allow fish an opportunity to adjust to the final energy level.

Fishers require access to the fish to carry out the activity. Oil and gas operators can prevent direct interaction with fishing activity by avoidance or where possible conducting activities during periods where fishing does not occur.

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.