Beaufort Sea and Mackenzie Delta 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

Key habitat

Polar bear distribution and habitat use in the Beaufort Sea varies with season. In winter (ice-covered season from October through April), most bears are actively hunting seals on areas of annual ice (ice that forms and melts annually). Areas within the Beaufort Sea that are most utilized for hunting include inter-island channels, and areas where ‘active ice' occurs, such as polynyas and landfast shore leads. The location of leads strongly influences the distribution of seals and polar bear hunting activity during winter. In the winter polar bears move south toward the shoreline of the mainland coast or Amundsen Gulf (Stirling 2002). The most important floe-edge and moving–ice habitats are distributed in a band through the Bathurst polynya. This intermediate zone of fractured, unconsolidated annual ice lies in shallow waters between the landfast ice along the coast and the multi-year pack ice further offshore (Stirling 1990).

Breeding occurs over relatively short periods during April and May, and adult females are concentrated in the best feeding habitat along the leads that parallel the coast. Males are drawn to these areas by the females' presence (Stirling et al. 1993). Most mating takes place on open sea ice. As the sea ice breaks up in the spring and early summer, polar bears follow the receding ice edge where seals occur. Where the ice melts completely during the summer months, most bears retreat off ice to denning locations on the North Slope of the Beaufort Sea and Banks Island, to den during the ice-free periods when prey is unavailable, or retreat northward to multi-year pack ice.

In early November, pregnant females dig maternity dens on land near the coast or offshore in the multi-year pack ice. Pregnant female bears may retire to maternity dens in late October to early November. These dens are found in snowdrifts on multiyear pack ice, but primarily on small islands near the western and southern shores of Banks Island, and to a lesser extent on islands and coastal areas from Tuktoyaktuk east to Alaska. Herschel Island appears to be the most important maternal denning area on the mainland coast (Stirling and Andriashek 1992). During periods of particularly cold or inclement weather, solitary males and females with cubs, may also shelter in dens on multiyear pack ice, within several hundred kilometres of the southern extent of pack ice (Stirling 2002).

Rationale for Selection

Polar bears are a high profile species for several reasons – they are a potential indicator species for measures of climate change, they provide social and economic benefits, and they are identified as a potential At-Risk Species (i.e., the area listed as Special Concern by COSEWIC). Canada supports a majority of the world's polar bear population and under the International Agreement on the Conservation of Polar Bears, the conservation of species is mandated. Additionally, the polar bear has previously been identified as an important component of the Nearshore Marine Valued Component in the recent Beaufort Delta Cumulative Effects Project (Dillon Consulting Limited and Salmo Consulting Limited 2005), the Marine Mammal Valued Component of the Northwest Territories Cumulative Impacts Monitoring Program, and within the Community Conservation Plans within the study area. Polar bears also provide direct economic support to the communities that provide consumptive (hunting) and nonconsumptive (tourism and wildlife viewing) use of the bears. Thus, concerns about the status of the species exist at both regional and national levels.

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

Sustainability

Polar bears are very closely tied to the presence of sea-ice from which they hunt, mate, and carry on other life functions. Maternal denning sites are a key element of bear ecology, potentially reducing the vulnerability of the cubs and nursing females to hunters and intraspecific predation. Historically, female polar bears were often hunted in maternal dens on Banks Island and the mainland, and the hunting of such bears may have contributed to the higher proportion of maternal denning sites currently found on multi-year pack ice off shore (Stirling 2002). However, declining ice extent and degrading ice character have been associated with a shift towards more land-based denning as availability and quality of pack ice denning habitat decreases (Fischbach et al. 2007). Further declines in sea ice availability and an increase in polar bears denning in coastal areas are predicted.

Susceptibility to development

In the eastern Beaufort Sea, most of the offshore drilling activity has been in shallower areas (<50 m) and there is overlap between the most important polar bear feeding habitat and offshore drilling activities (Stirling 1988). Large scale spills or blowouts during the fall or winter could affect prime breeding (see above) and foraging habitat. Oil, entrapped in ice, would eventually reach the floe edge and moving-ice habitats. There are likely two means whereby the viability of polar bear populations can be linked to project-specific impacts:

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

Habitat Susceptibility

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

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

The presence of oil or other contaminants resulting from accidents and malfunctions associated with petroleum exploration and fuel transfer also have the potential to reduce habitat availability. Contact with spilled oil may directly affect the health of individual bears, and/or reduce the availability of ringed seals. The population impacts that may result from such accidents would depend largely on the season, amount and type of contaminants released, climatic factors and the responses initiated.

Mortality Risk

Human-wildlife conflicts have occurred with regularity in areas where humans and bears coexist. For species such as polar bears, the loss of adult females in such conflicts poses a particular risk to the population. This is because polar bears have low reproductive rates, exist at low densities, and reproduce relatively late in life. High mortality rates of adult females would likely result in a relatively rapid population decline (i.e., within two to three generations).

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

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

Mitigation

Contaminant spills (particularly hydrocarbon spills) remain a potential risk that could have direct consequences to seal populations in the Beaufort Sea, and subsequently, to polar bear populations. This risk can be managed appropriately through prevention measures, and it can be considered to have a relatively low probability of occurrence. On-ice activities such as ice-platform based drilling, ice road construction, and flaring have the greatest potential for direct impacts to bears, either through habitat loss or increased mortality risk. Should development be initiated in areas where maternal dens are present, timing should coincide with the spring period when female bears are foraging away from maternal dens (from April to late spring). Females may occupy such dens during the open water season and during the birthing period (late October through to March or April).

Climate Change

The greatest overall threat to polar bears may be large-scale ecological change resulting from climatic warming (Stirling and Derocher 1993), which may change characteristics of sea ice. It is suspected that with a dramatic retreat of the pack ice, record amounts and duration of open water, and longer ice-free seasons that have predominated in this region in recent years, the amount of sea ice available as a substrate is reduced and bears spend less time in early summer and autumn travelling and foraging. With the progressive earlier breakup of sea ice and the shortened foraging season, bears are forced to come onshore earlier and this may result in nutritional stress that leads to intraspecific killing and consumption of polar bears in the southern Beaufort Sea (Amstrup et al. 2006, Stirling et al. 2008). Hence, climatic warming, longer ice-free periods and associated declines in Arctic sea ice lowers polar bear survival, and breeding and cub-of-the year survival declines (Monnett and Gleason 2006, Hunter et al. 2007, Regehr 2007, Rode et al. 2007).

Summer sensitivity scores

Summer (July - October)

With sea-ice breakup and a reduction in summer ice cover, polar bears in the Beaufort Sea either select habitats with a high proportion of old ice, which takes them northward as the ice melts or bears come ashore (Messier et al. 1994, Schliebe et al. 2008). Polar bears are excellent swimmers and swim while actively hunting, while moving between hunting areas, and while moving between sea ice and terrestrial habitats. Swimming is believed to be more energetically costly than walking, and bears often will abandon the melting ice in favor of land when ice concentrations drop below 50% (Derocher, Lunn, and Stirling, 2004).

Summer/Fall (July - October) Sensitivity

Low Sensitivity (1)

Areas that have very limited use year round, and thus, do not contribute substantially to the viability of the species in the area, in that the areas have little value for reproduction (denning) or survival (limited use for foraging). These areas are greater than 300 km beyond (i.e., northward) the summer extent of pack ice.

Low/Moderate Sensitivity (2)

These areas represent parts of first year and multi-year pack ice that have limited use as foraging and denning areas (during the open water period primarily), and is the transition ice zone of predominantly first year ice that is bound by the multi-year ice to the north and the open water to the south (Dickins et al. 1987).

Moderate Sensitivity (3)

These areas represent foraging areas in non-critical time periods (open water season) and include the summer limit of landfast ice to flow edge/moving ice area.

Moderate/High Sensitivity (4)

These areas represent foraging areas in critical time periods of spring (May seal pupping period) and early fall (area of moving ice/flow edges, polynyas), as well as extensively used nearshore denning areas during open water times of limited prey availability.

High Sensitivity (5)

Critical Habitat Areas are legally defined areas under the Species at Risk Act that represent habitats critically important to the survival of the species.

Winter sensitivity scores

Winter (November – June)

The location of leads strongly influences the distribution of seals and polar bear hunting activity during winter. In the winter polar bears move south toward the shoreline of the mainland coast or Amundsen Gulf (Stirling 2002). The most important floe-edge and moving–ice habitats are distributed in a band through the Bathurst polynya. This intermediate zone of fractured, unconsolidated annual ice lies in shallow waters between the landfast ice along the coast and the multi-year pack ice further offshore (Stirling 1990). In general, the polynya is visible as a distinct lead as early as March (Dickens et al. 1987). The maximum observed areal extent of the polynya during the period from April to June was used to establish a conservative set of boundaries for this zone for the winter/spring period (Dickens et al. 1987, Canadian Ice Service 2002). In the eastern Beaufort Sea, most of the offshore drilling activity has been in shallower areas (<50 m) and there is overlap between the most important polar bear feeding habitat and offshore drilling activities (Stirling 1988). Large scale spills or blowouts during the fall or winter could affect prime breeding (see above) and foraging habitat. Oil, entrapped in ice, would eventually reach the floe edge and moving-ice habitats.

Sensitivity areas in the winter are similar to the summer but also include the onshore and offshore maternity denning area. Maternal denning sites are a key element of bear ecology, potentially reducing the vulnerability of the cubs and nursing females to hunters and intraspecific predation. In early November, pregnant females dig maternity dens on land near the coast or offshore in the multi-year pack ice. Maternal dens located over broad regions of the Canadian Arctic were within 8 km of the coast (Harington 1968, Messier et al. 1994). Historically, female polar bears were often hunted in maternal dens on Banks Island and the mainland, and the hunting of such bears may have contributed to the higher proportion of maternal denning sites currently found on multi-year pack ice off shore (Stirling 2002). However, declining ice extent and degrading ice character have been associated with a shift towards more land-based denning as availability and quality of pack ice denning habitat decreases (Fischbach et al. 2007). Further declines in sea ice availability and an increase in polar bears denning in coastal areas are predicted. If the summer ice retreats far enough from shore and for a long enough time, it could prevent pregnant females that are foraging offshore from reaching the coast and bears will be forced to den in deteriorating pack-ice habitats (Fischbach et al. 2007). Should development be initiated in areas where maternal dens are present, timing should coincide with the spring period when female bears are foraging away from maternal dens (from April to late spring). Females may occupy such dens during the open water season and during the birthing period (late October through to March or April).

Winter (November - June) Sensitivity

Low Sensitivity (1):

Areas that have very limited use year round, and have little value for reproduction (denning) or survival (limited use for foraging).

Low/Moderate Sensitivity (2):

These areas represent annual ice and multi-year pack ice that have limited use as denning and foraging areas.

Moderate Sensitivity (3):

These areas represent foraging areas in non-critical time periods (November through early March) and is the transition ice zone of predominantly first year ice that extends from the northern boundary of the Bathurst Polynya and the southern boundary of the multi-year ice (Dickins et al.. 1987). Forage value of these areas is associated with the mid and early winter periods.

Moderate/High Sensitivity (4):

These areas (moving ice/flow edges, polynyas) represent foraging areas in critical time periods in winter (mid March and April).

High Sensitivity (5):

Critical Habitat Areas are legally defined areas under the Species at Risk Act that represent habitats critically important to the survival of the species. This includes extensively used nearshore denning areas used during early winter to early spring (November through April) for birthing. With reductions in stable old ice, increases in unconsolidated ice, and lengthening of the melt season, the proportion of polar bears denning in coastal areas will continue to increase, until such time as the autumn ice retreats far enough from shore that it precludes offshore pregnant females from reaching the coast in advance of denning.

Summary

Polar bears were considered a VEC because of their high public profile, economic importance, and importance within the food chain as the top predator in the Beaufort Sea. A higher sensitivity rating was most often associated with denning and foraging areas in critical time periods. Due to seasonal changes in polar bear distribution and habitat uses, it is recommended that a long-term view of the potential activities be considered when evaluating individual grids. Although oil and gas exploration activities may be limited to seasons when bears are not present (such as open water seismic), the potential petroleum production infrastructure associated with such exploration – which is the ultimate goal of exploration activities – may ultimately persist year round, and could impact polar bear populations beyond the season(s) of exploration.

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

References

Amstrup, S. et al. 2006. Recent observations of intraspecific predation and cannibalism among polar bears in the southern Beaufort Sea. Polar Biology 29: 997-1002.

Cherry, S.G., A.E. Derocher, I. Stirling and E.S. Richardson. 2009. Fasting physiology of polar bears in relation to environmental change and breeding behaviour in the Beaufort Sea. Polar Biology 32: 383-391

COSEWIC, 2008. COSEWIC assessment and update status report on the polar bear Ursus maritimus in Canada. Committee On the Status of Endangered Wildlife In Canada. Ottawa. vi + 75 pp.

COSEWIC, 2002: COSEWIC assessment and update status report on the polar bear Ursus maritimus in Canada. Committee On the Status of Endangered Wildlife In Canada. Ottawa. vi + 29 pp.

Fischbach, A.S., S.C. Amstrup and D.C. Douglas. 2007. Landward and eastward shift of Alaskan polar bear denning associated with recent ice changes. Polar Biology 30: 1395-1405

Harington, C. R. 1968. Denning habits of the polar bear (Ursus maritimus Phipps) Report Series 5. Canadian Wildlife Service, Ottawa.

Hunter, C.M., H. Caswell, M.C. Runge, E.V. Regehr, S.C. Amstrup and I. Stirling. 2007. Polar bears in the southern Beaufort Sea II: demography and population growth in relation to sea ice conditions. US Dept. of the Interior, US Geological Survey Administrative Report. 46 pp.

Messier, F., M. K. Taylor, and M. A. Ramsay. 1994. Denning ecology of polar bears in the Canadian Arctic Archipelago. Journal of Mammalogy 75: 420-430

Monnett, C. and J.S. Gleason. 2006. Observations of mortality associated with extended open-water swimming by polar bears in the Alaskan Beaufort Sea. Polar Biology 29: 681-687

Regehr, E.V., C.M. Hunter, H. Caswell, S.C. Amstrup and I. Stirling. 2007. Polar bears in the southern Beaufort Sea I: survival and breeding in relation to sea ice conditions, 2001-2006. US Dept. of the Interior, US Geological Survey Administrative Report. 45 pp.

Rode, K.D., S.C. Amstrup and E.V. Regehr. 2007. Polar bears in the southern Beaufort Sea III: stature, mass and cub recruitment in relationship to time and sea ice extent between 1982 and 2006. US Dept. of the Interior, US Geological Survey Administrative Rport. 28 pp.

Schliebe S, R.D. Rode, J.S. Gleason, J. Wilder, K. ProYtt, T.J. Evans, and S. Miller. 2008. Effects of sea ice extent and food availability on spatial and temporal distribution of polar bears during the fall open-water period in the southern Beaufort Sea. Polar Biol 31: 999–1010

Smith, M. and B. Rigby, 1981: Distribution of polynyas in the Canadian Arctic. pp. 7-28 in I. Stirling and H. Cleator (eds.) Polynyas in the Canadian Arctic. Canadian Wildlife Service. Occasional Paper No. 45.

Smith, T.G. 1980. Polar bear predation of ringed and bearded seals in the land-fast sea ice habitat. Can. J. Zool. 58: 2201-2209

Stirling, I. 2002. Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: a synthesis of population trends and ecological relationships over three decades. Arctic 55, Supp. 1: 59-76

Stirling, I. 1990. Polar bears and oil: ecologic perspectives. In Sea mammals and oil: confronting the risks. Edited by J.R. Geraci and D.J. St. Aubin. Academic Press, San Diego. pp. 223–234

Stirling, I., 1988: Polar Bears. The University of Michigan Press, Ann Arbor.

Stirling, I., 1980: The biological importance of polynyas in the Canadian Arctic. Arctic 33: 303-315

Stirling, I., E. Richardson, G.W. Thiemann and A.E. Derocher. 2008. Unusual predation attempts of polar bears on ringed seals in the southern Beaufort Sea: possible significance of changing spring ice conditions. Arctic 61: 14-22

Stirling, I. and D. Andriashek, 1992: Terrestrial maternity denning of polar bears in the eastern Beaufort Sea area. Arctic 45: 363-366.

Stirling, I., and A.E. Derocher, 1993: Possible impacts of climatic warming on polar bears. Arctic 46: 240-245.

Stirling, I. and N.A. Øritsland, 1995: Relationships between estimates of ringed seal and polar bear populations in the Canadian Arctic. Canadian Journal of Fisheries and Aquatic Sciences 52: 2594-2612.

Stirling, I., D. Andriashek and W. Calvert. 1993. Habitat preferences of polar bears in the western Canadian Arctic in late winter and spring. Polar Record 29: 13-24

Bowhead Whale

Key habitat

During June to September, bowhead whale summer distribution is primarily in the eastern Beaufort Sea where they form large loose aggregations offshore from approximately mid-August to late September (Hardwood and Smith 2002; Harwood et al. 2008). The aggregations form in traditional areas where oceanographic conditions favour the concentration of crustaceous zooplankton, their main prey item (Thomson et al. 1986). Key habitat areas include the Tuktoyaktuk Peninsula, the Amundsen Gulf, and the south and west coastal areas of Banks Island (COSEWIC 2005). Habitat requirements of bowhead whales in summer grounds largely depend on the distribution of main prey resources which can vary from year to year depending on temperature, salinity, light intensity and nutrient availability (Mackas et al. 1985). Whales can be found in deep (>200m) or shallow (<50m) waters depending on the summer month and the availability of food (Griffiths and Buchanan 1982, Richardson et al. 1985, Mate et al. 2000). The older, mature bowheads (including cows and calves) tend to be found in the further offshore feeding areas (e.g., off the Tuktoyaktuk Peninsula), whereas the sub adults tend to occur in feeding areas closer to shore (e.g., off the Yukon coast)(L. Harwood, pers. comm.).

Banks Island Coast and Amundsen Gulf

Banks Island Coast and Amundsen Gulf are the first summer areas bowhead reach after migrating through offshore routes of the Beaufort Sea (Fraker and Bockstoce 1980, COSEWIC 2005). Bowheads can reach the coastal waters of Bank Island and Amundsen Gulf as early as May (Branham et al. 1980). Although bowhead are more frequently seen in May near the Banks Island coast (Hazard and Cubbage 1982).

Bowheads are often seen in the Amundsen Gulf along King's Bay in late July and early August (Hazard and Cubbage 1982). The western half of Amundsen Gulf are important summer grounds during July, where bowhead take advantage of early ice break up in these areas and forage in deep waters (>200 m) (COSEWIC 2005).

Tuktoyaktuk Peninsula

Areas north of the Tuktoyaktuk Peninsula are important summer areas in late August and September (Hardwood and Borstad 1986, Richardson et al. 1987, Dickens et al. 1987) where whales have been observed feeding off the shore of the Peninsula (Würsig et al. 1989).

The Kugmallit Canyon, and Tuktoyaktuk Peninsula inner and outer shelves are considered sensitive habitat areas for bowhead whale in the southeastern Beaufort Sea.

Mackenzie River Plume

The influence of freshwater into the Beaufort Sea creates nutrient rich environmental conditions ideal for foraging bowhead whales. Areas off King Point, Shingle Point, Mackenzie Bay and Herschel Island have all been identified as important bowhead whale habitat (WMAC 2000a, WMAC 2000b, WMAC 2000c, Dickens et al. 1987).

Bowhead use areas around the Mackenzie Delta in late summer . Distribution in the Mackenzie Delta can vary from year to year where in some years whales stick to shallow ice-free waters and in other years they are found offshore either in or near ice (Richardson et al. 1987).

In late August and September bowhead congregate around the Mackenzie River plume, where turbid, brackish water from active surface circulation and upwellings likely create nutrient rich environments for invertebrate prey species (Hardwood and Borstad 1986, Würsig et al. 1989).

Between August and October bowheads have been seen near Herschel Bay as they slowly make their fall migration back to the Bering Sea (Hardwood and Borstad 1986, Richardson et al. 1987).

Herschel Island, Komakuk area, Mackenzie Canyon and the shelf break north of Herschel Island are all ranked sensitive for bowhead whale.

Rationale for Selection

Historically, the bowhead whale was a very important resource to the Inuit, aiding in survival by providing a year's worth of food, oil and building material for an entire camp from a single whale (NWMB 2000). Archaeological records indicate that bowhead whales have been hunted in the Canadian Arctic since 1100 A.D. (Freeman et al. 1998). In the NWT, the Inuvialuit Settlement Region is currently allowed to harvest one bowhead whale annually. Current hunting of bowhead whales by Inuit is more of a cultural and traditional importance rather than a food source. The bowhead whale hunt is viewed as a vital element to Inuit culture and the passage of traditional knowledge (NWMB 2000).

Other reasons for its selection include the importance of the Beaufort Sea to the bowhead whale's life history. Federally, the Bering-Chukchi-Beaufort bowhead whale population is listed as Special Concern in Canada (COSEWIC 2005) and lower risk/conservation-dependent by the World Conservation Union (IUCN). Due to commercial hunting pressures in the past, the bowhead whale was almost hunted to extinction (COSEWIC 2005). The Bering-Chukchi-Beaufort population has recovered from these detrimental levels but continued monitoring of the species is needed. Additionally, bowhead whales are an important component to the ecological functions in the Arctic seas both as predator and prey. Bowhead whale appear to be closely tied to the distribution of their prey (Würsig et al. 1989, Treacy et al. 2006) and could be a good indicator of ecological changes in the Beaufort Sea dynamics.

Sustainability

The Bering-Chukchi-Beaufort population had almost been hunted to extinction in the mid-19th century due to commercial whaling pressures. This population is not yet secure and currently is at about 50% of its historical population size and has increase 3.4% from 1978-2001 (George et al. 2004, COSEWIC 2005). The most recent documented population estimate is 10,740 (George et al. 2004). Regulation of commercial whaling is an important component in the sustainability of bowhead whales. Due to the late age of sexual maturity and low fecundity of this species, removal of individuals in the population can have significant effects on the population (COSEWIC 2005).

Historical sightings of bowhead whale in the Beaufort Sea indicate the importance of this area for spring, summer and fall migration periods. Predation, offshore human activity and climatic pressures that influence ice conditions all have the potential to affect the survival and distribution of the bowhead whale in the Beaufort Sea (COSEWIC 2005). Conservation of high use feeding areas within the Beaufort Sea is an important component in sustaining viable populations of this species as the distribution of bowhead whale appears to be closely linked to vertical and horizontal distribution of prey (Würsig et al. 1989).

Susceptibility to development

Potential implications of industrial development on bowhead whales in the Beaufort Sea include:

- industrial activities may reduce the quality and amount of suitable habitat available to bowhead whales, especially for feeding
- industrial activities may increase the risk of mortality to individual bowhead whales in proximity to developments
- industrial activities may cause disruption of migration patterns and behavior making whales more susceptible to other environmental pressures such as predation and climatic change

Habitat Susceptibility

Due to the occurrence of bowhead whale in the Beaufort Sea from spring to fall, they are susceptible to habitat impacts from industrial activities throughout most of the year in the Beaufort Sea. Residual effects from industrial activity may result in either complete loss of habitat, as is common with the 'footprint' of industrial developments, or effective habitat loss, whereby bowhead whales avoid habitat in proximity to development.

Development activities to which bowhead whales may be susceptible include:

- industrial pollution and miscellaneous spills
- noise due to seismic activities and vessel movement
- injuries due to marine vessel collisions
- island building or temporary drilling platforms

Industrial pollution and miscellaneous spills that are discharged have the potential to result in either complete or effective habitat loss. Bowhead whale habitats most susceptible to these releases are the shallow waters in the Mackenzie Delta and Amundsen Gulf. The population impacts that may result from an oil spill would depend largely on the season, amount and type of contaminants released, climatic factors and response initiated. An oil spill within the shallow waters and river estuaries identified as important bowhead whale habitat would be the most sensitive and could produce major site-specific impacts. Areas around the Mackenzie River plume would be vulnerable due to the large number of whales that congregate in the area in late summer. An oil spill further offshore within the feeding, movement and migratory areas and corridors may produce fewer impacts because they can navigate around the spill in these greater water depths. Contact with spilled oil may directly affect the availability of invertebrate food and therefore the health and migratory behavior of whales.

Man-made noise pollution in the Beaufort Sea may have detrimental effects on this species. Bowhead whale are sensitive to human noise created by drilling, marine construction, seismic exploration, and ships causing changes in normal behavioral patterns and in some cases avoidance of areas with activity (Richardson et al. 1986, 1990, 1995, Davies 1997). Presence of drilling rigs can create a significant temporary loss of available habitat (Schick and Urban 2000). Long-term effects of noise pollution on bowhead whales in the Beaufort Sea are unknown; although it is considered a high threat to bowheads in the eastern arctic (Moshenko et al. 2003).

Mortality Susceptibility

In addition to noise generation, marine vessels have the potential to collide with bowhead whales resulting in severe injuries. Collision with vessels can create large lacerations (George et al. 1994), which can affect the health of an individual whale directly and indirectly through alterations to feeding and other survival behavior. George et al. (1994) found that vessel-inflicted injuries where low at approximately 1% in the Bering-Chukchi-Beaufort Sea stock. This could be correlated to the low rate of vessels in the area (George et al. 2004); however, similar to right whales, it may also be due low survival rates of those whales that have collided with vessels (Kraus 1990).

Mitigation

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

High quality foraging areas are key areas that are important to the viability of the species, and therefore impacts here should be mitigated and/or avoided where possible. These areas include Mackenzie Bay and the Tuktoyaktuk Peninsula. Should development be initiated in such areas, timing should attempt to coincide with periods when bowheads are not present (from September to April).

In areas of bowhead spring and fall migration, marine vessel movement activities within these areas should be limited to levels to which the population-level impacts are not apparent.

On-ice activities are generally unlikely to produce residual effects beyond the frozen water season, and may be a preferable option to open water activities, especially if accidents and hazards are controlled.

Climate Change

Global circulation models predict substantial decreases in both thickness and coverage of arctic sea ice due to increased atmospheric CO_2. Present climate models are insufficient to predict regional ice dynamics, winds, mesoscale features, and mechanisms of nutrient resupply, which must be known to predict productivity and trophic response (Tynan and DeMaster 1997). However, we can speculate on the potential impacts of observed trends in Arctic climate on wildlife. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and the abundance and structure of some species. For bowhead whale, like most cetaceans, decreases in ice extent will be more of an indirect effect than actual loss of habitat (Tynan and DeMaster 1997). One of these indirect effects include the potential change in abundance and distribution of marine invertebrates the bowhead whales food source.

Ice algae are an important component in the Arctic environment being the primary source in the food chain (Alexander 1995). Formed at the ice-seawater boundary, this ice algae forms on the underside of the ice and becomes part of the water column during spring melt. The presence of this new food source in the water column in spring creates a bloom of phytoplankton, where copedpods (the primary prey of bowhead whales) thrive (Drolet et al. 1991, Tynan and DeMaster 1997). Therefore, ice edge habitat is a very important component to bowhead whales. Change in the timing or loss of this spring food source could result in a shift of behavior, migration patterns, distribution and survival of bowhead whales (COSEWIC 2005).

Sensitivity layers and scores

From April to June the majority of this population migrates towards summer areas in the eastern Beaufort Sea, following ice leads and open water areas that develop as a result of spring ice break up. Bowhead whale summer distribution is primarily in the eastern Beaufort Sea where they form large loose aggregations offshore from approximately mid-August to late September. Data sets on bowhead distribution from 1980-1986 and from more recent surveys in 2007-2008 have been used to derive this sensitivity map (Harwood, pers. comm.). Observed bowhead densities have been calculated for 20 km x 20 km grid cells, and grid cells with >5 bowheads/100 km2 have been designated as aggregation areas according to DFO's present working definition (Harwood et al. 2008).

The number of times that bowheads aggregated in a given grid cell have been tallied over the available survey years, with the frequency of aggregations being used to designate a sensitivity of 3, 4 or 5. The rating system below was based on the period that bowhead whales are present and use the areas for feeding as well as for movement and migration. Potential residual effects from development would be most detrimental to the viability of the population in congregation areas and areas where upwelling provides quality foraging habitat for theses activities. Thus, higher risk categories are associated with these important habitats.

Summer/fall (May-October) Sensitivity

Low sensitivity (1):

All non-aggregation areas shallower than 2 m, as bowheads cannot access such depths given their body size.

Low/Moderate Sensitivity (2):

All non-aggregation areas deeper than 2 m, i.e., those areas that have limited use as movement/migration corridors and/or foraging areas

Moderate Sensitivity (3):

Areas around the Mackenzie Delta in late summer. Distribution in the Mackenzie Delta can vary from year to year where in some years whales stick to shallow ice-free waters and in other years they are found offshore either in or near ice

Moderate/High Sensitivity (4):

Western half of Amundsen Gulf are important summer grounds during July, and areas off King Point, Shingle Point, Mackenzie Bay and Herschel Island have all been identified as important bowhead whale habitat.

High Sensitivity (5):

Areas north of the Tuktoyaktuk Peninsula are important summer areas in late August and September

Summary

The bowhead whale was largely selected as a VEC due to it is of cultural importance and traditional use to Inuit hunters. They are an important component to the ecological functions in the arctic sea, and are closely tied to invertebrate prey distributions making them a potentially good indicator of ecological changes in the Beaufort Sea dynamics.

Bowhead whales are present in the study area from spring to fall, with summer distribution primarily in the eastern Beaufort Sea. Key habitat areas include the west coastal areas of Banks Island, the Amundsen Gulf, the Tuktoyaktuk Peninsula, and the Mackenzie River Delta (COSEWIC 2005). Feeding is the predominant activity of bowhead whales in the Beaufort Sea. The bowhead whale's migration route in the Beaufort Sea follows leads in the ice where open water areas develop as a result of spring ice break up. Therefore, climatic changes have the potential to effect migration patterns, food abundance and survival of bowhead whales in the Beaufort Sea.

Potential impacts from industrial activity include pollution, miscellaneous spills, man-made noise impacts, and marine vessel collisions. Industrial activities occur during the winter season (i.e., in frozen water periods throughout much of the study area) are unlikely to result in direct impacts to bowhead whales as they winter in the Bering Sea. Industrial development during spring, summer and fall have the potential to impact bowhead whales depending on the location of these activities in the Beaufort Sea.

References

Alexander, V. 1995. The influence of the structure and function of the marine food web on the dynamics of contaminants in Arctic Ocean ecosystems. The Science of the Total Environment 160/161:593-603.

Bogoslovskaya, L.S., L.M. Votrogov, and I.I. Krupnik. 1982. The bowhead whale off Chukotka: migrations and aboriginal whaling. Report of the International Whaling Commission 32:391-399.

Braham, H.W., M.A. Fraker, and B.D. Krogman. 1980. Spring migration of the western Arctic population of bowhead whales. Marine Fisheries Review 42(9-10):36-46.

Braham, H.W., Krogman, B.D., and Carroll, G.M. 1984. Bowhead and white whale migration, distribution, and abundance in the Bering, Chukchi, and Beaufort seas, 1975–78. NOAA Tech. Rep. NMFS SSRF-778.

Carroll, G.M., J.C. George, L. F. Lowry, and K.O. Coyle. 1987. Bowhead whale (*Balaena mysticetus*) feeding activities near Point Barrow, Alaska, during the 1985 spring migration. Arctic 40:105-110

COSEWIC 2005. COSEWIC assessment and update status report on the bowhead whale *Balaena mysticetus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 51 pp.

Davies, J.R. 1997. The impact of an offshore drilling platform on the fall migration path of bowhead whales: a GIS-based assessment. Master's thesis, Western Washington University, Bellingham, Wash.

Dickins, D., L. Martin, I. Bjerkelund, S. Potter, D. Erickson, J. Harper, P. Norton, S. Johnson and P. Vonk. 1987. Environmental atlas for Beaufort Sea oil spill response. Prep. for Environment Canada Environmental Protection Service, Yellowknife, NWT and Whitehorse, Yukon. 182 pp + appendices

Dorsey, E.M., Richardson, W.J., and Würsig, B. 1989. Factors affecting surfacing, respiration, and dive behaviour of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea. Can. J. Zool. **67**: 1801–1815

Drolet, R., L. Fortier, D. Ponton, and M. Gilbert. 1991. Production of fish larvae and their prey in subarctic southeastern Hudson Bay. Marine Ecology Progress Series 77:105-118.

Finley, K.J. 1990. Isabella Bay, Baffin Island: An important historical and present-day concentration area for the endangered bowhead whale (*Balaena mysticetus*) of the eastern Canadian Arctic. Arctic 43(2): 137-152.

Fraker, M.A. and J.R. Bockstoce. 1980.

Summer distribution of bowhead whales in the eastern Beaufort Sea. Marine Fisheries Review 42(9-10): 57-64.

Freeman, M.M.R., L. Bogoslovskayas, R.A. Caulfield, I. Egede, I.I. Krupnik, and M.G. Stevenson. 1998. Inuit, Whaling, and Sustainability. AltaMira Press, A Division of Sage Publications, Inc, Walnut Creek, CA.

George, J.C., L.M. Philo, K. Hazard, D. Withrow, G.M. Carroll, and R.S. Suydam. 1994. Frequency of killer whale (*Orcinus orca*) attacks and ship collisions based on scarring on bowhead whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort Seas stock. Arctic 47(3):247-255.

George, J.C., Zeh, J., Suydam, R., and Clark, C. 2004. Abundance and population trend (1978-2001) of western Arctic bowhead whales surveyed near Barrow, Alaska. Marine Mammal Science 20:755-773.

Griffiths, W. B. and R.A. Buchanan. 1982. Characteristics of bowhead feeding areas. P 347-455 In: W.J. Richardson (ed.), Behaviour, distribution responses and feeding of bowhead whales *Balaena mysticetus* in the Beaufort Sea, 1980-81. Unpubl. Rep. By LGL Ecological Research Associates, Inc., Bryan, TX, for U.S. Bureau of Land Management, Washington. 456 p.

Harwood, L.A. and T.G Smith, 2002: Whales of the Inuvialuit Settlement Region in Canada's Western Arctic: An Overview and Outlook. Arctic. Vol. 55, Supp. 1 (2002) pp.77-93.

Harwood, L. A., A. Joynt, and S. Moore. 2008. Bowhead whale feeding aggregations in the Canadian Beaufort Sea and their role in the mitigation of effects of seismic underwater noise. Working Paper presented at the Review of Scientific Information on the Impacts of Seismic Sound on Fish, Invertebrates, and Marine Mammals, Workshop II, March 26-28, 2008, Ottawa, Ontario.

Hazard, K.W., and J.C. Cubbage. 1982. Bowhead whale distribution in the southeastern Beaufort Sea and Amundsen Gulf, summer 1979. Arctic 35: 519-523.

Koski, W.R., R.A. Davis, G.W. Miller, and D.E. Withrow. 1993. Reproduction. Pages 239-274 *in* J.J. Burns, J.J. Montague and C. J. Cowles, eds. The bowhead whale. Special Publication No. 2. Society for Marine Mammalogy, Lawrence, KS.

Lowry, L.F. 1993. Foods and feeding ecology. Pages 201-238 *in* J.J. Burns, J.J. Montague and C.J. Cowles, eds. The bowhead whale. Special Publication No. 2. Society for Marine Mammalogy, Lawrence, KS.

Mackas, D.L., K.L. Deman and M.R. Abbott. 1985. Plankton patchiness: biology in the physical vernacular. Bulletin of Marine Science 37(2):652-674.

Mate, B.R., G.K Krutzikowsky, and M.H. Winsor. 2000. Satellite-monitored movement of radio-tagged bowhead whales in the Beaufort and Chuckchi seas during the late-summer feeding season and fall migration. Can. J. Zool. 78: 1168-1181.

Moore, S.E., J.T. Clarke, and D.K. Ljunglbad. 1989. Bowhead whale (*Balaena mysticetus*) spatial and temporal distribution in the central Beaufort Sea during late summer and early fall 1979-86. Report of the International Whaling Commission 39:283-290.

Moshenko, R.W., S.E. Cosens and T.A. Thomas. 2003. Conservation Strategy for Bowhead Whales (*Balaena mysticetus*) in the Eastern Canadian Arctic. National Recovery Plan No. 24. Recovery of Nationally Endangered Wildlife (RENEW). Ottawa, Ontario. 51 pp.

Nunavut Wildlife Management Board (NWMB). 2000. Final report of the Inuit bowhead knowledge study. Nunavut, Canada

Richardson, W.J. and C.R. Greene. 1995. Marine Mammals and Noise. San Diego, CA: Academic Press.

Richardson, W.J., B. Würsig, and C.R. Greene Jr. 1990. Reactions of bowhead whales, *Balaena mysticetus*, to drilling and dredging noises in the Canadian Beaufort Sea. Mar. Environ. Res. 29: 135–160

Richardson, W.J., R.A. Davis, C.R. Evans, D.K. Ljungblad and P. Norton. 1987. Summer distribution of bowhead whales, *Balaena mysticetus*, relative to oil industry activities in the Canadian Beaufort Sea, 1980-84. Arctic 40: 93-104

Richardson, W.J., Fraker, M.A., Würsig, B., and Wells, R.S. 1985. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: reactions to industrial activities. Biol. Conserv. 32: 195–230

Richardson, W.J., Würsig, B., and Greene, C.R., Jr. 1986. Reactions of bowhead whales, *Balaena mysticetus*, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am. 79: 1117–1128

Richardson, W.J., Finley, K.J., Miller, G.W., Davis, R.A., and Koski, W.R. 1995. Feeding, social and migration behavior of bowhead whales, *Balaena mysticetus*, in Baffin Bay vs. the Beaufort Sea—regions with different amounts of human activity. Mar. Mamm. Sci. 11: 1–45

Schell, D.M., S.M. Saupe, and N. Haubenstock. 1987. Bowhead whale feeding: allocation of regional habitat importance based on stable isotope abundances. In W.J. Richardson (Ed.), Importance of the eastern Alaskan Beaufort Sea to feeding bowhead whales 1985-86, p. 369-415. Rep. to U.S. Minerals Manage. Serv. By LGL Ecol. Res. Assoc. Inc., NTIS No. PB88-150271.

Schick, R.S. and D.L. Urban. 2000. Spatial components of bowhead whale (*Balaena mysticetus*) distribution in the Alaskan Beaufort Sea. Can. J. Fish. Aquat. Sci. 57: 2193-2200.

Treacy, S.D., J.S. Gleason, and C.J. Cowles. 2006. Offshore distances of bowhead whales (*Balaena mysticetus*) observed during fall in the Beaufort Sea, 1982-2000: An alternative interpretation. Arctic 59(1): 83-90.

Wursig, B., E.M. Dorsey, W.J. Richardson and R.S. Wells. 1989. Feeding, aerial and play behaviour of the bowhead whale, *Balaena mysticetus*, summering in the Beaufort Sea. Aquatic Mammals 15: 27-37

Wursig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne and W.J. Richardson. 1985. Behaviour of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: a description. Fishery Bulletin 83: 357-377

Beluga Whale

Key habitat

The Eastern Beaufort Sea beluga population winters in the Bering Strait and migrates eastward through the Alaskan Beaufort Sea during April and May, arriving off the west coast of Banks Island in late May and early June (Moore et al. 1993). Offshore leads are important during this portion of their spring migration (Barber et al. 2001, Richard et al. 2001, Harwood and Smith 2002). Depending on ice conditions, they may first appear near Herschel Island in late April or early May, and come to the shallow waters of the Mackenzie Delta in June to early July. They then move in a southwestward direction along the landfast ice edge off the Tuktoyaktuk Peninsula and into Kugmallit Bay, East and West Mackenzie Bays, Shallow Bay and the Kendall Island area where they aggregate for much of July (Harwood and Smith 2002). These areas are presumed to be of considerable importance to beluga because they return to these areas each summer despite significant hunting pressures (North/South Consultants Inc. 2003). This area, which encompasses approximately 1800 km^2 , comprise the only known traditional summer concentration areas for the Beaufort Sea beluga stock. These areas are recognized as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans (CCP) as 711E, 714E and 716E – Beluga Management Zone 1A (WMAC 2000a,b,c). Category E comprises lands and water where cultural or renewable resources are of extreme significance and sensitivity. The CCPs recommend the highest degree of protection of category E lands and there shall be no development in these areas (WMAC 2000a,b,c). The shallow waters, bays and river estuaries of the Beaufort Sea described above are recognized as special designated lands in the Aklavik, Inuvik and Tuktoyaktuk Community Conservation Plans as 712C – Beluga Management Zone 2 (WMAC 2000 a,b,c). Zone 2 extends from Kay Point on the Yukon coast to Baillie Islands (Cape Bathurst) in the east, and includes waters shallower than 20 m. Category C comprises lands and waters where cultural or renewable resources are of particular significance and sensitivity during specific times of the year.

The reasons why belugas come into estuaries were not well understood until recently. Earlier theories included a thermal advantage for calves and food availability. More recently, it has been shown that occupation of these warm, less saline waters is related to their annual moult and is connected with significant hormonal changes correlated with new skin growth (Harwood and Smith 2002). Belugas use these areas for moulting, calving and feeding. Feeding is not always observed and empty stomachs in belugas landed in the subsistence hunt are common. Mother-calf pairs are believed to spend longer periods in shallow water than other age or gender classes. Belugas in these traditional summer concentration areas are harvested by Inuvialuit from Aklavik, Inuvik and Tuktoyaktuk.

Belugas also aggregate offshore in the Beaufort Sea, Amundsen Gulf and Viscount Melville Sound where it is presumed they engage in feeding activities prior to the fall migration (Harwood and Smith 2002; Barber et al. 2001, Richard et al. 2001, DFO 2000). Belugas from the Mackenzie Estuary use deep offshore areas on their way to M'Clure Strait rather than using the shallower waters near Banks Island

(Barber et al. 2001). In late August, the return migration consists of a variety of routes, varying from 100 to 400 km offshore of northern Alaska (Harwood and Smith 2002). During their migration to the wintering areas in the autumn, belugas feed heavily on schools of Arctic cod. This appears to be a very important time of the year for the accumulation of a thick layer of blubber, which acts both as insulation and a large reserve of energy. Few whales remain in the area past early September.

Rationale for Selection

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

Sustainability

The Eastern Beaufort population of beluga is considered Not At Risk (COSEWIC 2004).

Conserving habitat is fundamental to the viability of the Eastern Beaufort Sea beluga whale population. Belugas occurred most often in the Mackenzie Estuary and within a deep trench in M'Clure Strait and Viscount Melville Sound during the summer. In the fall, the whales occurred in the Mackenzie Estuary and Amundsen Gulf and north along the Yukon Coast (Barber et al. 2001). Presently, approximately 1716 km2 of shallow waters, including Mackenzie Bay at 1160 km2, the Kendall Island area at 193 km2, and Kugmallit Bay at 363 km2 has been identified as important beluga habitat.

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

Susceptibility to development

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

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

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

Habitat Susceptibility

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

Development activities to which beluga may be susceptible include:

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

Explanations for belugas abandoning these areas include:

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

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

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

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

Seasonality of Development Impacts

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

Population vs. Individual Level Impacts

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

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

Mitigation

There is a variety of potential project types that vary in spatial extent, duration, and intensity (e.g., ice-platform based drilling, ice road construction, seismic, shipping and other marine vessel transport), with a corresponding range in magnitude of impacts that may occur in the project area. Based on the summary of project specific residual effects, the seasonality of beluga whale movements, and the criteria used to define the grid rating, there are several strategies that can be applied to project-specific mitigation planning:

- An oil spill response plan should be developed for areas within the shallow waters and river estuaries identified as critical beluga habitat.
- In open water periods when aggregated belugas are feeding in shallow offshore waters, marine vessel movement activities within these areas should be limited to levels to which the population-level impacts are not apparent.
- Specific sites of summer aggregation to moult, feed, calve, socialize, rest and avoid predators are key areas that are important to the viability of the species, and therefore, impacts here should be mitigated and/or avoided where possible. These areas include the Kendall Island area, Kugmallit Bay, Mackenzie Bay and Estuary and within a deep trench in M'Clure Strait and Viscount Melville Sound. Should development be initiated in such areas, timing should attempt to coincide with periods when belugas are not present (from September to April).
- On-ice activities are generally unlikely to produce residual effects beyond the frozen water season, and may be a preferable option to open water activities, especially if accidents and hazards are controlled.

Climate Change

Global circulation models predict substantial decreases in both thickness and coverage of arctic sea ice due to increased atmospheric CO2. Present climate models are insufficient to predict regional ice dynamics, winds, mesoscale features, and mechanisms of nutrient resupply, which must be known to predict productivity and trophic response (Tynan and DeMaster 1997). However, we can speculate on the potential impacts of observed trends in Arctic climate on wildlife. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and the abundance and structure of some species. For cetaceans, the potential detrimental effects of decrease ice extent is more indirect than the loss of ice habitat (Tynan and DeMaster 1997). In the case of the beluga whale, this indirect effect is the potential loss of its predominant prey, the arctic cod (Boreogadus saida) which is intimately associated with ice-edge habitats (Bradstreet 1982). The arctic cod is dependent on the secondary production in these habitats with the latter being sustained by ice algae. Ice algae forms a thin, dense layer on the underside of ice at the ice-seawater interface and is well recognized as very important in the food web of marine mammals in the high Arctic (Bradstreet 1982, Tynan and DeMaster 1997).

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

Sensitivity layers and scores

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

Low Sensitivity (1)

Beyond the summer extent of pack ice, using the approximate summer extent of pack ice (defined in Stirling 2002).

Low/Moderate Sensitivity (2)

Area from the limit of summer pack ice to 400 km out from the shoreline (i.e., area south from the limit of summer pack ice to the area north of 400 km out from shore).

Moderate Sensitivity (3)

Polygon includes the area from the shoreline extending out to 400 km offshore. This area is considered seasonal migratory route habitat.

Moderate/High Sensitivity (4)

Polygons includes the area identified as critical summer mating and moulting habitat. The total of these areas include the area designated as Risk Layer 5, therefore the areas that are overlapped carry the higher designated Risk Layer.

High Sensitivity (5)

Proposed Protected Areas; polygons include the area that is being considered for status as a Protected Area.

Summary

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

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

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

References

COSEWIC, 2004: Assessment and Update Status Report on the Beluga Whale *Delphinapterus leucas* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 70 pp.

Department of Fisheries and Oceans Canada (DFO), 2000: Eastern Beaufort Sea Beluga. DFO Science Stock Status Report E5-38 (2000)

Devon Canada Corporation, 2004: Comprehensive Study Report Devon Beaufort Sea Exploration Drilling Program. Submitted to National Energy Board. URL: http://www.devonenergy.com/operations, last accessed February 9, 2007.

Erbe, C. and D.M. Farmer. 2000. Zones of Impact around Icebreakers Affecting Beluga Whales in the

Beaufort Sea. J. Acoust. Soc. Amer.1083:1332-1340

Fast, H., J. Mathias and F. Storace, 1998: Marine Conservation and Beluga Management in the Inuvialuit Settlement Region. Prepared for the Fisheries Joint Management Committee, Inuvialuit Settlement Region.

Harwood, L.A. and T.G Smith, 2002: Whales of the Inuvialuit Settlement Region in Canada's Western Arctic: An Overview and Outlook. Arctic. Vol. 55, Supp. 1 (2002) pp.77-93.

Harwood, L.A., S. Innes, P. Norton and M.C.S. Kingsley, 1996: Distribution and abundance of beluga whales in the Mackenzie Estuary, southeast Beaufort Sea, and west Amundsen Gulf during late July 1992. Canadian Journal of Fisheries and Aquatic Sciences 53:2262 – 2273.

Moore, S.E., J.T. Clarke and M.M. Johnson, 1993: Beluga distribution and movements offshore northern Alaska in spring and summer, 1980 – 1984. Report of the International Whaling Commission 43:375 – 386.

North/South Consultants Inc., 2003: Ecological Assessment of the Beaufort Sea Beluga Management Plan – Zone 1(a) as a Marine Protected Area. Prepared for the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) Working Group.

Pippard, L., 1983: Status of the St. Lawrence River Population of Beluga, Delphinapterus leucas. Canadian Field-Naturalist. 99:438-450.

Tynan, C.T. and D.P. DeMaster. 1997. Observations and predictions of Arctic climate change: potential effects on marine mammals. Arctic 50: 308-322

Wildlife Management Advisory Council (WMAC), 2000a: Aklavik Inuvialuit Community Conservation Plan. 166 pp.

Wildlife Management Advisory Council (WMAC), 2000b: Inuvik Inuvialuit Community Conservation Plan. 160 pp.

Wildlife Management Advisory Council (WMAC), 2000c: Tuktoyaktuk Inuvialuit Community Conservation Plan. 168 pp.

Ringed Seal

Key habitat

Preferred ringed seal habitat consists of flaw leads, pressure ridges and polynyas in the land-fast ice of the Arctic Ocean. Offshore pack ice is used irregularly. Very deep water areas appear less used than shallower depths (i.e., less than 100 m), but ringed seals are found throughout the Beaufort Sea (Stirling 1982). Ringed seals have a varied diet composed primarily of larger shrimp-like crustaceans, small fish and zooplankton. These food sources occur in open ocean areas, and in greater concentrations in areas where upwelling of currents or nutrient inputs occur. In late summer, prior to freeze up, the importance of foraging is heightened, as seals build up fat reserves for the winter.

Seasonally, there are some evident patterns that are associated with breeding, birthing, and summer feeding activities. During much of the winter, and until break up in June, adult seals maintain established territories around breeding areas and are generally solitary. Adult ringed seals maintain lairs and breathing holes beneath the snow throughout the winter (Smith and Stirling 1975), and females give birth in mid-March to mid-April in birthing lairs.

Prior to ice break-up in late June, ringed seals are distributed throughout the southern Beaufort Sea and can be easily observed hauling out on the ice to moult. Seals appear to prefer areas where water is 75 to 100 m deep for haul out locations (Stirling et al. 1982). Seals may aggregate in groups of up to 21 members in areas where greater food abundance is located during late summer (L. Harwood, pers. comm. 2007; Harwood and Stirling 1992). The location of aggregations within the Beaufort Sea varies between years, but such areas appear to be most common north of the Tuktoyaktuk Peninsula (Harwood and Stirling 1992). As freeze up commences in late autumn, adult seals move into coastal areas of stable, landfast ice and establish breeding territories. Although still solitary, seal concentrations may be higher along complex shorelines (such as those with fjords and islands), as compared to more simple coastal areas (Smith 1987). Also at this time, there is a general westward movement of adolescent and young of the year seal pups through the study area from the Amundsen Gulf to the

Chukchi Sea. This migration and segregation of age classes is thought to be in response to food availability and population pressures (GNWT 2007a).

Rationale for Selection

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

Sustainability

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

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

Susceptibility to development

Linkages to Development

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

Ice-Based Activities

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

Open Water Activities

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

Hydrocarbon Releases

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

Seasonality of Development Impacts

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

Population vs. Individual Impacts

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

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

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

Mitigation

Potential effects of large scale industrial development include displacement of seals from their habitats, increased mortality and decreased reproductive success. Ringed seal pups may be displaced from shore-fast ice by noise and there was a higher rate of abandonment of breathing holes near seismic survey areas (Frost and Lowry 1988, Kelly et al. 1988). It is recommended that the proposed activities occur during the open-water season after seals have pupped and moulted, fast ice has melted away, and flowing ice has retreated north and away from the project area.

Richardson (1995) found that vessel noise does not seem to strongly affect pinnipeds (seals, sea lions, fur seals, and walrus) that are already in the water. Seals on haulouts sometimes respond strongly to the presence of vessels and at other times appear to show considerable tolerance of vessels, and observed ringed seals hauled out on ice pans displaying short-term escape reactions when a ship approached within 0.4 - 0.8 km (Richardson, 1995). To reduce the likelihood of impacts to seals and other marine mammals, it is recommended that vessels will not operate within 0.5 mi (800 m) of haulouts and vessels reduce speed, avoid separating members from a group, and avoid multiple course changes. Therefore, impacts to seals and other marine mammals from vessel traffic associated with the proposed operations are expected to be minor.

The effects of offshore drilling on ringed seals in the Beaufort Sea were investigated in the past (Frost and Lowry, 1988; Moulton et al., 2003). Frost and Lowry (1988) found that local ringed seal populations were less dense within a 2-nautical mile buffer of manmade islands and offshore wells that were being constructed while Moulton et al. (2003) found less marked differences in ringed seal densities on the same locations after a period of habituation. Conceptually, it appears that ringed seals may be somewhat disturbed by drilling operations for a period of time, until the activity has been completed. Seals may avoid drilling operations, but because of the short duration of the proposed activities, the impacts are expected to be very brief and negligible.

Climate Change

Ringed seals mate, rear pups, moult, and rest on the sea ice surface. They require sufficient snow cover to construct lairs and the sea ice must be stable enough in the spring to successfully rear young. Changes in the extent, stability or the timing of breakup of the ice could reduce productivity (Smith and

Harwood 2001). Earlier ice break-up could result in premature separation of mothers and pups, leading to higher death rates among newborns.

Sensitivity layers and scores

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

Low Sensitivity (1):

This rating reflects areas that have very limited use or selection. Such areas do not contribute substantially to the viability of the species and these areas have little value for reproduction (denning) or survival (limited use for foraging). Such areas are generally identified as areas of multi-year pack ice.

Low/Moderate Sensitivity (2):

This rating reflects all areas of the Beaufort Sea, with the exception of multi-year pack ice, and areas classified as moderate or greater risk. These areas have low density, uniform use for foraging, and have moderate, but low-density use as denning areas.

Moderate Sensitivity (3):

These areas represent foraging areas that may result in aggregates of seals during late summer feeding periods. They are associated with oceanographic features and include the Mackenzie Canyon, Kugmallit Canyon, and areas of the coastal shelf (these areas are also typical areas of summer bowhead whale aggregation).

Moderate/High Sensitivity (4):

These areas represent extensively used near shore denning areas. There are no such areas existing in the study area, although some exist near Banks Island.

High Sensitivity (5):

Critical Habitat Areas, as defined by SARA; none exist in the study area.

Summary

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

References

CEAA (Canadian Environmental Assessment Agency), 2007: Voisey's Bay Mine and Mill Environmental Assessment Panel Report Section 11 Marine Mammals.

Frost, K.J., and L.F. Lowry, 1988: Effects of industrial activities on ringed seals in Alaska, as indicated by aerial surveys. *In* Port and ocean engineering under Arctic conditions. Vol. II. Symposium on noise and marine mammals. *Edited by* W.M. Sackinger, M.O. Jeffries, J.L. Imm, and S.D. Treacy. Geophysical Institute, University of Alaska Fairbanks, Fairbanks. pp. 15–25.

Government of the Northwest Territories (GNWT), 2007: Website Resource: Ringed Seals. Environment and Natural Resources, Wildlife Division.

Harris, R.E., G.W. Miller and W.J. Richardson, 2001: Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Mar. Mamm. Sci. 17(4): 795-812.

Harwood, L.A, 2007: Department of Fisheries and Oceans Canada. Personal Communication.

Harwood, L.A. and T.G Smith, 2002: Whales of the Inuvialuit Settlement Region in Canada's Western Arctic: An Overview and Outlook. Arctic. Vol. 55, Supp. 1 (2002) pp.77-93.

Harwood, L.A. and I. Stirling, 1992: Distribution of ringed seals in the southeastern Beaufort Sea during late summer. Canadian Journal of Zoology 70:891-900.

Kelly, B.P., J.J. Burns and L.T. Quakenbush, 1988: Responses of ringed seals *Phoca hispida* to noise disturbance, p. 27–38. In W.M. Sackinger, M.O. Jeffries, J.L. Imm and S.D. Treacy [eds.], Port and Ocean Engineering Under Arctic Conditions, Vol. II: Symposium on Noise and Marine Mammals. Geophysical Institute, University of Alaska Fairbanks.

Moulton, V.D., W.J. Richardson, M.T. Williams and S.B. Blackwell, 2003: Ringed seal densities and noise near and artificial island with construction and drilling. Acoustics Research Letters Online 4(4):112-117.

Richardson, W.J, 1995: Disturbance reactions pp. 241-324 In W.J. Richardson, C.R. Greene Jr., C.I. Malme and D.H. Thomson, eds. Marine Mammals and Noise. Academic Press, Inc.

Smith, T.G. and I. Stirling, 1975: The breeding habitat of the ringed seal (Phoca hispida). The birth lair and associated structures. Can. J. Zool. 53: 1297-1305.

Smith, T.G., M.O. Hammill and G. Taugbol. 1991. A review of the developmental, behavioural and physiological adaptations of the ringed seal, *Phoca hispida*, to life in the Arctic winter. Arctic 44: 124-131

Stirling, I., 2002: Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: a synthesis of population trends and ecological relationships over three decades. Arctic, Vol. 55: 59–76

Stirling, I. and T.G. Smith, 2004: Implications of warm temperatures and an unusual rain event for the survival of ringed seals on the coast of southeastern Baffin Island. Arctic 57:59-67.

Stirling, I. and N.A. Øritsland, 1995: Relationships between estimates of ringed seal and polar bear populations in the Canadian Arctic. Canadian Journal of Fisheries and Aquatic Sciences 52:2594-2612.

Stirling, I., R. Archibald and D. DeMaster, 1977: The distribution and abundance of seals in the Eastern Beaufort Sea. Journal of the Fisheries Research Board of Canada 34:976-988.

Stirling, I., M. Kingsley and W. Calvert 1982: The distribution and abundance of seals in the eastern Beaufort Sea. Canadian Wildlife Service, Environment Canada, Occasional Paper Number 47. Edmonton. 23 pp.

Zwanenburg, K.C.T., A. Bundy, P. Strain, W.D. Bowen, H. Breeze, S.E. Campana, C. Hannah, E. Head and D. Gordon, 2006: Implications of Ecosystem Dynamics for the Integrated Management of the Eastern Scotian Shelf. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2652. Fisheries and Oceans Canada.

Peary Caribou

Key habitat

Peary caribou prefer mesic tundra and polar desert habitat types consisting of lichens, grasses, sedges, and forbs (Parker and Ross 1976). In the winter, caribou prefer higher ground for easy foraging due to less snow cover (Parker and Ross 1976).

Peary caribou on Banks Island with and without calves noticeably prefer well drained lands on hills or slopes with undeveloped hummocks, which were mostly dominated by Dryas integrifolia and Kobresia myosuroides (Kevan 1974). Peary caribou with calves appear to moderately prefer wet areas with plant species such as Eriophorum scheuchzeri and Carex aqatalis and well drained lands on hills or slopes with hummocks (Kevan 1974). Vegetation in well developed hummocks included Dryas integrifolia and Cassiope teragona. Less preferred habitat types included: stony barrens and snow covered areas (Kevan 1974).

Banks Island

Key calving grounds are located in the north-east, south-east, and north-west sections of Banks Island (Larter and Nagy 2000a, Kevan 1974). High densities of Peary caribou with calves were observed in the north-east of Banks Island in June (Kevan 1974). Kevan (1974) indicated that identified areas in the northern end of Banks Island should be considered critical for caribou survival in the spring (Figure 8-2). The summer range for Peary caribou was identified in the northwest of Banks Island (Larter and Nagy 2000a). Peary caribou were also observed on the southeastern end of Banks Island in July 1998 and in the northwest end in July 1998 and 1999 (Larter and Nagy 2000b). The winter range has been acknowledged in the south-west section of Banks Island (Larter and Nagy 2000a).

Western Queen Elizabeth Islands

Limited data is available on key Peary caribou habitat on Prince Patrick, Eglinton, and Melville Islands (e.g. Miller et al. 1977a, Miller et al. 1977b, Larter and Nagy 2000b). Specific summering, wintering and calving grounds have not been identified on these islands. One exception might be the southern end of Dundas Peninsula on Melville Island which may serve as a summer range for Peary caribou (Larter and Nagy 2000b). Data collected by Miller et al. (1977a) in 1973 and 1974 suggest that large numbers of caribou migrate seasonally and interchangeably between these islands. One suggestion from reviewing this data is that a summer range for one group of caribou may serve as winter range for a different group of caribou and vice versa.

Eglinton Island

Caribou appeared to concentrate on the southern end of Eglinton Island in June and July 1974 (Miller et al. 1977a) (Figure 8-2). In total, 57 caribou were observed within separate groups on this section of the island. In 1973, approximately 87% of caribou overwintering on Eglinton Island migrated to either Melville or Prince Patrick Island in spring or early summer to (Miller et al. 1977a). Nonetheless, 50% of caribou overwintering on Prince Patrick Island migrated to either Melville or Eglinton Island in spring or early summer (Miller et al. 1977a).

Melville Island

The summer concentration for Peary caribou on Melville Island in July 1998 and 1999 was identified in the southern end of Dundas Peninsula (Larter and Nagy 2000b). They indicated that the majority of caribou in western Melville Island were gathered at this location. In June and July 1974, Miller et al. (1977a) identified small groups of Peary caribou throughout Mellville Island (Figure 8-2). Data obtained from a study conducted in 1973 found that 40% more caribou spent the summer on Melville Island than during the winter (Miller et al. 1977a).

Prince Patrick Island

During June and July 1974, caribou congregated on the central eastern end of Prince Patrick Island, specifically on land near Dames point (14 caribou), Manson Point (162 caribou), and Wilkie Point (33 caribou) (Miller et al. 1977a) (Figure 8-2). In 1973, approximately 50% of caribou overwintering on Prince Patrick Island migrated to either Melville or Eglinton Island in spring or early summer (Miller et al. 1977a). On the other hand, approximately 87% of caribou overwintering on Eglinton island, migrated to either Melville or Prince Patrick Island in spring or early summer (Miller et al. 1977a). In April 1974, 1234 caribou were observed wintering on Prince Patrick Island and only 46% remained for the summer months (Miller et al. 1977b).

Rationale for Selection

Peary caribou were mainly selected as a VEC due to their cultural and nutritional importance to Inuit communities (Tews et al. 2007). On Banks Island, Peary caribou are an important traditional food for individuals living in Sachs Harbour (Larter and Nagy 2000). Peary caribou are protected by Land Claim Agreements with the Inuvialuit (COSEWIC 2004). In addition, caribou are managed by Land Claim organizations and the Territorial governments.

Peary caribou were also selected as a VEC due to their listing territorially and federally. In the Northwest Territories, Peary caribou are listed as At Risk (NWT 2009a). The Banks Island and High Arctic populations of Peary Caribou are listed as Endangered under Schedule 2 of the Species at Risk Act (SARA 2009). The Low Arctic population is listed as Threatened under Schedule 2 (SARA 2009).

Sustainability

Peary caribou populations in the Queen Elizabeth Islands are in decline (Miller and Gunn 2003) as were Banks Island populations (Fraser et al. 1992, McLean et al. 1992). More recently, however, Banks Island populations appear to be stable or slowly increasing (J. Nagy, pers. comm. February 2, 2004 In COSEWIC 2004). Human harvest, natural predation and poor winter conditions are all possible explanations for population declines (McLean and Fraser 1992). Miller and Gunn (2003) concluded that the most likely explanation for die-offs in their study was poor winter conditions leading to reduced foraging which ultimately lead to malnutrition and starvation.

Peary caribou populations within or near the PEMT Area receive territorial (NWT 2009a) and federal protection (SARA 2009) due to their territorial and federal listed status (see Section 8.2). Peary caribou are also protected by Land Claim Agreements with the Inuvialuit (COSEWIC 2004). In addition, Peary caribou are protected on Banks Island in Aulavik National Park which occurs in key Peary caribou habitat. In 2010, Peary caribou and their habitat will also be protected under the new Species at Risk (NWT) Act (NWT 2009b).

Hunting has been proposed as possible cause of population decline on Banks Island (McLean and Fraser 1992). In addition, Gunn et al. (2006) have suggested that decreasing harvest limits may aid in Peary caribou recovery. In the past, the Banks Island Peary caribou population was assessed as Endangered by COSEWIC in 1991 (COSEWIC 2004). In May 2004, the Peary caribou was assessed separately from barren-ground caribou, and based on an updated status report, were designated Endangered because the population continues to decline (COSEWIC 2004). Extended consultations are under way by the federal government to legally list Peary caribou as Endangered under Schedule 1 of the Species At Risk Act. Peary caribou are currently managed by Land Claim organizations and the Northwest Territories government. Together, these groups work to conserve Peary caribou while allowing reasonable harvest. Only subsistence hunting by Inuvialuit is allowed. Since 1991, residents of Sachs Harbour have had a hunting quota of 36 caribou (only one male) (Madsen 2001). Continued hunting management should sustain Peary caribou populations where they are hunted (e.g., Banks Island) (COSEWIC 2004). In general, caribou populations should not be negatively affected by hunting as long as biologists and communities agree on conservation (COSEWIC 2004).

Peary caribou population growth may occur intermittently over many years if wolf populations are stable and if good weather reduces extreme snow and ice condition (Miller and Barry 2009). Although weather cannot be controlled, managing wolf populations may aid in sustaining Peary caribou populations. For example, in 2001, population growth on Banks Island occurred after Inuit hunters increased the wolf harvest in the 1990's (J. Nagy, pers. comm. 2004 In Gunn et al. 2006).

The effects of climate change are currently uncertain and may have positive and/or negative effects on Peary caribou.

Susceptibility to development

Few studies have been conducted on the effects of human activity on Peary caribou (Beaks Consulting 1975, Miller and Gunn 1979, Gunn and Miller 1980, Miller and Gunn 1981). For example, Peary caribou appear to be highly tolerant to seismic vehicles; however, snowmobile activity within 100 m has been known to disrupt caribou (Beaks Consulting 1975). Several studies have been conducted on the response of Peary caribou to helicopter harassment (Miller and Gunn 1979, Gunn and Miller 1980, Miller and Gunn 1981). Peary caribou cows and calves are the most affected by helicopter harassment; however, they are quick to return to normal activities (Miller and Gunn 1979, Gunn and Miller 1980). In addition, calf play and excitability significantly increased during helicopter activity (Miller and Gunn 1981). Larger groups and groups containing calves appear to be more affected than smaller groups (Miller and Gunn 1979). Although the effect of helicopter activity on caribou appears to be minimal and temporary, the energy utilization during harassment and the long term effects are unknown (Miller and Gunn 1979).

No studies have been conducted on the long term effects of human industrial activities on Peary caribou. Miller and Gunn (1979) have made several comments regarding the anticipated effects of human activity on Peary caribou. For example, human activities could have a negative effect on daily feeding, inter-island migrations and movement, gene flow, and island restocking. In addition, Parker et al. (1975) suggested that the effects of industrial activities occurring near malnourished caribou populations could be significant. Further Miller et al. (1977a) indicated that the effects of a pipeline in the Arctic would be difficult to determine due to the inter-island seasonal Peary caribou movements. Further research is needed to determine the long term effects of anthropogenic activities on Peary caribou populations.

Potential Residual Effects of Industrial Disturbance

Short or long term industrial disturbances may have residual impacts on Peary caribou populations. Industrial activities on land or in between the western Queen Elizabeth Islands would likely have a greater impact on caribou than activities in the Beaufort Sea or the McClure Strait. A major concern is that future shipping traffic and early/late season ice breaking has the potential to disrupt Peary caribou migration between Banks and Victoria Island.

Residual effects from industrial activity may result in either complete loss of habitat, as is common with the 'footprint' of industrial developments, or effective habitat loss, whereby Peary caribou avoid habitat in proximity to development. Industrial activities may also cause Peary caribou to alter migration routes to less preferred or longer routes. Further, industrial disturbances may increase result in additional energy losses. Potential residual implications of long term industrial development on Peary caribou within or near the PEMT Area include:

- Disruption or loss of critical calving grounds
- Disruption or loss of key summer and winter ranges
- Interference of movement and migration between critical habitat areas.
- Increased energy losses due to an increase in industrial disturbance

Peary caribou are most vulnerable at the end of winter (Miller et al. 1982), especially during severe winters (Miller and Gunn 2003). Increased energy losses due to an increase in industrial disturbance during these severe winters may be detrimental to the survival of a population. Therefore, additional mitigation and restrictions for industrial activities may be necessary near key habitat areas and migrations routes during late winter and early spring.

Mitigation

According to the reviewed literature, Peary caribou are most sensitive and vulnerable during inter-island winter migrations, during calving season and at key wintering and summering grounds. Activities which have the potential to negatively impact Peary caribou include:

- Any winter activities (e.g. shipping traffic and early/late season ice breaking) occurring between Banks Island and Victoria Island and near Prince Patrick Island and Eglinton Island.
- Low flying aircraft near key habitat areas (Figure 8-2).
- Open water activities occurring close to shore.
- On land activities (e.g. camps, access roads, pipelines, lease sites, air strips, aircraft fuelling stations, etc.) near key habitat areas and between migration routes.

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

- Permits may be required from associated federal and territorial governments if industrial activities are proposed in caribou habitat.
- Avoid industrial harassment or disturbance to Peary caribou. Permit terms and conditions typically disallow industrial harassment
- Spill response plan and contingency plan
- Reduce or eliminate anthropogenic disturbance or activities near calving grounds from April to August
- Reduce or eliminate anthropogenic disturbance or activities near key summer and winter ranges.
- Avoid interfering or disrupting caribou movements and migration

Additional mitigation and restrictions for industrial activities may be necessary near key habitat areas and migrations routes during late winter and early spring.

Climate Change

Noticeable changes in climate are predicted for the Canadian arctic. For example, models have predicted an increase in the average air temperature, an increase in precipitation, and a decrease in ice and snow cover (Kattsov and Kallen 2005). Increased temperatures are resulting in increased vegetation biomass, reduced vegetation nutritional quality, and an increase in insect populations (Gunn et al. 2009). In addition to warmer temperatures, increased sea levels are also anticipated (Church and White 2006) as well as reduced or no ice cover (Stroeve et al. 2007). Despite the predications in future climate change, a small number of studies exist on the effects of climate change on wildlife (Tews et al. 2007).

Historically, climate change has affected Peary caribou populations and those populations have adapted (Ferguson 1996). Whether negative or positive, future climate change should also have an effect on Peary caribou populations (Tews et al. 2007). Only one modeling study exists on the effects of climate change on Peary caribou (Tews et al. 2007). In this study, model parameters consisted of the following: (1) increase in disturbance events, (2) increase in forage inaccessibility, and (3) increase in biomass. Study results indicated that a significant reduction in winter population loss may occur during severe years if biomass increases to 50% and if disturbance events do not effect foraging. Similarly, Harding (2004) suggested that increased temperatures and reduced snow cover periods could have a positive effect on Peary caribou populations. Negative impacts to Peary caribou populations are anticipated if harsh winter conditions result in a reduction of foraging availability by greater than 30% over the next

100 years (Tews et al. 2007). In general, future predicted climate change could have positive or negative effects on Peary caribou (Table 8-1) (e.g. COSEWIC 2004, Harding 2004, Tews et al. 2007).

Some evidence of climate change in the Arctic is already occurring and the changes may eventually have an impact on Peary caribou populations. For example, shrubs in the Arctic have expanded 320 km2 over the past 50 years (Sturm et al. 2001). Therefore, extreme snow and ice cover events may not be an issue if taller and stronger plant species started growing in Peary caribou foraging grounds. In addition, sea levels are slowly rising (Church and White 2006), which may eventually force caribou to retreat to higher grounds (COSEWIC 2004). Furthermore, evidence exists that the Arctic sea ice extent has declined (Stroeve et al. 2007), which may eventually interfere or potentially eliminate Peary caribou inter-island movements. Although the future effects of climate change on Peary caribou are unknown and highly variable, Peary caribou have adapted to climate change in the past (Ferguson 1996).

Sensitivity layers and scores

Areas of higher sensitivity are typically those that support quality feeding areas, as well as movement and migratory corridors necessary for year-over-year survival. As with other VECs, when assessing a grid cell for sensitivity to development, all time periods should be considered. Habitats that support key life stages are important to identify regardless of the season at which it is most used, because habitat loss that occurs in one season may have impacts that extend beyond that season of impact.

Summer season: May 1 to October 31 Sensitivity

Key calving grounds are located in the northeast, southeast, and northwest sections of Banks Island (Larter and Nagy 2000a, Kevan 1974). Kevan (1974) indicated that identified areas in the northern end of Banks Island should be considered critical for caribou survival in the spring (Figure 8-2). Summer grounds for Peary caribou are located in the northwest (Larter and Nagy 2000a, Kevan 1974).

Low/Moderate Sensitivity (2):

The rest of Banks Island which is not identified as calving grounds, summer grounds, or wintering grounds is considered low/moderate sensitivity due to migration between these grounds during the spring and fall. These areas would be most sensitive during spring migration (April to June) and fall migration (August to October). Peary caribou can also be dispersed in low densities throughout the island.

Moderate Sensitivity (3):

Known key wintering grounds

Moderate/High Sensitivity (4):

Summer grounds for Peary caribou are located in the north-west of Banks Island.

High Sensitivity (5):

Calving grounds in the north-east, south-east, and north-west sections of Banks Island. These areas would be most sensitive from May until August.

Winter season: November 1 to April 30 Sensitivity

The winter range has been identified in the south-west section of Banks Island (Larter and Nagy 2000a). Peary caribou are most vulnerable at the end of winter (Miller et al. 1982), especially during severe winters (Miller and Gunn 2003). Increased energy losses due to an increase in industrial disturbance during these severe winters may be detrimental to the survival of a population. Thus, higher risk category is associated with important wintering habitat.

Low/Moderate Sensitivity (2):

Summer grounds located in the northwest of Banks Island. The rest of Banks Island which is not identified as calving grounds, summer grounds, or wintering grounds is considered low/moderate sensitivity due to migration between these grounds during the spring and fall. These areas would be most sensitive during spring migration (April to June). And fall migration (September to October). Peary caribou can also be dispersed in low densities throughout the island.

Moderate Sensitivity (3):

Calving grounds located in the northeast, southeast, and northwest sections of Banks Island.

Moderate/High Sensitivity (4):

Wintering grounds located in the southwest section of Banks Island (October to April)

Summary

The Peary Caribou was largely selected as a VEC due to their cultural and nutritional importance to Inuit communities. In the Northwest Territories, Peary caribou are listed as At Risk (NWT 2009a). Federally, the Banks Island and High Arctic populations of Peary Caribou are listed as Endangered under Schedule 2 of the Species at Risk Act and the Low Arctic population is listed as Threatened under Schedule 2 (SARA 2009). Within the study area Peary caribou are located on Banks Island throughout the year. Key calving grounds are located in the north-east, south-east, and north-west sections of Banks Island from May until August. Summer grounds for Peary caribou are located in the north-west of Banks Island. The winter range for Peary caribou is located in the south-west of Banks Island. In the study area, movement occurs between summer, winter and calving grounds in the spring and fall. Migration is also known to occur between Banks and north-western Victoria Island. Migration has not been documented between Banks Island and the western Queen Elizabeth Islands.

One modeling study exists on the effects of climate change on Peary caribou (Tews et al. 2007). Negative impacts to Peary caribou populations are anticipated if harsh winter conditions result in a reduction of foraging availability by greater than 30% over the next 100 years; however, increased temperatures and reduced snow cover periods could have a positive effect on Peary caribou populations.

Potential impacts from industrial activity include man-made noise impacts, low flying aircraft, anthropogenic development on Bank's Island and shipping during ice cover in between islands of known movements. Industrial activities near on in active calving grounds, active wintering grounds, and active migration routes could potentially have a long term negative impact on the population.

The sensitivity layers established for Peary caribou reflect the environmental sensitivity of an area should development occur. There is a variety of potential project types that vary in spatial extent, duration, and intensity, with a corresponding range in magnitude of impacts that may occur in the project area. Within the PEMT study area on Banks Island, the most sensitive areas would include calving grounds from May to August and wintering grounds from October to April.

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

Migratory Birds

Key habitat

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

Populations that are concentrated for any part of the year (e.g., staging, moulting, and foraging areas) are vulnerable to site-specific threats because a significant proportion of the population could be affected. As well, populations that occupy geographically restricted habitats (rare, threatened or endangered species) are vulnerable if their habitats are threatened. Many migratory birds use the Beaufort Sea from spring to fall, with arrival and departures influenced by break up and freeze up of the sea ice. Species include many species of sea ducks that are focused more on the marine environment and offshore areas for foraging and terrestrial environments, such as coastal shorelines and islands, for nesting. Other species are more terrestrial focused such as geese, swans, dabbling ducks and shorebirds. These species use shorelines, inland wetlands and upland areas for breeding and sometime use coastal inlets and deltas for foraging and staging. Onshore and offshore habitats are important to both groups of species.

Marine Focused Species

Offshore habitat is important to sea ducks or diving ducks such as eiders, scoters, mergansers, scaups and long-tailed ducks. Arrival and departure of sea ducks and diving ducks into the Beaufort Sea area is largely influenced by the break up and freeze up of the sea ice. They are well adapted for life at sea and are designed to be efficient swimmers in order to catch there marine prey. They are commonly found on the open sea near coastal areas foraging in large groups.

Stable environments with predictable food resources during the breeding season are an important component to the life history of sea ducks (Mehl 2004). Sea ducks have delayed maturity and typically begin breeding at two to three years of age. Delay of the nesting season due to seasonal weather conditions can result in failure of breeding for that year. Young of sea ducks are often raised in the open sea water where they are more exposed to predators (Mehl 2004). The vulnerability of the young during rearing period and the delayed reproductive maturity of adults makes sea ducks susceptible to population fluctuations and therefore sensitive to environmental change. Key breeding, foraging and staging habitats in the Beaufort Sea are important to the survival of these species.

Terrestrial Focused Species

Species such as dabbling ducks, geese, swans and shorebirds spend a lot of their time inland or along coastal land masses during the breeding season using habitats such as ponds, salt marshes, grass-sedge wetlands, and tidal mudflats. Upland and grassy-sedge habitats adjacent to wetland areas are often used for nesting with wetlands, ponds, lagoons, inland channels and salt marshes used for foraging, brood rearing and moulting. Invertebrates, crustaceans, and aquatic vegetation, that make up the diets of most of the terrestrial focused waterfowl, can be found inland in aquatic habitats or in coastal areas. Drought conditions or climatic delay of melt has the potential to drastically affect the quality and availability of these habitats and their much needed food sources.

Description of Habitat Zones

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

Rationale for Selection

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

Sustainability

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

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

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

Susceptibility to development

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

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

Onshore areas in relatively protected waters of inlets and bays, such as Thrasher Bay, Shoalwater Bay, and Shallow Bay are vulnerable to spills as beached oil can persist for some time (Dickins et al. 1987). Therefore, although impacts to migratory bird areas are most vulnerable during the summer season, when birds are present in the Beaufort Sea area, high sensitive habitat areas and those areas sensitive to persistence of beached oil are vulnerable all year round. Typical dispersant use for oil spills may be less effective in the areas of low salinity such as the Mackenzie River outflow (Dickson et al. 1987). Should a spill occur, certain response measures should be taken to divert oil away from areas where high sensitive bird habitats occur and clean up methods become more difficult, such as inlets southwest of Thumb Island in Liverpool Bay (Dickson et al. 1987).

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

Seismic lines associated with oil and gas exploration also have the potential to directly and indirectly effect available habitat to upland bird species in the Arctic. Plans to increase oil and gas exploration in the Canadian Arctic could have detrimental effects on breeding habitat for migratory birds. Due to the alteration of vegetation along seismic lines in upland tundra, the habitat for breeding birds becomes altered. Although birds have been documented using seismic lines, passerine abundance appears to be lower in these disturbed areas even 10 – 30 years after development (Ashenhurst and Hannon 2008).

Mitigation

During certain life-cycle phases (e.g., nesting, brood-rearing, moulting), bird species are particularly vulnerable to developmental impacts such as oil spills. There are several strategies that can be applied to project-specific mitigation planning:

Sea ducks and sea birds are especially vulnerable to oil spills. Important offshore areas such as the Cape Bathurst Polynya and Mackenzie River Delta should have appropriate oil spill response plans developed for specific water conditions in these areas.

Nesting and moulting seabirds and waterfowl concentrate in nearshore sheltered bays from late July to mid-August. Since they are flightless during the moult and relatively sedentary during nesting, they are susceptible to disturbance and vulnerable to oil spills during this period. Timing restrictions for development should be established for these nesting and molting periods and specific response plans for shoreline oil spills should be developed for these areas and include measure to divert oil away from areas.

Established Important Bird Areas, where possible, should be avoided for development. Depending on the specific IBA and it's timing of use restrictions periods should also be established for working in and around these areas. For example, mitigation to reduce bird disturbances will include flight path selection, flight altitudes, and flight timing to avoid those times that large concentrations of birds are present in the area.

Climate Change

Global circulation models predict substantial decreases in both thickness and coverage of arctic sea ice due to increased atmospheric CO2. Present climate models are insufficient to predict regional ice dynamics, winds, mesoscale features, and mechanisms of nutrient resupply, which must be known to predict productivity and trophic response (Tynan and DeMaster 1997). However, we can speculate on the potential impacts of observed trends in Arctic climate on wildlife. Birds are potentially useful as indicators of broader ecological effects of climate change because they occupy a wide range of habitats. Climatic variables most often identified as influencing bird responses include a rise in air and sea surface temperatures, rising sea levels, drying of wetlands, and sea ice variability. In northern regions, warming may extend nesting periods, provide more food for young and decrease chick mortality. However, warming may reduce breeding and foraging habitats, sea level rise may damage important shoreline nesting areas, and increasing storms during nesting season could destroy essential nesting effort, eggs, and chicks (UNEP 2005). Warmer continental temperatures can also affect suitable habitat for some birds, such as the red-necked phalarope where premature drying and encroachment of shrub vegetation has the potential to decrease existing breeding habitat (Walpole et al. 2008). Climatic change has the potential to drastically affect the crack and lead system of the Cape Bathurst Polynya. Increases in temperature or delay in seasonal climate shifts can greatly affect the size and availability of this critical bird habitat. Delay in the availability of this important habitat to seaducks could result in impacts to reproductive productivity to these species as they usually have a single nesting attempt and have the potential to skip a year of breeding due to weather impacts (Mehl 2004).

Climate change may lead to alterations in location, timing and length of migration routes. Spring migration of birds is generally considered more important than autumn migration because it determines their arrival timing at breeding grounds, which is crucial for mating and territory choice. Arthropod activity and abundance appears to be tied to date and weather in the Arctic, with temperature, wind and precipitation having strong influences (Tulp et al. 2008). Climatic change has the potential to alter the timing of food abundance for migratory birds. Warming trends could cause lower food abundance coinciding with the arrival of migratory birds, creating a necessary shift in the migratory schedule (Tulp et al. 2008). There is concern some long distance migrant bird species may not be able to alter their migratory behaviour sufficiently to match shifts in the availability of important food sources such as insects, flowers and berries (Climate Risk 2006). These timing shifts are a threat when they force birds' life cycles out of synchrony with plants and insects on which their survival and reproduction depends upon.

Sensitivity layers and scores

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

Summer/fall (May-October) Offshore Sensitivity

Many migratory birds use the Beaufort Sea from spring to fall, with arrival and departures influenced by break up and freeze up of the sea ice.

Low Sensitivity (1):

Areas that have very limited use year round and include the area beyond the summer extent of pack ice (approximate summer extent of pack ice as defined in Stirling 2002).

Low/Moderate Sensitivity (2):

Areas where populations are geographically widespread or widely dispersed throughout a variety of habitats. These populations are less vulnerable to site-specific threats, as only a small portion would be affected. Includes nearshore landfast ice zone which remains frozen in late May and early June, offshore areas to the limit of summer pack ice, and upland and floodplain.

Moderate Sensitivity (3):

Areas where populations are concentrated in a habitat site for any part of the year including staging areas, nesting colonies, moulting and feeding areas. Includes sites with moderate to high densities, but <1% of the Canadian population, and nearshore and offshore areas where the landfast and sea ice has melted to the limit of summer pack ice, upland and floodplain.

Moderate/High Sensitivity (4):

Populations that occupy geographically restricted habitats and sites that support at least 1% of the Canadian population and/or have a conservation area status or designation. This includes key areas along the Yukon North Slope (Blow River delta, Nunaluk Spit, Workboat Passage, Herschel Island, Babbage and Spring River deltas), the Yukon Coastal Plain, the Mackenzie River Delta, and areas along the Tuktoyaktuk Peninsula (Kugaluk, Moose, and Smoke Rivers; lower Anderson and Mason River deltas; Harrowby Bay, Kukjutkuk and Hutchinson Bay, McKinley Bay and Phillips Island). Also includes sites of exceptional species diversity, and includes coastal and offshore areas to the limit of summer pack ice and upland and floodplain.

High Sensitivity (5):

Sites that support 50% of the Canadian population. This includes the Cape Bathurst polynya and includes critical habitat as defined by the Species At Risk Act (SARA)

Summer/fall (May-October) Onshore Sensitivity

Many migratory birds use the Beaufort Sea from spring to fall, with arrival and departures influenced by break up and freeze up of the sea ice.

Low Sensitivity (1):

Areas that have very limited use year round.

Low/Moderate Sensitivity (2):

Areas where populations are geographically widespread or widely dispersed throughout a variety of habitats. These populations are less vulnerable to site-specific threats, as only a small portion would be affected. Includes coastal, upland and floodplain areas.

Moderate Sensitivity (3):

Areas where populations are concentrated in a habitat site for any part of the year including staging areas, nesting colonies, moulting and feeding areas. Includes sites with moderate to high densities, but <1% of the Canadian population, and coastal, upland and floodplain areas.

Moderate/High Sensitivity (4):

Geographically restricted habitats and sites that support at least 1% of the Canadian population and/or have a conservation area status or designation. This includes key areas along the Yukon North Slope (Blow River delta, Nunaluk Spit, Workboat Passage, Herschel Island, Babbage and Spring River deltas), the Yukon Coastal Plain, the Mackenzie River Delta, and areas along the Tuktoyaktuk Peninsula (Kugaluk, Moose, and Smoke Rivers; lower Anderson and Mason River deltas; Harrowby Bay, Kukjutkuk and Hutchinson Bay, McKinley Bay and Phillips Island). Also includes sites of exceptional species diversity, and includes coastal, upland and floodplain areas.

High Sensitivity (5):

Areas where populations are concentrated in a habitat site for any part of the year including staging areas, nesting colonies, moulting and feeding areas. Includes sites with high densities.

Summary

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

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

Eleven key terrestrial and marine migratory bird habitat sites have been identified. Each site selected supports at least 1% of the Canadian population of a migratory bird species during some part of its life cycle (nesting, moulting, staging), or a population that occupies geographically restricted habitat, or is a site of exceptional species diversity. These sites are recognized for their unique physical or ecological characteristics and as such, have a conservation designation (International Biological Programme Site, Canadian Important Bird Area, Migratory Bird Sanctuary, National Park, Territorial Park, Canadian Wildlife Service Key Migratory Bird Terrestrial or Marine Habitat site, special designated land in Community Conservation Plans). Migratory Bird Sanctuaries, National and Territorial Parks give birds full protection, while IBP, IBA, CWS Key Habitat, and CCP designations do not. Their identification is intended to raise awareness and draw attention to activities that may threaten an area.

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

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

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

References

Alexander, S.A., T.W. Barry, D.L. Dickson, H.D. Prus and K.D. Smith, 1988: Key areas for birds in coastal regions of the Canadian Beaufort Sea. Canadian Wildlife Service, Edmonton.

Alexander, S.A., D.L. Dickson and S.E. Westover, 1997: Spring migration of eiders and other waterbirds in offshore areas of the western Arctic. Pp. 6-20 *in* D.L. Dickson (ed.) 1997. King and common eiders of the western Canadian Arctic. Canadian Wildlife Service, Occasional Paper 94:6-20. Edmonton.

Ashenhurst, A.R. and S.J. Hannon. 2008. Effects of seismic lines on the abundance of breeding birds in the Kendall Island Bird Sanctuary, Northwest Territories, Canada. Arctic 61: 190-198.

Beckel, D., 1975: IBP ecological sites in subarctic Canada. Panel 10 summary report, International Biological Programme, University of Lethbridge.

Belanger, L. and J. Bedard, 1989: Responses of staging Greater Snow Geese to human disturbance. Journal of Wildlife Management 53:713-719.

Bowman, T.D. and M. Koneff, 2002: Status and trends of North American sea duck populations: what we know and don't know. North American sea duck conference and workshop, 6-10 November 2002, Victoria.

Bradstreet, M.S.W. 1982. Occurrence, habitat use, and behavior of seabirds, marine mammals, and Arctic cod at the Pond Inlet ice edge. Arctic 35: 28-40

Bromley, R.G., 1996: Characteristics and management implications of the spring waterfowl hunt in the western Canadian Arctic, Northwest Territories. Arctic 49:70-85.

Bunnell, F.L., D. Dunbar, L. Koza and G. Ryder, 1981: Effects of disturbance on the productivity and numbers of white pelicans in British Columbia - observations and models. Colonial Waterbirds 4:2-11.

Byers, T. and D.L. Dickson, 2001: Spring migration and subsistence hunting of king and common eiders at Holman, Northwest Territories, 1996-98. Arctic 54:122-134.

Climate Risk. 2006. Bird species and climate change. The global status report.

Cornish, B.J. and D.L. Dickson, 1997: Common eiders nesting in the western Canadian Arctic. pp. 50 *in* Dickson, D.L. (ed.) 1997. King and common eiders of the western Canadian Arctic. Canadian Wildlife Service, Occasional Paper No 94. Edmonton.

Cotter, R.C. and J.E. Hines, 2001: Breeding biology of brant on Banks Island, Northwest Territories. Arctic 54:357-366.

Cotter, R.C. and J.E. Hines, 2006: Distribution of breeding and moulting brant on Banks Island, Northwest Territories, 1992-1994. pp. 18-26 *in* Hines, J.E. and M.O. Wiebe Robertson (eds.) 2006. Surveys of geese and swans in the Inuvialuit Settlement Region, Western Canadian Arctic, 1989-2001. Canadian Wildlife Service, Occasional Paper No. 112.

Cotter, R.C., D.L. Dickson and Cindy J. Cotter, 1997: Breeding biology of the king eider in the western Canadian Arctic. pp. 51-57 *in*Dickson, D.L. (ed.) 1997. King and common eiders of the western Canadian Arctic. Canadian Wildlife Service, Occasional Paper 94. Edmonton.

Dickson, D.L., (ed.), 1997: King and common eiders of the western Canadian Arctic. Canadian Wildlife Service, Occasional Paper 94. Edmonton.

Dickson, D.L. and H.G. Gilchrist, 2002: Status of marine birds of the southeastern Beaufort Sea. Arctic 55:46-58.

Dickson, D.L., T. Bowman, A.K. Hoover, G. Raven and M. Johnson, 2005: Tracking the movement of common eiders from nesting grounds near Bathurst Inlet, Nunavut to their moulting and wintering areas using satellite telemetry, 2003/2004 progress report. Unpublished Report, Canadian Wildlife Service. Edmonton.

Environment Canada, 2001: Shorebird conservation strategy and action plan. Environment Canada Prairie and Northern Region. 17 pp.

Environment Canada, 2006: Written Submission to the Joint Review Panel Topic Specific Hearing Topic 7: Wildlife and Wildlife Habitat Migratory Birds including Kendall Island Bird Sanctuary. November 15-16, 2006. Mackenzie Valley Oil and Gas Project Environmental Assessment.

Gratto-Trevor, C.L., 1996: Use of Landsat TM imagery in determining priority shorebird habitat in the Outer Mackenzie Delta, NWT. Arctic 49:11-22.

Haszard, S.L. and R.G. Clark, 2002: Habitat requirements of white-winged and surf scoters in the Mackenzie delta region, Northwest Territories. North American sea duck conference and workshop, 6-10 November 2002, Victoria.

Hines, J.E., M.O. Wiebe Robertson, M.F. Kay and S.E. Westover, 2006: Aerial surveys of greater white-fronted geese, Canada geese and tundra swans on the mainland of the Inuvialuit Settlement Region, Western Canadian Arctic, 1989-1993. pp. 27-43 *in* Hines, J.E. and M.O. Wiebe Robertson (eds.) 2006. Surveys of geese and swans in the Inuvialuit Settlement Region, Western Canadian Arctic, 1989-2001.Canadian Wildlife Service, Occasional Paper No. 112.

Important Bird Areas (IBA) Canada, 2004: Important bird areas of Canada. Bird Studies Canada, BirdLife International and Nature Canada. URL: www.ibacanada.com, last accessed April 10, 2007.

Latour, P.B., J. Leger, J.E. Hines, M.L. Mallory, D.L. Mulders, H.G. Gilchrist, P.A. Smith and D.L. Dickson, 2006: Key migratory bird terrestrial habitat sites in the Northwest Territories and Nunavut. Canadian Wildlife Service, Occasional Paper. 121 pp.

Mallory, M.L. and A.J. Fontaine, 2004: Key marine habitat sites for migratory birds in Nunavut and the Northwest Territories. Canadian Wildlife Service, Occasional Paper No. 109.

Mehl, K. 2004. The curious lives of sea ducks. Ducks Unlimited. www.ducks.org/Conseration/WaterfowlBiology/2114/The CuriousLivesofSeaDucks.html

Newton, I., 1977: Timing and success of breeding in tundra-nesting geese. Pp. 113-126 *in* B. Stonehouse and C. Perrins (eds.) Evolutionary Ecology. University Park Press, London, UK.

Sudyam, R.S., D.L. Dickson, J.B. Fadely and L.T. Quakenbush, 2000: Population declines of king and common eiders of the Beaufort Sea. Condor 102: 219-222.

Tulp, I. and H. Schekkerman. 2008. Has prey availability for Arctic birds advanced with climate change? Hindcasting the abundance of tundra arthropods using weather and seasonal variations. Arctic 61: 48-60

Tynan, C.T. and D.P. DeMaster. 1997. Observations and predictions of Arctic climate change: potential effects on marine mammals. Arctic 50: 308-322

Walpole, B., E. Nol and V. Johnston. 2008. Pond characteristics and occupancy by red-necked phalaropes in the Mackenzie Delta, Northwest Territories, Canada. Arctic 61: 426-432

Wiebe Robertson, M.O. and J.E. Hines, 2006: Aerial surveys of lesser snow geese colonies at Anderson River Delta and Kendall Island, Northwest Territories, 1996-2001. pp. 58-61 57. *in*: Hines, J.E. and M.O. Wiebe Robertson (eds.) 2006. Surveys of geese and swans in the Inuvialuit Settlement Region, Western Canadian Arctic, 1989-2001. Canadian Wildlife Service, Occasional Paper No. 112.

Wiken, E., 1986: Terrestrial ecozones of Canada. Ecological Land Classification Series No. 19. Lands Directorate, Environment Canada. 26 pp.

Wildlife Management Advisory Council (WMAC), 1999: Status of waterfowl in the Inuvialuit Settlement Region. Canadian Wildlife Service, Yellowknife. 44 pp.

Wildlife Management Advisory Council (WMAC), 2000a: Aklavik Inuvialuit Community Conservation Plan. 166 pp.

Wildlife Management Advisory Council (WMAC), 2000b: Inuvik Inuvialuit Community Conservation Plan. 160 pp.

Wildlife Management Advisory Council (WMAC), 2000c: Tuktoyaktuk Inuvialuit Community Conservation Plan. 168 pp.

Traditional Hunting

Key habitat

Several onshore and offshore areas in the Beaufort Sea are used as traditional hunting areas for arctic species. These areas are organized by species and associated land marks below.

Polar Bear

Tuktoyaktuk Peninsul

Offshore of the Tuktoyaktuk Peninsula from the west of Pelly Island east to Franklin Bay is a key area for subsistence harvesting of polar bear during the winter (WMAC 2000c).

Beluga Whales

Mackenzie Bay

Mackenzie Bay is within the Beluga Management Zone 1A with three whaling camps used between June 15 to August 15 (WMAC 2000a). These camps are located at Shingle Point, Running River and Bird Camp.

Kendall Island

This island is adjacent to the Beluga Management Zone 1A and supports a summer whaling camp for the Inuvik people (WMAC 2000a).

Kugmallit Bay

The Bay is within the Beluga Management Zone 1A & 2 (WMAC 2000a). Four whaling camps of Tuktoyaktuk and Inuvik people occur around the bay including camps at West and East Whitefish station, Ikinaluk and on Hendrickson Island (WMAC 2000a, North/South Consultants Inc. 2003).

Ringed Seal

Tuktoyaktuk Peninsula

Coastal areas off the Tuktoyaktuk Peninsula including Kugmallit Bay extending north to Atkinson Bay; Liverpool Bay/Wood Bay, extending through Fingers Area, into Husky Lakes provide habitat for fall seal harvesting (WMAC 2000c).

Winter seal harvesting areas is provided on sea ice off the Tuktoyaktuk Peninsula from Baillie Island west to Pelly Island and north (WMAC 2000c).

Spring harvesting of seals is provided in the eastern portion of Husky Lakes just inside the Finger Lakes area from April to June.

Migratory Birds

Tuktoyaktuk Peninsula

Land from Mackenzie Bay to Liverpool Bay including Pullen Island and Kugmallit Bay provides fall goose harvesting habitat (WMAC 2000c).

Areas of the Beaufort Sea surrounding Garry Island, Pelly Island and Hooper Island, McKinley Bay, lands east of Kugmallit Bay and and Hutchison Bay provide summer goose harvesting areas (WMAC 2000c).

Spring goose harvesting areas are present along Islands in the western portion of the Mackenzie River Estuary, from eastern Richards Island to Mason River Estuary including all of the Tuktoyaktuk Peninsula and the Husky Lakes area (WMAC 2000c).

Fall goose hunting areas include all of the coastline from Yukon/Alaska border in the west, to the Mason River in the east, including sites on Anderson River and Crossley Lakes.

Mackenzie Bay

This area provides important past and present subsistence harvesting area for waterfowl (June to September).

Rationale for Selection

Hunting (and trapping) continues to be of cultural, social and spiritual importance for Inuvialuit communities, as well as, economic importance. The CCPs were developed to help protect the environment in the Mackenzie Delta / Beaufort Sea coastal, onshore and offshore areas to ensure cultural survival of the Inuvialuit Community. One of the goals of the CCP is to identify and protect important wildlife habitat, seasonal harvesting areas and cultural sites (e.g., cabin sites) and make recommendations for the conservation and management of the resources on which priority lifestyles depend. Oil pollution represents a threat to the area wildlife that is the foundation of subsistence livelihood and part of gross income. Section 13 of the Inuvialuit Final Agreement (IFA) identifies a wildlife compensation and liability regime for damages resulting from development.

The Government agrees that every proposed development of consequence to the Inuvialuit Settlement Region that is within its jurisdiction and that could have a significant negative impact on wildlife habitat or on present or future wildlife harvesting will be authorized only after due scrutiny of and attention to all environmental concerns and subject to reasonable mitigative and remedial provisions being imposed.

Sustainability

The total area used for hunting by the Inuvialuit has not changed much since the 1960s, but there has been a decline in the number of harvesters and a shift from full-time to part-time harvesting (Usher 2002). The mean annual harvest of country food has declined from the 1960s to the 1990s. There are several reasons for the decline; principally, the abandonment of dogs (which were primarily fed marine species of seal and whitefish) for transportation; the increased use of snowmobiles and the shift from full-time to part-time harvesting. These changes in lifestyle have led to an overall shift from marine to terrestrial country food sources. While the total amount of country food produced has declined, the amount consumed by Inuvialuit has increased. Subsistence harvesting thus continues to persist as significant economic and cultural practices in the region (Usher 2002).

Hunters typically show an affinity for particular harvesting areas (Bromley 1996; Byers and Dickson 2001). Much of the terrestrial wildlife harvesting occurs near the coast, due to the ease of transport and accessibility. To sustainably manage their resources, the Inuvialuit have designated special areas and recommended land use practices for their planning areas. In designating land management categories, the communities have prioritized land uses and activities, in addition to denoting areas of special ecological and cultural importance.

Susceptibility to development

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

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

Seals may be affected by changes to their food supply such as tainting. Seals do not avoid oiled areas. This has implications for birthing and nursing pups. As a result, an increase in pup mortality has been observed, in addition to eye and brain damage (Report of the Scientific Review Panel 2002). These changes could affect hunting and access to hunting areas, at least temporarily.

Whales do not avoid areas that have been oiled or otherwise contaminated. They do avoid areas where there are explosions by seismic airgun arrays by moving to the surface, hiding in acoustical shadows, move apart or simply avoid an area. (Report of the Scientific Review Panel 2002). These behavioural changes have been observed by Alaska Natives.

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

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

Mitigation

Oil pollution represents a threat to the area wildlife that is the foundation of subsistence livelihood and part of gross income. Section 13 of the Inuvialuit Final Agreement (IFA) identifies a wildlife compensation and liability regime for damages resulting from development.

Subject to Section 13(3), the Inuvialuit shall be compensated for actual wildlife harvest loss resulting from development in the Inuvialuit Settlement Region, and Section 13(4) …shall benefit from environmental protection measures designed to reduce future harvest loss resulting from development in the Inuvialuit Settlement Region.

The Government agrees that every proposed development of consequence to the Inuvialuit Settlement Region that is within its jurisdiction and that could have a significant negative impact on wildlife habitat or on present or future wildlife harvesting will be authorized only after due scrutiny of and attention to all environmental concerns and subject to reasonable mitigative and remedial provisions being imposed.

Climate Change

Climate change can have impact on the availability and use of species for traditional food. Historically, Arctic people are used to adapting to a changing environment; however, the current rate and extent of climate change may be outside of their historical experience (Riedlinger 1999). Climate changes observed in the 1990s were said to be without precedent and outside the range of variation that the Inuvialuit consider normal (Berkes and Jolly 2001).

Harvesting impacts from climate change included changes in access to resources, safety, predictability, and species availability (Berkes and Jolly 2001). Climate can be a determining factor on the access to harvesting areas. Faster snow melt and breakup of river ice due to warmer springs and deeper, softer snow fall can make it difficult to access some area and can shorten the length of time for harvesting (Berkes and Jolly 2001). These changes also make predicting safety of the environment difficult. Those hunting areas closer to shore, such as ice leads, may be less risky than areas farther offshore (Laidler et al. 2006). Ice movement in winter and spring in the 1990's was found to be less predictable with more movement, overall thinning and changes in the distribution of pressure ridges, and cracks and leads (Berkes and Jolly 2001).

All of these climatic changes in the environment impacts the availability of some species and can reduce access to traditional food (Ford et al. 2008). Some traditional harvesting areas maybe unavailable or shortened due to access difficulties or some may no longer provide key harvesting areas due to species response to a changed environment. In those areas where species are still available hunting conditions, such as visibility of seals on summer ice, can be more difficult due to the changed environment (Berkes and Jolly 2001).

Sensitivity layers and scores

Traditional Hunting

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

Low Sensitivity (1):

Lands and waters where there are no known significant and sensitive cultural or renewable resources i.e., limited hunting interest. These were identified as Category A lands in the CCPs.

Low/Moderate Sensitivity (2):

Lands and waters where there are cultural or renewable resources of some significance and sensitivity i.e., some hunting interest. These were identified as Category B lands in the CCPs.

Moderate Sensitivity (3):

Lands and waters where cultural or renewable resources are of particular significance and sensitive to change during specific times of the year. These were identified as Category C lands in the CCPs. Provision of the Environmental and Cultural/Land Use Components of a Strategic Environmental Assessment for the Canadian Beaufort Sea

Moderate/High Sensitivity (4):

Lands and waters where cultural or renewable resources are of particular significance and sensitivity throughout the year. These were identified as Category D lands in the CCPs.

High Sensitivity (5):

Represents lands and waters where cultural or renewable resources are of extreme significance and sensitivity. These were identified as Category E lands in the CCPs. This category recommends the highest degree of protection; there shall be no development on these areas.

Summary

The hunting of polar bears, beluga whales, ringed seals, and migratory birds were identified as crucial socio-economic and cultural components. This is true for the three Inuvialuit communities in the study area. These species are still consumed for food and used for clothing. The three communities continue to sustain their populations for subsistence harvest purposes. Industrial development, such as oil and gas activity, must not adversely effect the ability of northern aboriginal peoples to harvest wildlife.

References

Berkes, F. and D. Jolly. 2001. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conservation Ecology 5(2): 18.
[online] http://www.consecol.org/vol5/iss2/art18/

Bromley, R.G., 1996. Characteristics and management implications of the spring waterfowl hunt in the western Canadian Arctic, Northwest Territories. Arctic 49:70-85

Byers, T. and D.L. Dickson, 2001. Spring migration and subsistence hunting of king and common eiders at Holman, Northwest Territories, 1996-98. Arctic 54:122-134

COSEWIC, 2002. Assessment and Update Status Report on the Polar Bear Ursus maritimus in Canada. Committee On the Status of Endangered Wildlife In Canada. Ottawa. vi + 29 pp.

Fabijan, M., R. Brook, D. Kuptana and J.E. Hines, 1997. The subsistence harvest of king and common eiders in the Inuvialuit Settlement Region, 1988 – 1994. Pp. 67-73 in Dickson, D.L. (ed.) 1997. King and common eiders of the western Canadian Arctic. Canadian Wildlife Service, Occasional Paper 94. Edmonton.

Ford, J.D., Pearce, T., Gilligan J., Smit, B., and J. Oakes. 2008. Climate Change and Hazards Associated with Ice Use in Northern Canada Arctic, Antarctic, and Alpine Research 40(4):647-659.

Inuvialuit Regional Corporation. 1987. The Western Arctic Claim. The Inuvialuit Final Agreement as Amended January 15, 1987.

North/South Consultants Inc., 2003. Ecological Assessment of the Beaufort Sea Beluga Management Plan – Zone 1(a) as a Marine Protected Area. Prepared for the Beaufort Sea Integrated Management Planning Initiative (BSIMPI) Working Group.

Perham, C.J., 2005. Proceedings of the Beaufort Sea Polar Bear Monitoring Workshop. OCS Study MMS 2005-034. Prepared by U.S. Fish and Wildlife Service. Marine Mammals Management, Anchorage, AK. Prepared for the U.S. Dept. of the Interior, Minerals Management Services, Alaska OCS Region, Anchorage. 26 pp. + appendices

Reidlinger, D. 1999. Climate change and the Inuvialuit of Banks Island, NWT: using traditional environmental knowledge to complement western science. Arctic 52: 430-432

Report of the Scientific Review Panel, 2002. British Columbia Offshore Hydrocarbon Development.

Stirling, I., 2002. Polar bears and seals in the eastern Beaufort Sea and Amundsen Gulf: a synthesis of population trends and ecological relationships over three decades. Arctic 55: 59-76

Usher, P.J., 2002. Inuvialuit use of the Beaufort Sea and its resources, 1960-2000. Arctic 55(Supp. 1):18-28

Wildlife Management Advisory Council (WMAC), 1999. Status of waterfowl in the Inuvialuit Settlement Region. Canadian Wildlife Service, Yellowknife. 44 pp.

Wildlife Management Advisory Council (WMAC), 2000a. Aklavik Inuvialuit Community Conservation Plan. 166 pp.

Wildlife Management Advisory Council (WMAC), 2000b. Inuvik Inuvialuit Community Conservation Plan. 160 pp.

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Oil Spill Sensitivity

Oil Spill - Offshore - Summer and Fall; Winter and Spring

Offshore sensitivity was based on biological sensitivity and factors that influence the persistence of oil. The most important elements that control timing, duration and physical location of oil spills offshore are the ice and open water regimes. Oil spilled in landfast or multi-year ice environment is contained within a localized area and isolated from the marine environment until spring. After that, oil will spread to the marine environment by ice break-up, lead formations, or polynya.

The offshore area was divided into four zones during the winter/spring period: polynya, transition, landfast ice and overflooding. The transition ice zone of predominantly first-year ice that extends from the northern boundary of the Bathurst Polynya and the southern boundary of the multi-year ice. Landfast ice is the ice that forms between the shore and sina (ice edge). The overflooding zone refers to coastal areas in Mackenzie Bay, Kugmallit and Wood Bays where the sudden peak flow of relatively warm water leads to overflooding (Dickins et al. 1987).

Oill Spill - Shoreline

Shoreline sensitivity was based on biological sensitivity and factors that influence the persistence of oil such as wave exposure, coastal morphology, substrate and coastal stability. For example, shore zone oil will persist in areas of low wave exposure and low coastal relief (e.g., estuaries, embayments, deltas and inundated tundra) for a longer period than in areas of high wave exposure (e.g., barrier islands and spits).

In addition to shore zone response to spills, the 1 km offshore was classified according to open water and transition. The transition zone is first year ice bounded by the multi-year ice to the north and the open water to the south. In favourable summers, the transition zone will disappear completely until freeze-up in October (Dickins et al. 1987).

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 favourable 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 unfavourable. 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 favourable 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 favourable. Occurrences may or may not be known and the presence of undiscovered accumulations is possible.
- Rank 4. HIGH. Geological environment is very favourable. 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 favourable. 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 favourable 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.

EBSA (Ecologically & Biologically Significant Area)

http://www.beaufortseapartnership.ca/integrated-ocean-management/ecologically-and-biologically-significant-areas/