North Slope Borough
Background Report

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Prepared by:
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Abbreviations

AAAQS	Alaska Ambient Air Quality Standards
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AHFC	Alaska Housing Finance Corporation
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ANMC	Alaska Native Medical Center
ANWR	Arctic National Wildlife Refuge
ASRC	Arctic Slope Regional Corporation
ATV	All terrain vehicle
BLM	Bureau of Land Management
CRSA	Colville River Special Area
DCED	Department of Community and Economic Development
^{o}F	degrees Fahrenheit
DOD	Department of Defense
DDT	dichloro diphenyl trichloroethane
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
GMUs	game management units
HH	Household
HUD	Housing and Urban Development
ICAS	Inupiat Community of the Arctic Slope
IHS	Indian Health Services
IWC	International Whaling Commission
LMR	Land Management Regulations
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPH	miles per hour
NAAQS	National Ambient Air Quality Standards
NMFS	National Marine Fisheries Service
NPRA	National Petroleum Reserve – Alaska
NPS	National Park Service
NSB	North Slope Borough
PAHs	polycyclic aromatic hydrocarbons
PBR	potential biological removal
PCBs	polychlorinated biphenyls
POPs	Persistent Organic Pollutants
RAB	Restoration Advisory Board
SSOC	State Species of Concern
TCF	trillion cubic feet
TNHA	Tagiugmiullu Nunamiullu Housing Authority
TLSA	Teshekpuk Lake Special Area
UNEP	United Nations Environmental Programme
URUSA	Utukok River Uplands Special Area
USAED	U.S. Army Engineer District, Alaska
USBLM	U.S. Bureau of Land Management
WCC	Woodward-Clyde Consultants
Y-K	Yukon-Kuskokwim

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3.0 BACKGROUND REPORT

INTRODUCTION

The Background Report of the Comprehensive Plan provides more detailed information on the physical, biological, and human environments of the North Slope. It is intended to present information to assist in implementing the plan and the Title 19 Land Management Regulations that are based on the plan. The Background Report will also be useful to tribal governments, Native corporations, governments, and private industry corporations that plan for, manage, and develop resources and facilities on the North Slope. The Background Report is intended to provide information to assist in planning activities that are compatible with the people and natural environment of the North Slope. Throughout the Background Report, reference will be made to the use of Traditional and Contemporary Local Knowledge and other management practices that should be considered when pursuing activities within the Borough. The report is organized under the topics of physical, biological, and human environment.

3.1 PHYSICAL ENVIRONMENT

3.1.1 *Climate*

The North Slope Borough includes three regions with different climate, drainage, and geology characteristics: the arctic coastal plain, the Brooks Range Foothills and the northern portion of the Brooks Range. A dry, polar climate dominates the arctic coastal plain throughout the year, with short, cool summers and long, cold winters. Temperatures on the arctic coastal plain are typically below freezing from mid-October into May. Temperatures vary across the arctic coastal plain, depending on the proximity to the coast. In general, February is the coldest month with an average temperature of about -21 degrees Fahrenheit (^{o}F). July is typically the warmest month, with an average temperature of 46^{o}F. Maximum temperatures can range from -56 ^{o}F during winter months to as high as 78^{o}F in mid-summer. The nearby Arctic Ocean and abundant sea ice contribute to the cool, frequently foggy, summers (DCED 2004).

Early snow in the Brooks Range

Annual precipitation (both rainfall and snowfall) is low and mostly falls as snow during the winter. Precipitation varies somewhat across the arctic coastal plain. Kaktovik, located on Barter Island in the eastern portion of the Borough, receives approximately 5 inches of precipitation during the summer months and approximately 20 inches of snow during the winter months. Point Hope, located on the western end of the Borough, receives approximately 10 inches of precipitation annually, with snowfall of about 36 inches (DCED 2004).

South of the arctic coastal plain are the Brooks Range Foothills and the Brooks Range. There is a change in the climate conditions as the elevation increases. Air temperatures decrease rapidly with rising elevation (Nowacki, Spencer et al. 2001). Anaktuvuk Pass, located in the north-central portion of the Brooks Range, has more of a continental climate. Due to the higher elevation, summers are cool. The average temperature in January is about -14^{o}F, and the average summer temperature is about 50^{o}F. Extremes have been recorded from -56 to 91^{o}F.

Anaktuvuk Pass receives approximately 11 inches of precipitation in the summer months, and receives an average of 63 inches of snowfall per year (DCED 2004).

Prevailing winds blow cold air off the Arctic Ocean and are strongest during winter, often creating blizzard conditions. The prevailing wind direction is typically northeasterly to easterly, and southerly winds may break this pattern on occasion. The average annual wind speed in the region is approximately 12 miles per hour (MPH).

3.1.1.1 General and unique climate characteristics (seasons, ice characteristics both offshore and soil, atmospheric)

The treeless, wind-swept arctic coastal plain gradually rises from the Beaufort Sea coast southward to the foothills of the Brooks Range. This flat to rolling coastal plain is underlain by unconsolidated soil deposits of marine, fluvial (riverine), glaciofluvial (glacial), and eolian (wind) origin, and has no bedrock near the surface. Due to low temperatures, permafrost is continuous across the region, except under large rivers and thaw lakes. Permafrost and frost processes contribute to a large variety of surface features such as pingos, ice-wedge polygons, and oriented thaw lakes. The presence of permafrost prevents surface drainage so soils typically are saturated and have thick organic horizons. Due to the abundance of thaw lakes (covering up to 50 percent of the surface) and saturated soils, nearly the entire region supports wetland vegetation. Although drainage over most of the area is poor, there are numerous large, braided rivers that originate in the Brooks Range and drain northward to cross the coastal plain (Nowacki, Spencer et al. 2001).

Sea ice typically forms on the Beaufort and Chukchi Sea in November and remains through early June. The formation of first-year sea ice along the coast signals the start of freeze-up. During the first part of freeze-up, nearshore ice is susceptible to movement and deformation by winds and ocean currents. By late winter, the first-year sea ice is about 6 to 7 feet thick. The ice freezes to the seafloor and forms the bottomfast-ice subzone of the landfast-ice zone. The landfast-ice zone may extend from the shore out to depths of 45 to 60 feet (Wickersham & Flavin Planning Consultants 1982; U.S. Department of the Interior 2004).

Nearshore ice in the spring

Rivers and lakes start freezing in September. Some rivers and lakes freeze to the bottom, other maintain flow under the ice or have deep pools, which are critical to both the survival of fish and as a source of water for community and industrial uses (such as ice roads). Along the Beaufort Sea coast, breakup of the rivers and lakes generally begins in late May but may occur as late as mid-June. River ice begins to melt before the sea ice and, during the early stages of breakup, water from rivers may temporarily flood ice that has formed on the deltas.

Storms are a major factor in weather on the North Slope, and a consideration for all types of offshore and onshore human activity. Offshore storms can create hazards for residents pursuing subsistence activities, and create wave and ice conditions that are hazardous to oil exploration and production offshore structures. Storms also contribute to coastal erosion and ice override hazards (see Section 3.1.x). Onshore, storms can bring transportation to a halt, endanger people traveling between communities, and cause snow drifting that buries facilities and roads.

3.1.1.2 Trends and changes (ice characteristics)

Temperatures in Alaska and throughout the arctic appear to have fluctuated over the last few centuries. Changes in sea ice and permafrost are an important indicator of climate change (U.S. Department of the Interior 2004). Observations made over the last 50 years indicate a decline in the arctic sea-ice extent in all seasons, with the most prominent retreat in the summer. The average extent of sea-ice cover in summer has declined by 15 to 20 percent over the past 30 years. This decline is expected to accelerate over the next century with the projected near total loss of summer sea ice. Formation of sea ice is also occurring later in the season, which can increase the hazard of storms and coastal erosion. In addition, sea level is expected to rise on the order of 0.3 to 3 feet over the same time period (Hassol 2004) Observations indicate that permafrost is melting in some locations along the North Slope, resulting in problems for community facilities (see Section 3.1.3).

3.1.2 *Characteristics of North Slope physiographic zones (ocean, nearshore/coastal, riverine, uplands, foothills, mountains)*

Arctic Coastal Plain

The North Slope Borough includes the physiographic regions of the arctic coastal plain, the Brooks Range Foothills and the northern portion of the Brooks Range. The arctic coastal plain is characterized by periglacial features such as thaw lakes, marshes, and polygonal patterned ground. The coastal plain extends southward from the shoreline approximately 30 miles into the coastal lowlands. There is little topographic relief and relatively poor drainage. The polygonal patterned ground forms from ice wedges that freeze within contraction cracks in the soil. Throughout the year, these cracks fill with water and snow, then freeze and expand. Freshwater lakes cover approximately 26 percent of the arctic coastal plain (Nowacki, Spencer et al. 2001).

View of the arctic coastal plain and coastal lowlands

Brooks Range Foothills

The Brooks Range Foothills are characterized by gently rolling hills and broad exposed ridges form the northern flank of the Brooks Range. Narrow alluvial valleys and glacial moraines and outwash are interspersed among long linear ridges, buttes, and mesas comprised of tightly-folded sedimentary rocks. Most of the surface is mantled with colluvial and eolian deposits. A dry polar climate dominates the land, but is somewhat warmer and wetter than the arctic coastal plain. The surface is underlain by thick continuous permafrost and slope-related periglacial features, such as solifluction lobes and stone stripes, are common. Because the permafrost impedes drainage, soils in the active layer are usually saturated and have fairly thick organic horizons. Soils of the lower foothills tend to be calcareous, whereas the upper foothills are frequently acidic. Many braided streams and rivers with highly variable seasonal discharge are present. Lakes are infrequent. Some streams freeze solid to their bottoms, causing large aufeis deposits that last well into summer (Nowacki, Spencer et al. 2001).

Brooks Range

The Brooks Range is an east-west trending range that represents the northern extension of the Rocky Mountains. To the west and east, the topography becomes less rugged. High-energy streams and rivers cut through narrow ravines with steep headwalls etching a deeply-incised, dendritic pattern into the terrain. Few remnant small cirque glaciers exist in the Brooks Range. Valleys and lower mountain slopes on the north side of the range are covered by mixed shrub-sedge tussock tundra with willow thickets along rivers and streams. Alpine tundra and barrens dominate at higher elevations along the entire crest of the range (Nowacki, Spencer et al. 2001).

3.1.3 *General geological characteristics (mineral and oil/gas provinces)*

The geology of the North Slope Borough can be divided into four relatively distinct provinces: the central and eastern Brooks Range, the Delong Mountains in the western Brooks Range, the arctic foothills, and the arctic coastal plain (Wahraftig 1992).

Central/Eastern Brooks Range

The central and eastern Brooks Range encompasses several smaller mountain ranges, including (from west to east) the Endicott, Phillip Smith, Shublik, Franklin, Romanzof, and Davidson Mountains. These mountains were built by upthrusting of Paleozoic- and Mesozoic-aged sedimentary and metamorphic rocks during Mesozoic and Cenozoic time. A large body of granite intrudes the metamorphic rocks of the Romanzof Mountains in the eastern Brooks Range (Selkregg 1975; Moore, Wallace et al. 1994). Significant metalliferous lode deposits related to intrusion of polymetallic veins and skarn deposits have been identified in the Franklin and Romanzof Mountains (Nolkeberg, Bundtzen et al. 1992). This is an area of the North Slope with the high potential for mineral development.

Delong Mountains

The Delong Mountains are characterized by a deformed thrust-faulted belt of late Paleozoic to Mesozoic-aged sedimentary and mafic volcanic rocks (Moore, Wallace et al. 1994). Extensive coal beds occur within these rocks, and oil shale is common along the northern front of the mountains (Selkregg 1975). The Red Dog Mine, a massive sulfide deposit containing copper, zinc, lead, and silver, lies on the south side of the Delong Mountains near the southern boundary of the North Slope Borough (Wickersham & Flavin Planning Consultants 1982). Other significant metalliferous lode deposits have been identified along the Delong Mountains, including podiform chromite, bedded barite, and massive sulfide lead-zinc deposits (Nolkeberg, Bundtzen et al. 1992). This is an area of the North Slope with high potential for mineral development.

Arctic Foothills

The arctic foothills province extends along the north side of the Brooks Range and wraps around the west end of the Delong Mountains near Point Hope. The arctic foothills are composed of primarily Cretaceous-aged sedimentary rocks containing sandstone, conglomerate, siltstone, organic shale, and coal. These rocks comprise a sedimentary basin area known as the Colville foredeep and foreland fold belt, which is characterized by numerous east-west trending folds that trap several known oil and gas fields. It also contains more shallow deposits of frozen natural gas hydrates. These formations also contain extensive coalbeds and potential coalbed methane resources (Merritt and Hawley 1986; Kirschner 1992; Magoon III 1994; Tyler, Scott et al. 2000).

Arctic Coastal Plain

The arctic coastal plain is covered by Quaternary-aged unconsolidated deposits that overlie gently south-dipping Cretaceous- and Tertiary-aged sandstone, conglomerate, shale, and siltstone (Selkregg 1975). Extensive coalfields and potential coalbed methane resources occur beneath the arctic coastal plain in the Cretaceous and Tertiary formations (Merritt and Hawley 1986; Tyler, Scott et al. 2000). Deeper subsurface late Paleozoic and Mesozoic formations, that are buried extensions of Brooks Range rocks, thin out and truncate to the north against a major east-southeast trending structure known as the Barrow Arch. These conditions provide many stratigraphic traps that contain the major oil and gas fields of the Prudhoe Bay region (Selkregg 1975; Kirschner 1992). Approximately 20 oil and gas fields occur in the North Slope coastal region extending from Barrow to the Canadian border (Kirschner 1992; Magoon III 1994). The arctic coastal plain remains an area of high potential for oil and gas development.

3.1.4 *Air and Water Quality*

3.1.4.1 Air Quality

Air quality information in the North Slope Borough is limited to some villages and areas where oil development has occurred. An Ambient Air Quality Monitoring Station, operated at Nuiqsut since 1999, and a comprehensive year-long air quality and meteorological study at Prudhoe Bay, provide the best available estimate of existing conditions and changes that could occur with development. Data collected at the Nuiqsut site are representative of background and regional air quality in the Colville River Delta and the Alpine facility. These data indicate that air quality is in compliance with National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) for all pollutants and averaging periods (U.S. Department of the Interior 2004).

Emission sources in North Slope villages consist of diesel-fired generators and home heaters, open burning, small aircraft, and vehicle traffic. Regional sources of emissions consist of oil and gas production facilities such as Kuparuk, Milne Point, Prudhoe Bay, Northstar, Endicott and the Alpine facility.

Arctic haze is a phenomenon that typically affects the North Slope air quality in winter and spring, when visibility can be reduced from more than 50 miles to less than 5 miles. Arctic haze was first reported in the 1950s, well before North Slope developments took place. Scientists believe the haze is the result of long-range transport of pollution from the burning of heavy oils in industrialized Europe (USAED 1999).

Freshwater stream flowing to saltwater

3.1.4.2 Water Quality

Most freshwaters in the North Slope Borough are typically pristine in water quality. Along the coast, seawater often infiltrates upstream for several miles from the mouths of major rivers, increasing the sodium chloride (salt) concentrations. The concentration of total dissolved solids in streams generally increases from their headwaters to the mouth. Total dissolved solids vary seasonally from a low concentration during peak flow to increasingly high concentration as winter progresses. The freeze/thaw

cycle in the arctic plays a controlling role in water quality. In winter, surface waters less than 6 feet deep freeze solid. Major ions and other "impurities" in the ice are typically left in the sediment when breakup occurs, giving these waters a very low dissolved solid concentration (Wickersham & Flavin Planning Consultants 1982; U.S. Department of the Interior 2004). In waters deeper than six feet, ions are forced into the deeper water column with a proportionate increase of concentrations of dissolved solids. As a result, a distinct off-flavor and saline taste affect the potability of water from these shallower "deep-water" lakes and river pools by late winter.

Sources of potential water contamination include human activities associated with oil and gas exploration and production, and with the Borough's villages. Oil and gas activities can contaminate water from sources such as oil and fuel spills, runoff from developed sites, landfills, sewage treatment, and reserve pits associated with drilling. Villages contain similar sources of contamination, including fuel spills, landfills, and sewage disposal. The Borough encourages efforts to reduce potential sources of water contamination, such as the closure and restoration of existing reserve pits and improvements in landfill design and management.

3.1.5 *Hazards*

3.1.5.1 Erosion

Coastal Erosion

Coastal erosion is becoming a major problem in many communities in the North Slope Borough. Erosion is minimal during the winter months when the seas bordering the arctic coast are frozen. The ice acts as a wave dampener, retarding coastal erosion processes during this period. Ice ridges along the coast also serve to protect the coastal beaches and bluffs. However, during summer, erosion of the thawed beaches and the thermal erosion of coastal banks and bluffs proceed at a rate such that coastal retreat is a continuing problem throughout the Arctic. Recession rates as much as 33 feet per year have been reported along the coast of the arctic coastal plain (Selkregg 1975). The retreat is primarily due to thermal erosion and collapse of the coastal banks, as beaches are narrow or absent along much of the coast. Other factors contributing to coastal erosion are storm surges and wave action from major storms, and potentially rising sea levels over the next century (Hassol 2004).

Coastal erosion control project in Barrow

Several communities in the North Slope Borough are experiencing coastal erosion, specifically Barrow, Wainwright, Kaktovik, and Point Hope. Erosion control and protection measures are currently being used in some communities with mixed success. Continued needs for erosion protection and the effectiveness of protection measures should be assessed on a regular basis. Coastal erosion is also a major factor in siting community facilities and housing. During site selection for facilities (including airports, tank farms, and landfills) and housing, short and long-term potential for coastal erosion should be assessed.

River Erosion

Erosion of stream banks results from thermal erosion, bank undercutting, high velocity flooding, and ice scour by broken river ice during spring breakup. As water comes into contact with ice-cemented sediments, heat transfer causes the ice to melt. As streams thaw, the exposed bars, beaches and banks become sources of sand and silt for wind scour. Wind deflation blowouts are common along stream and lake banks (Selkregg 1975). The potential for erosion in communities located on rivers, such as Atqasuk, Nuiqsut, and Anaktuvuk Pass, should be assessed for existing and future facilities.

3.1.5.2 Flooding

Flooding on rivers occurs during spring breakup between May and early July. During spring breakup, ice jams increase the height of floodwater, especially in downstream reaches. When spring flow begins, water flows over the snow and ice in the channels. Flooding can extend for considerable distances beyond channels. Flooding subsides as channel ice is carried downstream and out to sea. The potential for riverine flooding should be assessed when designing and locating new facilities and housing, particularly in Atqasuk and Nuiqsut.

Rarely do flood events occur along the arctic coastal plain that result from precipitation events. Intense, long periods of rainfall can cause general flooding and swollen streams. This is not a normal yearly occurrence because of the low precipitation in the Arctic; however, floods from August rains have been extensive (Selkregg 1975).

During late fall, storm surges often cause significant flooding and damage along coastal areas. In the fall, the sea ice may be far enough offshore that high winds can develop high waves and a storm surge tide that inundate coastal areas. Both Barrow and Kaktovik have experienced flooding during fall storms, and potential for flooding should be a factor when siting new facilities and housing.

3.1.5.3 Permafrost melting

Permafrost consists of frozen soil, frozen rock, or buried ice masses that have remained below a temperature of 32^{o}F for more than two years. Continuous permafrost is present throughout the North Slope Borough, both on land and nearshore. Permafrost melting may occur due to both natural and man-made conditions. Seasonal fluctuations cause material near the ground surface to thaw and refreeze yearly. This active layer ranges from 0.5 to 10 feet thick and extends down to the top of permafrost. Occasionally the entire active layer may not refreeze in winter, potentially causing pressurized porewater to be forced to the surface forming ice sheets known as aufeis. Aufeis often forms in floodplain areas (Wickersham & Flavin Planning Consultants 1982).

Thermokarst ground features can form when ice-rich soil experiences melting due to either natural or man-made causes. These include mounds, sinkholes, tunnels, caverns, ravines, lake basins, circular depressions, and polygonal ground patterns. Natural thaw lakes, a dominant

feature in the arctic coastal plain, form by localized thawing of the upper permafrost by ponded water. Thaw lakes or subsidence may also develop in disturbed areas, such as minor depressions in the tundra caused by vehicle tracks. Thaw lake shorelines tend to migrate in the direction of prevailing winds, as wind increases the undercutting of soil (Wickersham & Flavin Planning Consultants 1982; USAED 1999).

Man-made structures such as roads, buildings, and pipelines can cause permafrost melting. Though all frozen soils are susceptible to thermal degradation, fine-grained ice-rich soils experience the most significant engineering property changes when thawed. Experience in arctic construction has yielded methods of placing structures in permafrost without significantly disturbing the thermal balance. Designs typically either insulate the permafrost or separate it from damaging heat sources. Examples include elevated roads with gravel insulation beneath, pilings that separate structures from the permafrost, and thermal piles that circulate fluids to draw heat from the ground. Frost heave can occur in fine-grained soils in the active layer, or on the edge of thaw bulbs adjacent to lakes, potentially affecting pilings and structures (Wickersham & Flavin Planning Consultants 1982; USAED 1999). Problems associated with the melting of permafrost and settlement under sewer lines has been reported in the community of Point Lay; system repairs have been required frequently over the past several years. Permafrost is a consideration for both the design and location of utilities, facilities and housing.

Climate changes may cause slow long-term permafrost melting due to both natural climate cycle effects and man-made contributions from carbon dioxide emissions. Studies of permafrost temperature profiles suggest that mean annual ground surface temperatures in Alaska have warmed on the order of 3 to 8^{o}F over the last century, and as much as 3 to 4 ^{o}F over the past few decades (Osterkamp 1984; Hassol 2004; U.S. Department of the Interior 2004). In addition, the depth of the active layer is increasing in many areas. Over the next 100 years, permafrost degradation caused by climate change is projected to shift the southern limit of continuous permafrost northward by several hundred miles, potentially reaching the southeast portion of the North Slope Borough (Hassol 2004). Since much of arctic engineering and construction design is based on assuming permafrost will remain frozen if structures are engineered properly, if the permafrost melts due to climate change, design bases are flawed and structures more likely to fail.

Permafrost is also present in offshore areas of the North Slope Borough, having formed when portions of the Chukchi and Beaufort seas were exposed to the arctic climate during periods of lower sea levels. Offshore permafrost occurs in both unbonded and ice-bonded forms. Ice-bonded sediment is held together by interstitial ice similar to onshore permafrost, while unbonded permafrost occurs where temperatures are below 32^{o}F but saline porewater inhibits ice formation. The depth to ice-bonded permafrost generally increases with distance from shore (USAED 1999). Like onshore permafrost, offshore ice-bonded permafrost is susceptible to thaw effects near man-made structures. Subsidence could threaten the stability of buried pipelines or wellbores.

Gas hydrates constitute another subsea permafrost concern. Gas hydrates are solid crystals of gas and ice that occur within and beneath subsea permafrost. Heat from offshore drilling could potentially change hydrates to a gas/water form (Wickersham & Flavin Planning Consultants 1982).

3.1.5.4 Ice override

Ice override occurs when sea ice is shoved onto shorelines and offshore islands by the pressure of moving ice sheets. Ice override is often referred to as ice ride-up and pile-up to describe horizontal and vertical ice movements, respectively. When moving sea ice contacts steep slopes or bluffs, failure tends to occur in a buckling mode, causing pile-up events; whereas ice ride-up tends to occur on more gently sloping beaches. Generally, wind is the main force that causes major ice override events. In the Beaufort Sea, a strong southwest wind combined with a high tide and westward currents create some of the most hazardous ice override conditions (USAED 1999). Capes and headlands are particularly affected by ice override because they are more exposed to shifting ice. Factors that make a coastline more susceptible to ice override include a relatively steep nearshore slope that allows ice to move close to shore before grounding, and an absence of offshore bars and shoals that impede ice movement (Maynard and Partch and Woodward-Clyde Consultants 1984).

Ice override can push aside beach and tundra material, potentially resulting in damage to coastal structures. Ice override events that shoved ice up to 40 feet high and 300 feet inland, crushing houses and boats, have been reported in the Barrow area (Wickersham & Flavin Planning Consultants 1982). Ice override events on barrier islands in the Point Lay area have been documented as moving 98 to 846 feet onshore and were up to 6.6 feet high (Maynard and Partch and Woodward-Clyde Consultants 1984). Moving ice also exerts lateral and vertical forces on offshore drilling structures and artificial islands. Artificial islands are typically engineered to include features such as slopes, benches, and walls that impede, deflect, or accommodate ice override (USAED 1999).

3.1.6 *Physical environment implications for development*

3.1.6.1 Seasonal limitations on development

Tundra Travel

The widespread occurrence of permafrost requires special engineering considerations for the design, construction and maintenance of structures and facilities. Permafrost degradation is primarily related to the insulation qualities of the surface layers and the ice content of the frozen ground beneath. Sensitivity is great along the arctic coastal plain, especially in the northern portion where the surface organic layer is thinnest and soil ice content is highest. Given these conditions, development along the coastal plain is limited to winter months when the ground surface is sufficiently frozen, there is adequate snow cover, and ice roads can be constructed. This prevents damage to the tundra material and subsequently to the underlying permafrost. Conditions and time frames for tundra travel are currently subject to federal, state, and borough regulations. In addition, traditional and contemporary local knowledge of the environment has been passed down from generation to generation and increased through the experience of Borough residents who have spent much of their lives working in and observing the environment. Residents have detailed knowledge of tundra conditions.

Tundra view in the summer months

All project proponents should consult with Borough staff and village residents during the planning and design stages of projects in order to incorporate traditional and contemporary local knowledge in an appropriate manner. The incorporation of traditional and contemporary local knowledge should be an integral component of the project plan; it is not a well-reasoned approach to ignore thousands of years of knowledge until a very late stage of project planning. The Borough particularly emphasizes that project proponents should foster constructive relationships with tribal governments and local governments.

Traditional and contemporary local knowledge has been utilized in the Arctic Gas pipeline project and the Alpine CD4 project to result in safer facility location and designs. There are some projects that the Borough was dissatisfied with how traditional and contemporary local knowledge was used. While there are still improvements to be made in the effective incorporation and utilization of traditional and contemporary local knowledge, efforts such as these will serve as educational tools for future projects.

Offshore Activities

Seasonal limitations also affect offshore vessel traffic and oil and gas operations. Offshore activities typically avoid both break-up and freeze-up conditions when sea ice is thin, broken, and unpredictable. As indicated in Section 3.1.1.1, sea ice typically forms in November and remains until early June. Open water conditions usually exist for 2 to 3 months in the summer (USAED 1999). Once shorefast ice forms and the ice is thick enough to support heavy equipment, ice roads can be constructed for travel in offshore areas.

However, the periods leading to break-up and freeze-up are a great concern for oil and gas exploration activities, due to the inability to contain and recover spilled oil in broken ice. Traditional and contemporary local knowledge on sea ice and severe weather conditions, such as fog, ice, winds, sea state, and currents, indicates that spill response would be severely impeded. Oil skimmers would have great difficulty working efficiently in broken ice and slush ice conditions. There are great dangers for boat travel during periods when unpredictable leads can open and shut quickly. Traditional and contemporary local knowledge is based on extensive experience navigating the Beaufort and Chukchi Seas over thousands of years.

Broken sea ice in early summer

All project proponents should consult with Borough staff and village residents during the planning and design stages of projects in order to incorporate traditional and contemporary local knowledge in an appropriate manner. The incorporation of traditional and contemporary local knowledge should be an integral component of the project plan; it is not a well-reasoned approach to ignore thousands of years of knowledge until a very late stage of project planning. The Borough particularly emphasizes that project proponents should foster constructive relationships with tribal governments and local governments.

3.1.6.2 Hazards

Hazards associated with development that are inherent to the arctic environment include permafrost thawing, channel flooding and erosion during spring breakup, and shoreline impacts. As indicated in Section 3.1.5.3, major engineering problems arise in areas underlain by permafrost containing poorly drained fine-grained sediments. These sediments contain large amounts of ice, and when disturbed, a change in the thermal balance causes the ice to melt. Thawing produces excessive wetting and plasticity, making the sediments unstable resulting in frost heaves, slumping and subsidence of the ground surface. These processes and cycles of freezing and thawing in the active layer can cause extensive damage to building foundations and other facilities, roads and airstrips. Design criteria for pads and structures needs to consider appropriate measures to insulate the soils (gravel pads, foam insulation) and use of thermal piles to avoid introducing heat into the permafrost. Similarly, tundra travel off of ice roads needs to consider adequate snow cover and soil freezing to avoid damaging the vegetation in a manner that will accelerate thawing of permafrost.

Location and design criteria for pads, roads and stream crossings need to consider both the magnitude of design flood events and the height of floodwater during spring breakup. The height of water during a given flood event is a function of the amount of snow and ice in the channel as breakup begins, and the presence of ice jams that may form as the channel ice begins to move downstream. If the height of floodwater is underestimated, pads, roads and other structures may be inundated during breakup. Design criteria for road and pipeline stream crossing also need to account for impacts from ice blocks as they are transported downstream during breakup conditions. Channel ice that is detached from the channel bottom as spring breakup occurs can cause damage to under-designed structures such as bridges, culverts and pipeline supports at stream crossings. Residents of North Slope communities have knowledge of local conditions related to flooding, breakup, and characteristics of specific rivers and streams. Consultation with local residents should occur as part of the siting and design process.

As indicated in Sections 3.1.5.1 and 3.1.5.4, the coastline of the Borough is subject to both ice override and thaw erosion of coastal bluffs. These hazards could conspire to impact as much as a several hundred foot swath of land adjacent to the shoreline. Design criteria for structures within this zone need to account for ice forces and coastal recession, and restrictions on future development within these areas should be considered on a site-specific basis.

3.1.6.3 Spill response

Oil and fuel spills can occur in areas of oil and gas exploration and production, and in villages. Potential impacts to soil and water resources from spills of oil or other contaminants are documented in other planning documents for North Slope projects (e.g., (USAED 1999; U.S. Department of the Interior 2004). Oil spills could occur from a variety of sources such as pipelines, exploration and production pads, roads, airstrips, bridges, or village fuel systems, and could reach tundra, lakes, rivers, or marine water and sediment. Spills released onto tundra can infiltrate snow, vegetation, and soil, or flow downhill until reaching surface water bodies or depressions. The spread of spills onto water surfaces depends on viscosity, temperature, and ice cover.

There are analyses that indicate that spills onto ice would be prevented from spreading rapidly by snow and ice roughness (U.S. Department of the Interior 2004). These sources also indicate that spills onto water between broken ice would not spread as rapidly as on open water and oil leaks under nearshore sea ice would likely not spread until breakup due to slow under ice currents. However, the Borough disagrees with such analyses. Traditional and contemporary local knowledge indicates that the effects of under-ice currents would have a major impact on

the spread of oil in the Beaufort and Chukchi Seas. There are also substantial limitations for boat operations for clean-up efforts during periods when unpredictable leads can open and shut quickly.

To date, there have been no oil spill recovery techniques that have been effectively designed or tested to clean up oil in spring broken ice conditions, fall freeze-up conditions, or under solid ice. In addition, there is a substantial lack of resources and technical capability to stop, recover, and clean up an oil spill in an offshore environment. There is not presently an ice-breaking barge located on the North Slope for oil spill response. Dispersants have not proved to be an effective option when tested in the North Slope Borough. Because of the existing risks of an oil spill from offshore resource development activities, the North Slope Borough has a vested interest in improving offshore oil spill response technology and techniques and encourages industry innovation in developing new spill response techniques to address the climatic conditions of the North Slope Borough.

Responses to spills require different measures depending on the location of the spill and season. Onshore spill containment during frozen ground conditions may include mechanical recovery using heavy equipment, whereas manual or natural degradation methods might be used in summer months to minimize damage to tundra and permafrost. Spill response in offshore areas may employ boats and booms in summer ice-free months; whereas response during broken ice conditions would be very difficult as previously discussed. Offshore spill response during continuous ice conditions may be similar to onshore winter response, making use of heavy equipment transported over ice road (USAED 1999). However, if spills penetrate cracks in ice, there are limited resources and techniques available for handling under-ice spills.

The difficulty in responding to spill events under certain conditions (offshore areas during broken ice, freeze-up or slush ice conditions, and under ice in frozen conditions; and onshore areas during summer months) suggests that development activities, particularly drilling, be seasonally limited to avoid these conditions and afford maximum response capability, unless drilling occurs on an onshore gravel pad. The risk of spills reaching and/or spreading on open waters can be minimized by avoiding the placement of oil development infrastructure in floodplains or near rivers, lakes, and beaches. The Borough has discouraged offshore development because of the current high level of impact risk to the subsistence way of life; there is simply a lack of resources and technical availability to effectively stop, recover, and clean up an oil spill in the offshore environment at any time of year in the North Slope Borough.

3.1.6.4 Persistence of airborne/water/soil contaminants in the arctic environment

Certain contaminants in air, water, and soil are known to persist in the arctic environment more than in temperate regions. A group of chemicals known as persistent organic pollutants (POPs) are carbon-based chemicals that include industrial compounds such as polychlorinated biphenyls (PCBs), pesticides such as DDT, and industrial wastes such as dioxins. These chemicals resist degradation through natural processes and bioaccumulate in living organisms. Long-range transport via the atmosphere is the most likely source of POPs in the arctic. While the use of most of these chemicals has been discontinued In the U.S. for years, they are still widely used in many developing countries. POPs are a concern in arctic Alaska not only because global air and water currents tend to carry them to northern regions, but also because they accumulate in the fat tissues of humans and animals at the top of the food chain, such as those that comprise a critical part of the subsistence diet of Native Alaskans (Chary 2000; Tesar 2000; Tesar 2000b). Current research suggests that POPs may have an effect on the immune systems of children in the arctic as well as other possible health effects (Tesar 2000a).

In 2002, several countries of North America and Europe were party to a global treaty to protect human health and the environment from POPs (United Nations Environmental Programme (UNEP) 2004). It is anticipated that global reduction in the use of POPs will occur as a result of this agreement; however, progress is expected to be slow since much money and time will be needed to replace POPs in developing countries that are highly effective for their intended use, such as pesticides that fight the spread of malaria (Tesar 2000a). POPs are not known to originate in the North Slope Borough, except for minor occurrences in soils at old military installations (Crump 2000). Other than the continued management of old contaminated sites by the military and ADEC, limitations on future development in the Borough would not have an effect on the presence of POPs in the physical or biological environment.

Spills of hydrocarbons or other contaminants that originate in the North Slope Borough from oil and gas operations or other sources are likely to persist in the physical environment in certain forms. Oil spills are subject to degradation and a number of interrelated weathering processes, including spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, sedimentation, and photo-oxidation. The toxicity of crude oil decreases with time as lighter, more harmful, aromatic hydrocarbons evaporate. Air quality impacts, acute chemical toxicity, and physical effects such as oiling of feathers, are greatest during the first month following a spill. Sublethal effects may be observed in surviving birds, mammals, and fish for years after a spill, as the toxic components of hydrocarbons such as PAHs persist in soils and lake or marine sediments (USAED 1999). Despite the acute short-term effects on tundra, recovery of vegetation has been documented in studies after several decades following oil spills (Athey, Reeder et al. 2001).

3.1.7 *Use of Traditional and Contemporary Local Knowledge*

Traditional and contemporary local knowledge of the physical environment has been passed down from generation to generation and increased through the experience of Borough residents who have spent much of their lives working in and observing the environment. Traditional and contemporary local knowledge means knowledge imparted by elders, hunters, gatherers, whaling captains and others amongst the Inupiat people about the culture and history of the Inupiat people and the natural environment, including, but not limited to, knowledge of subsistence habits, uses, and traditions, wildlife, flora, fauna, land, sea, water, air, and ecosystem conservation.

Residents have detailed knowledge of local conditions, including routine and historic events, which can affect the location and design of facilities and utilities. Traditional and contemporary local knowledge can provide information on local flooding, erosion, ice override, storm, and geological conditions.

Traditional and contemporary local knowledge for the North Slope area is well documented in written record at the University of Alaska – Anchorage, University of Alaska – Fairbanks, Barrow Tuzzy Consortium Library, North Slope Borough Planning Department Inupiat History Language and Culture division, North Slope Borough Planning Department's Geographic Information System, tribal organizations, and the Alaska Eskimo Whaling Commission records, among other locations. In addition, federal agencies such as the National Science Foundation, National Oceanic and Atmospheric Administration, and Minerals Management Service have specific funding and programs to elicit and document traditional and contemporary local knowledge, and have an obligation as tribal trustees to provide this information to the public.

All project proponents, including resource and village development projects, should consult with Borough staff and village residents during the planning and design stages of projects in order to incorporate traditional and contemporary local knowledge in an appropriate manner. The

incorporation of traditional and contemporary local knowledge should be an integral component of the project plan; it is not a well-reasoned approach to ignore thousands of years of knowledge until a very late stage of project planning. The Borough particularly emphasizes that project proponents should foster constructive relationships with tribal governments and local governments.

Traditional and contemporary local knowledge has been utilized in the Arctic Gas pipeline project (from Kaktovik) and the Alpine CD4 project (from Nuiqsut) to result in safer facility location and designs. There are some projects that the Borough was dissatisfied with how traditional and contemporary local knowledge was used. While there are still improvements to be made in the effective incorporation and utilization of traditional and contemporary local knowledge, efforts such as these will serve as educational tools for future projects.

The Alaska Eskimo Whaling Commission (Alaska Eskimo Whaling Commission 2005) provided an example of traditional knowledge being relied upon to inform decisions regarding development.

> When Phillips Petroleum proposed building an ice island to drill the McCovey Prospect, the NSB and AEWC, based on Eskimo traditional knowledge of arctic sea ice, informed state officials that the drill site was located in the "shear ice zone" and that attempting to drill this prospect from an ice island would be extremely dangerous. Fortunately, the State was persuaded and did not permit the drilling operation to go forward. Had the operator gone ahead with this project, it could have had serious environmental consequences and could well have endangered the lives of those who worked on the ice island.
>
> A different operator later applied to drill at the same site using a bottom-founded drilling structure. The Borough and the AEWC believed that this structure would be able to withstand the pressures of the shear ice zone, and agreed that the project should go forward.

Traditional whaling boat ready for the spring harvest

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 *Ecosystem/habitat components*

The North Slope Borough lies within the arctic region of Alaska, a planning unit defined by the Joint Federal-State Land Use Planning Commission as an area encompassing the drainage basins of the northward-flowing rivers from the divide of the Brooks Range into the Chukchi and Beaufort seas (Selkregg 1975). The arctic region, and thus the North Slope Borough, can be divided into habitat subregions, or provinces based on physiography that serves to support the biological resources. The Delong Mountains and the central and eastern Brooks Range constitute the southern boundary of the arctic region. The range is a rugged area comprised of high (elevation >2,500 feet), glaciated mountains, nearly barren of trees, extensively underlain by permafrost, and covered at lower elevations by alpine and tussock tundra vegetation. The Arctic Foothills (elevation 800-2,500 feet) abut the range to the north and are a passageway to the sea for numerous rivers, such as the Colville, Kuparuk, Sagavanirktok, and Canning, and consist of rolling tussock uplands and dwarf shrub, herbs, and lichen tundra habitat (United States Geological Survey 1995) *in:* (Alaska Department of Natural Resources 1998). The arctic coastal plain (elevation <800 feet) connects the foothills with the arctic coast and is distinguished by the numerous lakes, thaw ponds, frost cracks, and polygonal ground formations that support extensive wetland habitats (Selkregg 1975). The arctic coast is the terminus for many river deltas emptying to the open sea, and is generally low-lying except for occasional bluffs and sea cliffs (Figure B-1). The key fish, wildlife, marine mammal, and protected species within the area that depend on these habitats for survival are discussed below.

View of the Brooks Range, near Anaktuvuk Pass

3.2.2 *Fish*

Fish species on the North Slope must deal with harsh environmental conditions such as seasonal cycles of freezing and thawing to survive. Winter lasts from between eight and ten months, during which freezing temperatures reduce fish habitat by more than 95 percent (U.S. Department of the Interior 1998). As a result, fish overwintering habitat becomes extremely important for the survival of fish populations, and care must be taken that development activities (such as water withdrawal, gravel mining, and bridges) do not impact these habitats. During the winter food is scarce, so fish are required to feed extensively during summer to accumulate energy reserves for over-wintering. Fish on the North Slope grow more slowly than fish living in warmer regions where food is plentiful year-round (U.S. Department of the Interior 1998). The key fish species known to occur in marine and freshwater regions of the North Slope are listed in Table 3.2-1. Three main categories of fish species are considered in this document: freshwater or resident, migratory, and marine. Many of these species are important for subsistence use.

3.2.2.1 Distribution of fish (location and seasons, migratory pathways)

In the Arctic, fish distribution depends on a number of factors, such as adequate over-wintering areas, appropriate feeding and spawning areas, and access to these areas, generally through interconnected waterways (U.S. Department of the Interior 1998). At the onset of winter, nearshore waters begin to freeze, and resident and migratory fish move upstream, while marine species that have migrated nearshore to feed, move further offshore. During the winter, streams less than six feet deep freeze solid to the bottom, and resident and migratory fish move to over-wintering streams and lakes with depths exceeding seven feet, where there is appropriate habitat and ample oxygen to sustain large numbers of fish (U.S. Department of the Interior 2004).

During the summer (open water period), melting coastal ice paired with river runoff creates relatively warm and brackish (low to moderate salinity) nearshore conditions. This band of brackish water typically extends from 1 to 6 miles offshore, but can extend as a plume to 15 miles offshore in areas of river deltas (U.S. Department of the Interior 1998). Marine invertebrates are present in this nearshore area because of the quantities of detritus transported and discharged into marine waters by the major rivers. The concentration of invertebrates, in turn, creates an influx of feeding migratory fish to the nearshore brackish area, and occasionally resident and marine fish.

Freshwater Fish

Freshwater fish species (also known as resident species) generally remain within freshwater rivers, streams, lakes, and ponds year-round. These fish feed, spawn, rear, and overwinter throughout these watersheds. The abundance of most arctic freshwater fish is limited by the availability of proper wintering habitat (National Research Council 2003). Large drainage systems of the central and eastern Borough such as the Colville, Sagavanirktok, and Canning rivers support diverse populations of freshwater fish species. The key freshwater species include arctic grayling (*Thymallus arcticus)*, round whitefish (*Prosopium cylindraceum*), lake trout (*Salvelinus namaycush)*, Alaska blackfish (*Dallia pectoralis)*, ninespine stickleback (*Pungitius pungitius*), and slimy sculpin *(Cottus cognatus)* (Froese 2004; U.S. Department of the Interior 2004).

The diet of freshwater fish consists of terrestrial and aquatic insects and larvae, zooplankton, snails, clams, fish eggs, and small fish (U.S. Department of the Interior 1998). Lake trout reportedly consume large quantities of slimy sculpin and ninespine stickleback, in addition to least cisco, round whitefish, and grayling (U.S. Department of the Interior 1998). Freshwater fish typically spawn from early spring to early fall in habitat with suitable gravel or rubble. As mentioned previously, winter temperatures drive fish to the deeper areas of lakes, rivers, and streams (U.S. Department of the Interior 1998).

Arctic grayling are one of the most abundant and widespread freshwater species in the Colville River drainage above the confluence of the East and West Delta channels. In addition to the Colville River, arctic grayling typically overwinter in deep areas within large river systems such as the Kuparuk, Sagavanirktok, and Canning rivers. In spring, adults move to tributaries to spawn, and during the summer, they move further downstream, into lakes or the main channel, to feed (National Research Council 2003). The lakes and streams of the Colville River watershed also support populations of ninespine stickleback, slimy sculpins and a small population of blackfish (U.S. Department of the Interior 2004).

The Sagavanirktok River delta provides over-wintering habitat for arctic grayling (Ott 1997; Alaska Department of Natural Resources 1998), while the middle reaches of the Canning River

provide habitat for arctic grayling and round whitefish (Alaska Department of Natural Resources 1998). In addition to the Canning River, the Kavik and Shaviovik rivers provide important spawning and over-wintering habitat for arctic grayling (Alaska Department of Natural Resources 1998).

Smaller river systems, like the Tingmiaksiqvik River, provides habitat for round whitefish and arctic grayling during the summer and winter (U.S. Department of the Interior 2004). Round whitefish are also found in Fish Creek (U.S. Department of the Interior 2004). Lake trout are widely distributed in lakes north and west of Fish Creek. The Utuoko and Kokolik rivers support populations of arctic grayling (Wickersham 1993b).

Migratory Fish

Migratory fish can be divided into two categories, anadromous and amphidromous. Anadromous fish are hatched and reared in freshwater, migrate to and spend a majority of their adult lives at sea, and then return to their natal freshwater rivers and lakes to spawn and die. Amphidromous species migrate often between estuarine nearshore waters and freshwater rivers and streams, usually in search of food, refuge, or spawning habitat. In comparison to anadromous fish species, amphidromous species live longer, grow more slowly, and become sexually mature later in life (U.S. Department of the Interior 1998). Anadromous streams are indicated in Figure B-6.

All migratory species feed primarily on epibenthic mysids and amphipods, as well as copepods, fish, and insect larvae during the summer, and most species cease feeding when they return to freshwater in the fall (U.S. Department of the Interior 1998). For those species that spawn during this time, their spawning habitat likely also serves as their over-wintering habitat, because the requirements are the same.

Anadromous Fish

Key anadromous species found in the North Slope Borough include arctic char (*Salvelinus alpinus)*, Dolly Varden (*S. malma malma*), arctic cisco (*Coregonus autumnalis*), Bering cisco *(Coregonus laurettae*), chum and pink salmon (*Oncorhynchus keta* and *O. gorbuscha* respectively), and rainbow smelt (*Osmerus mordax dentex)*. Depending on the species, juvenile anadromous fish can spend up to four years (e.g., Dolly Varden) maturing and feeding in freshwater before moving to marine waters (Froese 2004). Also depending on species, adults can spend up to five years feeding and growing to maturity (e.g., chum salmon) in nearshore marine waters before returning to natal waters to spawn (Froese 2004). Refer to Figure B-6 for key anadromous streams.

The nearshore brackish waters and lagoon systems (e.g., Nelson and Simpson lagoons) along the Beaufort Sea form a corridor along the coast through which anadromous fish migrate and feed. Adult fish generally leave the freshwater systems and enter the Beaufort Sea during early summer, after the nearshore ice has melted, to feed and accumulate energy reserves for over-wintering, or if sexually mature, for spawning (Alaska Department of Natural Resources 1998). Most anadromous species disperse to nearshore areas parallel to the shore whereas species more tolerant of the cold (e.g., arctic cisco and some arctic char) disperse widely from their stream of origin (U.S. Department of the Interior 1998). Migration back to their natal rivers varies by species, but most anadromous fish return to spawn by mid-September (Alaska Department of Natural Resources 1998). As mentioned for freshwater species above, the Colville, Sagavanirktok, and Canning river drainage systems support a wide variety of populations of migratory fish species.

The Colville River provides habitat (especially over-wintering) for dominant populations of arctic cisco and smaller populations of chum and pink salmon, and Dolly Varden (Alaska Department of Natural Resources 1998). Both pink and chum salmon are taken in the fall subsistence fisheries (U.S. Department of the Interior 2004). Arctic cisco are one of the most abundant and widely distributed whitefish in the coastal waters of the Bering Sea during the summer and the lower Colville River during the fall (U.S. Department of the Interior 2004). Arctic ciscos of the Colville River do not spawn in Alaska, but migrate from their natal Mackenzie River Delta system in Canada and move westward into the Alaska Beaufort Sea during late summer (U.S. Department of the Interior 2004). Their migration is a function of wind-generated coastal currents (National Research Council 2003). There is limited information on Bering cisco, but like arctic ciscos, they are likely distributed in the coastal waters of the Beaufort Sea during the summer and the lower reaches of the Colville River during the winter. They are a relatively important subsistence species in Barrow (U.S. Department of the Interior 2004).

The Sagavanirktok River delta provides over-wintering habitat for Dolly Varden and arctic char (Ott 1997; Alaska Department of Natural Resources 1998).

The spring-fed upper reaches of the Canning River provide spawning and over-wintering habitat for Dolly Varden and arctic char (Alaska Department of Natural Resources 1998). In addition to the Canning River, the Kavik and Shaviovik rivers provide spawning and over-wintering habitat for Dolly Varden and arctic char (Alaska Department of Natural Resources 1998).

River systems other than the Colville, Sagavanirktok, and Canning watersheds, although smaller, provide important habitat for a variety of fish species. The Hula Hula River is a major spawning and over-wintering area for arctic char; a smaller over-wintering area is located about 19 miles inland from the river mouth (Wickersham 1993b). This drainage is heavily used by the residents of Kaktovik (Wickersham 1993b). Spawning and over-wintering areas for arctic char are also found near the headwaters of the Aichilik River and the Egaksrak River, as well as the Ekaluakat River, which is a tributary to the Egaksrak (Wickersham 1993b). One of the larger perennial springs in the North Slope Borough, Sadlerochit Springs, is considered important habitat for rearing juvenile arctic char (Wickersham 1993b). Shublik Spring, located near the confluence of the Marsh Fork and Canning Rivers, provides important over-wintering habitat for arctic char (Wickersham 1993b).

The Korgakut River is possibly one of the most important streams in the eastern North Slope to provide habitat for arctic char. A 20-mile section of this river harbors spawning and over-wintering arctic char (Wickersham 1993b). The Utuoko and Kokolik Rivers support populations of arctic char, pink salmon, and chum salmon (Wickersham 1993b).

Rainbow smelt are unlike other anadromous fish in that they spend their winters and summers in nearshore brackish waters and spawn in the spring. Spawning takes place in the lower reaches of the Colville River (U.S. Department of the Interior 2004).

Amphidromous Fish

Key amphidromous species found in the North Slope Borough include: broad whitefish (*Coregonus nasus),* humpback whitefish (*C. oidschian*), and least cisco (*C. sardinella*) (Froese 2004; U.S. Department of the Interior 2004). Amphidromous fish can spawn either in a marine or freshwater environment, and do not necessarily die afterwards, as with anadromous fish (U.S. Department of the Interior 1998). Most amphidromous species spend more time in brackish, nearshore waters than in marine waters, but some populations (i.e., non-migratory components) of least cisco, and broad and humpback whitefish remain within freshwater river and lakes year-round (U.S. Department of the Interior 1998).

The least cisco is one of the most abundant whitefishes in the nearshore areas of the Beaufort Sea, especially Prudhoe Bay and Sagavanirktok Delta areas (Alaska Department of Natural Resources 1998). The least cisco spawns during late September and October in the Colville, Ikpikpuk, and Prive rivers (U.S. Department of the Interior 2004).

The Colville, Ikpikpuk, and Chipp rivers provide regionally important habitat (especially over-wintering) for dominant populations of broad and humpback whitefish (Alaska Department of Natural Resources 1998; Morris 2003; National Research Council 2003). The broad whitefish are distributed throughout the freshwater systems of the North Slope during summer and fall, and are an important subsistence fishery (U.S. Department of the Interior 2004). The Ublutuoch River, although relatively small, appears to be an important wintering area for broad whitefish as well as important spawning grounds because the gravel substrate remains thawed during the winter (Morris 2003). Broad whitefish have been documented to move during three different periods: during spring, the fish move to small streams/productive riverine habitats; in the summer they move to more productive habitats; and from summer to fall, they move to spawning and wintering areas (Morris 2003). The humpback whitefish summer distribution is likely limited to main river channels and low-salinity coastal areas (U.S. Department of the Interior 2004).

Marine Fish

The marine environment along the North Slope consists of inlets, lagoons, sand bars, and mudflats (U.S. Department of the Interior 1998). Key marine species found along the North Slope include arctic cod (*Boreogadis saida*), fourhorn sculpin (*Triglopsis quadricornis*), and arctic flounder *(Pleuronectes glacialis)* (Froese 2004; U.S. Department of the Interior 2004). Marine fish prefer the colder, more saline waters seaward of the nearshore brackish zone, and spend their entire lives in the marine environment, although some species migrate nearshore during summer to feed. The diet of these marine fish species consists primarily of marine invertebrates such as amphipods, mysids, isopods, and copepods. In addition, flounders prey on bivalve mollusks, while fourhorn sculpins consume juvenile cod. Occasionally, marine and migratory fish species will be in direct competition with one another for food, usually in the nearshore areas.

Arctic cod are very abundant in coastal regions during the summer and winter. In the Beaufort Sea, the fish may also be found in estuarine lagoons and into fresh water river mouths. The movements of arctic cod between nearshore and offshore environments are related to spawning as well as ice distribution (U.S. Department of the Interior 2004).

Fourhorn sculpin and arctic flounder exhibit nearshore habitat preferences similar to arctic cod, as they are found in cold brackish and moderately saline water near the coast. Both species migrate nearshore during summer to feed, and may travel considerable distances up rivers (U.S. Department of the Interior 2004). Fourhorn sculpin travel into the freshwater of coastal rivers, and as far as 85 miles upstream in the Meade River (U.S. Department of the Interior 2004). These fish move onshore-offshore seasonally; they travel to deeper water in the spring, and remain there until summer (U.S. Department of the Interior 2004).

3.2.2.2 Trends and development considerations

Freshwater Fish

Development in the North Slope Borough can affect the dispersal or survival of freshwater fish through the alteration of drainage patterns, in combination with water withdrawals and contamination (National Research Council 2003). Drainage patterns are most altered by the

construction of gravel roads or pads in or through wetlands and drainage areas. During spring breakup, if long roads interrupt the flow of snow melt, the water level can be artificially raised, thereby causing a high-velocity water flow through culverts that can inhibit or delay upstream movement by fish. During summer, the water flow is lower than in spring, and some fish, such as the broad whitefish, must move to deeper waters to overwinter. Impoundments caused by improperly placed culverts or streambed modifications can reduce the water flow so that the shallow area freezes early, or is too shallow for passage, thereby trapping the fish and leading to mortality (National Research Council 2003). The proper placement and use of open bottom culverts as opposed to closed-bottom culverts will help to ensure proper flow and access of fish to other areas of a stream. Some human alterations have been found to enhance or create freshwater fish habitat. Abandoned gravel pits that have filled with water and are linked to an existing water body have been shown to provide additional overwintering habitats for freshwater fish such as arctic grayling (National Research Council 2003).

Water withdrawals for the construction of ice roads can affect water quality, available amount, and alter water flow, thereby disrupting fish habitat. The removal of water in fish-bearing lakes is regulated by the Alaska Department of Natural Resources. The use of screens while pumping water can prevent fish from being deposited on ice roads, thereby leading to mortality. However, not all contractors install screening in their pumps (National Research Council 2003). Any contamination near fish-bearing water bodies can become concentrated when the water volume is reduced or flow altered due to an activity mentioned above, thereby becoming more harmful to the fish.

Seismic activity related to development activities has caused fish harm and mortality due to the sudden and large changes in ambient pressure. The introduction of vibratory or percussion equipment has proven to generate a slower velocity energy below the threshold known to affect fish in streams and lakes, thereby reducing the adverse effect on fish (National Research Council 2003).

Migratory Fish

As mentioned above for freshwater fish, gravel and ice roads, and water withdrawals can alter habitat for migratory fish (anadromous and amphidromous) and prevent movement throughout water bodies. Because migratory fish must be able to reach freshwater spawning grounds from marine waters, any construction in the nearshore waters could disturb the fish or prevent their passage to the freshwater stream (National Research Council 2003).

Any modification of the coastal environment that would prevent or interrupt the movement of migratory fish to spawning or overwintering grounds can lead to reduced recruitment. Structures such as sold-fill causeways have been shown to alter the coastal currents and alter fish movements within the coastal band of warm water. Changes in nearshore circulation can lead to temperature and salinity changes, which can affect sensitive species such as broad whitefish. Filled causeways built perpendicular to the shoreline as opposed to parallel to the shore exert more of an impact on currents and fish. The Borough oversees a causeway-monitoring program, which has shown that the West Dock Causeway has interfered with the eastward movement of juvenile least cisco and humpback whitefish moving from the Colville River to Prudhoe Bay during early summer (National Research Council 2003). This blockage was reduced by a breach retrofit in 1996. For these reasons, development activities should favor the use of breaches or elevated causeways, over solid-fill causeways.

Marine Fish

As mentioned for migratory fish above, the construction of causeways should incorporate design features that ensure the passage of fish and do not restrict coastal currents. Because many marine fish use the coastal area for feeding, any alteration of water chemistry or temperature may interfere with the distribution of prey. If prey becomes scarce, fish must expend more energy than usual to find prey, or compete with other larger fish, their nutritional load may decline, thereby possibly leading to poor health and mortality or reduction in recruitment.

The effects of climate change and increasing temperatures over the past 10-15 years have been more pronounced in the arctic regions than elsewhere in the world (National Research Council 2003). Warming of ocean waters may improve fish stocks of arctic cod, which may lead to increased commercial fishing pressure in the Arctic Ocean and Beaufort Sea (Union of Concerned Scientists 2005).

Table 3.2-1
Key Fish Species Found in the North Slope Borough

Common Name	Scientific Name	Inupiaq Name
Arctic grayling	*Thymallus arcticus*	Sulukpaugaq
Lake trout	*Salvelinus namaycus*	Iqaluaqpak
Alaska blackfish	*Dallia pectorali*	Iluunqiniq
Ninespine stickleback	*Pungitius pungitius*	
Slimy sculpin	*Cottus cognatus*	
Round whitefish	*Prosopium cylindraceum*	Savigunnaq
Arctic cisco	*Coregonus autumnalis*	Qaaktak
Bering cisco	*Coregonus laurettae*	
Rainbow smelt	*Osmerus mordax dentex*	Ilhuagniq
Arctic char	*Salvelinus alpinus*	Iqalukpik
Chum salmon	*Oncorhynchus keta*	Iqalugrauq
Pink salmon	*Oncorhynchus gorbuscha*	Amaqtuuq
Dolly Varden	*Salvelinus malma*	Iqalukpik
Rainbow smelt	*Osmerus mordax*	Ilhuagniq
Least cisco	*Coregonus sardinella*	Igalussaq
Broad whitefish	*Coregonus nasus*	Aanaakliq
Humpback whitefish	*Coregonus oidschian*	Pikuktuuq
Arctic cod	*Boreogadis saida*	Igalugaq
Fourhorn sculpin	*Triglopsis quadricornis*	Kanayuq
Arctic flounder	*Pleuronectes glacialis*	Naataagnaq

Source: (Wickersham & Flavin Planning Consultants 1982; Froese 2004; U.S. Department of the Interior 2004)

3.2.3 *Wildlife (mammals and birds)*

3.2.3.1 Major species

Although there is low biodiversity on the North Slope, the ecological importance of the major species discussed herein can be attributed to their abundance and therefore crucial role in helping maintain the stability of the food web. Many of these major species are important to Borough residents as subsistence resources, and some are protected under federal law. Subsistence is discussed in Section 3.3.3 of this document. Tables 3.2-2 and Table 3.2-3 list the key terrestrial mammal species and the key bird species found in the North Slope Borough, respectively.

Information regarding distribution, population size and trends for terrestrial mammals was obtained from various Alaska Department of Fish and Game (ADF&G) management reports, which are cited by author. These reports describe distribution in terms of game management units (GMUs), four of which lie within the North Slope Borough. GMU 26A encompasses the western North Slope (or arctic slope) of the Brooks Range including the western Brooks Range; GMU 26B includes the central North Slope of the Brooks Range and central Brooks Range; GMU 26C encompasses the eastern North Slope of the Brooks Range and the eastern Brooks Range; and just the northwest portion of GMU 23 lies within the Borough in the far western Brooks Range. Depending on the range of a species, the reference to a GMU may be applicable to only a specific geographic area. For example, GMU 26C refers to just the eastern Brooks Range for Dall sheep, whereas for the musk oxen, GMU 26C refers to the eastern North Slope.

The Secretary of the Interior designated three special management areas in the North Slope Borough in 1977 due to their significant wildlife and bird value. These areas are managed for maximum protection of the wildlife resources during oil and gas development activities. The Utukok River Uplands Special Area (URUSA) spans about 4 million acres and contains critical calving habitat for caribou. The Teshekpuk Lake Special Area (TLSA) includes important nesting, staging, and molting habitat for a large number of ducks, geese, and swans and covers approximately 1.7 million acres. The Colville River Special Area (CRSA) includes the bluff and riparian habitats of the Colville River and has been recognized since the 1950s as one of the most significant regional habitats for raptors in North America (Kessel and Cade, 1956, 1958; Cade, 1960; White and Cade, 1971 (U.S. Department of the Interior 2004).

Table 3.2-2
Key Terrestrial Mammal Species Found in the North Slope Borough

Common Name	Scientific Name	Inupiaq Name
Caribou	*Rangifer tarandus*	Tuttu
Moose	*Alces alces*	Tuttuvak
Dall sheep	*Ovis Dalli*	Imnaiq
Musk ox	*Ovibus moschatus*	Uminmak
Grizzly bear	*Ursus arctos*	Aklaq
Hoary marmot	*Marmots caligata*	Siksrikpak
Wolf	*Canis lupus*	Amaguq
Arctic fox	*Alopex lagopus*	Tigiganniaq
Red fox	*Vulpes fulva*	Kayuqtuq
Wolverine	*Gulo luscus*	Qavvik
Arctic ground squirrel	*Spermophilus parryii*	Siksrik

Source: (Wickersham 1993b; U.S. Department of the Interior 2004) and various ADF&G authors cited above.

3.2.3.2 Distribution of wildlife (location and seasons, migratory pathways)

Caribou

Four distinct herds of barren-ground caribou (*Rangifer tarandus grantii*) have been identified in arctic Alaska based on their fidelity to calving grounds (U.S. Department of the Interior 2004). Moving from west to east these herds include: the Western Arctic Herd, the Teshekpuk Herd, the Central Arctic Herd, and the Porcupine Caribou Herd. In general, caribou prefer treeless tundra and mountains during all seasons, but portions of some herds winter in the boreal forest south of the Brooks Range and outside of the North Slope Borough (Alaska Department of Fish and Game 2004). Refer to Figure B-11 for a generalized illustration of the caribou winter and summer ranges. Figure B-10 illustrates the key calving areas for each of the herds.

The summer diet of caribou includes the willow leaves, sedges, mushrooms, and flowering tundra plants; beginning in September when the ground is snow-covered, caribou consume lichens (reindeer moss), dried sedges, and small shrubs. Newborn calves are subject to predation by wolves, grizzly bears, and golden eagles (Alaska Department of Fish and Game 2004). Adult caribou are prey for sport and subsistence hunters, and are, in most cases, the primary terrestrial mammal species harvested for subsistence in the villages in the Borough (refer to Section 3.3.3 for a discussion on subsistence).

Patterns of caribou habitat use vary seasonally, differ from year to year, and are dependent on weather conditions. Deep snow and cold weather can delay migration to calving grounds, thereby prolonging the calving period and affecting calf survival. Conversely, early snowmelt and subsequent plant growth can facilitate early spring migration and promote both calf and adult survival (Seaton 2003). Insect activity increases during periods of warm temperatures (>55 degrees Fahrenheit) and mild winds (<8 miles per hour) and caribou move to the coast or mountain ridges where lower air temperatures and higher winds reduce the number if insects (Dau 1986; Lenart 2003a). This variable distribution has probably contributed to the significant overlap among the four recognized arctic caribou herds that has occasionally been observed over the years, contributing to a significant gene flow between the herds (North Slope Borough 2004). Despite the shifts in distribution throughout the seasons, there are recognizable patterns in migration for the herds. Refer to Figure B-10 for caribou calving areas and Figure B-11 for summer and winter ranges for all four herds. The primary range and distributions for each of the four caribou herds are described below.

The Western Arctic Herd range covers approximately 140,000 square miles in northwestern Alaska, from approximately the Colville River to the western coast of Alaska, and as far south as Norton Sound. Their range spans five GMUs and associated subunits (21D, 22A-E, 23, 24, and 26A). Fall migration and rut for the Western Arctic Herd begin in mid August and often continue until late November, as caribou move southwest generally toward Kotzebue Sound and Norton Sounds. During most of the period from 1980 to 1995, the Western Arctic Herd wintered in the Nulato Hills as far south as the Unalakleet River drainage. Since the 1996, the herd has progressively shifted its southernmost boundary of wintering grounds northwest to the Seward Peninsula, in addition to becoming more dispersed. Most Western Arctic caribou begin migrating north through Anaktuvuk Pass, Chandler Pass, and Killik Pass and reach their calving grounds at the headwaters of the Utukok, Meade, Ketik, and Colville rivers (in the URUSA) by late May. The summer range for the Western Arctic Herd includes the calving grounds as well

Caribou on the coastal plain

as post-calving grounds in the northern foothills and mountains of the Brooks Range west of the Trans-Alaska Pipeline. Large post-calving aggregations form in parts of the Delong Mountains and its northern foothills west of and including the upper Utukok and Kuguruk drainages. Insect harassment in early July forces nearly the entire herd to seek relief and they rapidly move from the Lisburne Hills/Cape Thompson area eastward toward Howard Pass and Chandler Lake, creating an annual peak concentration of the Western Arctic Herd (Dau 2003b).

The Teshekpuk Herd was described in 1978 as a distinct herd, separate from the Central Arctic Herd or Western Arctic Herd (Davis and Valkenburg 1978 *in* (North Slope Borough 2004). The range of the Teshekpuk Herd centers on Teshekpuk Lake, located on the central arctic coast. The Teshekpuk Herd is found in GMU 26A. Fall migration to the herd's wintering grounds generally begins in mid September. Since the 1990s, wintering grounds of this herd have included the area near Atqasuk and south of Teshekpuk Lake, but some caribou venture on westward to the coastal plain of the Chukchi Sea or head south of the Brooks Range through Anaktuvuk Pass. The Teshekpuk Herd has typically migrated from its wintering grounds back towards Teshekpuk Lake during late April and May, taking the most direct route (North Slope Borough 2004). The Teshekpuk Herd tends to settle to the northeast and east of the lake during calving, but by late July when the insect season peaks, most caribou flee to the coast seeking harassment relief.

The range of the Central Arctic Herd extends from the northern foothills of the Brooks Range to the Beaufort Sea and from the Colville River east to the Canning River. The Central Arctic Herd is generally found in GMUs 26B and 26C. Fall migration for the Central Arctic Herd begins during August, and by September most of the herd is along the northern and southern foothills and mountains of the Brooks Range. Caribou from the Western Arctic Herd occasionally mix with the Central Arctic Herd during fall and winter. It is likely that Central Arctic Herd mixes with the Teshekpuk Herd during late summer, fall, and winter, and that their range may overlap with the winter and summer ranges of the Porcupine Caribou Herd (Lenart 2003a). About half of the Central Arctic Herd (the eastern segment) tend to remain east of the Sagavanirktok River during calving and insect seasons, while the other half (the western segment) range on the west side of the river, including the Prudhoe Bay and Kuparuk oilfields (Lawhead 1988; Cameron, E. Lenart et al. 1995). During insect seasons, animals from both herd segments move to within 20 miles of the Beaufort Sea coast (Lawhead and Curatolo 1984).

The range for the Porcupine Caribou Herd covers 130,000 square miles of remote, roadless wilderness east of the Canning River through the Arctic National Wildlife Refuge (ANWR) and the Yukon and Northwest Territories of Canada. The Porcupine Caribou Herd is found in four GMUs (25A, 25B, 25D, and 26C). During the spring, the Porcupine Herd migrates to the coastal plain of ANWR for calving. In June and early July, the Porcupine caribou generally move from the coastal plain to the foothills of the Brooks Range. During insect season, the herd moves up to the ridge tops of the Brooks Range for insect relief. In the fall, the herd continues its inland migration into the Yukon and Northwest Territories of Canada. The herd generally winters in Canada, although during late August and September of 1999-2000 and 2001-2002, a considerable number of caribou returned to Alaska from Canada and wintered near Arctic Village. During the winters of 2000-2001 and 2002-2003, few Porcupine caribou remained in Alaska.

Moose

Unlike caribou, moose (*Alces alces*) of the arctic are not recognized as distinct herds. Distribution of moose across the North Slope is more restricted than caribou; therefore, moose of the North Slope Borough are only found in portions of GMUs 26A and 23. Moose have been present on the North Slope since the 1920s. These animals are generally restricted to riparian

habitat adjoining rivers and streams, but sometimes move to the foothills of the Brooks Range and along the coastal plain (Carroll 2002; Dau 2002a).

On the North Slope, moose are heavily dependent on willow shrub habitats, especially during fall and winter months. During summer, moose consume vegetation in shallow ponds, forbs, and the leaves of willow. Moose are the prey of wolves and brown bears (Alaska Department of Fish and Game 2004). Moose are generally ranked second behind caribou as the terrestrial wildlife species most harvested for subsistence in the villages in the North Slope Borough. Due, in part, to their distribution along major rivers and accessibility, both resident and nonresident recreational hunters avidly pursue them.

Most moose migrate seasonally to calving, rutting, and wintering areas. During the summer, bull moose are widespread between the northern foothills of the Brooks Range Mountains to the arctic coast, while cows move from the river bottoms but remain within the tributaries and hills near riparian habitat, although some venture onto the coastal plain. During fall and after mating, or rut, moose move back to the riparian corridors or large river systems. The Colville River drainage supports the largest concentrations of moose in the North Slope Borough during winter (U.S. Department of the Interior 2004). When spring arrives, most moose disperse to the foothills of the Brooks Range. In late May and early June, pregnant cows move away from the river bottoms to calve. Moose in the Borough travel anywhere from a few miles up to 60 miles during these seasonal movements (Carroll 2002).

Dall Sheep

Dall sheep (*Ovis Dalli*) are found throughout the mountains of the eastern Brooks Range, are sporadically distributed within the Central Brooks Range, and are indigenous to the Delong Mountains in northwest Alaska (a portion of which lies within the North Slope Borough). Their habitat includes open alpine ridges, meadows, and steep slopes with extremely rugged terrain. Within the Borough, the range of Dall sheep includes portions of GMU 23 and all of GMUs 26A-C (Lenart 2002; Stephenson 2002; Dau 2002b).

Dall sheep diets vary by range. A wide variety of plants are consumed during summer, whereas the winter diet is limited to dry, frozen grass and sedge stems, and occasionally lichen and moss. Both rams and pregnant ewes are attracted to mineral licks during the spring and often travel many miles to eat this soil (Alaska Department of Fish and Game 2004). Dall sheep are harvested for subsistence purposes, but their mountainous habitat makes them less accessible to hunters, so they rank after moose in importance.

Within the Central Brooks Range, Dall sheep are sporadically distributed, and are considered to be one population. The animals have well-developed social systems, in which the ewes and rams each form their own groups, intermingling at mineral licks and during mating season. Dall sheep tend to occur in low densities in the western Brooks Range, and highest densities in the northern drainages of the eastern Brooks Range, where they are distributed throughout the mountains due to suitable habitat and weather conditions that provide favorable winter range. Studies of sheep movements in the eastern Brooks Range have shown that major river drainages inhibit movement, thereby resulting in discrete populations within this area (Alaska Department of Fish and Game 2004). Dall sheep do not travel far during seasonal migrations and are very loyal to their home ranges. However, mineral licks are seasonally very important, and the sheep may travel some distance to reach a lick site. In general, Dall sheep movements are likely related to the availability of food and weather.

Brown Bear

Black bears are not found north of the Brooks Range, and are therefore not present in the North Slope of Alaska (Alaska Department of Fish and Game 2004). Polar bears are discussed in Section 3.2.4 (Marine Mammals).

Within the Borough, brown bears (*Ursus arctos*) are found throughout the eastern and western North Slope of the Brooks Range, including the associated foothills, and occasionally on the coastal plain. Their habitat is diverse, and can vary depending on food availability. The range of brown bears within the North Slope Borough includes portions of GMU 23 and GMU 26A-C (Carroll 2003a; Dau 2003a; Stephenson 2003a).

Brown bears are omnivorous, with diets that commonly consist of berries, grasses, sedges, horsetails, fish, ground squirrels, and roots of many kinds of plants. Occasionally, brown bears prey on newborn moose and caribou calves, and are capable of killing and consuming healthy adults of these species. Bears are attracted to carrion as well as human garbage (Alaska Department of Fish and Game 2004). Brown bears are occasionally harvested for subsistence purposes.

Brown bears are typically solitary animals, and are distributed throughout the North Slope, with the highest densities in the foothills of the Brooks Range and the lowest densities on the coastal plain. Some brown bears have been observed moving from the mountains to the coastal plain in the vicinity of the Porcupine Caribou Herd calving area, as well as near salmon spawning grounds in rivers nearby.

When food is unavailable or scarce during the winter, brown bears hibernate in dens for durations ranging from five to seven months. Preferred denning areas on the coastal plain include low hills, dry lake margins, and stream banks, often approaching 20 miles of the coast (Alaska Department of Natural Resources 1998). Recent ADF&G brown bear research confirms that some of the bears using the oilfields on the North Slope den within a mile of the coast (Alaska Department of Natural Resources 1998). Brown bears remain in hibernation until spring (April or early May), unless disturbed by unseasonably warm weather.

Musk Oxen

Musk oxen *(Ovibus moschatus)* are indigenous to northwest Alaska, but they disappeared around the 19th century. ADF&G reintroduced four populations of musk oxen into Alaska, two of which are located within the North Slope Borough. The Cape Thompson population, reintroduced during 1969 to 1970, inhabits the portion of GMU 23 from the mouth of the Noatak River to Cape Lisburne (Lenart 2003b; Dau 2003c). The population reintroduced at the Kavik River (1970) and at Barter Island (1969) inhabits areas of GMUs 26B and 26C, including a group that resides in the Franklin Bluffs area near the Sagavanirktok River (Dau 2003c).The habitat for musk oxen is varied and their distribution is widespread.

Musk oxen consume a variety of vegetation, including grasses, forbs, sedges, and woody plants. During the summer they are found in riparian areas (Dau 2001). During winter, the animals concentrate their feeding efforts to vegetated bluff areas with shallow snow accumulations (Alaska Department of Fish and Game 2004). Predators of musk oxen include wolves, and in recent years, brown bears. Musk oxen are hunted mainly for trophy, but also for meat. The hair of musk oxen, or “qiviut”, is sought after for weaving into clothing.

Musk oxen are social animals, usually forming large, non-roaming groups of between 6 and 60 animals during the winter season. The animals are poorly adapted to movement in deep snow,

so when snow depth exceeds 10 to 12 inches, the animals seek out exposed ridges and domes with minimal snow cover. Musk oxen survive on body fat during the winter, reducing the need to search for food. During the summer, feeding animals tend to form smaller groups of 5-20 animals that move frequently, generally toward riparian habitats (Lenart 2003b; Dau 2003c).

In spring of 1999, moderately long-range migrations were documented in the central arctic slope area by a group of 50 musk oxen that traveled about 32 miles from the Itlillik Hills to east of the Kuparuk River (Lenart 2003b; Dau 2003c). Since their reintroduction to Alaska in 1969, musk oxen have extended their range along the arctic coastal plain about 500 km (310 miles) eastward into Yukon, Canada (as far as Babbage River) and as far west as Fish Creek.

Furbearers

Key furbearer species in the North Slope Borough include: wolf (*Canis lupus)*, wolverine (*Gulo luscus)*, arctic fox (*Alopex lagopus*), and red fox (*Vulpes fulva*). This group of animals is harvested for subsistence during winter months, mainly for their fur. Information on the abundance and distribution of furbearer species is limited.

Wolves are found throughout GMU 26, in the mountains of the Brooks Range and the tundra of the entire Arctic Slope, and rarely on the coastal plain. Wolf packs can have a large range, dependent on the availability of prey (moose, caribou, and Dall sheep). Wolves are highly social animals that tend to live in packs of 6 or 7 animals that usually remain within an established territory. The territory of an Alaskan wolf pack averages about 600 square miles, ranging from 300 to 1,000 square miles. Wolves that target migratory caribou may, however, temporarily abandon their territory and travel long distances if necessary.

Wolverines are highly dispersed in the Brooks Range and the foothills. The range of wolverines is vast and mainly determined by availability of food, which primarily consists of carrion and small mammals. Wolverines are solitary creatures that travel extensively in search of food. The home ranges of same sex adults are generally separate from one another. The home range size of an adult wolverine is very extensive, with males covering up to 240 square miles, and females frequenting a smaller area, generally between 50 to 100 square miles. The home range of the resident male may overlap the ranges of up to six females (Alaska Department of Fish and Game 2004). The number of wolverines on the coastal plain is lower than in the mountains and foothills of the Brooks Range (Bee and Hall 1956; ExxonMobil 2001).

Both red and arctic foxes are found throughout GMU 26, and in the portions of GMU 23 that are within the North Slope Borough boundary, essentially in the treeless coastal areas of the North Slope (Carroll 2001; Dau 2001a). Foxes prey on small mammals and consume carrion. The arctic fox is the most common furbearer on the arctic coastal plain. Arctic fox distribution and movement is related to the availability of food. When local food is scarce, these foxes may travel long distances (80 to 1,400 miles), whereas when food is locally abundant, arctic foxes may remain near their natal dens year-round, which are more or less permanent (Eberhardt and Hanson 1978). During the summer, breeding arctic fox pairs are territorial and defensive, whereas during late fall and winter, the foxes are less territorially defensive and may interact with other foxes in areas where food is abundant (ExxonMobil 2001). Red foxes prefer extensive lowland marsh and tundra regions, which they share with the arctic fox. Where the ranges of the two species overlap, the red fox is dominant. Both red and arctic foxes may use the same den year after year. Their dens are usually located on the coastal plain, and sites include pingos, small mounds, low hills, essentially areas with thin snow accumulations, sandy soils, and surface stability (ExxonMobil 2001).

Other small mammals such as arctic ground squirrel (*Spermophilus parryii),* ermine (short-tailed weasel), least weasel, snowshoe hare, two species of lemmings, three vole species, and two species of shrews are found in the North Slope Borough area and serve as a source of food for larger mammals and some birds. Arctic ground squirrels are found in highest densities along major river drainages, and are most abundant on the coastal plain.

Birds

Birds found in the North Slope Borough can be grouped into two main categories: waterfowl and other water birds, and terrestrial birds. Waterfowl and other water birds include swans, geese, eiders, ducks, loons, grebes, shorebirds, and seabirds (gulls, jaegers, and terns). Terrestrial birds include passerines (songbirds) ptarmigan, raptors, and ravens. Both Steller's and spectacled eiders are found on the North Slope, are listed as threatened under the ESA, and are therefore discussed separately under Section 3.2.3, Protected Species. Most of these species are migratory and are only present on the North Slope for breeding and nesting between late May to October. During this period, nesting habitats are snow-free, and food and open water are available. Key bird species found in the North Slope Borough are listed in Table 3.2-3. Figure B-7 illustrates habitat use by birds across the North Slope Borough. Figure B-8 indicates critical habitat for spectacled eider, the range for Steller's eider, geese molting concentration areas, habitats for other selected species, and known nesting areas.

Waterfowl and Other Water Birds

Species of waterfowl and other water birds common in the North Slope Borough area include Pacific and red-throated loons; tundra swan; greater white-fronted, Canada, and lesser snow geese; black brant; long-tailed and northern pintail ducks; and king and common eiders. In addition, black guillemot, a species that is on the Proposed Bureau of Land Management (BLM) Sensitive Species List for Alaska, may occur in offshore areas (Johnson and Herter 1989; U.S. Department of the Interior 2004). Waterfowl populations are concentrated on the arctic coastal plain, where the birds nest near aquatic habitats along the coast, ponds, or lakes, where food is nearby.

Nearly all of the waterfowl and other water bird species are migratory and are found in the Borough seasonally, generally from May through October. Soon after spring migration, most of these bird populations disperse to nesting grounds located primarily in coastal areas and near water bodies. River deltas and wetlands are particularly important to waterfowl as nesting and breeding areas. During August to late September (before and during the fall migration) the use of lagoons and other coastal habitats by these birds peaks (Alaska Department of Natural Resources 1998).

Three colonies of snow geese have been identified in Alaska, according to ADF&G: 50 nests in the Ikpikpuk River delta, another 50 nests in Kasegaluk Lagoon at the Kukpowruk River delta adjacent to the Chukchi Sea coast, and one nest on Howe Island (located in the Sagavanirktok River Delta) (Alaska Department of Natural Resources 1998).

Howe Island also supports colonies of nesting black brant (Alaska Department of Natural Resources 1998), but the largest nesting concentration of brant on the ACP is located in the Colville River Delta (Johnson and Herter 1989), with another concentration located in the Sagavanirktok River Delta (U.S. Department of the Interior 2004). The major river deltas and other areas along the coastal plain attract greater-white fronted geese for nesting and rearing (Alaska Department of Natural Resources 1998). Canada geese prefer to nest inland, on bluffs along major rivers (Alaska Department of Natural Resources 1998).

Common eiders concentrate for nesting in the Return Islands, Jones Islands, McLure Islands, Cross Island, and Lion Point (Alaska Department of Natural Resources 1998). Nearshore coastal distribution during nesting surveys indicate that breeding pairs of common eiders are more numerous along the coast between the Colville River Delta and the Canadian border than they are along the coast (U.S. Department of the Interior 2004). A large concentration of king eiders is present to the south and east of Teshekpuk Lake (U.S. Department of the Interior 2004).

Eiders take to the air *(J. London)*

Pacific, red-throated, and yellow-billed loons breed across the arctic coastal plain, concentrating during the spring near the Sagavanirktok, Kuparuk, and Colville river deltas (Alaska Department of Natural Resources 1998). Of these species, the Pacific loon is the most abundant, with large concentrations occurring west of Teshekpuk Lake and in a small area near the Colville River south of Nuiqsut. Red-throated loons are common in the Colville River Delta, and occur in relatively high densities both northeast and southwest of Teshekpuk Lake. Yellow-billed loons are the least abundant of the loon species on the arctic coastal plain, the Colville River Delta and the area between the Chipp and Ikpikpuk rivers supports some of the highest breeding densities in Alaska (Smith, L.C. Byrne et al. 1993). Two loon species, the yellow-billed and red-throated, are on the Proposed BLM Sensitive Species List for Alaska (U.S. Department of the Interior 2004). The yellow-billed loon is being considered for listing under the Endangered Species Act (National Research Council 2003).

The northern pintail is the most abundant duck on the arctic coastal plain, with concentrations near Teshekpuk Lake (U.S. Department of the Interior 2004). The long-tailed duck is the second most abundant duck on the arctic coastal plain, with nesting concentrations scattered along the arctic coastal plain (especially near Flaxman Island) as well as near Teshekpuk Lake (U.S. Department of the Interior 2004). Long-tailed ducks inhabit the lagoon systems of the Beaufort Sea, west of the Canning River, to forage and rest during molt and post molt periods (Flint, Reed et al. 2003).

The TLSA attracts between 18,500 and 68,500 (15 year average was estimated at 37,827) brant and greater white-fronted, Canada, and snow geese during their nesting, staging, and molting for several months each summer. The numbers of brant and geese using this area exceed that of any other known molting area (U.S. Department of the Interior 1998).

The shorebirds that frequent the North Slope Borough area include American golden-plover; dunlin; semipalmated, pectoral, and buff-breasted sandpipers; long-billed dowitcher; red-necked and red phalaropes; Baird's, western, and stilt sandpipers; semipalmated and black-bellied plover; and numerous other species. These birds occupy a range of moist to dry tundra habitat for nesting, rearing young, and feeding. Some shorebirds such as sandpipers and phalaropes prefer to nest near wet meadows. The North Slope contains very productive shorebird habitat (U.S. Department of the Interior 2004). Sandpipers, dowitchers, phalaropes, and dunlins occur in greater densities than other bird groups across the arctic coastal plain (U.S. Department of the Interior 2004). Shorebirds are generally present on the North Slope from May to September, with most species occupying tundra-nesting grounds during early summer, and then moving to coastal habitats, such as Kasegaluk Lagoon, to feed before migrating in September. One shorebird species, the buff-breasted sandpiper, occurs regularly on the North Slope and is on the Proposed BLM Sensitive Species List for Alaska (Alaska Department of Natural Resources 1998).

Seabirds present in the North Slope Borough include glaucous and Sabine's gulls; arctic tern; pomarine, parasitic, and long-tailed jaegers; common and thick-billed murres; horned and tufted puffins; black-legged kittiwakes, and numerous other species. Glaucous gulls are a widespread migrant and breeder on the arctic coastal plain, with areas of high-density nesting located both east and west of Dease Inlet and southeast of Teshekpuk Lake (U.S. Department of the Interior 2004). Sabine's gulls are found on the arctic coastal plain less frequently than glaucous gulls but are common in the area north of Teshekpuk Lake where they nest on the shores or islands of tundra lakes (U.S. Department of the Interior 2004). Arctic terns are common breeders and migrants of the Beaufort Sea area. Nesting occurs mainly near the coast but may also occur inland (U.S. Department of the Interior 2004). Mures and kittiwakes nest in large numbers at Cape Lisburne.

Terrestrial Birds

Songbirds found in the North Slope Borough include Lapland longspur, savannah sparrow, redpoll, snow bunting, yellow wagtail and numerous other species. Most songbirds generally arrive on the North Slope during late May to early June and remain until mid to late August before migrating south to warmer regions (ExxonMobil 2001). The Lapland longspur is the most common songbird on the arctic coastal plain; its preferred nesting areas are moist habitats and wet meadows (ExxonMobil 2001). The snow bunting is also a very common breeder on the arctic coastal plain, with nests commonly found near areas of development (U.S. Department of the Interior 2004). All songbirds are seasonal migrants to the North Slope Borough. Many songbird species nest in the foothills of the Brooks Range.

Raptors common to the North Slope Borough area include arctic peregrine falcon; gyrfalcon; rough-legged hawk; golden eagles; snowy and short-eared owls; and northern harrier. Bald eagles are occasionally observed in the Borough but are not common. Raptors nest primarily along larger river bluffs and cliffs, but some, especially owls, nest on the tundra. Golden eagles are known to nest across the North Slope. The snowy owl and gyrfalcon are known to overwinter on the North Slope (U.S. Department of the Interior 2004). Nesting raptor densities along the Colville River are among the highest in the world (National Research Council 2003).

Other terrestrial bird species that are generally year-round residents in the North Slope Borough include willow and rock ptarmigan, and common ravens. Willow and rock ptarmigan nest in the tundra, while ravens prefer to nest on tall buildings and other anthropogenic structures. There is little information about the distribution of the ptarmigan because these species are not usually recorded during aerial surveys for birds on the arctic coastal plain, but they are generally found across the North Slope (Mallek, R. Platte et al. 2003; U.S. Department of the Interior 2004).

Table 3.2-3
Key Bird Species Found in the North Slope Borough

Common Name	Scientific Name	Inupiaq Name
American golden-plover	*Pluvialis dominicus*	Tullik
Arctic peregrine falcon	*Falco peregrinus*	kirgavik
Arctic tern	*Sterna paradisaea*	Mitqutaillaq
Bald eagle	*Haliaeetus leucocephalus*	Tinmiaqpak
Black brant	*Branta bernicla nigricans*	Niglingauraq
Black guillemot	*Cephus grylle*	Inagiq
Buff-breasted sandpiper	*Tryngites subruficollis*	Satqagiilaq
Canada goose	*Branta canadensis*	Iqsragutilik
Common eider	*Somateria mollissima*	Amauligruaq
Common raven	*Corvus corax*	Tulugaq
Common redpoll	*Carduelis flammea*	Saqsakiq
Dunlin	*Calidris alpina*	Siiyukpaligauraq
Glaucous gull	*Larus glaucescens*	Nauyaq
Golden eagle	*Aquila chrysaetos*	
Greater white–fronted Goose	*Anser albifrons*	Nigliq
Gyrfalcon	*Falco rusticolus*	aatqarruaq
King eider	*Somateria spectabils*	Qinalik
Lapland longspur	*Calcarius lapponicus*	Qupaluk/Putukiiiluk
Lesser snow goose	*Chen caerulescens*	Kanuq
Long-billed dowitcher	*Limnodromus scolopaceus*	Siiyukpalik
Long-tailed duck	*Clangula hyemalis*	Aaqhaaliq
Long-tailed jaeger	*Stercorarius longicaudus*	Isunnaq
Northern harrier	*Circus cyaneus*	Papiktuuq
Northern pintail	*Anas acuta*	Kurugaq
Pacific loon	*Gavina pacifica*	Malgi
Parasitic jaeger	*Stercorarius parasiticus*	Migiaqsaayuk
Pectoral sandpiper	*Calidris melanotos*	Puviaqtuuq
Pomarine jaeger	*Stercorarius pomarinus*	Isunnagluk
Ptarmigan, rock/willow	*Lagopus mutus/ lagopus*	Niksaaktuniq/ Aqargiq
Red phalarope	*Phalaropus fulicaria*	
Red-necked phalarope	*Phalaropus lobatus*	Auksruak
Red-throated loon	*Gavina stellata*	Qaqsraupiagruk
Rough-legged hawk	*Buteo lagopus*	Qilgiq
Sabine's gull	*Xema sabini*	Aqargigiaq
Savannah sparrow	*Passerculus sandwichensis*	Aanaruin suliuqpa
Semipalmated sandpiper	*Calidris pusilla*	Livilivillakpak
Short-eared owl	*Asio flammeus*	Nipailuktaq
Snow bunting	*Plectrophenax nivalis*	Amautligaq
Snowy owl	*Nyctea scandiaca*	Ukpik
Spectacled eider	*Somateria fisheri*	Qavaasuk
Steller's eider	*Polysticta stelleri*	Igniqauqtuk
Tundra swan	*Cygnus columbianus*	Qugruk
Yellow wagtail	*Motacilla flava*	
Yellow-billed loon	*Gavia adamsii gray*	Tuullik

Source: (Wickersham 1993b; Brower and Opie 1996; U.S. Department of the Interior 2004)

3.2.3.3 Trends and development considerations

Caribou

The Western Arctic Herd was comprised of approximately 242,000 animals in 1970, but by 1976 it had declined dramatically to just 75,000 animals. During the period from 1976 to 1990, the herd grew at an approximate annual rate of 13 percent to a minimum population size of 416,000. According to an ADF&G 1999 summer aerial photograph census, the Western Arctic Herd population was estimated to be at least 430,000 animals. This number is lower than the 1996 estimate of 463,000 caribou, suggesting that the herd declined about one or two percent each year from 1996 to 1999, but is still very large. Caribou exposure to the bacterium that causes brucellosis has been low since 1996. The primary impact of this disease is a reduction of reproductive success, although brucellosis is probably not currently affecting the population dynamics of the Western Arctic Herd (Dau 2003b).

Sensitive habitat areas for the Western Arctic Herd include the parts of the Delong Mountains and its northern foothills west of and including the upper Utukok and Kuguruk drainages, as well as the Howard Pass/Chandler Lake area described in Section 3.2.3.2 (Dau 2003b).

A cooperative satellite telemetry project was initiated in 1990 by the North Slope Borough, ADF&G, and BLM to evaluate seasonal ranges, annual movements, and habitat use by the Teshekpuk Herd. Because the Teshekpuk Herd is an important subsistence resource for much of the North Slope Borough, understanding the herd distribution and size can help improve management and the harvest success rate. From 1990 to 2000, studies indicated more variability in the annual movements of the Teshekpuk Herd, as well as a wider distribution area than previously thought (North Slope Borough 2004). For example, although most all calving took place near historic Teshekpuk Herd calving grounds of Teshekpuk Lake, some caribou wintered as far south as the Seward Peninsula, intermingling with the Western Arctic Herd (North Slope Borough 2004). Accessibility of their traditional calving area around Teshekpuk Lake appears to be key to calving success for the Teshekpuk Herd. In 1997 and 2001, a heavy snow and late melt prevented many cows from returning to this area in time to calve, and the result was very poor calf survival (53 percent and 44 percent, respectively). However, in 2002, snowmelt was relatively early, allowing access to the calving area, and resulting in a 74 percent calf survival rate (Carroll 2003c).

The Central Arctic Herd was recognized as a distinct herd in the mid 1970s, and the population was estimated at 5,000 animals in 1975. The herd size increased to approximately 13,000 animals by 1983, and the increase continued to over 23,000 caribou by 1992. In 1995, the herd experienced a decline to about 18,100 animals, but then stabilized until 2000 when it increased again considerably to over 27,000 animals. This recent population increase was due to low adult mortality and high calf survival rates during 1998 to 2000 (Lenart 2003a).

Because both industry and government have an interest in developing potential oil resources in ANWR, the coastal plain on which the Porcupine Caribou Herd calves, US and Canadian state and federal agencies have cooperated to conduct baseline studies of the herd. The US and Canada have formed the International Porcupine Caribou Board (1987) to coordinate management and research of the herd. During the 1960s and 1970s the Porcupine Caribou Herd population was stable at about 100,000 animals. In 1979, the population began to experience an annual increase of approximately 5 percent, and by 1989, had reached 178,000 animals. Around 1992, the Porcupine Caribou Herd population had decreased to 160,000, likely due to lower calf survival rates after harsh winters. This decline continued to a population reduction to approximately 129,000 animals in 1998, and declined again in 2001 to 123,000 caribou in 2001, likely due to increased adult mortality (Lenart 2003a). It is thought that current

levels of reproduction may not be sufficient to reverse the population decline since 1989 (Lenart 2003a).

Although all four herds of caribou have been exposed to oil and gas exploration activity in the past 50 or 60 years, it is only the Central Arctic Herd that has been regularly and directly exposed to the relevant surface development (National Research Council 2003). The lack of a baseline against which to compare changes in the caribou population dynamics makes it difficult to assess the effects of such development (National Research Council 2003). However, studies of the Central Arctic Herd have shown that, in general: 1) development, in combination with insect harassment, can impair caribou movement between coastal and inland habitats; 2) increased development could increase the loss of preferred habitats for browsing and subsequent nutrient status of lactating females; and 3) reproductive success of Central Arctic Herd females congregating near oilfields has been lower than for females outside of oilfield developments (National Research Council 2003).

The primary resource development considerations include protection of important habitat areas and migratory routes, including minimizing fragmentation of habitat through the cumulative effects of resource development. Areas critical for caribou calving and insect relief are examples of important habitat, and they may change from year to year based on snow and other climate conditions. The Borough has recommended minimum pipeline heights and other design measures to reduce potential impacts on caribou migration. Activities associated with resource and village development should accommodate measures to avoid or minimize adverse habitat and migration impacts during project planning, design, construction, and operation. Developers should consult with village residents and Borough staff when siting and designing facilities.

Moose

The North Slope is the northern limit for the Alaskan moose, hence moose occur in low densities (U.S. Department of the Interior 2004). Since about 1940, moose populations in the western North Slope have increased in size. Surveys conducted since 1970 indicate that the population increased steadily from about 1,200 animals in 1970 to about 1,500 in 1991. During 1990-1995, moose populations in the Colville River drainage area suffered sharp declines. Adult mortality and poor recruitment were identified as possible reasons for the decline, possibly caused by adverse weather, increased predation, and deteriorating range (O'Hara, Dau et al. 1998). By 1995, however, the population had declined to about 750 animals. In 1996, the population began to recover (Carroll 2002).

Sensitive habitat areas for moose include riparian areas for feeding and migration and willow shrub areas for winter habitat. Development considerations for moose might include avoidance of such habitat areas. During the winter moose can be more stressed due to the lack of food availability, weather, and predation. They are therefore more susceptible to disturbance in the winter season. Limiting the removal of gravel from floodplains, which border many riparian areas, can help reduce the impacts to moose habitat during development activities.

Dall Sheep

There have been few sheep surveys conducted in the Central Brooks Range, but during the early to mid-1970s the population appeared to be low. During the 1980s and 1990s, surveys indicated that the population had increased, stabilized, and then declined. Heavy snowfalls during the late 1980s and early 1990s caused another decline in population. By 1996, the population appeared to be stabilizing or increasing. From 1996 to 2002, the population appeared to be stable, with minor fluctuations (Lenart 2002).

In the Eastern Brooks Range, sporadic surveys have shown that populations appeared to be high during the 1980s with declines in the late 1980s and early 1990s, likely due to severe weather conditions. In 1985 an estimated 13,000 sheep were in the Eastern Brooks Range. In the Hula Hula River drainage, the populations have declined by 40 percent since the mid 1980s, with similar declines appearing in other areas as well. Sheep populations continue to be small in the Eastern Brooks Range, based on anecdotal reports (Stephenson 2002). Sheep can be found in large concentrations near Galbraith Lake, and Slope Mountain is a known lambing area.

In the Western Brooks Range, Dall sheep are at the northwest margin of their range in Alaska, and the populations appear to be more prone to fluctuations due to adverse weather conditions. Sheep in this area are at a lower density than other areas of the Brooks Range. Beginning in 1990, high natural mortality dramatically diminished the population size, prompting the National Park Service (NPS) to either close or shortened the hunting season in this area. Limited hunting was reestablished in 1998, after some rebound in sheep numbers (Dau 2002b).

Dall sheep are sensitive to disturbance from aircraft noise; therefore altitude restrictions are needed to prevent adverse behavioral changes, especially during lambing. Due to the steep nature of sheep habitat, it is unlikely that increased development on the North Slope will directly affect populations. It is possible, however, that steeper gravelly slopes might be considered for material sites, processing, or mining, and sheep habitat should be identified prior to any such habitat altering activities.

Brown Bear

The brown bear population in the Brooks Range declined during the 1960s due to guided hunting, but has been recovering since the introduction of permit hunt regulations that began in 1997 (Carroll 2003a). Densities of brown bears are generally higher in the foothills of the Brooks Range and lowest on the arctic coastal plain (Stephenson 2003a).

Current estimates of brown bear densities in general habitat zones of the western North Slope (GMU 26A) are as follows (all measured in areas of 1,000 square kilometers, or 386 square miles): 0.5-2 bears on the arctic coastal plain, 10-30 bears in the foothills of the Brooks Range, and 10-20 bears in the mountains of the Brooks Range (Carroll 2003a). However, specifically, the most current density information for the Utukok and Kokolik drainages in GMU 26A shows 29.5 animals per 1,000 square kilometers (or 386 square miles) were recorded in 1992 (Carroll 2003a).

Prior to 1987, the population estimate of brown bears in the western North Slope (GMU 26A) was between 645-780 animals. The most current population information for brown bears from 1988 indicates between 900-1,120 animals in GMU 26A (Carroll 2003a). In the eastern Brooks Range (26B-C), the brown bear population is currently estimated to be 1,800 animals (Stephenson 2003a).

Oil and gas development on the North Slope has changed the distribution of brown bears. The destruction of habitat due to facility development and the availability of anthropogenic food sources (garbage) have served to draw bears nearer to developed areas. Mortality of bears has increased due to road development, which allows hunters accessibility to previously inaccessible areas, and to an increase in human-bear interactions, which can result in the death of the bear (National Research Council 2003). Denning may be disrupted by seismic exploration activities (National Research Council 2003). Development considerations regarding brown bears might include designing facilities to reduce sprawl into nearby habitat areas and proper waste management that discourages scavenging.

Musk Oxen

From 1970 to 2000, the Cape Thompson population increased by approximately 8 percent annually, with the highest density of musk oxen estimated at 0.13 animals per square miles (Dau 2003c).

The musk oxen population in GMUs 26B and C (central and eastern North Slope) increased steadily during the 1970s and 1980s; in Unit 26C expanding eastward into Canada, westward into Unit 26B, and eastward into Unit 26A during the late 1980s and early 1990s. The population appeared to be stable during the mid 1990s with approximately 500-600 animals total in Units 26B and 26C. Surveys in 2001 and 2002 showed combined (GMU 26B and C) population numbers had declined and were 426 and 348 animals, respectively (Lenart 2003b). It is now estimated that between 600-700 musk oxen inhabit the eastern North Slope (Lenart 2003b).

Although there have been no detected effects of seismic exploration on musk oxen (some herds avoid areas of noise, while others do not), the effects are of concern because musk oxen are year round residents of the North Slope (National Research Council 2003). Helicopter and low-flying aircraft noise occasionally cause musk oxen to stampede and abandon their calves (National Research Council 2003). Development considerations might include routing aircraft away from known densities of parturient musk oxen to avoid disturbance.

Furbearers

Population trend and density information for furbearers is limited, with the exception of wolves. ADEC manages wolves separately from other furbearers.

Wolves

Wolves are found throughout the central and eastern arctic slope, but are less abundant in these areas due to lower populations of prey, such as moose (Stephenson 2003b). Estimates in the fall of 1992 indicated that between 150 and 215 wolves in 22-32 packs were present in these areas (Stephenson 2003b). Fall wolf densities in these areas are estimated at 5.7-8.3 wolves per 1,000 square miles (Stephenson 2003b).

Wolf numbers on the western arctic coastal plain and Brooks Range (GMU 26A) have fluctuated since the 1900s due to a number of factors: changes in prey populations (moose and caribou); a 1950s federal wolf control program; and public aerial and snowmobile hunting since the 1960s (Carroll 2003b). Bans on aerial hunting in 1970 and land-and-shoot hunting in 1982 promoted an increase in the wolf population, especially in the mountains and foothills of the Brooks Range (U.S. Department of the Interior 2004).

Results of surveys show that the densities of wolves (wolves per 1,000 square kilometers or 386 square miles) in GMU 26A appeared to increase from approximately 2.6 wolves in 1987 to 4.2 wolves in 1992, dropping slightly to 4.1 wolves in 1992. An incomplete 1998 survey indicated a decline in densities in GMU 26A (Carroll 2003b). Wolf numbers in GMU 26A have likely dropped in recent years due to a reduction in prey; since the moose population in this area declined by 75 percent between 1992 and 1996 (Carroll 2003b).

Wolverine

A fall population of 821 wolverines was estimated for the western North Slope (GMU 26A), based on a density of 0.5 wolverine per 100 square miles (U.S. Department of the Interior 2004). More recent surveys have not been conducted, but informal sightings of wolverines in the

western Brooks Range from 1997 to 2000 suggested that the populations in the more remote areas of GMU 26A were high compared to previous years (Dau 2001a).

Arctic and Red Foxes

No quantitative data are available for arctic or red fox populations, but general observations serve to provide some population information. With the decline of pelt harvesting since 1929, it is likely that arctic fox numbers have increased. Because arctic foxes in the Prudhoe Bay oil field area readily use developed areas for habitat and a source of food (garbage), their densities are greater in the oil fields than in surrounding undeveloped areas, and their populations have grown larger and more stable (National Research Council 2003; U.S. Department of the Interior 2004). The increase in arctic fox populations due to development could affect regional populations of some bird species by way of increasing the extent of predation and the foxes' accessibility to previously inaccessible bird nesting locations such as barrier islands (National Research Council 2003). Development considerations regarding arctic foxes might include proper waste management that discourages scavenging as well as design modifications to discourage animal passage.

Surveys in the western Brooks Range from 1997 to 2000 indicated that the red fox population was high, and that both arctic and red fox populations were unusually high during the winter of 2000-2001 (Dau 2001a). Although no quantitative data is available for GMU 26A foxes, arctic foxes are more abundant along the arctic coastal plain while red foxes prefer the interior regions.

Birds

Waterfowl and Other Water Birds

In 1990, Howe Island was found to support 380 to 450 snow goose nests. In the past, fox predation had decimated the snow goose colony, but because the island is isolated in early spring by discharge from the Sagavanirktok River, foxes have been prevented from reaching the island in most years (Alaska Department of Natural Resources 1998). The population of lesser snow geese on the arctic coastal plain has increased in recent years, and a number of scattered nests or small colonies consisting of less than 13 nests have been reported near the coast from Fish Creek to the Ikpikpuk River Delta (U.S. Department of the Interior 2004). In the western delta of the Ikpikpuk River, a minimum of 1,149 nests was located in 2003, which is 25 percent greater than the count in 2002 (Ritchie, Shook et al. 2004a). A brood rearing survey in 2003 yielded an estimation of over 3,360 snow geese in 48 different groups between Barrow and the Fish Creek delta. As in previous years, the geese were concentrated (87 percent of the total) in the Smith Bay subregion (Ritchie, Shook et al. 2004a).

The population of Canada geese on the arctic coastal plain has varied from as few as 3,000 birds (1989 and 1994) to as many as 47,000 in 1986 and 1999 (U.S. Department of the Interior 2004). The 2002 population estimate was 52 percent lower than the 1985 to 2001 mean population size (U.S. Department of the Interior 2004). Since 1992 it appears that the brant population on the arctic coastal plain is increasing (U.S. Department of the Interior 2004). A brood-rearing survey in 2003 yielded an estimation of 19,800 brant in 118 groups between Barrow and Fish Creek, which is a 67 percent increase from numbers recorded in 2002 (Ritchie, Shook et al. 2004a). The largest nesting populations of brant in development areas are on Howe and Duck Islands, which are both near the Endicott Causeway. Although brant nesting in development areas is relatively uncommon (only 2 percent of the breeding population), nesting success in these areas is low (44-55 percent) compared to nesting success in non-developed areas (around 80 percent) (National Research Council 2003). High predation is the likely cause

of such low nesting success. Because brant are very sensitive to disturbance by aircraft, especially helicopters during molt (National Research Council 2003), development considerations should include the establishment of flight patterns to avoid molting brant populations, or creation or road links between fields.

Tundra swan densities in the Colville River Delta are three to five times greater than in other areas along the North Slope (Alaska Department of Natural Resources 1998). During aerial surveys in 2003, 86 tundra swan nests (0.06 nests/km2) were observed in the Barrow area, which represents a 38 percent decrease from records in 2002. The highest nesting densities were on the Meade River delta (Ritchie and King 2004b). Predation in existing oil field development areas during the early 1990s did not seem to have influenced nest success (83 percent), which was comparable to success in a non-developed area like the Arctic National Wildlife Refuge (76 percent) (National Research Council 2003). Because swans are sensitive to human disturbance at distances greater than 1600 feet away, nesting success of swans may be more influenced by disturbance than habitat loss. Habitat loss due to development can be offset by the large amount of breeding habitat currently available on the North Slope, the low densities of swans throughout their range, and the natural territorial spacing between nests. Climate change during the past decade has been more pronounced on the North Slope, which has produced longer frost-free periods during the breeding season, thereby beneficially affecting swans through an increase in nesting success (National Research Council 2003).

An increasing trend in the red-throated loon population on the arctic coastal plain was reported from 1986 to 2002 (U.S. Department of the Interior 2004). However, Larned et al. (2003) reported a decreasing trend in the numbers of red-throated loons during 1992 to 2003 (U.S. Department of the Interior 2004). The population of yellow-billed loons has been stable since at least 1986 (U.S. Department of the Interior 2004). During aerial surveys in the Barrow area in 2003, three yellow billed loons were observed (Ritchie, Shook et al. 2004a). There are currently no Pacific loon density or trend estimates for oil fields on the North Slope, but they tend to nest on the shores of impoundments in developed areas (National Research Council 2003).

Pintail numbers fluctuate from year to year, without any reported significant population trends since aerial surveys began in the mid-1980s (U.S. Department of the Interior 2004). Larned et al. (2003) reported an increasing trend in the long-tailed duck population in the arctic coastal plain prior to 2003, but Mallek et al. (2003) reported a declining trend from 1985 to 2002 (U.S. Department of the Interior 2004)

The king eider is the most abundant eider species on the arctic coastal plain (Larned, R. Stehn et al. 2003), followed by the common eider. Data from eider counts as they pass Point Barrow during migration indicates that the king eider population has declined by approximately 56 percent since 1976 (Suydam, D.L. Dickson et al. 2000). However, an increasing population trend for king eiders on the arctic coastal plain from 1993 to 2003 was reported by Larned et al. (2003). Aerial surveys in 2003 in the Barrow region yielded an abundance (0.26 birds/square kilometer) that was 85 percent higher than those recorded in 2002, as well as being higher than all other years of the Barrow study area (0.14-0.25 birds/square kilometer in 1999-2002) (Ritchie, Shook et al. 2004a). There do not appear to be any trends in existing developed areas for king eiders, and they do not appear to avoid anthropogenic structures, however predation in developed areas generally causes lower nesting

Common eider *(J. London)*

success than in non-developed areas of the North Slope. Common eiders nest primarily on barrier islands and use anthropogenic structures as nesting cover, and there are no trends related to oil field development and nesting (National Research Council 2003).

The densities of shorebirds nesting on the arctic coastal plain vary depending on location and habitat. For example, densities of 30 nests per square miles were reported on study plots in drained-lake basin habitat, but only 5 nests per square miles were reported on tussock/ridge tundra on the central NS (U.S. Department of the Interior 2004). Shorebirds appear to prefer wet sedge willow and moist sedge shrub habitats in the Colville River Delta, where the overall shorebird nest density of nearly 35 nests per square miles was observed (U.S. Department of the Interior 2004). Shorebird populations in areas of oil field development appear to be stable, except for the dunlin, which has declined in both development and non-development areas along the North Slope (National Research Council 2003). Near roads and gravel pads, shorebird densities tend to be lower than in more distant areas, although densities are higher on the leeward sides of roads than elsewhere. Increased predation in areas of development likely affects local shorebird populations through the reduction of nesting success (National Research Council 2003).

The population of jaegers (parasitic, long-tailed, and pomarine) along the arctic coastal plain has remained relatively stable from 1992 to 2003 (U.S. Department of the Interior 2004). The glaucous gull population on the arctic coastal plain has remained stable since 1992 (U.S. Department of the Interior 2004). The arctic coastal plain population of Sabine's gulls fluctuated between 5,000 and 8,000 birds between 1992 and 2003, except for a low of 2,800 birds in 1998 (U.S. Department of the Interior 2004). Larned et al. (2003) reported an increasing trend in the arctic tern population of the arctic coastal plain from 1992 to 2003 (U.S. Department of the Interior 2004).

Oil and gas development on the North Slope has affected tundra habitat used by breeding and molting birds through the placement of fill and by thermokarst. Gravel fill and associated dust can cause accelerated or delayed snowmelt, which can affect the quality and availability of underlying vegetation. For waterfowl, a major offshore oil spill would endanger molting flocks in nearshore lagoons. Due to the higher predator densities in development areas, concentrated predation seems to be the primary reason for lower nesting successes in these areas (National Research Council 2003). These affected bird populations may be supplemented by immigration of birds from other areas. Development considerations might include proper waste management (garbage) to reduce the attractiveness of anthropogenic food sources in developed areas to predators/scavengers such as gulls, ravens, foxes, and bears.

Terrestrial Birds

The average nest density for Lapland longspurs on study plots near the Colville River was 8.0 nests per square miles (U.S. Department of the Interior 2004). The savannah sparrow, redpoll, snow bunting, and yellow wagtail appear to be fairly common breeders on the arctic coastal plain (U.S. Department of the Interior 2004).

Willow ptarmigan appear to be much more abundant in the central and west North Slope than rock ptarmigan, with higher nest densities reported for willow ptarmigan than for rock ptarmigan near the Colville River (U.S. Department of the Interior 2004).

In an aerial survey over Barrow in 2003, snowy owl observations had decreased 49 percent from 2002 and the density (0.03 birds/km2) was at the lower end of densities recorded between 1999 and 2002 (0.03-0.11 birds/km2) (Ritchie, Shook et al. 2004a).

Snowy owl chick

The population trend for the common raven has paralleled that of the human development on the North Slope. The lack of appropriate nesting habitat limited the number of ravens prior to development on the North Slope; however, over the past several decades common ravens have become much more abundant on the North Slope (especially the arctic coastal plain) as nesting habitat in the form of buildings, antennas, drill rigs, and other tall structures has become more abundant. Due to the presence of human food sources on the arctic coastal plain, some ravens over-winter near their nesting grounds (U.S. Department of the Interior 2004).

The effects of oil and gas North Slope development on terrestrial birds would be the same as discussed under Waterfowl and Other Water birds above. Development considerations in the foothills of the Brooks Range should account for the possibility that new development could impinge on raptor nesting and hunting success. Human and aircraft activity near nests should be regulated (National Research Council 2003).

Climate change during the past decade may affect the reproduction timing and success of many bird species on the North Slope. The increase in frost-free periods and warmer temperatures may lead to a change in the tundra vegetation abundance and type, thereby altering the availability of some food sources for some birds (National Research Council 2003).

3.2.4 *Marine Mammals*

3.2.4.1 Key species

Marine mammal species that occur regularly in the Beaufort Sea include the ringed seal (*Phoca hispida)*, bearded seal (*Erignathus barbatus)*, spotted seal (*Phoca largha)*, polar bear (*Ursus maritimus)*, Pacific walrus (*Odobenus rosmarus divergens*), and beluga whale (*Delphinapterus leucas)*. Bowhead whales *(Balaena mysticetus)*, also present, are listed as endangered under the Endangered Species Act (ESA), and are discussed in Section 3.2.6 (Protected Species). The Marine Mammal Protection Act of 1972 (MMPA) protects all marine mammals in U.S. waters by directing that they shall "be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management, and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem" (U.S. Department of the Interior 2004). Key marine mammal species found in the North Slope are listed in Table 3.2-4; a generalized illustration is provided in Figure B-9. Walrus and other species are not indicated on this map.

Some marine mammals, such as the Bowhead whale, bearded seals, ringed seals, Pacific walrus, and polar bears, are important subsistence species for hunters from Barrow, Nuiqsut, and Kaktovik. Subsistence hunters take beluga whales when they are available, particularly in Point Lay and Wainwright (U.S. Department of the Interior 2004). Subsistence is discussed in Section 3.3.3.

3.2.4.2 Distribution (spatial and seasonal, migratory pathways)

Ringed seals, bearded seals, and polar bears are present year-round and move extensively throughout the Beaufort Sea region. Beluga whales are normally present from April to October, and spotted seals are present from July through mid-October (U.S. Department of the Interior 2004). Pacific walrus are generally present in the Alaska portion of the Beaufort Sea during summer months of open water (Alaska Department of Natural Resources 1998)

Ringed Seal

The Bering, Chukchi, and Beaufort seas support the Alaska stock of ringed seals, which are the smallest, yet most abundant, of the arctic ice seals (U.S. Department of the Interior 2004). Ringed seals travel to areas near the coast at the beginning of winter with the formation of shorefast ice, and then return to sea in the spring with breakup or movement of the ice pack (Alaska Department of Fish and Game 2004). Ringed seals have an affinity for ice-covered waters and occupy seasonal and permanent ice. They pup on the ice or in lairs under the snow in late winter/early spring (National Research Council 2003; Angliss 2004). Seals that winter in the Bering Sea likely summer in the northern Chukchi Sea or Arctic Ocean (Alaska Department of Fish and Game 2004)

Bearded Seal

Bearded seals are present throughout the year in the Beaufort Sea, with the abundance of the migratory population centered in the Bering Sea in shallow water (about 650 foot depth) (Angliss 2004; U.S. Department of the Interior 2004). The seasonal migrations of this seal are in response to the movement of sea ice (Alaska Department of Fish and Game 2004). Adults are almost always associated with ice, whereas young seals sometimes remain in ice-free nearshore areas where they frequent bays and estuaries (Alaska Department of Fish and Game 2004).

Spotted Seal

Spotted seals are medium-sized north Pacific seals, the Alaska stock of which occurs from the Bering Sea to the Beaufort Sea in the Arctic Ocean (U.S. Department of the Interior 2004). These seals migrate south from the Chukchi Sea in October through the Bering Strait in November to reach their breeding areas in the Bering Sea. Seals overwinter along the ice edge, move to the southern margin of ice during spring, and then head to coastal habitats for the summer, such as Kasegaluk Lagoon (Angliss 2004). Spotted seals are not common in the Beaufort Sea, but are present during the ice-free summer season (July through mid-October) from Bristol Bay in the southeastern Bering Sea to north of Demarcation Point in the eastern Beaufort Sea (U.S. Department of the Interior 2004). Recently, spotted seals also have used Smith Bay at the mouth of the Piasuk River (U.S. Department of the Interior 2004).

Walrus

Most of the North Pacific walrus population is found west of Barrow, in waters of the Bering and Chukchi seas. However, some individuals move east through the Alaska portion of the Beaufort Sea on their way to Canadian waters. During this time, they are found in relatively shallow waters, either close to ice or land. The diet of walruses consists mainly of bottom dwelling invertebrates such as clams, snails, and crabs (Alaska Department of Natural Resources 1998).

Polar Bear

Polar bears and gulls *(R. Suydam)*

Polar bears are distributed throughout the arctic and are found in the Beaufort Sea year-round, making seasonal offshore migrations as the landfast ice melts every summer (U.S. Department of the Interior 2004). The diet of polar bears consist primarily of ringed and bearded seals, but can include walrus and beluga whale as the opportunity arises (U.S. Department of the Interior 2004). Polar bears often are attracted to the shore to scavenge marine mammal carcasses during the fall open-water period. Recently, large numbers of polar bears have been attracted to areas near the villages of Barrow and Kaktovik, and near the Nuiqsut whaling camps on Cross Island during the fall (U.S. Department of the Interior 2004).

Beluga Whale

The seasonal distribution of beluga whales is affected by ice cover, temperature, access to prey, tidal conditions, and human interactions. During winter, the whales are found in offshore waters and associated with pack ice, whereas they migrate in the spring to molt and calve in warmer near shore waters including estuaries and bays (Angliss 2004). During the summer, beluga whales from two stocks, the Beaufort Sea and the eastern Chukchi Sea, can be found in North Slope waters (U.S. Department of the Interior 2004). The Beaufort Sea stock of beluga whales begin migrating north from wintering areas in the Bering Sea and are usually seen at Point Barrow by mid-April (U.S. Department of the Interior 2004).

Belugas appeared to be common near shorefast ice in the region until ice moves offshore in July (Hazard 1988). There are known concentrations of beluga whales in Kasegaluk Lagoon (Angliss 2004). A few groups (ranging up to 100 belugas) were observed north and east of the Colville River Delta near Jones, Pingok, and Thetis islands during fall migration (U.S. Department of the Interior 2004). More recently, hunters from Nuiqsut reported sightings of belugas swimming in the Nigliq Channel of the Colville River as well as some stranded in shallow water in the Fish Creek Delta (U.S. Department of the Interior 2004). Kasegaluk Lagoon on the Chukchi Sea is an important habitat area for beluga whales.

3.2.4.3 Trends and development considerations

Ringed Seal

Currently, the size of the Alaska ringed seal population is unknown, but estimates indicate between 1 million to 3.5 million animals (U.S. Department of the Interior 2004). The ringed seal Beaufort Sea population appears to range from 40,000 in winter to 80,000 in summer (U.S. Department of the Interior 2004).

Near Prudhoe Bay, densities of ringed seals ranged from 0.15 to 0.28 seals per square miles between 1997 and 2002 (U.S. Department of the Interior 2004), which are lower than densities calculated in the same area during the 1980s (U.S. Department of the Interior 2004).

Aerial surveys conducted during 1999-2000 in the eastern Chukchi Sea indicated that during winter ringed seals were more common in nearshore fast ice and pack ice, with lower densities occurring in offshore pack ice. The coastal waters south of Kivalina and near Kotzebue Sound supported the highest densities of ringed seals. Food availability (a variety of invertebrates and fish, including arctic cod) paired with fast ice distribution may influence densities of ringed seals in the Chukchi Sea (Bengtson 2001; Alaska Department of Fish and Game 2004). Ringed seals return to the open sea during ice breakup in spring (Alaska Department of Fish and Game 2004).

The effects of climate change and increasing temperatures over the past 10 to 15 years have been more pronounced in the arctic regions than elsewhere in the world. Seals that are associated with ice, such as the ringed seal are especially sensitive to changes in weather and sea surface temperatures because such changes directly affect their ice habitat. Any change in ice habitat can shift the population densities and distribution (Angliss 2004).

Commercial fisheries have been responsible for incidental kill of ringed seals, with two mortalities reported from the observer program for the Bering Sea groundfish trawl fishery in 1992.

Because ringed seals are common offshore in waters where oil and gas development have occurred, they are more prone than other seals to effects from contamination from oil spills and disturbance caused by industrial noise from air and water. Noise can cause behavioral reactions and displacement of some species. Displacement of ringed seals can affect subsistence harvest levels, as well as decreasing reproductive success of the species (National Research Council 2003). Development considerations for all ice-associated seals should include noise-reduction measures and oil spill contingency plans.

Bearded Seal

A reliable estimate of the abundance of bearded seals in the Beaufort Sea is currently unavailable (U.S. Department of the Interior 2004). However, it appears that densities in the western Beaufort Sea are highest during the summer and lowest during the winter (U.S. Department of the Interior 2004).

Aerial surveys conducted during 1999-2000 in the eastern Chukchi Sea indicated that densities of bearded seals were generally higher in offshore pack ice, with the exception of high densities of bearded seals observed south of Kivalina. Food availability (wide variety of invertebrates and some fishes) paired with fast ice distribution may influence densities of bearded seals in the Chukchi Sea (Bengtson 2001; Alaska Department of Fish and Game 2004).

Commercial fisheries have been responsible for incidental kill of bearded seals. As reported from the observer program for the Bering Sea groundfish trawl fishery, the bearded seal mortalities include: three in 1991, four in 1994, one in 1998, and two in 1999 (Angliss 2004).

The effects of climate change and increasing temperatures over the past 10 to 15 years are expected to affect ice-associated bearded seals as described for ringed seals above.

Spotted Seal

There is currently no reliable estimate of the numbers of spotted seals in Alaska, however, the population of the Bering Sea was estimated in the early 1970s to be 200,000 to 250,000 during mating season (Angliss 2004).

Commercial fisheries have been responsible for incidental kill of spotted seals. As reported from the observer program for the Bering Sea/Aleutian Islands groundfish fishery, the mortalities include three spotted seals in 1996 (Angliss 2004).

The effects of climate change and increasing temperatures over the past 10 to 15 years are expected to affect ice-associated spotted seals as described for ringed seals above.

Walrus

The population size of the Pacific walrus has been heavily influenced by human exploitation of the animal. The population size was estimated to be between 50,000 and 100,000 animals in the mid 1950s, and probably increased in size during the 1960s and 1970s due to reductions in hunting pressures. Aerial surveys indicated population levels of between approximately 200,000 and 230,000 animals from 1975 to 1990 (Angliss 2004). The current population size is unknown.

Commercial fisheries have been responsible for incidental kill or injury of walruses. As reported from the observer program for the Bering Sea groundfish trawl fishery, there were five walrus mortalities and one injury (alive) during 1996 to 2000 (Angliss 2004).

The effects of climate change and increasing temperatures over the past 10 to 15 years are expected to affect ice-associated Pacific walrus as described for ringed seals above.

Polar Bear

Polar bear density in the region from Point Barrow to Cape Bathurst was estimated to be one bear per 76 to 110 square miles (U.S. Department of the Interior 2004). The two most important natural factors affecting polar bear distribution are sea ice and food availability (U.S. Department of the Interior 2004).

The Beaufort Sea polar bear stock has increased in number during the past 30 years at an estimated annual rate of 2 percent or more (U.S. Department of the Interior 2004). The Beaufort Sea stock now consists of more than 2,000 animals and is believed to be at or near carrying capacity (U.S. Department of the Interior 2004).

Polar bear with seal carcass *(T. Olemaun)*

Polar bear maternal dens are more concentrated along the coastal plain of the eastern North Slope (ANWR) and less common along the western arctic coastal plain (U.S. Department of the Interior 2004). In 2001, of the 35 dens reported on the arctic coastal plain, all were found along bluffs or along river/creek drainages within 15 miles of the coast (U.S. Department of the Interior 2004).

The effects of climate change and increasing temperatures over the past 10 to 15 years have been more pronounced in the arctic regions than elsewhere in the world. For polar bears, the effects can include changes in denning behavior caused by reduced snow cover and earlier spring thaws. The approach of pack ice nearer to the coastline due to earlier melting of shorefast ice provides more access to land for polar bears, which has been causing an increase in aggregations of bears on land. An increase in bears on land may lead to more human-bear interactions and possibly more defense of life or property kills. With polar bears congregating on

shore, it is easier for tourists to view them than if they were on pack ice, and demand for polar bear viewing may increase with continued warming temperatures in the arctic.

Funding for polar bear research had increased since 1994, but there has been little funding provided to USFWS for management, so the research funding has produced little useful application.

Because polar bears are common offshore in waters where oil and gas development have occurred, they are prone to effects from contamination from oil spills and disturbance caused by industrial noise. For a majority of the year, polar bears are not very sensitive to noise or other human disturbances. Pregnant females and those with newborn cubs on land and sea ice, however, are very sensitive to noise and vehicle noise. An event of disturbance of a bear in a maternity den due to seismic noise has been documented. Displacement of polar bears can affect subsistence harvest levels as well as decreasing reproductive success of the species (National Research Council 2003).

In-water structures can be attractive to polar bears because such structures can cause leads in the ice through which the bears hunt seals. Buildings on land can also attract bears due the likely presence of anthropogenic food sources. Development considerations for polar bears might include noise-reduction measures and oil spill contingency plans. Other development considerations regarding polar bears should include siting facilities away from the coast where known dens occur (USFWS requires industry to avoid dens as much as possible) and proper waste management that discourages scavenging to reduce or avoid the instances of human-bear interactions.

Beluga Whale

The Beaufort Sea stock of beluga whales is estimated at more than 39,000 animals, based on data from an aerial survey conducted in 2002 (Angliss and Lodge 2002; Angliss 2004; U.S. Department of the Interior 2004). This stock of belugas is considered to be stable or increasing (Angliss 2004).

The maximum count of belugas of the eastern Chukchi Sea stock during the 1998 survey is considered underestimated at 1,172 animals. However, that number is similar to counts in the same area during summers of 1989-1991 (1,200 animals) and during the summer of 1979 (1,104 to 1,601) (Angliss 2004). This stock does not appear to be declining, based on these data (Angliss 2004).

Beluga whales (R. Suydam)

Because beluga whales are sensitive to human interactions, any increase in activity offshore in the Beaufort Sea might affect the population dynamics of the whales. Development considerations might include restricting the placement of structures and removal of gravel in sensitive habitat areas such as Kasegaluk Lagoon. The nearshore waters of the Chukchi Sea are popular gillnet fishery locations. There have been no reported injuries or mortalities as a result of commercial fishing gear entanglement. However, an increase in commercial fishing pressure for arctic cod due to improved stocks (see Section 3.2.2.2) as a result of climate change would increase the amount of gear used, which may lead to more fishing nets becoming loose and washing up on shore or entangling whales.

Table 3.2-4
Key Marine Mammal Species found in the North Slope Borough

Common Name	Scientific Name	Inupiaq Name
Bowhead whale	*Balaena mysticetus*	Aqviq
Beluga whale	*Delphinapterus leucas*	Sisuaq
Bearded seal	*Erignathus barbatus*	Ugruk
Ringed seal	*Phoca hispida*	Natchiq
Spotted seal	*Phoca largha*	Qasigiaq
Pacific walrus	*Odobenus rosmarus divergens*	Aivaq
Polar bear	*Ursus maritimus*	Nanuq

3.2.5 *Vegetation*

Tundra, which refers to as the rolling, treeless plains of arctic regions, dominates the terrestrial vegetation of the North Slope Borough, and is categorized into three types: alpine, moist, and wet (Selkregg 1975). Alpine tundra vegetation is found in the well-drained mountainous range areas, and consists mainly of low, mat-forming vegetation communities including heather (*Cassiope sp.*), blueberry (*Vaccinium uliginosum*), crowberry (*Empetrum nigrum*), and Labrador tea (*Ledum decumbens*), interspersed with willow (*Salix ssp.*) and dwarf birch (*Betula nana exilis*). Outcrops and talus slopes exposed to harsh environmental conditions support cushion-forming herbaceous vegetation such as moss campion (*Silene acaulis*), mountain avens (*Dryas ssp.*), and purple mountain saxifrage (*Saxifraga oppositifolia*). Lichens (*Cladonia spp.*) and mosses (*Sphagnum ssp.*) are common as well and serve as food for caribou.

Moist tundra vegetation dominates the vegetation community of the foothills region, and consists of tussocks of cottongrass (*Eriophrum vaginatum*), between which mosses, lichens, and herbs such as mountain avens and cloudberry (*Rubus chamaemorus*) thrive. Dwarf scrub (woody vegetation) communities consisting of willow, dwarf birch, Labrador tea, and crowberry are also present. The moist tundra is divided by the numerous river drainages found in the area, the floodplains of which support a different vegetation community consisting of high shrubs. Undisturbed areas of this community support willows, some herbs such as monkshood (*Aconitum delphinifolium)* and lupine *(Lupinus arcticus),* mosses and lichens, and occasionally alders (*Alnus crispa*) and cottonwood trees (*Populus balsamifera balsamifera*). Disturbed areas closest to the streambed are colonized by horsetail (*Equisetum arvense*), dwarf fireweed (*Epliobium latifolium)*, and alpine bluegrass (*Poa alpina*).

The wet soil conditions in the arctic coastal plain support wet tundra herbaceous communities dominated by sedges or grasses (graminoids). Dwarf scrub communities are found where soil conditions are dryer, such as at thaw lake margins, along river bluffs, or other more elevated, well-drained areas (United States Geological Survey 1995).

3.2.6 *Protected Species (T&E, MMPA)*

Protected species are those listed under:

- the Endangered Species Act (ESA), as amended by U.S. Fish and Wildlife Service (FWS) and the U.S. National Marine Fisheries Service (NMFS) October 2002;
- the ADF&G State Species of Concern (SSOC);
- the MMPA;

- and the Proposed Bureau of Land Management (BLM) Sensitive Species List for Alaska[1].

The black guillemot, and yellow-billed and red-throated loons, previously described in Section 3.2.3, are on BLM's Proposed Sensitive Species List for Alaska (U.S. Department of the Interior 2004). The remainder of the protected species is discussed in the following sections.

3.2.6.1 Distribution (spatial and seasonal, migratory pathways)

Bowhead whale

The bowhead whale has been classified as endangered under the ESA since 1973, although no critical habitat has been designated for this species. It has been suggested that that the Bering-Chukchi-Beaufort Seas population of bowhead whales be delisted under the ESA (U.S. Department of the Interior 2004). The bowhead whale is also listed as depleted under the MMPA and is considered an ADF&G SSOC.

The western arctic stock of bowhead whales is the only stock found in U.S. waters (Angliss 2004). Most of this stock migrates annually between the Bering and Beaufort seas (Angliss 2004). In the spring (March through June), they move from their wintering areas in the northern Bering Sea (November to March), through the Chukchi Sea to the Beaufort Sea where they remain from mid-May to September (Angliss 2004). In the fall (September through November) the bowhead whales return to the Bering Sea to winter, following a route that extends from the eastern Beaufort Sea, along the continental shelf across the Chukchi Sea, and south along the coast of the Chukchi Peninsula (U.S. Department of the Interior 2004). For a majority of the year, bowheads are associated with sea ice, except during the summer when they are found in relatively ice-free waters in a broad area from Amundsen Gulf and the Eastern Beaufort Sea to the eastern part of the East Siberian Sea (Angliss 2004; U.S. Department of the Interior 2004). The pathway of spring migration follows fractures in the sea ice along the Alaskan coast, usually in the shear zone between the shorefast and pack ice (Angliss 2004).

Bowhead whales feed on concentrated invertebrates in numerous areas that vary spatially and temporally throughout the fall migration along the coastline of Alaska (U.S. Department of the Interior 2004). Research shows that the extent of ice cover can influence fall migration (Moore 2000). Whales moving through the central Beaufort Sea have been observed migrating closer to shore during light to moderate ice coverage years (median distance offshore 18 to 25 miles), and farther offshore in heavy coverage ice years (median distance offshore 35 to 45 miles) (U.S. Department of the Interior 2004).

Steller's Eider

The Northern American breeding population of Steller's eider was federally listed as a threatened species in 1997 due to a reduction in the number of breeding birds and suspected reduction in the breeding range in Alaska. Critical habitat has been established for Alaska populations of Steller's eider, but there is no designated critical habitat on the North Slope (U.S. Department of the Interior 2004).

[1] BLM Manual Section 6840 defines sensitive species as "...those species that are: (1) under status review by the FWS or NMFS; or (2) whose numbers are declining so rapidly that Federal listing may become necessary; or (3) with typically small and widely dispersed populations; or (4) those inhabiting ecological refugia or other specialized or unique habitat."

Of the three recognized breeding populations of Steller's eiders, one occurs in Alaska and nests primarily on the arctic coastal plain (U.S. Department of the Interior 2004). During seasons other than breeding, Steller's eiders generally are found in shallow marine habitats along the Alaska Peninsula and the eastern Aleutian Islands extending eastward to lower Cook Inlet (U.S. Department of the Interior 2004). Apparently the range for the Steller's eider on the arctic coastal plain formerly extended east from Wainwright into the Canadian Northwest Territories (U.S. Department of the Interior 2004). Steller's eiders have been reported as far east as Prudhoe Bay (1997), but no recent sightings have been reported east of the Sagavanirktok River (U.S. Department of the Interior 2004). No nesting sites have been reported east of Cape Halkett, other than one 2001 record inland near the Colville River (U.S. Department of the Interior 2004). Aerial surveys performed during 1989-2000 indicated that although Steller's eiders occur over a vast area on the arctic coastal plain, the density is much greater near Barrow (USFWS 2002). The apparent importance of Barrow as a breeding area for Steller's eiders prompted the North Slope Borough to sponsor subsequent aerial surveys during 1999-2002. Their surveys confirmed the extensive use of the Barrow area by nesting Steller's eiders (USFWS 2002).

Steller's eider *(R. Suydam)*

Steller's eider nests are located on tundra habitats often associated with tundra ponds or thaw lakes and vegetation both near the coast and at inland locations (U.S. Department of the Interior 2004). Avian predators, including peregrine falcon, gyrfalcon, and snowy owls have been the predominant natural cause for mortality of adult Steller's eiders (U.S. Department of the Interior 2004).

Spectacled Eider

Spectacled eiders were listed as threatened under the ESA in May 1993 due to a 95 percent decline of the Yukon-Kuskokwim (Y-K) Delta breeding population in the previous two decades. Critical habitat has been established for Alaska populations of spectacled eider, but none is located on land on the North Slope. Some critical habitat is located on Ledyard Bay between Point Lay and Cape Lisbourne (U.S. Department of the Interior 2004).

The spectacled eider is a medium-sized sea duck that breeds along coastal areas of western and northern Alaska and eastern Russia, and winters in the Bering Sea (Petersen et al. 2000). Three breeding populations have been described, two of which occur in Alaska: one in the Y-K Delta in western Alaska, and the other on the North Slope of Alaska.

Wintering habitat for the spectacled eider is located in the Bering Sea south of St. Lawrence Island (U.S. Department of the Interior 2004). There is incomplete documentation of the spring migration routes of spectacled eiders, especially on the arctic coastal plain (U.S. Department of the Interior 2004). Most of the available data comes from counts of eiders as they migrate past Point Barrow in late May and early June (U.S. Department of the Interior 2004). Only small numbers of spectacled eiders have been reported offshore during spring migration waterbird counts east of the Colville River at Simpson Lagoon, possibly because most birds migrate overland across the arctic coastal plain following river drainages (U.S. Department of the Interior 2004).

In general, spectacled eiders on the arctic coastal plain prefer to breed near large, shallow thaw lakes with nest sites often located within 3 feet of a lake shore (U.S. Department of the Interior 2004).

3.2.6.2 Trends and Development Concerns

Bowhead Whale

The western arctic stock of bowhead whales is the largest of the five stocks found in the arctic and subarctic (Angliss 2004). In 1848, the stock size was estimated at 10,400 to 23,000 animals, before commercial whaling decreased the stock by 1914 to between 1,000 and 3,000 animals (U.S. Department of the Interior 2004). After commercial whaling ended in 1921, the western arctic stock has been slowly increasing, with population numbers at approximately 9,860 whales (U.S. Department of the Interior 2004). This population increase occurred at an annual rate of 3.3 percent from 1978 to 2001 (U.S. Department of the Interior 2004). Although there are no observer program records of bowhead mortality as a result of commercial fisheries in Alaska, there have been reported cases of whale entanglement in fisher nets and crab gear. Entanglement and scarring attributed to commercial fisheries may include over 20 cases as reported in subsistence harvest reports, and the average rate of entanglement in crab pot gear for 1997-2001 was 0.2 whales (Angliss 2004).

Bowhead whale at the surface (G.Zelinsky)

In terms of effects from development activities, bowhead whales are most sensitive to marine seismic exploration noises. Other activities such as exploratory drilling, ship and aircraft traffic, water discharges, dredging, and production drilling can also cause fall-migrating bowheads to divert around the noise sources. These noises can divert the bowheads sometimes by as much as 12 miles, possibly forcing them seaward, away from hunters, into impassable areas, and into less productive feeding grounds. The morphology of bowheads predisposes them to exceptional harm from contact with spilled oil due to the diversity of tissues that can be affected (National Research Council 2003). For this reason, although a major oil spill in North Slope waters may not be probable, the effects could be grave for bowhead whale populations, and therefore for subsistence communities. Considerations for terrestrial development should include the use of directional drilling to reduce the need for offshore oilrigs as well as conflict avoidance measures, especially during migration.

The effects of climate change and increasing temperatures over the past 10 to 15 years have been more pronounced in the arctic regions than elsewhere in the world. Bowheads are found in association with sea ice, and may be sensitive to alterations in arctic weather, sea surface temperatures, ice extent, or the subsequent effect on prey availability (Angliss 2004). A decrease in ice extent may increase the accessibility of the near shore area for large ships, and may also allow access during periods of time that were previously impassable due to ice cover. An increase in shipping activity can affect bowhead whales, in terms of noise disturbance, ship strikes, and migratory path interference. An increase in commercial fishing and crabbing pressure, possibly associated with improved stocks (see Section 3.2.2.2) as a result of climate change, would increase the amount of gear used, which may lead to more fishing nets

becoming loose and washing up on shore or entangling whales. Marine development considerations in light of climate change should include conflict avoidance measures during the fall migration and subsistence hunting season.

The MMPA requires that a potential biological removal (PBR) level be established for the western arctic bowhead stock to help regulate harvest and manage the stock at a productive level. The PBR of 89 animals is superceded by the authority of the International Whaling Commission (IWC) over subsistence harvest management for this stock. The block quota established by the IWC for the period 2002-2007 is 280 bowhead whale strikes, up to 67 of which can be taken annually (Angliss 2004).

Steller's Eider

Aerial surveys indicate that Steller's eiders are widely distributed across the arctic coastal plain from Point Lay to the Sagavanirktok River with very few sightings east of the Colville River. However, they are present across the arctic coastal plain in low densities (0.001 birds per square miles in 2003) (USFWS 2002; U.S. Department of the Interior 2004). The Barrow area supports the highest concentrations, although breeding does not occur there every year, perhaps due to predator/prey cycles (USFWS 2002; U.S. Department of the Interior 2004). For example, during the 1990s, Steller's eider breeding at Barrow corresponded with a high lemming population.

Aerial breeding pair surveys indicated that the arctic coastal plain Steller's eider population averaged about 1,000 birds between 1986 to 2001, but surveys conducted during months earlier in the year indicated a lower population, averaging approximately 170 birds from 1992 to 2003 (U.S. Department of the Interior 2004). It appears that a reduction in both occurrence and breeding frequency of Steller's eiders had occurred on the arctic coastal plain, with the exception of the Barrow area. This conclusion was based on comparisons of historical and recent data (USFWS 2002; U.S. Department of the Interior 2004).

Although the causes for the decline of the Steller's eider population in Alaska are still unknown, they may include hunting, predation pressure in breeding areas on the North Slope, the ingestion of lead shot, and changes in the marine environment (USFWS 2002; U.S. Department of the Interior 2004).

For both species of eiders (as well as all other ESA-listed species), development considerations must include a Section 7 Consultation with FWS before any activities that may adversely affect habitat can be conducted.

Spectacled Eider

During the 1970s, approximately 50,000 female spectacled eiders nested in the Y-K Delta of western Alaska. Historically, the North Slope population was likely much smaller than Y-K Delta population. In 1958, the spectacled eider was the most abundant eider species migrating along river systems south of Barrow in spring; however there is little information available describing the status of the North Slope spectacled eider population prior to 1992 (U.S. Department of the Interior 2004). In 1992, the FWS began conducting aerial surveys for breeding eiders; the surveys have continued annually through the 2003 breeding season (U.S. Department of the Interior 2004). From 1992 to 2003, the North Slope spectacled eider population ranged from approximately 5,000 to 9,000 birds, remaining relatively stable (U.S. Department of the Interior 2004).

Spectacled eiders arrive on the North Slope to nest in late May or early June. They occur in low densities of approximately 0.1 birds per square mile across the North Slope from Wainwright to the Prudhoe Bay area, with the highest concentrations occurring within approximately 40 miles of the coast between Barrow and Wainwright, and northeast of Teshekpuk Lake (U.S. Department of the Interior 2004). Spectacled eider densities of 0.05 to 0.10 birds per square mile were reported during two years of surveys on the central North Slope. It appears that nesting habitat in the Fish Creek Delta may be attracting more spectacled eiders (greater densities) than other portions of the central North Slope (U.S. Department of the Interior 2004).

Counts of wintering spectacled eiders show foraging populations of between 360,000 to 375,000 birds in the Bering Sea south of St. Lawrence Island (U.S. Department of the Interior 2004). The eiders congregate to forage for invertebrates at depths of 150 to 230 feet in areas of open leads (U.S. Department of the Interior 2004).

For both species of eiders (as well as all other ESA-listed species), development considerations must include a Section 7 Consultation with FWS before any activities that may adversely affect habitat can be conducted.

3.2.6.3 Use of Traditional and Contemporary Local Knowledge

Traditional and contemporary local knowledge of the biological environment has been passed down from generation to generation and increased through the experience of Borough residents who have spent much of their lives working in and observing the environment. Traditional and contemporary local knowledge means knowledge imparted by elders, hunters, gatherers, whaling captains and others amongst the Inupiat people about the culture and history of the Inupiat people and the natural environment, including, but not limited to, knowledge of subsistence habits, uses, and traditions, wildlife, flora, fauna, land, sea, water, air, and ecosystem conservation.

Residents have detailed knowledge of local distribution of fish, wildlife, and their habitat, that can affect the location and design of facilities and utilities. Traditional and contemporary local knowledge can provide information on the location of critical habitat and migration corridors.

Traditional and contemporary local knowledge for the North Slope area is well documented in written record at the University of Alaska – Anchorage, University of Alaska – Fairbanks, Barrow Tuzzy Consortium Library, North Slope Borough Planning Department Inupiat History Language and Culture division, North Slope Borough Planning Department's Geographic Information System, tribal organizations, and the Alaska Eskimo Whaling Commission records, among other locations. In addition, federal agencies such as the National Science Foundation, National Oceanic and Atmospheric Administration, and Minerals Management Service have specific funding and programs to elicit and document traditional and contemporary local knowledge, and have an obligation as tribal trustees to provide this information to the public.

All project proponents, including resource and village development projects, should consult with Borough staff and village residents during the planning and design stages of projects in order to incorporate traditional and contemporary local knowledge in an appropriate manner. The incorporation of traditional and contemporary local knowledge should be an integral component of the project plan; it is not a well-reasoned approach to ignore thousands of years of knowledge until a very late stage of project planning. The Borough particularly emphasizes that project proponents should foster constructive relationships with tribal governments and local governments.

Traditional and contemporary local knowledge has been utilized in the Arctic Gas pipeline project and the Alpine CD4 project to result in safer facility location and designs. There are some projects that the Borough was dissatisfied with how traditional and contemporary local knowledge was used. While there are still improvements to be made in the effective incorporation and utilization of traditional and contemporary local knowledge, efforts such as these will serve as educational tools for future projects.

The Alaska Eskimo Whaling Commission (Alaska Eskimo Whaling Commission 2005) provided several examples of western science confirming traditional knowledge.

1. The Bowhead Quota at the International Whaling Commission

In 1977, the International Whaling Commission, with the cooperation of the U.S. Government, imposed a ban on the Alaskan Eskimo bowhead whale subsistence hunt, based on a National Marine Fisheries Service study concluding that the western arctic bowhead population was in serious decline and that the increasing subsistence hunt was threatening its survival. Inupiat elders and whaling captains informed the U.S. that the bowhead population was healthy and growing and that our hunt was not a threat. As government scientists claimed that the bowhead population was below 1,000, whaling captains and elders reported that the population was in the range of 4,000 to 5,000 (North Slope Borough Department of Wildlife 2005).

The problem that the U.S. scientists were having was that they didn't know enough about bowhead whale behavior to know how to design a census count for the population. The North Slope Borough hired scientists to design and carry-out a bowhead census using techniques taught to them by elder whaling captains. It took several years to complete the first full census. When it was completed, however, the population estimates supported the information given by whaling captains and elders. Subsequent population studies continue to confirm those early reports and to confirm that the population is in fact healthy and growing.

2. Bowhead Whale Reactions to Offshore Industrial Noise

The fall bowhead hunting villages, especially Nuiqsut and Kaktovik, have been experiencing adverse effects from offshore oil and gas activity since the early to mid-1980's. Primarily, these adverse effects have taken the form of changes to bowhead migratory behavior – changes in swimming breathing patterns, offshore deflection – in response to different types of noise. Whaling captains have reported these changes in behavior from the beginning of offshore oil and gas exploration in the Beaufort Sea. Effects have been observed when migrating whales encounter supply and support vessels drilling (especially from drill ships), low flying aircraft, ice breakers, and active seismic vessels.

With the beginnings of seismic exploration during the open water season in the central and eastern Beaufort Sea, the fall captains began to report that as the migrating whales approached the noise source, the whales became skittish, changing their swimming and breathing patterns at distances of up to 30 to 35 miles from the noise source. They reported that the migration then would begin to move offshore, deflecting away from shore as much as 20 to 30 miles. Also, they did not appear to return to their "pre-deflection" path.

Federal agencies and operators refused to acknowledge that migrating bowhead whales reacted to industrial noise. However, a three year study (1996, 1997, 1998) of the effects of the offshore seismic activity on fall migrating bowhead whales ultimately confirmed that the whaling captains were correct regarding the change in behavior and were quite accurate in their estimates of the distances at which whales were reacting.

The study confirmed that migrating bowhead whales deflect around seismic noise at a minimum distance of 20 kilometers (12 miles), with the central part of the migration several more miles out. Changes in the migration were observed at a distance of approximately 35 kilometers (21 miles) east of the noise source and the deflection continued for at least 40-50 kilometers (24-30 miles). The study also demonstrated that the whales change their rate of calling at a distance of at least 45 kilometers (27 miles) away from the seismic source. This study was designed through a stakeholder/peer review process that included whaling captains and NSB and industry scientists.

The lesson of these research projects is that science in the Arctic is best when it is undertaken as a collaborative effort. Our people's traditional knowledge of the Arctic and its living resources can provide important information for researchers trying to design studies or interpret results. This is especially true if the research relates to resources or areas of the Arctic that are important to our survival, such as the behavior of our subsistence resources, weather, and sea ice.

3. Conflict Avoidance Agreements

The AEWC devised Conflict Avoidance Agreements as an aid in mitigating adverse effects on the bowhead hunt from offshore industrial operations. The AEWC uses traditional knowledge to direct timing and seasons of operations to avoid interference with subsistence bowhead hunting.

4. Open Water Season Peer Review Meetings

Each spring, the National Marine Fisheries Service hosts a meeting of NSB, industry and government scientists, whaling captains, and other stakeholders to review monitoring plans, designed and submitted by offshore operators, for activities planned during [the] following fall open water season. The monitoring plans, required under the U.S. Marine Mammals Protection Act, are designed to detect interference with marine mammals caused by the planned operations so that measures can be designed and implement to mitigate potential adverse impacts to fall open water subsistence hunting. Review of the plans at these meetings is a collaborative effort between western science and traditional knowledge. Here, traditional knowledge plays a role in helping operators stay within the federal standard for protection of marine mammal subsistence hunting.

3.3 HUMAN ENVIRONMENT

3.3.1 *Land status, management and use*

3.3.1.1 Ownership status

The ownership of land on the North Slope influences who has access to land and how it is used and managed. However, describing land ownership in the North Slope Borough is difficult, due to a number of factors:

- overlapping ownership interests,
- sometimes vague boundary descriptions
- informal (unrecorded) land transfers in the area, and
- pending land transfers to the state and Alaska Native Corporations, under the Alaska Statehood Act and the Alaska Native Claims Settlement Act (ANCSA).

Surface and subsurface ownership interests in the North Slope Borough are held by the federal government, state government, the Borough, villages, regional and village Native corporations, and private individuals, including Native allotments. As in many areas, surface and subsurface owners may differ, particularly in communities and Native allotments. Figure B-2 illustrates the land ownership status at a gross scale within the North Slope Borough.

Federal Government

The federal government is a predominant landholder within the North Slope Borough, with interests in surface and subsurface estates in the area (Figures B-1 and B-2). Federal agencies responsible for land management include the Bureau of Land Management (BLM), US Fish and Wildlife Service (FWS), National Park Service (NPS), and Department of Defense (DOD).

The National Petroleum Reserve – Alaska (NPRA) contains over 23 million acres and is primarily managed by the BLM for a competitive oil and gas leasing program (U.S. Department of the Interior 2004). Lease sales have been conducted in both the Northeast and Northwest planning areas. The North Slope Borough communities of Atqasuk, Barrow, Nuiqsut, and Barrow physically are located within the NPRA or have corporation lands that are located within NPRA. Residents of other Borough communities use lands within NPRA for subsistence and other traditional uses. In addition to NPRA, the Townsite Trustee in the Bureau of Land Management holds title to restricted lots in several villages, which places the lands in tax exempt status, but also places limitations on transfer of title.

The Arctic National Wildlife Refuge (ANWR) is located on the east side of the Borough and units of the Alaska Maritime National Wildlife Refuge are located along the west coast of the Borough. The refuges are managed by the FWS. The community of Kaktovik is located within the boundaries of ANWR and the community of Point Hope is situated between two units of the Alaska Maritime National Wildlife Refuge. Residents from other Borough communities use lands within both refuges for subsistence and other traditional uses. Primary management activities in the refuges include ecosystem monitoring, research, and invasive species management.

Both the Gates of the Arctic National Park and Preserve and the Noatak National Preserve are also partially located within the North Slope Borough. These two units are located along the southern border of the Borough in the Brooks Range. The community of Anaktuvuk Pass is located within the boundaries of the Gates of the Arctic National Park and Preserve. Residents

of other Borough communities use lands within both parks for subsistence and other traditional uses.

There are numerous DOD sites throughout the Borough. Many of the sites are being closed and facilities dismantled. There are ongoing efforts to eliminate hazards and to clean up contaminated wastes. The military sites were often located in close proximity to communities, or in areas used for subsistence and other traditional uses.

Defense Early Warning (DEW) Line Station near Kaktovik

State Government

The State of Alaska has surface and subsurface interests in approximately 3.5 million acres located within the North Slope Borough. The state maintains ownership of lands extending from the mean low tide line to three miles off-shore. The State of Alaska holds surface and subsurface rights to most of Prudhoe Bay and the surrounding area.

The Alaska Department of Natural Resources (ADNR) is responsible for managing state lands within the Borough. ADNR also manages the oil and gas leasing and exploration program for state lands and waters.

The state has selected lands for ownership throughout the Borough, under the terms of the Alaska Statehood Act. Some of these lands have been conveyed and patented to the state, but final conveyance on many tracts is still pending. The state also owns the James Dalton Highway corridor, as well as several of the airports located throughout the Borough, which are managed by the Alaska Department of Transportation and Public Facilities.

North Slope Borough

The North Slope Borough also owns lands throughout the Borough boundaries, but the lands are primarily located in the vicinity of villages. The Borough holds the title to village lands in Point Lay, as the community remains unincorporated. The Borough is entitled to select land from the State as part of their municipal entitlement. However, the ability to select and obtain lands has been delayed.

The North Slope Borough's municipal land entitlement is 89,850 acres. The NSB originally selected 144,273 acres in 1990. It relinquished 59,842 selected acres, selected an additional 276 acres at Deadhorse, and received title to 364 acres, leaving a balance of 84,619 acres of active selections. Of that 84,000 acres approximately 11,000 acres has been approved for conveyance to the NSB in preliminary decisions. The Borough may select an additional 5,231 acres to fulfill its municipal entitlement. In December 1994, the Borough applied for a 180 acre

land fill site about five miles south of Deadhorse (ADL 415433) and DNR now considers that a municipal selection. However, Borough selection and conveyance have been hampered by the limited amount of land classified as available by ADNR. In addition, opposition to Borough selections by industry support groups has hampered conveyance.

Villages

The villages retain title to municipal lands, generally located in the vicinity of the communities. Villages are entitled to select land from ANCSA village corporations under Section 14 (c) 3 of the act; however, many villages have not completed their selections. As stated above, occasionally the Borough holds title to municipal lands in lieu of the village. Within each village, there are typically lands held by private individuals, including Native allotments, as well as lands held by the local village ANCSA Corporation. In addition, there may be lands held by the regional corporation, or by the Bureau of Land Management Townsite Trustee.

Regional Native Corporation

Arctic Slope Regional Corporation (ASRC) is a regional ANCSA Native corporation that owns interests in surface and subsurface lands throughout the North Slope Borough. The ANCSA did not permit the regional corporation to select lands within the NPRA, however the Alaska National Interest Lands Conservation Act (ANILCA) made a provision for limited selections. A "specific provision allowed ASRC to select the subsurface of village-selected lands if lands within 75 miles of the village lands were made available for commercial development." The ASRC selected the subsurface estate under all lands selected by Nuiqsut and under a portion of the lands conveyed to Wainwright. At Nuiqsut, the ASRC will receive the subsurface rights once the entitlement is completed" (U.S. Department of the Interior 2004). Land selections and conveyances to ASRC have not yet been completed. The corporation is entitled to select 631,282.33 acres (BLM 2005). BLM records further indicate that the corporation has been conveyed more than its entitlement of lands, however the records note that there is an accounting error, which is in the resolution process.

There are other aspects of ANCSA that apply to regional and village corporation lands. Section 14 (c) 3 requires that village corporation allow selection and conveyance of up to 1280 acres of land for public purposes to municipal governments where the corporations are located. Under section 14(h), a regional corporation may select lands of cultural importance. Section 17(b) requires identification and provision of easements to provide public access to public lands.

The Alaska Land Transfer Acceleration Act (2004) "represents and attempt to clear up the conflicting land claims of three distinct parties in Alaska – the State, Alaska Native Corporations, and Native allottees – in time for the fiftieth anniversary of Alaska's statehood in 2009. These claims are grounded in the Alaska Statehood Act, Alaska Native Claims Settlement Act, and the Native Allotment Act of 1906" (Brooks 2005). Many parties are interested in resolving these long-standing land claim issues.

Village Native Corporations

Village ANCSA Native corporations hold title to the surface of lands throughout the North Slope Borough; these lands are primarily located in close proximity to the villages. Land selections and conveyances have not yet been completed in most villages.

Native Allotments and Other Private Landowners

There are also many Native allotments throughout the Borough. The status of these claims varies; 570 allotments have been conveyed and 99 are still pending surveys or processing (Moreno 2005). Activities that may affect Native allotments where title has been transferred or are still being adjudicated require approval from both the allotment owner and the Bureau of Indian Affairs, who acts as trustee for Native allotment owners.

Restricted townsite lots are platted and surveyed lots within villages that have been conveyed in individual Alaska Natives. They are also subject to a trust relationship with the Bureau of Indian Affairs.

Other private individuals also hold title to land within the North Slope Borough, typically located in villages.

Further discussions of historic land ownership issues may be found in earlier North Slope Borough Plans (Wickersham & Flavin Planning Consultants 1982; North Slope Borough 1984). Current status information may be obtained from the Bureau of Indian Affairs and the Bureau of Land Management.

3.3.1.2 Land use

Lands within the North Slope Borough are used for a variety of purposes, including community related activities (residential, commercial and public institutional uses), subsistence, industrial and resource development, transportation, and recreation. Current land use has not been comprehensively mapped, although approximate locations of specific use can be found in various planning documents reports.

The North Slope Borough Comprehensive Plan (Wickersham & Flavin Planning Consultants 1982) broadly defined four land use zoning districts, related to existing and proposed land uses: the Village District, Barrow District, Conservation District, and Resource Development District. A Dalton Highway Transportation Corridor District was defined separately as a Transportation Corridor in a comprehensive plan for the haul road area (North Slope Borough 1980). The Scientific Research District was adopted by ordinance in 2003. Two districts are proposed for addition to the Borough zoning districts, the Special Habitat District and the Subsistence Use District. These land use districts are formally defined in Borough Title 19, Land Management Regulations (LMR). The LMR provides information on uses allowed within each of the zoning districts and permit administrative approvals. Figure B-3 illustrates the North Slope Borough zoning districts.

Village District

Each of the Borough villages, with the exception of Barrow, is zoned as a Village District. The goal of the Village Districts is to maintain traditional values, and lifestyles in the vicinity of the Borough communities. While there is no further zoning to guide development within each village, land uses include residential, public and semi-public, transportation, commercial, and industrial.

Village of Nuiqsut

Barrow Districts

The Barrow District is also intended to maintain subsistence activities for local residents, however it also acknowledges the increasingly urban development demands in the area. The Barrow district includes specific land use zones of industrial, mixed use, suburban, and reserve districts. Barrow Zoning Ordinances are part of the LMR.

Conservation District

The Conservation District encompasses the entire Borough, with the exceptions of the Village Districts, the Barrow District, and areas specifically re-zoned to the Resource Development District. The goal of the Conservation District is to preserve the natural ecosystem, including the subsistence species that local residents depend upon for subsistence. To date, the Borough has rezoned 932,903 acres from Conservation District to Resource Development Districts.

Resource Development District

The Resource Development District is intended to accommodate large-scale resource extraction, balanced with protecting subsistence resources and coordinating with other Borough policies. Rezoning from Conservation to Resource Development requires preparation of a Maser Development Plan, and approval by both the Planning Commission and the Assembly.

Transportation Corridor District

Transportation Corridor Districts are established to provide a strip of land to accommodate linear transportation facilities, such as roads and pipelines. The specific standards for each particular Transportation Corridor District are established pursuant to the Comprehensive Plan and Title 19 policies, but may vary from one transportation corridor to another, depending upon the location, types of transportation facilities involved, and the temporary and permanent development within the district, and other factors.

Dalton Highway Transportation Corridor District

The Haul Road Corridor has evolved from an industrial road with restricted access to a public access road managed by the state and federal government. The Dalton Highway Transportation Corridor District was formed to guide land use and development in the corridor; to coordinate resource development within the district; protect fish, wildlife, water resources, cultural resources, and visual resources within the corridor; and to manage recreation activities and development within the corridor (North Slope Borough 1980).

Scientific Research Zoning District

The Scientific Research District was created by ordinance on July 1, 2003. The intent of this district is exclusively for scientific research and support facilities necessary for that research. The district is intended to conserve areas that have scientific research value or have been used for scientific research for more than twenty years. In 2005, two Scientific Research Districts have been identified, Barrow Scientific Research District and Toolik Field Station Scientific Research District. These areas do not appear on Figure B-3; refer to Official Zoning Maps available from the North Slope Borough, which reflect current ordinances.

Special Habitat Zoning District (Proposed in Title 19 revisions)

The Special Habitat District encompasses areas of the Borough that have a high importance to Borough residents for subsistence resources. These areas are considered inappropriate for development activities. This designation is identified so that the NSB lands may be so designated through a rezoning process in a manner consistent with Title 19, the NSB Coastal Management Plan, and the NSB Comprehensive Plan. There are no Special Habitat Districts identified to date; there are no Special Habitat Districts indicated on Figure B-3. Refer to Official Zoning Maps available from the North Slope Borough, which reflect current ordinances.

Subsistence Use District (Proposed in Title 19 revisions)

The Subsistence Use District encompasses areas of the Borough that have a high importance to Borough residents for subsistence resources. This district is intended to encompass specific areas that are regularly utilized by Borough residents for subsistence purposes. Development activities would be permitted in these areas only if it can be determined that they will not interfere or conflict with subsistence uses and the environment in ways that cannot be mitigated. This designation is identified so that the NSB lands may be so designated through a rezoning process in a manner consistent with Title 19, the NSB Coastal Management Plan, and the NSB Comprehensive Plan. There are no Subsistence Use Districts identified to date; there are no Subsistence Use Districts indicated on Figure B-3. Refer to Official Zoning Maps available from the North Slope Borough, which reflect current ordinances.

Further description of the Borough land use districts may be found in the prior comprehensive plan (Wickersham & Flavin Planning Consultants 1982) and in the Title 19 Land Management Regulations.

Traditional uses and activities

In addition to the land use districts designated in the LMR, a variety of traditional land uses occur throughout the North Slope Borough for subsistence and cultural purposes (Figure B-4). Access to areas for traditional uses, regardless of land ownership, is a concern of village residents. Many documents record traditional land uses and subsistence activities in the Borough (Brown 1979; Wickersham & Flavin Planning Consultants 1982; Wickersham 1993b; Fuller and George 1997; Hepa 1997). Generations of Inupiat people have used the area for thousands of years; use patterns and locations change with the seasons, animal migrations, and weather. With so many complex variables involved in land use, it has been a daunting task to map traditional use areas. Some communities, such as Nuiqsut, have identified important subsistence use areas (Brown 1979; Wickersham & Flavin Planning Consultants 1982; Wickersham 1993b; Fuller and George 1997; Hepa 1997). Important use areas are generally documented on a project-specific basis. Primary concerns include loss of or damage to traditional use areas, and loss of or interference of access to traditional use areas. Activities associated with resource and village development should accommodate

Harvesting ear bones from a young bowhead whale

measures to avoid or minimize adverse impacts during project planning, design, construction, and operation. Developers should consult with village residents and Borough staff when siting and designing facilities.

3.3.1.3 Land management

Mirroring the land ownership patterns, there are land management programs administered by the federal government, state government, borough, corporations, and villages. Management applies to both specific resource development activities and lands in general.

The federal agencies routinely prepare management plans for public lands. The BLM has prepared Integrated Activity Plans for portions of NPRA, and will continue to do so. The FWS has prepared a Comprehensive Conservation Plan (CCPs) for management of ANWR. The NPS has also prepared management plans for both the Gates of the Arctic National Park and Preserve, and Noatak National Preserve. These are public planning processes, with management objectives and guidelines defined for each management unit.

The State of Alaska manages lands through preparation of Area Plans, which classify lands for use and eligibility for selection by the Borough under municipal entitlement. The plan also includes management guidelines for use on state lands. An Area Plan has been prepared for State lands in the western portion of the Borough, west of NPRA.

The North Slope Borough also coordinates other land management programs, including the Coastal Management Program (North Slope Borough 1984) and the land use regulations for the Borough (1990). The Borough primarily remains focused on protecting and managing subsistence resources for Borough residents. However the Coastal Management Program is being revised due to changes in state law. The land use regulations are also being revised, due to changes in demands on local resources.

Oil and gas leasing is administered by multiple entities. The federal government, through the BLM, administers leasing in the NPRA. The Minerals Management Service (MMS) administers resource development activities in the Outer Continental Shelf, and the FWS administers oil and gas exploration within ANWR. The State of Alaska administers oil and gas programs on State lands and waters, and holds lease sales. ASRC pursues oil and gas exploration and development on their lands. In addition, the North Slope Borough remains actively involved in permitting resource development activities within its boundaries through application of both the Comprehensive Plan and LMR.

Several local plans have been produced in the North Slope Borough. The community of Wainwright has a village-level comprehensive plan (Alaska Consultants Incorporated 1978, approximate). The plan has background information, traditional land use patterns, goals for land use and community facilities, and goals for regional and local transportation. While the plan is somewhat dated, it is a good historic reference. The community of Nuiqsut produced a cultural plan, *Nuiqsut Paisanich,* shortly after the community was re-established (Brown 1979). The plan documented the cultural landscape, how the community practices its heritage way of life, issues facing the community, and important subsistence use areas. While this plan is also dated, it is still very important to the community, and should be used as a guide for development in the vicinity of Nuiqsut. The community of Kaktovik produced a guide for people interested in working in the Kaktovik area (Karl E. Francis & Associates 1991, approximate). While this document does not follow the format of a comprehensive plan, it identifies important cultural values and issues in the community. The remaining communities do not have current, approved village-level comprehensive plans. Several communities have expressed interest in updating or

developing village-level comprehensive plans to address current issues facing the communities. In addition, many of the village corporations have plans for their land management programs.

3.3.2 *Socioeconomic Characteristics*

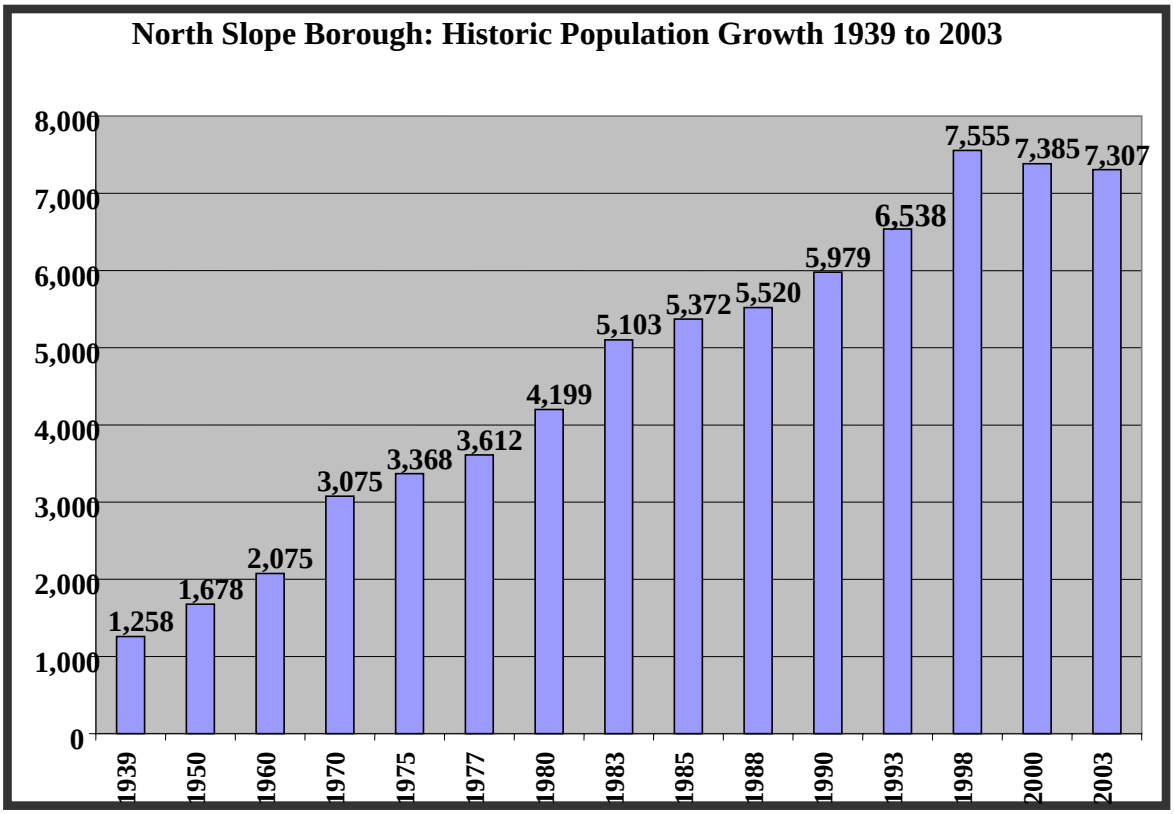
Approximately every five years, the North Slope Borough conducts an independent census, including socioeconomic research. The most recent census was conducted in 2003; the census report contains an overview for the Borough as well as profiles for each of the communities. Topics addressed include: population, employment, income, housing, education, subsistence, Inupiaq language use, and other community indices. (Shepro, Maas et al. 2003). The following section provides an overview of socioeconomic characteristics; for more information please refer to the North Slope Borough Socioeconomic Report (Shepro, Maas et al. 2003).

The oil and gas industry still provides the primary source of revenue for North Slope Borough government services, despite a decline in the industry, and a subsequent decline in revenue levels. Funding from state sources has also declined in recent years, further impacting employment levels and the Borough's ability to provide services. The North Slope Borough and the North Slope Borough School District are large employers in the region; the decline in Borough revenues has affected employment and income throughout the North Slope (Shepro, Maas et al. 2003).

3.3.2.1 Population/demographic characteristics

The North Slope Borough's population increased fairly steadily from 1,258 residents in 1939 to a high of 7,555 residents in 1998. The population then declined by approximately three percent, to 7,307 residents in 2003 (Figure 3-1). During this time, Anaktuvuk Pass, Atqasuk, Kaktovik, and Point Lay gained residents, while Barrow, Nuiqsut, Point Hope, and Wainwright lost residents. Barrow and Wainwright had the largest decreases in population (Shepro, Maas et al. 2003).

Figure 3-1



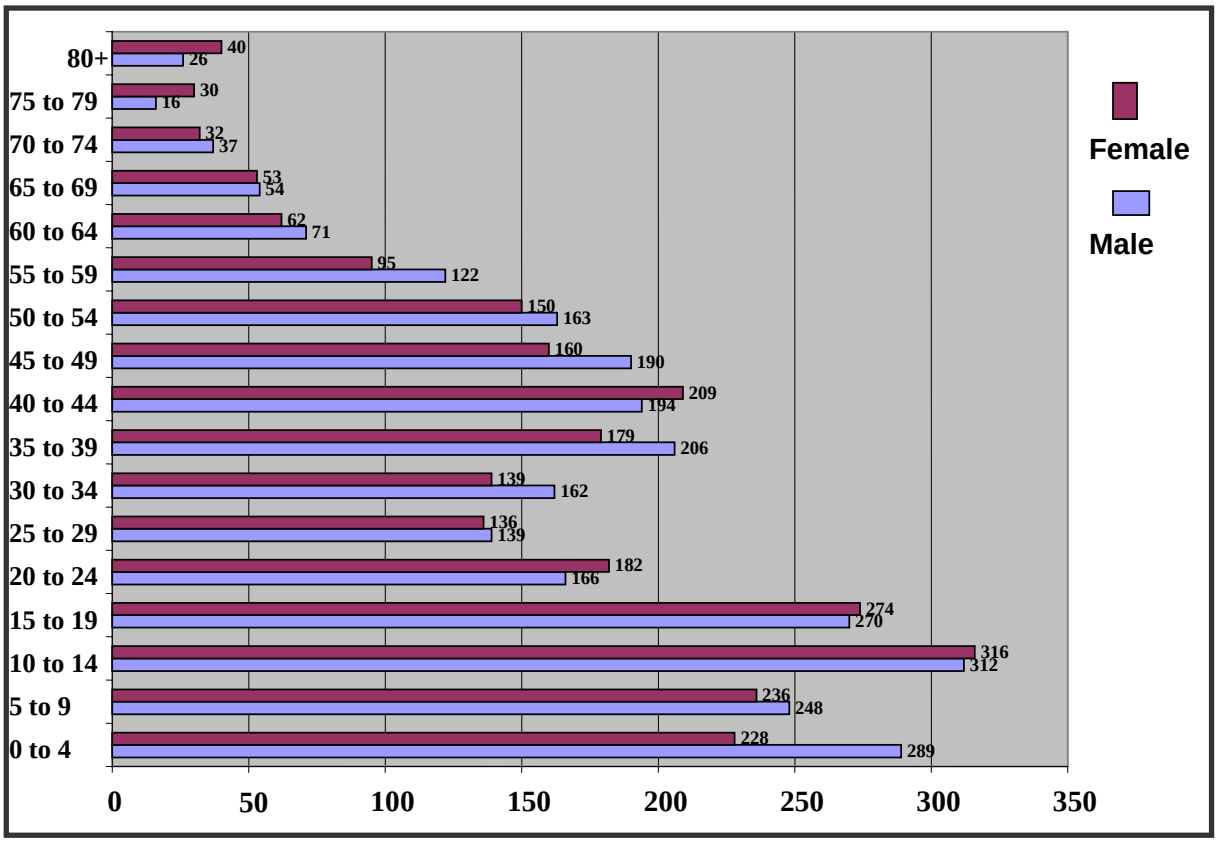
North Slope Borough Population

Source: (Shepro, Maas et al. 2003)

The majority of the population is Inupiat Eskimo (71.7 percent), with the remainder of the population comprised of Caucasians (15.5 percent), Filipinos (7.5 percent), Pacific Islanders (1.9 percent), and small numbers of other ethnic groups (Shepro, Maas et al. 2003).

The Borough has a young population, with average ages and median ages below those of the state or nation. This creates a high ratio of dependents to wage earners, and has implications for future education funding and the need for future housing, other services, and creation of job opportunities. (Shepro, Maas et al. 2003). Figure 3-2 illustrates the Borough's population distribution by age and gender. Table 3.3-1 provides population trend projections for each community in the Borough through 2020.

Figure 3-2
North Slope Borough Population by Age and Gender



Source: (Shepro, Maas et al. 2003)

Table 3.3-1
North Slope Borough Population Projections Through 2020

NORTH SLOPE BOROUGH								
COMMUNITY	1993	1996*	1998	2000**	2003	2010	2015	2020
Anaktuvuk Pass								
High	**270**	**306**	**314**	**282**	**346**	**352**	**361**	**366**
Medium						**335**	**340**	**342**
Low						**322**	**325**	**333**
Atqasuk								
High	**237**	**226**	**224**	**228**	**250**	**290**	**301**	**312**
Medium						**270**	**283**	**274**
Low						**265**	**269**	**266**
Barrow								
High	**3,908**	**4,276**	**4,641**	**4,581**	**4,429**	**4,501**	**4,603**	**4,612**
Medium						**4,488**	**4,462**	**4,465**
Low						**4,279**	**4,198**	**4,102**
Kaktovik								
High	**230**	**223**	**256**	**293**	**286**	**305**	**319**	**327**
Medium						**298**	**302**	**305**
Low						**280**	**289**	**272**
Nuiqsut								
High	**418**	**435**	**420**	**433**	**416**	**435**	**437**	**445**
Medium						**432**	**430**	**436**
Low						**420**	**425**	**427**
Point Hope								
High	**699**	**764**	**805**	**757**	**764**	**810**	**815**	**822**
Medium						**799**	**803**	**807**
Low						**775**	**778**	**775**
Point Lay								
High	**192**	**180**	**246**	**247**	**260**	**288**	**292**	**296**
Medium						**272**	**276**	**278**
Low						**265**	**269**	**262**
Wainwright								
High	**584**	**563**	**649**	**546**	**556**	**575**	**582**	**585**
Medium						**570**	**575**	**572**
Low						**560**	**558**	**553**
NSB Totals								
High	**6,538**	**7,157**	**7,555**	**7,385**	**7,307**	**7,556**	**7,710**	**7,765**
Medium						**7,464**	**7,471**	**7,479**
Low						**7,166**	**7,111**	**6,990**

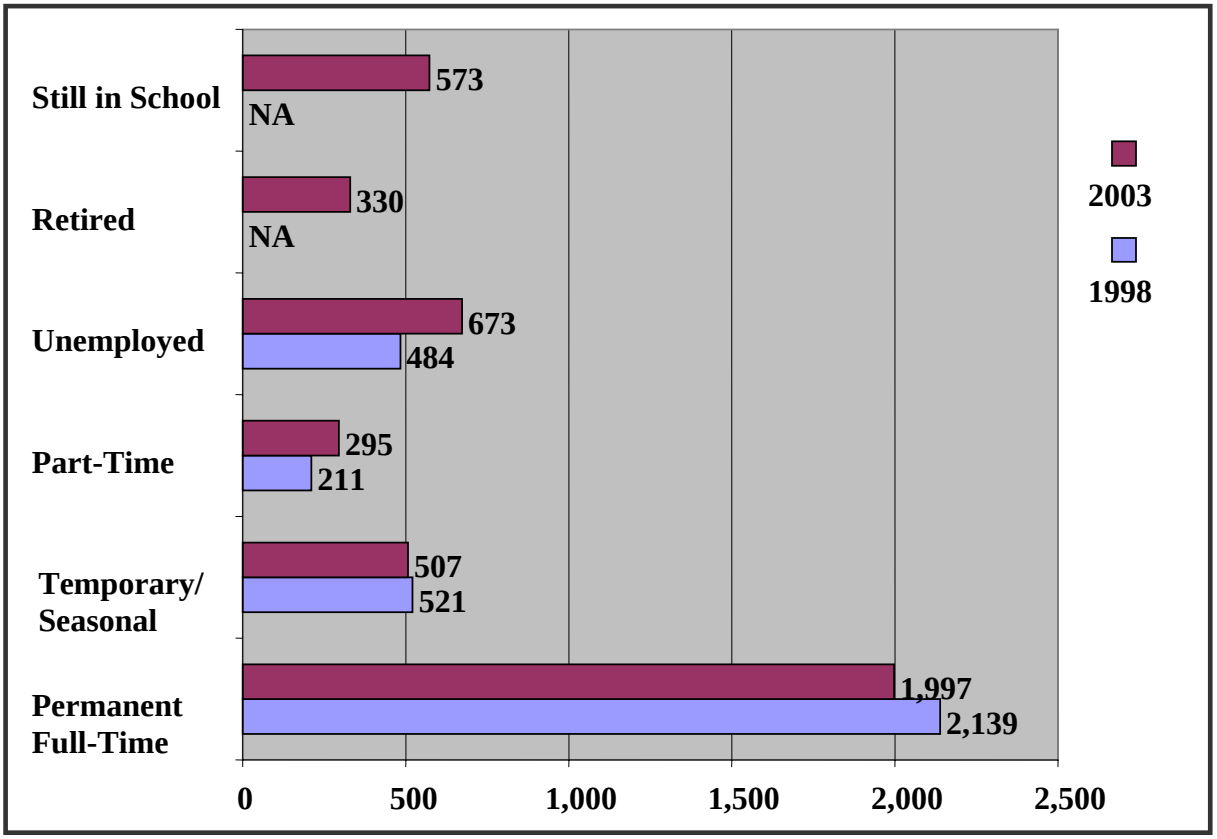
Note: *AK Dept of Labor Research &Analysis (Revised 1/13/99); ** 2000 US Bureau of Census

Source: (Shepro, Maas et al. 2003).

3.3.2.2 Employment and income

The Alaska Department of Labor and Workforce Development estimated that unemployment in the Borough averaged 11.9 percent in 2003, while the North Slope Borough's estimate for unemployment was 22.9 percent for the same period (Figure 3-3). This discrepancy between estimates stems from different definitions of unemployment. The Borough's definition of unemployment includes discouraged workers, or people who are involuntarily unemployed but who are not submitting unemployment reports because they have exhausted their benefits or because they have given up hope of finding local employment. The small communities in the North Slope Borough have limited employment opportunities and high rates of involuntarily unemployed residents (Shepro, Maas et al. 2003).

Figure 3-3
North Slope Borough Employment Status in 1998 and 2003



Source: (Shepro, Maas et al. 2003)

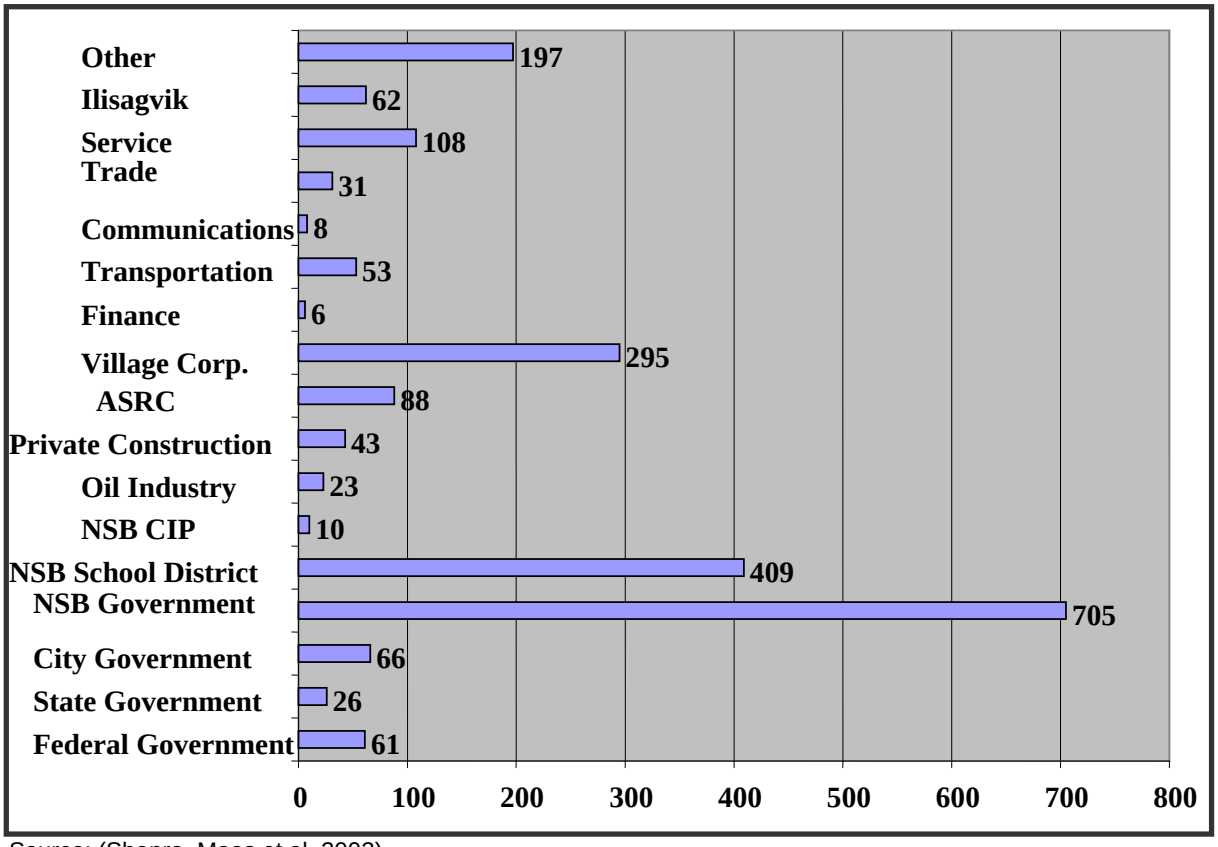
Employment in the North Slope Borough has shifted in recent years. The Borough and the school district have historically been the largest employers of local residents in the region (Figure 3-4). Employment of local residents in the resource development industry has been frustratingly low. While Figure 3-4 displays only 23 employees directly employed by the "oil industry," the number is likely higher if one considers the local employees who work in the resource industry under other employers, such as village corporations. Residents and industry would both like to see increases in the number or Borough residents directly employed by the resource development industry. Some petroleum companies and Native corporations are attempting to improve local hire. However there are a number of barriers to increasing local employment in the resource development industry, which are addressed in the goals and objectives under socioeconomics.

In recent years, the number of permanent full-time jobs has decreased, while the number of part-time jobs and unemployed residents increased. This trend mirrors the Borough's decline in revenues (Shepro, Maas et al. 2003). Interest is high in creating more private sector jobs for local residents.

Regional and village corporations are creating some jobs through subsidiaries and joint ventures, and some companies involved in resource development are attempting to increase local employment through training programs and other opportunities. However, job requirements can create conflicts with subsistence activities. The need to complete education and training and address substance abuse problems are challenges that must be overcome to order to increase local employment. Addressing these challenges will require cooperative

education and training efforts on the part of the Borough, School District, ANCSA corporations, tribal organizations and resource development industry.

Figure 3-4
Employment of North Slope Borough Residents by Employer



Source: (Shepro, Maas et al. 2003)

Household and per capita incomes in the Borough have increased substantially over the past 10 years (Table 3.3-2). However, income disparities remain between Inupiat and non-Inupiat individuals and households. In addition, local incomes still fall below the mean and median household and per capita incomes of the state and the nation (Shepro, Maas et al. 2003). It is important to note that income is not the only measure of economic well-being in Borough communities; subsistence resources provide a substantial amount of food for Borough households. However, cash income remains very important for households, considering the high costs for supplies (including subsistence supplies) and travel.

Table 3.3-2
Average Household and Per Capita Income in the North Slope Borough

North Slope Borough: Average Per Capita and Household Income*		
Household Income	1993	$44,462
	1998	$51,121
	2003	$55,793
Per Capita Income	1993	$12,874
	1998	$13,633
	2003	$24,932

Note : *Results include only those households and individuals responding to the census survey and this question.

Source: (Shepro, Maas et al. 2003)

The poverty level in the communities outside Barrow increased dramatically between 1998 and 2003 (Shepro, Maas et al. 2003). In 1998 there were a total of 76 Poverty Level (as defined by the U.S. Census Bureau) and Very Low Income (defined as 1.25 percent of the Poverty Level) households, comprised of 185 individuals. By 2003 this number had increased to a total of 100 households out of 480 reporting household income and household size, or 436 individuals living at or immediately above the official poverty line (Table 3.3-3).

Table 3.3-3
Poverty Level Households in Communities Outside Barrow

North Slope Borough: Poverty Level Households in Communities Outside Barrow 2003*		
Community	Poverty Level	Total HHs Reporting
Anaktuvuk Pass	29	77
Atqasuk	4	28
Kaktovik	3	41
Nuiqsut	12	65
Point Hope	21	121
Point Lay	12	42
Wainwright	19	106
Total	100	480

Note : *Results include only those households responding to the census survey and the questions of household income and size.

Source: (Shepro, Maas et al. 2003)

3.3.3 *Subsistence*

3.3.3.1 Fish and wildlife resources

Subsistence activities on the North Slope are oriented both to the land and to the sea. Birds, fish, marine mammals, land mammals, and plants are all sources of subsistence food and supplies. Coastal communities are logically more dependent upon marine mammals and coastal resources, while inland communities are more dependent upon caribou and other terrestrial resources. Bowhead whales, beluga whales, several species of seals, and caribou still provide the bulk of subsistence needs for local communities. Other subsistence resources include: waterfowl, ptarmigan, anadromous and freshwater fish, furbearers, large mammals, beluga whale, and vegetation (University of Alaska - Arctic Environmental Information and Data Center 1978; National Research Council 2003). Section 3.2 provides an overview of the biological environment, including species used for subsistence.

3.3.3.2 Cultural importance

The cultural identity of North Slope Borough residents has been rooted in a subsistence lifestyle and its associated social and cultural framework for thousands of years. This fundamental relationship between the people, the land, sea, plants and animals is still prevalent today. Another important factor of cultural identity is the Inupiaq language; Inupiaq and subsistence activities are intimately linked (University of Alaska - Arctic Environmental Information and Data Center 1978; National Research Council 2003).

Shares of muktuk ready for distribution

North Slope Borough residents have developed an efficient lifestyle for living in arctic regions that involves a direct interaction between the people and their environment. Their adaptive harvest of land and sea resources has allowed them to survive changing environmental and resource conditions. Flexibility, in response to change, has been and continues to be the key to local resilience (Maynard and Partch and Woodward-Clyde Consultants 1984).

In addition to social and cultural importance, subsistence resources provide an important source of nutrition on the North Slope. These locally obtained foods generally constitute a large portion of the diet, especially where imported foods are more expensive and less readily available. Subsistence foods are generally high in protein and low in carbohydrates. According to a recent socioeconomic study (Shepro, Maas et al. 2003), nearly all Inupiat households in the Borough utilize subsistence resources for food. This study found that there was an increase in the number of Inupiat households who depend on local subsistence resources for half or more of the food they consume between 1998 and 2003. However the same study noted that the overall consumption of subsistence resources in the Borough declined between the two census years (Table 3.3-4). This discrepancy was attributed to the difference in sample populations; a large number of non-Inupiat teachers were not in residence at the time of the 1998 census, but they were available for the 2003 census.

Native foods are seen to be essential to the Inupiat character of life. “Aside from the basic nutritional value of Native foods, the Inupiat hold the conviction that Native foods maintain their health and strength” (Maynard and Partch and Woodward-Clyde Consultants 1984). Many

aspects of Inupiat life are involved with the harvest, preparation, and distribution of subsistence foods and other resources.

There is an extensive network for sharing subsistence products. Within the village, subsistence resources are shared with elders and family members who may not be able to obtain their own subsistence foods. Subsistence foods are also shared locally during celebrations and holidays. In addition to local sharing and exchange, the custom extends regionally between other North Slope villages, as well as to relatives living in larger communities such as Fairbanks and Anchorage (Maynard and Partch and Woodward-Clyde Consultants 1984). However, recent sharing trends indicate that subsistence foods are now shared more often within local communities and less often with households in other communities (Shepro, Maas et al. 2003).

Table 3.3-4
Household Consumption of Subsistence Resources

	Households 1998	Percentage 1998	Households 2003	Percentage 2003
None	35	3	165	13%
Very little	128	12%	217	17%
Less than half	211	20%	182	14%
Half	216	21%	241	19%
More than half	188	18%	183	14%
Nearly all	134	13%	165	13%
All	126	12%	130	10%
Total	1038	100%	1283	100%

Note: Data indicates households that responded to a question regarding how much of the meat, fish, and birds eaten in the household came from local food sources

Source: (Shepro, Maas et al. 2003);
(North Slope Borough Transportation Plan 2005)

While the subsistence traditions remain steadfast, they have experienced many changes due to the introduction of Western society. The petroleum discoveries on the North Slope have provided an infusion of cash, technology, and capital development projects. Technological and social adaptations have been developed to respond to the natural changes and to those precipitated by the introduction of Western activities during the past 150 years (Maynard and Partch and Woodward-Clyde Consultants 1984). In addition, the number of non-Inupiat households has increased in the communities in recent years (Shepro, Maas et al. 2003). Since non-Inupiat households generally have low levels of reliance on subsistence resources, there are shifts in some community resource utilization data.

Petroleum discoveries and development have evoked major changes to the way of life in the North Slope Borough. In evaluating the cumulative effects of oil and gas activities on the human environment, the National Research Council (National Research Council 2003) found that "many activities associated with petroleum have changed the landscape in ways that have had aesthetic, cultural, and spiritual consequences; those consequences will increase as the use of these facilities and infrastructure declines." Continuing resource development projects have the potential to impact the sociocultural and subsistence patterns of Borough residents (Wickersham & Flavin Planning Consultants 1982; National Research Council 2003). Continuing coordination between Borough residents and developers is needed to minimize sociocultural and environmental impacts. In addition, research is needed to focus on the rising levels of environmental and sociocultural change.

3.3.3.3 Economic importance

This section is excerpted from the North Slope Borough Coastal Management Plan (Maynard and Partch and Woodward-Clyde Consultants 1984):

> The obvious economic aspect of subsistence is that these foods represent income. Several studies have attempted to calculate the dollar value of subsistence foods in terms of replacement market goods. When opportunities for employment tighten, residents can adjust to smaller incomes. The cash economy has not displaced the subsistence economy. Successful hunters redistribute their take to others, particularly to relatives and the elderly, who may not be able to provide for their own needs. Wage earners contribute money to the support of subsistence activities (e.g. equipment and supplies) and help ensure the provision of subsistence foods to the entire community. This combination of subsistence and wage contributions have allowed the Inupiat to weather cycles in employment variability.
>
> The availability of job opportunities on the North Slope has not caused a decrease in the desire to pursue subsistence activities; there is a general preference for spending time in both wage and subsistence activities. Wage earners carry out subsistence activities during non-work time such as vacations, weekends, and after work hours. In other instances it is very common for a family member to work and monetarily sponsor someone else in their subsistence pursuits. A sponsor receives a measure of status and also part of the catch for assisting the hunt.

3.3.3.4 Regional patterns of subsistence activity and seasonal rounds

Subsistence activities occur year-round, with seasonal emphases. Annual use patterns are dependent upon natural cycles, availability of resources, travel conditions, and other environmental factors. Some species may be present year-round, but are only harvested when permitted. Other species are opportunistically harvested or as environmental conditions (such as sea ice) allow. Furbearers are not often harvested during the summer months as the pelts are lighter and the animals are raising their young.

Subsistence harvest activities vary with each community and their surrounding environment. These patterns have a long historical basis, and have been modified with the establishment of permanent settlements and changing conditions (Maynard and Partch and Woodward-Clyde Consultants 1984). The coastal communities generally engage in a fall whaling season and some communities also have a spring whale hunt. Caribou are available year-round near most of the Borough communities. Birds and fish are also available in the Borough throughout most of the year. Refer to the Village Profiles (Section 4.0) for an overview of subsistence activities in each community.

3.3.3.5 Use areas (historic and current), modes and locations of access

The residents of the North Slope Borough travel throughout the area in pursuit of subsistence activities. The use areas for coastal villages extend miles out into the ocean. Inland waters, such as rivers and lakes, are also used for fishing and bird hunting areas. Refer to Figure B-5 for an illustration of the distribution of subsistence uses in the North Slope Borough. Figures 3-5, 3-6, and 3-7 illustrate general areas of subsistence use by the Borough communities. These use areas are intended to be general representations; developers should consult with local communities, tribes, and Borough staff when planning and designing projects and facilities.

Understanding the area of influence of subsistence is critical to understanding the geographic area that must be considered in assessing whether appropriate subsistence protections are in place. Identifying only traditional harvest areas greatly under-represents areas deserving of protection. In addition, one must consider camps, cabins, access routes, butchering sites, and staging areas. Native allotments inherently involve subsistence related activities. Another factor to evaluate is disruptive activities that have the potential to deflect migratory species (e.g. whales, caribou, fish, waterfowl) away from traditional harvest areas and subsistence users. Areas critical to the welfare of the subsistence species, such as concentration areas, calving areas, feeding areas, and molting and brooding areas are particularly vulnerable to disturbance. The area of influence of subsistence uses must be evaluated on a case-by-case basis.

The subsistence hunting areas for land mammals are the most extensive of all subsistence use areas. The area covers nearly the entire North Slope Borough, extending from the Brooks Range to the coastal plains. Modes of travel include a variety of all terrain vehicles, as well as snow machines.

Almost the entire coastline of the Borough is used for marine mammal hunting, extending twenty-five miles or more offshore. A combination of traditional skin boats and motorized boats are used for subsistence activities. Snow machines are also used during the winter months for hunting marine mammals from the sea ice.

Figure 3-5
General Subsistence Use Areas for Wainwright, Anaktuvuk Pass, and Kaktovik

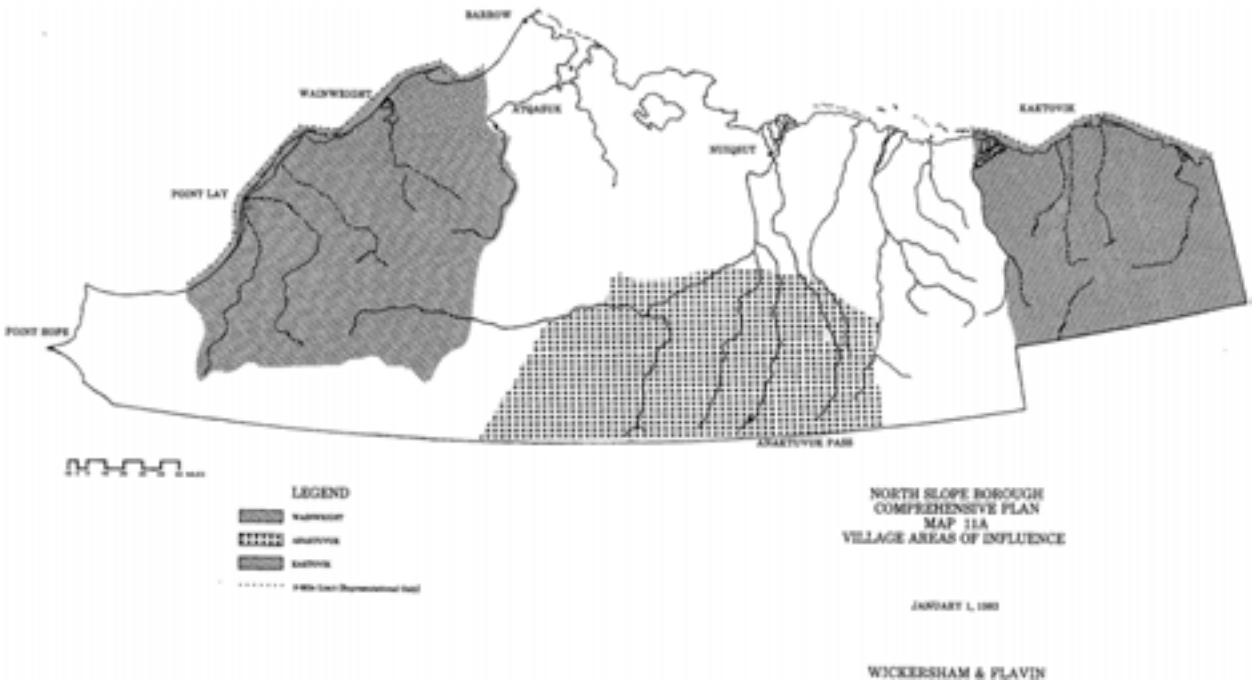


Figure 3-6
General Subsistence Use Areas for Point Lay, Atqasuk, Nuiqsut

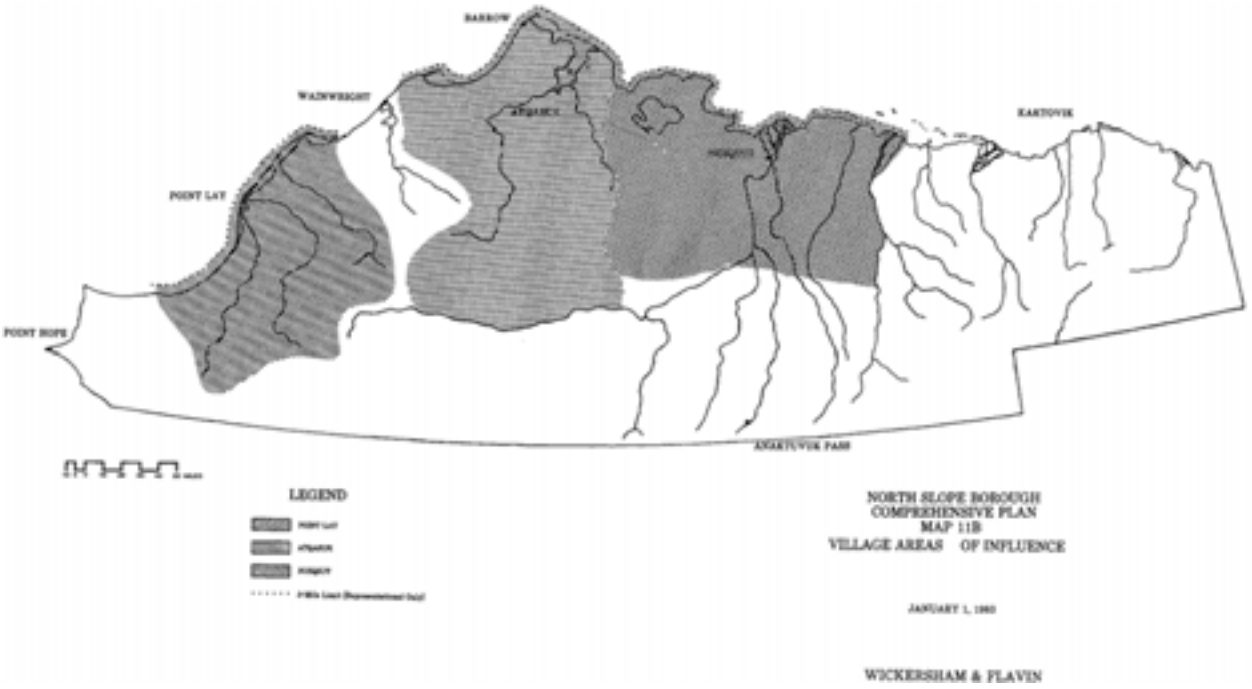
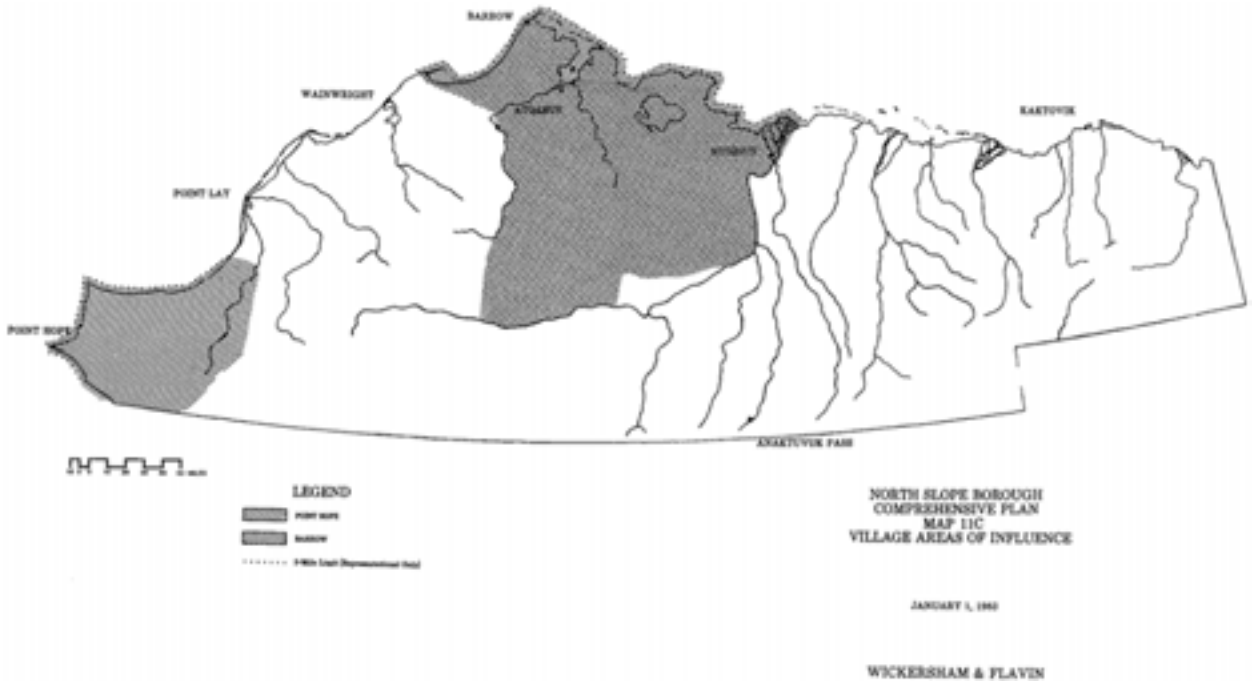


Figure 3-7
General Subsistence Use Areas for Point Hope and Barrow



Birds are primarily hunted in the river deltas and along the coastal plain. Nearly the entire coastline of the Borough is productive habitat for migratory birds and waterfowl. Subsistence fishing also occurs in the coastal waters as well as in rivers and lakes. All-terrain vehicles, snow machines, and boats are used for travel.

Borough residents are concerned about current and cumulative effects of oil and gas development on subsistence resources and activities. Concerns include habitat fragmentation, disruption of migration routes and pathways for fish and wildlife, disturbance and deflection of wildlife from traditional harvest areas, restrictions or exclusions of Borough residents from areas traditionally used for harvest, cumulative contamination, and potential catastrophic events such as oil spills. Activities associated with resource and village development should accommodate measures to avoid or minimize adverse impacts to subsistence resources and activities during project planning, design, construction, and operation. Developers should consult with village residents and Borough staff when siting and designing facilities, or planning for resource exploration and construction activities.

3.3.4 *Cultural Values and Resources*

3.3.4.1 Cultural Values

The people of the North Slope Borough to place great importance in maintaining their culture and lifestyle. The culture has strong ties with the natural environment, including the lands, waters, animals and vegetation. Traditional activities are central to historic and contemporary lifestyles, with subsistence seasons focusing seasonal activities. Family relationships and kinships continue to be strong influences to contemporary life, shaping social interactions, including cooperative activities and sharing.

While complex value systems are difficult to describe, some of these central, traditional Inupiat values have been captured at a North Slope Borough Youth and Elders Conference. The values are described and displayed in a set of posters developed by the North Slope Borough School District, in cooperation with the Native Village of Barrow and PetroStar, Incorporated (North Slope Borough School District 2003). Schools throughout the Borough display the posters, with text in Inupiaq and English, and photos that illustrate the values. The following excerpt is the English text from the posters.

> **COMPASSION –** Though the environment is harsh and cold, our ancestors learned to live with warmth, kindness, caring and compassion.
>
> **AVOIDANCE OF CONFLICT –** The Iñupiaq way is to think positive, act positive, speak positive and live positive.
>
> **LOVE AND RESPECT FOR OUR ELDERS AND ONE ANOTHER –** Our Elders model our traditions and ways of being. They are a light of hope to younger generations. May we treat each other as our Elders have taught us.
>
> **COOPERATION –** Together we have an awesome power to accomplish anything.
>
> **HUMOR –** Indeed, laughter is the best medicine!
>
> **SHARING –** It is amazing how sharing works. Your acts of giving always come back.
>
> **FAMILY AND KINSHIP –** As Iñupiaq people, we believe in knowing who we are and how we are related to one another. Our families bind us together.

KNOWLEDGE OF LANGUAGE – With our language we have an identity. It helps us to find out who we are in our mind and in our heart.

HUNTING TRADITIONS – Reverence for the land, sea and animals is the foundation of our hunting traditions.

RESPECT FOR NATURE – Our Creator gave us the gift of our surroundings. Those before us placed ultimate importance on respecting this magnificent gift for their future generations.

HUMILITY – Our hearts command we act on goodness. Expect no reward in return. This is part of our cultural fiber.

SPIRITUALITY – We know the power of prayer. We are a spiritual people.

Many research projects and development projects have documented cultural values and activities in the North Slope Borough. For more detailed information on Inupiat culture, please refer to original sources (Lantis 1959; Chance 1966; Burch 1975; Spencer 1976; North Slope Borough 1984; Chance 1990; USAED 1999; U.S. Department of the Interior 2004). The Inupiat Heritage and Language Center in Barrow has a wealth of information, some of which still needs to be cataloged, transcribed, and analyzed.

Understanding and accommodating local values and traditional practices is important when developing local hire and training programs, siting and designing facilities, or planning for resource exploration and construction activities. Consultation with the North Slope Borough and potentially affected communities is recommended prior to conducting these activities.

3.3.4.2 Archaeological, Historical, and TLUI resources

The Alaska Department of Natural Resources, Office of History and Archaeology, maintains the Alaska Heritage Resource Survey, with detailed information regarding cultural resources throughout the state, including the North Slope Borough. In addition, the North Slope Borough maintains a geographic database called the Traditional Land Use Inventory. These databases are voluminous, with detailed information on historic and contemporary traditional use areas.

For more detailed information on archaeological, historical, and traditional land uses, these databases should be consulted. Regional prehistoric, historic, and contemporary information may also be found at the Inupiat Heritage and Language Center in Barrow. In addition, planning projects have developed concise summaries of historic and archaeological information in the area, such as the North Slope Borough Coastal Management Plan (North Slope Borough 1984), the Beaufort Sea Oil and Gas Development Project for Northstar (USAED 1999), and the plans for the NPRA (U.S. Department of the Interior 2004).

Borough residents are concerned about current and cumulative effects of oil and gas development on archaeological, historic, and TLUI resources. Industrial development is one of the leading sources of discovery and documentation of new archaeological and cultural sites on the North Slope. Concerns include damage to and degradation of resources, restrictions or exclusion of Borough residents from important cultural resource areas, and damage from potential catastrophic events such as oil spills. Activities associated with resource and village development should accommodate measures to avoid or minimize adverse cultural resource impacts during project planning, design, construction, and operation. Developers should consult with village residents and Borough staff when siting and designing facilities.

3.3.4.3 Use of Traditional and Contemporary Local Knowledge

Traditional and contemporary local knowledge of the physical, biological, and cultural environment has been passed down from generation to generation and increased through the experience of Borough residents who have spent much of their lives working in and observing the environment. Traditional and contemporary local knowledge is highly valued by Borough residents. There are many instances where traditional and contemporary local knowledge has revealed understandings of the environment that western science had not been able to discover. In many other instances traditional and contemporary local knowledge and western science have had similar findings.

Traditional and contemporary local knowledge for the North Slope area is well documented in written record at the University of Alaska – Anchorage, University of Alaska – Fairbanks, Barrow Tuzzy Consortium Library, North Slope Borough Planning Department Inupiat History Language and Culture division, North Slope Borough Planning Department's Geographic Information System, tribal organizations, and the Alaska Eskimo Whaling Commission records, among other locations. In addition, federal agencies such as the National Science Foundation, National Oceanic and Atmospheric Administration, and Minerals Management Service have specific funding and programs to elicit and document traditional and contemporary local knowledge, and have an obligation as tribal trustees to provide this information to the public.

All project proponents, including resource and village development projects, should consult with Borough staff and village residents during the planning and design stages of projects in order to incorporate traditional and contemporary local knowledge in an appropriate manner. The incorporation of traditional and contemporary local knowledge should be an integral component of the project plan; it is not a well-reasoned approach to ignore thousands of years of knowledge until a very late stage of project planning. The Borough particularly emphasizes that project proponents should foster constructive relationships with tribal governments and local governments.

Traditional and contemporary local knowledge has been utilized in the Arctic Gas pipeline project and the Alpine CD4 project to result in safer facility location and designs. There are some projects that the Borough was dissatisfied with how traditional and contemporary local knowledge was used. While there are still improvements to be made in the effective incorporation and utilization of traditional and contemporary local knowledge, efforts such as these will serve as educational tools for future projects.

Whalebone arch and skin boats in Barrow

3.3.5 *Governance and regional/community organizations*

3.3.5.1 Organizations, Jurisdictions and Responsibilities

Borough Government

The North Slope Borough is the largest municipality in the United States, in terms of landmass. It was established as a first class borough in 1972 and a Home Rule Charter was adopted in 1974. The Borough is the regional government for the eight villages within the 89,000 square miles of the Alaskan arctic, north of the Brooks Range. The Borough government consists of an elected mayor, a seven-member assembly, a seven-member school board, and an eight-member planning commission (University of Alaska - Arctic Environmental Information and Data Center 1978; North Slope Borough 2004a).

The powers of the Borough include: taxation, education, planning, platting, and zoning. In addition, the villages have transferred to the Borough many powers typically held by cities, including: area-wide police powers, streets and sidewalks, water, sewers and sewage treatment, garbage and solid waste services and facilities, watercourse and flood control facilities, health services and hospital facilities, telephone systems, utilities (light, power, and heat), transportation systems, housing, management of historic sites and facilities, and libraries. The Borough also presently has responsibility for services typically provided by the state or other entities, such as airport and aviation facilities, and housing and urban development.

Petroleum and natural resource development projects are the greatest source of property tax revenues for the region. With these revenues, the Borough has provided many services to its residents, including improvements in sanitation, water and sewer systems, education, public safety, and cultural services (Shepro, Maas et al. 2003). In addition to providing public services, the Borough strives to protect regional subsistence habitat and the local way of life (Hopson 1978).

While the Borough has provided a high level of service throughout its municipality for over three decades and has been self-sufficient compared to other areas of rural Alaska, the levels of service provided are declining due to decreases in revenues. It is becoming imperative that the Borough reduce costs and eliminate duplication of services that are typically provided by other entities in other areas of the state. The Borough is striving to improve coordination with partner groups within and outside the Borough to maintain services for its residents and maintain fiscal integrity. This includes working together to identify additional sources of funding for services and facilities, and training and maintaining the workforce needed to support them. Potential partners include federal and state entities such as the Denali Commission, the EPA, Alaska Native Tribal Health Consortium, Village Safe Water, the Alaska Department of Transportation and Public Facilities, Alaska State Troopers, ANCSA Native corporations, and regional and village tribal governments.

City Governments

With the exception of Point Lay, all communities in the North Slope Borough are incorporated as second-class municipalities. A mayor and an elected city council typically govern the communities. Some communities are beginning to express interest in resuming some local powers that were transferred to the Borough decades ago, including preparation of village comprehensive plans.

Tribal Governments

All of the North Slope communities have federally recognized tribal governments; each village has an active tribal council. In addition to the local governing bodies, there are two regionally active tribal organizations. The Inupiat Community of the Arctic Slope (ICAS) is a federally recognized tribal organization and provides assistance to villages in areas of realty, transportation, and resource management programs. The Arctic Slope Native Association (ASNA) has been active in the North Slope Borough for many years, but the primary focuses of the organization in recent years are healthcare and social services. In addition, Maniilaq Association (Kotzebue) and Tanana Chiefs Conference (Fairbanks) provide health and social services in some Borough villages.

Alaska Eskimo Whaling Commission

The Alaska Eskimo Whaling Commission (AEWC) is a critical regional entity, with influence on local, regional, national, and international policies that affect bowhead whales and subsistence uses of the whales. The commission functions as a non-profit corporation, with the goal of protecting bowhead whales, their habitat, and Native subsistence uses of bowhead whales. The AEWC is also a strong supporter of bowhead whale research. The commission was initially formed in 1977 to represent ten Eskimo whaling communities before the United States Government and the International Whaling Commission (Alaska Eskimo Whaling Commission 2004).

The AEWC has worked with the oil industry to develop the Good Neighbor Policy and Conflict Avoidance Agreements with regard to oil and gas exploration and development activities in waters offshore the North Slope Borough. These agreements are a model for protection of subsistence resources and cultural values, and are being applied to agreements and permit conditions for resource development activities onshore.

ANCSA Corporations

Arctic Slope Regional Corporation is a private, for-profit corporation that was established through the ANCSA to represent the business interests of the Arctic Slope Inupiat (Arctic Slope Regional Corporation 2004). The corporation has a deep respect for the Inupiat heritage and is committed to preserving the Inupiat culture and traditions. The corporation operations are strongly based in natural resources, holding title to approximately five million acres of land. ASRC represents all eight villages on the North Slope.

The local village corporations include: Atqasuk Inupiat Corporation, Cully Corporation (Point Lay), Kaktovik Inupiat Corporation, Kuukpik Village Corporation (Nuiqsut), Nunamiut Inupiat Corporation (Anaktuvuk Pass), Olgoonik Corporation (Wainwright), Tikigaq Corporation (Point Hope), and Ukpeagvik Inupiat Corporation (Barrow). While the corporations are not governing bodies, they are influential in decisions made by local and regional governments.

3.3.5.2 Fiscal/financial characteristics

Borough revenues have been in decline since the beginning of the 1990s and are projected to continue to decline through 2010. The oil and gas industry provides approximately 97 percent of the Borough's property taxes, which comprises nearly 70 percent of the Borough's budget (Arctic Development Council 2003; Ahmaogak Sr. 2004). However, oil production has declined and tax revenues have correspondingly decreased.

The largest projected decline in non-tax revenues is due to declines in investment income; cash balances, and interest rates (Ahmaogak Sr. 2004). In addition, there has been a precipitous decline in grants and other funding provided by the federal government and the State of Alaska. This combination of revenue declines has seriously impacted the Borough's ability to provide services in recent years.

With all major sources of revenue in decline, Borough services and employment have been dramatically reduced. The Borough is the largest employer in all North Slope communities; thus, these budget cuts have had widespread economic and employment ramifications throughout the region.

The Borough has developed a series of strategic plans to address the revenue and budget declines (Arctic Development Council 2003; Ahmaogak Sr. 2004; North Slope Borough 2004a). Despite the economic hardships, the Borough appears to be maintaining fiscal integrity. Recent bonds proposed for sale continue to receive high ratings by national indices (North Slope Borough 2004).

3.3.6 *Economic Development*

3.3.6.1 Oil, gas, and mineral development

Oil and Gas. Oil and gas development in this region has been a substantial revenue source for the Borough, state, industry, and employees that work in the oilfield. Resource development funding, based from this area, has made the development of infrastructure and facilities possible across the Borough. The oil and gas deposits of the North Slope are among the largest ever found in North America.

While Prudhoe Bay has been the largest producing oil field in the United States, followed closely by the Kuparuk Field, the forecast for production in these fields is for continued decline. New fields have been brought on line recently, including the Northstar and Alpine Fields. The National Petroleum Reserve – Alaska (NPRA) is expected to have between 5.9 to 13.2 billion barrels of oil and between 39.1 and 83.2 trillion cubic feet (TCF) of natural gas (Arctic Development Council 2003). After 15 years of being reserved, the NPRA was re-opened for new development in 1999. Lease sales have continued in the NPRA in 2004 and offshore in 2005, and exploration and development is actively occurring.

While the North Slope Borough has traditionally supported onshore oil exploration and development, the Borough has always required that development plans include prevention measures specifically designed to protect subsistence resources, wildlife, and the arctic environment. The Borough has not supported offshore resource development activities because of the lack of resources and technical capability to stop, recover, and clean up an oil spill in the offshore environment. The risks to the environment, resources, and people in the event of a spill are too great to be tolerated. A major oil spill in the Beaufort Sea would threaten the very existence of the people and culture in the North Slope Borough.

The coastal plain of the Arctic National Wildlife Refuge (ANWR) is also anticipated to have large deposits of recoverable oil and gas. However, only one exploratory well has been drilled in the area, on Native Corporation lands to the southeast of Kaktovik. An act of Congress would be required to open the coastal plan for exploration and leasing.

Coal. Approximately 40 percent of the total coal resources of the United States are located in the western portion of the North Slope Borough. These resources are generally high in BTU value and low in sulfur, making them valuable for number of uses. "The hypothetical resource of

high-rank coal in the western arctic coalfield is 4 trillion tons, of which 150 billion tons is classified as identified resources. During World War II, coal was mined around the Atqasuk area to fuel the community of Barrow. The possible development of coal resources in the region will diversify local economy and improve the standard of living by lowering local energy costs. However, lack of surface transportation and more compatible energy sources like natural gas are the key obstacles to the development of coal on the North Slope" (Arctic Development Council 2003).

Local communities are very interested in alternative fuel sources, particularly with the rising cost of importing diesel. Development of coal and coal gas resources in the area could stimulate the local and regional economies with development of an export market as well as the local home heating market.

Minerals. Hard rock mineral deposits have been identified in the portion of the Borough adjacent to the Red Dog mine, and exploration activities to identify and quantify reserves are ongoing. The likelihood of development depends on the nature of deposits and ability to transport processed ore out of the Borough in an economic manner. Extension of the transportation system that connects the Red Dog mine with the Chukchi Sea may facilitate development.

Sand and Gravel. Sand and gravel, as well as a variety of mineral deposits have been located throughout the North Slope Borough. These resources are a key commodity for both village and oil and gas development activities, given their value in pads for structures and in constructing roads. Access to sand and gravel deposits and lack of existing transport options have been limiting factors for development.

Figure B-12 depicts known petroleum and mineral resources throughout the North Slope Borough.

3.3.6.2 Tourism and commercial recreation

Recreation and commercial tourism have the potential for both economic benefit and cultural threat. Commercial tourism is an important economic activity in Barrow, and is beginning to contribute to the economies of other villages. However, commercial tourism and recreation in areas used by residents for subsistence activities has the potential to create cultural conflict and compete for subsistence resources. The following section is excerpted from the North Slope Regional Comprehensive Economic Development Strategy (Arctic Development Council 2003):

> Tourism is the fastest growing industry in Alaska and the second largest private sector employer in the state. About 1.4 million people travel to Alaska every year, and visitors spend nearly $1 billion in Alaska, or about $770 per visitor. The industry has a 78 percent resident hire rate and employs over 27,000 people. Although this is a huge market, the 1993 North Slope Tourism Potential estimates that only 3 percent of all Alaska tourists visit the Arctic. Barrow, Prudhoe Bay and Kotzebue have been the main destinations. The North Slope Borough's unique arctic location, rich Eskimo indigenous culture, midnight sun, tundra and wildlife offer visitors a lifetime experience. With the right marketing package and consistent management, the North Slope Borough communities should be able to substantially increase tourism activity and revenues.
>
> The region's rich and dynamic Eskimo culture and lifestyle, including whaling, Eskimo dancing, and storytelling offer the culture and historical tourist a unique experience. For the ecotourism and adventure traveler, the North Slope Borough offers great

opportunities for bird watching, wildlife viewing, sport fishing, dog-sledding, fishing, river rafting, canoeing, kayaking and other outdoor activities.

While detailed tourism economic impact data for the North Slope Borough is hard to obtain, the overall number of independent travelers, winter tourists, ecotourism and adventure based travelers is growing in the region. In addition, there are increasing convention bookings in Barrow. The majority of the North Slope communities have been very interested in attracting more visitors and supporting tourism industry growth, although a few communities are divided over what types of tourism and how much should be allowed in their village and the surrounding area. Most communities have seen a developing tourism industry as a way to diversify the local economy, making up for the downsizing of governments. Native corporations are very active in supporting the tourism industry; they are the owners of all the hotels and restaurants in the villages outside Barrow; the Waldo Arms Hotel in Kaktovik being only the exception. The Arctic Slope Regional Corporation owns a hotel, a restaurant and a tour operation in Barrow.

A lack of basic and adequate tourist facilities is a handicap in developing tourism on the North Slope. Most of the hotels in the outlaying villages are very basic; no telephones in the rooms and most of the hotels have common TV rooms, showers and toilets. Almost all the hotels outside of Barrow are closed during the winter low traffic season. Funds are needed for constructing and improving hotels, restaurants and other facilities throughout the region. High transportation and accommodation costs are other obstacles to tourism development. A transportation cost between the villages has been previously noted; average room and board is about $150 per night per person on the North Slope. In addition, some residents are concerned that the promotion of tourism will increase the air traffic and impact subsistence activities.

Given the potential for cultural conflict and competition with subsistence, public and private landowners that permit commercial recreation and tourism on their lands need to coordinate with the Borough and affected communities to avoid, minimize, or mitigate potential adverse impacts.

3.3.6.3 Arts and crafts

Native arts and crafts are produced throughout the North Slope Borough, with specialties varying by location and artisan. Products include whalebone and caribou skin masks, ivory carvings, baleen baskets, ulus, Eskimo dolls, clothing, jewelry, and beadwork. Some villages have local cooperatives to sell their products. A borough-wide cooperative opened in September 2004 at the Inupiat Heritage and Language Center in Barrow (North Slope Borough 2004c; North Slope Borough 2004d). The cooperative assists local artists to make their products available for sale in wider markets. There is potential for expanding the existing cooperative, and establishing community based cooperatives. The Northwest Arctic Borough provides a model for an expanded cooperative system.

Craft sales in Barrow

Income from local arts and crafts is important throughout the North Slope Borough (Table 3.3-5).

Approximately one fifth of households participate in making and selling arts and crafts. Household income varies among the communities. In most communities there are a few households that have markedly higher annual craft incomes than the average income demonstrates (Shepro, Maas et al. 2003).

Table 3.3-5
Arts and Craft Participation in North Slope Borough Communities

Community	Participation in Arts and Craft Production	Average Annual Income
Anaktuvuk Pass	18.5 percent	$2,000 - $3,000
Atqasuk	14.1 percent	$210
Barrow	No information	No information
Kaktovik	18.6	<$500
Nuiqsut	23.2 percent	$480
Point Hope	21.2	$2,373
Point Lay	20 percent	$368
Wainwright	20 percent	$400

Source: (Shepro, Maas et al. 2003)

3.3.6.4 Retail and commercial services

Retail trade and commercial services presently account for a small percentage of the Borough economy (Shepro, Maas et al. 2003). Retail trade accounted for 31 reported jobs in the Borough, or approximately 1.4 percent of employment. Similarly, commercial services accounted for 108 reported jobs or 4.9 percent of employment.

Barrow is the regional center for retail and commercial services, although every village has some degree of local services. Prudhoe Bay is the regional center for retail and commercial services associated with oil and gas development.

3.3.7 *Transportation*

Air travel is the primary means of access to the North Slope Borough and its villages for both passengers and freight. Alaska Air serves Barrow with two flights daily; all other communities are served by regional air carriers.

Deadhorse is the primary transportation hub for the oil fields and the eastern-most communities of the North Slope Borough. The primary public transportation facilities in this area include an airstrip that is owned and maintained by the state, and the northern portion of the Dalton Highway.

Meeting the plane in Point Lay

The Dalton Highway provides year-round access to Deadhorse and Prudhoe Bay. This is the only road access from the Borough to the State of Alaska road system. During the winter months an ice road often reaches from the Prudhoe Bay-Kuparuk road system to the Alpine oilfield and nearby Nuiqsut. There is currently a proposal to construct the Colville River Road,

which would be a gravel road to provide year-round access to the NPRA and a spur road to Nuiqsut (Cashman 2004).

During the ice-free season, which occurs only for a few weeks during mid-summer, barges can access the both the Prudhoe Bay area and coastal communities to deliver fuel, supplies, and heavy equipment.

Within the villages, all terrain vehicles (ATVs) and snow machines are primary modes of mechanized transportation. Cars and trucks are also common in the villages and share the roads with ATVs, snow machines, and pedestrians. A public bus system ceased operation in Barrow in July 2005. A van service for senior citizens also operates in Barrow and in many of the villages.

For a more detailed discussion of transportation, refer to the North Slope Borough Comprehensive Transportation Plan (ASCG Incorporated 2004; ASCG Incorporated 2005)

3.3.8 *Infrastructure and Physical Facilities*

3.3.8.1 Water, Sewer, and Solid waste

Water and sewer utilities are owned by the North Slope Borough. Private utility companies operate and maintain some community systems and the Borough operates and maintains other systems. A Borough-wide piped water and sewer system project that began in 1996 and is completed and operational. On average in 2003, more than 85 percent of the households in each village had running water piped to their homes. More than 50 percent of households in each village also had flush toilets, and the remaining households were dependent on honey buckets. The completion of a second piped water and sewer project that would connect the remaining households relying on water delivery and honey buckets to the piped water and sewer system is dependent on obtaining funding. The Borough also constructed and operated washeterias in many of the villages; however, due to reductions in revenue, some of these washeterias have been transferred to other entities, but most are currently closed. Section 3, Village Profiles, contains specific information related to the water and sewer utilities in each village.

As the Borough continues to face reductions in revenues, operation of water and sewer systems could become problematic. Systems were designed when funding was not a problem and efficiency of operations and maintenance was less of a priority. The Borough will need to work with cooperative partners such as city government, ANCSA corporations, tribal organizations, and state (ADEC) and federal government (ANTHC, EPA, Denali Commission) to maintain the current level of service to village residents.

The North Slope Borough owns and oversees the operation of eight landfills. The locations of individual landfills are discussed for each village in Section 3. All of the landfills or landfill expansions have been constructed since 2000 and have design lives ranging from 10 to 50 years. Refuse is collected by the North Slope Borough.

3.3.8.2 Power

In general, utilities are owned by the North Slope Borough, and private utility companies operate the facilities. Section 3, Village Profiles, contains specific information related to the power utilities in each village.

With the exception of Barrow, diesel oil remains the primary source of heat for village households, regardless of the main heating system in use. Each community has multiple bulk storage, intermediate, and day tanks for fuel storage scattered throughout the village. All fuel storage tanks are connected above ground. Fuel is delivered by barge, and distributed via pipeline and truck, depending on whether the recipient is institutional, commercial or residential.

While communities have back up generators, they remain vulnerable to breakdowns and other problems such as fuel supply, which can be disastrous during winter months. A recent outage in Kaktovik during a winter storm resulted in significant damage and threatened public health and safety. Power generation and distribution is also vulnerable to decreasing Borough revenues. The Borough will need to work with cooperative partners such as city governments, ANCSA corporations, tribal organizations, and state (AEA) and federal government (ANTHC, EPA, Denali Commission) to maintain the current level of service to village residents.

Several communities are interested in developing wind power generation to offset the high cost of fuel. Wind generation was briefly tried in the past, in villages such as Point Lay, and discontinued. However, new technology and the experience gained by regions that have successfully developed wind power generation, such as the Northwest Arctic Borough, suggest that wind power should be seriously explored.

3.3.8.3 Communications

In general, North Slope Borough residents utilize a fully digital local telephone system, local dial-up Internet, a community teleconference center, cable television, public radio broadcast, an interactive video distance education system, wide area data network, and several two-way radio technologies for their telecommunication needs. There is a need for higher bandwidth services for Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright. There is also a need for more immediate emergency dispatch radio connections and improved telecommunications between Barrow and the outlying communities. Section 3, Village Profiles, contains specific information related to the communication infrastructure in each village.

The industrial district of Prudhoe Bay and Deadhorse is served by the Arctic Slope Telephone Association Cooperative (ASTAC). The industrial district is spread over a large area, with bases that connect to the public switched network via the ASTAC central office at Deadhorse. Telecommunication links are via a combination of buried wire, microwave, radio, and satellite. Fiber optic cable has recently connected Deadhorse and Valdez, the southern terminus of the Trans-Alaska Pipeline (Arctic Slope Telephone Association Cooperative 2004).

Satellite facilities in Point Hope

3.3.8.4 Natural Gas

Natural gas has been available to Barrow for a relatively long time, and the majority of Barrow area facilities are heated by natural gas. Additionally, Nuiqsut is currently undergoing an energy conversion from diesel to natural gas; the natural gas system is expected to be operational in 2006. Access to and the availability of natural gas to these communities will need to be maintained. In additional, the availability of natural gas supplies to other villages will be a high priority when planning for additional oil and gas exploration and development.

3.3.8.5 Service Area 10

The North Slope Borough established Service Area 10 in 1975 to provide utilities to industrial customers in the Deadhorse and Prudhoe Bay area, including solid waste collection and disposal, potable water production and distribution, and sanitary waste collection and disposal. The Borough also provides police protection in the area. However, the ordinance that established the district identified that Borough services in this area would be different than services provided in the Borough communities. For example, the Borough has not provided housing, social services, or community facilities in Service Area 10.

3.3.9 *Health, Education, and Social Services*

3.3.9.1 Health care

The following section is excerpted from the North Slope Regional Comprehensive Economic Development Strategy (Arctic Development Council 2003):

> Medical and health services within the North Slope Borough are provided by federal, local, and state government. Indian Health Services (IHS), a federal health program for American Indians and Alaska Natives, provides medical and health services to more than 5,000 tribal members in the region. The North Slope Borough Department of Health and Social Services serves all residents within the boundaries of the North Slope Borough by providing a comprehensive health and social delivery system throughout the region. The State of Alaska also provides some services to residents of the North Slope. One State-funded social worker and one juvenile probation officer live in Barrow and travel to all communities for village services.
>
> Samuel Simmonds Memorial Hospital, funded by the IHS and North Slope Borough, is a 14-bed general medical facility accredited by the Joint commission on Accreditation of Healthcare Organizations. Services provided are outpatient clinic, emergency room, general inpatient services, health screening, prenatal and well-baby care. Personnel from the Alaska Native Medical Center (ANMC) in Anchorage provide specialty clinics. Eye care and dental care are also available in the hospital. Arctic Slope Native Association and Ukpeagvik Inupiat Corporation under contract share hospital programs. In addition to Samuel Simmonds Memorial Hospital, each community has a village based clinic providing some basic service to the village residents. Due to physical isolation, accessing health care in the borough, particularly in the outlaying communities, is extremely difficult. All of the residents who live outside Barrow are without primary health care services and they must travel by plane to access medical care in Barrow. Residents of Point Hope and Anaktuvuk Pass receive some medical care from Kotzebue (Maniilaq Association) and Fairbanks (Tanana Chiefs Conference), respectively. Patients throughout the region are often referred to hospitals and specialized facilities in Anchorage when necessary.
>
> Tele-health is a huge step forward in the North Slope Borough medical and health service. The North Slope Borough Department of Health and Social Services operates the Tele-health Network to provide medical care through telecommunications. Tele-health uses desktop video telephones to link seven outlaying village clinics with the Samuel Simmonds Memorial Hospital, the Alaska Native Medical Center in Anchorage and the Maniilaq Health Center in Kotzebue. This technology provides distant physicians and laboratories the information to determine appropriate treatment and whether or not patients require transport to out-of-town facilities for treatment. It can reduce unnecessary patient travel and disruptions to patient's family and lifestyle.

The North Slope Borough Department of Health and Social Services Agency offers comprehensive health and social services and programs to the borough residents. Some of the services and programs are: Community Health Aides, Emergency Medical Services, Public Health Nursing, Public Assistance, Mental Health, Alcohol and Drug Abuse, Arctic Women in Crisis, Parent-infant Program, Infant Learning Program, Senior citizens Program, Children's Receiving Home, the Women Infant and Children (WIC) Program, Alternate Program for Youth, Environmental Health, and Community Health Education and Medical Development.

While most of the services and programs are outreach to the villages, the need for these services is not being uniformly met throughout the region. Regrettably, children daycare, independent living services for the seniors, facilities and programs for youth are needed in many of the smaller villages.

Point Hope Health Clinic

3.3.9.2 Education

The North Slope Borough School District provides education for pre-school students through grade 12 in all communities. The district administers ten schools; there is one school in each village and three in Barrow. Ilisagvik College offers vocational courses and certificates as well as associate degrees for adults in the region.

The mission statement of the North Slope Borough School District is:

> The North Slope Borough School District is committed to providing opportunities to help all students become productive and contributing citizens. Students will maintain our values of caring, sharing, and giving by understanding our history and traditions.

Some of the objectives adopted by the school board for the 2005 – 2006 school year focused on increasing parental and community involvement in education, improving student attendance, and improving academic achievement. Some of the school board objectives echo other community and regional goals, such as developing technical career programs with agencies and businesses and encouraging the development of local teachers.

The 2003 census conducted in the Borough (Shepro, Maas et al. 2003) indicated that elementary and high school enrollment levels declined, while middle school enrollment

increased slightly. The number of pre-school aged children has increased sharply, particularly in the communities outside Barrow.

The 2003 census reported that 38 percent of individuals in households that responded to the survey were of pre-school age or were still pursuing education through the high school level. Of the remaining respondents, 19 percent did not complete high school; 81 percent graduated from high school, received a GED, or had pursued higher levels of education (Shepro, Maas et al. 2003). By comparison, the 2000 US Census statistics indicate that over 88 percent of Alaskan over the age of 25 have attained high school graduation or equivalent.

The 2003 census also indicated that there was an increase in the number of adults pursuing advanced education or training. While some communities showed an increase in willingness to travel away from their home to pursue additional education or training, other communities were less willing to consider travel for training. Business management, computer programming, teaching, and accounting were the fields that local residents were most interested in for additional education (Shepro, Maas et al. 2003).

Kali School in Point Lay

3.3.9.3 Public Safety (police, fire, search and rescue)

The North Slope Borough provides police services, fire protection and prevention services, as well as search and rescue in all of the local communities.

The Police Department has an office and personnel in each community. The headquarters and dispatch center are located in Barrow, as well as the jail. Police services include responses to requests for assistance, investigation of crimes, patrols, and public education (including school programs) (North Slope Borough 2004a).

Fire stations are also located in each community, with full-time and volunteer staff. Services provided by the Fire Department include fire prevention programs, training for emergency responders and volunteer fire fighters, and extinguishing fires. The department has a key role in emergency response, in conjunction with the Search and Rescue Department (Arctic Development Council 2003; North Slope Borough 2004a).

The Search and Rescue Department also has an office and personnel in each community on the North Slope. The mission of the department is to increase the safety of Borough residents. They provide programs to reduce the number of emergency incidents and guide planning for disaster preparedness. In addition, they respond to search and rescue emergencies. The department maintains equipment for use in search and rescue operations, including aircraft for medevacs and searches. Volunteers are key to many department operations (Arctic Development Council 2003; North Slope Borough 2004a).

3.3.9.4 Housing

Throughout the North Slope Borough, the majority of residents live in single-family homes (Shepro, Maas et al. 2003). Multi-family dwellings (such as duplexes and apartments), trailers, and other structures also exist in the communities. The demand for additional housing is high in most North Slope Borough communities, including housing for seniors and low-income residents.

The demand for housing has increased due to the rising costs of housing and rental properties (Arctic Development Council 2003). Household sizes are increasing in some communities as young families and senior citizens combine households with their extended families. The Tagiugmiullu Nunamiullu Housing Authority (TNHA) is the primary source of low-income housing loans and assistance in the region.

Housing quality remains an issue throughout the Borough. Availability of utilities is increasing, due to completion of capital improvement projects. However, there are still many homes without complete plumbing or kitchen facilities (Shepro, Maas et al. 2003; DCED 2004). Borough residents have become very accustomed to the Borough providing home construction and maintenance. As the Borough has discontinued providing housing services (construction and maintenance) due to budget limitations, there has been confusion over responsibilities for housing. The Borough will encourage TNHA (the regional housing authority) and communities to work with cooperative partners such as city and tribal governments, ANCSA corporations, and the state (AHFC) and federal government (HUD, Denali Commission, BIA) to maintain the current level of service to village residents.

Homes in Wainwright

3.3.9.5 Community Recreation

Most of the Borough communities desire indoor recreation facilities, but they are not generally available. School gymnasiums provide indoor recreation opportunities for basketball, volleyball, and other sports, during the school year. Some communities have indoor swimming pools, generally associated with the school. Barrow has a recreation center, Piuraagvik, as well as a Boys and Girls Club, and facilities in the schools. It is important to note that the Borough does not hold powers for recreation; city governments retained these powers. Thus, the Borough is not pursuing community recreation facilities, but will encourage city and tribal governments and ANCSA corporations to seek grants and alternative funding sources to meet their needs for recreation facilities.

Outdoor recreation opportunities abound throughout the North Slope Borough. Winter activities can include snowmobiling, dog sledding, snowshoeing, and cross country skiing. Summer activities can include wildlife viewing, kayaking and river rafting, hiking, and camping.

Cultural festivals, such as Nalukatak and Kivgiq offer opportunities for Eskimo dancing, storytelling, traditional games, and other language and performance arts. Cultural festivals not only attract residents from across the region, but also residents of neighboring regions and visitors from afar.

3.3.10 *Contamination/hazardous waste*

ADEC has sites listed in their contaminated sites database for all eight North Slope Borough villages. ADEC defines a contaminated site as "a location where hazardous substances, including petroleum products, have been improperly disposed." Understanding of environmental and health impacts has increased and standard disposal practices have improved over the years. However, existing contaminated sites have the potential to threaten public health or the environment and can cause economic hardship to people and communities. There are a variety of efforts underway to clean up many of the sites, as noted on the state website (ADEC 2004).

Many of the contaminated sites in the Borough are related to old military installations. A restoration advisory board (RAB) is formed to work with a particular community during environmental restoration at military installations. Six of the eight Borough communities have a RAB, including: Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright.

Section 4, Village Profiles, contains specific information related to the areas of potential contamination in each village. The Contaminated Sites Database (ADEC 2004) contains additional information on sites throughout the North Slope Borough, including many sites outside of village boundaries. Current reports on site cleanup efforts are available on the website.

Barrow sunset

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