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# SECTION 3
# DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.1 INTRODUCTION

### 3.1.1 Plan Area

The ASDP Area encompasses approximately 890,000 acres of federal, state, and private lands in the central Arctic Coastal Plain of Alaska's North Slope. This area includes the Colville River Delta and the portions of the Ublutuoch River, Judy Creek, Fish Creek, Kalikpik River, and Kogru River drainages in the easternmost part of the National Petroleum Reserve-Alaska. The village of Nuiqsut and Colville Village are the only permanent populated centers within the Plan Area. The existing oil production infrastructure includes APF-1 and sales pipeline and a gas line to Nuiqsut. The area studied in this EIS is generally bounded on the west by 152º30'0" west longitude, the south by 70º0'0" north latitude, the east by the Colville River, and the north by the Beaufort Sea Coast, as shown on Figure 1.1.1-1.

The Arctic Coastal Plain, extending from sea level south to approximately 600 feet in elevation is treeless, generally flat to gently rolling, and spotted with shallow lakes and ponds. The Plan Area lies within two different and complex hydrologic regimes, the Colville River Delta and the area west of it. The Delta area is relatively flat, tundra-covered terrain, with local relief produced by a complex network of lakes interspersed with low-lying ridges and channels, associated with the ephemeral and distributary nature of deltaic systems.

The area west of the Delta is characterized by a few dominant streams, such as Fish and Judy Creeks, and periglacial features associated with low relief and poor drainage, such as thaw-lakes, marshes, and polygon-patterned ground (BLM 1998a). This area drains into Harrison Bay and the Beaufort Sea through the Kalikpik and Kogru Rivers and through Fish Creek and its major tributaries—Judy Creek and the Ublutuoch River. It is dominated by ice wedge polygons covered by wet tundra that is treeless. Surface elevations in the area range from approximately 20 to 120 feet.

Water resources in the Plan Area consist largely of surfacewater streams, lakes, and ponds; groundwater is very limited. Climate and permafrost are the dominant factors limiting water availability (BLM 1998a). Surface water and groundwater resources are described in detail in Section 3.2.2.

### 3.1.2 Existing Infrastructure in the Plan Area

#### 3.1.2.1 Nuiqsut and Colville Village

**NUIQSUT**

Nuiqsut is a second-class city of approximately 450 people situated along the west bank of the Nigliq Channel within the Colville River Delta, as shown on Figure 1.1.1-1. Nuiqsut encompasses approximately 9 square miles of land within the NSB and is approximately 20 miles south of the Beaufort Sea Coast and 8 miles southwest of APF-1 at CD-1.

Public utilities provide essential services to the residents. Nuiqsut has an airstrip and a complete road and street grid. Electricity and potable water delivery services are provided to residential homes and public buildings. The village recently completed a piped water and sewer delivery project. Financed by the NSB Capital Improvements Program, the project included a wastewater treatment plant and a water treatment plant with connections to all homes and buildings in Nuiqsut. Communication services include a local telephone network with long-distance capability and a cable television distribution system (PAI 2002a).

During construction of the original APF-1, a pipeline was constructed by the NSB that transports natural gas from APF-1 to Nuiqsut. The pipeline crosses approximately 13.7 miles—8.8 miles above ground and 4.9 miles buried—of land managed by the State of Alaska and Kuukpik Corporation (Joint Pipeline Office 2003).

A 4,300-foot airstrip owned and operated by the NSB serves Nuiqsut year-round. In addition, for as many as 5 months a year (commonly mid-December through April), Nuiqsut is connected to the road system. Since 1991, ice roads have connected the Colville River Delta to the Kuparuk and Prudhoe Bay road system. From there, access to Deadhorse and the Dalton Highway is possible (PAI 2002a). In addition, a spur road, historically constructed during different years by either CPAI or the NSB, connects the village of Nuiqsut to the ice road network for APF-1. Additional details about Nuiqsut are presented in Section 3.4.

#### COLVILLE VILLAGE

Colville Village is situated on the site of the Helmericks' family home on Anachlik Island, on the northeast side of the Colville River Delta. The site was established in the mid-1950s and consists of several homes, a lodge, an airstrip, aircraft hangars, warehouses, a barn, workshops, and other outbuildings. Additional details about Colville Village are presented in Section 3.4.

### 3.1.2.2 Existing Alpine Processing Facilities

The existing oil production infrastructure for APF-1 is on the Colville River Delta between the Nigliq and Sakoonang Channels and approximately 8 miles north of Nuiqsut. Production pads CD-1 and CD-2 (Figure 1.1.1-1) began oil production in November 2000 and 2001, respectively.

Infrastructure at the existing CD-1 production pad fully supports the ongoing drilling and production operations, including activities at the CD-2 site. Facilities and equipment currently installed include processing facilities, production wells, camp facilities, sanitation utilities (water and wastewater), a drilling mud plant, an airstrip, a maintenance complex, warehouse buildings, disposal wells, an emergency response center, communications, power generation, and various mobile equipment (Wiggin and Dotson 2002).

The CD-2 production pad is a satellite, approximately 3 miles to the west of CD-1. Access to the site is by a gravel road, of which approximately 5,000 feet (closest to CD-1) is coincident with the edge of the airstrip. Currently at CD-2, a temporary camp provides support for ongoing drilling operations.

Pipelines consist of a gathering pipeline that transports unprocessed produced oil and water from CD-2 to APF-1 at CD-1, a seawater line from the seawater treatment plan at Oliktok Point, a miscible injectant line between CD-1 and CD-2, and a 34-mile-long oil sales pipeline with a small diesel line from APF-1, connecting to the Kuparuk River oilfield. Pipelines are elevated above the tundra by VSMs, except at the main channel crossing of the Colville River, where approximately 4,300 feet of the oil sales pipeline was installed beneath the river channel using HDD. Entry and exit locations for the HDD segment of the pipeline are set back approximately 300 feet from the Colville River's banks.

### 3.1.2.3 Hazardous Materials

Hazardous materials and solid waste have been introduced into the Plan Area through activities associated with Department of Defense (DOD) facilities and oil and gas exploration prior to the development of the Colville River Unit. In addition, population centers in the area introduce, store, and maintain hazardous materials, hazardous waste, and solid waste. The following sections provide information on potential hazardous material sites within the Plan Area.

#### DEPARTMENT OF DEFENSE SITES

The Kogru Distant Early Warning (DEW) line station (Figure 3.1.2.3-1) is located near the Kogru River. It was built as part of a defensive advance warning radar system in the 1950s, and is one of 18 sites constructed across northern Alaska at approximately 50-mile intervals. The Kogru station is also known as POW-2, POW-B, and 2nd Point from Barrow. It was classified as an intermediate station and consisted of a single, five-module operation and living building, support facilities with Doppler-type radar fences, and a runway (OHM 2000).

The Kogru station was active from 1957 through 1963. Investigative and cleanup activities have been performed intermittently since 1985. Between 1995 and 1999, the following buildings were demolished: the shop building, radar tower, AST for fuel, fuel pump house, living and operations building, and warehouse. Approximately 525 cubic yards of soil contaminated by petroleum, oils, and lubricants (POL) were excavated and placed in 1-yard Supersacks. Waste streams were sampled for characterization and disposal options, and materials were removed and transported offsite for disposal. Materials removed included: soil contaminated by POL and polychlorinated byshenyl (PCBs), creosote-treated wood, lead-based paint chips, PCB-containing equipment (transformers and electrical equipment), and nonregulated demolition debris (OHM 2000). After removal actions were completed, the gravel pads were fertilized and seeded. According to the remediation report, current concerns at the site include additional debris and an exposed landfill.

A Naval Aritc Research Laboratory (NARL) remote research camp was located at Putu, which lies east of Nuiqsut near the west bank of the Colville River's main channel. The site was used from the late 1950s to the 1970s. The building was removed and little evidence of the site remains (PAI 2002a).

## OIL AND GAS EXPLORATION ACTIVITIES

Oil and gas exploration activities within the Plan Area have included winter seismic exploration surveys and oil and gas exploration drilling. Figure 3.1.2.3-1 shows the location of exploration wells within the Plan Area.

### NAVY AND USGS EXPLORATION SITES

The Navy conducted oil and gas exploration activities in the National Petroleum Reserve-Alaska from 1944 through 1953. During that time, 44 test wells were drilled and three small oil fields were discovered—Umiat, Simpson, and Fish Creek (USGS professional paper 1399). One of the early Navy test wells is within the Plan Area; Fish Creek 1 was drilled in 1949.

Cleanup operations conducted by the USGS in 1981 indicated that Fish Creek 1 was used as a disposal site for stockpiled debris. Typically, disposal sites were stripped of tundra overburden, excavated, filled with stockpiled metal debris, and compacted. The sites were then backfilled with 2 feet or more of fill and covered with the stockpiled tundra overburden. Seed and fertilizer were spread at the Fish Creek 1 site.

A second period of exploration was conducted within the National Petroleum Reserve-Alaskafrom 1974 through 1982 by the Navy (1974 and 1975) and the USGS (1976 through 1982). During this period, 28 exploration wells were drilled and 14,770 line miles of seismic survey were collected and interpreted (USGS professional paper 1399). Typically, reserve pits and flare pits were used to contain drilling waste. (Reserve pits are no longer used on the North Slope.) Four exploration wells drilled during this period are within the Plan Area: Atigaru Point (1977), North Kalikpik (1978), South Harrison Bay (1977), and West Fish Creek (1977). These sites were included in the USGS cleanup and revegetation program between 1977 and 1979. The ADEC has approved closure of the inactive reserve pits for these four sites.

### OTHER OIL AND GAS EXPLORATION SITES

Additional exploration wells have been drilled within and near the Plan Area at the locations shown on Figure 3.1.2.3-1. The earliest exploration well, Colville 1, was drilled east of the Plan Area in 1966 by Sinclair Oil and Gas. Subsequently, wells were drilled within the Plan Area by Gulf Oil Corporation, Texaco Inc., Amerada Hess Corp., ARCO Alaska Inc., CPAI, and Anadarko Petroleum Corporation.

### OTHER HAZARDOUS MATERIALS AND SOLID WASTE WITHIN THE PLAN AREA

Established winter travel routes servicing North Slope communities and recreational trails cross the Plan Area. Fuel storage areas and inevitable small spills are likely along these corridors. Solid waste and human waste also could have been introduced into these corridors.

The facilities associated with the village of Nuiqsut are described in Section 3.1.2.1. A brief overview of potential hazardous materials associated with the village includes, but is not limited to, the following:

- Bulk fuel storage areas and fueling systems
- Home heating systems
- Transportation—all-terrain vehicles, snowmobiles, boats, airplanes, and automobiles
- Permitted Class III landfill
- Wastewater treatment plant
- PCBs within transformers and electrical equipment

# 3.2 PHYSICAL CHARACTERISTICS

## 3.2.1 Terrestrial Environment

### 3.2.1.1 Physiography

The North Slope of Alaska encompasses three physiographic provinces: the Arctic Coastal Plain, the Arctic Foothills, and the Brooks Range. The Plan Area extends approximately 40 miles inland from the coast and is situated entirely within the Arctic Coastal Plain province. The Arctic Coastal Plain rises gradually from sea level to a maximum elevation of roughly 600 feet, and is comprised of two distinct zones: tundra lowlands and coastal area (Figure 3.2.1.1-1).

#### TUNDRA LOWLANDS

Treeless periglacial features associated with flat topography, poor drainage and underlying permafrost characterize the tundra lowlands. Thaw-lakes and polygonal surface patterns on interlake ice wedges are the dominant terrain features (BLM and MMS 1998a). Ice wedges, which produce the polygonal surface patterns, progressively become larger as winter contraction fractures in the surface soils fill with water during the brief summer thawing period, then freeze again during winter. As this seasonal process repeats, the polygons grow and become the most recognizable surface features over the entire North Slope. Another prominent feature on the lowlands are scattered pingos, low mound-like features formed in the centers of drained lakes, as water-saturated soil freezes inward from the basin sides.

The Colville River is the dominant feature along the eastern boundary of the Plan Area, covering approximately 250 square miles. The river transitions from a meandering channel to a highly channelized delta discharging to the Beaufort Sea. The broad delta plain consists of a network of active and abandoned channels (oxbow lakes), separated by either tundra-vegetated or shallow water areas that form extensive wetland habitats.

Coastal lakes are frequently elongated perpendicular to the prevailing winds from the erosive action of eddy currents (BLM and MMS 1998a). The lakes become more rounded and generally smaller farther inland. Features providing relief are limited to riverbank bluffs (some hundreds of feet high near the Arctic Coastal Plains' southern border with the Arctic Foothills), and scattered pingos.

### COASTAL ZONES

The coastal area along the Arctic Ocean is generally low and flat, and is frequently separated from the mainland by barrier islands and alongshore spits. These spits support little vegetation, and lagoons typically develop behind them. The coastal area extends approximately 8 to 20 miles offshore and includes the shallow inner waters of the Beaufort Sea continental shelf.

The coastline is subject to minor tidal fluctuations of about 1 foot. The shoreline is characterized primarily by fine-grained soils, which are prevalent in the eastern National Petroleum Reserve-Alaska. These soils erode more rapidly than coarse-grained material such as that on the beaches of the Chukchi Sea (BLM 1981). The shoreline characteristics (e.g. tidal flat, tundra cliff, sand beach, etc.) have been classified using the Environmental Sensitivity Index classification scheme developed by NOAA (Figures 3.2.1.1-2 and 3.2.1.1-3) (Research Planning, Inc., 2002).

The Beaufort Sea continental shelf is relatively narrow, extending for 35 to 50 miles offshore with depths up to 600 feet, before steeply dropping off into the Arctic Ocean Basin. The surface circulation of the Beaufort Sea is dominated by a clockwise gyre in the Arctic Ocean Basin. Currents along the coastline can be highly variable, moving easterly or westerly, depending primarily on local wind patterns (State of Alaska 1975).

The prevailing current places ocean ice against the coastline in the Plan Area for as long as 9 months of the year. Shipping is thus constrained to the summer season, typically from July through September. Even then, prevailing northeast winds and offshore currents can cause pack ice to block areas of the coastline for weeks.

## 3.2.1.2 Geology

The Plan Area is situated at the transition between two major geologic structures, the Colville Basin and the Barrow Arch (Figure 3.2.1.2-1). Formation of the Colville Basin, Barrow Arch, and the associated Brooks Range was initiated during mid-Cretaceous compression of the Arctic Alaska Plate, produced by rift-zone expansion in the marine basin bordering the plate to the north. The resulting deformation formed the Brooks Range thrust-fault belt and the foreland Colville Basin and Barrow Arch (Moore et al. 1994). Present day seismic activity and deformation of Quaternary sediment evidence the continuation of mountain building in the Brooks Range. Although Alaska is seismically active, the North Slope has not experienced an earthquake exceeding a magnitude of 5.3 since 1968 (http://www.giseis.alaska.edu).

The stratigraphic sequence within the Plan Area comprises Mississippian- to Quaternary-aged sediments ranging from 31,000 to 37,000 feet in thickness. Lithologies vary from marine limestones to marine and deltaic sands and shales (Gyrc 1985a) (Figure 3.2.1.2-2). Oil exploration on the North Slope has historically targeted hydrocarbon plays within the Ellesmerian sandstones along the crest of the Barrow Arch (Figure 3.2.1.2-3). However, the 1994 to 1995 discovery of the Alpine Field in a previously unrecognized Jurassic sandstone reservoir has redirected exploration efforts to the Beaufortian Sequence. The Beaufortian Sequence lies between drilling depths of 6,000–11,000 feet in the Plan Area, and consists of Kuparuk Sandstone, Jurassic Sandstones, and Middle Jurassic Simpson Sandstone (BLM 2003b). Plan Area bedrock is mantled by the Quaternary-aged unconsolidated sediments of the Gubik Formation. This formation is largely comprised of fluvial and glaciofluvial sediments but also includes ma-rine, eolian, and lacustrine components (Rawlinson 1993). Landforms on the Beaufort Coastal Plain are predominately formed by lacustrine processes; whereas the sculpting of Colville Delta landforms is predominantly accomplished by fluvial processes (Jorgenson et al. 2003a). The distribution of surface deposits in a section of the Plan Area is shown on Figure 3.2.1.2-4.

### PETROLEUM POTENTIAL

Advancements in directional drilling technology, westward expansion of Prudhoe Bay infrastructure, and the probability of petroleum accumulations in area subsurface reservoirs have decreased the minimum field volume necessary for, and risk associated with, commercial oil field development in the Plan Area. A detailed review of past development and forecasting of future exploration is presented by the BLM (BLM and MMS 1998a, BLM 2003b).

The assessment of oil and gas resources requires integration of geological interpretations, seismic mapping, petrophysical evaluation of reservoir rocks, geochemical analyses of source rocks, predictions of source rock maturation expulsion and migration, and accumulation of hydrocarbons. Ultimately, economic factors, such as cost per barrel to produce the oil from the subsurface versus market price, determine the minimum reserve volume necessary for a commercial venture. However, statistical methods are useful for assessing the degree of uncertainty and/or subjectivity in geologic data evaluations, and are also useful for providing a risk analysis related to potential presence of oil and gas accumulations.

The potential for oil resources is reported as a range from the 5 percent probability of occurrence, which is physically possible, though highly unlikely, to the 95 percent probability of occurrence, which indicates a much smaller potential oil value, but is quite likely to occur. Where the range of resources is large, the mean value is reported.

Recoverable resources are assumed to exist in a number of pools or accumulations that are drilled and tested during exploration. A size rank for undiscovered pools shows a lognormal distribution. These pools can include oil, gas, mixed oil and gas, and condensate resources. They could also be distributed anywhere within the area analyzed. The analyzed area in this case is the 13.2 million acres that were also assessed as part of the Northwest National Petroleum Reserve-Alaska IAP/EIS, a recent planning effort of the BLM, and it includes all portions of the Plan Area within the National Petroleum Reserve-Alaska. The predominant exploration target of the ASDP across this area is the Beaufortian Barrow Arch East play. Statistical modeling predicts the existence of approximately 141 prospects in this play, distributed unevenly across the 13.2 million acres that were assessed. Approximately 11 of the 25 largest prospects are hypothesized to be oil pools; gas, condensate, and mixed pools compose the others.

Current geologic analyses by the BLM suggest that the northernmost portion of the National Petroleum Reserve-Alaska, along the Barrow Arch, has the highest potential for oil and gas resources. This area of high geologic potential comprises approximately 1.87 million acres.

Of the approximately 1.87 million acres that have high geologic potential for oil and gas resources, approximately 1.51 million acres are close enough to existing infrastructure and have sufficient volumes of modeled resources in discrete prospects (or accumulations) to have economic potential. Of this total, approximately 680,000 acres are in the Plan Area west of the Nigliq Channel. The BLM does not have data to adequately model the Plan Area east of the Nigliq Channel. The mean resource value in the Plan Area can be apportioned as a fraction of the entire area with high economic potential. There could be a pool larger than the Alpine Field in the 1.51 million acres. As modeled, subsidiary pools would be smaller than the Alpine Field and would reflect a lognormal distribution. The size distribution for individual pools, however, might not be proportionately distributed geographically. Larger pools could be disproportionately under- or over-represented in the Plan Area. Statistically, there is no inference that the largest, or any of the larger, pool sizes may be present in the Plan Area.

Geologic and geophysical mapping identify numerous potential prospects for exploration. These efforts show that the discrete prospects are not evenly distributed across the northern National Petroleum Reserve-Alaska or the Plan Area. The small prospects lack sufficient reserves to offset development costs. The mapping also shows that prospects occur at different stratigraphic levels. Some prospects overlie one another, a placement that is economically fortuitous because it creates potential for multiple exploration targets to be developed from a single surface facility.

At oil prices of $30/bbl, statistical modeling conducted by the BLM as part of its Northwest National Petroleum Reserve-Alaska IAP/EIS, which also covers the Plan Area, suggests as many as 16 prospects may occur in the 1.51 million acres with sufficient oil accumulations to be economically viable. Apportioning these hypothetical hydrocarbon accumulations across the 1.51 million acres of the northern National Petroleum Reserve-Alaska, places seven of the theoretical prospects within the portion of the Plan Area that is coincident with the Northeast National Petroleum Reserve-Alaska area. Considering a success scenario for the seven modeled hydrocarbon accumulations, up to four pads may be required and developed in addition to the three proposed by CPAI (CD-5, CD-6, and CD-7). Finally, in the statistically unlikely case in which a hydrocarbon pool in this area contains more than 100 million barrels (MMbbl) of oil reserves, utilization of two production pads to recover the oil maybe necessary.

The possibility may exist with state leases within the northeast Colville River area for further discoveries of oil accumulations in the range of 40 to 50 MMbbl, similar to the low API gravity oil found at CD-3 and CD-4. If an economically feasible method of extracting the heavy oil can be determined, then two additional production pads on these state lands may be developed.

#### 3.2.1.3 Permafrost

The Plan Area is located in a zone of laterally continuous permafrost. Ground within this zone has remained at or below 32°F for at least two consecutive years. The active layer above permafrost ground is subject to freeze thaw cycles. Maximum thaw depths (recorded at an active layer monitoring station proximal to the Fish Creek test well) (Figure 3.2.1.2-4) ranged from 11.02–11.81 inches over a 4 year period (1998 to 2001) (http://www.geography.uc.edu/~kenhinke/CALM/sites.html). Active layer thickness measured from 1987 to 1992 on a transect extending approximately 40 miles south from Prudhoe Bay increased from a coastal minimum of 8.3 inches to an inland maximum of 2.4 feet (Romanovsky and Osterkamp 1995). The depth of permafrost at the West Fish Creek #1 Borehole (Figure 3.2.1.2-4) in 1977 was 879.26 feet below the ground surface. Below this depth, geothermal heat precludes maintenance of permanently frozen ground. Mean annual permafrost temperatures measured in the Prudhoe Bay area over seven years (1986 to 1992) ranged from 19.8°F to 15.6°F (Romanovsky and Osterkamp 1995). Recent permafrost warming of 1.1°F (1987 to 1998) at inland sites and 2.7°F (1988 to 1998) at coastal sites on the Arctic Coastal Plain, and melting of wedge ice in the Plan Area is attributed to both high latitude warming and increased snowcover (Steiglitz et al. 2003, Jorgenson et al. 2003).

Permafrost is sensitive to changes in both climate and terrain. Natural or human actions that alter the local thermal conductivity and heat capacity of the active layer will change the permafrost condition. Climatic cooling, maturation of vegetation, increased surface reflectivity (albedo), and decrease in snow cover decrease heat flux to the subsurface and allows permafrost to increase in thickness and/or areal extent. Landforms associated with aggradation of ice-rich permafrost include ice wedge polygons and pingos. Alternatively, climatic warming, removal or compaction of overlying vegetation, mass wasting episodes and flooding will increase heat flux to the subsurface and allow permafrost to decrease in thickness and/or areal extent. Degradation of ice-rich permafrost is often accompanied by mechanical failure of previously frozen soils via solifluction, thermal erosion, thaw settlement, or collapse of the ground surface due to melting of massive ground ice, a phenomenon referred to as thermokarst (Lawson 1986, Lachenbruch and Marshall 1983). Inundation of thermokarst pits (Everett 1980) and infilling of low-lying margins of drained lake basins (Jorgenson et al. 2003d) can lead to development of primary and secondary thaw-lakes, respectively.

The degree and extent of thermokarst is related to the physical properties of sediment grain size, the volume and distribution of ground ice, and the topographic position of affected sediments (Walker et al. 1987). Organic and fine-grained mineral soils are generally poorly-drained and saturated. Upon freezing, the volume of ice generated exceeds the soil pore space volume, and tends to segregate as massive ice bodies such as vein, lenses, and wedge ice (NRC 2003). Wedge ice in the Plan Area occupies about 20 percent by volume of the landscape and is particularly vulnerable to melting because of its near surface position (Jorgenson et al. 2003d). Degradation of permafrost in ice-rich slits produces sediment with little or no strength that is highly susceptible to mechanical failure and hydraulic and thermal erosion. Alternatively, coarse-grained mineral soils are relatively well-drained and undersaturated. Because the volume of ice produced on freezing is accommodated by the pore space in coarse-grained deposits, degradation of permafrost in ice-poor units typically results in minimal and uniform thaw settlement. Moisture levels in well-drained soils are typically insufficient for thaw-lake development (Jorgenson et al. 2003d).

In a comparison of North Slope test well locations 30 years after disturbance, Lawson (1986) observed that removal of the vegetative mat overlying silty sediments with large amounts of ground ice at the East Oumalik test well site produced 9.8–16.4 feet of subsidence, compared to 1.3–6.6 feet of settlement in sandy materials with small amounts of ground ice at the Fish Creek test well site (Lawson 1982). As an extension of this investigation Lawson (1986) estimated ice-poor sediments require 5 to 10 years to regain stability whereas ice-rich sediments may require at least 30 years. If thermokarst creates impoundments or surface water flow, the heat absorbed by standing water and the mechanical action of flowing water will expand the lateral extent of subsidence. At the East Oumalik test well site, thermokarst covered twice the area of initial disturbance because thermal and hydraulic erosion had propagated the thawing of sediments (Lawson 1982). Studies conducted in a section of the Plan Area (Jorgenson et al. 1995, 2003d) estimated the potential mean thaw settlement for surface deposits, based on typical ice volumes and structures. Table 3.2.1-1 provides mean ice volumes and estimates of thaw settlement for deposits located in the portion of the Plan Area depicted on Figure 3.2.1.2-4 (coincident with the Northeast National Petroleum Reserve-Alaska area).

Potential thaw settlement estimates are lowest for eolian sand deposits (including both active and inactive deposits) because of their low ice volume and the uniform distribution of ice in the soil pore spaces. Thaw settlement estimates are also low for thaw basins, but because basin units are often located in depressions, even limited thaw settlement can lead to localized flooding and lateral expansion of permafrost degradation. The high volumes of ice present as near-surface ice wedges, or in ice-rich organic and silt layers in alluvial and abandoned overbank deposits, result in high estimates of potential mean thaw settlement for these units. However, alluvial and abandoned overbank deposits are not susceptible to river flooding due to their location outside the active floodplain (Jorgenson et al. 1995, 2003d). For this reason, water is not as likely to be impounded and propigate permafrost degradation.

**TABLE 3.2.1-1 MEAN ICE VOLUMES AND POTENTIAL AMOUNTS OF THAW SETTLEMENT FOR GEOMORPHIC UNITS IN A SECTION OF THE PLAN**

| Geomorphic Deposit | Mean Ice | Potential Mean Thaw Settlement ± |
|---|---|---|
| alluvial marine and alluvial | 71 | 1.67 ± 1.3 |
| ice-rich thaw basin centers | 66 | 0.89 ± 0.95 |
| ice-rich thaw basin margins | 62 | 0.62 ± 0.75 |
| ice-poor thaw basin centers | 59 | 0.72 |
| ice-poor thaw basin margins | 48 | 0.13 ± 0.16 |
| eolian inactive sand | 45 | 0.33 ± 0.23 |

#### 3.2.1.4 Soils

Soil is the body of solids, liquids, and gasses at the land surface that is able to naturally support plant growth or has been visibly modified from its parent material. Two soil orders, Gelisols and Entisols are identified within the section of the Plan Area depicted on Figure 3.2.1.2-4. The unique property of Gelisols is the presence of permafrost and soil features associated with frost action. Entisols are dominated by mineral soil materials and distinct soil horizons are absent. Entisols are often located in areas of active erosion or deposition and thus do not experience the extended periods of stability necessary for modification by soil forming processes (NRCS 1999).

Soil order members are further categorized by soil class. Twenty-four soil classes are present in the section of the Plan Area depicted on Figure 3.2.1.2-4. Soils in this section of the Plan Area have not been fully classified and mapped using the current NRCS soil taxonomy. However, Table 3.2.1-2 presents the relative abundance of, descriptions of, landforms associated with, and susceptibility to frost deformation for the most commonly observed soil types.

**TABLE 3.2.1-2 DESCRIPTION OF SOIL CLASSES OCCURRING IN THE PLAN AREA**

| Soil Order | Soil Class | % of Observations | Description | Associated Landform | Subject to Frost Deformation? |
|---|---|---|---|---|---|
| Gelisol | Typic Aquorthel | 11.5 | wet, fine-grained soil with thin organic layer | inactive overbank deposits | No |
| Gelisol | Typic Historthel | 8.6 | wet soil with thick organic layer | various | No |
| Entisol | Typic Cryptopsamment | 8.0 | sandy, well-drained soil | eolian sand deposits | No |
| Gelisol | Typic Aquiturbel | 7.5 | wet, fine-grained soil with thin organic layer | various | Yes |
| Gelisol | Typic Histoturbel | 6.9 | wet soil with thick organic layer | polygons, drained lake basins, terraces | Yes |

The presence of permafrost is the dominant control on soil forming processes in the Arctic. Mechanical weathering of surface material in the Arctic is largely accomplished by repetitive freezing and thawing, and is therefore restricted to the transitional periods between winter and summer when diurnal freeze thaw cycles are active. Ice-rich permafrost acts as a barrier to infiltrating water and causes saturation of the overlying soil horizons. Cold and saturated soil conditions limit both biologic and chemical transformations in the active layer. Limited biological decomposition facilitates the accumulation of organic material as thick surface horizons; whereas limitations on chemical weathering restrict the availability of nutrients to tundra vegetation. Nutrients are further depleted from surface layers by infiltration of acidic precipitation and the subsequent leaching of cations (Everett 1979, Everett and Brown 1981). Reduction of iron and magnesium oxides is common in anoxic mineral horizons. Where saturation is uniform, reducing conditions lower the overall soil color, however, where saturation is spatially variable, neighboring zones of reduction and oxidation produce soil mottles (Ping et al. 1998). Variable moisture content in active layer soils is responsible for the differential change in soil volume on freezing, resulting in frost deformation of soil horizons, polygonal surface patterning, and incorporation of organic material at depth via cryoturbation. Localized soil expansion during active layer freezing is amplified by the migration of soil water to the freezing front. The temperature gradient set up during freezing induces water toward the freezing front, resulting in the formation of segregated ice bodies.

### 3.2.1.5 Sand and Gravel

A common denominator in nearly all oil and gas development is the need for granular mineral materials such as sand and gravel. These materials are used for construction of roads, pads, and airfields. On Alaska's North Slope, the presence of permafrost creates special engineering and geotechnical problems affecting construction and maintenance of gravel infrastructure. The presence of large amounts of near-surface ice in the form of wedges, masses, and intergranular ice requires that development activity not disturb the thermal regime of the ground surface.

The surface materials of the Plan Area include marine silts, sands, and clays; beach and deltaic deposits; thaw-lake deposits; alluvium and fluvial-lacustrine deposits; eolian sands and upland silts; and sandstones and shales. Gravels are found specifically in active and inactive floodplains and low terraces (BLM 1998a). Because sand and gravel have economic value, BLM regulations (43 CFR 3600) provide for the sale of mineral materials defined generally as common varieties of sand, stone, gravel, clay, and other materials (BLM 1998a).

There was concern as early as 1974 (BLM 1998a) that in certain areas of the Arctic Coastal Plain, sand and gravel resources would become scarce. Roads in the Kuparuk River Unit (KRU) and Prudhoe Bay Unit (PBU) benefited from quality gravel sources that have been relatively inexpensive to develop. West of the Colville

River, however, the Plan Area is characterized by an apparent scarcity of suitable gravel for road, pad, and airstrip construction (PN&D 2002a).

### GRAVEL MINE SITES

Existing and potential gravel sites within the Plan Area include the ASRC Mine Site and the Clover Potential Gravel Source (Figure 2.2.3-1). Use of these sites would require developing ice roads and pads to support mining and transportation of the gravel. Other gravel sites currently unknown could also be used for FFD.

### ASRC MINE SITE

The ASRC Mine Site is approximately 9 miles southeast of CD-1, on the east side of the Colville River across from Nuiqsut (Figure 2.2.3-1). The site contains a low quality material, defined as sandy gravel to gravelly sand, with interbedded discontinuous layers of silt (PN&D 2002a).

The ASRC Mine Site is permitted (Department of the Army Permit: Colville River 17, 4-960869) and has an approved reclamation plan that would be revised before reopening the mine. The permitted area is 152.9 acres (67.0 acres for the Phase 1 permit area and 85.9 acres for the Phase 2 permit area). Phase 1 was developed in 1998 and 1999, with a total of approximately 1.03 million cubic yards of sand and gravel excavated and hauled for use by the Alpine Development Project (CD-1 and CD-2). Overburden soils were shot, hauled, and temporarily stockpiled outside the pit on ice pads. Before break-up each season, the stockpiled overburden was placed back into the pit area.

Ultimately, the 1998 and 1999 Phase 1 mining pits were developed as two lakes with adjoining canals, creating a 9-acre waterfowl nesting island. The lakes include 7.5 acres of very shallow littoral zones (less than 1.5 feet deep) and 10 acres of shallow littoral zones (6 feet to 1.5 feet deep) for wildlife habitat (TMA 2000). Monitoring of the reclamation plan is ongoing.

Estimated sand and gravel reserves for Phase 2 are 1.9 million to 2.5 million cubic yards (PN&D 2002c).

### CLOVER POTENTIAL GRAVEL SOURCE

The Clover Potential Gravel Source is on the western edge of the Colville River Delta (Figure 2.2.3-1). The site was identified from exploratory well cuttings and was further investigated during the winter seasons of 2000–2001 and 2001–2002. Exploratory borings identified sandy gravel and gravelly sand beneath approximately 5 to 20 feet of overburden soils (silts and silty sands). The approximate footprint of the site is 65 acres (1,680 feet by 1,680 feet) (see Appendix O), and the quantity of sand and gravel resources is estimated at 2.5 million cubic yards. Development of the mine site would require a permit and reclamation plan (Appendix O).

## 3.2.1.6 Paleontological Resources

The paleontological record of the Plan Area ranges in age from the Paleozoic through Cenozoic. The record comprises fossils of both micro- and macro-organisms and plant remains, encompassing a variety of depositional environments from nonmarine to marine.

Fossils within the Plan Area are known from a total of at least 38 paleontological localities. Pleistocene fossils including mammoth, mastodon, horse, bison, muskox, caribou, lion, wolf, and bear are common throughout the area, most notably along the river drainages. From the late Cretaceous Prince Creek Formation, at least 25 localities have been reported, mostly in the Ocean Point area (Lindsay 1986, Gangloff 2002). Fossils in the Prince Creek Formation have been found ranging from 3 kilometers northwest of Ocean Point to 4 kilometers south of Kikak. These localities include dinosaur-rich bonebeds and microvertebrate sites documented thus far, and also include associated microflora. In particular, there have been reported findings of dinosaurs including Ceratopsidae, a small theropod, Hypsilophodontidae, Hadrosauridae, a pachycephalosaur, Troodontidae, Dromaeosauridae, and Ornithomimosauridae. Other vertebrate fossils found include tetrapod, theropod, and ornithopod dinosaur footprints, as well as mammals including Multituberculata, Placentalia, and Marsupalia. Various invertebrates including clams, and wood and plant fossil debris have also been found in the Prince Creek Formation of the Plan Area. (Lindsay 1986, Gangloff 2002).

In the Mesozoic/Cenozoic Schrader Bluff formation, one locality has been reported with bivalves, brachiopods, ostracodes, gastropods, and foraminifera (Lindsay 1986). In the Pliocene and later Pleistocene deposits, one locality has been reported in the Colville Formation with gastropods and pelecypods, eight localities in the Gubik Formation with a sea otter, seal, mollusks, gastropods, bivalve, and scallop, and six localities in unnamed formations with mammoths, musk oxen, mollusks, gastropods, pelecypods, ostracods, barnacles, and wood. (Lindsay 1986).

The Ocean Point site on the Colville River (Figure 3.1.2.3-1) within the Plan Area marks a globally-significant find of dinosaur fossils in upper Cretaceous strata. These fossils are notable in several respects. The specimens are well preserved by varying degrees of mineralization and have been subsequently entombed in permafrost. The combination of these preservation mechanisms allows extraction of biomolecular material previously unattainable in fossils of this age. Additionally, the Ocean Point fossils represent the northernmost occurrence of dinosaurs in North America (Gangloff 1998, Phillips 1990).

## 3.2.2 Aquatic Environment

### 3.2.2.1 Water Resources

#### CLIMATIC FACTORS

Snowmelt and ground blizzards are two primary climatic factors that influence the hydrologic balance in the Plan Area and on the North Slope in general. A little more than half the total annual precipitation occurs as snow (USDA 1996). Snowmelt contributes the majority of the annual runoff and helps maintain a saturated layer of surface soils. Prevailing winds blow cold air off the largely frozen Arctic Ocean, often creating blizzard conditions with drifting and compacted snow (Sloan 1987). These ground blizzards redistribute the snow based on minor terrain features and exposures.

Low amounts of precipitation occur throughout the summers that are interspersed with heavier rainstorms usually in the foothills during July and August. Summers, which are short and relatively cool near the coast, can be somewhat longer and warmer inland. Freeze-up usually begins first on the Arctic Coastal Plain and then proceeds southward toward the foothills. Because winters are long, most small streams and shallow lakes are frozen to the bottom much of the year. Streams in the Plan Area are fed by runoff and have no flow during winter (except perhaps the Colville River, which may flow under ice during the winter in some years), limiting available water to the deeper pools and stream reaches. The onset of snowmelt and the subsequent runoff often begins earlier in the foothills and moves north as the summer season progresses (BLM and MMR 1998a).

The intensity of Beaufort–Chukchi Cyclones has increased in the summer over the last 40 years (Lynch, et al, 2003). These findings indicate that retreating sea ice and increased open water have an affect on the frequency and intensity of cyclonic activity in most of the Arctic. The Office of Naval Research, U.S. Arctic Research Commission (2004) report that although there is considerable debate over predicted changes in Arctic climate patterns due to global warming, one likely scenario it that over the next 20 years, the volume of Arctic sea will further decrease approximately 40%, and the lateral extent of sea ice will be sharply reduced (at least 20%) in summer. This means that polar low-pressure systems will become more common and boundary layer forced convection will increase mixed (ice-water) precipitation. Cloudiness will increase, extending the summer cloudy regime with earlier onset and later decline. The likelihood of freezing mist and drizzle will increase, along with increased vessel and aircraft icing.

## SUBSURFACE WATER (GROUNDWATER)

Subsurface water resources are controlled by their general proximity to large surface water bodies (including lakes, streams, and rivers) and by association with permafrost. In general, usable subsurface water in the Plan Area is limited to distinct and unconnected (isolated) shallow zones. This limited availability is due to the presence of permafrost, which is an almost continuous zone throughout the North Slope (Williams 1970).

The frozen state of the soils combined with fine-grained and saturated conditions form a confining layer that prevents percolation and recharge from surface water sources, and movement of groundwater. Such restrictions are reflected in the number of lakes and other poorly-drained areas that dominate the Coastal Plain Area. Because percolation and recharge are restricted, the formation of usable subsurface water resources is limited to: unfrozen supra-permafrost material or taliks (thawed zones) beneath relatively deep lakes, or hyporheic zones in thawed sediments below major rivers and streams. In the Plan Area, shallow supra-permafrost water also occurs seasonally within the active zone above the impervious permafrost. The thickness of the active layer is typically 1.5 feet, but ranges from 1 foot under dense organic mats, to 4 feet in coarse-textured soil (Rawlinson 1993, Gyrc 1985).

Usable deep subsurface water is limited to those reserves with acceptable water quality. Groundwater within permafrost or beneath permafrost zones (from 700 to 2,165 feet-deep on the North Slope) (Rawlinson 1993) tends to be brackish or highly saline. The origin of the poor water quality is unknown but is usually thought to be either connate water or inherited from one or more of the marine transgressions of the Pleistocene. The poor water quality existing in the subpermafrost aquifers is a strong indicator of little connection between supra-permafrost and subpermafrost water.

### SHALLOW SUBSURFACE WATER

Larger lakes with depths greater than approximately 6 to 7 feet generally do not freeze to the bottom in the winter, allowing an unfrozen zone, or talik, to remain beneath the lake (Sloan 1987). Walker (1983) has theorized that a discontinuous, thawed hyporheic zone exists beneath the Colville River Delta due to irregular water depths in the area, changes in channel morphology across the delta, and heterogeneity in the channel sediments. Some of these theorized hyporheic zones in the prodelta or “delta fringe” area would likely have high salinity due to their proximity to the Beaufort Sea.

The thawed hyporheic zone below the Colville River, or the taliks associated with larger lakes, could be suitable for pumping water when the channel-bottom or lake-bottom sediments consist of porous materials, such as sands or gravels. For example, during construction of the TAPS, shallow water wells (galleries) were installed in the bed of the Sagavanirktok River. Although those wells in the lower river generally provided adequate supply, others in the upper river did not. Nelson and Munter (1990) describe thawed zones beneath deep river pools of arctic rivers as a series of discrete units separated by permafrost barriers. Apparently, the barriers resulted from the riverbed freezing below shallow riffles, which suggested that the water supply was directly related to the size of the pool in the river (Sloan 1987).

In general, while these shallow groundwater zones do exist, they are typically very small relative to those in more temperate systems, and there would likely be no difference between using the “shallow subsurface” waters and the lake or river water. Galleries or off-channel sumps are used to provide a mechanism to withdraw water at higher rates than possible, using screened intakes placed in-channel. However, their purpose is not to provide a “shallow-subsurface” water source during winter (B. Morris 2003).

### GROUNDWATER WITHIN PERMAFROST

Groundwater within permafrost or intra-permafrost water occurs in discontinuous confined locations, where often the presence of dissolved salts depresses the freezing point of the water. The saline quality of the groundwater makes it unsuitable for drinking water and potentially harmful to vegetation if it’s discharged on the tundra surface. The usability of this type of groundwater source is likely to be limited because of the nature of its formation.

#### DEEP GROUNDWATER

Deep wells drilled through the permafrost in the vicinity of Prudhoe Bay have encountered highly mineralized groundwater at depths of 3,000 to more than 5,000 feet, but little data on deepwater sources in the Plan Area exist (Sloan 1987, BLM 1998a). Although there are no water well data in the area, geophysical data suggest that the depth to the base of permafrost and subpermafrost water could be significantly shallower in the Plan Area. On the basis of knowledge about Prudhoe Bay wells and other regional studies, groundwater in the Plan Area beneath the permafrost, or subpermafrost water, is likely brackish to saline (Williams and Van Everdingen 1973) and, therefore, not a usable water resource for surface placement or human consumption. However, it may be used for deep-well injections for disposal or reservoir maintenance.

#### RECHARGE

Snowmelt provides the major source of water for recharge to the shallow water-bearing zones that occur below large lakes and major streams, and to the annual thaw zones that occur beneath the ponds and marshy areas of the Colville River Delta. Deeper groundwater zones beneath the permafrost, however, are not as readily recharged. Subpermafrost water could be recharged from areas to the south in the Arctic Foothills and the Brooks Range and has a much longer residence time in the ground. It is also possible that the subpermafrost water could represent stagnant and/or isolated water zones that were cut off from recharge and groundwater movement as a result of the formation of permafrost during the Pleistocene, or that were isolated by orogenic events associated with the formation of the Brooks Range.

#### SPRINGS

Landsat imagery analysis located numerous groundwater springs on the North Slope by identifying the large overflow icings (aufeis) created downstream during the winter. However, none of these springs were located in the Plan Area (Sloan 1987).

### LAKE HYDROLOGY

Lakes and ponds are the most prevalent features of the Plan Area (Figure 3.2.2.1-1). Unlike streams, which have large volumes of water present during break-up or the odd storm surge, some of the larger lakes have readily available year-round water (Sloan 1987). Availability of year-round water is determined by the depth of the lake. Those lakes with water depths greater than 6 to 7 feet generally will have free water under ice during the winter season.

In general, the melting of ice-rich permafrost can cause surface subsidence, often creating thaw-lakes, ponds, or beaded stream channels. Sellman et al. (1975) concluded that most lakes and ponds on the Arctic Coastal Plain originated from thawing the shallowest, ice-rich permafrost layer. They found that in permafrost near the coast, the upper 10 to 12 feet contained as much as 80 percent segregated ice. Disturbance of the vegetation or water and wind erosion could initiate melting of the upper ice-rich zones and trigger the development of thaw-lakes.

Recharge of lakes in the Plan Area occurs through three mechanisms: melting of winter snow accumulations within a lake drainage basin, over-bank flooding from nearby streams, and rainfall precipitation. Based on results of lake recharge investigations conducted on lakes within and outside the Delta, it appears that arctic lakes are typically recharged to above bankfull on an annual basis. Recharge from snowmelt or overland flow or a combination of both are the dominant recharge mechanisms (Michael Baker Jr. Inc. 2002e).

Shallow lakes and ponds (less than 6 to 7 feet deep) dominate the Arctic Coastal Plain in the Plan Area. The water temperature generally mimics ambient air temperature with a lag time related to lake volume (i.e. thermal mass). While river temperatures in the Plan Area have been documented at 62ºF, some shallow clear arctic lakes have been documented to reach summer temperatures as high as 68ºF (BLM 1998a). These lakes, if connected to a stream, provide extremely valuable rearing and feeding habitat for fish. The shallow lakes and ponds begin freezing up in September and freeze to the bottom by mid-winter. They become ice-free in late June or early July, approximately one month earlier than the deep lakes (Walker 1983).

Deep lakes (greater than 6 to 7 feet deep) with relatively large areas extend throughout the southern and western regions of the Plan Area. Some exhibit complex geomorphologic shoreline features (e.g., bays, spits, lagoons, islands, and beaches, as well as extensive shoal areas) and provide diverse ecological habitats, such as an over-wintering area for fish and aquatic invertebrates. These large lakes also provide the most readily available winter water supply. Lakes with a surface area greater than 10 acres cover approximately 16 percent of the Colville River Delta. These larger lakes are generally 11–15 feet deep, but can exceed 30 feet. Because they have a large thermal mass, the lakes remain covered by ice into early July, much later than the smaller lakes (Walker et al. 1978).

The physical characteristics of seven representative lakes in the Plan Area are summarized in Table 3.2.2-1. These lakes were selected as study lakes for the Alpine Lakes Recharge Study because they are typical of lakes suitable for water supply lakes in the Alpine Development Project area. Detailed descriptions and compilations of data and physical characteristics on more than 200 lakes in the Plan Area are contained in MJM Research (2000a and 2000b). The lake depth data from these studies are presented on Figure 3.2.2-1.

**TABLE 3.2.2-1 PHYSICAL CHARACTERISTICS OF RECHARGE STUDY LAKES IN THE PLAN AREA**

| Lake Number | Estimated Volume (million gallons) | Area (acres) | Maximum Depth (feet) |
|---|---|---|---|
| L9312 | 300 | 100 | 14 |
| L9313 | 160 | 69 | 12 |
| L9310 | 211 | 61 | 24 |
| L9282 | 1800 | 480 | 28 |
| L9342 | 65 | 25 | 12 |
| L9283 | 76 | 74 | 10 |
| L9275 | 730 | 376 | 18 |

Note: Lake data provided by CPAI in Michael Baker Jr. Inc. (2002e).

#### RECENT LAKE STUDIES

Ongoing and future oilfield activities within the Plan Area would use ice roads and pads for access and transportation during the winter. Each season, millions of gallons of fresh water are withdrawn from regional lakes to construct ice roads and pads. Water withdrawals for construction could begin as early as December and continue through April. The ice roads are usually completed by mid-winter. However, water withdrawals for ice road and pad maintenance continue throughout the exploration season. In addition to ice road and pad construction, freshwater lakes are used as potable water supplies for temporary rig and exploration camps and as sources of make-up water for exploratory drilling operations (Michael Baker Jr. Inc. 2002e).

Recently, a number of studies focusing on lakes in the Plan Area were conducted. These include a Reanier & Associates (2000) study for Phillips Alaska, Inc. (PAI) which consisted of measuring lake volume (from surface area and bathymetry data) and in situ water quality parameters for 32 lakes identified as potential water sources for ice road and pad construction.

MJM Research (2000a, 2000b and 2001) conducted surveys of over 93 lakes in the eastern National Petroleum Reserve-Alaska within the Plan Area and additional 109 lakes within the Colville River Delta. During the surveys, the researchers measured fish abundance, lake cross-sections, lake bathymetry and general water quality parameters. From the physical data, researchers reported maximum lake depths and calculated lake volumes, including the maximum extractable or permitable volume. As of January 27, 2000, 30 percent of the water below a presumed 7 feet of ice cover may be extracted. Prior to this date, 15 percent of the water was permitted for extraction.

MJM Research (2003) extensively monitored two lakes in the Plan Area. Researchers investigated the effect of water withdrawal on water chemistry and fish populations by measuring fish abundance, lake area and bathymetry, water temperature, pH, specific conductivity, and turbidity. Over a 5-year study period, withdrawals generally did not affect water chemistry, nor did they directly affect fish populations. However, population of slimy sculpin in Lake L9312 has shown a continuous decline since sampling began in 1999.

Two lake investigations specifically dealing with over-winter water use and lake recharge were conducted during the winter of 2000–2001. The programs were initiated by BPXA and PAI and developed in coordination with the BLM. Both studies sought to investigate whether winter water withdrawals had a measurable effect on water quality, and to quantify water surface elevation changes caused by pumping. The BPXA study concluded within the limitations of the methodology used, that there was little evidence that water quality changed as a result of pumping. The study further suggested that water surface elevation changes in pumped lakes were within the range of changes seen in reference lakes, and that changes in water surface elevations were correlated with changes in ice thickness (Oasis 2001).

The winter of 2000–2001 PAI study was designed to monitor water levels and water quality at both pump and reference lakes, determine the amount of free water under the ice, and assess the amount of recharge to the lakes in the summer. Withdrawal rates were typically well below the maximum allowable. The PAI study concluded that water level decreases caused by pumping did not advance the freezing rate of the study lakes, and that water levels depressed by pumping returned to pre-pump levels before freeze-up. In view of in situ and analytical water quality results, the study concluded that pumping did not appear to cause significant degradation of water quality in the study lakes (Michael Baker Jr. Inc. 2002e).

Michael Baker Jr. Inc. (2002e) conducted monitoring and recharge studies of several lakes in the Alpine Development Project area and the surrounding Plan Area. The studies were designed to evaluate the magnitude and impacts of water withdrawn for ice road and pad construction during exploration activities at these lakes. The studied lakes included five pump lakes: L9911, L9817, M9912, M9922, and M9923; and four reference lakes: L9807, L9823, M0024, and M9914. Site visits were conducted so that lake conditions during pre-pump, post-pump, post-break-up, and pre-freeze-up periods were measured. The investigators concluded that water surface elevations in the majority of pump lakes were lowered more than in reference lakes, most likely due to pumping. The dominant mechanism for recharge of the lakes was melting winter snow accumulations within the drainage basin of each lake. Data from 2001 and 2002 studies as well as anecdotal information at seven North Slope communities (including Nuiqsut) indicate that the magnitude of spring recharge has always been sufficient to compensate for withdrawals (Michael Baker Jr. Inc. 2002e).

With respect to the lakes' water quality, pumping did not appear to affect temperature, pH, turbidity, sulfate, and nitrate levels did not appear. In pump lakes where a water circulator was employed, average post-pump dissolved oxygen concentrations were higher than in reference lakes. Naturally occurring seasonal changes in water quality are a characteristic of North Slope Coastal Plain lakes. Seasonal water chemistry changes are likely influenced by the proportion of under-ice water volume to open-water lake volume. It is expected that pumping will have a greater impact on water chemistry in shallow lakes than it would in deep lakes, provided the lakes are similar in size and that the volume removed is comparable. However, broad regional generalizations regarding lake chemistry and lake chemistry changes due to seasonality and water withdrawal should be avoided (Michael Baker Jr. Inc. 2002e).

## STREAM AND RIVER HYDROLOGY

### DRAINAGES IN THE PLAN AREA

The Plan Area is dominated by the Colville River Drainage Basin, the largest river on the North Slope. Smaller waterways within the region include Fish Creek and the Kogru and Kalikpik Rivers. Also within the Plan Area are Judy Creek and the Ublutuoch River, which are major tributaries of Fish Creek (Figure 3.2.2.1-2). A summary of general hydrologic data for the major drainages within the Plan Area is provided in Table 3.2.2-2.

**TABLE 3.2.2-2 SUMMARY OF GENERAL HYDROLOGIC DATA OR DRAINAGES IN THE PLAN AREA**

| Stream or Channel | Tributary to | Mean Elevation (feet msl) | Drainage Area ($mi^2$) | Number of Lakes (Proportion of Drainage as Lake Area) |
|---|---|---|---|---|
| Colville River<br>Nigliq Channel<br>East Channel | Harrison Bay | NA | 20,920 | NA |
| Kogru River | Harrison Bay | NA | NA | NA |
| Kalikpik River | | 110 | 431 | 107 (25%) |
| Fish Creek | Harrison Bay | 134 | 1,827 | 116 (22%) |
| Ublutuoch River | Fish Creek | 114 | 248 | 20 (15%) |
| Judy Creek | Fish Creek | 196 | 666 | 92 (18%) |
| Inigok Creek | Fish Creek | 186 | 270 | 57 (21%) |
| Kikakrorak River[1] | Colville River | 310 | 379 | 17 (4%) |
| Kogosukruk River[1] | | 402 | 543 | 5 (1%) |

Sources: BLM 1998a and URS Corporation 2003
Notes: [1]The Kikakrorak and Kogusukruk Rivers are tributaries of the Colville River, immediately south of the Plan Area.

#### Colville River

The Colville River is the longest river (370 miles) and has the largest drainage basin (20,920 square miles) on the North Slope of Alaska. The drainage basin extends from the Brooks Range to the Arctic Ocean (Jorgenson et al. 1996). Flow in the Colville River is controlled by some large tributaries that are outside the Plan Area and head in either the Brooks Range or the Foothills. These include the Etivluk, Anaktuvuk, Chandler, and Killik Rivers in the upper basin, and the Kogosukruk, Kikakrorak, and Itkillik Rivers in the lower basin. The last three rivers join the Colville River approximately 28 and 24 miles southwest and only 4 miles southeast of the village of Nuiqsut, respectively. The Itkillik enters the Colville River just upstream and south of the head of the Colville River Delta.

#### Colville River Delta

The Colville River Delta is more than 25 miles-long and covers approximately 250 square miles (Jorgenson et al. 1994) or approximately 1.2 percent of the entire Colville River Drainage Basin. The head of the Colville River Delta is the downstream most point where the river flows in a single channel. It is located a short distance downstream from the Itkillik River confluence.

Most of the water reaching the Delta is carried to the ocean through two main channels: the East (or Main) Channel and the Nigliq Channel. The East Channel is significantly larger than the Nigliq Channel and also distributes into a number of smaller channels, including the Sakoonang, Tamayayak, Elaktoveach, Kupigruak and Ulamnigiaq Channels (Figure 3.2.2.1-3). From infrequent observations made before 1967, Arnborg et al. (1967) estimated that approximately 80 percent of the annual discharge at the head of the Delta flowed into the East Channel and its distributaries, and the remaining 20 percent flowed into the Nigliq Channel. More recently, Jorgenson et al. (1996) reported that 38 percent of the peak flow discharge in 1995 (i.e., 233,000 cfs) was in the Nigliq Channel. In contrast, Michael Baker, Jr. Inc. (2004) reported that during the 2003 peak discharge estimated at 350,000 cfs only about 17 percent of this flow was estimated to be in the Nigliq Channel, and during a July 2004 low flow of 17,100 cfs only 650 cfs (or 3.8%) was measured in the Nigliq Channel (R. Kemnitz, 2004).

While detailed studies of the proportions of flow in the various channels across the Delta have not been made, it is evident that the proportion between the Nigliq and East Channels changes throughout the year, especially when ice jams occur during break-up near the entrance to these channels (Walker, 1982; Michael Baker, 2004d). During high flows, the Nigliq and other minor channels may carry much more than 20 percent, while as was evident in July 2004 during low water summer months the proportional flow in the Nigliq Channel can be much less than that amount. The proportion of flows in the East and Nigliq Channels is also not constant over the long-term because the geometry of channel conditions continues to evolve as a result of natural erosion and sedimentation processes in the Delta.

In general, the channels of the Colville River Delta are braided and broad and have high width-to-depth ratios. The East Channel is approximately 3,000 feet-wide, with depths ranging from 15 to 25 feet (measured from typical summer water surfaces) but as little as 10 feet and exceeding 40 feet at a few locations (Ray and Aldrich 1996). The Nigliq Channel is approximately 1,000 feet-wide and 10 to 30 feet-deep (Walker 1983, Ray and Aldrich 1996). Maximum depths are approximately 40 feet. The Sakoonang, Tamayayak and Ulamnigiaq Channels are narrower, on the order of 200 and 500 feet, respectively. The deepest parts of those channels approach 30 feet (Ray and Aldrich 1996).

#### Fish Creek Basin

Much of the Plan Area lies within the lower portions of the Fish Creek Basin (Figure 3.2.2.1-2). Fish Creek flows northeast and enters Harrison Bay just west of the Colville River Delta. The drainage basin is relatively large (1,827 square miles) with portions of its headwaters in the Arctic Foothills, as well as the Arctic Coastal Plain. Twenty-two percent of the basin is covered with lakes (URS Corporation 2003). The Fish Creek Basin consists of three significant tributary basins: Inigok Creek (270 square miles), Judy Creek (666 square miles), and Ublutuoch River (248 square miles) (URS Corporation 2003). Only the Judy Creek Basin has a significant portion of its headwaters in the Arctic Foothills (BLM 1998a). During flood stage in lower Fish Creek, one main (east) channel and a minor (west) channel with multiple other distributary channels are pathways for the river to Harrison Bay.

Judy Creek and the Ublutuoch River enter Fish Creek approximately 26 and 10 miles, respectively, upstream from its mouth (URS Corporation 2003). Because a portion of the Judy Creek headwaters originate at a higher elevation in the Brooks Range than those of other streams, Judy Creek tends to break-up first (URS Corporation 2001, BLM 2001). Portions of the Ublutuoch River are entrenched, which creates narrower floodplains and steeper riverbanks (BLM 2001).

The Fish Creek Basin streams have relatively low gradients and highly sinuous channels over at least the lower half of their stream courses. The Fish Creek and Judy Creek Channels' banks and beds consist of sand and silt-sized material. Undercut stream banks and bank sloughing are common along the outside of meander bends (URS Corporation 2003). Sand dunes form along portions of Fish and Judy Creeks (BLM 2001). In contrast to Fish and Judy Creeks, the Ublutuoch River Channel is incised within relatively steep upper banks that are vegetated with dense brush (BLM 1998a).

### Kalikpik and Kogru River Basins

The Kalikpik and Kogru Rivers cross the northwest portion of the Plan Area only in the region considered for FFD (Figure 3.2.2.1-2). Information about these streams is limited to general physiographic information. The Kogru River is a relatively small riverine estuary, located at sea level, and was formed by coalescing thaw-lakes associated with coastal erosion and rising sea level during the Holocene. The Kalikpik River Basin (431 square miles) borders the Fish Creek Basin to the south, and its overall drainage patterns, lake density (25 percent), and northeast flow directions are similar to those of the lower Fish Creek Basin. No hydrologic data are available for the Kogru and Kalikpik Rivers.

#### RIVER DISCHARGE PROCESSES

Although hydrologic data for North Slope streams are sparse, all streams for which data are available share distinctive stream flow characteristics. Flow typically is nonexistent or at least not measurable through much of the winter. Stream flow begins in late May or early June as a rapid flood event termed “break-up.” Combined with ice and snow damming, break-up can inundate extremely large areas in a matter of days. More than half of the annual discharge for a stream can occur during a period of several days to a few weeks during break-up (Sloan 1987). Most streams continue to flow throughout the summer but at relatively low discharges. Rainstorms can increase stream water levels to the point that fish in shallow lakes with minor stream connections are not stranded over winter. Stream flow ceases at most streams shortly after freeze-up in September.

Long-term continuous discharge data are generally not available for streams in the Plan Area, including the Colville River, its channels, and the Fish Creek Basin streams. However, long-term hydrographic data exist for streams to the east that have similar size and physiography as some of the Plan Area drainages. One such drainage is the Kuparuk River (Figure 1.1.1-1), which has most of its 3,310 square meter basin in the foothills. Figure 3.2.2.1-4 is a composite hydrograph of the Kuparuk River that demonstrates the distinctive seasonal flow characteristics of streams on the North Slope (URS Corporation 2001).

### Colville River

Walker and McCloy (1969) described the seasonal distribution of flow in the Colville River as follows:

- Winter is an approximately 33-week period of little flow.
- Spring is an approximately 3-week period characterized by increasing flow, break-up of the ice cover, and flooding.
- Summer is an approximately 12-week period of low flow during dry periods and higher flow during rainy periods.
- Fall is an approximately 4-week period of low, stable flow.

The USGS gaged the Colville River at Nuiqsut from June 9 to September 30, 1977. The gaging station was located just downstream of the confluence with the Itkillik River and upstream of the junction of the East and Nigliq Channels. The maximum average daily flow of 277,000 cfs was recorded on the first day. As shown by Figure 3.2.2.1-5, flow continued to decrease throughout the remainder of the summer to a low of 9,800 cfs at the end of the gaging season (USGS 2003).

The USGS recently established a continuous recording gaging station on the Colville River at Umiat (approximately 75 miles upstream from Nuiqsut) in August 2002. Although several discharge measurements have been made, the rating curve is not fully developed and discharge data are not yet available (USGS 2003). Earlier continuous stage and discharge records of the Colville have been collected from May 25 to October 20, 1962 by Arnborg, et al (1966), and for much shorter infrequent periods, generally around breakup, from 1992 to 1995 by Jorgenson, et al (1996).

Continuous water surface elevations and discharge data were also collected for the Fish Creek Basin streams in 2001. The data collection began during break-up in June and ended during the first stages of freeze-up in early September. Figures 3.2.2.1-6 through 3.2.2.1-8 demonstrate that water surface elevations and peak discharge do not correlate well during break-up, but are closely related afterwards. The figures also show that Judy and Fish Creeks both experienced increases in discharge during the latter part of the summer associated with August rainfall events. These events produced much smaller peak flows than those that occurred during break-up.

#### FLOODING REGIME

The mechanism that produces floods on North Slope rivers is influenced by the type of physiographic region drained, the size of the drainage area, and the frequency of the event being considered. Snowmelt flooding occurs annually in all North Slope rivers. For rivers having drainage basins entirely within the Arctic Coastal Plain, snowmelt flooding nearly always produces the annual peak discharge. The flooding regime is more complex for those basins with a significant portion of their drainage area in the Brooks Range and Arctic Foothills in addition to the Arctic Coastal Plain. Basins that drain the Brooks Range and Arctic Foothills can experience summer floods from large rainstorms. On these rivers, rainfall floods are less frequent than snowmelt floods, but could produce larger, less frequent floods. In 27 years of data on the Sagavanirktok River near Sagwon, the two largest floods resulted from rainfall.

All the observed peak flows (i.e., 15 years in total) on the Colville River have occurred during spring break-up. Summertime precipitation or late summer/fall snowmelt events have been observed to produce low magnitude floods on the delta. High-intensity, low-duration rainfall combined with a saturated active layer has resulted in rapid and relatively large volume contributions to the channels and in upstream areas. These rainfall floods, however, have been smaller than the typical floods associated with spring break-up. For example, as noted above, in 2003 the peak breakup flow in Umiat was 234,000 cfs (USGS, 2004) and at the head of the Delta 350,000 cfs (Michael Baker, 2003), compared to the peak in July of 116,000 cfs (rainfall-runoff generated) at Umiat, and later in the year a fall (October) peak of 83,900 cfs (largely snowmelt-generated) at Umiat (BLM 2004). The large rain-induced floods on the Colville River have approximated the water surface elevation and velocity of about a 2-year spring break-up (Michael Baker, Jr. Inc. 2004b).

### Head of Colville River Delta

Long-term records of flow do not exist for the Colville River. However, on the basis of more than 40 years of observations made by the Helmericks family (J. Helmericks 1996, Michael Baker Jr. Inc. 2002c, 2002d), rainfall events were not observed to have produced over-bank flooding. Given the information provided by the Helmericks and considering the size of the drainage basin, it is likely that the spring snowmelt period yields the largest floods in the Colville River.

A few years of observation in the 1960s and 1970s and more frequent observations from 1992 to 2003 indicate that the peak break-up discharge for the Colville River at the head of the Delta typically occurs between mid-May and mid-June (see Table 3.2.2-3). On the basis of these data, the median date of peak break-up discharge is around May 31. Generally, the main channels are ice-free within a few days before or after the peak discharge. Although in some years ice does not clear completely from the channels for as long as 2 weeks after the peak discharge (Ray and Aldrich 1996), the timing of the peak discharges has occurred during or after the timing of the peak water surface elevations. For example, in 2002, at the head of the Colville River Delta, the peak discharge of 300,000 cfs occurred with a river stage of approximately 14 feet msl on May 27 (as discussed in Section 4A.2.2, based on an analysis of stage-discharge rating curves, some of the peak discharge estimates may be ice-effected and possibly overestimated), 3 days after the peak water surface elevation of approximately 17 feet with a discharge of 230,000 cfs (Michael Baker Jr. Inc. 2002c).

**TABLE 3.2.2-3 SUMMARY OF BREAK-UP DATA OBTAINED AT THE HEAD OF THE COLVILLE RIVER DELTA, 1962–2003**

| Year | Approximate Date Water Began to Flow | Peak Water Surface Elevation (feet BPMSL) | Peak Break-Up Discharge[1]( cfs) | Date of Peak Water Surface Elevation[2] | Number of Days Between First Water and Peak Flow |
|---|---|---|---|---|---|
| 2003 | May 27 | 13.8 | 350,000 | June 5 | 9 |
| 2002 | May 23 | 16.9 | 300,000 | May 24 | 1 |
| 2001 | June 5 | 17.4 | 300,000 | June 10 | 5 |
| 2000 | June 8 | 19.3 | 580,000 | June 11 | 3 |
| 1999 | May 22 | 14.0 | 203,000 | May 30 | 8 |
| 1998 | May 21 | 18.1 | 213,000 | May 29 | 8 |
| 1997 | May 20 | 15.1 | 177,000 | May 29 | 9 |
| 1996 | May 15 | 17.2 | 160,000 | May 26 | 11 |
| 1995 | May 8 | 15.7 | 233,000 | May 16 | 8 |
| 1994 | May 16 | 13.0 | 159,000 | May 25 | 9 |
| 1993 | - | 20.0 | 379,000 | May 31 | - |
| 1992 | - | 14.7 | 188,000 | June 2 | - |
| 1977 | - | 19.9 | 407,000 | June 7 | - |
| 1973 | May 25 | - | - | June 8 | 11 |
| 1971 | May 23 | - | - | June 2 | 10 |
| 1964 | May 28 | - | - | June 3 | 6 |
| 1962 | May 19 | 13.2 | 215,000 | June 14 | 26 |

Source: Michael Baker Jr. Inc. 2003
Notes:
[1] None of the peak values were measured directly; all the values were estimated indirectly by either stage-discharge extrapolations or using a simplified slope-area method.
[2] The date of the peak water surface elevations does not coincide with the timing of the peak discharge, but usually occurred up to a week before the peak discharge.

A review of the 17 available years on record show that the estimated peak break-up discharge at the head of the Delta has ranged from a low of 159,000 cfs in 1994 to as much as 580,000 cfs in 2000, and has averaged approximately 270,000 cfs. Also, a 1989 flood was estimated to have a peak break-up discharge of 775,000 cfs (this peak was estimated as the best-fit of high-water driftline elevations and a two-dimensional model of the delta discussed in section 4A.2.2; the one standard deviation of the estimate yields a discharge ranging from 665,000 to 930,000 cfs), but no water surface elevation data are available for this event. Recorded peak water surface elevations have ranged from a low of 13 feet in 1994 to 20 feet in 1993, with an average peak water surface elevation of approximately 16.5 feet. Flow velocities at the head of the Colville River Delta during the 2-year spring peak discharge are on the order of 5 to 6 feet per second (fps) (Micheal Baker Jr. Inc. and HydroConsult 2002).

Although break-up flows on the Colville River only last approximately 3 weeks, they represent approximately half the total annual flow (Micheal Baker Jr. Inc. and HydroConsult 2002). For the smaller basins originating only on the Arctic Coastal Plain, the break-up flows represent a much higher proportion of the total annual flow. In 1971 an estimated 55 percent of the annual flow of the Colville River occurred during an 18-day period of spring break-up (Walker 1972). In 1962, however, break-up flooding occurred during a 30-day period (Arnborg et al. 1967), during which 45 percent of the total flow was recorded only between the 6 days from May 24 to

May 30. Although data for other years are sparse, these two years are representative of the type of flow volumes during typical break-up flooding.

### Colville River Delta

Although historical hydrologic data for the Colville River Delta are in general limited, break-up studies have been conducted on the Delta since 1992 (Michael Baker Jr. Inc. 2003). These monitoring efforts have been developed to further the understanding of the hydrologic characteristics associated with spring break-up flooding events and provide data needed for the design of production pads and other oil field facilities adjacent to the Nigliq, Sakoonang, Tamayayak and Ulamnigiaq Channels. Reports by Michael Baker Jr. Inc. (2003, 2002c, 2002d, 2001b), summarize the observations and measurements made during recent spring break-ups. Additional studies concerning break-up of the Colville River Delta and modeling of flood stages in the vicinity of CD-3 and CD-4 have also been prepared by Michael Baker Jr. Inc. (2004a, 2002a, 2002b, 2001a, 1998).

The Michael Baker Jr. Inc. studies focused on measuring the change in water surface elevations through the 1- to 2-week break-up period at representative locations in various distributary channels and near the head of the Colville River Delta. Water surface elevations were measured on an approximate daily basis from direct observations of temporary staff gages at each monitoring site, high-water marks left on the staff gages, or surveyed level loops of water levels or high-water marks. Further, peak discharges were estimated by using a simplified USGS slope-area method (Michael Baker Jr. Inc. 2001a).

During 2002, the peak water surface at the gaging station adjacent to the CD-3 production pad occurred between 1:35 p.m. on May 25 and 11:45 a.m. on May 26 at an elevation of 9.6 feet British Petroleum mean sea level (BPMSL). Measured peak water surface elevations in the immediate vicinity of CD-3 were compared to water surface elevations predicted by the two-dimensional surface water model developed for the Colville River Delta (Michael Baker Jr. Inc. 2002b, 2001a, 1998, Shannon & Wilson Inc. 1996). From a linear interpolation between the water surface elevations predicted for the 2- and 10-year open-water floods, it was estimated that the peak water surface elevations observed during spring 2002 at CD-3 will likely be equaled or exceeded on average approximately once every 7 years.

Peak water surface elevations near the CD-4 production pad were monitored during the 2000 and 2001 spring break-ups. The peak water surface elevation was estimated to be between 10.5 and 11.0 feet BPMSL, and to have an average return period of approximately 20 years (based on predicted water surface elevations) during 2000. During 2001, the peak water surface elevation was estimated at 10.2 feet BPMSL and to have an average return period of 7 years (based on predicted water surface elevations) (Michael Baker Jr. Inc. 2002c).

During break-up 2002, peak water surface elevations and peak flows were estimated for three of the proposed crossings on the Sakoonang, Tamayayak and Ulamnigiaq Channels (Figure 2.4.1.1-6). The break-up data summarized in Table 3.2.2-4 indicate that discharges are greater in the Sakoonang and Tamayayak Channels.

Since 1996, peak water surface elevations have been measured and peak discharges have been estimated in various distributary channels near the Delta coastline. The peak water surface elevation at the head of the West Ulamnigiaq Channel, which is adjacent to CD-4 location, is available for 2002 and 2001. Peak water surface elevation was 5.8 feet in 2002 and 7.1 feet in 2001. Peak discharges at this location were 300,000 cfs in both 2002 and 2001. A peak discharge of 300,000 cfs corresponds to a recurrence interval of 4 years (Michael Baker Jr. Inc. 2002d). Peak water surface elevations and peak discharges for other locations along the Colville River Delta coastline are summarized in Table 3.2.2-5.

### TABLE 3.2.2-4 SUMMARY OF 2002 PEAK FLOW HYDROLOGIC CONDITIONS FOR CHANNEL CROSSINGS NEAR CD-3

| Channel | Estimated Time of Peak Water Surface Elevation | Peak Discharge (cfs) | Estimated Discharge at Peak Water Surface Elevation (cfs) | Width of Flow at Peak Water Surface Elevation (feet) | Maximum Depth at Peak Water Surface Elevation (feet) | Average Velocity at Peak Water Surface Elevation (fps) |
|---|---|---|---|---|---|---|
| Sakoonang | late evening, 26 May | 10,500 | 9,800 | 450 | 11.6 | 2.7 |
| Tamayayak | early morning, 27 May | 10,700 | 10,700 | 630 | 12.1 | 2.0 |
| Ulamnigiaq | early morning, 27 May | 7,700 | 6,900 | 690 | 19.0 | 1.8 |

Source: Michael Baker Jr. Inc. 2002d
Note: All values are based on a 2001 cross-sections survey by Kuukpik Corporation/LCMF Inc.

### TABLE 3.2.2-5 SPRING PEAK WATER SURFACE ELEVATIONS NEAR THE DELTA COASTLINE

| Year | Location | Elevation (feet BPMSL) | Peak Discharge at Head of Delta (cfs) | Recurrence Interval of Peak Discharge (years) |
|---|---|---|---|---|
| 2002 | West Ulamnigiaq Channel adjacent to CD-4 | 5.8 | 300,000 | ≈4 |
| | East Ulamnigiaq Channel near TBM FIOSO | 5.6 | | |
| | Monument 28 | 3.7 | | |
| | Monument 35 | 5.5 | | |
| 2001 | West Ulamnigiaq Channel adjacent to CD-4 | 7.1 | 300,000 | ≈4 |
| | East Ulamnigiaq Channel near TBM FIOSO | 7.4 | | |
| | Monument 28 | 3.8 | | |
| 2000 | Monument FIORD M1 | 5.77 | 580,000 | 25 |
| | TBM FIOSO | 6.32 | | |
| | Helmericks House | 7.39 | | |
| | Helmericks Hangar | 7.24 | | |
| | N. End Helmericks Runway | 7.10 | | |
| 1999 | Monument 28 | 2.85 | 203,000 | <2 |
| | Monument M1 | 3.00 ± 0.1 | | |
| 1998 | Monument 28 | 4.51 ± 0.47 | 213,000 | ≈2 |
| | Monument 35 | 4.22 ± 0.08 | | |
| 1997 | Monument 28 | 3.97 | 173,000 | <2 |
| | Monument 35 | 4.73 | | |
| 1996 | Monument 28 | 4.3 | 160,000 | <2 |

Sources: Michael Baker Jr. Inc. 2002d, Michael Baker Jr. Inc. and HydroConsult 2002
Notes:
Monument 28 is located approximately 2.0 miles upstream from the mouth of the Nigliq Channel.
Monument 35 is located approximately 3.0 miles upstream from the mouth of the East Channel.
Monument M1 is located approximately 2.3 miles upstream from the mouth of the Fiord Channel. TBM FIOSO is located approximately 3.5 miles upstream from the mouth channel with M1.
TBM FIOSO is located approximately 4.2 miles upstream from the mouth of the channel with M1.
The results of these recent studies indicate that fluctuations in river stage at the head of the Delta during the short break-up period have amounted to more than 9 feet. The fluctuation in stage decreased in a seaward direction to approximately 5 to 8 feet in the mid-Delta areas (near CD-4) and to less than 4 feet near the Delta mouth (near CD-3). Further, the timing of the peak discharges typically occurs after the timing of the peak water surface elevations.

### Fish Creek Basin

The hydrologic conditions on Fish Creek, Judy Creek and the Ublutuoch River were investigated during 2001, 2002 and 2003 (URS Corporation 2001 and 2003, Michael Baker Jr. Inc. 2003). These water bodies were monitored to provide hydrologic and hydraulic information for engineering and environmental assessments. Noncontinuous water surface elevations and discharge data were collected during the 2001, 2002 and 2003 spring and summer seasons. Few data, however, are available to enable predictions of water surface elevations and peak water velocities caused by ice-jamming at project specific sites (bridges, roads, pads, pipes, etc.). URS Corporation (2001, 2003) established monitoring sites at six locations along Fish Creek (River miles (RMs) 0.7, 11.7, 18.4, 25.1, 32.4, and 43.3), four locations along Judy Creek (RMs 7, 13.8, 21.8, and 31.0), and two locations along the Ublutuoch River (RMs 13.5 and 13.7) during spring break-up (Figure 3.2.2.1-1). The monitoring consisted of recording snow and ice conditions and water surface elevations. During this time, discharge measurements were made periodically at various stations along each stream. During the summer, monitoring of the water surface elevations and discharge continued for each creek at four of the stations. Data for these stations are summarized in Table 3.2.2-6.

Channel cross-sectional data were collected to understand the effect of ice and snow on water surface elevations, the magnitude and timing of flood peak, and the magnitude of the observed riverbed movement. For example, at Fish Creek RM 25.1, peak water surface elevation was affected by ice in 2001 but not 2002. Although peak discharge was higher in 2002 than 2001, peak stage was higher in 2001 than 2002 because of the ice affect. At Judy Creek RM 7.0, peak water surface elevation was affected by ice in 2001 but not 2002. Similar to Fish Creek, peak discharge was higher in 2002 than 2001 but peak stage was higher in 2001 than 2002 because of the ice affect. Spring break-up occurred earlier in the Ublutuoch River than in Fish or Judy Creeks. At the Ublutuoch River RM 13.7, ice was in the channel at the time of peak stage in 2002. Although peak discharge was higher in 2001 than 2002, peak stage was higher in 2002 than 2001 because of the ice affect. (URS Corporation 2003).

Michael Baker Jr. Inc. (2003) conducted quantitative and qualitative evaluations of 2003 spring break-up of Fish Creek, Judy Creek and the Ublutuoch River. Water surface elevation monitoring stations were set up at RMs 32.4, 25.1, and 11.7 in Fish Creek; RMs 13.8 and 7.0 in Judy Creek; and RMs 1.9 and 6.8 in the Ublutuoch River. RM 6.8 of the Ublutuoch River is the site of a proposed bridge under Alternative A—CPAI Development Plan. Water surface elevations were recorded throughout spring break-up. Peak stage occurred between June 5 and June 8 at the three monitoring stations in Fish Creek. The channel was free of ice at the upstream station at the time of peak stage. Floating ice was in the channel at the middle station during peak stage, which affected the observed water surface elevation. At the downstream station, ice may have been in the channel during peak stage. Thus, it is unknown if the observed water surface elevation was affected by ice.

In Judy Creek, peak stage occurred either late on June 5 or early on June 6. Bottomfast ice was not present in the channel during peak stage; indicating peak water surface elevations were not ice-affected. In the Ublutuoch River, peak stage occurred either late on June 6 or early on June 7 at the upstream station. Peak stage at the downstream station of the Ublutuoch River coincided with that of Fish Creek at the downstream station. It is likely that the flooding conditions on lower Fish Creek produced backwater effects on the lower Ublutuoch River that affected the timing and elevation of the peak water surface at Ublutuoch RM 1.9. Bottomfast ice was in place at both monitoring stations during the peak stage. Thus, observed water surface elevations were affected by ice, which is an important consideration for bridge design.

In the Ublutuoch River, discharge was directly measured near the proposed bridge site at RM 6.8 on June 9 and 10. Discharge was indirectly measured using channel slope, channel cross-section, channel ice depth and water surface elevation for the period of spring break-up. Observations made from flight reconnaissance during the break-up period noted that the lower west floodplain was fully inundated and conveyed flow during high flows and/or during periods when ice was in the main channel. The east and upper west floodplains were also inundated during spring break-up but conveyed little flow.

Recently, a small streams monitoring project was implemented to make observations and collect data during breakup on seven small unnamed tributary streams within the Fish Creek Basin (PN&D, 2003. The basins for these streams are all less than 10 square miles but will be crossed byt the proposed roads to CD-5, 6 and 7. Three of the streams are well-developed beaded streams, while the others range from 1 to 2 ft wide channels to broad swales that concentrate overland flow.

#### FLOOD FREQUENCY PREDICTIONS

Peak discharge data collected at the head of the Colville River Delta and data from two nearby rivers (Kuparuk and Sagavanirktok Rivers) were used to estimate the flood magnitude and frequency of the Colville River (Shannon & Wilson 1996, Michael Baker Jr. Inc. and HydroConsult 2002). The flood-peak discharge estimates for head of the Colville River are presented in Table 3.2.2-7. This study and the uncertainty associated with the flood frequency predictions is discussed in detail in Sections 4A.2.2.6 and 4F.2.2.6.

Also, Michael Baker Jr. Inc. (2004, 2002d, 1998), and Shannon & Wilson Inc. (1997) predicted water surface elevations based on similar analyses for the Colville River Delta, including at the existing Alpine Development Project facilities, at the pad locations and at the proposed and existing bridge crossings. Modeling and analyses indicate that, at the time of the peak discharge of the 50-year flood, most of the Delta will be under water (Michael Baker Jr. Inc. 2004a). Observations of flooding on the Delta indicate that floodwaters often cover up to an estimated 65 percent of the Delta (Walker 1983). In 1992 (less than a 2-year flood event) and 1993 (approximately a 5-year flood event), floodwaters covered an estimated 43 percent and 58 percent, respectively, of selected portions of the Delta (Jorgenson et al. 1994).

Similarly, other than the data collected in 2001 and 2002 (URS Corporation 2001, 2003), no other historical flood-peak discharge data are available for Fish Creek, Judy Creek, nor the Ublutuoch River. Flood frequency and magnitude were estimated for various locations along these streams by using historical data collected on other rivers in the region and the 2001 and 2002 data recently collected. URS Corporation (2003) estimated flood frequency discharges by assuming that the average flood-peak discharges observed in 2001 and 2002 were equal to the mean annual flood (the 2-year event), and by adjusting the regional flood frequency curve to reflect this relationship. The flood-peak discharge estimates for the Fish Creek basin streams are presented in Table 3.2.2-7.

URS Corporation (2003) utilized historical and 2001 through 2002 discharge data, water surface elevation data, and hydraulic roughness to estimate a water surface profile for the 100-year flood period along Judy Creek and Fish Creek. The models used in this analysis assume that the channels are unaffected by snow and ice blockages. Figure 3.2.2.1-7 shows the area inundated by a 100-year event (URS Corporation 2003). The floodplain is widest at the mouth of Fish Creek (6 miles). The width of the floodplain at Fish Creek RM 25.1 is 2 miles.

On the basis of the flood frequency analyses performed by URS Corporation (2001, 2003) for the Fish Creek basin streams, the annual peak discharge associated with snowmelt events, for a given return period, is greater than the annual peak discharge associated with rainfall events. Similarly, for a given magnitude of annual peak discharge, it is more likely that the flood-peak will occur as the result of snowmelt rather than rainfall.

It should be noted that for both the Colville River Channels and the Fish Creek basin streams, the peak flows usually occur after the peak water surface elevations. The current two-dimensional model used to estimate peak flow during break-up in the Colville River Delta does not account for channel ice or ice jams. The one-dimensional model and normal depth computations used to estimate peak flow during break-up in Fish Creek streams allow channel ice but not ice jams to be modeled. Although data used in the models was obtained when channel ice was present, the models do not account for channel ice and/or ice jams. During a low frequency event, such as a 200-year event, most of the Delta is submerged. An ice jam or channel ice in one channel will have very little overall effect on delta-wide water surface elevations.

Both channel ice and ice jams have the potential to significantly alter local water surface elevations, but the lack of a model that predicts the effects from channel ice or ice jams on the delta does not affect pad and road design. Pad and road height are governed by thermal criteria, not by flood criteria. For example, the water surface elevation for a 200-year event at CD-4 is 15.7 ± 1 feet. The pad height was designed to be 19.0 feet.

### STORM SURGES ON THE FRINGE OF THE COLVILLE RIVER DELTA

A storm surge is coastal flooding caused by the seawater piling up against the shore as a result of wind stress and atmospheric pressure differences caused by a storm. Along the northern coast of Alaska, storm surges usually occur during late summer and fall (August to October). The two worst cases of surge flooding on record occurred in October 1963 and September 1970 (Reimnitz and Maurer 1979, Lynch et al. 2002). Along the fringe of the Colville River Delta, two storm surge drift lines (identified by local residents as related to the 1963 and 1970 storms) had elevations of 5.0 and 6.6 feet above msl, respectively (Jorgenson et al. 1993). Estimates of storm surge heights at the Delta fringe for frequency intervals of 10, 50, and 100 years are 6.5, 9.2, and 10.6 feet, respectively (Jorgenson et al. 1993).

Gloersen et al. (1999), Lynch et al. (2004) and Walsh et al. (1996) comment on the change in intensity, frequency and impact of high-wind events as a function of climate change. The storm surges in 1963 and 1970 were caused by Beaufort-Chukchi cyclones, one type of high-wind event. The intensity of Beaufort-Chukchi cyclones has significantly increased over the past 40 years in summer but not in other seasons (Gloersen et al. 1999, Lynch et al. 2002). While cyclone frequency throughout the arctic is highly variable over long time scales, the frequency of cyclones in the Beaufort-Chukchi region has been historically low. The intensity and frequency of cyclonic activity throughout the arctic is associated with the amount of open-water and sea ice. Such a correlation has not been found for the Beaufort Sea. Open-water in the Beaufort Sea has little or no influence on subsequent local surface winds or sea level pressure distribution. Accordingly, retreating sea cannot be considered to be a strong influence on the past or future trends in the frequency or intensity of Beaufort-Chukchi cyclones (Lynch et al. 2003). However, retreating sea ice will have implications for the impacts of storms on the northern coast of Alaska (Office of Naval Research, Arctic Research Commission (2004). Sea ice protects the coast from storm surges. As sea ice retreats, the impact of storm surges will increase. Climate change increases the probability of storm surge events.

Of particular concern and difficult to forecast is the potential effect of storm surges during a large summer storm and the effect, if any, that a simultaneous storm surge during any large flows would have on river stage and discharge because of a sea level rise at the river mouth. Frequency analyses of observed storm surges and hindcast analyses of the strongest westerly storms suggest 6 feet as the 100-year storm surge. This estimate is based on surges resulting from storms that occurred only during August through October. These late summer/fall storm surges could affect the lower portions of the Delta (i.e., in the vicinity of CD-3), but this is a time when streams are at their lowest point and thus it will likely not be an issue. There are no recorded observations of strong westerly storms during the months of May and June, when the spring break-up occurs and stream flow is highest (URS Corporation 2001), but usually at this time, the sea ice is shorefast and storm surges are not an issue.

### COLVILLE RIVER SEDIMENT EROSION, TRANSPORT AND DEPOSITIONAL PROCESSES

Very little information is available regarding sediment transfer processes in the Colville River. Arnborg, et al. (1967) found that about 5.8 million tons of silt was transported down the Colville River during the hydrologic year of 1962, and about three-fourths of this total was transported during a 20-day period centered around spring break-up. The 1962 flood is considered to be equivalent to the mean annual, or approximately 2-year flood (Michael Baker, Jr. Inc. 2004b). Sediment loads during summer floods are more dependent on stage and can be relatively high because sediment sources are unfrozen and highly mobile. The highest summer suspended sediment concentration noted in the 1962 study, nevertheless, was less than half that measured during the spring break-up period (Michael Baker, Jr. Inc. 2004b).

The bulk of sediment movement and thus deposition in the lower Delta is assumed to be associated with spring break-up. High velocity springtime events flush out accumulated sediment and maintain channel depths in major channels like the Nigliq. Sedimentation during spring break-up events usually occurs in over-bank areas. It is probable that without the high springtime velocities, many of the subordinate channels in the lower Delta would fill with silt (Michael Baker, Jr. Inc. 2004b).

High break-up flood velocities keep the majority of sediment from settling out before reaching the coast. When sea ice is still intact during break-up, highly-sediment-charged floodwaters tends to flow out over the sea ice and then deposit the load on the sea ice. A portion of this sediment is deposited on the ocean's floor at the foot of the Delta, the remainder, still riding on the ice pack, is carried out to sea as summer coastal currents move the ice away from the shore. Michael Baker, Jr. Inc. (2004b) estimated that over 580,000 cy of silt is delivered to the ocean by the Nigliq Channel during a typical 20-day period centered around break-up.

Rain-induced floods, however, can combine relatively high sediment loads with lower relative velocities. These events could result in significant amounts of deposition within low relief areas such as subordinate channel mouths. Rain-induced events can thus be a significant contributor of sediment to the downstream portion and the mouth of channels like the Nigliq (Michael Baker, Jr. Inc. 2004b).

#### DELTA-WIDE BANK AND CHANNEL MIGRATION

Based on observations and measurements of bank migration within the Colville River Delta, Walker (1994) concluded that the majority of annual bank erosion within the delta occurs within a two- or three-week period during or shortly after the spring break-up flood. He found that the maximum bank erosion often occurred during the recession of the break-up flood peak. During summer when thawed banks are more susceptible rain-induced flood events also account for erosion. According to Michael Baker, Jr. Inc. (2004b), bank erosion within the Delta typically proceeds in abrupt steps, separated by long periods of apparent stability.

#### COLVILLE RIVER DELTA COASTAL PROCESSES

Although the Delta is primarily shaped by fluvial processes, its coastline is shaped by nearshore ocean currents and wind. The predominant longshore or littoral currents at the Delta mouth parallel the shore and trend strongly from east to west. Michael Baker, Jr. Inc. (2004b) reported that about 80 percent of the spring break-up sediment load is delivered to the ocean via the East Channel, however, the portion of this sediment that is entrained and moved in a westerly direction by littoral drift is unknown. It is likely that a sizable portion of the sediment that eventually ends up at the mouth of the Nigliq Channel originally came from the East Channel but was subsequently re-entrained by the sideshore currents and transported in a westerly direction.

Additionally, Michael Baker, Jr. Inc. (2004b) also noted that the Arctic coastline is becoming more active and that apparently, shore to ice distances in the Arctic Ocean as a whole have increased over the last several decades. Because pack ice retreat increases fetch, increased waves and energy impact the coast. A more active and more mobile coast results. The increased sediment transport from the East Channel toward the mouth of the Nigliq Channel via littoral drift may be one result of a more mobile coastline.

## TABLE 3.2.2-6 SUMMARY OF DISCHARGE AND WATER SURFACE ELEVATION DATA FOR FISH CREEK BASIN STREAMS

| | Fish Creek at RM 25.1 | | | Fish Creek at RM 32.4 | | | Judy Creek at RM 7.0 | | | Ublutuoch River at RM 13.7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (ft BPMSL) | Discharge (cfs) | Average Velocity (fps) |
| **2001** | | | | | | | | | | | | |
| 6/7 | 17.56 | 3110 | 1.48 | | | | | | | | | |
| 6/8 | 18.33 | 4760 | 1.88 | 20.78 | 709 | 0.76 | 26.72 | 3957 | NA | | | |
| 6/9 | 18.08 | 5185 | NA | 20.87 | 698 | 0.75 | 26.31 | 4410 | 2.90 | | | |
| 6/10 | | | | | | | | | | 17.07 | 1440 | 3.82 |
| 6/11 | 16.97 | 6050 | 2.93 | 21.67 | 2070 | 1.81 | 25.36 | 3826 | NA | | | |
| 6/12 | | | | | | | | | | 15.10 | 1170 | 3.84 |
| 6/13 | 16.14 | 4600 | 2.71 | | | | | | | 13.07 | 988 | 3.77 |
| 6/14 | | | | 21.56 | 3100 | 2.29 | | | | | | |
| 6/15 | 16.99 | 6100 | 2.95 | 22.23 | 3657 | NA | 24.44 | 2300 | 2.87 | | | |
| 6/16 | | | | 21.60 | 3120 | 2.25 | | | | | | |
| 7/17 | 10.91 | 755 | NA | 17.43 | 578 | 1.78 | 20.30 | 154 | 0.47 | | | |
| 7/18 | | | | | | | | | | 5.72 | 35.6 | 1.14 |
| 8/13 | | | | | | | | | | 5.74 | 33.9 | 1.12 |
| 8/14 | 10.18 | 511 | NA | 16.92 | 345 | 1.54 | 20.25 | 157 | 0.46 | | | |
| 9/5 | 10.25 | 511 | NA | 16.95 | 349 | 1.29 | 20.15 | 158 | 0.52 | | | |
| 9/6 | | | | | | | | | | 5.85 | 41.7 | 1.31 |

**TABLE 3.2.2-6 SUMMARY OF DISCHARGE AND WATER SURFACE ELEVATION DATA FOR FISH CREEK BASIN STREAMS (CONT'D)**

| | Fish Creek at RM 25.1 | | | Fish Creek at RM 32.4 | | | Judy Creek at RM 7.0 | | | Ublutuoch River at RM 13.7 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (feet BPMSL) | Discharge (cfs) | Average Velocity (fps) | Water Surface Elevation (ft BPMSL) | Discharge (cfs) | Average Velocity (fps) |
| **2002** | | | | | | | | | | | | |
| 5/22 | | | | | | | | | | 18.06 | 1903 | 3.21 |
| 5/23 | 16.74 | 6752 | 3.28 | 20.60 | 1584 | 1.48 | 25.60 | 5053 | NA | 16.32 | 1711 | 3.47 |
| 5/24 | 17.70 | 8575 | 3.67 | 21.15 | 1800 | NA | 26.34 | 6823 | 4.92 | 14.87 | 1416 | 3.44 |
| 5/25 | 18.22 | 8910 | 3.83 | 21.76 | 2334 | 1.68 | 26.76 | 7125 | 4.81 | | | |
| 5/26 | 18.08 | 8930 | 3.75 | | | | | | | | | |
| 5/27 | | | | 22.42 | 3703 | 2.27 | | | | | | |
| 5/28 | 16.95 | 4760 | 2.54 | 22.00 | 3110 | 2.14 | 25.05 | 1531 | NA | | | |
| 5/31 | 16.00 | 4018 | 2.29 | | | | | | | | | |

**TABLE 3.2.2-7 FLOOD PEAK DISCHARGE ESTIMATES FOR STREAMS IN THE PLAN AREA**

| Location | Drainage Area ($mi^2$) | Discharge (cfs) | | | | |
|---|---|---|---|---|---|---|
| | | 2-year | 10-year | 50-year | 100-year | 500-year |
| Colville River (Head of Delta) | 20,920 | 240,000 | 470,000 | 730,000 | 860,000 | 1,300,000 |
| Fish Creek at RM 0.7 | 1,827 | 17,500 | 32,100 | 46,700 | 53,000 | 72,000 |
| Fish Creek at RM 25.1 | 1,461 | 14,100 | 26,100 | 38,300 | 43,600 | 59,800 |
| Fish Creek at RM 32.4 | 783 | 7,700 | 14,700 | 22,100 | 25,400 | 35,900 |
| Judy Creek at RM 7.0 | 647 | 6,400 | 12,300 | 18,600 | 21,500 | 30,500 |
| Judy Creek at RM 13.8 | 593 | 5,800 | 11,400 | 17,300 | 19,900 | 28,400 |
| Ublutuoch River at RM 8.0 | 233 | 2,400 | 4,800 | 7,600 | 8,900 | 13,100 |
| Ublutuoch River at RM 13.7 | 222 | 2,200 | 4,600 | 7,200 | 8,500 | 12,600 |

Sources: Michael Baker Jr. Inc. 2002c and URS Corporation 2003
Note: The error estimate of discharge is ±10%.

### CHANNEL BED AND STREAM BANK STABILITY FOR FISH CREEK BASIN STREAMS

Observations of bed conditions on the Fish Creek basin streams suggest that bed load transport can be significant and the bed channel forms might not be stable under normal high-flow conditions. URS Corporation (2001, 2003) recently conducted studies of bed load transport and the stability of the beds of the Fish Creek basin streams. Bed load was measured twice during 2002 break-up season only on Fish Creek (RM 25.1). It was estimated that 351 and 423 tons per day (tpd) were transported on May 25 and May 26, 2002, respectively, during a flow of approximately 8,900 cfs (the approximate peak flow of 2002).

During break-up 2001, URS Corporation collected samples of the bed material on Fish Creek, Judy Creek, and the Ublutuoch River. These data are summarized in Table 3.2.2-8. In general, the bed material in Fish and Judy Creeks is more fine-grained and more mobile than in the Ublutuoch River. As an example, the unstable bed conditions of two gaging station locations along Fish Creek (at RMs 25.1 and 32.4) are shown by Figures 3.2.2.1-10 and 3.2.2.1-11. The figures indicate that while the channel width remained the same, during break-up between June 8 and June 14, 2001, the Fish Creek bed was scoured up to 7 feet in certain sections of the channel and it aggraded up to 2 feet in other sections. In contrast, very little bed change was measured on the Ublutuoch River at RM 13.7. In fact, during the time of the peak water surface elevation and peak discharge on the Ublutuoch River, the water was flowing on snow and bottomfast ice within the channel.

**TABLE 3.2.2-8 BED MATERIAL ON FISH CREEK, JUDY CREEK, AND THE UBLUTUOCH RIVER**

| Stream Course | River Mile | Bed Material | D50[1] (feet) | Riverbed Elevation Change During Break-Up (feet) | |
|---|---|---|---|---|---|
| | | | | 2001 | 2002 |
| Fish Creek | 25.1<br>32.4 | sand with some silt | 0.00041<br>0.00012 | 5 to 7 | 1 to 3 |
| Judy Creek | 7.0 | sand with some silt | 0.00057 | 5 | 2 |
| Ublutuoch River | 13.7 | gravel with some sand | 0.02300 | not mobile | not mobile |

Source: URS Corporation 2003
Notes: [1]D50 is the median grain size of the bed material.

## ICE CONDITIONS

### FREEZE-UP AND WINTER CONDITIONS ON RIVERS, THE COLVILLE RIVER DELTA, AND HARRISON BAY

From November through May or June, 90 to 100 percent of the Beaufort Sea is covered with sea ice (MMS 1996). The formation of sea ice may start as early as September or as late as December. During the first part of freeze-up, near-shore ice is susceptible to movement and deformation by modest winds and currents. Movement could be a mile or more per day, and deformation could take the form of ice pile-ups and ride-ups on beaches and the formation of offshore rubble fields and small ridges. Ice ride-ups occur when a whole ice sheet slides in a relatively unbroken manner over the ground. Ride-ups larger than 160 feet are not very frequent. By late winter, first-year sea ice is approximately 6 to 7 feet-thick. In waters 6 to 7 feet-thick, the ice is frozen to the seafloor and forms the bottom-fast-ice subzone of the land-fast-ice zone. The land-fast-ice zone could extend from the shore out to depths of 45 to 60 feet. The ice, in water depths greater than approximately 6 to –7 feet, is floating and forms the floating fast-ice subzone (consisting of floating ice unattached to land). As the winter progresses, extensive deformation within the land-fast-ice zone generally decreases as the ice thickens and strengthens and becomes more resistant to deformation (BLM and MMR 1998a).

Seaward of the land-fast-ice zone is the stamuhki, or shear, zone. This zone is a region of dynamic interaction between the relatively stable ice of the land-fast-ice zone and the mobile arctic pack ice. This interaction results from the formation of ridges and leads—or areas of open-water. The plowing action of drifting ice masses could cut linear depressions, or ice gouges, into the seafloor sediments. The dominant orientation of these gouges generally is parallel to the coast. In the Beaufort Sea, the region of most intense ridging and gouging occurs in water depths of approximately 50 to 100 feet. In water depths of less than 30 feet, the maximum gouge depths generally are less than 1 foot (Weeks et al. 1984). Ridges with keels deep enough to become grounded help to stabilize the land-fast ice.

### BREAK-UP ON HARRISON BAY AND THE BEAUFORT SEA

Along the Beaufort Sea coast, break-up generally begins approximately mid-July but could occur in mid-June or late August (MMS 1996). River ice begins to melt before sea ice and, during the early stages of break-up, water from rivers could temporarily flood ice that has formed on deltas. The floodwater will drain through openings in the ice, and the force of the water could be great enough to scour depressions on the seafloor—these depressions are called strudel scours. As break-up proceeds, there is an increase in open-water areas as the ice moves farther offshore. During the summer and fall, shifting winds and currents can move the pack ice toward or away from the coast. In some years, the pack ice could remain along or very near the coast. Movement of the pack ice along the coast could cause some individual pieces to become grounded in shallow waters, where they could remain for the summer.

### IMPACT OF ICE ON FLOODING DURING BREAK-UP

#### Colville River Delta

Ice jams in the Colville River and Delta channels have been observed to cause significant flooding on the Delta during spring breakup periods of low to moderate discharge (Walker, 1983; Michael Baker, 2004d). Ice jams form during the early spring period of thaw and are composed of fragmented ice formed by the breakup of an upstream ice sheet. The ice cover is broken during a rapid rise in river discharge associated with snowmelt runoff that accompanies increased air temperatures, solar radiation and sometimes rain on snow events (USCOE, 2002). An ice jam is a stationary accumulation of ice that restricts flow in a river. The flow restriction may cause significant increases in water levels upstream of the jam, and significant decreases in flow and water levels downstream of the jam (White and Zufelt, 1974). Two kinds of ice jams can form along a river reach: the simple ice jam and the dry ice jam (Michel, 1971). The simple ice jam is common on the Delta and occurs when ice floes accumulate in front of a solid ice cover. Typically, the ice jam is of uniform shape and water flows freely (but under pressure) under the accumulated ice. Due to the jam's characteristic static manner, it produces a regular increase in water level along its length. The jam is destroyed when the rate of increase of river discharge exceeds a particular threshold or by the impact of further oncoming ice floes.

The dry ice jam, less commonly observed on the Delta but still an imporant condition, is formed by the jamming of ice floes at an obstacle which may be an existing ice accumulation or irregularity in river channel width, depth, slope and/or curvature. In this case, the ice jam completely blocks the whole flow section down to the river bottom. The water has to flow by infiltration through the ice plug which results in rapid upstream increases in water level. The jam is unstable and moves out when the upstream water level increases above a threshold (Michel, 1971).

The main factors affecting ice jam formation are the previous winter conditions, the shape and size of the breakup discharge and relative positions of fluvial transitions and hydraulic features (Michel, 1971). Ice jams are typically characterized by broken, fragmented ice pieces that begin at a river channel location where the volume of ice transported to the location exceeds the ice transport capacity. Once the ice pieces reach a jam initiation point, the ice fragments cease moving, begin accumulating and form an ice jam. The maximum size of an ice jam depends on flow conditions, available ice supply, the strength and size of ice pieces (USCOE, 2002) and the hydraulic geometries of the ice jam location (Michel, 1971).

The maximum extent of the effects of ice jams is largely controlled by the physiography of the river channel, floodplain and valley. Ice jams that form in relatively moderate to steep gradient rivers confined by valleys can result in large water-level rises that flood the immediate areas. Some of these can be severe; for example, the Yukon river rose 65 ft in the spring of 1930 to flood the village of Ruby (Henry, 1965). Water level rises of 20 ft or more are common when an ice jam is formed. In contrast, ice jams that form in relatively gentle unconfined terrain, like the Colville River Delta, can result in restricted (governed by Delta relief and channel geometry as opposed to the height of valley walls) water-level rises but with widespread inundation.

In 1966, although no measurements of discharge or water surface elevations were recorded at the time, an ice jam in the vicinity of the Putu Channel (near the present location of Nuiqsut) caused water to flow over the bank for up to 4 miles east of the East Channel. Also at this time, ice floes were deposited up to 1 mile east of the East Channel (PAI 2002).

Observations of ice jams on the Colville River indicate that they are composed of large chunks and flows to small pieces. Ice jams with larger pieces tend to be more common during the early stages of breakup. Less often a jam is composed of a single large floe, but when they do occur can cause signficant changes . During spring breakup 2004, a large single floe (over 5,000 ft long by 1,250 ft wide) was wedged diagonally across the entrance to the East Channel of the Delta, extending across the entire width of the channel under water. The ice-jam blockage caused a higher than normal proportion of water to flow into the Nigliq Channel (Michael Baker, 2004d). During breakup 1981, a very large floe was carried from the main channel near the Itkillik River just upstream of the head of the Delta into the entrance to the Nigliq Channel. The wedged floe was anchored to the right bank on peat and to the left bank on sand dunes. The ice jam was sufficient to divert most of the Nigliq Channel water back to the east through the Putu Channel and back into the main East Channel (Walker, 1982).

In support of oilfield development activities, systematic and continuous qualitative monitoring of ice conditions and ice jams on the Delta during spring breakup began in 1998 (Michael Baker, 2004d). The ice monitoring programs have included aerial and ground-based observations and photography. Daily aerial surveys have become a principal component of the programs. The daily surveys are begun as soon as floodwaters are present and continue until all floating ice has moved out of the channel. Daily observations of the status of ice in the various major channels, the locations of ice jams and the presence or lack of ice-related flow alterations (i.e., overbank flooding or backwater effects) are recorded. When taken in summary over the past seven years, the surveys provide very useful information regarding typical ice behavior and ice jamming trends (i.e., frequency at a location, typical area of effect) on the Delta.

Based on data and information from ice monitoring studies conducted in 1981 (Walker, 1982), 1993 (Shannon & Wilson, 1993) and the 1998-2004 ice survey programs described above, Michael Baker (2004d) prepared a table summarizing the locations of ice jam observations including a provisional frequency of occurrence rating (Table 3.2.2-9) and a map depicting ice-jam prone locations on the Colville Delta (Figure 3.2.2.1-12). They caution that only generalized conclusions should be made due to: 1) the limited data base, 2) ice surveys were not identical from year to year (i.e., due to variations in weather, flight patterns, program interests, and the steady improvement of ice survey techniques), and 3) the subjective (qualitative) nature of the surveys. Further, much of the available data does not support differentiating between minor or major jams or the effects of these jams. Nevertheless, the data and information in Table 3.2.2-9 and Figure 3.2.2.1-12 provide a useful framework to identify potential ice jam locations and to help address possible impacts associated with ice jamming. The table and figure indicate that over the period 1998-2004, when there were at least seven years of observations, ice jams were observed at least four of those years at five locations:

- just upstream of the head of the Delta at the mouth of the Itkillik River,
- at the meander bend in the Nigliq Channel just upstream of Nuiqsut,
- in the Putu Channel,
- at the entrance to the Sakoonang Channel, and
- in the Sakoonang Channel between the entrance and the Alpine facilities.

Two other locations also appear prone to ice jams (3 of 7 years): the entrance to the East Channel and the Nigliq Channel at the CD-4 location.

#### Fish Creek Basin Streams

In Fish and Judy Creeks, observations made during the 2001 spring break-up indicate that snow and ice influence the shape and size of the channel cross-section, cause ice jams, and affect hydraulic roughness. As a result, discharge at the outset of spring break-up can result in higher water surface elevations than similar discharges later in the summer. Likewise, backwater elevations are usually greatest when water first begins to flow over snow (at the outset of spring break-up) and decrease with time and increased discharge. For example, in Fish Creek at RM 25.1 on June 7, 2001, the water surface elevation was approximately 3.7 feet higher than it would have been at a similar discharge during the summer. On June 8, 9 and 10, the differences were approximately 2.1, 1.9, and 0.8 feet, respectively. By June 11, the observed water surface elevation was equal to that which would be expected during a similar discharge later in the summer. Similar observations were made at other Fish Creek and Judy Creek locations (URS Corporation 2001).

In general, for Fish and Judy Creeks peak discharge usually lags peak water surface elevation by 1 to 3 days during break-up. While it is not uncommon for water surface elevations to drop as discharges increase during break-up, water surface elevations will increase without a corresponding increase in discharge during ice jams. It is also noteworthy that channel snow and ice affect peak water surface elevation more frequently than peak discharge. In general, channel snow and ice do not affect channel discharge unless there is a damming effect. The key point is that the peak discharge usually follows the peak water surface elevation rather than being coincident.

**TABLE 3.2.2-9 ICE JAM LOCATION SUMMARY, COLVILLE RIVER DELTA 1981, 1993, 1998-2004**

| Observation Location | | 1981 | 1993 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Upper Colville River** | | | | | | | | | | | | |
| | Ocean Point | n | n | | | | | | x | x | 2 | 29% |
| | Mouth of Itkillik River | n | n | | | x | | x | x | x | 4 | 57% |
| | Monument 1 | n | n | x | | | | | | | 1 | 12% |
| | Entrance to East Channel | n | n | x | | | x | | | x | 3 | 43% |
| | Entrance to Nigliq Channel | x | n | | | | | | | | 1 | 14% |
| **Nigliq Channel** | | | | | | | | | | | | |
| | Meander Bend just upstream of Nuiqsut | n | x | | x | x | x | x | x | x | 7 | 88% |
| | Nigliq Slough | n | n | | | x | | x | | | 2 | 29% |
| | At approximate location of CD-4 | n | n | | | | x | x | x | | 3 | 43% |
| | In vicinity of proposed bridge crossing | n | n | | | x | | | | | 1 | 14% |
| | Channel reach downstream of proposed bridge | n | n | | | | | | | | 0 | 0% |
| **East Channel** | | | | | | | | | | | | |
| | Putu Channel | n | n | | x | x | x | x | x | | 5 | 71% |
| | At Colville-Kachemach confluence | n | x | | | | | | | | 1 | 13% |
| | At Helmericks – Colville Village | n | n | | | | | x | n | n | 1 | 20% |
| **Sakoonang Channel** | | | | | | | | | | | | |
| | Entrance to Sakoonang Channel | n | n | x | x | | x | | | x | 4 | 57% |
| | Between entrance and Alpine | n | n | | x | x | x | x | | | 4 | 57% |
| | Channel reach downstream of Alpine | n | n | | | | | | | | 0 | 0% |
| **Tamayayak/Ulamnigiaq Channels** | | | | | | | | | | | | |
| | Entrance to Tamayayak Channel | n | n | n | n | x | x | | n | n | 2 | 67% |
| | In Tamayayak Channel | n | n | n | n | | x | | n | n | 1 | 33% |
| | In West Ulamnnigiaq at proposed CD-3 location | n | n | n | n | | | | n | n | | 0% |
| | In West Ulamnnigiaq downstream of proposed CD-3 location | n | n | n | n | | | | n | n | | 0% |

Source: Michael Baker, 2004d

Notes: % = the percentages shown represent the proportion of times ice jams were observed relative to the toal observations for each observation location.

For the Ublutuoch River, snow and ice conditions were much different than for Fish and Judy Creeks at the beginning of the 2001 break-up. The Ublutuoch River Channel was entirely blocked by snow and ice at RM 13.7. From the start of flow until June 21, the water gradually cut through the snow and ice until it reached the permanent channel bed. During this time, the snow and ice had a dramatic impact on the channel hydraulics. The shape, size, and elevation of the channel cross-section, the hydraulic roughness, and the energy slope were all affected by the snow and ice. The most significant effect was the change in the elevation of the riverbed. During the period that snow and ice affected the water surface elevation, the riverbed was physically higher than it was during the summer. The peak water surface elevation and discharge occurred sometime between June 9 and 10. At that time, flow was being conveyed on snow, approximately 8.4 feet above the permanent riverbed. As a result, the peak water surface elevation was dramatically higher than it would have been if the same discharge would have occurred during summer (URS Corporation 2001).

#### 3.2.2.2 Surface Water Quality

No marine or fresh water in the Plan Area is impaired by pollutants, according to the ADEC. Therefore, no actual or imminent persistent exceedances of water quality criteria or adverse impacts to designated uses, as defined in the state's water quality standards, has been documented. Water chemistry in lakes and ponds in the Plan Area is highly variable and dependent on the distance from the Beaufort Sea, frequency of flooding, and whether the lakes and ponds are tapped (connected to river channels most of the year) or perched (isolated from rivers channels most of the year) (CPAI 2002). Most freshwater bodies in the Plan Area are soft, dilute calcium-bicarbonate waters. Near the coast, however, sodium chloride (salt) concentrations are more common than bicarbonate concentrations (BLM 1998). Water bodies close to the Beaufort Sea are saline from storm surges and sea spray. As storm surges push seawater up the Colville River channels, fresh water in tapped lakes mixes with saltwater. Average salinity measurements are typically highest in river channels [12.5 part per thousand (ppt)], intermediate in tapped lakes (7.2 ppt), and lowest in perched lakes (1.0 ppt) (Moulton 1993b). The differences in salinity correspond with varying concentrations of dissolved minerals.

Winter freeze and summer recharge cycles cause contrasting effects in water quality. In winter, surface waters less than 6 feet deep on the North Slope generally freeze solid, but water bodies as shallow as 5 feet deep in the Colville River Delta may remain partially unfrozen. During winter freezing, major ions (i.e., calcium, magnesium, sodium, potassium, hardness, alkalinity, chloride, sulfate and nitrate) and other impurities are excluded from downward-freezing ice and forced into the underlying sediment. Spring snowmelt and resulting water flow across the surface of the ice removes the cover from lakes, allowing the wind to mix the water column throughout the summer. Recharge of lakes through sheet flow during spring counteracts the effects of water loss and ion concentration caused by evaporation in the summer. The net result of the input of snowmelt waters and spring sheet flow in deeper lakes is to preserve their existing water chemistry.

##### TURBIDITY

Turbidity, or a measure of water clarity, varies seasonally in the Plan Area with the transport of sediment by the Colville River during flooding. Most fresh waters have low suspended-solid concentrations and, therefore, low turbidity for the majority of the year. Later in summer, suspended-sediment concentrations in the Colville River decrease to as low as 3 ppm (BLM 1998). During spring break-up, the Colville River carries suspended sediment from the foothills of the Brooks Range, and has a higher turbidity than any of the smaller rivers originating within the Arctic Coastal Plain. Most of the annual sediment load is carried between May and October, with approximately 75 percent flowing to the Delta in early summer (May and June) from the beginning of break-up to the end of break-up flooding (ARCO Alaska Inc. 1997). Extrapolation of 1977 water quality sample results for suspended solids shows that sediment transport ranged from 438,000 tpd in June, to a few hundred tpd during the low-flow period in July (USGS 2003).

##### ALKALINITY AND PH

Alkalinity and pH are important parameters in controlling the susceptibility of fresh waters to acid rain or acid snowmelt. Sulfur dioxide ($SO_2$) and nitrogen oxides ($NO_x$) in the atmosphere, which come from electric power generation that relies on burning fossil fuels like coal, are the primary causes of acid rain. The strength of the effects of acid rain depend on many factors, including how acidic the water is, and the chemistry and buffering capacity of the soils involved. Alkalinity is a measure of the acid-buffering capacity of the water. The pH is a measure of how acid the water is. A pH of 7 indicates a neutral balance of acid and base; a pH below 7 indicates acid water. The State of Alaska considers a pH range within 6.5 to 8.5 necessary to protect aquatic wildlife (ADEC 2002).

Fresh waters in Alaskan coastal tundra are only weakly buffered (BLM 1998). In ponds, alkalinities during snowmelt are about twofold lower than the midsummer alkalinities of 20 milligrams per liter (mg/L) as lcalcium carbonate ($CaCO_3$). Lake alkalinities also are low, on the order of 25 mg/L as $CaCO_3$. Alkalinities in individual coastal rivers of the Colville River Delta are higher, ranging between lows of 15 to 20 and highs of 65 to 80 mg/L as $CaCO_3$ in summer and reaching even greater alkalinity values at lower flow rates. Winter alkalinities in unfrozen pools are on the order of 150 to 200 mg/L as $CaCO_3$.

In ponds, pHs are depressed to below pH 7 as snowmelt runoff enters them. The pond pHs then rapidly increase to between 7 and 7.5 after snowmelt (Prentki et al. 1980). The initial low pH is due to acidity of snow on the North Slope, which has a median pH of 4.9 (Sloan 1987). This low pH, which is below the pH 5.5 expected for uncontaminated precipitation, is thought to be a result of sulfate fallout from arctic air masses industrially contaminated from pollution sources in Eurasia (BLM 1998). In lakes, pHs are near neutral, about pH 7 (O'Brien et al. 1995). In tundra brown-water streams (so called because of the color caused by tannins) and some foothill streams, pHs can be lower because of the presence of naturally occurring organic acids. In tundra lakes, creeks, and rivers of the Colville River system, pHs are higher, seasonally ranging between 6.5 and 8.5 (Kogl 1971).

### OXYGEN

The measurement of dissolved oxygen refers to the amount of gaseous oxygen dissolved in the water. Two measurements are typically provided for dissolved oxygen levels: the absolute concentration in mg/L [or parts per million (ppm)] and the percent of saturation. The concentration of oxygen required to reach a level of 100 percent saturation varies according to pressure, temperature, and salinity. The absolute concentration of dissolved oxygen in arctic waters tends to be higher than in other waters because the solubility of oxygen increases with decreasing water temperature. This generality applies to clear-water streams and clear-water (larger) lakes within the Plan Area. Summer concentrations of dissolved oxygen in Colville River system lakes, creek, and rivers range from 8 to 12 mg/L by weight (Kogl 1971).

Colored-water streams, ponds, and lakes in the Arctic, however, generally have lower dissolved oxygen concentrations. Oxygen-saturation values in Plan Area ponds during the summer months generally fall below 100 percent, although a range between 60 and 118 percent has been observed (Prentki et al. 1980). Oxygen values can be much lower (less than 10 percent saturation) in vegetated shorelines or in water pooled on wet tundra (BLM 1998). In these locations, chemical processes in the underlying sediment deplete oxygen from the water as rapidly as the water can take up oxygen from the air.

In winter, in deeper lakes of the Arctic Coastal Plain, waters remaining beneath the ice tend to become supersaturated with oxygen (Prentki et al. 1980, O'Brien et al. 1995). During ice formation, dissolved oxygen is excluded from the freezing ice into the water column. Exclusion adds more oxygen than underwater respiration by benthic organisms removes. In general, however, the occurrence of supersaturated dissolved oxygen concentrations is less common in Plan Area lakes than a decreasing oxygen concentration. Decreasing oxygen concentrations are more likely because the two primary sources of dissolved oxygen, mixing of waters with air and photosynthesis by aquatic vegetation, do not occur in the winter due to inhibiting effects of ice cover and darkness.

The winter oxygen regime typically decreases in lakes where such factors as bathymetry can inhibit mixing. For example, in Lakes M9906, M9913, M9907, and M9915 near CD-1, the dissolved oxygen concentration decreased throughout the winter (URS Corporation 2001). The amount of oxygen that can be held by the water is a function of temperature, salinity, and pressure (gas solubility). Gas solubility decreases with increasing salinity and conductivity and with decreasing pressure. During monitoring in 2001, there was a notable decrease in dissolved oxygen between February and March (levels dropped to less than 1 mg/L in all four lakes), when the most significant increase in ice thickness and corresponding increase in conductivity occurred. Additional monitoring of permitted water withdrawal lakes, conducted in 2003, showed pockets of dissolved oxygen concentrations. Reductions in oxygen concentrations did not appear to inhibit survival of least cisco fish as shown by the recapture of a tagged cisco the following summer (Moulton 2003).

Late winter measurements of oxygen in unfrozen pools in smaller rivers indicate significant residual oxygen (9 mg/L) and 70 to 99 percent saturation (BLM 1998). The Colville River, with deep, connected channels in its delta, also maintains adequate (for fish utilization) to supersaturated winter oxygen concentrations (USGS 2003).

### POTABILITY

Potable water is defined as fresh water free from micro-organisms, parasites, and any other substances at a concentration sufficient to present a potential danger to human health. The primary source of potable water for the Plan Area would be surface water. Treatment according to State of Alaska Drinking Water Regulations, 18 AAC 80, is required for any potable drinking water system. Secondary standards provide specific parameters that define contaminant concentrations which must not be exceeded. Additionally, water must have a generally agreeable taste and odor to be considered potable.

Surface water bodies in the Plan Area generally do not meet potable water standards without treatment. Ponds and local streams are highly-colored from dissolved organic matter and iron (BLM 1998). The ADEC Division of Environmental Health advises that surface waters in Alaska are likely to be contaminated with intestinal wastes from birds, animals, and man, and should be treated before consumption (ADEC 2003). Fecal contamination from avian, caribou, and lemming populations is the primary source of water quality reduction below drinking water standards for fecal coliform in small water bodies in the Plan Area (BLM 1998). Larger lakes and rivers with higher water volumes tend to be less contaminated with fecal coliform; however, fecal contamination may occur locally in areas surrounding long-term campsites and cabins because of inadequate sewage disposal. Low concentrations of fecal coliform colonies were detected in less than 5 percent of discrete water quality samples taken in the Colville River near Umiat and Nuiqsut from 1953 through 1981; no fecal coliform was detected in the remaining samples (USGS 2003).

### SOURCES OF OIL AND HYDROCARBONS IN THE NATIONAL PETROLEUM RESERVE-ALASKA

Naturally occurring surface oil seeps are well documented on the North Slope. There are several known seeps in the Plan Area (BLM 1998), including those at Oil Lake and Fish Creek. The peat that underlies the North Slope carries substantial hydrocarbon content. This content is evidenced by: natural sheens that occur in ponds or flooded footprints in the tundra or in the foam on the downwind shoreline of lakes on windy days, and elevated hydrocarbon levels in sediments with peat. These phenomena result from the naturally occurring oil seeps and are not the result of industrial activities. The Colville River drainage includes coal and oil-shale outcrops, the oil seeps, and peat. An oil seep at Umiat along the Colville River led to Navy exploration at that site in 1944 (USGS 2001). The North Slope has reserves of Bituminous and Subbituminous coalthat could be developed in the foreseeable future; however, analyses by the DOE’s Energy Information Administration, indicate this is unlikely due to accessibility and recovery factor constraints (DOE 1999).

### TRACE METALS

Pond, lake, and river waters on the North Slope are, in general, low in trace metals compared to most temperate-zone fresh waters (Prentki et al. 1980). However, the water quality conditions of the Colville River do not always meet water quality criteria set by the ADEC. Naturally occurring copper, zinc, cadmium, and lead have commonly been found at concentrations above the criteria established to protect aquatic life from toxic effects (ADEC 2002, USGS 2003). These metals come from the soils in the undeveloped watershed. The variations in water quality are part of the natural environment for fish and wildlife in the Colville River Delta and do not result from man-made disturbances (USACE 1998).

### ORGANIC NUTRIENTS

The primary nutrients required for algae productivity and availability of food for fish are nitrogen and phosphorus. The nutrient regimes of the freshwater and marine environments reflect and respond to seasonal climatic extremes (Schell 1975). In the summer, relatively high concentrations of nutrients exist in the Colville River until the water reaches Harrison Bay, where phytoplankton communities consume most of the nitrate. Nitrogen concentrations are generally higher in the spring than in the fall because freezing concentrates nutrients in the water bodies. Another source of organic nutrients is regeneration of ammonia (a preferable source of nitrogen compared to dissolved organic nitrogen) through the conversion of dissolved organic nitrogen by heterotrophs under the winter ice (Schell no date).

Although low concentrations of nitrogen are the limiting factor in phytoplankton productivity in coastal marine water, fresh water in the rivers is primarily phosphate limited. Even though the Colville River is able to support an abundant fishery, phosphate concentrations in freshwater bodies are generally very low (Schell 1975). In the seawater, however, phosphate concentrations are usually higher.

Nutrient levels in lakes and ponds are much lower than in the Colville River. Samples taken in 1971 had nitrate and nitrite concentrations that were almost undetectable in lake and pond water (Alexander et al. 1975). Phosphate concentrations were also much lower in lakes and ponds than in the Colville River.

## ESTUARINE WATER QUALITY

Many small bays along the coastline within the Plan Area appear to be old thaw-lakes that have since connected with the Beaufort Sea. The Kogru River is an example of a coastal area where thaw-lakes apparently have joined together to form a bay about 18 miles-long. Water quality in these estuarine waters changes seasonally because of ice cover, wind-driven mixing and storm surges, and fresh water drainage during spring break-up.

### SALINITY

The basic characteristics of the bays and coastal waters are summarized in reports by Barnes, Schell, and Reimnitz (1984) and in reports for the Outer Continental Shelf Environmental Assessment Program (OCSEAP)(USDOC, NOAA, 1978, 1984, 1987, 1988). These reports explain that all of the National Petroleum Reserve-Alaska bays and lagoons are very shallow, and all are shoreward of the 10-meter isobath (line of equal bathymetry or water depth). The circulation in this shallow water during the summer is wind-driven and rapid. Circulation is very slow under the winter ice cover. Summer values of salinity in Harrison Bay and Simpson Lagoon vary in the wide range of 10 to 6 ppt, dropping rapidly to fresh water as the river channels in the Delta are approached (Schell et al. 1971).

As the flow from the Colville River decreases in early fall and storm surges associated with westerly winds occur, fresh water left in the Delta channels from the summer flow is gradually replaced by seawater (Schell et al. 1971). The denser salt water flows inward along the channel bottom with accompanying outflow of fresh water into Harrison Bay on the surface. The principal result of the saltwater intrusion is to create isolated marine environments in separate channels. Historically, marine water intrusion has occurred during winter with salt water reaching as far upstream as Ocean Point; however, recent measurements upstream in the Colville River reveal that this phenomenon does not occur every year. Storm surges are more important in the water exchange process during the summer, because although this is a tidally influenced area, lunar tides along the North Slope are very small, averaging 20 to 30 centimeters (8 to12 inches) (Norton and Weller 1984, Selkregg et al. 1975). In the winter however, ice restricts water movement from storm surges, and lunar tides have a larger effect.

### TURBIDITY

The rivers on the North Slope of Alaska are partly or wholly frozen for 6 to 9 months of the year, with the result that almost all of the yearly flow is restricted to short spring and summer periods. The great seasonality of the water and suspended sediment flow regimes is reflected in the fact that 43 percent of the annual flow and 73 percent of the total inorganic suspended load of the Colville River were discharged during a 3-week period at spring break-up (late May to early June) (Telang et al. 2003). Suspended-sediment samples taken along the Colville River in 1970 showed an increase in suspended load and percent sand and mud as the flow gradient of the river decreases abruptly at the mouth of the Nigliq Channel. This sharp decrease is indicative of a high rate of sediment deposition within the Delta (Dygas et al. 1971).

### MARINE WATER QUALITY

#### SALINITY

When seawater freezes, only the water molecules form ice; the salt is cast-off as brine into the underlying water column. The brine does not drain or flush out of the shallow bays; instead, it collects on the sea floor, gradually raising the salinity level from 32 to more than 100 ppt in some seafloor depressions (Schell 1975, Newbury 1983). Where the access to open seawater is relatively unrestricted, the circulation of less saline water into the bay and the draining of hypersaline water from shallow, near-shore, under-ice waters is quite rapid. A combination of tidal pumping and density currents accounts for the rapid exchange rate (Schell 1975).

#### TURBIDITY

Turbidity values in the near-shore Beaufort Sea are dependent on wind- and wave-induced turbulence that resuspends bottom sediment and material discharge from the Kuparuk and Colville Rivers. Therefore, in the winter, under-ice turbidity of marine waters is at its lowest outside the area of ice gouging and strudel scours, a phenomenon that could resuspend bottom sediment. The highest turbidity values are found during spring break-up and periods of heavy precipitation when river discharge is high, resulting in turbid plumes that are discharged into the near-shore coastal waters. The farther offshore, the less influence will be felt on turbidity values from coastal erosion and the Colville River discharge of sediment. Suspended sediment concentrations in the near-shore waters may range from 30 to more than 300 mg/L (MMS 2002). In the winter, suspended-sediment concentrations may range from about 2 to 70 mg/L.

## 3.2.3 Atmospheric Environment

### 3.2.3.1 Climate and Meteorology

The Plan Area is within the Arctic Coastal Zone, the northernmost of three climatactic zones on the North Slope. Winters (typically October through April) are long and cold and summers (typically May through September) are short and cool. The climate is one of the harshest environments in North America, where snow might fall even in August. The average daily temperature falls below freezing more than 200 days per year in Nuiqsut. In the Plan Area, the temperatures are warmer than those farther inland on the North Slope; with less precipitation consisting predominantly of snow, although the maximum precipitation is in August. Snow cover has a large seasonal cycle and varies substantially from year to year. Seasonal snow cover on the North Slope can begin in late September to early October and might not disappear until May through mid-June. Interannual variations in the timing of snowmelt are due to variations in polar and arctic weather patterns and associated winds. Climatic conditions for the three climate zones on the North Slope are shown in Table 3.2.3-1.

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures is presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). Data was collected at the Nuiqsut ambient air quality monitoring station for the period April 1999 through March 2003. It shows the annual mean temperature is approximately 12 degrees Fahrenheit (°F) in the Plan Area. A temperature climate summary for the Plan Area is provided in Table 3.2.3-2. Temperatures on the North Slope are typically below freezing from mid-October into May. Heavy construction work and oil exploration are conducted in many areas in winter because both the ground and the streams are frozen hard enough to allow the use of heavy equipment. February is the coldest month, with an average temperature of approximately -16°F. July is the warmest month, with an average temperature of 47°F.

Average snow depth from January through April is 10 inches in Barrow and 15 inches in Umiat, which is in the foothills. The USGS collected snow data in the National Petroleum Reserve-Alaska from 1977 to 1979 and from 1982 to 1983. Snow depths ranged from 0.85 to 1.4 feet during this period of record. Annual average snow depths at several monitoring stations on the coastal North Slope are shown in Table 3.2.3-3, along with other climatological data for the region. It shows snowfall is greatest in October in the Arctic Zone but can occur during any month of the year.

**TABLE 3.2.3-1 CLIMATIC CONDITIONS IN ALASKA NORTH OF THE BROOKS RANGE**

| | Arctic Foothills | Arctic Inland | Arctic Coast |
|---|---|---|---|
| Distance to the ocean (miles) | 93–186 | 93–124 | <12 |
| Elevation (feet) | 984–3,281 | 164–1,312 | <164 |
| **Air Temperature (°F)** | | | |
| Mean annual | 16.5 | 9.7 ±0.7 | 9.7 ±0.7 |
| **Degree-Day (°F-day)** | | | |
| Freeze | 7,232 | 9,572 | 8,906 |
| Thaw | 1,472 | 1,706 | 788 |
| **Precipitation (inches)** | | | |
| Snow | 6.1 | 5.0 | 4.5 |
| Rain | 6.6 | 4.1 | 3.4 |
| Annual total | 12.8 | 9.0 | 7.8 |
| **Seasonal Snow Cover** | | | |
| Average starting date | 27 Sep. | 1 Oct. | 27 Sep. |
| Range | 11 Sep. to 15 Oct. | 19 Sep. to 12 Oct. | 4 Sep. to 14 Oct. |
| Average duration (days) | 243 | 236 | 259 |
| Range (extreme) | 226 to 261 | 198 to 260 | 212 to 288 |
| Average maximum thickness (inches) | - | 16.9 | 12.6 |
| Range (extreme) | - | 28 to 70 | 10 to 83 |
| **Thaw season** | | | |
| Average starting time | 28 May | 25 May | 6 Jun. |
| Range (extreme) | 18 May to 15 Jun. | 28 Apr. to 6 Jun. | 26 May to 19 Jun. |
| Average length (days) | 122 | 129 | 106 |
| Range (extreme) | 104 to 139 | 105 to 167 | 77 to 153 |

Source: BLM 1998

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures is presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). Data was collected at the Nuiqsut ambient air quality monitoring station for the period April 1999 through March 2003. It shows the annual mean temperature is approximately 12°F in the Plan Area. A temperature climate summary for the Plan Area is provided in Table 3.2.3-2. Temperatures on the North Slope are typically below freezing from mid-October into May. Heavy construction work and oil exploration are conducted in many areas in winter because both the ground and the streams are frozen hard enough to allow the use of heavy equipment. February is the coldest month, with an average temperature of approximately -16°F. July is the warmest month, with an average temperature of 47°F.

Prevailing northeasterly winds are strongest during winter, often creating blizzard conditions. Southwesterly winds occasionally break this pattern with penetration of mid-latitude storms into the region. The annual mean wind speed is approximately 12.8 miles per hour(mph) (see Table 3.2.3-3). Nuiqsut exhibits a strong bimodal wind direction distribution dominated by northeasterly through easterly directions approximately 45 percent of the time and south–southwesterly through westerly directions the remainder of the time (SECOR International Inc. 2003). Recent quarterly data collected at the Nuiqsut Ambient Air Quality Monitoring Station show a mean 10-meter wind speed of 11.4 mph and a maximum hourly average wind speed of 32.4 mph.

Plume dispersion and diffusion in general is a function of turbulence in the near-surface layer of the atmosphere. When the lower atmosphere is in thermal equilibrium (that is, warmer air on top, colder air on the bottom) and wind speeds are low, there is less plume dispersion and conditions are termed “stable.” When wind speeds are higher, like those in the Plan Area, conditions are more neutral, and plume dispersion improves. With increased surface heating from the sun, dispersion characteristics shift to an unstable pattern because heated air near the ground rises and turns the lower atmosphere over, thereby inducing additional mixing. Table 3.2.3-4 summarizes the frequency distribution of stability class for the Plan Area. As expected, the table shows the Plan Area is dominated by neutral stability conditions and good plume dispersion. The upper boundary of the lower atmosphere is referred to as the “mixing height” for atmospheric modeling purposes. The mixing height is defined as the distance above the surface within which dispersion of air emissions takes place. The mixing height is typically at the vertical location in the atmosphere where a thermal inversion occurs, thus “capping” vertical motion in the lower atmosphere. Mixing heights are defined through meteorological measurements. Since these measurements require sophisticated vertical temperature measurements (i.e., radiosonde), data availability is typically very sparse and commonly collected at major airports or military installations. For the Plan Area, the nearest mixing height database is from Barrow. It is the Barrow mixing height data that has been used for air quality modeling for the air quality operating permits for the production pads CD-3 and CD-4.

### CLIMATE CHANGE ON THE NORTH SLOPE

Carbon dioxide ($CO_2$) is associated with greenhouse gas emissions, along with other gases such as methane. Greenhouse gases are vital to life on earth because they help to maintain ambient temperatures. However, increasing greenhouse gas emissions augment this effect and contribute to overall global climatic changes, typically referred to as global warming. Anthropogenic $CO_2$ emissions are a product of fossil fuel combustion. Natural processes such as zooplankton and phytoplankton respiration, photosynthesis and vegetative decay, forest fires and volcanic eruptions also contribute substantially to the global $CO_2$ emissions inventory. Global warming could ultimately contribute to a rise in sea level, destruction of estuaries and coastal wetlands, and changes in regional temperature and rainfall pattern, with potentially major implications to agricultural and coastal communities.

Global temperature is predicted to rise 3 degrees Centigrade (°C) (5°F) in the next 100 years, and could even rise higher (BLM and MMS 1998a). Many scientists believe this increase is associated with increasing global greenhouse gas levels. Computer models indicate that such increases in temperature will not be equally distributed globally, but are likely to be accentuated at higher latitudes, such as in the Arctic, where the temperature increase could be more than double the global average (BLM and MMS 1998a). Warming during the winter months is expected to be higher than during the summer. Northern areas would also likely experience increased precipitation (BLM and MMS 1998a).

### TABLE 3.2.3-2 NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM TEMPERATURE CLIMATE SUMMARY (PERIOD OF RECORD APRIL 9, 1999 THROUGH MARCH 31, 2003)

| 2-Meter Temperature (°F) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean[1] | | | Extreme | | | | | |
| Month | Max Daily (Mo. Avg) | Min. Daily (Mo. Avg) | Monthly | Record High (Hr. Avg) | Year | Day | Record Low (Hr. Avg) | Year | Day |
| April | 6.6 | -8.5 | 0.0 | 36.5 | 2002 | 26 | -29.2 | 2000 | 4 |
| May | 25.1 | 13.6 | 19.8 | 65.3 | 2002 | 24 | -19.7 | 2001 | 1 |
| June | 47.5 | 33.8 | 40.1 | 75.2 | 2000 | 25 | 23.0 | 2000 | 5 |
| July | 54.2 | 39.7 | 47.1 | 82.4 | 2001 | 16 | 29.1 | 2002 | 26 |
| August | 48.7 | 37.2 | 43.0 | 82.0 | 1999 | 5 | 26.1 | 2000 | 27 |
| September | 39.8 | 30.3 | 34.7 | 65.8 | 2002 | 5 | 7.5 | 1999 | 30 |
| October | 18.6 | 9.5 | 14.5 | 35.1 | 2002 | 3 | -17.0 | 1999 | 31 |
| November | 5.1 | -6.9 | -0.6 | 32.5 | 2002 | 1 | -31.9 | 1999 | 5 |
| December | -6.5 | -17.5 | -11.9 | 27.5 | 2001 | 28 | -43.8 | 1999 | 18 |
| January | -9.1 | -21.3 | -15.2 | 10.9 | 2003 | 22 | -45.6 | 2002 | 23 |
| February | -10.0 | -21.8 | -15.5 | 5.2 | 2003 | 8 | -45.4 | 2001 | 25 |
| March | -8.7 | -20.9 | -14.8 | 17.6 | 2003 | 6 | -40.0 | 2003 | 26 |
| Monitoring Period | 17.6 | 5.6 | 12 | 82.4 | 2001 | | -45.6 | 2002 | |

Sources: SECOR International, Inc. 2002, 2003; Nuiqsut Ambient Air Quality Monitoring Program Annual Report 2003

Notes:

[1]Nuiqsut Ambient Air Quality Monitoring Program 1999 to 2003.

**TABLE 3.2.3-3 REGIONAL CLIMATOLOGICAL NORMALS (1971–2000)**

| Month | Avg. Minimum Temperature (°F) | Avg. Maximum Temperature (°F) | Avg. Temperature (°F) | Avg. Precipitation (inches)[a] | Avg. Snowfall (inches)[a] | Avg. Snow Depth (inches)[a] | Mean Wind Speed (mph)[b] |
|---|---|---|---|---|---|---|---|
| January | -19.6 to -23.4 | -7.7 to -11.5 | -13.7 to -17.5 | 0.11 to 0.18 | 2.3 to 2.5 | 7 to 9 | 12.5 |
| February | -22.0 to -25.3 | -9.8 to -14.0 | -15.9 to -19.7 | 0.13 to 0.15 | 2.1 to 2.4 | 7 to 10 | 13.1 |
| March | -20.0 to -22.4 | -7.4 to -9.2 | -13.7 to -15.8 | 0.08 to 0.13 | 1.9 to 2.3 | 8 to 11 | 12.7 |
| April | -7.3 to -9.4 | 6.1 to 6.3 | -0.5 to -1.7 | 0.10 to 0.17 | 2.5 | 8 to 11 | 12.9 |
| May | 15.3 to 15.5 | 24.9 to 27.3 | 20.1 to -21.4 | 0.03 to 0.15 | 1.2 to 1.9 | 4 to 6 | 12.0 |
| June | 30.4 to 31.1 | 39.5 to 45.8 | 35.0 to 38.5 | 0.35 to 0.37 | 0.7 | 0 to 1 | 11.4 |
| July | 34.3 to 37.5 | 46.5 to 56.1 | 40.4 to 46.8 | 0.80 to 0.90 | 0.0 to 0.3 | 0 | 12.7 |
| August | 33.8 to 36.1 | 43.6 to 51.5 | 38.5 to 38.7 | 1.04 to 1.19 | 0.4 to 0.7 | 0 | 13.3 |
| September | 27.1 to 27.5 | 34.8 to 38.2 | 31.2 to 32.7 | 0.52 to 0.65 | 3.7 to 4.1 | 0 to 1 | 12.2 |
| October | 7.7 to 9.8 | 19.2 to 19.3 | 13.5 to 14.6 | 0.33 to 0.46 | 7.0 to 8.5 | 3 to 4 | 13.4 |
| November | -6.4 to -10.7 | 1.5 to 4.6 | -0.9 to -4.6 | 0.11 to 0.23 | 3.3 to 3.5 | 5 to 7 | 14.1 |
| December | -16.4 to -20.2 | -4.7 to -8.6 | -10.6 to -14.4 | 0.11 to 0.16 | 2.3 to 3.2 | 6 to 8 | 13.0 |
| Annual | 3.6 to 5.0 | 15.8 to 16.9 | 10.3 to 10.4 | 3.88 to 4.57 | 29.2 to 30.6 | 4 to 6 | 12.8 |

Sources: Western Regional Climate Center; Alaska Climate Research Center

Notes:

[a] Monthly Climate Summaries for Barrow WSO Airport (9/2/49 to 12/31/02) and Kuparuk, Alaska (2/1/83 to 12/31/02).

[b] Mean wind speed at Barrow WSO Airport (1996 to 2002) Latitude: 71°17 Min. N; Longitude: 156°46 Min. W; Elevation: 30.8 feet.

**TABLE 3.2.3-4 FREQUENCY DISTRIBUTIONS OF ATMOSPHERIC STABILITY CLASS MEASUREMENTS AT NUIQSUT 1999–2001**

| Stable Category | Frequency % |
|---|---|
| Extremely Unstable (A) | 5 |
| Unstable (B) | 4 |
| Slightly Unstable (C) | 12 |
| Neutral (D) | 67 |
| Slightly Stable (E) | 9 |
| Stable (F) | 3 |

Source: SECOR International, Inc. 2003

Changes in permafrost are an important indicator of climate change. Temperature data for permafrost in Alaska has been collected from borings over the last two decades. Using oil exploration wells distributed in the Arctic Coastal Plain and the foothills, Lachenbruch and Marshall (1986) measured the temperatures of permafrost to depths of more than 600 feet and showed that the mean surface temperature is likely to have warmed 2° to 4°C during the last few decades to a century. The Alaska Climate Research Center (2003) reports no increases over 5°F during the last three decades at any of Alaska's first-order weather stations for the period of 1971 to 2000. As discussed in Section 2.3.7.1, ice road construction is necessary during construction and development-drilling phases, and can commence once the depth of frozen ground reaches 12 inches, accompanied by 6 inches of snow cover. It is unknown what impact, if any, a 2° to 4°C increase would have on ice road construction and maintenance. Potential impacts from an increase in mean surface temperature include preventing ambient temperatures from reaching levels cold enough for fast ice road construction, and shortening the season length as a result of earlier spring break-up and subsequent melt. If the ice road season is shortened due to an increase in mean surface temperature, construction and development-drilling schedules would be modified, or appropriate measures, such as the use of road insulating materials, may be proposed to extend the season. Future climate changes could potentially affect a number of meteorological conditions in coastal regions such as the North Slope. These conditions include frequency and intensity of storms, storm surges, and flooding. Changes in weather patterns could potentially result in a greater frequency of stronger storms. Melting ice reserves, and subsequent changes in mean sea level, could potentially increase the frequency of storm surges of a given height. Rising river and sea levels from climate change could also result in increased frequency and intensity of flooding. Although there has been no evidence to correlate an increase in storm activity with climate change, studies continue to investigate the potential role that climate change may have on future meteorological conditions.

### EFFECT OF TOPOGRAPHY

Figures depicting geographic features including lakes, rivers, and villages are presented on Figures 1.1.1-1 and 3.2.2.1-1. The regional topography of the Plan Area is relatively flat with little general influence on wind patterns (Section 3.2.1.1 for a detailed description of terrain). Wind speed and direction are typically influenced at ground level by significant features such as deep valleys (i.e. channeling effect) or mountains (i.e. leeward effect). No such features exist in the Plan Area. Local air drainage or stagnation in local low-lying areas could occur under inversion conditions. Such lower boundary layer topographic features do not affect atmospheric motion typical of wind conditions.

The Plan Area is depicted on Figure 1.1.1-1 and described in Section 1.2.1. The 890,000-acre Plan Area's eastern boundary is the Colville River Delta just west of its easternmost channel. The boundary extends southwest, following the Colville River. The southern boundary is the township line between Ts. 7 and 8

N., Umiat Meridian. The western boundary is the township line between Rs. 2 and 3 W., Umiat Meridian. The northern boundary is the section lines separating Secs. 31-32 from Secs. 29-30 in T. 15 N., R. 2 W., Umiat Meridian and eastward along the coast to the point of beginning.

#### 3.2.3.2 Existing Ambient Air Quality

The applicant's proposed action will be in an area that is in attainment of all National Ambient Air Quality Standards (NAAQS) and Alaska Ambient Air Quality Standards (AAAQS) for criteria pollutants (Table 3.2.3-5). The air quality in the Colville River Delta is generally excellent as a result of few anthropogenic and naturally-occurring air pollution sources and excellent dispersion conditions created by prevailing strong winds. Higher particulate loading of the atmosphere tends to occur more in the summer months when there is no snow and ice cover. Wind blown particulate emissions occur in the Plan Area from river banks, sandbars and gravel roads, and occasional tundra fires. Existing air quality in the Plan Area is pristine, and concentrations of gaseous regulated air pollutants are substantially lower than NAAQS and AAAQS. Emission sources in the Plan Area consist mainly of diesel-fired generators in small villages, snowmobiles, and small amounts of local vehicle traffic. Existing emissions sources at the Alpine Development Project's production and drilling areas outside of the Plan Area include the following:

- Gas-fired turbines and heaters
- Incinerators
- Emergency flares
- Standby diesel-fired power generators
- Portable diesel engines and heaters
- Storage tanks
- Fugitive hydrocarbon process emissions
- Mobile sources (vehicle traffic and aircraft)

Most of these emission sources are subject to federal New Source Performance Standards (NSPS) under existing air quality permit conditions administered by the ADEC, with specific requirements for controlling criteria pollutants. Additionally, the sludge incinerators are subject to the National Emission standards for Hazardous Air Pollutants (NESHAP) for the control of mercury. These existing emission sources do not significantly affect the air quality or visibility, nor do they interfere with the attainment of the NAAQS or AAAQS. There are no federally protected Class I wilderness areas or national parks within 100 kilometers of the Plan Area.

At Nuiqsut, existing emission sources consist of diesel-fired electric generators and home heaters, open burning, occasional small aircraft, and vehicle traffic. Regional sources of emissions consist of oil and gas production facilities 30 to 70 miles east of the Plan Area, including Kuparuk, Milne Point, Prudhoe Bay, North Star, Endicott, and Badami.

Additional emission sources would result from the installation of the following new equipment within the Plan Area and are discussed in Section 4:

- Five drill sites (DS) heaters, 20 Million BTUS per hour (MMBtu/hr), gas-fired (one at each satellite pad)
- Two emergency generators, 500 kW, liquid fuel-fired, installed at CD-3 and CD-6, assuming Alternative A is implemented, and all sites except CD-3 are road accessible. If they are not road accessible, then one emergency generator would be added at each of the five sites.
- One power generator, 3.1 megawatte (MW), gas-fired (CD-6)
- One Frame 5 turbine, 36,700 horsepower, gas-fired (ACX3)
- One heater, 30 MMBtu/hr, gas-fired (ACX3)

Background air quality in the area surrounding the Plan Area was obtained from ambient air quality monitoring stations in the vicinity. Two stations were operated at the KRU, one immediately downwind of major combustion sources at APF-1. This data was not included in the permit. The other monitoring site, at DS-1F, was relatively isolated from KRU emission sources, so data collected from DS-1F are conservatively representative of background or regional air quality in the KRU area. Data from DS-1F shows that concentrations of air contaminants are below the NAAQS, as shown in Table 3.2.3-5. The station at DS-1F was located 47 miles east–southeast of CD-1.

CPAI has operated an ambient air quality monitoring station at Nuiqsut since 1999 as an ADEC permit condition of the Alpine Development Project, and also for the benefit of the residents of Nuiqsut. A detailed description of the Nuiqsut Ambient Air Quality Monitoring Program (monitoring station located 14 miles south of CD-1) (UTMx = 575,710, UTMy = 7.792.060), including measurement techniques and quality assurance procedures are presented in the 4th Quarter 2002 Monitoring Report (SECOR 2003). The permit condition required collection of 1 year of ambient levels of NOX, sulfur oxides (SOX), paticulate matter less that 10 microns (PM10), and dispersion meteorological data. Data collected at Nuiqsut are representative of background or regional air quality in the Plan Area. The data (Table 3.2.3-6) indicate that air quality is also in compliance with applicable NAAQS and AAAQS for all pollutants and averaging periods, except for a single day's exceedance of the 24-hour PM10 standard in 1999 (prior to the operation of the APF). In this case, elevated particulate concentrations measured on that day were the result of wind-generated dust from the dried exposed banks of the nearby Nigliq Channel.

**TABLE 3.2.3-5 MAXIMUM CONCENTRATIONS OF AMBIENT POLLUTANTS MONITORED AT KRU AND NUIQSUT COMPARED TO FEDERAL AND STATE AMBIENT AIR QUALITY STANDARDS**

| Air Pollutant | Federal and State Standards | Maximum Monitored Concentration (μg/m$^3$)[a] | |
|---|---|---|---|
| | Concentration/Averaging Time | KRU (DS-1F)[b] | Nuiqsut[c] |
| Ozone ($O_3$) | 0.12 ppm, 1-hr avg.(235 μg/m$^3$) | 100.0 | NA |
| Carbon Monoxide (CO) | 9 ppm, 8-hr avg. (10,000 μg/m$^3$) | 575 | NA |
| | 35 ppm, 1-hr avg. (40,000 μg/m$^3$) | 1,035 | NA |
| Nitrogen Dioxide ($NO_2$) | 0.053 ppm, annual arithmetic mean (100 μg/m$^3$) | 4.9 | 5.6 |
| Sulfur Dioxide ($SO_2$) | 0.030 ppm, annual arithmetic mean (80 μg/m$^3$ ) | 2.6[d] | 0.0 |
| | 0.14 ppm, 24-hr avg. (365 μg/m$^3$) | 13.1 | 2.6 |
| | 0.5 ppm 3-hr avg. (1,300 μg/m$^3$) | 55.0 | 7.8 |

### TABLE 3.2.3-5 MAXIMUM CONCENTRATIONS OF AMBIENT POLLUTANTS MONITORED AT KRU AND NUIQSUT COMPARED TO FEDERAL AND STATE AMBIENT AIR QUALITY STANDARDS (CONT'D)

| Air Pollutant | Federal and State Standards | Maximum Monitored Concentration ($\mu g/m^3$)[a] | |
|---|---|---|---|
| Particulate Matter ($PM_{10}$) | 50 $\mu g/m^3$, annual arithmetic mean | 11.2 | 8.2 |
| | 150 $\mu g/m^3$, 24-hr avg. | 63 | 223[e] |
| Reduced Sulfur (as $SO_2$) | 50 $\mu g/m^3$, 30-min.<br>no federal standard | 8.3[f] | 15.7 |
| Lead | 1.5 $\mu g/m^3$, calendar quarter | NA | NA |

Sources: 40 CFR Part 50; CPAI 2002; AAC 1997
Notes:
[a] National and state standards, other than those based on annual average, are not to be exceeded more than once a year.
[b] Maximum concentrations measured during November 1990 to October 1992.
[c] Maximum concentration measured during July 1999 to June 2001.
[d] Minimum instrument detection level.
[e] $PM_{10}$ exceedance was due to wind-generated dust on a very windy day in early fall 1999.
[f] Maximum 1-hour average

### TABLE 3.2.3-6 NUIQSUT AMBIENT AIR QUALITY MONITORING PROGRAM MEASURED $NO_2$, $SO_2$, AND $PM_{10}$ CONCENTRATIONS APRIL 9, 1999 TO MARCH 31, 2003

| Annual Average $NO_2$ Concentration (ppm) | Maximum 3-hour $SO_2$ Concentration (ppm) | Maximum 24-hour $SO_2$ Concentration (ppm) | Annual Average $SO_2$ Concentration (ppm) | Maximum 24-hour $PM_{10}$ Concentration ($\mu g/m^3$) | | Annual Average $PM_{10}$ Concentration ($ug/m^3$) | |
|---|---|---|---|---|---|---|---|
| | | | | Standard | Actual | Standard | Actual |
| 0.008 | 0.008 | 0.002 | 0.000 | 39.0 | 33.6 | 11.2 | 9.3 |

Source: SECOR International, Inc. 2003
Notes:
"Standard" refers to measured concentrations based on a flow rate corrected from actual conditions to USEPA-designated standard conditions by using a pressure of 1 atmosphere and a temperature of 25°C

### 3.2.3.3 Noise

The operation of equipment during exploration, drilling, facility construction (including mining activities) and production and the use of aircraft for transportation of personnel and materials contribute noise to the environment. The Plan Area is remote and sparsely populated with few existing sources of man-made noise. Existing sources of noise include:

- Vehicle operations (Autos, trucks, Ors and snowmobiles) and community noise (generators and other small equipment motors) within the village of Nuiqsut
- Autos, trucks, Ors and snow mobiles used for subsistence hunting and travel among villages and between villages and hunting camps
- Boat operations (outboard motors)
- Aircraft operations at Nuiqsut
- Vehicle operations at CD-1 and CD-2
- Equipment operations at CD-1 and CD-2
- Aircraft operations into CD-1
- Aircraft operations at Colville Village
- Incidental aircraft and boat operations into the regional by recreationists and scientific researchers
- Incidental aircraft operations transiting the Plan Area

Background noise in Nuiqsut, the only community located within the Plan Area, is limited to general community noise, vehicle operations and occasional aircraft operations. The primary non-man-made noise source is the wind. The Noise Control Act of 1972 (and amendments, Quiet Community Acts of 1978, 42 USC 4901-4918) directs individual states to regulate environmental noise and directs governmental agencies to comply with noise standards (statutes and regulations) set by local communities. The State of Alaska and the NSB have not established specific community noise regulations that would govern the noise environment of Nuiqsut. In the absence of a standard set by the community, USEPA guidelines recommend that a day –night sound level ($L_{dn)}$ of 55 decibels on the A-rated scale (dBA) be used as a community noise standard. The level has been determined by USEPA to be sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (USEPA 1972). A second standard, Leq[1] of 70 dBA or less over a 40-year period is recommended by USEPA for protection against hearing loss in the general population from non-impulsive noise. As a reference, the noise generated in a variety of everyday situations that humans could experience is given in Table 3.2.3-7. The USEPA has also published guidelines for noise emissions from certain types of construction equipment including equipment transporters, portable air-compressors and medium- and heavy-duty trucks. The Federal aviation Administration (FAA) has established noise standards for overflight and airport noise, although no standards have been established for civilian helicopters.

[1] Leq is the equivalent steady sound level that, if continuous during a specific time period, would represent the same total acoustic energy as the actual time varying sound.

No ambient noise data is available to determine existing community noise levels. However based on the rural character of Nuiqsut and its separation from CD-1 and CD-2 facilities and all ambient noise in the community except for aircraft operations, it is assumed that ambient noise within the community is community generated (by the sources listed above).

At its closest, Nuiqsut is approximately 9.5 miles from CD-1 (which includes the processing facility, APF-1) and CD-2. Power generation and other equipment at CD-1 and CD-2 could result in noise emissions adjacent to this equipment in the range of 85 to 110 dBA. Table 3.2.3-8 lists the typical noise emissions from a variety of equipment typically found in North Slope oil field operations. These noise levels are attenuated as distance from the noise source increases. At 1,000 feet equipment noise emission of 85 to 110 dBA are likely to be 70 dBA or less. They would not contribute any noise at a distance of 9.5 miles to the community noise level in Nuiqsut. It is not anticipated that equipment operating at CD-4 would contribute any noise at approximately 5 miles away.

Residents of Nuiqsut are periodically exposed to aircraft noise both from aircraft operations at the Nuiqsut airstrip and from overflights of the community. Passing fixed wing aircraft (single-engine) would emit a noise level of 66 to 76 dBA (flying at 1,000 feet). Twin-engine planes, transporting operation and maintenance personnel to the CD-3 site, at 1,000 feet would emit a noise level of 69 to 81 dBA. Helicopters typically have noise emissions of between 68 to 78 dBA (flying at 1,300 feet). During takeoff and landings aircraft, especially jet aircraft have much higher noise emissions, however, these higher noise levels occur for a shorter period of time.

While there is little ambient noise in areas away from oil production facilities and population centers, residents of Nuiqsut and other North Slope communities who undertake subsistence harvest activities have expressed concern about the disturbance and flight of subsistence resources (caribou and birds for example) in response to noise generated by construction activities, facility operations, and aircraft operations. As noted previously, noise emissions from fixed place facilities attenuate rapidly with distance from the facility except for the area in proximity to Nuiqsut, CD-1 and CD-2 ambient noise levels are low. Noise from aircraft operations could occur anywhere in the Plan Area but is concentrated near Nuiqsut, CD-1 and Colville Village where airstrips are located. Helicopter flights between facilities on tour of the Plan Area extend short duration higher-level noise emissions into more remote areas.

A noise monitoring program conducted at the Gas Handling Expansion (GHX) Project in the Prudhoe Bay oilfield from 1989 to 91 evaluated the effects of project-related noise on water bird populations, particularly nesting Canada Geese and brood-rearing Brant that inhabit the area annually during May through September (Anderson et al. 1992). The effects of noise from the GHX facility were evaluated by looking for differences in abundance, distribution, and habitat use that could be attributed to avoidance of noise, utilizing different testing methodologies. The study determined that the GHX compressors and turbines contributed to background noise levels mostly at lower frequency ranges at 31.5–63 hertz (Hz). Noise levels on the shore of Prudhoe Bay increased from 1989 to 1991, from an average Leq of 52.2 dBA–54.9 dBA, largely due to gravel-hauling traffic.

Another study was conducted to address the issue of whether noise from the HPE-2 facility, located in the KRU caused a significant impact to waterfowl in the designated wetlands adjacent to the facility (Hampton et al. 1988). The study was limited to construction of the HPF-2 facility, and did not include the ADSP area. From 1985 to 1986, the ambient noise level within the Plan Area was measured at 32 dBA. Hearing sensitivity of birds is known to be between 2 and 3 kilohertz (kHz) (Hampton et al. 1988). During 1985, construction activities, the sound levels averaged 74 dBA, and waterfowl were observed in the study area within 500 meters of the planned site for HPE-2. The estimated average noise level the birds were exposed to in 1985 was 42.4 dBA. During 1986, the noise level ranged from 95 to 105 dBA with installation of one large and 12 portable generators at the pad. Heavy equipment and pipefitting in-creased the noise level to a range of 107 to 128 dBA. Waterfowl were seldom observed with 500 meters of the facility and roads during construction, with the majority of waterfowl observed at least 100 meters from the HPF-2 pad.

**TABLE 3.2.3-7 ACOUSTICAL SCALE—TYPICAL NOISE SOURCES**

| Noise Source | Decibel (dBA) |
|---|---|
| Turbo jet engine (aircraft) | 150 |
| Sonic boom; threshold of pain | 140 |
| Pipe organ | 130 |
| Jet takeoff at 200 feet | 125 |
| Riveter, chipper | 120 |
| Night club | 115 |
| Motorcycle at 20 feet | 110 |
| Power mower | 105 |
| Physical discomfort | 100 |
| Freight train at 50 feet | 95 |
| Propeller plane fly-over at 1,000 feet | 90 |
| Electric mixer | 85 |
| Freeway traffic at 50 feet; garbage disposal | 80 |
| Noisy office | 75 |
| Average traffic at 100 feet; vacuum cleaner | 70 |
| Air conditioning unit | 60 |
| Normal conversation at 12 feet | 50 |
| Light traffic at 100 feet; refrigerator | 45 |
| Average residence | 40 |
| Library | 35 |
| Whisper | 20 |
| Leaves rustling; threshold of good hearing | 10 |
| Threshold of excellent, youthful hearing | 0 |

Source: Plog et al. 1988

However, a greater number of birds utilized habitats in the study area during 1986 than 1985 but at a greater distance from the construction area.

Johnson et al. (2003a) conducted a study to determine, among other things, the effects of noise from air traffic on the greater white-fronted goose nest distribution. It was determined that noise levels from helicopters and airplanes at CD-3 were likely to be less than at the Alpine airstrip because of fewer flights and use by twin-engine planes rather than the noisier four-engine planes used at the Alpine Development Project.

None of the three studies discussed above were limited to observing the effects of noise on avian populations, but rather focused on the combination of visual disturbance (such as air traffic and motor vehicles) and noise. See Section 4A.3.3 for a further discussion.

**TABLE 3.2.3-8 TYPICAL OIL FIELD NOISE SOURCES**

| Source | Noise Level (dBA) | Distance from Source (meters) |
|---|---|---|
| HPE-1 (operating) | 88–105 | 0 |
| HPE-1 (flare) | 78–82 | 50 |
| HPE-2 (construction) | 95–105 | 0 |
| Drill Rig | 82–92 | 25 |
| Production Module | 88–105 | 0 |
| Pickup truck | 67–75 | 0 |
| Semi truck | 73–85 | 0 |
| Gravel truck | 93–102 | 0 |
| Helicopter (206B) | 115 | 10 |

Source: Environmental Science and Engineering, Inc. 1985 to 1986

## 3.3 BIOLOGICAL RESOURCES

Section 3.3 describes the existing flora and fauna of the Plan Area. This section identifies species that occur in the Plan Area and the habitats they use, summarizes the life histories of important species, and explains their relationship to proposed facilities. This section also addresses the overall North Slope context in which these species occur.

In addition, Section 3.3 identifies federally listed Threatened or Endangered species that occur in the Plan Area; these species are addressed in detail in Section 3.3.5. There are no species in the Plan Area that are listed as threatened or endangered by the State of Alaska.

Further, this section also addresses species on the BLM's Sensitive Species list for Alaska. Species are placed on this statewide list if (1) their populations are known to be declining or (2) very little is known about them and no formal surveys have been done yet to determine the extent of their range. These BLM Sensitive Species are not federally listed as threatened or endangered; the primary goal of the BLM's Sensitive Species Policy is to prevent the need to list the species in the future. The BLM Sensitive Species for Alaska are listed in Appendix E.

The animals and plants in the Plan Area occur across the North Slope and in many other parts of Alaska. These species, their habits, and their habitats have been described in detail in recent EISs, EAs, and planning documents with particular bearing on the North Slope including the Plan Area. These documents are incorporated by reference and include the following.

- Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a)
- Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003b)
- EIS for Final Environmental Impact Statement: Renewal of The Federal Grant for the TAPS ROW (BLM 2002)
- CRU Satellite Development Environmental Evaluation Document (EED) (PAI 2002a)
- Alpine Development Project EED (ARCO et al. 1997)
- Alpine Environmental Assessment (PAI 2002b)
- Liberty Development and Production Plan, Final EIS (MMS 2002)
- Beaufort Sea Oil and Gas Development/Northstar Project (USACE 1999)
- Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002)
- Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a)
- The Natural History of an Arctic Oil Field (Truett and Johnson 2000)
- Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (NRC 2003)

Relevant information from these documents (and/or references cited in these documents) and other sources is included in the remainder of Section 3.3 and subsequent sections that address biological resources and impacts to those resources.

Furthermore, extensive field studies sponsored by CPAI over several years on a variety of taxa (including Burgess et al. 2000, 2002a, 2002b, 2003a, 2003b, 2003c; Johnson and Stickney 2001; Johnson et al. 2000a, 2000b, 2001, 2002a, 2003a, 2003b, 2003c; Jorgenson et al. 2003; Lawhead and Johnson 2000; Lawhead and Prichard 2002; MJM Research 2001, 2002; Moulton 2001, 2002; Reanier and Associates 2000; URS 2001) have provided much useful information on the biology of the Plan Area.

## 3.3.1 Vegetation

### 3.3.1.1 North Slope

The North Slope is bounded on the north by the Beaufort Sea and on the south by the crest of the Brooks Range. The North Slope includes three physiographic provinces that have unique vegetation, topography, geology, and soils: the Arctic Coastal Plain, the Arctic Foothills, and the Brooks Range (Wahrhaftig 1965). These provinces are described in BLM and MMS (1998a), TAPS Owners (2001a), and Nowacki et al. (2001).

The ASDP Area lies entirely in the Arctic Coastal Plain. The Arctic Coastal Plain, also referred to as the Beaufort Coastal Plain by Nowacki et al. (2001), is a flat undulating plain that extends from the Beaufort Sea Coast southward to the foothills of the Brooks Range. This region is dominated by many lakes and poorly drained soils. Permafrost is continuous across the Arctic Coastal Plain, except under large rivers and large thaw-lakes. The permafrost creates an impermeable layer that impedes drainage and perches the water table at or near the surface, resulting in poorly drained saturated soils. For these reasons, nearly the entire region supports wetlands. The Arctic Coastal Plain is characterized by a network of polygonal ground and oriented-thaw-lakes that follow a cyclical pattern of formation and drainage in response to the degradation of ice-rich permafrost (Billings and Peterson 1980; BLM and Ducks Unlimited [DU] 2002).

These large-scale permafrost-related landscape features, and smaller-scale permafrost-related features such as strangmoor ridges, frost scars, and naturally induced thermokarst, are important in creating the relief that determines vegetation patterns on the Arctic Coastal Plain (Peterson and Billings 1978). These processes are detailed further in Billings and Peterson (1980); Peterson and Billings (1980); and BLM and DU (2002). Nowacki et al. (2001) describes the dominant vegetation on the Arctic Coastal Plain as wet sedge tundra in drained lake basins, swales, and floodplains; tussock tundra and sedge-Dryas tundra on gentle slopes; and low willow thickets on well-drained riverbanks.

Many investigations of the vegetation of Alaska's North Slope have been conducted over the years. For a history and bibliography of these efforts, see Talbot (1996) and the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a).

### 3.3.1.2 Plan Area

The vegetation of the Plan Area has been mapped most recently by the BLM in cooperation with DU, USFWS, and the NSB (BLM and DU 2002) and by Jorgenson et al. (1997, 2003c). The BLM and DU (2002) digitally mapped the entire National Petroleum Reserve-Alaska from 1994 to 1996 by using Landsat Thematic Mapper imagery and field verification to assess, measure, and document vegetation classes. A portion of the Northeast National Petroleum Reserve-Alaska Plan Area was mapped most recently from 2001 to 2002 with the use of an ecological land survey approach that inventoried terrain units (surface geology, geomorphology), surface forms (primarily ice-related features), and vegetation characteristics (Jorgenson et al. 2003c). The vegetation of the Colville River Delta was mapped from 1992 to 1996 (Jorgenson et al. 1997) using the same ecological land survey approach as in the Northeast National Petroleum Reserve-Alaska study. To present the vegetation classes for the entire Plan Area, the BLM and DU (2002) earth cover classes were linked with similar Jorgenson et al. (1997, 2003c) vegetation classes. Figure 3.3.1.2-1 presents the vegetation classes mapped for the entire Plan Area

(Jorgenson et al. 1997, 2003c; BLM and DU 2002). Table 3.3.1-1 presents the comparison of vegetation classes with earth cover classes. Plant species likely to occur within vegetation classes are described in Table 3.3.1-2.

The USFWS National Wetlands Inventory (NWI) Maps (Harrison Bay A-2, A-3, A-4, A-5, B-1, B-2, B-3, B-4, B-5, C-3, C-4, C-5) show that wetlands and deepwater habitats cover approximately 99 percent of the Plan Area. The USFWS defines wetlands as possessing one or more of the following three characteristics: (1) predominantly supports wetland vegetation; (2) has predominantly undrained hydric soil; and (3) is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al. 1979). The USACE defines wetlands as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas such as tundra. Table 3.3.1-3 presents Cowardin et al. (1997) wetland/upland classifications for the Jorgenson et al. (1997, 2003c) vegetation classes and corresponding BLM and DU (2002) earth cover classes mapped in the Plan Area.

The primary functions of wetlands, as defined by the USACE (1999), fulfilled by Plan Area wetlands include: wildlife habitat, fish habitat, production export, nutrient removal, sediment/toxicant retention and sediment/shoreline stabilization. North Slope wetlands are maintained by continuous permafrost, which limits infiltration (Ford and Bedford 1987), and these wetlands are frozen and snow-covered eight to nine months of the year. In summer, the shallow active layer has minimal capacity for water uptake and permafrost wetlands provide reduced storage for floodwaters and no groundwater recharge function (Senner 1989, Ford and Bedford 1987). Primary values of wetlands, as defined by the USACE (1999), in the Plan Area include: domestic water supply, recreation (subsistence hunting and fishing), education/scientific value, uniqueness/heritage, visual quality/aesthetics and threatened or endangered species habitat.

The BLM maintains a list of sensitive plant species for BLM lands in Alaska. This list was developed in coordination with the Alaska Natural Heritage Program (AKNHP) and includes species of plants with declining populations or species for which there is very little information and for which no formal surveys have been conducted to determine the extent of their range. In addition, the AKNHP maintains a database of Alaska's rare vascular plants to assist federal and state personnel and other interested parties in identifying and managing these species (Lipkin and Murray 1997). Ten species of plants classified as sensitive by the BLM's Alaska office and rare by the AKNHP could occur in the Plan Area (Lipkin 2003, pers. comm.). These plant species, their global and state rank, the habitat in which they are likely to occur, and their occurrence in the Plan Area are presented in Table 3.3.1-4. Of these species, only *Poa hartzii* ssp. *alaskana* has been found by rare plant surveys in the area (Jorgenson et al. 2003c). No threatened, endangered, or candidate plant species are known to occur within the Plan Area (USFWS 2003).

The Plan Area can be divided into four ecodistricts that have unique physiographic characteristics and repeating assemblages of terrain units, surface forms, and vegetation: Colville River Delta, Lower Colville Floodplain, Western Beaufort Coastal Plain, and Beaufort Sea Coast (Jorgenson et al. 2003c) (Figure 3.3.1.2-1). The following discussion summarizes the vegetation of the Plan Area by these ecodistricts, as defined and described in Jorgenson et al. (1997, 2003c). The classification and areal extent of Jorgenson et al. (1997, 2003c) vegetation classes with corresponding BLM and DU (2002) earth cover classes mapped in the Plan Area are presented in Table 3.3.1-1.

### COLVILLE RIVER DELTA

The Colville River Delta is the largest and most complex delta on the Arctic Coastal Plain of Alaska. It encompasses approximately 15 percent of the Plan Area and is characterized by migrating distributary channels; numerous lakes, ponds, and oxbows; natural levees; sand dunes; sand bars; and mudflats

(Figure 3.3.1.2-1) (Walker 1976, 1983). The outer portion of the Delta is dominated by tidal action, storm surges, and sedimentation from the Colville River. Salt-killed and halophytic vegetation are common. Some of the largest areas of coastal salt marsh on the North Slope are present in the Colville River Delta (Jefferies 1977). The inner portion of the Colville River Delta is less affected by coastal processes, but still includes some salt-affected areas. Coastal barrens occur on river bars, low and tall shrubs grow on slightly higher areas with frequent sedimentation, and dwarf shrub communities occur on well-drained river terraces with marshes in channel ponds.

#### LOWER COLVILLE FLOODPLAIN

The Lower Colville Floodplain includes the portion of the Colville River floodplain south of the Colville River Delta. The Plan Area boundary follows the western border of the Lower Colville Floodplain west of Ocean Point but includes this ecodistrict to the northeast (Figure 3.3.1.2-1). This region occupies approximately 2 percent of the Plan Area. Barrens occur on river bars, low and tall shrubs grow on areas of frequent sedimentation, alder (Alnus crispa) occurs on the floodplain, and dwarf shrub is uncommon. Higher in the floodplain, wet meadows occur on poorly drained soils that are occasionally flooded and on abandoned floodplain deposits that are rarely flooded (Jorgenson et al. 2003c).

#### WESTERN BEAUFORT COASTAL PLAIN

The Western Beaufort Coastal Plain encompasses about 77 percent of the Plan Area and lies within the northeastern portion of the National Petroleum Reserve-Alaska The Western Beaufort Coastal Plain is characterized by a flat to gently rolling coastal landscape dominated by thaw-lakes and meandering floodplains of Keolok Creek, Kalikpik River, and the area of Fish and Judy creeks (Figure 3.3.1.2-1) (Jorgenson et al. 2003c). Southeast of the Judy Creek floodplain, the coastal plain is gently rolling with many rather shallow lakes. Wet and moist meadows are found in low-lying areas and swales, and tussock tundra occurs on upper slopes and broad ridges. A gently rolling coastal plain region extends from Fish Creek to the Meade River. Abundant lakes have formed in depressions created by distinctive linear dunes and wet and moist meadows occur in low-lying basins and swales. Tussock tundra occurs on upper slopes, and dry and moist dwarf shrub communities are found on exposed dune ridges. Southeast of Teshekpuk Lake and south of the Kogru River, the coastal plain is relatively flat with abundant but usually small thaw-lakes. Wet and moist meadows occur in low-lying areas and swales while tussock tundra is found on upper slopes and broad ridges (Jorgenson et al. 2003c).

#### BEAUFORT SEA COAST

The Beaufort Sea Coast encompasses approximately 6 percent of the Plan Area and includes portions of the Central and Western Beaufort Sea Coast ecodistricts as defined by Jorgenson et al. (2003c). The Central Beaufort Sea Coast includes the salt-affected coastal area at the mouth of Fish Creek near the Colville River Delta. The Western Beaufort Sea Coast includes the salt-affected coastal area between the Ikpikpuk River and Fish Creek (Figure 3.3.1.2-1). Salt marshes along the Beaufort Sea Coast are often only a few meters in extent because of the unstable and erosion-prone shoreline (Macdonald 1977). In addition to salt marshes, the Beaufort Sea Coast area is characterized by coastal barrens along beaches and mudflats, coastal wet meadows on mudflats, and coastal lakes and ponds. Brackish thaw-lakes and drained basins are particularly abundant in the Western Beaufort Sea Coast (Jorgenson et al. 2003c).

### 3.3.1.3 Wildlife Habitats

Several wetland habitats were identified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b) as important to fish, waterfowl, and shorebirds because of the high value or scarcity of these habitats in the region. These wetlands include fish-bearing lakes and streams, riparian shrub lands, and the following classes described by Bergman et al. (1977): shallow and deep Arctophila ponds (Aquatic Grass Marsh), deep open lakes (Deep Open Water), basin-complex wetlands (Young and Old Basin Wetland Complexes), and coastal wetlands (Salt Marsh, Salt-killed Tundra, and Tidal Flat). Wildlife habitat classes developed and described in more detail by Jorgenson et al. (1997, 2003c) are presented on Figure 3.3.1.3-1, with vegetation type and wetland class equivalents in Table 3.3.1-3. Habitat classes have been mapped (Jorgenson et al. 1997, 2003c) for approximately 37 percent of the Plan Area, including all of the Colville River Delta and about 24 percent of the National Petroleum Reserve-Alaska within the Plan Area. These habitat classes have been evaluated for wildlife-habitat relationships within the Plan Area. Habitat preferences of species or species groups are presented in the following descriptions of wildlife resources within the Plan Area.

## TABLE 3.3.1-1 COMPARISON OF VEGETATION CLASSES WITH EARTH COVER CLASSES, AND THE AREAL EXTENT OF CLASSES WITHIN THE PLAN AREA

| Vegetation Types [1] | Earth Cover Classes[2] | AREAL EXTENT WITHIN ECODISTRICTS IN PLAN AREA[1] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Beaufort Sea Coast | | Colville River Delta | | Lower Colville River Floodplain | | Western Beaufort Coastal Plain | | Totals | |
| | | Acres | (%) | Acres | (%) | Acres | (%) | Acres | (%) | Acres | (%) |
| Water | Clear Water, Turbid Water, Ice | 39,045 | (67.3%) | 42,330 | (28.9%) | 3,900 | (25.8%) | 120,245 | (18.2%) | 205,520 | (23.4%) |
| Riverine Complex | not described[3] | 0 | (0.0%) | 0 | (0.0%) | 0 | (0.0%) | 698 | (0.1%) | 698 | (0.1%) |
| Fresh Grass Marsh | *Arctophila fulva* | 239 | (0.4%) | 369 | (0.3%) | 210 | (1.4%) | 1,766 | (0.3%) | 2,584 | (0.3%) |
| Fresh Sedge Marsh | *Carex Aquatilis* | 2,787 | (4.8%) | 32 | (0.0%) | 377 | (2.5%) | 37,758 | (5.7%) | 40,954 | (4.7%) |
| Deep Polygon Complex | Flooded Tundra—Low Centered Polygons | 1,699 | (2.9%) | 3,275 | (2.2%) | 2,243 | (14.8%) | 47,991 | (7.3%) | 55,208 | (6.3%) |
| Young Basin Wetland Complex (ice-poor) | Flooded Tundra—Non Patterned | 1,190 | (2.0%) | 0 | (0.0%) | 415 | (2.7%) | 21,306 | (3.2%) | 22,911 | (2.6%) |
| Old Basin Wetland Complex (ice-rich) | not described[3] | 0 | (0.0%) | 2 | (0.0%) | 0 | (0.0%) | 15,673 | (2.4%) | 15,675 | (1.8%) |
| Wet Sedge Meadow Tundra | Wet Tundra, Sedge/Grass Meadow | 3,805 | (6.6%) | 39,131 | (26.7%) | 1,874 | (12.4%) | 141,011 | (21.4%) | 185,821 | (21.1%) |
| Salt-killed Wet Meadow | not described[3] | 7 | (0.0%) | 6,362 | (4.3%) | 0 | (0.0%) | 0 | (0.0%) | 6,369 | (0.7%) |
| Halophytic Sedge Wet Meadow | not described[3] | 486 | (0.8%) | 3,931 | (2.7%) | 0 | (0.0%) | 36 | (0.0%) | 4,453 | (0.5%) |
| Halophytic Grass Wet Meadow | not described[3] | 0 | (0.0%) | 398 | (0.3%) | 0 | (0.0%) | 0 | (0.0%) | 398 | (0.0%) |
| Moist Sedge-Shrub Tundra | not described[3] | 7 | (0.0%) | 2,880 | (2.0%) | 0 | (0.0%) | 41,519 | (6.3%) | 44,406 | (5.1%) |
| Tussock Tundra | Tussock Tundra, Dwarf Shrub | 2,837 | (4.9%) | 525 | (0.4%) | 2,850 | (18.9%) | 201,966 | (30.6%) | 208,179 | (23.7%) |
| Dryas Tundra | not described[3] | 0 | (0.0%) | 117 | (0.1%) | 0 | (0.0%) | 1,242 | (0.2%) | 1,359 | (0.2%) |
| Cassiope Tundra | Moss/Lichen | 491 | (0.8%) | 0 | (0.0%) | 3 | (0.0%) | 7,240 | (1.1%) | 7,734 | (0.9%) |

## TABLE 3.3.1-1 COMPARISON OF VEGETATION CLASSES WITH EARTH COVER CLASSES, AND THE AREAL EXTENT OF CLASSES WITHIN THE PLAN AREA (CONT'D)

| Vegetation Types [1] | Earth Cover Classes[2] | AREAL EXTENT WITHIN ECODISTRICTS IN PLAN AREA[1] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Beaufort Sea Coast | | Colville River Delta | | Lower Colville River Floodplain | | Western Beaufort Coastal Plain | | Totals | |
| | | Acres | (%) | Acres | (%) | Acres | (%) | Acres | (%) | Acres | (%) |
| Halophytic Dwarf Willow-Graminoid Tundra | not described[3] | 0 | (0.0%) | 143 | (0.1%) | 0 | (0.0%) | 0 | (0.0%) | 143 | (0.0%) |
| Open and Closed Low Willow | Low Shrub | 10 | (0.0%) | 7,896 | (5.4%) | 2,741 | (18.1%) | 2,911 | (0.4%) | 13,557 | (1.5%) |
| Open and Closed Tall Willow | Tall Shrub | 0 | (0.0%) | 29 | (0.0%) | 0 | (0.0%) | 658 | (0.1%) | 687 | (0.1%) |
| Dune Complex | Dunes/Dry Sand | 1,038 | (1.8%) | 0 | (0.0%) | 72 | (0.5%) | 4,804 | (0.7%) | 5,914 | (0.7%) |
| Partially Vegetated | Sparsely Vegetated | 365 | (0.6%) | 5,300 | (3.6%) | 204 | (1.4%) | 4,280 | (0.6%) | 10,149 | (1.2%) |
| Barrens | Barren Ground/Other | 3,539 | (6.1%) | 33,917 | (23.1%) | 56 | (0.4%) | 6,497 | (1.0%) | 44,009 | (5.0%) |
| no data[4] | | 430 | (0.7%) | 0 | (0.0%) | 160 | (1.1%) | 1,913 | (0.3%) | 2,503 | (0.3%) |
| shadow[5] | | 84 | (0.1%) | 0 | (0.0%) | 0 | (0.0%) | 0 | (0.0%) | 84 | (0.0%) |
| Total | | 58,060 | (6.6%) | 146,637 | (16.7%) | 15,104 | (1.7%) | 659,512 | (75.0%) | 879,314 | (100.0%) |

Notes:
[1] Vegetation Types and Ecodistricts based on ecological land classifications conducted by ABR, Inc. (Jorgenson et al. 2003).
[2] Earth Cover Classes from BLM and DU (2002).
[3] Some Earth Cover and Vegetation Classes did not correspond well enough.
[4] The vegetation class "no data" refers to areas within the Plan Area that do not overlap with the BLM earthcover shapefile.
[5] The vegetation class "shadow" refers to areas within the Plan Area and BLM earth-cover shapefile where the vegetation type could not be determined because the vegetation was obscured by clouds or shadows or the quality of the spectral signature precluded classification.

**TABLE 3.3.1-2 CLASSIFICATION AND DESCRIPTION OF VEGETATION CLASSES IN THE PLAN AREA**

| Vegetation Types | Description |
|---|---|
| Water | Permanently flooded, non-vegetated water bodies. |
| Riverine Complex | Permanently flooded channels and narrow bands or patches of vegetation too small to be mapped separately. Vegetation classes include Water, Barren or Partially Vegetated gravel bars, Fresh Sedge or Grass Marsh, Wet Sedge Meadow, Moist Sedge–Shrub Tundra, or Low Willow Shrub. |
| Fresh Grass Marsh | Shallow lakes, river ox-bows, shallow margins of large lakes, and shallow water of slow-moving headwater streams. Dominated by *Arctophila fulva*. |
| Fresh Sedge Marsh | Permanently flooded shallow water, shallow margins of large lakes, and shallow water of slow-moving headwater streams. Dominated by *Carex aquatilis* and could be associated with *Scorpidium scorpioides* and *Eriophorum angustifolium*. |
| Deep Polygon Complex | Mosaic of vegetation where low-centered polygons have particularly deep (>0.5 meter) centers fringed by Fresh Grass or Sedge Marsh. Broad, low, rims of Wet Sedge Meadow or Moist Sedge–Shrub Tundra separate the centers. |
| Young Basin Wetland Complex (ice-poor) | Complex mosaic of open water, Fresh Sedge and Grass Marshes, Wet Sedge Meadow, and Moist Sedge–Shrub Tundra in recently drained lake basins characterized by patches too small (< 0.5 hectare) to map individually. |
| Old Basin Wetland Complex (ice-rich) | Occurring in portions of less recently drained basins and characterized by vegetation found in association with ice wedge development including Wet Sedge Meadow Tundra with low-centered polygons, Moist Sedge–Shrub, and Tussock Tundra. Fresh Grass Marshes are absent and Sedge Marsh occurs only in flooded portions of margins. Complexes comprise at least three vegetation types, with no single type dominant. Minimum size for complexes is 2 hectares. |
| Wet Sedge Meadow Tundra | Low-lying, poorly drained areas with vegetation dominated by *Carex aquatilis, Eriophorum angustifolium,* and mosses. Associated with nonpatterned ground, low-centered, or disjunct polygons. |
| Salt-killed Wet Meadow | Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and where salt-tolerant plants are actively colonizing. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium Beeringianum,* and *Salix ovalifolia.* |
| Halophytic Sedge Wet Meadow | Coastal areas with wet, saline soils typically dominated by the sedges C*arex subspathacea* and *C. ursina.* Associated species often include *Puccinellia phryganodes*, *Salix ovalifolia, Calamagrostis deschampsioides, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.* |
| Halophytic Grass Wet Meadow | Along the Beaufort Sea Coast, delta margins, and shorelines of tapped lakes and patches among brackish tidal pools and bare mudflats. Dominated by *Dupontia fisheri,* associated with *Puccinellia phryganodes, P. andersonii, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.* |
| Moist Sedge–Shrub Tundra | Lowland sites on moderately well-drained flats and gentle slopes, frequently associated with high-centered and mixed high- and low-centered polygons. Vegetation is co-dominated by sedges (e.g. *Carex Bigelowii*, *C. aquatilis, Eriophorum angustifolium)*, and dwarf or low shrubs including *Dryas integrifoli*a, *Salix planifolia pulchra,* and *Salix reticulata*. |

### TABLE 3.3.1-2 CLASSIFICATION AND DESCRIPTION OF VEGETATION CLASSES IN THE PLAN AREA (CONT'D)

| Vegetation Types | Description |
|---|---|
| Tussock Tundra | High-centered and mixed high- and low-centered polygons on broad slopes. Dominated by the tussock-forming sedge *Eriophorum vaginatum.* Associated species could include *Ledum decumbens*, *Vaccinium vitis-idaea, Salix planifolia pulchra, Betula nana, Salix phlebophylla, Dicranum* sp. *Hylocomium splendens, Dryas integrifolia*, *Salix reticulata, Carex Bigelowii*, *Cassiope tetragona, Salix reticulata* and *Tomentypnum nitens.* |
| Dryas Dwarf Shrub Tundra | Dry, upland, sandy slopes, crests, and well-drained river terraces dominated by *Dryas integrifolia.* Associated species include *Salix glauca, S. reticulata, Arctostaphylos alpina, Arctagrostis latifolia, Thamnolia vermicularis,* and *Cetraria cuculata*. |
| Cassiope Dwarf Shrub Tundra | Old dunes and banks dominated by *Cassiope tetragona*. *Cassiope*-dominated sites typically are very species rich, common associated species include *Dryas integrifolia, Salix phlebophylla, S. reticulata*, *Vaccinium vitis-idaea*, *CarexBbigelowii*, *Hierochloe alpina,* and *Arctagrostis latifolia*. |
| Halophytic Willow Dwarf Shrub Tundra | Coastal areas with moist to wet, saline or slightly saline soils typically dominated by *Salix ovalifolia* or co-dominated by *S. ovalifolia* and halophytic graminoids. Associated species include *Carex subspathacea, C. aquatilis, C. glareosa*, *Calamagrostis deschampsioides, Dupontia fisheri, Drepanocladus* sp. and *Thamnolia vermicularis.* |
| Open and Closed Low Willow Shrub | Riverine, lowland or upland communities dominated by low willows (0.2–1.5 meters) with an open (25–75% cover) or closed (>75%) canopy. Typically dominated by *Salix lanata richardsonii, S. planifolia pulchra,* or *Salix glauca,* with *Carex aquatilis, Equisetum arvense, E. variegatum, Arctagrostis latifolia, S. reticulata, C. Bigelowii, S. alaxensis, Arctostaphylos rubra, Dryas integrifolia*, and *Tomentypnum nitens.* |
| Open and Closed Tall Willow Shrub | Very well-drained, sandy, and frequently disturbed areas dominated by *Salix alaxensis*. Willows often are >1.5 meters tall with an open (25–75% cover) or closed (>75%) canopy. Understory species could include *Salix lanata, Equisetum arvense, Chrysanthemum bipinnatum, Festuca rubra, Aster sibiricus, Bromus pumpellianus, S. glauca, Arctostaphylos rubra,* and *Astragalus alpinus.* |
| Dune Complex | Complex formed on inactive sand dunes. Vegetation in moist to wet swales typically is Low Willow Shrub, Wet Sedge Meadow Tundra, or Fresh Sedge Marsh, while dry to moist sandy, dune ridges commonly are Dryas Dwarf Shrub Tundra or Low Willow Shrub. |
| Partially Vegetated | Riverbanks, upland sand dunes, and shallow lake basins (5–30% vegetative cover). Colonizers include *Deschampsia caespitosa*, *Salix alaxensis*, *Salix lanata*, *Juncus arcticus, Chrysanthemum bipinnatum*, *Stellaria humifusa*, *Elymus arenarius mollis, Equisetum arvense,* and *Trisetum spicatum*. |
| Barrens | Nonvegetated flats on river bars, sand dunes, tidal flats, and recently drained lake bottoms (<5% cover). Typical species include *Salix alaxensis, Elymus arenarius mollis, Festuca rubra*, *Deschampsia caespitosa, Juncus arcticus, Stellaria humifusa,* and *Equisetum arvense*. |

**TABLE 3.3.1-3 COMPARISON OF VEGETATION CLASSES, HABITAT CLASSES, AND NATIONAL WETLANDS INVENTORY CLASSES FOR THE PLAN AREA**

| Vegetation Types[a] | Habitat Class[a] | National Wetlands Inventory Class[b] |
|---|---|---|
| Water | Brackish Water (tidal ponds) | E1UBL |
| Water | Deep Open Water with Islands or Polygonized Margin* | L1UBH, PUBH |
| Water | Deep Open Water without Islands* | L1UBH, PUBH |
| Water | Nearshore Water | E1UBL |
| Water | River or Stream | R1UBV, R2UBH, R3UBH |
| Water | Shallow Open Water with Islands or Polygonized Margin | PUBH, L1UBH |
| Water | Shallow Open Water without Islands | PUBH, L1UBH |
| Water | Tapped Lake with High-water Connection | PUBH, L1UBH |
| Water | Tapped Lake with Low-water Connection | E1UBL |
| Riverine Complex | Riverine Complex* | R3UBH, R3USA, PEM1/SS1A, PEM1B |
| Fresh Grass Marsh | Aquatic Grass Marsh* | L2EM2H, PEM2H |
| Fresh Sedge Marsh | Aquatic Sedge Marsh | PEM1H |
| Deep Polygon Complex | Aquatic Sedge with Deep Polygons | PUBH, PEM2H, PEM1F, PEM1/SS1B |
| Young Basin Complex | Young Basin Wetland Complex (ice-poor)* | PUBH, PEM2H, PEM1H, PEM1/SS1B, PEM1B |
| Old Basin Complex | Old Basin Wetland Complex (ice-rich)* | PUBH, PEM1H, PEM1F, PEM1/SS1B |
| Wet Sedge Meadow Tundra | Nonpatterned Wet Meadow | PEM1F |
| Wet Sedge Meadow Tundra | Patterned Wet Meadow | PEM1/SS1B, PEM1/SS1F |
| Salt-killed Wet Meadow | Salt-killed Tundra* | E2US/EM1P |
| Halophytic Sedge Wet Meadow | Salt Marsh* | E2EM1P |
| Halophytic Grass Wet Meadow | Salt Marsh* | E2EM1P |
| Moist Sedge–Shrub Tundra | Moist Sedge–Shrub Meadow | PEM1/SS1B |
| Tussock Tundra | Moist Tussock Tundra | PEM1/SS1B, PEM1B |
| Dryas Dwarf Shrub Tundra | Upland and Riverine Dwarf Shrub* | Upland, PSS3B |
| Cassiope Dwarf Shrub Tundra | Upland and Riverine Dwarf Shrub* | PSS3B |
| Halophytic Willow Dwarf Shrub Tundra | Salt Marsh* | E2SS1/EM1P, E2SS1P |
| Open and Closed Low Willow Shrub | Moist Sedge–Shrub Meadow | PSS1/EM1B, PSS1B |
| Open and Closed Low Willow Shrub | Riverine Low and Tall Shrub* | PSS1A, PSS1B |

### TABLE 3.3.1-3 COMPARISON OF VEGETATION CLASSES, HABITAT CLASSES, AND NATIONAL WETLANDS INVENTORY CLASSES FOR THE PLAN AREA (CONT'D)

| Vegetation Types[a] | Habitat Class[a] | National Wetlands Inventory Class[b] |
|---|---|---|
| Open and Closed Low Willow Shrub | Upland Low and Tall Shrub | PSS1/EM1B, PSS1B |
| Open and Closed Tall Willow Shrub | Riverine Low and Tall Shrub* | PSS1C |
| Open and Closed Tall Willow Shrub | Upland Low and Tall Shrub | Upland |
| Dune Complex | Dune Complex | Upland, PEM1B, PEM1/SS1B, PSS1B |
| Barren and Partially Vegetated | Barrens (Riverine, Eolian, or Lacustrine) | Upland, L2USA, PUSD, R2USD, R3USD, E2USN |
| Barren and Partially Vegetated | Tidal Flat* | E2USN |

Notes:
*Represents key wetland habitats that were correlated to Bergman et al. (1977) habitats indentified in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD (BLM and MMS 1998b).
[a] Habitat and Vegetation classes from Jorgenson et al. 2003
[b] National Wetland Inventory Classes correlated to the Local Ecosystem Types (adapted from Appendix 8, Jorgenson et al. 2003 from information provided by Joanna Roth and Torre Jorgenson, ABR, Inc.), relationship to Habitat and Vegetation classes could vary; coding based on Cowardin et al. 1979

| | | |
|---|---|---|
| E1UBL | = | Estuarine, subtidal, unconsolidated bottom, subtidal |
| E2EM1P | = | Estuarine, intertidal, emergent, persistent, irregularly flooded |
| E2SS1P | = | Estuarine, intertidal, scrub-shrub, broad-leaved deciduous, irregularly flooded |
| E2SS1/EM1P | = | Estuarine, intertidal, scrub-shrub, broad-leaved deciduous and emergent, persistent, irregularly flooded |
| E2USN | = | Estuarine, intertidal, unconsolidated shore, regularly flooded |
| E2US/EM1P | = | Estuarine, intertidal, unconsolidated shore and emergent, persistent, irregular flooded |
| L1UBH | = | Lacustrine, limnetic, unconsolidated bottom, permanently flooded |
| L2EM2H | = | Lacustrine, littoral, emergent, nonpersistent, permanently flooded |
| L2USA | = | Lacustrine, littoral, unconsolidated shore, temporarily flooded |
| PEM1B | = | Palustrine, emergent, persistent, saturated |
| PEM1F | = | Palustrine, emergent, persistent, semipermanently flooded |
| PEM1H | = | Palustrine, emergent, persistent, permanently flooded |
| PEM2H | = | Palustrine, emergent, nonpersistent, permanently flooded |
| PEM1/SS1A | = | Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, temporarily flooded |
| PEM1/SS1B | = | Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, saturated |
| PEM1/SS1F | = | Palustrine, emergent, persistent and scrub-shrub, broad-leaved deciduous, semipermanently flooded |
| PSS1A | = | Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded |
| PSS1B | = | Palustrine, scrub-shrub, broad-leaved deciduous, saturated |
| PSS1C | = | Palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded |
| PSS1/EM1B | = | Palustrine, scrub-shrub, broad-leaved deciduous and emergent, persistent, saturated |
| PSS3B | = | Palustrine, scrub-shrub, broad-leaved evergreen, saturated |
| PUBH | = | Palustrine, unconsolidated bottom, permanently flooded |
| PUSD | = | Palustrine, unconsolidated shore, seasonally flooded/well drained |
| R1UBV | = | Riverine, tidal, unconsolidated bottom, permanent-tidal |
| R2UBH | = | Riverine, lower perennial, unconsolidated bottom, permanently flooded |
| R2USD | = | Riverine, lower perennial, unconsolidated shore, seasonally flooded/well drained |
| R3UBH | = | Riverine, upper perennial, unconsolidated bottom, permanently flooded |
| R3USA | = | Riverine, upper perennial, unconsolidated shore, temporarily flooded |
| R3USD | = | Riverine, upper perennial, unconsolidated shore, seasonally flooded/well drained |
| Upland | = | All areas not defined as wetland or deepwater habitats |

**TABLE 3.3.1-4 VEGETATION SENSITIVE SPECIES THAT COULD OCCUR IN THE PLAN AREA**

| Common Name(s) | Scientific Name | AKNHP Rank[a] | Habitat | Occurrence Within Plan Area |
|---|---|---|---|---|
| Nodding semaphoregrass, Sabine grass | Pleuropogon sabinei* | G4G5 S1 | Muddy shores and shallow water | North of Plan Area – Horseshoe Lake area and adjacent sites in Harrison Bay (north and northeast of Teshekpuk Lake) |
| Alaska bluegrass | Poa hartzii Alaskana* | G3G4T1 S1 | Dry sands and gravels of active floodplains | Plan Area – Fish Creek and Judy Creek (also known from sites along the Meade River and from the eastern Brooks Range near Lake Peters) |
| Ellesemereland whitlow-grass | Draba subcapitata | G4 S1 | Dry calcareous, gravelly tundra; pingos | Coastal areas east and west of Plan Area – Prudhoe Bay and Chandler Lake |
| – | Draba micropetala* | G4 S1 | Beach ridges and tundra on eroding coastal bluffs | Coastal areas east and west of Plan Area – Barrow and Lonely |
| Few flowered whitlow-grass | Draba pauciflora | G4? S1 | Mesic tundra and beach ridges | Coastal areas east and west of Plan Area – Barrow and Chandler Lake |
| Stipulated cinquefoil, Circumpolar cinquefoil | Potentilla stipularis* | G5 S1 | Sandy substrate such as sandy meadows and riverbank deposits | South and west of Plan Area – Umiat, Colville site (upriver of Umiat), and from upper Noatak region |
| – | Oxytropis sordida | G5 S2? | Gravelly substrate along rivers | East of Plan Area – Kuparuk |
| Drummond's bluebell | Mertensia drummondii* | G2Q S2 | Sand dunes | South and west of Plan Area – Kogusukruk River and Meade River |
| Hairy lousewort | Pedicularis hirsuta* | G4G5 S1 | Moist to wet tundra especially lake shores and river banks, on stony or sandy soil | Coastal areas east and west of Plan Area |
| Pygmy aster– | Eurybia pygmaea* (formerly called Aster pygmaeus) | G3 S2 | Sand bars and gravel deposits | East of Plan Area – Kuparuk |

Sources: www.uaa.alaska.edu/enri/aknhp_web/index.html and Lipkin 2003, pers. comm.
Notes:
[a]Global Rankings: G2=Imperiled globally, G3=Rare or uncommon globally, G4=Apparently secure globally, but cause for long-term concern, G5=Demonstrably secure globally, G#G#-Global rank of species uncertain and best described as a range between two ranks, G#Q=Taxonomically questionable, G#T#=Glabal rank of species and global rank of described variety or subspecies. State Rankings: S1=Critically imperiled in state, S2=Imperiled in state.
*Identifies vegetation species on the BLM's Sensitive Species List (see Appendix E).

### 3.3.2 Fish

This discussion incorporates, by reference, the descriptions of the fish resources of the Plan Area included in the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and the Colville River Unit Satellite Development Environmental Evaluation Document (PAI 2002a). This section uses these descriptions, augmented by other fish- and habitat-related information, from historical and ongoing research pertinent to this review. Up to and including 1985, Slaybaugh et al. (1989) identified approximately 15 studies that had been conducted in the region of interest. Since then at least 14 additional studies (for example, Moulton 1994, 1996a, 1996b, 1998, 1999a, 1999b, 2000, 2001, 2002; Hemming 1995; MJM Research 2001, 2002) have been conducted on habitats, species descriptions, distributions, and collection sites and methods. These papers and additional studies form the basis for the following discussion. Inupiat names for fish are noted in Table 3.3.2-1, parenthetically after the English name in the subsection titles in Section 3.3.2.4, Fishes of the Plan Area, and after the first mention of the English names of those fish if appearing before Section 3.3.2.4.

**TABLE 3.3.2-1 FISH SPECIES LIKELY TO BE FOUND IN THE COLVILLE RIVER DRAINAGE, THE NATIONAL PETROLEUM RESERVE-ALASKA COASTAL STREAMS AND LAKES, AND NEARSHORE COASTAL ZONE**

| Common Name | Scientific name | Inupiat Name |
|---|---|---|
| **Anadromous Species** | | |
| Arctic cisco | *Coregonus autumnalis* | Qaataq |
| Bering cisco | *Coregonus laurettae* | Tiipuq |
| Rainbow smelt | *Osmerus mordax* | Ilhaugniq |
| Pink salmon | *Oncorhynchus gorbuscha* | Amaqtuuq |
| Chum salmon | *Oncorhynchus keta* | Iqalugruaq |
| **Amphidromous Species (**some remain in fresh water year-round**)** | | |
| Dolly Varden | *Salvelinus malma* | Iqalukpik |
| Least cisco | *Coregonus sardinella* | Iqalusaaq |
| Broad whitefish | *Coregonus nasus* | Aanaakliq |
| Humpback whitefish | *Coregonus pidschian* | Piquktuuq |
| **Freshwater Species** | | |
| Arctic grayling | *Thymallus arcticus* | Sulukpaugaq |
| Burbot | *Lota lota* | Titaaliq |
| Lake trout | *Salvelinus namaycush* | Iqaluaqpak |
| Round whitefish | *Prosopium cylindraceum* | Savigunnaq |
| Alaska blackfish | *Dallia pectoralis* | Iluuginiq |
| Ninespine stickleback | *Pungitius pungitius* | Kakalisauraq |
| Slimy sculpin | *Cottus cognatus* | Kanayuq |
| Northern pike | *Esox lucius* | Siulik |
| Longnose sucker | *Catostomus catostomus* | Milugiaq |

### TABLE 3.3.2-1 FISH SOPECIES LIKELY TO BE FOUND IN THE COLVILLE RIVER DRAINAGE, THE NATIONAL PETROLEUM RESERVE-ALASKA COASTAL STREAMS AND LAKES, AND NEARSHORE COASTAL ZONE (CONT'D)

| Common Name | Scientific name | Inupiat Name |
|---|---|---|
| **Marine Species** | | |
| Fourhorn sculpin | *Myoxocephalus quadricornis* | Kanayuq |
| Arctic flounder | *Liopsetta glacialis* | Nataagnaq or Puyyagiaq |
| Arctic cod | *Boregogadus saida* | Iqalugaq |
| Saffron cod | *Eleginus gracilis* | Uugaq |

Note:
Tables 3.3.2-1 and 3.3.2-2 were compiled based upon reviews of historical scientific studies conducted in the Colville Drainage and Northeast National Petroleum Reserve-Alaska area. They reflect the cumulative research efforts of the past 25 years. They would include: Alt and Furniss 1976; Alt and Kogl 1973; Bendock 1979a, 1979b, 1980, 1981, 1982; Bendock and Burr 1980, 1984a, 1984b, 1985; Craig and Haldorson 1981; Fawcett, Moulton, and Carpenter 1986; Furniss 1974; Kogl 1971; Kogl and Schell 1974; McElderry and Craig 1981; Mecklenburg, Mechlenburg, Thorsteinson 2002; MJM Research 2001, 2002; Moulton 1996a, 1996b, 1999a, 2000, 2002; Moulton and Fawcett 1984; Moulton and Carpenter 1986; Moulton and Field 1991, 1994; Moulton, Field, and Kovalsky 1990; Moulton, Lestelle, and Field 1992, 1993; Moulton, Field, and Brotherton 1986b; Netsch, Crateau, Love, and Swanton 1977; PAI 2002; Philo, George, and Moulton 1993a; Reanier and Associates 2000; URS 2001.

### 3.3.2.1 North Slope

The North Slope and Beaufort Sea experience subfreezing temperatures for nearly 9 months of the year, and from October to May surface waters of the ocean and freshwater systems are frozen. By late winter, ice cover could reach a thickness of 6 feet. Because rivers, streams, and lake systems of the North Slope are relatively shallow, ice cover can decrease available freshwater habitat by as much as 95 percent (Craig 1989b). In June, rising air temperatures and increasingly longer periods of solar radiation bring about the spring melt, and by mid-July fresh water and nearshore marine waters are usually ice-free. As the summer progresses, air temperatures and solar radiation raise water temperatures to their mid-summer highs. In August, the process begins to reverse. Decreasing air temperatures and rapidly decreasing daylight result in lower water temperatures. First ice typically appears in September, marking the onset of winter.

The seasonal cycle also creates a nearshore marine habitat that is vital to the many migratory fishes of the North Slope. In summer, river runoff coupled with the melting of coastal ice creates warm, brackish (low to moderate salinities) conditions in nearshore areas, particularly near the mouths of rivers (Craig 1984). Marine invertebrates migrate into this brackish nearshore band where they thrive in the warm, detritus-laden shallows. In addition, freshwater invertebrates are washed downstream into the brackish coastal zone. Many of the fishes that overwinter in freshwater habitats and river deltas disperse along the coast to feed in this prey-rich environment that could extend several miles offshore. It has been estimated that of all the marine and freshwater habitat available to fishes during summer, coastal waters hold 90 percent of the exploitable prey biomass (Craig 1989a). It is during this brief summer period that fish achieve most of their yearly growth (Fechhelm et al. 1992; Griffiths et al. 1992) and accumulate fat and protein reserves needed to survive the Arctic winter (Fechhelm et al. 1995, 1996).

Freshwater species seldom use nearshore habitats. When they use these habitats it is predominantly as migration corridors between freshwater systems along the coast.

During winter, the key element for survival in freshwater systems is the availability of unfrozen water (Craig 1989a). By late winter, water bodies less than 6 feet deep freeze to the bottom, except in large river delta lakes. (See further discussion below in Section 3.3.2.2, under Colville River Delta.) Viable habitat is limited to deep lakes and ponds and to the deeper channels and holes within streams and river channels. Deeper waters also must be sufficiently large to sustain many fish for several months. In standing waters, depths of 7 feet are considered the minimum for supporting overwintering freshwater fish (PAI 2002a). The severity of the weather can affect the amount of overwintering habitat. Colder winters or a lack of insulating snow cover can increase ice thickness. Oxygen depletion caused by overcrowding can result in extensive mortality (Schmidt et al. 1989). Craig (1989a) estimated that an increase in ice thickness of only 12 inches could decrease the volume of water at “an average overwintering site” by at least 20 percent; overcrowding can potentially result. Severe winter ice could also freeze portions of the spawning grounds where the eggs of some species are deposited.

Beaufort Sea fishes have adapted four basic life-history strategies that allow them to cope with the seasonal cycles of the Arctic. They could be anadromous, amphidromous, freshwater, or marine.

Anadromous fishes, such as salmon, are hatched and initially reared in freshwater river systems before migrating to sea, where they spend most of their lives (Myers 1949, Craig 1989a). They return to fresh water as adults only to spawn. The Arctic form of anadromy is typically somewhat different from the general case. For example, species like the Arctic cisco (Qaataq) return annually to overwinter in larger river systems of the North Slope, but they remain in the lower reaches where waters are brackish rather than occupy fresh water or the super-cold oceanic waters of the Arctic Ocean (Morrow 1980b).

Amphidromy is a variation of anadromy. In this strategy, fish cycle annually between freshwater habitats in winter and coastal marine environments in summer (Myers 1949, Craig 1989a). Amphidromous fishes spawn and overwinter in rivers and streams but migrate from these freshwater environments into coastal waters during the ice-free summer months to feed. The amphidromous life-history strategy might not be used by all members within a species. Some species could have large amphidromous components, but other sectors of their populations could remain in fresh water year-round and use nearshore waters to migrate to other freshwater systems. Other species could forage extensively in both freshwater and coastal habitats during summer.

Anadromous and amphidromous fishes disperse into coastal waters with the spring break-up. Their distribution is generally confined to the brackish nearshore band (Craig and Haldorson 1981; Craig 1984), although the spatial extent of the summer dispersal depends on species and age. By late summer, decreased solar heating that accompanies the rapidly decreasing daylight, decreased river discharge, and mixing with cold, saline ocean water all contribute to the deterioration of the brackish nearshore. The combination of thermal and photoperiod cues triggers return migrations to spawning and overwintering areas. Movements of amphidromous species within the summer season are often extensive when some fish move considerable distances within the rivers of the Plan Area to accessible deep and shallow off-channel lakes and tundra stream systems. Extensive movements between coastal systems during summer have also been observed (Morris, pers. comm.).

Freshwater species, and those non-migratory components of amphidromous stocks, largely remain within river, stream, and lake systems year-round, although during summer they could venture into coastal areas where waters are brackish. However, for some species summer movements within the rivers of the Plan Area are extensive and directed toward productive, off-channel lake and stream systems in the spring and early summer and toward deepwater overwintering habitats in autumn and early winter.

In contrast, marine fishes spend their entire lives at sea, although some species could migrate into nearshore, brackish coastal waters during summer. Some species, such as fourhorn sculpin (Kanayuq) and Arctic flounder (Nataagnaq or Puyyagiaq), migrate from oceanic-shelf waters to nearshore coastal waters during summer and could even travel considerable distances upriver (Morrow 1980b).

#### 3.3.2.2 Habitats in the Plan Area

The proposed development is within the Colville River Delta, the Fish Creek drainage (including Judy Creek and the Ublutuoch River), and the Kogru and Kalikpik river drainages (Figure 3.2.2.1-2). This region and the nearby coastal zone contain a variety of habitats that support approximately 30 fish species (PAI 2002a). The complex mosaic of river and stream channels and coastal lakes of this area form a highly dynamic system of interconnected habitats (Figure 3.3.1.3-1). These habitats are variously used for overwintering, feeding, rearing, and spawning and as migration corridors.

Four types of lakes predominate in the Plan Area. These have been defined based primarily on the potential for access by fish (Moulton 1996):

- Tapped lake: A lake with an active connection to a river channel during the summer period of high water. The channel is normally a short, low-velocity channel formed when the lake was tapped and drained. Tapped lakes have year-round connecting channels that fish can pass through during summer. However, because most of these lakes are shallow (typically less than 6 feet deep) and drain, they and their channels do not provide winter habitat. Tapped lakes, however, provide excellent rearing habitat during summer and are heavily used by juvenile broad whitefish (Aanaakliq), humpback whitefish (Piquktuuq), and least cisco (Iqalusaaq).

- Drainage lake: Drainage lakes are part of a defined drainage system; that is, there is an active connection to a creek or stream channel. They, like tapped lakes, are used as summer rearing habitat. Although they are typically shallow, drainage lakes, unlike trapped lakes, do not drain as water levels recede.

- Perched lake: These lakes occur at higher elevations and are flooded under high water conditions but do not drain like tapped lakes when floodwaters recede. In perched lakes, survival of fish beyond one summer depends on lake depth. If greater than 7 feet deep, perched lakes could support spawning, and, for some species, all other stages of the life cycle. Perched lakes often lack well-defined connections to stream and river channels. Low-elevation lakes flood every spring during break-up, while those at higher elevations flood less frequently during periods of unusually high water. Perched lakes show a gradation of use depending upon how frequently a lake is inundated by the spring flood. Lakes that are flooded every year or two are typically occupied by broad whitefish and least cisco, but round whitefish (Savigunnaq) and humpback whitefish or almost any species represented in the river (for example, burbot [Titaaliq]) can also occur. Lakes that flood less frequently contain primarily least cisco, with lesser numbers of other species.

- Tundra lake: Tundra lakes are defined as thaw-lakes not within or connected to a river drainage. Tundra lakes thus have little potential for access by fish. Of the 73 tundra lakes that have been sampled in recent years (Moulton 1998), 16 contained ninespine sticklebacks (Kakalisauraq), 2 had Alaska blackfish (Iluuginiq), and 1 had an Arctic grayling (Sulukpaugaq) present.

All of the rivers, streams, and creeks in the region constitute important fish habitat, as do most of the non-tundra lakes, especially the lakes in the Colville River Delta. Figure 3.3.2.2-1 provides an overview of the lakes in the Plan Area that contain fish. Following MJM Research (2001), lakes in which fish presence was verified are divided into those lakes containing species sensitive to habitat changes likely to be associated with project activities (for example, water withdrawal) and those containing species more resistant to such changes. Species sensitive to such activities include whitefishes, ciscoes, salmon, Dolly Varden (Iqalukpik), Arctic grayling, burbot, and lake trout (Iqaluaqpak); resistant species include Alaska blackfish and ninespine stickleback. A high proportion of the lakes containing species that are likely sensitive to project activities are in the Colville River Delta and adjacent to the other rivers in the project area.

The most important fish habitats in the Plan Area are those deeper than 5 to 7 feet, which allows for overwintering. These include river channels and deep lakes. During summer, virtually all streams and lakes that are accessible are used by fish. These ephemeral habitats constitute important rearing grounds and migratory pathways among habitats.

### COLVILLE RIVER DELTA

The river channels and lakes of the Colville River Delta, including the Nigliq Channel, provide substantial overwintering habitat to a number of species (e.g., the Nigliq Channel may be one of the primary overwintering sites for Arctic cisco). Within the Colville River Delta, major river-channel habitat includes the Nigliq Channel and the main channel of the Colville River between the Itkillik River and the Kupigruak channels. These channels convey most of the summer flow, as well as hold substantial volumes of water during the winter.

During summer, this habitat constitutes some 47 percent of the surface waters of the Delta. These channels also are used for overwintering and as seasonal migration corridors for freshwater, anadromous, and amphidromous fishes (PAI 2002a). The major channels also are the site of the subsistence and commercial fisheries that are conducted in the Delta during autumn and winter. As noted above, overwintering habitat is crucial to the survival of regional fishes. The deep channels of the Colville River provide the most important fish overwintering habitat on the North Slope. In addition to providing a significant volume of wintering habitat, the Colville River also could have regional significance to broad whitefish for spawning (Morris 2000; Morris 2003, pers. comm.).

In most winters, the main channel of the Colville River ceases to flow, although it largely does not freeze solid. The main channel can support overwintering fish if there is oxygenated water below the ice. Channel depths that can support fish either in pools or a continuous channel will depend on the severity of winter and fall snow cover. In those winters when the Colville stops flowing, denser and colder salt water may move upstream from the coast, in some years as far upstream as Ocean Point. Arctic cisco will migrate upstream with the salt front.

The Nigliq Channel behaves similarly but stops flowing much earlier because of the constriction at the head of the channel. Flow in the Nigliq stops considerably earlier in the winter season compared to the main channel. However, even the Nigliq appears to have sustained flow much later into the winter over the past several years, based on anecdotal information from fishers and researchers (Morris 2004 pers. comm.).

The Colville River Delta is laced with numerous minor channels that, although shallow, transport a substantial volume of water during the spring (PAI 2002a). These channels have low to no flow during summer, and they typically freeze to the bottom during winter. In summer these habitats constitute approximately 13 percent of the surface waters in the Delta. Many species of fish use these minor channels for migration, as well as rearing habitat for juveniles. In mid- to late summer, minor channel habitat contains young-of-the-year and yearling broad whitefish, humpback whitefish, round whitefish, and least cisco.

Large lakes in the Colville River Delta with depths as shallow as 5 feet have the potential to winter fish (Morris 2004, pers. comm.)

Tapped lakes in the Colville River Delta comprise approximately 15 percent of the surface water area in summer.

Drainage lakes in the Delta are those connected to streams that drain into the Colville River. There is only one complex of drainage lakes within the Delta, and these account for only approximately 1 percent of the water surface area within the Delta in summer.

Perched lakes account for approximately 24 percent of the summer water surface area of the Delta, of which approximately 10 percent frequently floods and 14 percent infrequently floods. In the Colville River Delta, approximately 90 percent of the perched lakes are deeper than 8 feet and likely support fish (Moulton 1998). One such perched lake contained an 835-mm-long broad whitefish, possibly the largest specimen of this species ever caught in Alaska (Moulton 1999a).

There are no tundra lakes in the Colville River Delta.

In summary, almost all of the surface waters of the Delta, with the exception of some perched lakes, are used by resident fish. Highest-value habitats include water bodies greater than 7 feet deep, because they provide overwintering habitat. However, the shallow ephemeral stream and lake habitats with stream connections constitute valuable rearing and migratory-corridor habitat The value or significance of ephemeral habitats is often overlooked because of their typically small size and restricted seasonal use. Nevertheless, they are important fish-bearing habitats. Perched lakes, especially those that are deep and flood regularly, are likewise important fish-bearing habitats.

### FISH CREEK AND ASSOCIATED DRAINAGES

Stream or river channel habitat in this region is provided by Fish and Judy creeks and the Ublutuoch River. Some areas of these streams are deep enough to allow for overwintering; therefore, they are extremely important fish habitats. Recent summer surveys (for example, Moulton 2000) show that as many as 11 species use Fish and Judy creeks, and at least eight species occur in the Ublutuoch River. These rivers appear to be important habitats for Arctic grayling, all the whitefishes (except round whitefish) and ciscoes, and burbot — all important subsistence species. In addition, the chum salmon (Iqalugruaq) was documented to occur in the Ublutuoch River, and a Dolly Varden was documented in Fish Creek (Moulton 2000). The lower 14 kilometer (km) of the Ublutuoch River (not including lakes) represents the single largest volume of overwintering habitat in the Fish and Judy Creek drainages (Morris 2003). It is used by most species inhabiting the drainage and appears potentially significant for the spawning of broad whitefish and burbot. Large numbers of broad whitefish overwinter in the Ublutuoch River upstream and downstream of the proposed bridge site Morris 2003). Prime feeding and wintering areas have also been reported at the confluence of Fish and Judy creeks.

Drainage and perched lakes also occur in this region and are important fish habitats. However, most of the lakes outside the immediate floodplain of the area rivers are tundra lakes.

### KOGRU AND KALIKPIK RIVER DRAINAGES

The Kogru and Kalikpik river drainages have received little attention in historical and recent surveys. The Kalikpik River, however, was sampled in 1983 (Bendock and Burr 1984). The sites sampled reflected stream widths of 40 to 60 feet and maximum depths of 5 to 6 feet. Species documented to have been present include broad whitefish, Arctic grayling, least cisco, and round whitefish. The full complement of species that occur within similar habitats of the region would also be expected to occur in these rivers.

## 3.3.2.3 Essential Fish Habitat (EFH)

As noted in Alaska Department of Fish and Game (ADF&G), NOAA Fisheries, and North Pacific Fisheries Management Council (NPFMC) (1995), the Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act in 1996 to require the description and identification of Essential Fish Habitat (EFH) in fishery management plans, adverse impacts on EFH, and actions to conserve and enhance EFH. Guidelines were developed by the NMFS (now NOAA Fisheries) to assist Fishery Management Councils (Councils) in fulfilling the requirements set forth by the Act. In addition, the Act requires consultation between the Secretary of the Interior (Secretary) and federal and state agencies on activities that could adversely affect EFH for those species managed under the Act. It also requires the federal action agency to respond to comments and recommendations made by the Secretary and Councils.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.). For the purpose of interpreting the definition of EFH, “waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and could include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers the full life cycle of a species.

### NORTH SLOPE CONTEXT

While there are no federally managed fisheries in the Beaufort Sea, the ranges of the five species of Pacific salmon that are covered under a fishery management plan extend into the Beaufort Sea. Three of these (chinook, sockeye, and coho salmon) are extremely rare, with no known spawning stocks occurring along the northernmost part of Alaska. Spawning populations of pink and chum salmon, however, have been documented. Given these distributions, marine and freshwater habitats of the Beaufort Sea are classified as salmon EFH, albeit the resource level associated with this region is low as compared to more southerly regions of Alaska.

Specifically, salmon EFH has been defined as aquatic habitat (both freshwater and marine) necessary to allow salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. Freshwater EFH for the salmon fisheries in Alaska included all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Alaska. Marine EFH has been defined to include all estuaries and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (EEZ), extending 200 km offshore. Salmon EFH in the fresh waters of Alaska includes virtually all of the coastal streams south of approximately 70°N latitude. Salmon EFH in marine waters is designated as the area within the EEZ down to a depth of 500 meters (NPFMC 1999, as cited in BLM and MMS 2003b). North Slope salmon populations are at the northern extremes of the species ranges. These populations are relatively small and occur only in larger river systems where fish can spawn and eggs don't freeze in gravel (Peltz 2003). Current salmon populations have had a very difficult time establishing and persisting, most likely because of the marginal habitats (Craig 1989, as cited in BLM and MMS 2003b; Fechhelm and Griffiths 2001, as cited in BLM and MMS 2003b).

EFH data are required to be organized by species (five species), life-stage (six life stages have been identified for salmon), and information level:

Level 1: Presence or absence distribution data are available for some or all parts of the geo-graphic range of the species

Level 2: Habitat-related densities of the species are available

Level 3: Growth, reproduction, or survival rates within habitats are available

Level 4: Production rates by habitat are known

An additional level of information, Level 0, has been added to accommodate conditions where no systematic sampling has been conducted for the species and life stages in parts of the known geographic range (NPFMC 1998). This level includes salmon that could have been caught opportunistically in small numbers during research or other activities, but no systematic surveys for salmon life stages have been conducted.

In the Arctic (Region V) there are 30 life stage/species combinations for salmon requiring information. The highest level of information available for any life stage/species in the Arctic Region is Level 1, and 8 of the cells are characterized by Level 0 information. The Arctic Region has the lowest level of salmon EFH information of all the six regions used to characterize Alaska salmon stocks (NPFMC 1998).

#### PLAN AREA SALMON EFH

As described above, spawning of pink and chum salmon occurs in very low numbers in the Colville River and associated tributaries in the Plan Area. The National Marine Fisheries Act recognizes waters cataloged under AS 16.05.870 (Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes) as EFH (ADF&G 1998). For purposes of this proposed action, Fish Creek (stream number 330-00-10840 in the catalog), Judy Creek (stream number 330-00-10840-2043), the Ublutuoch River (stream number 330-00-10840-2017), and the Colville River (stream number 330-00-10700) are considered EFH for chum and pink salmon. Chum and pink salmon are listed in the catalog as using these four watercourses for migration. No other salmon streams in the area of proposed use are noted in the catalog (ADF&G 1999). The estuarine and marine areas bordering the Plan Area are EFH for all five species of Pacific salmon.

### 3.3.2.4 Fishes of the Plan Area

This section provides life-history information for the principal fish species that occupy the Plan Area (see Table 3.3.2-1). Table 3.3.2-2 provides summary information for these species; additional details for selected species are provided in the following text. We begin with the anadromous and amphidromous species because of their importance to humans. We next describe the freshwater species of the Plan Area, and last we address the marine species that likely occur in the nearby coastal zone and could travel up rivers during summer and even in winter.

Two freshwater species (threespine stickleback [*Gasterosteus aculeatus*] and Arctic lamprey [Nimigiaq; *Lampetra camtschatica*] occur only as vagrants in the Plan Area (Morris 1980), and four marine species (capelin [Panmigriq or Panmaksraq; *Mallotus villosus*], Pacific herring [Uqsruqtuuq; *Clupea harengus*], Pacific sand lance [*Ammodytes hexapterus*], and kelp snailfish [*Liparis tunicatus*] occur only sporadically offshore (Dew and Mancini 1982; Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Moulton and Fawcett 1984; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1995, 1996, 1997). These species are not included in the below tables nor are they addressed further in the text.

No fish that occur in the Plan Area are listed as federally Threatened or Endangered or as Sensitive Species by the BLM in Alaska.

## ANADROMOUS FISH

### ARCTIC CISCO (QAATAQ)

The Arctic cisco is one of the most abundant and widely distributed coregonids found in the coastal waters of the Beaufort Sea during summer (Bendock 1979a; Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Fawcett et al. 1986; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Underwood et al. 1995; Griffiths et al. 1997). It is the principal species targeted in the fall subsistence and commercial fisheries that operate in the Colville River Delta (Moulton 1994, 1995; Moulton and Field 1988, 1991, 1994; Moulton et al. 1992, 1993). By virtue of its size, the Colville River is the only system west of the Mackenzie River, Canada, that can support substantial overwintering populations of subadult and adult Arctic cisco (Craig and Mann 1974). The drainage contains approximately 75 km of deep-water, main-channel habitat, much of it in the lower reaches. Moulton (1997) estimated that the number of Arctic cisco greater than 250millimeter (mm) long that overwinter in the Colville River System fluctuates between 200,000 to more than a million fish.

## TABLE 3.3.2-2 SUMMARY OF FISH LIKELY TO BE FOUND IN THE PLAN AREA

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| **Anadromous Species** | | | | | | | | | |
| Arctic cisco | | | | | F, W, Sp | | Su | F, W | Principal target species of fall subsistence and commercial fisheries in Colville River Delta. Abundant and widespread coastally in summer. Could spend most of life in brackish to marine waters, including in winter; likely spawns in Canada's Mackenzie River in fall. Rare in freshwater coastal plain lakes and streams west of Colville River in the eastern National Petroleum Reserve-Alaska and in lakes and streams of Colville River Delta. On Colville River overwintering probably limited to lower reaches and Delta. Move into lower Colville River channels in fall. Yields in Colville River commercial and subsistence fisheries often exhibit positive correlation with salinity. Many Colville River individuals likely spawn in Mackenzie River in Canada and overwinter in larger North Slope drainages. ***See text for details.*** |
| Bering cisco | | | | | F, W, Sp | | Su | F, W | Of minor importance to the Colville River subsistence fishery (Moulton 2001). Very little known about Bering cisco in Beaufort Sea. Some speculation that fish could be transients from Yukon River or from Russian rivers (Burns 1990). Apparently most abundant near coast in areas of high salinity (Alt 1973), thus considered anadromous. However presence of individuals in spawning condition 1,610 km inland from the mouth of the Yukon River in mid-June suggests either overwintering in middle Yukon or very rapid migration (Alt 1973). Spawn in fall. |
| Rainbow smelt | | | | | Sp | | Su, F, W, | | Pelagic; throughout Beaufort Sea. Spawn in spring (McPhail and Lindsey 1970; Scott and Crossman 1973). Spawn multiple times; sexual maturity at approximately age 6-8. Can live well into teens (Kendel et al. 1975; Morrow 1980b; Bond and Erickson 1989). Fry carried downriver, emerge into coastal waters by early summer (Kendel et al. 1975; Percy 1975; Ratynski 1983; Bond and Erickson 1987). In Alaskan Beaufort Sea, spawning probably limited to Colville River; other rivers too small to provide open-water and under-ice channels for spring spawning migration. Spawn in lower reaches of Colville River; probably go upstream only enough to reach fresh water (Morrow 1980b; Burns 1990). Aside from spawning, overwinter and summer in brackish coastal areas and deltas. Not normally found in freshwater coastal plain lakes and streams to west of Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002), but reported in low to moderate numbers in river channels and tapped lakes of Colville River Delta (Moulton 1996a, 1996b). |

## TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| Pink salmon | | | | | YR | Su | Su | (negligible F) | Small runs occur in Colville River (Bendock 1979b; McElderry and Craig 1981). Spawn in the fall. In recent years, "substantial numbers" taken near Itkillik River as part of fall subsistence fishery (George 2001, pers. comm.). A minor portion of total subsistence catch; not a target species (Pedersen and Shishido 1988; Moulton and Field 1988, 1991, 1994; Moulton et al. 1986b, 1990, 1992, 1993; Moulton 1994, 1995, 1996b; George 2001, pers. comm.). Carcasses have been observed on banks of Ublutuoch River (Morris 2003, pers. comm.). ***See also Section3.3.2.3, Essential Fish Habitat.*** |
| Chum salmon | | | | | YR | Su | Su | (negligible F) | Small runs in Colville River drainage. Bendock (1979b) reported taking 35 chum salmon in the lower reaches of the river and indicated that spawning occurred in the lower river from mid-August to mid-September. In recent years, smolts have been caught in the lower Delta (Moulton 1999a, 2001). Although chum salmon are taken in the fall subsistence fishery, they constitute only a minor portion of total catch (Pedersen and Shishido 1988; Moulton and Field 1988, 1991, 1994; Moulton et al. 1986b, 1990, 1992, 1993; Moulton 1994, 1995, 1996b, 1997). Small runs also could occur in rivers closer to Barrow. One female chum salmon was captured in a fyke net set in the Ublutuoch River in 2001. ***See also Section3.3.2.3, Essential Fish Habitat.*** |
| **Amphidromous Species** | | | | | | | | | |
| Dolly Varden | | | | | YR | Su | Su | | Spawn alternate years in mountain streams from Colville River to Mackenzie River where perennial springs provide winter open-water. Sexual maturity at 7-9 years in Arctic. Juveniles remain in natal streams for several years before first migration to sea. Some males non-amphidromous, remaining in natal rivers for entire life. Rare in freshwater coastal plain lakes and streams to west of Colville River in the eastern National Petroleum Reserve-Alaska and in channels, lakes, and streams of Colville River Delta. Amphidromous individuals migrate downriver with spring break-up and disperse into coastal waters. Return migrations to spawning and overwintering areas typically begin in August. Channels of the Colville River Delta are principal migratory corridor; Plan Area not spawning, overwintering, or foraging grounds. ***See text for details.*** |

## Table 3.3.2-2 Summary of Fishes Likely to be Found in the Plan Area (cont'd)

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| Least cisco | Su | YR | YR | | YR | Su | Su | F, W | Exhibit two life-history patterns: some amphidromous, others strictly freshwater. Some freshwater populations migratory, moving among lakes, streams, and rivers; others non-migratory or lake-dwelling populations. In summer and fall, common throughout coastal North Slope including freshwater coastal plain lakes and streams west of Colville River in eastern NATIONAL PETROLEUM RESERVE-ALASKA; river channels, outer channels, tapped lakes, and perched lakes of Colville River Delta; and abundantly in Beaufort Sea coastal waters. Spawn late September and October in Colville, Ikpikpuk, and Price rivers. Non-migratory forms spawn in sand and gravel; eggs hatch the following spring. Colville River Delta very important least cisco overwintering habitat. Typically overwinters in upper reaches of the Delta. ***See text for details.*** |
| Broad whitefish | Su | YR | YR | | YR | Su | Su | Su, F, W | Common summer and early autumn in all coastal North Slope habitats. Juveniles appear intolerant of high salinities. Upstream spawning runs June-September; spawning September-November, over gravel bottoms; adults disperse throughout watershed to overwinter where water depth is sufficient; young hatch the following spring; disperse downriver. Rearing in low-velocity areas throughout middle and lower river. ***See text for details.*** |
| Humpback whitefish | Su | YR | YR | | YR | Su | Su | F, W | Range includes Colville River and many rivers farther west. Spawn September and October in Delta and in middle and upper reaches of Colville River. Spawn in moderately swift running water over gravel bottoms in lakes, streams, and rivers. The average life span for Colville River fish probably mid- to upper 20s. Excluding upriver spawning runs, summer distribution within Colville River and National Petroleum Reserve-Alaska appears limited to main river channels, deltas, and low-salinity coastal areas. Generally few in Fish and Judy creeks or in nearby perched lakes during summer. Frequently in river channels and tapped lakes of Colville River Delta, but scarce in perched lakes. Very abundant in outer Delta. Apparently intolerant of high salinities in summer, but could overwinter in the lower Colville River Delta in high salinities. Juveniles appear to remain close to lower Delta***. See text for details.*** |

## TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| **Freshwater Species** | | | | | | | | | |
| Arctic grayling | Su | Su | Su | YR | YR | Su | | | Widespread and abundant in Colville River above confluence of east and west delta channels; in main channel, major tributaries, smaller rivers and streams, and many Alpine lakes; however, occurrence is sporadic. Spawn in most of these upstream habitats; exhibit no particular substrate preference. Spawning in main Colville River channels heaviest upstream of confluence with Etivluk River; downstream, spawning more limited to side tributaries and larger stream channels. Far less common in channels, lakes, and streams of lower Delta and in freshwater coastal plain lakes and streams west of Colville River in the eastern NATIONAL PETROLEUM RESERVE-ALASKA. Many adults and subadults use Ublutuoch River to summer and overwinter. In Fish and Judy creeks most strongly associated with tundra drainages and tundra drainage outfalls in main channels. ***See text for details.*** |
| Burbot | Su | YR | Su | | YR | Su | | | In Colville River watershed and coastal lakes and streams of the NATIONAL PETROLEUM RESERVE-ALASKA; typically taken in small numbers. Early surveys could have underestimated their North Slope distribution. Spawn in Colville River near Umiat in late winter. Rearing areas include mouths of minor tributaries of lower Colville River Delta. Appear to spawn in lower Ublutuoch River within Plan Area; move extensively throughout main channel habitats and small tundra drainages during open-water season. ***See text for details.*** |
| Lake trout | | YR | | | | | | | In many mountain lakes of Colville River watershed; observed less regularly in main channel, main tributaries, and larger streams of upper system (Kogl 1971; Furniss 1974; Bendock 1979b, 1982). Extremely rare in river channels, streams, and lakes of lower Colville River and Delta and throughout coastal plain east and south of Fish Creek (MJM Research 2001; Moulton 1996a, 1996b, 1999a, 2000, 2002). Widely distributed in coastal plain lakes north and west of Fish Creek in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock and Burr 1984a, 1984b; Philo et al. 1993a). Might wander within lake systems; no defined population migrations (Morrow 1980b). Does not enter coastal brackish waters during summer. |

## TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| Round whitefish | Su | YR | YR | | YR | Su | | | Common in upper Colville River watershed; records from lower reaches of the Anaktuvuk, Chandler, Killik, Itkillik, and Kogosukruk rivers; Shanin and Chandler lakes; and several unnamed lakes and streams of upper Colville River system (Kogl 1971; Furniss 1974 Alt and Kogl 1973; Bendock 1979b; Bendock and Burr 1984a). In Fish Creek, Judy Creek, the Ublutuoch River, and some smaller streams of coastal plain west of Colville River; largely absent from many lakes of eastern National Petroleum Reserve-Alaska (Bendock and Burr 1984a, 1984b; Philo et al. 1993a; MJM Research 2002; Moulton 2000, 2001, 2002). Common in Colville River Delta river channels and tapped lakes; rare in perched lakes (Moulton 1999a, 1999b). Small to moderate numbers taken regularly in coastal waters; distribution restricted to low-salinity areas near river deltas (Griffiths and Gallaway 1982; Fawcett et al. 1986; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Griffiths et al. 1997). |
| Alaska blackfish | Su | Su | Su | YR | YR | Su | | | Presence occasional in Colville drainage and the National Petroleum Reserve-Alaska (Bendock and Burr 1980, 1984b; MJM Research 2001, 2002; Moulton 2002), the eastern limit of its northern Alaska range (Mecklenburg et al. 2002). Low numbers in the National Petroleum Reserve-Alaska lake and stream surveys possibly the result of inefficiency of gill nets at capturing small fish (Bendock and Burr 1984b). Thus abundance in many habitats could be underestimated. Few caught in Colville River Delta fyke net surveys in river channels and tapped lakes (Moulton 1999b). Slightly higher numbers caught in high and low perched lakes, but only sporadically. |
| Ninespine stickleback | Su | Su | Su | YR | YR | Su | | | Common in lakes and streams of Colville River watershed and the National Petroleum Reserve-Alaska (Furniss 1974; Bendock and Burr 1984a, 1984b; MJM Research 2001, 2002; Moulton 2002). A forage fish for other species. Small size (<75 mm), most probably eluded detection in pre-mid-1990s gill net and angler surveys; usually minnow traps, seines, or fyke nets required (Kogl 1971; Furniss 1974; MJM Research 2001, 2002; Moulton 2002). Thus abundance in many habitats could be underestimated. Found in most river channels, tapped lakes, and perched lakes in Colville River Delta fyke net surveys (Moulton 1999b); the overwhelmingly dominant species collected in both high and low perched lakes. |
| Slimy sculpin | Su | Su | Su | | YR | Su | | | Common in lakes and streams of Colville River watershed and the National Petroleum Reserve-Alaska (Furniss 1974; Bendock and Burr 1984a, 1984b; Moulton 2002). A forage fish for other species. Small size (<75 mm), most probably eluded detection in pre-mid-1990s gill net and angler surveys; usually minnow traps, seines, or fyke nets required (Kogl 1971; Furniss 1974; Moulton 2002). Thus abundance in many habitats could be underestimated. |

## TABLE 3.3.2-2 SUMMARY OF FISHES LIKELY TO BE FOUND IN THE PLAN AREA (CONT'D)

| Species | Habitat Preferences (includes all life stages) (W = winter, Sp = spring, Su = summer, F = fall, YR = year round) | | | | | | | Subsistence Fishery (W = winter, Sp = spring,Su = summer, F = fall, YR = year round) | Notes (Also, see footnote in Table 3.3.2-1 for additonal reference information.) |
|---|---|---|---|---|---|---|---|---|---|
| | Tapped Lakes | Drainage Lakes | Perched Lakes | Tundra Lakes | Rivers | Streams | Marine | | |
| Northern pike | | | | | YR | | | | Limited distribution in Plan Area. In upper Colville drainage, restricted to two lakes in northern foothills of Brooks Range, near upper Killik River (Burns 1990). In Colville River fisheries, taken incidentally in lower part of the river; little evidence of occurrence elsewhere in Colville drainage (Burns 1990). In coastal streams and lakes of the eastern NATIONAL PETROLEUM RESERVE-ALASKA, restricted to middle and upper reaches of Ikpikpuk River (Netsch et al. 1977; Bendock and Burr 1984b; MJM Research 2001, 2002; Philo et al. 1993a; Moulton 2001). Although rare throughout channels, lakes, and streams of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b, 1999a), found in low numbers in several lakes near the mouth of the Itkillik River (Moulton 1998). |
| Longnose sucker | Su | YR | YR | | YR | Su | | | In main Colville River Channel and many tributaries and smaller rivers of the upper watershed (Bendock 1979b). In Colville River Delta, common in low numbers in stream channels and tapped lakes but rare in perched lakes (Moulton 1999a, 1999b). Rare in coastal plain lakes and streams west of Colville River (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002). |
| **Marine Species** | | | | | | | | | |
| Fourhorn sculpin | | | | | Su | | YR | | Demersal; in nearshore brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980b). Migrate into brackish coastal habitats during summer to feed; could travel considerable distances up rivers (for example, reported 144 km upstream in Meade River by Morrow 1980b). Small numbers sporadically in Colville River Delta (Moulton 1996b, 1999b); no evidence of major upstream migrations in the eastern National Petroleum Reserve-Alaska or Colville watershed. Numerous in Nigliq Channel in autumn, creating nuisance for fishermen when gill nets touch the bottom (Moulton 2003). |
| Arctic flounder | | | | | Su | | YR | | Demersal; in nearshore brackish and moderately saline waters (Scott and Crossman 1973; Morrow 1980b). Migrate into brackish coastal habitats during summer to feed; could travel considerable distances up rivers. Small numbers sporadically in Colville River Delta (Moulton 1996b, 1999b); no evidence of major upstream migrations in the eastern National Petroleum Reserve-Alaska or Colville watershed. |
| Arctic cod | | | | | | | YR | | Abundant in coastal waters; do not actively move into freshwater or low-salinity habitats (Dew and Mancini 1982; Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Moulton and Fawcett 1984; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1995, 1996, 1997). |
| Saffron cod | | | | | | | YR | | Frequently enter rivers; could go considerable distances upstream. Might be found both nearshore and offshore during summer (Morrow 1980a). |

Arctic cisco appear to be truly anadromous in that, except for spawning, they could spend most of their lives in brackish to marine waters, including during the winter (Scott and Crossman 1973; Morrow 1980b). Under-ice winter surveys in the Mackenzie Delta, Canada, (Percy 1975; Mann 1975), the Sagavanirktok River and Delta (Alt and Furniss 1976; Dew 1982; Bendock and Burr 1984a; Adams and Cannon 1987; Schmidt et al. 1989), and the Colville River and Delta (Kogl and Schell 1974; Bendock 1979b, 1981, 1982; Adams and Cannon 1987) rarely report the presence of Arctic cisco in areas where salinities are low. In contrast, relatively large numbers of Arctic cisco are reported in overwintering areas of moderate to high salinity (Craig and Haldorson 1981; Adams and Cannon 1987; Schmidt et al. 1989). Bond (1982) reported that Arctic cisco overwintering in Tuktoyaktuk Harbor, Canada, remain below the halocline (a vertical salinity gradient). In the Colville River, Arctic cisco move into lower river channels in fall as salinity increases after ice formation (Moulton and Field 1988; Moulton 1994). Yields in the Colville River commercial and subsistence fisheries often exhibit a positive correlation with salinity (Moulton et al. 1990, 1992; Moulton and Field 1994). Saline intrusion, however, has not significantly occurred during the past several winters in the Colville River main channel, and subsistence catches have been the lowest on record. Arctic cisco are rare in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska and in the lakes and streams of the Colville River Delta (Netsch et al. 1977; Bendock and Bur 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 1996a, 1996b, 1999a, 1999b, 2000, 2002).

Arctic cisco spawning areas have never been identified in Alaska. Many of the Arctic cisco that inhabit the Colville River likely originate from spawning stocks in the Mackenzie River in Canada (Gallaway et al. 1983; Fechhelm and Fissel 1988; Bickham et al. 1989; Moulton 1989; Fechhelm and Griffiths 1990; Schmidt et al. 1991; Morales et al. 1993; Underwood et al. 1995; Colonell and Gallaway 1997; Moulton 2001). It is hypothesized that in summer, newly hatched fish are transported westward into Alaska by wind-driven coastal currents. Once in Alaska, they take up overwintering residence in some of the larger North Slope drainages such as the Colville and Sagavanirktok rivers. Beginning at approximately age 5 they enter the fall commercial and subsistence fisheries that operate in the lower Colville River and Delta (Moulton and Field 1988, 1991, 1994; Moulton et al. 1992, 1993; Moulton 1994, 1995, 2001). It is believed that once they reach sexual maturity (approximately 7 years old) they migrate back to the Mackenzie River to spawn (Gallaway et al. 1983).

Therefore — given (1) the extremely low numbers of Arctic cisco in coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska and in the lakes and streams of the Colville River Delta during summer, (2) their strong summer abundance in coastal waters, (3) their apparent anadromous nature, and (4) assuming that most fish originate from spawning stocks in the Mackenzie River, Canada — much of the Colville watershed and the lake, pond, and stream systems in the eastern National Petroleum Reserve-Alaska are not important habitat for this species. Overwintering is probably limited to the lower reaches of the Colville River and Delta where waters remain brackish.

#### BERING CISCO (TIIPUQ), RAINBOW SMELT (ILHAUGNIQ), PINK SALMON (AMAQTUUQ), AND CHUM SALMON (IQALUGRUAQ)

Summary information on these species is in Table 3.3.2-2.

## AMPHIDROMOUS SPECIES

### DOLLY VARDEN[2] (IQALUKPIK)

Amphidromous Dolly Varden spawn in many of the mountain streams between and including the Colville and Mackenzie rivers (Bain 1974; Craig and McCart 1974, 1975; Smith and Glesne 1982; Craig 1977a, 1977b; Daum et al. 1984; Craig 1984; Everett et al. 1997). They are alternate-year spawners that reach sexual maturity at 7 to 9 years in the Arctic (Morrow 1980b). Spawning occurs in areas where perennial springs provide fish with open-water habitat throughout the winter (McCart 1980; Craig 1984). Juveniles remain within their natal streams for several years before their first migration to sea (Craig 1977a, 1977b, 1977c). There is also a component of the population consisting of non-amphidromous males that remain within their natal rivers for their entire life (Craig 1977a, 1977b).

The Anaktuvuk and Chandler rivers support the greatest numbers of Dolly Varden in the Colville River watershed (Bendock 1980, 1981). Both rivers are fed by a number of perennial springs that maintain open-water leads throughout the winter (Bendock 1982). Dolly Varden also are found in large glacial lakes of the Kurupa, Anaktuvuk, and Chandler rivers (Furnis 1974; Bendock 1979b; Bendock and Burr 1985). Lake-bound resident forms (probably relict Arctic char) inhabit several alpine lakes in the area, and year-round stream residents are also found in smaller streams (Bendock 1979b). Dolly Varden are rare in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002) and in the channels, lakes, and streams of the Colville River Delta (Moulton 1996a, 1996b, 1999a).

Amphidromous Dolly Varden migrate downriver with the spring break-up and disperse out into coastal water to feed (Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1996). They could even migrate out to oceanic waters of the Beaufort Sea shelf to forage (Fechhelm et al. 1997). Return migrations to spawning and overwintering areas typically begin in August. Although the Plan Area does not serve as spawning, overwintering, or foraging grounds for Dolly Varden, the channels of the Colville River Delta are the principal migratory corridors for this species.

### LEAST CISCO (IQALUSAAQ)

Least cisco exhibit two different life-history patterns. Some are amphidromous, whereas others are strictly freshwater forms (McPhail and Lindsey 1970; Scott and Crossman 1973). Some freshwater populations are migratory, moving among lakes, streams, and rivers; others are non-migratory or lake-dwelling populations. Freshwater populations could consist of dwarf forms existing sympatically with normal-size fish (Cohen 1954; Wohlschlag 1954; Mann 1974; Mann and McCart 1981).

During summer and fall, least cisco are common in nearly all habitats of the coastal North Slope. They are distributed throughout the freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002); they occur in the river channels, outer channels, tapped lakes, and perched lakes of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b, 1999a, 1999b); and they are one of the most abundant species found in Beaufort Sea coastal waters (Craig and Haldorson 1981, Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Philo et al. 1993b; Griffiths et al. 1996). Adults from Colville

[2] Fish of the genus *Salvelinus* along the Beaufort Sea Coast and on the North Slope before the mid-1980s were identified as the Bering Seawestern Arctic form of the Arctic char (*S. alpinus*) (after McPhail 1961). These "char" (anadromous, residual, and isolated stream resident forms) from the continental slope west of the Mackenzie River are in fact Dolly Varden; lake-dwelling forms from this area are relict Arctic char (Reist et al. 1997; Morrow 1980a; Behnke 1980, 1984).

River stocks regularly disperse as far east as Brownlow Point, some 180 km away (Fechhelm et al. 2000; Griffiths et al. 2002a). Within the Colville River Delta, lakes are occupied by normal, large, and stunted forms with no obvious geographical separation among them (Moulton 1999a).

Least cisco spawn in late September and October (Morrow 1980b). Fall spawning runs, most likely of amphidromous forms, occur in the Colville, Ikpikpuk, and Price rivers (Bendock and Burr 1984b). Spawning of non-migratory forms takes place in lakes. Eggs are deposited in sand or gravel along river and lake shores (Scott and Crossman 1973). Eggs remain on the bottom over winter and hatch the following spring.

The Colville River Delta is a very important least cisco overwintering habitat. Least cisco prefer lower salinities than do Arctic cisco, which prefer more brackish conditions. Thus the least cisco typically overwinters in the upper reaches of the Delta, whereas the Arctic cisco overwinters along or near the coast.

#### BROAD WHITEFISH (AANAAKLIQ)

During summer and early fall, broad whitefish, like least cisco, are common in virtually all habitats of the coastal North Slope. They are distributed throughout the freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Research 2001, 2002; Moulton 2000, 2002); they occur in the river channels, outer channels, tapped lakes, and perched lakes of the Colville River Delta (Fawcett et al. 1986; Moulton 1996a, 1996b); and they are one of the most abundant species found in Beaufort Sea coastal waters (Craig and Haldorson 1981; Griffiths and Gallaway 1982; Griffiths et al. 1983; Moulton et al. 1986a; Cannon et al. 1987; Glass et al. 1990; Reub et al. 1991; Griffiths et al. 1996). Juveniles appear to be intolerant of high salinities and typically remain close to river deltas (Fechhelm et al. 1992). Adults undergo more extensive coastal migrations (Morris 2000). Significant portions of the broad whitefish populations along the northern coast appear to move to and from spawning/wintering areas and summer rearing areas via nearshore habitats and to rely more on productive stream and lake habitats for summer feeding.

Upstream spawning runs begin as early as June and could last into September (Morrow 1980b). Spawning occurs from September into November, however, most spawning is complete by mid-October. Fish in spawning condition and actual spawning events have been observed in the late summer and early fall in the Colville River near Ocean Point, at the mouth of the Anaktuvuk River (McElderry and Craig 1981), near Umiat (Alt and Kogl 1973; Bendock 1979b), in the Nigliq Channel (Kogl and Schell 1974), and in the Ikpikpuk River (Bendock and Burr 1984b). Following spawning, which takes place over gravel bottoms, adults disperse throughout the watershed to overwinter (Morrow 1980b). Young hatch the following spring and disperse downriver. Rearing is in isolated backwaters, oxbows, and other low-velocity areas throughout the middle and lower river (Moulton and Carpenter 1986, citing T. Bendock ADF&G, pers. comm.). The network of small streams is particularly valuable as rearing habitat, and these streams also serve as migratory corridors among habitats. Overwintering could occur anywhere in the Colville and National Petroleum Reserve-Alaska watersheds provided there is sufficient water depth. McElderry and Craig (1981) reported broad whitefish of all sizes in many of the lakes and main channels of the Colville River Delta as far inland as the mouth of the Anaktuvuk River during September.

Congregations of broad whitefish begin to arrive at spawning areas several weeks to more than a month before spawning. Because Beaufort broad whitefish tend to winter at spawning areas, they will persist in high concentrations after spawning until break-up dispersal occurs. Broad whitefish tend not to disperse from spawning grounds unless water quality changes necessitate movement (Morris 2000, 2003). Spawning likely takes place predominantly in September and into October in the mid-Beaufort populations. The Ublutuoch River is used extensively by broad whitefish during all seasons and provides significant wintering habitat for this species.

### HUMPBACK WHITEFISH (PIQUKTUUQ)

North Slope populations of humpback whitefish are centered around the Colville River and occur in many rivers farther to the west. They spawn in the Delta and in the middle and upper (upstream from Umiat) reaches of the Colville River during September and October (Alt and Kogl 1973; Kogl and Schell 1975; Bendock 1979b). Fish in spawning condition also have been reported in the upper Ikpikpuk drainage in September (Bendock and Burr 1984a). Spawning occurs in moderately swift running water over gravel bottoms in lakes, streams, and rivers (Alt 1979). The average life span for Colville River fish is probably to the mid- to upper 20s, and a fish estimated to have been 37 years old has been reported (Burns 1990).

Excluding upriver spawning runs, the summer distribution of humpback whitefish within the Colville River and the National Petroleum Reserve-Alaska appears limited to main river channels, deltas, and low-salinity coastal areas. Bendock and Burr (1984b) reported that although humpback whitefish were distributed throughout the Ikpikpuk River drainage and the lower reaches of Fish Creek and the Kalikpik River, they occur in only two (3 percent) of the lakes sampled. Philo et al. (1993a) reported taking only 18 humpback whitefish (0.1 percent of total catch) during a 3-year survey of Teshekpuk Lake just northwest of the Plan Area. Excluding a large July run of adult humpback whitefish in the Ublutuoch River and some fish taken in a tapped lake off Judy Creek in June, few fish were collected in Fish and Judy creeks or in nearby perched lakes during the summer (MJM Research 2002; Moulton 2002). Humpback whitefish were frequently found in river channels and tapped lakes of the Colville River Delta, but were scarce in perched lakes (Moulton 1996a, 1996b). Humpback whitefish are very abundant in the outer Colville River Delta (Fawcett et al. 1986), and adults regularly disperse eastward to Prudhoe Bay (Fechhelm 1999). Juveniles appear to remain close to the lower Delta, presumably because of their intolerance for saline waters (Fawcett et al. 1986; Burns 1990).

The apparent intolerance to high salinities during summer is somewhat inconsistent with overwintering preference. There is evidence that humpback whitefish overwinter in the lower Colville River Delta, where salinities are high (Burns 1990). Morrow (1980b) considered the species to be “truly anadromous.” If so, only the very lower reaches of the Colville River Delta would offer viable overwintering habitat.

## FRESHWATER SPECIES

### ARCTIC GRAYLING (SULUKPAUGAQ)

Grayling are one of the most widespread and abundant species in the Colville River drainage above the confluence of the East and West Delta channels (Kogl 1971; Bendock 1979b). They occur in the main Colville River channel near Umiat, in major tributaries (Itkillik, Anaktuvuk, Chandler, Killik rivers), in smaller rivers and streams (Awuna, Kiligwa, Kuna, Kurupa, Ipanavik, and Nuka rivers; Aupuk and Ikagiak creeks), and in many of the Alpine lakes (such as Shainin, Sitchiak, Ahaliorak, Chandler, Betty, and Etivlik lakes) (Kogl 1971; Furniss 1974; Bendock 1979b). Grayling spawn in most of these upstream habitats and exhibit no particular preference for substrate (Bendock 1979b; Morrow 1980b). Bendock (1979b) observed that spawning in the main Colville River channels was heaviest upstream from the confluence of the Etivluk River. Downstream, primary spawning habitat was more limited to side tributaries and larger stream channels.

Grayling are far less common in the channels, lakes, and streams of the lower Colville River Delta (Moulton 1996a, 1996b, 1999a) and in freshwater coastal plain lakes and streams to the west of the Colville River in the eastern National Petroleum Reserve-Alaska (Netsch et al. 1977; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a; MJM Reasearch 2001, 2002; Moulton 2000, 2002). Concentrations of adult and subadult Arctic grayling use the Ublutuoch River extensively during summer and for overwintering. Arctic grayling in Fish and Judy creeks are most strongly associated with tundra drainages and tundra drainage outfalls in the main channels. Although widely distributed, their occurrence is sporadic, particularly in the perched and tapped lakes of the Delta (Moulton 1996a, 1996b, 1999a).

#### BURBOT (TITAALIQ)

Burbot are distributed throughout the Colville River watershed and the coastal lakes and streams of the National Petroleum Reserve-Alaska but are typically taken in small numbers (Furniss 1974; Bendock 1979b, 1982; Bendock and Burr 1984b; Philo et al. 1993a). They have been taken in Anaktuvuk, Chandler, and lower Killik rivers and in the Colville River near the mouth of the Killik River (Bendock 1979b). Bendock and Burr (1984b) noted that burbot are not easily captured by gill nets and that early surveys could have underestimated their distribution within North Slope drainages. Fyke net surveys conducted in the channels and lakes of the Colville River Delta reported small sporadic catches (Moulton 1996a, 1996b). Burbot spawn in the Colville River near Umiat in late winter. Rearing areas include the mouths of minor tributaries of the lower Colville River Delta (Bendock 1979b). Burbot also appear to spawn in the lower reaches of the Ublutuoch River within the Plan Area and move extensively throughout main channel habitats and small tundra drainages during the open-water season although numbers of burbot in the Fish Creek drainage are low (Morris 2003).

#### LAKE TROUT (IQALUAQPAK), ROUND WHITEFISH (SAVIGUNNAQ), ALASKA BLACKFISH (ILUUGINIQ), NINESPINE STICKLEBACK (KAKALISAURAQ), SLIMY SCULPIN (KANAYUQ), NORTHERN PIKE (SIULIK), AND LONGNOSE SUCKER (MILUGIAQ)

Summary information on these species is in Table 3.3.2-2.

### MARINE SPECIES

#### FOURHORN SCULPIN (KANAYUQ), ARCTIC FLOUNDER (NATAAGNAQ OR PUYYAGIAQ), ARCTIC COD (IQALUGAQ), AND SAFFRON COD (UUGAQ)

Summary information on these species is in Table 3.3.2-2.

## 3.3.2.5 Fisheries

Commercial and subsistence fisheries operate in the Colville River Delta. Catch and effort records have been maintained for the commercial fishery since 1967 (Gallaway et al. 1983, 1989). Additional, early research describing the fisheries can be found in George and Nageak (1986), Moulton et al. (1986b), Nelson et al. (1987), and Craig (1989b). More recently, fishery data have been collected as part of Prudhoe Bay and other monitoring studies (Moulton et al. 1990, 1992, 1993; Moulton and Field 1988, 1991, 1994; Moulton 1994, 1995, 1997, 2001, 2002).

### COMMERCIAL FISHERIES

The Helmericks family operates an under-ice commercial fishery in the Colville River Delta during fall (Gallaway et al. 1983, 1989). Harvest records have been rigorously maintained since 1967 and provide a detailed history of annual harvest over the past 35 years. Fishing typically begins in early October and continues through the end of November. It is conducted in the main (Kupigruak) and east channels of the river near Anachlik Island (Gallaway et al. 1983, 1989). The three principal species targeted in the fishery are Arctic cisco, least cisco, and humpback whitefish.

Arctic cisco is the dominant species taken in the fishery, with gill net catches consisting largely of fish ranging in age from 5 to 8 years (Moulton 2003). The total annual harvest averages 17,927 fish, but catch varies considerably among years. Catch-per-unit-effort (fish/day/46 meters of net) from 1967 to 2000 ranged from a high of 196 fish/day in 1986 to a low of 12.2 fish/day in 1980 (Figure 3.3.2.5-1). These fluctuations are largely due to variable recruitment of young fish from spawning grounds in Canada's Mackenzie River system (see species accounts in Section 3.3.2.4 and Table 3.3.2-2). Strongly recruited year classes enhance yields; poorly recruited year classes result in weaker harvests. Physical conditions within the Delta also affect annual harvest. Arctic cisco prefer brackish water, and when conditions become too fresh they move out of traditional fishing areas. Yields regularly exhibit a positive correlation with salinity (Moulton et al. 1990, 1992; Moulton and Field 1994).

The last peak in the catch rate of Arctic cisco in the Colville River Delta fishery occurred in 1996 and was the third highest observed for the period of record (Figure 3.3.2.5-1). There was a marked decline in Arctic cisco abundance between 1996 and 2002 (Moulton 2003). The catch rates during 2001–2002 are reported to have been among the lowest on record. The lack of saline water intrusion up the Colville River main channel could be a contributing factor to the observed declines. Thus, abundance of Arctic cisco in the fishery has exhibited a near-continuous decline over the past 6 years. This decline is not unprecedented. Similar declines were seen between 1973 and 1980 (this period was followed by a peak year in abundance in 1981) and between 1986 and 1991 (a period again followed by increased catch rates in 1992 and a peak in 1993) (Gallaway et al. 1983, 1989; Moulton 2001). On the basis of abundance of near-commercial-size Arctic cisco in the coastal zone during summer 2002 and 2003, it appears that a rebound in the fishery should be seen in the 2003 fall fishing season (Fechhelm et al. 2003; Fechhelm 2003).

The harvest of least cisco also fluctuates among years, partially in response to natural oscillations in population. However, this species also responds to physical conditions on the Delta, preferring water less saline than does the congeneric Arctic cisco. When water becomes too saline, yields often decline (Moulton 2001b).

The harvest of humpback whitefish has changed dramatically over the 35-year period of record. Before 1981, annual catch rates were nominal at fewer than 5 fish/day/46 meters of net (Figure 3.3.2.5-1). Following a 5-year data gap from 1982 to 1986, the harvest increased to annual levels ranging from 4 to 44 fish/day/46 meters of net. The reasons for this dramatic change in annual harvest are unclear.

### NUIQSUT SUBSISTENCE FISHERY

Information on the seasonal timing of the subsistence fishery can be found in Table 3.3.2-2.

The Inupiat community of Nuiqsut operates subsistence fisheries in the Colville River Delta year-round, although most fishing effort occurs in summer and fall. The summer fishing season generally begins in July and extends until early September when freeze-up ends the open-water period (Moulton et al. 1986b). Fishing is concentrated in the Nigliq Channel in the western Colville River Delta, in the main stem Colville River just upstream of Nuiqsut in the Tiragruag area, and in Fish Creek (Craig 1989b; George and Nageak 1986). The fishery targets broad whitefish, with the harvest ranging from approximately 3,000 to 4,000 fish (Moulton et al. 1986b; Nelson et al. 1987). Other species taken incidentally include Dolly Varden, humpback whitefish, pink salmon, and chum salmon.

The fall under-ice fishery, which is the major fishery of the year, begins in late September to early October and typically lasts through late November (Moulton 1997). The fishing effort is concentrated in the upper Nigliq Channel near Nuiqsut, the lower Nigliq Channel near Woods Camp, and the Nigliq Delta (Craig 1989b; Moulton 1999b). Over the past 15 years, the effort has shifted downstream, and 2000 was the first year in which fishing effort in the Delta was the highest of the three areas (Moulton 2001). Arctic cisco is the principal species targeted, accounting for nearly 70 percent of the total annual harvest. Other targeted species include least cisco, broad whitefish, and humpback whitefish. The estimated mean annual harvest from 1985 to 2000 was 21,241 Arctic cisco, 7,011 least cisco, 1,860 humpback whitefish, and 667 broad whitefish. Species taken incidentally include Bering cisco, Arctic grayling, rainbow smelt, round whitefish, Dolly Varden, burbot, Arctic flounder, and fourhorn sculpin.

The harvests of Arctic cisco and least cisco fluctuate among years for the same reasons described above for the commercial fishery.

Additional information on the subsistence fishery can be found in Section 3.4.3 (Subsistence Harvest and Uses).

### 3.3.3 Birds

Approximately 80 bird species are likely to occur in the Plan Area and in nearshore waters of the Beaufort Sea (BLM and MMS 1998a). Table 3.3.3-1 lists the common, scientific, and Inupiaq names of these species. Most birds in the Plan Area are migratory and arrive in May and June. Some species begin to migrate to wintering or molting grounds as early as July, and for individuals of a few species, fall migration could extend into November (Table 3.3.3-2). The following description of the birds of the Plan Area concerns primarily the common and regularly occurring species, although uncommon species are also mentioned as they are considered sensitive or of special concern to regulatory agencies. The predominant groups in terms of number of species and individuals are waterfowl (tinmiagruich) and shorebirds, although the single most numerous species is the passerine, Lapland longspur (See Table 3.3.3-3) (Derksen et al. 1981; Johnson et al. 2003a; Burgess et al. 2003a). Also represented in the Plan Area are loons (malgitch), seabirds, and raptors. These species and their habitats have been described in detail in recent EISs, environmental assessments, and planning documents, including the Liberty Development and Production Plan (MMS Alaska OCS Region 2002b); the Beaufort Sea Oil and Gas Development/Northstar Project (USACE Alaska District 1999); the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a); the Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a); the Colville River Unit Satellite Development Environmental Evaluation Document (PAI 2002a); and the Northwest National Petroleum Reserve-Alaska Draft IAP/EIS (BLM and MMS 2003). This discussion incorporates, by reference, these descriptions and augments them with information from historical and ongoing research pertinent to this review.

Results of aerial surveys flown during different nesting stages may not always show the same population trends. The USFWS’s aerial breeding pair surveys during late June through early July are presented here to set the context for general patterns of distribution for most waterbirds across the Arctic Coastal Plain (Mallek et al. 2003). The USFWS’s mid-June surveys designed to detect pre-nesting male eiders before they leave the Arctic Coastal Plain in late June to early July are presented for king eiders, spectacled eiders, and Steller’s eiders (Larned et al. 2003). Population trends presented are based on 1986 to 2002 breeding pair surveys for all waterfowl and loons, except eiders (Mallek et al. 2003). Population sizes and trends for eiders, seabirds, owls, and common ravens are based on 1992 to 2003 eider survey results (Larned et al. 2003b). The USFWS’s breeding pair survey and eider survey results are presented to describe bird distributions across the Arctic Coastal Plain and to evaluate effects of hypothetical field development in Section 4. Site-specific aerial and ground-based survey results are presented to describe bird densities and distributions in the areas next to the five CPAI proposed pad locations and to evaluate potential effects of the proposed development alternatives in Section 4.

**TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA**

| Common Name | Scientific Name[a] | Inupiaq Name[b] | Status[c] | Occurrence[d] |
|---|---|---|---|---|
| **Waterfowl (Tinmiagruich) and Waterbirds** | | | | |
| Greater white-fronted goose | *Anser albifrons* | niglik | -- | C/B |
| Snow goose | *Chen caerulescens* | kanuq | -- | U/B, C/M |
| Canada goose | *Branta canadensis* | iqsragutilik | -- | C/B |
| Brant | *Branta bernicla* | niglingaq | SS | C/B |
| Tundra swan | *Cygnus columbianus* | kugruk | -- | C/B |
| Gadwall | *Anas strepera* | -- | -- | Acc |
| American wigeon | *Anas americana* | | -- | U/B |
| Mallard | *Anas platyrhynchos* | kurugaktak | -- | R/B |
| Northern shoveler | *Anas clypeata* | alluutaq | -- | R/B |
| Northern pintail | *Anas acuta* | kurugak | -- | C/B |
| Green-winged teal | *Anas crecca* | qaiffiq | -- | U/B |
| Canvasback | *Aythya valisineria* | | -- | Acc |
| Greater scaup | *Aythya marila* | qaqluktuuq | -- | U/B |
| Lesser scaup | *Aythya affinis* | kaklutuk | -- | R/B |
| Steller's eider | *Polysticta stelleri* | igniqauqtu | T | R/B |
| Spectacled eider | *Somateria fischeri* | kavaasuk | T | U/B |
| King eider | *Somateria spectabilis* | qinalik | SS | C/B |
| Common eider | *Somateria mollissima* | amauligruaq | -- | C/B |
| Surf scoter | *Melanitta perspicillata* | aviluktuq | SS | U/B |
| White-winged scoter | *Melanitta fusca* | killalik | -- | U/B |
| Black scoter | *Melanitta nigra* | tuungaagrupiaq | SS | Acc |
| Long-tailed duck | *Clangula hyemalis* | ahaaliq | SS | C/B |
| Red-breasted merganser | *Mergus serrator* | aqpaqsruayuuq | -- | R/B |
| **Loons (Malgitch) and Grebes** | | | | |
| Red-throated loon | *Gavia stellata* | qaqsraupiagruk | SS | C/B |
| Pacific loon | *Gavia pacifica* | qaqsrauq | -- | C/B |
| Yellow-billed loon | *Gavia adamsii* | tuullik | BCC, SS | U/B |
| Red-necked grebe | *Podiceps grisegena* | aqpaqsruayuuq | -- | U/B |
| Horned grebe | *Podiceps auritus* | subliq | -- | Acc |
| **Ptarmigan** | | | | |
| Willow ptarmigan | *Lagopus lagopus* | nasaullik | -- | C/B |
| Rock ptarmigan | *Lagopus mutus* | niksaaktun | -- | U/B |
| Cranes | | | | |
| Sandhill crane | *Grus canadensis* | tatirgak | -- | U/B |
| Raptors and Owls | | | | |
| Bald eagle | *Haliaeetus leucocephalus* | tinmiaqpak | -- | R |
| Northern harrier | *Circus cyaneus* | papiktuuq | -- | U/B |

**TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA (CONT'D)**

| Common Name | Scientific Name[a] | Inupiaq Name[b] | Status[c] | Occurrence[d] |
|---|---|---|---|---|
| **Raptors and Owls** | | | | |
| Rough-legged hawk | *Buteo lagopus* | qixbiq | -- | U/B |
| Golden eagle | *Aquila chrysaetos* | tingmiak | -- | U/B |
| Merlin | *Falco columbarius* | tinmiabruum kirbavia | -- | R |
| Gyrfalcon | *Falco rusticolus* | aatqarruaq | -- | U/B |
| Peregrine falcon | *Falco peregrinus* | kirgavik | BCC, SS | B/M |
| Snowy owl | *Bubo scandiacus* | ukpik | -- | C/B |
| Short-eared owl | *Asio flammeus* | nipailuktaq | -- | C/B |
| **Shorebirds** | | | | |
| Black-bellied plover | *Pluvialis squatarola* | tullikpak | -- | C/B |
| American golden-plover | *Pluvialis dominica* | tullik | BCC | C/B |
| Semipalmated plover | *Charadrius semipalmatus* | kurraquraq | -- | U/B |
| Whimbrel | *Numenius phaeopus* | sigguktuvak | BCC | U/B |
| Bar-tailed godwit | *Limosa lapponica* | turraaturaq | BCC | U/B |
| Red knot | *Calidris canutus* | | SS | R |
| Ruddy turnstone | *Arenaria interpres* | tullignaq | -- | C/B |
| Black turnstone | *Arenaria melanocephala* | -- | BCC | Acc |
| Sanderling | *Calidris alba* | kimitquilaq | -- | R/B |
| Semipalmated sandpiper | *Calidris pusilla* | livalivakpauruk | -- | C/B |
| Western sandpiper | *Calidris mauri* | -- | -- | R/B |
| Least sandpiper | *Calidris minutilla* | livalivaurak | -- | R/B |
| White-rumped sandpiper | *Calidris fuscicollis* | -- | -- | R/B |
| Baird's sandpiper | *Calidris bairdii* | puviaqtuuyaaq | -- | U/B |
| Pectoral sandpiper | *Calidris melanotos* | puviaqtuuq | -- | C/B |
| Dunlin | *Calidris alpina* | kayuttavak | BCC | C/B |
| Stilt sandpiper | *Calidris himantopus* | -- | -- | C/B |
| Buff-breasted sandpiper | *Tryngites subruficollis* | puviaqtuuq | BCC, SS | U/B |
| Long-billed dowitcher | *Limnodromus scolopaceus* | kilyaktalik | -- | C/B |
| Wilson's snipe | *Gallinago delicata* | -- | -- | U/B |
| Red-necked phalarope | *Phalaropus lobatus* | qayyiuun | -- | C/B |
| Red phalarope | *Phalaropus fulicarius* | auksruaq | -- | C/B |
| **Seabirds** | | | | |
| Pomarine jaeger | *Stercorarius pomarinus* | isunngluk | -- | U/B; C/M |

**TABLE 3.3.3-1 COMMON, SCIENTIFIC AND INUPIAQ NAMES AND STATUS OF BIRD SPECIES FOUND IN THE PLAN AREA (CONT'D)**

| Common Name | Scientific Name[a] | Inupiaq Name[b] | Status[c] | Occurrence[d] |
|---|---|---|---|---|
| Parasitic jaeger | *Stercorarius parasiticus* | migiaqsaayuk | -- | C/B |
| Long-tailed jaeger | *Stercorarius longicaudus* | isunnaq | -- | C/B |
| Herring gull | *Larus argentatus* | nauyavvaaq | -- | R/S |
| Thayer's gull | *Larus thayeri* | -- | -- | R/M |
| Glaucous-winged gull | *Larus glaucescens* | -- | -- | Acc |
| Glaucous gull | *Larus hyperboreus* | nauyak | -- | C/B |
| Sabine's gull | *Xema sabini* | iqirgagiaq | -- | U/B |
| Black-legged kittiwake | *Rissa tridactyla* | -- | -- | R/S |
| Arctic tern | *Sterna paradisaea* | mitqutailaq | BCC | C/B |
| Black guillemot | *Cepphus grylle* | -- | SS | U/B |
| **Passerines** | | | | |
| Common raven | *Corvus corax* | tulugaq | -- | C/B |
| Arctic warbler | *Phylloscopus borealis* | sonakpalutuniq | BCC | R |
| Bluethroat | *Luscinia svecica* | -- | -- | R |
| Yellow wagtail | *Motacilla flava* | iksriktaayuuq | -- | U/B |
| American tree sparrow | *Spizella arborea* | misapsaq | -- | U/B |
| Savannah sparrow | *Passerculus sandwichensis* | okpisioyuk | -- | C/B |
| Lapland longspur | *Calcarius lapponicus* | qupaluk, putukiiluk | -- | C/B |
| Snow bunting | *Plectrophenax nivalis* | amautlgaq | -- | U/B |
| Common redpoll | *Carduelis flammea* | saksakiq | -- | C/B |
| Hoary redpoll | *Carduelis hornemanni* | saksakiq | -- | U |

Notes:

[a] Scientific names from List of the 2,031 Bird Species (with Scientific and English Names) Known from the A.O.U. Check-list Area (http://www.aou.org/aou/birdlist.html). The list incorporates changes made in the 42nd, 43rd, and 44th supplements to the check-list, as published in *The AUK* 117:847-858 (2000); 119:897-906 (2002); 120:923-932 (2003). Subspecies designations are presented where relevant.

[b] Inupiaq names as presented in PAI (2002a), Appendix B, Table B-3 and in Birds of Central Beringia, a taxonomic List in English, Russian, Inupiaq, Siberian Yupik, and Latin (http:/www.nps.gov/akso/beringia/berinotesnov97.htm).

[c] Federal status under the Endangered Species Act of 1973; USFWS Status Region 7 (Alaska Region) (USFWS 2002); and BLMSensitive Species status (Appendix E).

[d] Occurrence information from C.B. Johnson, pers. comm. (2003); Johnson and Herter (1989), Armstrong (1995), and USFWS (1999a).

Acc = Accidental
BCC = USFWS Birds of Conservation Concern
E = Endangered
R = Rare
SS = BLM Sensitive species
U = Uncommon
B = Breeding bird
C = Common
M = Migration
S = Summer
T = USFWS Threatened
W = Winter

### TABLE 3.3.3-2 APPROXIMATE CHRONOLOGY OF ACTIVITIES FOR SELECTED BIRDS NESTING IN THE PLAN AREA

| Species or Groups | Arrival in Nesting Area | Egg Laying | Hatch | Brood Rearing | Adult Molt | Fall Migration |
|---|---|---|---|---|---|---|
| Greater white-fronted goose | mid May–early June | late May–mid June | late June–early July | late June–late Aug. | mid July–early Aug.[a] | mid Aug.– mid Sept. |
| Brant | late May–early June | early June–late June | late June–mid July | late June–early Sept. | mid July–mid Aug.[b] | mid Aug.– mid Sept. |
| Tundra swan | mid May–late May | late May–early June | late June–mid July | late June–mid Sept. | mid July–Aug. | late Sept.–early Oct. |
| Loons | late May–early June | mid June–late June | mid July–late July | mid July–early Sept. | Winter | late Aug.–Sept. |
| Northern pintail males | late May | mid June–late June | early July–late July | early July–early Sept. | mid July–early Aug. | early Aug.–mid Sept.[c] |
| Long–tailed duck | late May | late June–early July | mid July–late July | mid July–early Sept. | late July–early Sept.[d] | late Sept.–Oct. |
| Black-bellied plover | late May–early June | early June–late June | mid July | mid July–Aug. | Not applicable | Aug.–mid Sept. |
| Semipalmated sandpiper | late May–early June | early June–-late June | late June–mid July | late June–July | Not applicable | late July–mid Aug. |

Source: BLM and MMS 1998a

Notes:

[a] Nonbreeding young of the previous year and failed because breeders molt late June–late August.

[b] Nonbreeding, failed breeder molt–migrant brant: late June–early August.

[c] Male pintails depart early July–early August.

[d] Includes males, nonbreeders, failed breeders, as well as females with broods.

**TABLE 3.3.3-3 OCCURRENCE AND ESTIMATED POPULATION NUMBERS OF SELECTED BIRD SPECIES FOR THE ARCTIC COASTAL PLAIN AND THE PLAN AREA**

| Common Name | Occurrence | Population Numbers[a] | | |
|---|---|---|---|---|
| | | Estimated Coastal Plain Population (mean)[b, c] | Estimated NE NPR-A Populations[d] | Estimated 2002 Plan Area Populations[e] |
| **Waterfowl** | | | | |
| Greater white-fronted goose | mid May-mid Sept. | 124,579 | 16,740 | 4,315 |
| Molting | | - | 7,024 | - |
| Snow goose | | 2,557 | - | - |
| Canada goose | early June-late July | 19,349 | 13,001 | 171 |
| Brant | late May-early Sept. | 9,720 | - | 655 |
| Molting | late June-early Aug. | - | 17,570 | - |
| Tundra swan | mid May-early Oct. | 9,998 | 1,821 | 319 |
| Northern pintail | late May-mid Sept. | 229,611 | 49,564 | 2,484 |
| Scaup | late May-mid Sept. | 33,422 | 8,864 | 49 |
| King eider | late May- Oct. | 12,881 | 8,418 | 1,170 |
| Common eider[f] | late May- Oct. | 2,580 | 0 | 0 |
| Long-tailed duck | late May- Oct. | 111,768 | 22,056 | 1,905 |
| Scoters | late May-early Sept. | 11,210 | 1,357 | - |
| **Loons** | | | | |
| Red-throated loon | early June-late Sept. | 3,072 | 533 | 440 |
| Pacific loon | late May-late Sept. | 27,657 | 6,309 | 2,022 |
| Yellow-billed loon | mid May-mid Sept. | 2,957 | 898 | 296 |
| **Seabirds** | | | | |
| Glaucous gull | early May-Nov. | 11,720 | 2,882 | 586 |
| Sabine's gull | late May-early Sept. | 6,413 | 1,819 | 377 |
| Arctic tern | late May-early Sept. | 10,036 | 5,608 | 1,227 |
| Jaegers | late May-mid Sept. | 3,983 | 1,357 | 560 |
| **Raptors and Owls** | | | | |
| Arctic peregrine falcon | mid April-mid Sept. | - | - | - |
| Gyrfalcon[d] | Resident | 100 | - | - |
| Rough-legged hawk[d] | late April-early Oct. | 600-1,000 | - | - |
| Short-eared owl | | 86 | - | - |
| Snowy owl | | 851 | - | - |
| **Passerines** | | | | |
| Common raven | Resident | 63 | - | 20 |

Notes:
- dash indicates no population estimate was available.
[a] Population numbers are minimal estimates, and annually variable with standard errors ranging from 5 percent to over 75 percent of the estimated population.
[b] Population estimates for all waterfowl and loons, except eiders, with visibility correction factors applied to duck species are long-term averages from 1986-2001 from Mallek et al. (2003). Population estimates for colonial nesting species, snow goose and brant, may not reflect true population size.
[c] Population estimates for eiders, seabirds, raptors and owls, and common raven are long-term averages from 1992-2003 from Larned et al. (2003b). Visibility correction factors not applied, averages are minimum population estimates used to track population trend.
[d] Population estimates as presented in BLM and MMS (1998a).
[e] Population estimates calculated from aerial or ground-based survey densities uncorrected for visibility within the Plan Area (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b).
[f] Population estimates based on aerial surveys during late June are averages from 1999-2002 (Dau and Anderson 2002).

#### 3.3.3.1 Habitat

The following habitat characteristics are attractive to loons, geese, ducks, and shorebirds (Derksen et al. 1979, 1982; Weller et al. 1994 as presented in BLM and MMS 2003):

- Presence of large, deep lakes with persistent ice floes providing refuge from terrestrial predators
- Availability of shoreline with relatively low relief allowing predator detection
- Presence of extensive peat/mud zone for resting and presence of extensive meadows of high-quality sedges, grasses, and mosses for feeding
- Low predator populations
- Low levels of human disturbance
- Proximity to coastal staging areas

**NORTH SLOPE**

Bergman et al. (1977) and later Derksen et al. (1981) used a wetland classification system to describe habitats used by birds in the National Petroleum Reserve-Alaska and the Prudhoe Bay area. This system focuses on waterbirds and was based on the characteristics of ponds and lakes in terms of water depth and presence or absence of the emergent sedge *Carex aquatilis* and the emergent grass *Arctophila fulva*. Eight habitat types were described: (I) flooded tundra, (II) shallow ponds with emergent *Carex*, (III) shallow ponds with emergent *Arctophila*, (IV) deep lakes with emergent *Arctophila*, (V) deep lakes without emergent *Arctophila*, (VI) basin complex (large, partially drained lake basins that could be flooded during spring melt), (VII) beaded streams, and (VIII) coastal aquatic habitats in low areas that border the Beaufort Sea (Bergman et al. 1977). Deep open lakes provide invertebrate and fish prey for diving ducks and loons. Coastal wetlands are used by staging shorebirds; brood-rearing, molting and staging waterfowl; and passerines. The Colville River corridor contains tall shrub stands used for nesting by some passerines. Riverbanks provide nesting habitat on bluffs adjacent to foraging habitats for raptors. Dry tundra is preferred by some shorebird species for nesting (BLM and MMS 2003).

**PLAN AREA**

Habitat selection preferences for nesting birds in the Plan Area have been determined by relating the percent use for each available habitat type to the percent available (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b). Habitat selection analyses were conducted for nesting sites and brood-rearing areas using data collected during ground searches or during aerial surveys in both the Colville River Delta and in the National Petroleum Reserve-Alaska portion of the Plan Area. Table 3.3.3-4 summarizes available habitats. In general, the Colville River Delta sites contain brackish, tapped lake, and riverine habitats absent from the National Petroleum Reserve-Alaska sites, while the National Petroleum Reserve-Alaska sites contain tussock tundra, which is rare in the Colville River Delta (Table 3.3.3-4). Nest densities recorded for all species located during large waterbird ground searches in the Colville River Delta were more than double the nest densities in the National Petroleum Reserve-Alaska sites with the exception of CD-5 (and therefore the total National Petroleum Reserve- Alaska) (Table 3.3.3-5). CD-5 is the site closest to the Colville River Delta of the four National Petroleum Reserve-Alaska sites (Figure 2.3.3.1-1 and Table 3.3.3-4). Habitat use and selection in the Plan Area are summarized in Table 3.3.3-6 and discussed in the following species accounts.

**TABLE 3.3.3-4 HABITAT DISTRIBUTIONS FOR GROUND-BASED NEST SEARCH AREAS AND AERIAL SURVEYS IN THE PLAN AREA**

| Habitat | Colville River Delta Sites | | | | National Petroleum Reserve-Alaska Sites[a] | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Alpine[b](%) | CD-3[c](%) | CD-4[d](%) | Colville[d] Delta | CD-5(%) | CD-6(%) | CD-7(%) | Clover(%) | NPR-A Total(%) |
| Open Nearshore Water | 0 | 3.4 | 0 | 1.8 | 0 | 0 | 0 | 0 | 0.5 |
| Brackish Water | 0 | 1.9 | 0 | 1.2 | 0 | 0 | 0 | 0 | 0.2 |
| Tapped Lake with Low-water Connection | 2.6 | 8.6 | 1.0 | 3.9 | 0 | 0 | 0 | 0 | 0.2 |
| Tapped Lake with High-water Connection | 7.6 | 2.8 | 8.7 | 3.8 | 0 | 0 | 0 | 0 | <0.1 |
| Salt Marsh | 5.8 | 3.8 | 1.0 | 3.0 | 0 | 0 | 0 | 0 | 0.5 |
| Tidal Flat | 0 | 6.3 | 0 | 10.2 | 0 | 0 | 0 | 0 | 1.2 |
| Salt-killed Tundra | 0 | 7.3 | 0 | 4.7 | 0 | 0 | 0 | 0 | <0.1 |
| Deep Open Water without Islands | 8.5 | 4.9 | 6.4 | 3.8 | 0.3 | 3.2 | 15.5 | 0 | 7.2 |
| Deep Open Water with Islands or Polygonized Margins | 0.9 | 2.0 | 1.6 | 1.4 | 5.8 | 0 | 5.8 | 0 | 5.2 |
| Shallow Open Water without Islands | <0.1 | 0.4 | 0.3 | 0.4 | 0.2 | 0.2 | 1.0 | 0 | 1.0 |
| Shallow Open Water with Islands or Polygonized Margins | 0.1 | 0.1 | 0.1 | 0.1 | 8.2 | 1.2 | 4.6 | 0 | 1.6 |
| River or Stream | <0.1 | 7.1 | 10.7 | 14.9 | 0 | 0 | 0.1 | 0 | 0.9 |
| Aquatic Sedge Marsh | 0.8 | 0 | 0.1 | <0.1 | 1.6 | 0.9 | 15.8 | 0 | 1.7 |
| Aquatic Sedge with Deep Polygons | 1.1 | 4.1 | 1.1 | 2.4 | 0 | 0 | 0 | 0 | <0.1 |
| Aquatic Grass Marsh | 1.0 | 0.2 | 0.6 | 0.3 | 0 | 0 | 0.9 | 0 | 0.3 |
| Young Basin Wetland Complex | 0 | 0 | <0.1 | <0.1 | 0 | 0 | 1.6 | 0 | 0.4 |
| Old Basin Wetland Complex | 0 | 0 | <0.1 | <0.1 | 16.2 | 4.5 | 5.9 | 0 | 8.8 |
| Riverine Complex | 0 | 0 | 0 | 0 | 0 | 3.8 | 0 | 0 | 0.4 |
| Dune Complex | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.1 |
| Nonpatterned Wet Meadow | 9.0 | 10.5 | 6.4 | 7.5 | 1.7 | 0.1 | 19.3 | 0.8 | 3.1 |
| Patterned Wet Meadow | 41.2 | 20.2 | 30.5 | 18.6 | 32.1 | 6.6 | 2.6 | 7.3 | 11.3 |
| Moist Sedge-Shrub Meadow | 10.9 | 2.1 | 5.3 | 2.4 | 16.2 | 23.5 | 20.9 | 52.6 | 23.2 |
| Moist Tussock Tundra | 0 | 0.8 | 0.6 | 0.5 | 17.8 | 55.7 | 5.5 | 39.3 | 27.4 |
| Riverine or Upland Shrub | 5.9 | 2.6 | 11.7 | 5.0 | 0 | 0.3 | 0.4 | 0 | 2.7 |
| Barrens (riverine, eolian, or lacustrine) | 1.7 | 10.8 | 14.0 | 14.3 | 0 | 0 | 0 | 0 | 1.0 |
| Artificial (water, fill, peat road) | 2.9 | 0.1 | 0.1 | <0.1 | 0 | 0 | 0 | 0 | 0 |
| Nest Densities | | | | | | | | | |
| Nest Density (nests/km$^2$) | 7.9 | 18.4 | 10.2 | 12.2 | 18.1 | 4.0 | 6.1 | 0.0 | 9.0 |

Notes: [a] Burgess et al. 2003b [b] Johnson et al. 2003a [c] Johnson et al. 2003b [d] Burgess et al. 2003a

TABLE 3.3.3-5 GROUND-BASED NEST DENSITIES (NEST/KM$^2$) IN THE PLAN AREA

| | | CD North | CD South | Alpine West | Lookout | Spark | |
|---|---|---|---|---|---|---|---|
| Species[a] | Alpine (6-year mean)[b] | CD-3 (4-year mean)[c] | CD-4 (3-year mean)[b] | CD-5 (2-year mean)[c] | CD-6 (2-year mean)[c] | CD-7 (2-year mean)[c] | NPR-A Area (2003)[d] |
| **Waterfowl and Waterbirds** | | | | | | | |
| White-fronted goose | 3.4 | 11.4 | 4.6 | 9.5 | 3.0 | 1.0 | 5.8 |
| Snow goose | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 |
| Canada goose | 0.1 | 0.1 | 0 | 3.5 | 0.1 | 0 | 1.4 |
| Brant | 0.2 | 1.4 | 0 | 1.8 | 0 | 0 | 0.6 |
| Tundra swan | 0.4 | 0.3 | 0.3 | 0.2 | 0 | 0 | <0.1 |
| Mallard | 0 | 0 | <0.1 | 0 | 0 | 0 | 0 |
| Northern shoveler | 0.1 | <0.1 | 0.1 | 0.2 | 0 | 0 | 0 |
| Northern pintail | 0.5 | 0.2 | 1.3 | 0.3 | 0.2 | 0.6 | 0.1 |
| Green-winged teal | 0.1 | 0 | <0.1 | 0 | 0.2 | 0 | <0.1 |
| Greater scaup | 0.1 | 0 | <0.1 | 0 | 0 | 0 | <0.1 |
| Lesser scaup | <0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| King eider | <0.1 | 0.1 | 0 | 0.5 | 0 | 0.6 | 0.7 |
| Long-tailed duck | 0.4 | 1.4 | 0.2 | 0.5 | 0.4 | 0.4 | 0.4 |
| **Loons and Grebes** | | | | | | | |
| Red-throated loon | 0.2 | 0.6 | 0.2 | 0.2 | 0.1 | 0 | 0.1 |
| Pacific loon | 0.5 | 0.9 | 0.4 | 1.9 | 0 | 1.2 | 0.9 |
| Yellow-billed loon | 0.1 | 0.3 | 0.1 | 0 | 0.1 | 0.2 | 0.1 |
| Red-necked grebe | 0.1 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| **Grouse** | | | | | | | |
| Willow ptarmigan | 0.7 | 0.3 | 1.6 | 0.6 | 1.0 | 0 | 0.4 |
| Rock ptarmigan | <0.1 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| **Cranes and Large Shorebirds** | | | | | | | |
| Sandhill crane | <0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Whimbrel | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| Bar-tailed godwit | 0.1 | 0.1 | 0.1 | 0 | 0 | 0 | 0.2 |
| Wilson's snipe | <0.1 | 0 | 0 | 0 | 0 | 0 | 0 |

## Table 3.3.3-5 Ground-based Nest Densities (Nest/km$^2$) in the Plan Area (cont'd)

| | | CD North | CD South | Alpine West | Lookout | Spark | |
|---|---|---|---|---|---|---|---|
| **Species[a]** | **Alpine (6-year mean)[b]** | **CD-3 (4-year mean)[c]** | **CD-4 (3-year mean)[c]** | **CD-5 (2-year mean)[c]** | **CD-6 (2-year mean)[c]** | **CD-7 (2-year mean)[c]** | **NPR-A (2003)[d]** |
| **Raptors and Owls** | | | | | | | |
| Northern harrier | 0 | 0 | <0.1 | 0 | 0 | 0 | 0 |
| Short-eared owl | <0.1 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| **Seabirds** | | | | | | | |
| Parasitic jaeger | 0.1 | 0.1 | <0.1 | 0.1 | 0 | 0.2 | 0.2 |
| Long-tailed jaeger | 0.1 | 0 | 0.2 | 0.2 | 0 | 0 | 0.1 |
| Glaucous gull | 0.1 | 0.4 | 0.1 | 1.0 | 0 | 0.2 | 0.7 |
| Sabine's gull | <0.1 | 0.4 | 0 | 0 | 0 | 0.6 | 0.2 |
| Arctic tern | 0.4 | 0.8 | 0.4 | 0.4 | 0.1 | 0.5 | 0.7 |

Notes:
[a] Nest densities for small shorebirds and passerines are presented in Table 3.3.3-7.
[b] Burgess et al. 2003a (Table 6)
[c] Means calculated from data presented in Burgess et al. (2003a), Burgess et al. (2003b), Johnson et al. (2003b) and Johnson et al. (2004).
[d] Johnson et al. 2004

## TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a]

| Habitat | Greater White-Fronted Goose[b] | | | Lesser Snow Goose | | Canada Goose | | Black Brant | | Tundra Swans | | Northern Pintail | | Scaup | King Eiders | | Long-Tailed Ducks | | Red-Throated Loons | | Pacific Loons | | Yellow-Billed Loons | | Glaucous Gulls | | Sabine's Gull | | Arctic Tern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nesting | Brood-rearing | Staging | Brood-rearing | Staging | Brood-rearing | Staging | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Pre-nesting | Nesting | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing |
| **Colville River Delta[c]** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Open Nearshore Water | A | | | | U | | | | | A | A | | | | | | | | | | | | | | | | | | | |
| Brackish Water | | U | | U | U | | U | | P | | P | | | | P | | | | U | U | P | U | | | U | U | | | | |
| Tapped Lake with Low-water Connection | A | U | U | | | U | | | | A | P | | | | | | | | | | | | A | | | U | | | | |
| Tapped Lake with High-water Connection | A | | | | | U | | | | A | P | | | | | | | | | | P | U | | P | U | | | | | |
| Salt Marsh | A | | | | | | U | | | P | P | | | | | | | | | | | | | | | | | | | |
| Tidal Flat | | | | | U | | | A | A | A | A | | | | A | | | | | | | | A | | | | | | | |
| Salt-killed Tundra | A | | | | | | U | P | | P | | U | | | | U | A | | U | | A | | A | | | | U | U | | |
| Deep Open Water without Islands | A | U | | U | | | | | | | P | | U | | A | | P | U | | | | U | | P | | | | U | | U |
| Deep Open Water with Islands or Polygonized Margins | | U | U | | | | | | | P | P | U | U | | | U | P | U | | | P | U | P | P | U | U | U | U | U | U |
| Shallow Open Water without Islands | | | | | | | | | | | | | | | | | | U | | | | | | | | | | | | |
| Shallow Open Water with Islands or Polygonized Margins | | | | | | | | | | | | | | | | | P | | U | U | P | U | | | | | | U | U | U |
| River or Stream | | | U | | | | | A | | A | A | | | | P | | | | | | | | A | A | | | | | | |
| Aquatic Sedge with Deep Polygons | P | | | | | | | P | | P | | U | U | U | | U | P | U | U | U | A | | P | | U | U | U | | U | U |

## TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

| Habitat | Greater White-Fronted Goose[b] | | | Lesser Snow Goose | | Canada Goose | | Black Brant | | Tundra Swans | | Northern Pintail | | Scaup | King Eiders | | Long-Tailed Ducks | | Red-Throated Loons | | Pacific Loons | | Yellow-Billed Loons | | Glaucous Gulls | | Sabine's Gull | | Arctic Tern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nesting | Brood-rearing | Staging | Brood-rearing | Staging | Brood-rearing | Staging | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Pre-nesting | Nesting | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing |
| Aquatic Grass Marsh | | | | | | | | | | | P | | | | | | | | | | | | | | | | | | | |
| Nonpatterned Wet Meadow | | | | U | | | | | | | | U | | U | A | | | | | | A | | | A | | | U | U | U | U |
| Patterned Wet Meadow | P | U | | | | | U | | | P | | U | | U | A | U | | | U | | A | | P | A | | | U | U | U | U |
| **Colville River Delta[c]** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Moist Sedge-Shrub Meadow | A | | | | U | | | | | P | | U | | | | | | | | | | | A | | | | | | | |
| Riverine or Upland Shrub | A | | | | | | | | | A | A | U | | | A | | | | | | | | A | | | | U | | | |
| Barrens (riverine, eolian, or lacustrine) | A | | | | | | U | | | A | A | | | | A | | | | | | | | A | A | | | | | | |

## TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

| Habitat | Greater White-Footed Goose | | | Canad Goose | | Black Brant | | Tundra Swans | | Northern Pintail | | King elders | | Long-Tailed Ducks | | Red-throated Loons | | Pacific Loons | | Yellow-billed Loons | | Glaucous Gulls | | Sabine's Gull | | Artic Tern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nesting | Brood-rearing | Staging | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Pre-nesting | Nesting | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing |
| **NPR-A Sites[d]** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Brackish Water | | | | | | | | | | | | P | | | | | | | | | | | | | | | |
| Tapped Lake with Low-water Connection | | | | | | | | | P | | | | | | | | | | | | | | | | | | |
| Deep Open Water without Islands | A | U | U | | | | | A | P | | | P | | | U | | | | U | | P | | | | | | |
| Deep Open Water with Islands or Polygonized Margins | A | U | U | | | | U | | P | | | P | | | | | | U | U | P | P | U | | U | | | U |
| Shallow Open Water without Islands | | | | | | | | | | | | P | | | U | | | | U | | | | | | | | |
| Shallow Open Water with Islands or Polygonized Margins | A | U | | U | | U | | P | | | | P | U | U | | U | U | U | U | | | U | U | U | U | U | U |
| Aquatic Sedge Marsh | A | | | | | | | | | U | | P | U | U | U | | | U | U | P | | | | U | U | U | U |
| Aquatic Grass Marsh | | | | | | | | P | | | | | | | | | | | U | P | | | | | | | |
| Riverine Complex | | | | | | | U | | | | | | | | U | | | | | | | | | | | U | |
| Young Basin Wetland Complex | | | | | | u | | | | | | | | | | | | | | | | | | | | U | |
| Old Basin Wetland complex | P | U | U | U | | | | | A | U | | | U | U | | U | U | | | A | | | | | | U | U |
| Nonpatterned Wet Meadow | A | | | | | | | | | | | | | U | | | | | | | | | | | | | |

## TABLE 3.3.3-6 HABITAT USE (U) OR SELECTION (A-AVOID, P-PREFER) FOR GROUND-BASED NEST SEARCHES OR AERIAL SURVEYS IN THE PLAN AREA[a] (CONT'D)

| Habitat | Greater White-Footed Goose | | | Canad Goose | | Black Brant | | Tundra Swans | | Northern Pintail | | King elders | | Long-Tailed Ducks | | Red-throated Loons | | Pacific Loons | | Yellow-billed Loons | | Glaucous Gulls | | Sabine's Gull | | Artic Tern | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nesting | Brood-rearing | Staging | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Pre-nesting | Nesting | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing | Nesting | Brood-rearing |
| **NPR-A Sites[d]** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Patterned Wet Meadow | P | | U | | | | | U | A | U | U | A | U | | | | | | | U | | | | | | | |
| Moist Sedge-Shrub Meadow | U | | U | | U | | | | A | | | A | | U | | | | | | A | A | | | U | | | |
| Moist Tussock Tundra | P | | | | | | | | A | U | U | A | | U | U | | | | | A | A | | | | | | |
| Riverine Low and Tall Shrub | | U | | | | | | | | | | | | | | | | | | | | | | | | | |

Notes:
[a] Selection(A,P) is based on use in proportion to availability compared to random habitat selection. If no selection analysis was completed use information is presented. Use (U) is reported as occurrence for ≥10% of nests or broods within a habitat
[b] Johnson et al. 2003a, 2004
[c] Burgess et al. 2003a, Johnson et al 2004
[d] Burgess et al. 2003b, Johnson et al. 2004

### 3.3.3.2 Waterfowl (Tinmiagruich)

Numerous species of waterfowl, including 15 species of ducks, 4 species of geese, and 1 swan species, regularly occur across the Arctic Coastal Plain and in the Plan Area (Table 3.3.3-1 and Table 3.3.3-3). Species-specific surveys within the Plan Area have focused on tundra swan, black brant (*Branta bernicla nigricans*), spectacled eiders, Steller's eiders, and king eiders. Focus on these species has been based on their status as sensitive, federally listed as threatened, or of special concern of regulatory agencies and on the importance of the Plan Area as breeding, molting, brood-rearing, and/or staging habitat (Johnson et al. 1999). Spectacled and Steller's eiders are discussed in Section 3.3.5, Endangered and Threatened Species.

#### GEESE

##### NORTH SLOPE

Four goose species commonly nest on the North Slope. In order of decreasing abundance, these are greater white-fronted goose, Canada goose, brant, and snow goose (*Chen caerulescens*), (Table 3.3.3-3). Greater white-fronted goose is the most common and widespread of the four species, and their population increased at a rate of approximately 2 percent per year on the Arctic Coastal Plain during 1986 to 2002 (Mallek et al. 2003). Derksen et al. (1981) reported that greater white-fronted geese nested on upland sites or polygonal ground near shallow *Carex* [Aquatic Sedge Marsh] and *Arctophila* [Aquatic Grass Marsh] wetlands, while post-breeding birds used deep open lakes [Deep Open Water] during the molting period. Greater white-fronted geese concentrate on the Arctic Coastal Plain southeast of Point Lay, east of Wainwright, and northeast of Teshekpuk Lake (Figure 3.3.3.2-1).

The Canada goose is a common species that nests in low densities in the Prudhoe Bay area, the Colville River Delta, and the National Petroleum Reserve-Alaska. It is a much more common breeder in the interior of Alaska than on the Arctic Coastal Plain. After nesting, small flocks of interior-nesting Canada geese migrate to the Arctic Coastal Plain where they aggregate with locally nesting geese to molt (S. Johnson 2003, pers. comm.). The Arctic Coastal Plain population of Canada geese has varied from lows near 3,000 in 1989 and 1994 to highs near 47,000 in 1986 and 1999 (Mallek et al. 2003). The 2002 population estimate was 52 percent lower than the mean population size calculated from the surveys conducted from 1986 through 2001 (Mallek et al. 2003). Derksen et al. (1981) reported that Canada geese in the National Petroleum Reserve-Alaska fed in upland sites and in flooded tundra and shallow *Carex* [Aquatic Sedge Marsh] wetlands during June but moved to deep open lakes [Deep Open Water] that afforded more protection from predators during the July molt.

Brant nest in small and large colonies that are used year after year. These colonies generally are near the coast but could be 30 km or more inland (Derksen et al. 1981; BLM and MMS 1998a; Reed et al. 1998). Brant nest at many locations in the Prudhoe Bay area. The greatest nesting densities have been at two colonies, one in the Colville River Delta and the other in the Sagavanirktok River Delta (Sedinger and Stickney 2000). There are approximately 100 nesting pairs in the Kuparuk River Delta. The numbers of nests in parts of the Colville River Delta have increased dramatically in recent years, while the number of nests in the Sagavanirktok River Delta have declined (Sedinger and Stickney 2000). Due to the clumped distribution of colonial nesting species such as brant and snow geese, population estimates from standard aerial breeding pair surveys may not reflect the true population size and distribution (Mallek et al. 2003). Brant often build nests on small islands in ponds or river deltas and on offshore islands. Broods are reared on nearby tidal flats and salt marshes and at inland lakes. Brant use deep *Arctophila* lakes for nesting and could move broods to deep open lakes for brood-rearing (Bergman et al. 1977; Derksen et al. 1981), although most brood-rearing takes place in coastal areas. Large numbers of molting and brood-rearing brant use lakes located north and east of Teshekpuk Lake in the National Petroleum Reserve-Alaska (Derksen et al. 1982).

Snow geese nest primarily in arctic Canada and Russia, although a few small colonies nest on Alaska's Arctic Coastal Plain. The population of snow geese on the Coastal Plain has increased dramatically in recent years (Ritchie et al. 2000) and recently, the Ikpikpuk colony has been the largest on the Arctic Coastal Plain. The colony on Howe Island in the Sagavanirktok River Delta, adjacent to the active Endicott oil production field, declined in the late 1990s, apparently as a result of terrestrial predators (foxes and bears) (Johnson 2000a). A few other small and medium-sized colonies are scattered across the Beaufort Sea Coast. Because of the colonial nesting tendency of snow geese, breeding pair surveys might not reflect the true population size and distribution (Mallek et al. 2003).

#### PLAN AREA

Greater white-fronted geese nested at all proposed development areas except the Clover Potential Gravel Source (Table 3.3.3-5). Highest nesting densities for this species were at the Colville River Delta sites (Figure 3.3.3.2-2) and at CD-5 in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-3 and Table 3.3.3-5). Nesting greater white-fronted geese preferred Patterned Wet Meadow and Aquatic Sedge with Deep Polygons in the Colville River Delta (Table 3.3.3-6). Patterned Wet Meadow was also used for nesting at the National Petroleum Reserve-Alaska sites, but Aquatic Sedge with Deep Polygon habitat was not available at these sites (Tables 3.3.3-4 and 3.3.3-6). Brood-rearing and staging geese used Deep Open Water habitats in both areas and Tapped Lakes with Low-Water Connection in the Colville River Delta (this habitat type was not available in the National Petroleum Reserve-Alaska sites) (Tables 3.3.3-4 and 3.3.3-6).

Canada geese nest on small islands in lakes in the Prudhoe Bay area but until recently had not been reported nesting in the Colville River Delta or the National Petroleum Reserve-Alaska (Johnson et al. 1998). In recent years 1 or 2 nests annually have been reported near the Alpine Facilities, and as many as 10 nests were reported in the Plan Area (Johnson et al. 1997, 1998). Nest densities were highest at CD-5 for the National Petroleum Reserve-Alaska sites, with little nesting at the Colville River Delta sites (Table 3.3.3-5). In the Colville River Delta, nesting was on Tapped Lakes, which were not available at the National Petroleum Reserve-Alaska sites; the National Petroleum Reserve-Alaska nesting habitats included Shallow Open Water with Islands and Old Basin Wetland Complex (Table 3.3.3-4).

The largest brant colony on the Arctic Coastal Plain is in the Colville River Delta approximately 12 to 24 km east of the proposed CD-3 development (Johnson et al. 2002). Nest densities were highest at the CD-3 site in the Colville River Delta (Figure 3.3.3.2-4) and at the CD-5 site in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-5 and Table 3.3.3-5). Aquatic Sedge with Deep Polygons was preferred nesting habitat in the Colville River Delta and was used as nesting habitat in the National Petroleum Reserve-Alaska sites (Table 3.3.3-6). During brood-rearing, brant preferred Brackish Water habitats (Table 3.3.3-6). Most brant nests in the area proposed for satellite development are in the northeast portion of the Plan Area, although two additional colonies were located just outside the northeast section of the Plan Area (Burgess et al. 2003b). The remaining portion of the area proposed for satellite development lacks suitable nesting habitat and is farther from the coast than brant are typically found. Ritchie et al. (2002b) reported a brant colony in the Plan Area near the coast west of Fish Creek that varied over years from 25 to 55 nests. From 1995 to 2001, the numbers of brant in the Harrison Bay area during brood-rearing surveys varied from 566 to more than 6,000 birds (Ritchie et al. 2002b).

Snow geese nested at the CD-3 site but were not recorded at any other proposed development site (Table 3.3.3-5). The numbers of snow geese observed during brood-rearing surveys in Harrison Bay have ranged from 50 to more than 600 birds (Ritchie et al. 2002). Small numbers of nests have also been recorded on the outer portions of the Colville River Delta in recent years (Helmericks 2003a, pers. comm.), and a brood-rearing flock was present on the east side of the Delta in 2001 (Noel et al. 2002d).

### SWANS (QUGRUK)

#### NORTH SLOPE

Approximately 20 percent of tundra swans on the Arctic Coastal Plain are in the Northeast National Petroleum Reserve-Alaska during nesting, with almost 20 percent of these within the Plan Area (Table 3.3.3-3). Both tundra swans and swan nests have increased at a mean of approximately 4 percent per year from 1986 to 2002 (Mallek et al. 2003). Ritchie and King (2000) reported a similar upward trend in the numbers of nests and adult swans in the Kuparuk oilfield from 1988 to 1997, although overall nest density did not increase (Ritchie et al. 2002a). Tundra swan concentrations across the Arctic Coastal Plain include areas around Dease Inlet, southeast of Teshekpuk Lake, the Colville River Delta, and east of the Colville River (Figure 3.3.3.2-6). During nesting, tundra swans select deep

*Arctophila* ponds [Fresh Grass Marsh], and *Arctophila* could be an important food source, although other types of vegetation and invertebrates are also consumed (Derksen et al. 1981). Tundra swan nest mounds, usually situated within 100 meters of large lakes, are often used repeatedly (Stickney et al. 2002). Lakes with complex shorelines could be preferred because they have small coves and sheltered areas that are suitable for emergent vegetation such as *Arctophila* and provide forage and escape cover for swans. During brood-rearing, swans could feed on land, as well as on lakes and ponds, and broods could move overland between lakes (Limpert and Earnst 1994). Tundra swans sometimes congregate into flocks of several hundred birds or more as they stage before fall migration.

#### PLAN AREA

Tundra swan nest densities were substantially higher in the Colville River Delta than in the National Petroleum Reserve-Alaska portion of the Plan Area (Table 3.3.3-5). Tundra swan nest density was slightly higher at the Alpine Facility than at either CD-3, CD-4 or CD-5 (Figure 3.3.3.2-7 and Table 3.3.3-5). Few tundra swan nests were found near proposed development locations in the National Petroleum Reserve-Alaska (Figure 3.3.3.2-8 and Table 3.3.3-5). Tundra swan nesting and brood-rearing habitat use in the Colville River Delta and the National Petroleum Reserve-Alaska are presented in Table 3.3.3-6. Habitats preferred for nesting and brood-rearing in the Colville River Delta were more diverse than those in the National Petroleum Reserve-Alaska study area, but in both areas tundra swans selected Deep Open Water with Islands for both nesting and brood-rearing (Table 3.3.3-6).

### DUCKS

#### NORTH SLOPE

Fifteen duck species (Table 3.3.3-1) regularly occur on the Arctic Coastal Plain (Mallek et al. 2003). The two most common species are northern pintail and long-tailed duck (Table 3.3.3-3), which together comprise approximately 85 percent of the total Arctic Coastal Plain duck population (Mallek et al. 2003). Other species, including four eider species, occur in much lower densities. Two of the eider species—spectacled eider and Steller’s eider—are federally listed threatened species and are discussed in Section 3.3.5, Endangered and Threatened Species.

Northern pintails are the most numerous duck in the Northeast National Petroleum Reserve-Alaska and in the Plan Area (Table 3.3.3-3). Populations on the Arctic Coastal Plain showed no consistent trend between 1986 and 2002 (Mallek et al. 2003). Two concentration areas of nesting birds occur in the Northeast National Petroleum Reserve - Alaska, both northeast and southeast of Teshekpuk Lake (Figure 3.3.3.2-9). Additional concentration areas are east of Wainwright, south of Barrow, and southeast of Dease Inlet. Northern pintails are found most commonly on *Arctophila* wetlands [Aquatic Grass Marsh], particularly shallow wetlands and beaded streams where *Arctophila* is present, although deep *Arctophila* lakes are used extensively during the brood-rearing period (Derksen et al. 1981).

Eiders use primarily coastal routes during migration and arrive in the Beaufort Sea area in late May and early June. King eiders are the most numerous eider species on the Arctic Coastal Plain (Table 3.3.3-3) (Larned et al. 2003). King eider populations on the Arctic Coastal Plain have shown an increasing trend of 3 percent per year since 1993 (Larned et al. 2003). Fall migration counts of king eiders at Barrow, however, had decreased by 50 percent between the 1970s and 1990s (Suydam et al. 2000). There are two large concentration areas of nesting king eiders on the Arctic Coastal Plain, one northwest of Atqasuk and one south of Teshekpuk Lake extending east to Atigaru Point (Figure 3.3.3.2-10). The largest of these areas, south of Teshekpuk Lake, is within the Northeast National Petroleum Reserve-Alaska and the Plan Area (Figure 3.3.3.2-10). King eiders use shallow and deep *Arctophila* wetlands [Aquatic Grass Marsh] during the nesting period and deep *Arctophila* ponds through July and August during brood-rearing, although some brood-rearing could also occur on shallow *Carex* ponds [Aquatic Sedge Marsh] (Derksen et al. 1981). Higher densities of molting king eiders occur during July in deep-water habitats in Harrison Bay than in nearshore and deep-water habitats from Cape Halkett to Brownlow Point (Fischer et al. 2002).

Approximately 2,500 Pacific-race common eiders (*Somateria mollissima v-nigrum*) occur along the Alaska Beaufort Sea Coast during late June (Table 3.3.3-3) (Dau and Anderson 2002). Fall migration counts of common eiders at Barrow decreased by 50 percent between the 1970s and 1990s (Suydam et al. 2000). Common eiders nest primarily in loose aggregations or colonies on barrier islands, although they also nest on coastal spits or beaches (Gouldie et al. 2000). Nearshore coastal distributions during nesting surveys indicate that breeding pairs of common eiders are most numerous along the central Beaufort Sea Coast between the eastern edge of the Colville River Delta and Brownlow Point (Dau and Anderson 2002). No common eiders used the Plan Area coastline during 2002 (Dau and Anderson 2002). Nest sites are usually associated with driftwood or beach rye grass (*Elymus arenarius*). Common eiders also use manmade causeways and gravel islands in the Prudhoe Bay area for nesting (Johnson 2000b). Common eiders were more common in nearshore waters than offshore waters between Cape Halkett and Brownlow Point, where they were more abundant in areas east of Harrison Bay during June to August (Fischer et al. 2002)

Long-tailed ducks are the second most numerous duck species on the Arctic Coastal Plain (Table 3.3.3-3). Approximately 20 percent of the long-tailed duck population nests in the National Petroleum Reserve-Alaska, with about 5 percent nesting in the Plan Area (Table 3.3.3-3). The Arctic Coastal Plain nesting population of long-tailed ducks showed a declining trend of approximately 3 percent per year between 1985 and 2002 (Mallek et al. 2003). Nesting concentrations are scattered across the Arctic Coastal Plain, with the largest concentration areas east of Deese Inlet and in the southern portion of the Northeast National Petroleum Reserve-Alaska (Figure 3.3.3.2-11). Smaller concentration areas in and near the Plan Area are south of the Kogru River and southeast of the Colville River Delta (Figure 3.3.3.2-11). During the breeding season, long-tailed ducks use shallow *Carex* [Aquatic Sedge Marsh] and shallow Arctophila ponds, as well as deep *Arctophila* wetlands and beaded streams [Aquatic Grass Marsh] (Bergman et al. 1977; Derksen et al. 1981). During brood-rearing almost half of the broods were reported on deep *Arctophila* lakes, with significant numbers also using deep open lakes and shallow *Carex* wetlands (Derksen et al. 1981). After breeding, male long-tailed ducks use coastal lagoons for molting. The density of long-tailed ducks in the shallow waters of Harrison Bay is generally lower than in shallow marine waters from Prudhoe Bay to Brownlow Point (Fischer et al. 2002).

#### PLAN AREA

Nesting concentrations of northern pintails were highest at CD-4 in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Habitat use was more variable in the Colville River Delta than at the National Petroleum Reserve-Alaska sites, although Aquatic Sedge Marsh with or without Deep Polygons were used for nesting in both areas (Table 3.3.3-6).

King eiders nested at the CD-3 and the Alpine Facility in the Colville River Delta, and pre-nesting eiders appeared to use the outer delta to a greater extent than the inner delta (Figure 3.3.3.2-12). King eider nest densities were highest at CD-7 and CD-5 (Table 3.3.3-5) in the Plan Area, although nests were found clustered between CD-6 and CD-7 (Figure 3.3.3.2-13). Although king eiders nest in the Colville River Delta, they could be more common as a nesting species in areas east and west of the Delta (Figure 3.3.3.2-12). Pre-nesting king eider densities increase from the Fish Creek Delta westward across the central portion of the Plan Area, consistent with the concentration area shown on Figure 3.3.3.2-13 (Noel et al. 2001).

A few common eiders have been observed in the outer Colville River Delta (Figure 3.3.3.2-12). They were not reported nesting at any of the Colville River Delta or the National Petroleum Reserve-Alaska sites proposed for development (Burgess et al. 2003a, 2003b; Johnson et al. 2003a, 2003b). Common eiders were less common in the shallow waters of Harrison Bay than in the shallow marine waters from Prudhoe Bay to Brownlow Point during June to August.

Long-tailed ducks nested at all proposed pad locations (Table 3.3.3-5and Figure 3.3.3.2-14), with the highest nesting density at CD-3 and the lowest density at CD-4 in the Colville River Delta. Long-tailed ducks used a wide variety of habitats for nesting, but used Shallow Open Water with Islands and Aquatic Sedge habitats in both the Colville River Delta and the National Petroleum Reserve-Alaska (Table 3.3.3-6).

### 3.3.3.3 Loons (Malgitch)

#### NORTH SLOPE

Three loon species, Pacific, red-throated, and yellow-billed, breed on the North Slope. Loons arrive on the North Slope in late May and establish breeding territories on tundra lakes and ponds as soon these habitats are free of ice and snow (Table 3.3.3-2). After nesting, loons could move to marine habitats before migration in August and September (Johnson and Herter 1989).

Red-throated loons are much less common than Pacific loons on the Arctic Coastal Plain (Table 3.3.3-3). Mallek et al. (2003) reports an increase in the numbers of red-throated loons on the Arctic Coastal Plain from 1986 to 2002. The largest concentration area for red-throated loons appears east of the Northeast National Petroleum Reserve-Alaska, with two small concentrations in the Plan Area (Figure 3.3.3.3-1). Red-throated loons use shallow *Arctophila* wetlands [Aquatic Grass Marsh] that are usually situated near the coast or near large lakes with fish (Derksen et al. 1981). Red-throated loons regularly forage away from their nesting pond, flying to larger lakes or to marine habitats to feed and to bring fish back to their young (Barr et al. 2000).

The Pacific loon is the most abundant loon species across the Arctic Coastal Plain (Table 3.3.3-3), and aerial surveys during the last 10 years have indicated that the population is stable (Mallek et al. 2003). Most of the largest concentration areas for Pacific loons are outside of the Northeast National Petroleum Reserve-Alaska, with two small concentrations and a part of one large concentration within the Plan Area (Figure 3.3.3.3-2). Pacific loons nest on small islands and vegetation platforms near the water's edge (Kertell 1994, 2000), and nests most frequently are found on deep *Arctophila* lakes [Deep Open Water with Islands or Polygonized Margins] and to a lesser extent on deep open lakes [Deep Open Water without Islands] (Bergman et al. 1977; Derksen et al. 1981). Pacific loons exhibit site fidelity to breeding locations, often returning to the same lake or pond in successive years (Kertell 2000).

The yellow-billed loon is the least abundant loon species on the Arctic Coastal Plain (Table 3.3.3-3), and the population growth rate has shown no trend from 1986 to 2002 (Mallek et al. 2003). The largest concentration area for yellow-billed loons is southeast of Deese Inlet, with a lower concentration area in the northwest corner of the Plan Area (Figure 3.3.3.3-3). Yellow-billed loons nest on deep open lakes and deep *Arctophila* lakes [Deep Open Water with Islands or Polygonized Margins] that are generally larger than those used by other loon species (Derksen et al. 1981; North 1986; Burgess et al. 2003b; Johnson et al. 2003b), although nests could also occur on smaller wetlands adjacent to large lakes (North 1986; Burgess et al. 2003b; Johnson et al. 2003b). Yellow-billed loon nests are constructed on islands and along the shoreline where adults feed on fish and invertebrates, and nest sites might be reused in subsequent years (North 1994). Pairs that nest in small lakes could move broods overland to nearby larger lakes (North 1986).

#### PLAN AREA

Red-throated loons are much less common than Pacific loons in the Northeast National Petroleum Reserve-Alaska, as well as in the Plan Area (Table 3.3.3-3) (Noel et al. 2002; Burgess et al. 2003a, 2003b). The highest nesting densities of red-throated loons in the Plan Area have been recorded near CD-3 in the Colville River Delta (Figure 3.3.3.3-4 and Table 3.3.3-5), where they used a variety of wetlands habitats for nesting and brood-rearing (Table 3.3.3-6) (Johnson et al. 2003b). Red-throated loon nests are found only at CD-5 for the National Petroleum Reserve-Alaska sites (Figure 3.3.3.3-5), where Old Basin Wetland Complex habitats were used for both nesting and brood-rearing (Table 3.3.3-6). Offshore transects conducted between Cape Halkett and Brownlow Point from June through August found that red-throated loons used the Harrison Bay shallow area primarily during July, and the Harrison Bay deep area during August (Fisher et al. 2002).

Pacific loons are the most abundant loon species in the Plan Area (Table 3.3.3-3; Noel et al. 2001, 2002c; Burgess et al. 2003b). Pacific loons nest in a wide variety of habitats throughout the Plan Area (Table 3.3.3-6). In the Colville River Delta, Pacific loons used brackish water and tapped lakes with high-water connections for both nesting and brood-rearing, habitats that were not available at the National Petroleum Reserve-Alaska sites (Figure 3.3.3.3-4 and Table 3.3.3-4). In the National Petroleum Reserve-Alaska sites, Pacific loon nest densities were highest at CD-5 and

CD-7 (Figure 3.3.3.3-5 and Table 3.3.3-5), where loons used Shallow-Open Water with Islands and Aquatic Sedge Marsh for both nesting and brood-rearing (Table 3.3.3-6). These habitats were rare at the Colville River Delta sites (Table 3.3.3-4). Andres (1993) reported that Pacific loons in the Colville River Delta portion of the Plan Area made frequent foraging trips to marine habitats, particularly during brood-rearing. Pacific loons were the most abundant loon species observed during offshore surveys between Cape Halkett and Brownlow Point, with consistent use of the Harrison Bay shallow areas (Fischer et al. 2002).

Densities of nesting yellow-billed loons were highest at CD-3 and CD-7 (Table 3.3.3-5), but were still low in these areas. The Colville River Delta is an important nesting area for yellow-billed loons (Figure 3.3.3.3-4), according to North and Ryan (1988) and Johnson et al. (1999), whose surveys were mainly in the Delta habitats. Surveys in the Fish and Judy creek drainages identified concentrations of nests near these streams in the National Petroleum Reserve-Alaska (Figure 3.3.3.3-5) (Burgess et al. 2003b). The nesting population in the Fish and Judy creek drainages could be as large or larger than the Colville River Delta nesting population (Burgess 2003, pers. comm.; Burgess et al. 2003b; Johnson et al. 2003b). Yellow-billed loons selected Deep Open Water with Islands or Polygonized Margins for both nesting and brood-rearing in the Colville River Delta and at the National Petroleum Reserve-Alaska sites (Table 3.3.3-6). This habitat was relatively rare in both the Colville River Delta (1.4 percent of available habitats) and at the National Petroleum Reserve-Alaska sites (5.2 percent of available habitats) when searched for nests (Table 3.3.3-4). Fischer et al. (2002) reported that densities of yellow-billed loons were significantly higher in the shallow waters of Harrison Bay during the summer than in seven other shallow and deepwater areas between Cape Halkett and Bullen Point.

### 3.3.3.4 Ptarmigan

#### NORTH SLOPE

Two species of ptarmigan, willow and rock, are found in the Plan Area. Ptarmigan are ground-nesting birds in the grouse family that could remain on the Arctic Coastal Plain as year-round residents. Rock ptarmigan could conduct local migrations during the fall to obtain willow forage (Johnson and Herter 1989). These species are not generally recorded during aerial surveys for birds on the Arctic Coastal Plain (Larned et al. 2003; Mallek et al. 2003).

#### PLAN AREA

Noel et al. (2001) reported that willow ptarmigan were far more abundant in the eastern National Petroleum Reserve-Alaska than rock ptarmigan, and Johnson et al. (2003a) reported higher nest densities for willow ptarmigan than for rock ptarmigan in the CD-3, CD-4, and ASDP study areas in the Colville River Delta. Burgess et al. (2003b) found only willow ptarmigan nesting at CD-5 and CD-6 in the National Petroleum Reserve-Alaska, although some unidentified ptarmigan nests were also reported (Table 3.3.3-5). Ptarmigan used Patterned Wet Meadow and Moist Sedge-Shrub habitats for nesting, and Moist Sedge-Shrub habitats for brood-rearing at both the Colville River Delta and at the National Petroleum Reserve-Alaska sites (Burgess et al. 2003 a, b; Johnson et al. 2003a).

### 3.3.3.5 Raptors and Owls

#### NORTH SLOPE

Raptors are birds of prey that include falcons, hawks, eagles, and owls. The snowy owl and gyrfalcon are the only raptors known to overwinter on the Arctic Coastal Plain; all others migrate south to overwinter (Johnson and Herter 1989). Most raptors on the North Slope are cliff-nesting species, but the northern harrier, snowy owl, and short-eared owl nest on the ground. The arctic peregrine falcon (*Falco peregrinus tundrius*) was removed from the Endangered Species List in 1994, with monitoring of the population required until 1999 (59 FR 50796). The gyrfalcon is an uncommon species on the Arctic Coastal Plain but is a fairly common nesting species south of the Plan Area in the foothills of the Brooks Range and on cliffs and bluffs along the Colville River (Figure 3.3.3.5-1). Gyrfalcons use nests constructed by rough-legged hawks or ravens in previous years (Johnson and Herter 1989, and references therein). Gyrfalcons have used abandoned raven nests on artificial structures such as the trans-Alaska pipeline (Ritchie 1991). The rough-legged hawk nests in the Brooks Range and along the cliffs and bluffs of the Colville River (Figure 3.3.3.5-1). Ritchie (1991) also reported a rough-legged hawk nest on tundra near the Dalton Highway. Rough-legged hawks have also been reported using manmade structures for nest sites (Ritchie, 1991). Golden eagles nest in the Brooks Range, but they are not known to nest in the Plan Area (Ritchie 2003, pers. comm.). Although the main prey of the golden eagle is the arctic ground squirrel, they are also known to prey on newborn caribou calves during spring (Johnson and Herter 1989). Bald eagles and merlins also are occasionally observed on the Arctic Coastal Plain.

Ground-nesting raptors on the Arctic Coastal Plain include snowy and short-eared owls and the northern harrier (Table 3.3.3-5). These species breed irregularly across the Arctic Coastal Plain and are most common during highs in microtine rodent populations.

#### PLAN AREA

Three falcon species—peregrine falcon, gyrfalcon, and merlin—occur in small numbers in the Plan Area. Hawks in the Plan Area include the rough-legged hawk and northern harrier. Golden and bald eagles could also range into the area. Two owl species, snowy and short-eared, also nest in the Plan Area. Arctic peregrine falcons nest along the Colville River south of Ocean Point (Figure 3.3.3.5-1). Five to nine peregrine nests have been reported in this area annually since 1999 (Swem 2003, pers. comm.). Arctic peregrine falcons have also been reported nesting in the Plan Area near the CD-7 site (Figure 3.3.3.5-1) (Johnson and Stickney, 2001; Burgess et al. 2002a) and apparently are expanding their range on the Arctic Coastal Plain (Ritchie and Wildman 2002). The gyrfalcon is a fairly common nesting species south of the Plan Area in the foothills of the Brooks Range and on cliffs and bluffs along the Colville River. No recent nests were reported for the portion of the CRSA within the Plan Area (Figure 3.3.3.5-1). Rough-legged hawks nest in the Brooks Range and along the cliffs and bluffs of the Colville and other rivers. Since 1999, three to nine nests have been reported annually in the portion of the CRSA within the Plan Area (Figure 3.3.3.5-1) (Swem 2003, pers. comm). Bald eagles and merlins are uncommon visitors in the Plan Area.

Ground-nesting raptors that occur and breed irregularly in the Plan Area include snowy and short-eared owls and northern harrier. Northern harriers and short-eared owls have nested at CD-4. Short-eared owls have also nested at CD-2. (Figure 3.3.3.5-1 and Table 3.3.3-5)

### 3.3.3.6 Shorebirds

#### NORTH SLOPE

The North Slope provides some of the most productive shorebird habitat in northern Alaska. More than 30 species of shorebirds are known to breed on the North Slope, and as many as 6 million shorebirds are thought to spend the summer there (Cotter and Andres 2000). In general, shorebirds are present on the North Slope from May to September. After hatching, brood-rearing shorebirds move to tundra and aquatic habitats adjacent to their nests. Many shorebirds move to coastal habitats to feed after young have fledged and before migrating during late August and September (Andres 1994; Johnson and Herter 1989; PAI 2002a, Appendix B). Shorebird nesting densities on the Arctic Coastal Plain could range from 65 nests/Square kilometer ($km^{2)}$ in the Point McIntyre area (TERA 1993) to 163 nests/$km^2$ at the Alpine Facility (Johnson et al. 2003a). Shorebird nest densities within the Plan Area were within the range of densities (12 to 80 nests/$km^2$) found across the National Petroleum Reserve-Alaska (Cotter and Andres 2000). Shorebird nesting is variable not only from place to place but also year to year depending on weather (Troy 2000). Post-breeding shorebirds (150 birds/$km^2$) use the lower Colville River Delta, within 6 km of the Delta's northern edge, more heavily than any other North Slope site (Andres 1994).

#### PLAN AREA

Nine shorebird species are common breeders, seven species are uncommon breeders and four species are rare breeders in the Plan Area (Table 3.3.3-1) (PAI 2002a, Appendix B, Table B-3; BLM and MMS 1998a, Table III.B.4-4). The discussion of shorebirds within the Plan Area focuses on common or regularly occuring species, although some uncommon species are mentioned if they are considered sensitive or of special concern to regulatory agencies. Common shorebirds within the proposed development area fall largely within the plover and sandpiper/phalarope families. Nest densities based on shorebird plots near proposed development areas in the National Petroleum Reserve-Alaska and at the Alpine Facility in the Colville River Delta are presented in Table 3.3.3-7. Approximately 41,000 post-breeding shorebirds (assuming a complete turnover every seven days) use primarily shoreline silt barrens [Tidal Flat] and sparsly vegetated salt marshes [Salt Marsh] in the lower Colville River Delta during July and August (Andres 1994). Andres (1994) found that dunlins (48 percent ) dominated post-breeding shorebird use of the lower Colville River Delta followed by semipalmated sandpipers (22 percent), red-necked phalarope (10 percent), western sandpiper (6 percent), pectoral sandpiper (4 percent) and stilt sandpiper (4 percent).

### TABLE 3.3.3-7 NEST DENSITIES (NESTS/KM$^2$) FROM SHOREBIRD PLOTS IN THE PLAN AREA

| Species | Colville River Delta | National Petroleum Reserve-Alaska Sites | | | |
|---|---|---|---|---|---|
| | | Alpine West | Lookout | Spark | National Petroleum Reserve-Alaska Area (3-year mean)[e] |
| | Alpine[a] | CD-5 (3-year mean)[b] | CD-6 (2-year mean)[c] | CD-7 (3-year mean)[d] | |
| **Shorebirds** | | | | | |
| Black-bellied plover | 1.7 | 0.6 | 0 | 0.3 | 2.0 |
| American golden-plover | 2.1 | 0.8 | 1.3 | 0 | 1.3 |
| Bar-tailed godwit | 0.4 | 0.3 | 0.6 | 0 | 0.5 |
| Semipalmated sandpiper | 19.6 | 3.3 | 2.5 | 2.5 | 11.4 |
| Baird's sandpiper | 0 | 0 | 0 | 0 | 0.1 |
| Pectoral sandpiper | 37.1 | 7.2 | 5.6 | 5.6 | 10.7 |
| Dunlin | 1.3 | 0.8 | 1.3 | 0 | 1.6 |
| Stilt sandpiper | 1.7 | 2.8 | 0 | 0 | 1.8 |
| Buff-breasted sandpiper | 0 | 0 | <0.1 | 0 | 0.8 |
| Long-billed dowitcher | 2.9 | 3.1 | 2.5 | 0.8 | 5.1 |
| Red-necked phalarope | 9.2 | 2.5 | 1.9 | 4.7 | 5.4 |
| Red phalarope | 6.3 | 3.6 | 0 | 1.1 | 2.9 |
| **Passerines** | | | | | |
| Yellow wagtail | 0.4 | 0 | 0 | 0 | 0.3 |
| Savannah sparrow | 2.1 | 0 | 0.6 | 1.7 | 1.9 |
| Lapland longspur | 37.5 | 8.1 | 18.1 | 9.2 | 25.1 |
| Common redpoll | 0.4 | 0.8 | 0.6 | 0 | 1.4 |

Notes:
[a] 4-year mean from 6 Reference Plots (Johnson et al. 2003a)
[b] 3-year mean from 4 Plots (Burgess et al. 2003b, Johnson et al. 2004)
[c] 2-year mean from 4 plots (Burgess et al. 2003b, Johnson et al. 2004)
[d] 3-year mean from 4 Plots (Burgess et al. 2003b, Johnson et al. 2004)
[e] 3-year mean from 24 plots (Burgess et al. 2003b, Johnson et al. 2004)

#### PLOVERS

Plovers that are considered common in the Plan Area include the black-bellied plover and American golden-plover (Table 3.3.3-1). Plovers tend to nest on upland sites that are drier than those used by other shorebirds (Johnson and Herter 1989; PAI 2002a, Appendix B). Black-bellied plovers breed most commonly near the coast and tend to nest in dry tundra habitats next to wet areas (Derksen et al. 1981; Johnson and Herter 1989). Brood-rearing also occurs on wet tundra habitats. Nesting densities for black-bellied plovers in the Plan Area were higher at the National Petroleum Reserve-Alaska sites than at the Alpine Facility in the Colville River Delta (Table 3.3.3-7). The American golden-plover commonly breeds at both coastal and inland locations (Johnson and Herter 1989). They prefer to nest in dry upland tundra areas but will move to moist or wet sedge tundra areas for brood-rearing (Troy 2000). Nesting densities within the Plan Area were highest at CD-5 and CD-6 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). More Moist Tussock Tundra habitats are available in the National Petroleum Reserve-Alaska area than near the Alpine Facility (Table 3.3.3-4).

#### SANDPIPERS AND PHALAROPES

Sandpipers and phalaropes considered abundant to common in the Plan Area include dunlin, semipalmated sandpiper, pectoral sandpiper, long-billed dowitcher, red-necked phalarope, and red phalarope (Table 3.3.3-1). These shorebird species use a wide variety of habitat types but tend to nest in Wet Sedge Meadows and Aquatic Sedge and Grass Marshes. Shorebird nests, including pectoral and semipalmated sandpipers, occurred most frequently in Patterned Wet Meadow and Moist Sedge-Shrub Meadow habitats near the Alpine Facility in the Colville River Delta (Johnson et al. 2003a). Dunlins and semipalmated sandpipers also nest in Moist Tussock Tundra habitats (Johnson and Herter 1989; PAI 2002a, Appendix B).

Dunlins use a wide range of habitat types but are more abundant near the coast than inland (Derksen et al. 1981; Johnson and Herter 1989). Nesting densities were highest in the National Petroleum Reserve-Alaska, at CD-6 and in the Colville River Delta (Table 3.3.3-7), where dunlins used Moist Tussock Tundra and Patterned Wet Meadow habitats. Fledglings move to coastal areas during late July and early August, while adults move to upland areas for flocking and departure to the coast. During post-breeding shorebird surveys in the Colville River Delta, dunlins were approximately 50 percent of all sightings and were most abundant on coastal shoreline silt barrens (Andres 1994).

Pectoral sandpipers nest in highest densities in wet or moist tundra with low-centered polygons in the Prudhoe Bay region (Troy 1988). Shorebird studies in the National Petroleum Reserve-Alaska near Inigok (Cotter and Andres 2000) found pectoral sandpipers nesting exclusively in drained lake basins. Nest densities in the Plan Area were highest at the Alpine Facility in the Colville River Delta, followed by CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Post-breeding males and females and fledged young move toward the coast from mid- to late July before migration (Derksen et al. 1981).

Semipalmated sandpipers were less abundant at both the Colville River Delta and the National Petroleum Reserve-Alaska sites than pectoral sandpipers (Table 3.3.3-7). They use both inland tundra and coastal habitats throughout the season, nesting on wet tundra, well-drained tundra, and dry tundra (Derksen et al. 1981). Shorebird studies in the National Petroleum Reserve-Alaska near Inigok (Cotter and Andres 2000) found semipalmated sandpipers nesting exclusively in drained lake basins. Semipalmated sandpipers were 22 percent of all sightings during post-breeding shorebird surveys in the Colville River Delta (Andres 1994).

Long-billed dowitchers use a variety of nesting habitats across the Arctic Coastal Plain, but appear to prefer wet habitats associated with strangmoor (Troy 2000). Long-billed dowitchers were found nesting at all of the proposed development locations in the Plan Area, with the highest nest densities near CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7).

Red phalaropes are less common in the Plan Area than red-necked phalaropes. Red-necked phalaropes nest at higher densities at inland wet-tundra locations than at coastal sites (Derksen et al. 1981). Nest densities for red-necked phalaropes were highest at CD-7 and CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Red phalaropes prefer wet non-patterned tundra and aquatic tundra with strangmoor ridges for nesting in Prudhoe Bay (Troy 1988). Nest densities of red phalaropes in the Plan Area were highest in the Colville River Delta and near CD-5 in the National Petroleum Reserve-Alaska (Table 3.3.3-7). These sites contain higher proportions of Patterned Wet Meadow (analogous to aquatic tundra with strangmoor ridges) than either the Alpine Facility or CD-6 and CD-7 (Table 3.3.3-4).

The red knot is considered an uncommon migrant and locally uncommon breeder in the Beaufort Sea area and a casual migrant to the Colville River Delta. Records of single birds or small groups are the rule over most of the North Slope (Johnson and Herter 1989; PAI 2002a, Appendix B). No red knot nests were recorded during shorebird studies at sites in the Colville River Delta and the National Petroleum Reserve-Alaska (Table 3.3.3-7).

Buff-breasted sandpipers tend to use drier habitat than do other shorebirds and are considered part of the "upland" species guild (with American golden-plovers, dunlins, and Baird's sandpipers) because of their dependence on drier sloping areas or polygonal featured tundra (Lanctot and Laredo 1994). Lanctot and Laredo (1994) described the habitat use of the buff-breasted sandpiper by sex and breeding stage based on the results of previous studies. Displaying males first occur in areas free of snow such as barren ridges, creek bands, and raised, well-drained areas with reticulate-patterned ground and sparse vegetation (such as *Dryas* sp.) [Barrens, Partially Vegetated and Dryas Dwarf Shrub Tundra]. Within 3 to 5 days of their arrival, most males are found displaying together in leks on non-patterned ground, moist sedge and cottongrass meadows with closely spaced tussocks and with dwarf willow thickets [Moist Sedge-shrub Meadow; Patterned Wet Meadow]. Most males abandon these sites within 1 to 2 weeks to display closer to nest sites, typically on dry slopes with numerous sedge tussocks [Moist Sedge-Shrub Meadow], on moss-willow-varied tussocks [Moist Tussock Tundra], and in moist or wet sedge-graminoid meadows on non-patterned or strangmoor ground [Wet Sedge Meadow Tundra]. Brood-rearing females have been seen in moist and emergent vegetation along and in stream beds [Riverine Complex, Aquatic Sedge and Grass Marsh]. Buff-breasted sandpiper nests were found in the National Petroleum Reserve-Alaska area near CD-6 (Table 3.3.3-7) (Burgess et al. 2003b).

Bar-tailed godwit nests have been recorded at the Alpine Facility in the Colville River Delta and at CD-5 and CD-6 in the National Petroleum Reserve-Alaska, where nests were primarily in Patterned Wet Meadow habitats (Table 3.3.3-7) (Burgess et al. 2003b). Nest densities were highest at CD-6 (Table 3.3.3-7).

### 3.3.3.7 Seabirds

Six species of seabirds common across the Arctic Coastal Plain are likely to occur in the Plan Area: glaucous and Sabine's gulls; pomarine, parasitic, and long-tailed jaegers; and arctic tern (Table 3.3.3-3). Most seabirds arrive on the Arctic Coastal Plain in early to late May and leave in September to November (Table 3.3.3-3). In addition, the black guillemot could occur in offshore areas (Johnson and Herter 1989).

#### NORTH SLOPE

Jaegers are on the open sea during the winter but migrate to tundra breeding grounds during the summer. The Arctic Coastal Plain population of jaegers shows no significant trends, remaining relatively stable at approximately 3,800 individuals (Table 3.3.3-3) (Larned et al. 2003). Parasitic jaegers are predators of eggs and young of waterfowl and tundra-nesting shorebirds and passerines, as well as small mammals (Maher 1974). Long-tailed jaegers consume fewer small mammals and birds and more insects than other jaegers. Pomarine jaegers feed primarily on lemmings and will not breed unless the lemming population is high (Maher 1974).

Glaucous gulls are a common migrant and breeder on the Arctic Coastal Plain (Table 3.3.3-3). Glaucous gulls nest across the Arctic Coastal Plain, with concentrations both east and west of Dease Inlet and on barrier islands (Figure 3.3.3.7-1) (Irving 1960; Sage 1974). The glaucous gull population on the Arctic Coastal Plain has remained stable since 1992 (Larned et al. 2003). Nests in mainland areas are often on small islands in lakes, and pairs could nest singly or in small colonies. Glaucous gulls depart the breeding grounds by mid-September and migrate westward along the coast. While on the breeding grounds, glaucous gulls are opportunistic feeders, preying on eggs and chicks of other bird species, particularly waterfowl (Johnson and Herter 1989). In addition, they feed extensively in the marine environment on prey that includes fish, isopods, and worms. Glaucous gulls also scavenge along shorelines and in areas of human habitation, and coastal surveys indicate that many glaucous gulls occur on transects adjacent to coastal villages (Dau and Anderson 2002).

Sabine's gulls are less common than glaucous gulls on the Arctic Coastal Plain and nest in single pairs or small colonies on the shores or islands of tundra lakes (Table 3.3.3-3) (Johnson and Herter 1989; Noel et al. 2001). The

Arctic Coastal Plain population of Sabine's gulls fluctuated between 5,000 and 8,000 birds between 1992 and 2002, except for a low of 2,800 birds in 1998 (Larned et al. 2003). They feed on a variety of small fish, insects, and other invertebrates (Ehrlich et al. 1988).

The arctic tern is a fairly common breeder and migrant in the Beaufort Sea area that nests most commonly near the coast but could also nest inland (Table 3.3.3-3) (Johnson and Herter 1989). Arctic terns increased by approximately 7 percent per year on the Arctic Coastal Plain between 1992 and 2002 (Larned et al. 2003). Arctic terns nest on islands in tundra lakes and ponds, on barrier islands, and on gravel bars along lakes and rivers—often in areas where there is little or no vegetation. Arctic terns sometimes nest colonially with other terns, gulls, and waterfowl.

#### PLAN AREA

Parasitic and long-tailed jaegers have been recorded breeding in the Plan Area in small numbers (Table 3.3.3-5) (Burgess et al. 2002a, 2003b; Johnson et al. 2002). Pomarine jaegers have not nested in the Plan Area during recent years. Pomarine jaegers are more common west of the Plan Area but could be common in the Plan Area during migration (Johnson and Herter 1989).

The number of glaucous gulls in the Plan Area has doubled or tripled in the last 40 years, with a new colony of 25 to 30 pairs established about 4 miles southeast of the Alpine Facility (Figure 3.3.3.7-2), after construction (J. Helmericks 2004 pers. comm.). Glaucous gulls are scattered throughout most of the Plan Area, with the highest nesting densities at CD-5 and CD-7 in the National Petroleum Reserve-Alaska (Figure 3.3.3.7-3) and CD-3 in the Colville River Delta (Figure 3.3.3.7-2 and Table 3.3.3-5). Nesting habitats used within both the National Petroleum Reserve-Alaska and the Colville River Delta sites included Deep Open Water with Islands (Table 3.3.3-6). In the Colville River Delta glaucous gulls also used Brackish Water for nesting and brood-rearing (Table 3.3.3-6). Glaucous gulls were common in shallow-water strata between Cape Halkett and Brownlow Point, but showed a westward shift in distribution from June to August (Fischer et al. 2002). Glaucous gulls were generally more concentrated in shallow water areas to the east of Harrison Bay and the Colville River Delta (Fischer et al. 2002). Concentrations of non-breeding glaucous gulls around landfill sites are common, and there has been speculation that breeding gulls near coastal villages might benefit from landfills as an additional food source (Day 1998). Glaucous gulls have also been observed feeding on fish wastes and fishing nets lost during winter near the Alpine pipeline crossing on the Colville River (J. Helmericks 2004 pers. comm.).

A few Sabine's gull nests have been recorded at CD-3 and the Alpine Facility in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Sabine's gulls nested in a wider variety of habitats at the Colville River Delta sites than at the National Petroleum Reserve-Alaska sites, although they used Shallow Open Water with Islands in both areas (Table 3.3.3-6).

Arctic terns nested at all proposed development locations (Table 3.3.3-5). The highest nesting densities were at CD-3 in the Colville River Delta and CD-7 in the National Petroleum Reserve-Alaska (Table 3.3.3-5). Arctic terns used a wider variety of nesting habitats in the Colville River Delta than in National Petroleum Reserve-Alaska; however, they used Shallow Open Water with Islands habitats in both areas (Table 3.3.3-6).

### 3.3.3.8 Passerines

#### NORTH SLOPE

Most passerines found on the Arctic Coastal Plain winter in temperate and tropical regions in the Americas or southern Asia (BLM and MMS 1998a). They generally arrive on the North Slope from late May to early June and remain until mid- to late August (Johnson and Herter 1989). With the exception of the common raven, passerines on the North Slope are a tundra-nesting species. Their nests are built on the ground, frequently in the shelter of an overhanging bank, bush, or grass clump (Johnson and Herter 1989). Table 3.3.3-8 presents nesting and foraging habitats used by passerines.

**TABLE 3.3.3-8 NESTING AND FORAGING HABITATS USED BY PASSERINES IN THE PLAN AREA**

| Species | Nesting Habitat | Foraging Habitat |
|---|---|---|
| Common raven | Cliffs, communications towers, oilfield infrastructure | Opportunistic and highly variable |
| Yellow wagtail | Willow shrub tundra or tussock tundra under an overhang | Open tundra and willow thickets |
| Savannah sparrow | Open sedge tundra | Sedge and other open tundra |
| Lapland longspur | Tundra habitats | Tundra habitats |
| Common redpoll | Shrub tundra | Tundra habitats and shrub thickets |

Sources: Armstrong 1995

The common raven is the only resident species that is likely to occur in the Plan Area (Table 3.3.3-1) (PAI 2002a, Appendix B, Table B-3; BLM and MMS 1998a). Common ravens are common in the foothills and mountains of the Brooks Range south of the Plan Area. They nest on cliffs where they construct nests that could be used in subsequent years by rough-legged hawks or gyrfalcons (Johnson and Herter 1989). Before human development on the Arctic Coastal Plain, common ravens were uncommon and rare nesters because of the lack of suitable nesting habitat. However, over the past several decades common ravens have become much more abundant on the Arctic Coastal Plain, including the Northeast National Petroleum Reserve-Alaska Plan Area, as nesting habitat in the form of towers, antennas, drill rigs, buildings, and other tall structures have become more abundant (Johnson and Herter 1989). Some common ravens overwinter on the Arctic Coastal Plain and in the Plan Area near anthropogenic food sources (Helmericks 2003a, pers. comm.). As their numbers have increased, common ravens have become common predators of tundra-nesting birds on the Arctic Coastal Plain in general (Day 1998), and in the Plan Area (Helmericks 2003b, pers. comm.).

### PLAN AREA

At least 10 species of passerines occur in the Plan Area (Table 3.3.3-1). Of these, seven are known or probable breeders; however, only four species, the yellow wagtail, Savannah sparrow, Lapland longspur, and common redpoll, are common to abundant breeders in the Plan Area (Table 3.3.3-1).

Lapland longspurs are the most abundant passerine species in the Plan Area (Derksen et al. 1981), where they nested in higher densities than any other bird species at almost all sites sampled in the National Petroleum Reserve-Alaska (Table 3.3.3-7). Recent breeding bird surveys conducted near CD-5, CD-6, and CD-7 in the National Petroleum Reserve-Alaska found four species of nesting passerines: the yellow wagtail, Savannah sparrow, Lapland longspur, and common redpoll (Burgess et al. 2002b, 2003b, Johnson et al. 2004). The Lapland longspur was the most abundant passerine at all the National Petroleum Reserve-Alaska sites, representing 90 percent of the nests (Table 3.3.3-7). These same four passerine species also nested at the Alpine Facility in the Colville River Delta, where the Lapland longspur was again the most abundant species, representing 83 percent of the nests recorded (Table 3.3.3-7) (Johnson et al. 2003a).

Common ravens first began nesting in the vicinity of the Plan Area in the late 1950s, when a nest was established on the microwave tower at the Oliktok DEW Line Station. However, common ravens have become much more numerous during the late 1990s with a total of 20 individuals recorded (J. Helmericks 2004, pers. comm.). Common ravens were rarely observed in the area of the Alpine Facility before 1998, when they first used buildings as roosting sites, and a nest was suspected but not confirmed (Johnson et al. 2003a). Nesting at the Alpine Facility was confirmed in 2000 and 2001, although no increase in rates or sources of loon and waterfowl nest depredation were found after construction of the Alpine Facility (Johnson et al. 2003a). Common ravens nesting at Alpine, Nuiqsut and Meltwater, based on flight directions, reduced nesting success up to 26 miles away at the Anachlik nesting colony by as much as 80 percent in 2003 (J. Helmericks 2004, pers. comm.). A common raven nest was also established on the well head at CD-7 in the National Petroleum Reserve-Alaska; this nest was later removed and a cover was installed to prevent further nesting (C. Rea 2003, pers. comm.).

## 3.3.4 Mammals

### 3.3.4.1 Terrestrial Mammals

Terrestrial mammals in the Plan Area include caribou, muskoxen, moose, grizzly bear, arctic fox, red fox, wolverine, gray wolf, and small mammals including the arctic ground squirrel, ermine, least weasel, lemmings, voles, and shrews (BLM and MMS 1998a, 2003; BLM 2002a; TAPS Owners 2001a; Truett and Johnson 2000; PAI 2002a). These species occur across the North Slope and in many other parts of Alaska and are listed in Table 3.3.4-1. Polar bears occur in the Plan Area, but they are generally considered marine mammals and are described in Section 3.3.4.2.

No terrestrial mammals in the Plan Area are listed under the federal or State of Alaska Endangered Species Acts (TAPS Owners 2001a; BLM and MMS 1998a, 2003; PAI 2002a). The only terrestrial mammal species on the BLM Sensitive Species list that might occur in the Plan Area is the Canada lynx. Lynx occur at low densities in the mountains and foothills of the Brooks Range and are generally not found on the coastal plain, including the Plan Area (Carroll 1998) so they are not discussed further.

**TABLE 3.3.4-1 MAMMAL SPECIES KNOWN OR SUSPECTED TO OCCUR IN THE REGION OF THE COLVILLE RIVER DELTA, ALASKA**

| Common Name | Scientific Name | Inupiaq Name | Abundance |
|---|---|---|---|
| **Large Mammals** | | | |
| Lynx | *Lynx canadensis* | niutuiyiq | rare |
| Caribou | *Rangifer tarandus* | tuttu | abundant |
| Muskox | *Ovibos moschatus* | umifmak | common |
| Moose | *Alces alces* | tuttuvak | uncommon |
| Grizzly (brown) bear | *Ursus arctos* | akjaq | common |
| Gray wolf | *Canis lupus* | amabuq | rare |
| Wolverine | *Gulo gulo* | qavvik | uncommon |
| Arctic fox | *Alopex lagopus* | tibiganniaq | common |
| Red fox | *Vulpes vulpes* | kayuqtuq | uncommon |
| **Small Mammals** | | | |
| Arctic ground squirrel | *Spermophilus parryii* | siksrik, sigrik | abundant |
| Ermine (short-tailed weasel) | *Mustela erminea* | itibiaq | common |
| Least weasel | *Mustela nivalis* | naulayuq | uncommon |
| Tundra hare | *Lepus othus* | ukallisugruk | rare |
| Snowshoe hare | *Lepus americanus* | ukalliatchiaq | rare |
| Brown lemming | *Lemmus trimucronatus* | aviffapiaq | uncommon |
| Collared lemming | *Dicrostonyx groenlandicus* | qixafmiutaq | common |
| Northern red-backed vole | *Clethrionomys rutilus* | aviffaq | rare? |
| Tundra vole | *Microtus oeconomus* | aviffaq | uncommon |
| Singing vole | *Microtus miurus* | aviffaq | common |
| Barrenground shrew | *Sorex ugyunak* | ugrugnaq | common? |
| Tundra shrew | *Sorex tundrensis* | ugrugnaq | uncommon? |
| **Other Mammals** | | | |
| Mink | *Mustela vison* | itibiaqpak | rare |
| River otter | *Lontra canadensis* | pamiuqtuuq | rare |
| Porcupine | *Erethizon dorsatum* | qifabluk | rare |
| Coyote | *Canis latrans* | amabuuraq | rare |

Source: This table was modified from Table B-8 of PAI 2002a
Notes: ? indicates that occurrence in the Plan Area is uncertain; and species designated as rare are at the limit of their range

## CARIBOU

### NORTH SLOPE

There are four caribou herds in arctic Alaska; from west to east they are the Western Arctic Herd (WAH), the Teshekpuk Lake Herd (TCH), the Central Arctic Herd (CAH), and the Porcupine Caribou Herd (PCH). Caribou of the TCH and CAH have a portion of their ranges in the Plan Area (Figure 3.3.4.1-1). The Plan Area is peripheral range for the PCH and WAH (BLM and MMS 2003) and information on these herds is available in other documents (BLM and MMS 1998a, 2003; USGS 2002).

Caribou herds are defined by the geographic location of their calving areas. Cow caribou of the North Slope herds have fidelity to calving areas although there may be overlap of other seasonal ranges and interbreeding between different herds (Skoog 1968; Whitten and Cameron 1983; Bergerud et al. 1984; Davis et al. 1986; Cameron and Whitten 1986; Prichard et al. 2001; Cronin et al. 2003). In general, it can be expected that the impact of the proposed developments will be the same to any caribou, regardless of their herd designation. A possible exception is the caribou of the CAH that may be habituated to the existing oilfields at Prudhoe Bay and the surrounding area.

### TESHEKPUK LAKE HERD

#### Population Status and Range

The TCH was recognized as a separate herd from the WAH and CAH in the mid-1970s (Davis and Valkenburg 1978). The primary range of the TCH is the in the northern portion of the National Petroleum Reserve-Alaska west of the Colville and Itkillik rivers with winter range sometimes extending south of the Brooks Range as far as Galena or the Seward Peninsula (Figure 3.3.4.1-1) (Kelleyhouse 2001; Prichard et al. 2001; BLM and MMS 2003). Animals from the TCH may occur as far east as the Arctic National Wildlife Refuge (ANWR). Studies have shown that the ranges of radio-collared caribou varied annually from 3,772 km$^2$ to 219,214 km$^2$ (Philo et al. 1993d), and also varied by season (Prichard et al. 2001). The Teshekpuk Lake area contains habitats that are used by TCH caribou year-round.

Estimates of the number of animals in the TCH were about 3,000 to 4,000 in 1978 to 1981(Davis and Valkenburg 1979; Cronin et al. 1998b) and 4,000 in 1982 (BLM pers. comm. 2003d). In 1984, the first photocensus of the TCH showed 11,822 caribou (Silva 1985). Other photocensus estimates in 1985 (13,406 caribou), 1989 (16,649 caribou), and 1993 (27,686 caribou) showed a steady increase in the TCH (Carroll 1992, 1995). This was followed by a decrease in the herd estimate in 1995 (25,076 caribou) (Carroll 1997). The herd then increased in 1999 (28,627 caribou) (Carroll 2003) and in 2002 (45,166 caribou) (Carroll pers. comm.). It is unlikely that the TCH actually increased from 28,000 to 45,000 between 1999 and 2002. It is more likely that the 1999, and possibly the 1995 censuses were underestimated due to unfavorable weather conditions (Carroll, pers. comm 2004). These censuses are summarized and compared to other arctic herds by several authors (Cronin et al. 1998b; Ballard et al. 2000; NRC 2003). The TCH has grown faster than the CAH over the last 30 years, and it has been suggested this is because of the impact of oilfield development on the CAH (NRC 2003). However, the PCH has recently declined without oilfields in its range (USGS 2002), indicating that factors such as population density, range condition, predation, immigration/emigration, and others can affect caribou numbers (Cronin et al. 1997, 1998b). These factors have not been quantified in the CAH and TCH so the reason for the different herd growth rates are not certain.

#### Migration

Most TCH caribou begin migrating from winter ranges across northwestern Alaska to the Teshekpuk Lake area during May and June. By early June most of the cows move into calving areas around the lake (Figure 3.3.4.1-2) (Carroll 1999a; Prichard et al. 2001). After calving, most TCH caribou move north of Teshekpuk Lake through the land corridor between the lake and the Kogru River on the east. They may also use the land area between the lake and Smith Bay on the west. Most of the herd uses areas along the coast for insect relief during mid-July to August, when TCH caribou spread out on all sides of the lake. Fall movements of the TCH occur after the insect season and are variable among individual caribou and years (Philo et al. 1993d; Whitten 1997; Carroll 2001; Prichard et al. 2001). Most TCH caribou winter on the coastal plain, and some winter in the Plan Area. However, in some winters some TCH caribou migrate far to the south of the coastal plain to Anaktuvuk Pass, the Seward Peninsula or other areas (Figure 3.3.4.1-4) (Prichard et al. 2001).

#### Calving Grounds

The calving grounds of the TCH are primarily in the northeast corner of the National Petroleum Reserve-Alaska near and around Teshekpuk Lake (Figure 3.3.4.1-2), including shoreline areas (Davis and Valkenburg 1979; Carroll 1992; Philo et al. 1993d; Kelleyhouse 2001; Prichard et al. 2001; BLM and MMS 1998a, 2003). If the snowmelt is in late spring, more caribou will calve south and west of the lake than if snowmelt is in early spring (Carroll 2001). Kelleyhouse (2001) reported that the size of the TCH annual calving grounds ranged between 2,431 $km^2$ and 4,820 $km^2$. The most concentrated calving areas ranged between 134 $km^2$ and 589 $km^2$. Recent calving by the TCH has been concentrated on the east side of Teshekpuk Lake (Figure 3.3.4.1-2) (BLM and MMS 1998a). Carroll (2001) reported that in 2000, calving occurred on all sides of Teshekpuk Lake and that more calves than usual were south and west of the lake. Aerial survey data (1999 to 2001) suggest that caribou use the entire area around Teshekpuk Lake, as well as the western part of the Plan Area during the calving period (Noel 1999; Noel 2000; Jensen and Noel 2002; Noel and George 2003).

#### Summer Distribution and Insect-Relief Areas

The Teshekpuk Lake area is important as summer range because of prevailing winds and proximity to the coast and river deltas that provide insect relief habitat with adjacent forage (BLM and MMS 1998a, 2003). On the Arctic Coastal Plain, caribou behavior and movements during summer are greatly influenced by harassment from mosquitoes and oestrid flies, forage availability, and weather (White et al. 1975; Dau 1986). During periods with little or no insect activity, summer distribution of caribou is related to the availability of easily digestible forage (White et al. 1975). Caribou tend to move to insect relief habitats, usually on the coast during warm periods with insect activity, and then move inland to foraging areas when insect activity decreases.

The TCH summer range is between Barrow and the Colville River (Figures 3.3.4.1-1) (BLM and MMS 1998a, 2003; Jensen and Noel 2002). In June and July, caribou are often located around the shore and islands of Teshekpuk Lake and in the area between Teshekpuk Lake and the Beaufort Sea from the Ikpikpuk River to the Kogru River. Many caribou also use summer habitats throughout the Plan Area (Jensen and Noel 2002) including the Colville Delta (Figures 3.3.4.1-3 and 3.3.4.1-4). These areas are used regularly by the TCH for insect relief and foraging (Carroll 1999a; Prichard et al. 2001). Additionally, small groups of caribou use the Pik Dunes (approximately 30 km south of Teshekpuk Lake) during insect harassment (Philo et al. 1993d). Other insect relief habitats in the summer ranges include sand dunes and ridges (BLM and MMS 1998a). The relatively narrow land areas on the east and west sides of the lake are travel corridors for caribou moving between habitats north and south of the lake (Prichard et al. 2001).

#### Fall and Winter Range Use And Distribution

Some caribou of the TCH occur year-round in the Teshekpuk Lake area (Davis and Valkenburg 1978; Prichard et al. 2001). During fall (August to September) many caribou have been observed around the lake and in the Plan Area as far east as Fish Creek (Prichard et al. 2001; Jensen and Noel 2002). Use of the Plan Area as winter range may include from 10 percent to 100 percent of the herd (BLM and MMS 1998a). During most years, TCH caribou winter on the North Slope coastal plain including the Plan Area, but some or all of the herd may also winter in other locations (Figure 3.3.4.1-5). In some years, some of the herd has migrated as far as the Seward Peninsula to the south (Carroll 1992; Philo et al. 1993d; BLM and MMS 2003; Prichard et al. 2001), Point Hope to the west, and the Dalton Highway north of Wiseman to the east (BLM and MMS 2003; Prichard et al. 2001). There is some overlap of the TCH and the WAH winter ranges (Carroll 1999a; BLM and MMS 1998a, 2003; Prichard et al. 2001).

### Harvest and Predation

Subsistence harvesting of the TCH occurs from July through the winter by residents of all North Slope villages, including Atqasuk, Barrow, Point Hope, and Wainwright (Carroll 1999a; Prichard et al. 2001). Harvest by Nuiqsut and Anaktuvuk Pass residents also occurs from July through the winter if animals are present (PAI 2002a; Brower and Opie 1996, 1997). It is difficult to determine the numbers of TCH caribou harvested because not all hunters report their harvest and because most villages harvest caribou from more than one herd. However, village subsistence records and radiotelemetry data allow estimation of TCH harvest. During 1999 to 2000, approximately 2,500 TCH caribou were harvested, and during 2000 to 2001, approximately 2,760 TCH caribou were harvested by residents of North Slope villages (G. Carroll, pers. comm.). The numbers of TCH caribou harvested by sport hunters is generally small, and mostly in the Colville River drainage (Carroll 2001). The TCH has one of the highest harvest rates of the herds in Alaska.

Wolf predation of the TCH is not well-documented, but wolf densities on the North Slope coastal plain are low (BLM and MMS 1998a, 2003). The greatest harvests of wolves from the western North Slope (ADF&G Game Management Unit [GMU] 26A) have been near Nuiqsut and Anaktuvuk Pass (Carroll 2000a; Shideler 2000). Other predators of TCH caribou include grizzly bears, wolverines, and golden eagles (Murphy and Lawhead 2000). These species prey primarily on calves, but bears also kill adults. Data on bear, wolverine, and eagle predation of the TCH is not available, but is believed to be low.

## CENTRAL ARCTIC HERD

### Population Status and Range

The annual range of the CAH extends from the Colville Delta on the west to the Canning River on the east, and from the Beaufort Sea Coast on the north to the south slope of the Brooks Range (Figure 3.3.4.1-1) (Cameron and Whitten 1979; NRC 2003). During summer, CAH caribou occur on the coastal plain and some may occur west of the Colville River in the Plan Area and east of the Canning River in the Arctic National Wildlife Refuge. Calving occurs between the Colville and Canning rivers within 160 km of the Beaufort Sea (Cameron and Whitten 1979; USGS 2002; NRC 2003).

The CAH was estimated at approximately 5,000 caribou in 1975 and increased to approximately 23,444 in 1992 (Whitten and Cameron 1979; Cronin et al. 1998b; Lenart 1999b, 2003). The CAH declined to 18,093 in 1995 and then increased again to 19,730 in 1997 and 27,128 in 2000 (Lenart 1999b and unpublished data). The most recent photocensus conducted in 2002 documented approximately 32,000 caribou (Lenart 2003). The growth rate of the CAH was lower than that of the TCH and WAH, but higher than that of the PCH, over the last 30 years. These census data are summarized by several authors (Cronin et al. 1998b; 2000, 2001; NRC 2003; USGS 2002; Ballard et al. 2000).

The NRC (2003) concluded that the decline of the CAH between 1992 and 1995 likely resulted from low net calf production that was caused by synergistic negative impacts of summer insect harassment and displacement from oilfield habitats. The potential negative impact of the oilfields on caribou is also described by the USGS (2002). However, negative impacts of the oilfields, including the conclusion that oilfield impacts caused the CAH decline between 1992 and 1995, are equivocal because the CAH grew rapidly in other years. In addition, the TCH, without oilfields in its range, had a similar decline between 1993 and 1995 (NRC 2003) suggesting a potential common cause of declines in these herds on the North Slope. Other analyses showed that the decline of the CAH between 1992 and 1995 could be due to factors other than the affect of oilfields, including population density, immigration and emigration (Cronin et al. 1997; Cronin et al. 2000). The relative importance of natural factors such as winter and summer range conditions, population density, snow depth, insect harassment, predation, interherd movements, and anthropogenic (human-caused) factors associated with oil development on the dynamics of the CAH has not been determined (Cronin et al. 1997, 1998a, 1998b, 2000, 2001; Ballard et al. 2000; NRC 2003; USGS 2002; Murphy and Lawhead 2000).

### Migration

CAH caribou migrate between winter ranges in the Brooks Range and summer ranges on the Arctic Coastal Plain (Cameron and Whitten 1979; Fancy et al. 1989). In general, pregnant cows arrive on the coastal plain between early May and early June, calving occurs between the last week of May and the second week of June, and bulls arrive by early July (Roby 1978; Whitten and Cameron 1980; Lawhead and Curatolo 1984; Jakimchuk et al. 1987). A gradual southward fall migration generally occurs after the insect season ends in mid-August (BLM and MMS 1998a, 2003).

### Calving Grounds

The CAH calves between the Colville and Canning rivers to the east of the Plan Area. Calving usually occurs within 160 km of the Beaufort Sea, with concentrated areas east and west of the Sagavanirktok River (Cameron and Whitten 1979; USGS 2002; NRC 2003). One calving area includes a broad area east of the Sagavanirktok River, west of the Canning River, and south of Bullen Point. The other calving area is west of the Sagavanirktok River. Between 1993 to 2002 the greatest calving densities in this area west of the Sagavanirktok River were approximately 20 km south of the Kuparuk oilfield (Lawhead and Johnson 2000; Lawhead et al. 2003). Lower densities of calving occurred within and adjacent to the Kuparuk and Milne Point Oilfields during this time period. Calving has occurred in the oilfield areas since the oilfields were built in 1980 to 1981. However, the proportion of the herd calving in and near the oilfields has decreased since the mid-1980s (USGS 2002; NRC 2003; Noel et al. 2004). Although there is not a clear cause-and-effect relationship explaining the apparent shift in calving densities to the south, it could be due to avoidance of the oilfields (Murphy and Lawhead 2000; USGS 2002; NRC 2003). Alternatively, the change in calving density could be a result of a range expansion as the herd grew over the last 25 years, or other factors.

### Summer Distribution and Insect-Relief Areas

The summer range of the CAH includes the area between the Canning and Colville rivers and between the Brooks Range and Beaufort Sea (Figure 3.3.4.1-1) (Smith 1996; Murphy and Lawhead 2000; NRC 2003). A combination of wind, weather, insects, and forage availability affect caribou distribution in summer. When harassed by insects, caribou of the CAH typically use coastal areas, river deltas and bars, and non-vegetated habitats such as gravel roads and pads for relief (White et al. 1975; Dau 1986; Pollard et al. 1996b; Noel et al. 1998). During periods of harassment by insects, large groups of caribou have been observed along the Beaufort Sea coastline, near Franklin Bluffs, on oilfield roads and gravel pads, and on the deltas of the Canning, Kadleroshilik, Kuparuk, Sagavanirktok, Shaviovik, and Staines rivers (Gavin 1983; Carruthers et al. 1984; Lawhead and Curatolo 1984; Pollard et al. 1996a, 1996b; Noel and Olson 1999a, 1999b; Olson and Noel 2000). Aerial surveys have documented CAH caribou moving west into the Colville River Delta in the Plan Area in the summer. The largest such documented movement (more than 10,000 caribou) occurred in the third week of July 2001 (Lawhead and Prichard 2002; PAI 2002a).

### Winter Range Use and Distribution

Most CAH caribou move from the summer range on the coastal plain south to the Brooks Range (Figure 3.3.4.1-1) (Cameron and Whitten 1979; Lenart 1999b; BLM and MMS 2003). Radio-tracking flights during March 2001 and February 2002 located caribou north and south of the Brooks Range and east and west of the Dalton Highway/TAPS corridor (Lenart unpublished data). In many years, several hundred CAH caribou overwinter on the coastal plain, including areas within the Kuparuk and Prudhoe Bay oilfields. Fall and winter ranges of the CAH, may overlap with those of the TCH and WAH (Cronin et al. 1998b; Lenart 1999b; Prichard et al. 2001).

### Harvest and Predation

Between 200 and 900 CAH caribou are harvested each year by local subsistence hunters from Nuiqsut and Kaktovik, and non-local hunters. Non-local subsistence and sport harvest is mostly along the Dalton Highway (Lenart 1999b; Murphy and Lawhead 2000). As noted for the TCH, wolf predation of the CAH is not well-documented, but wolf densities on the North Slope are low (Carroll 2000a; Shideler 2000). Other predators of CAH caribou include grizzly bears, wolverines, and golden eagles (Murphy and Lawhead 2000). Data on the extent of bear, wolverine, and eagle depredation of the CAH is not available.

#### PLAN AREA

The Plan Area is used by caribou from both the TCH and the CAH. The Colville River Delta is at the western edge of the CAH range and the eastern edge of the TCH range (Figure 3.3.4.1-1) (PAI 2002a: 4-73). In a study of the distribution of TCH caribou from 1990 to 1999, calving ranges were smallest, summer ranges intermediate, and winter ranges were largest in the Plan Area (Prichard et al. 2001). Telemetry data over the last 20 years indicate that caribou of the WAH rarely occur in the Colville River Delta, except as peripheral range for dispersing animals (PAI 2002a, Appendix B). PCH caribou may also use the Plan Area as peripheral range (BLM 2004b).

#### Calving Grounds

Telemetry and aerial survey data indicate that some TCH calving occurs in the western part of the Plan Area (Figures 3.3.4.1-2 and 3.3.4.1-3) (Burgess et al. 2003b; Noel 1999; Noel 2000), although most calving occurs to the west of the Plan Area (Figure 3.3.4.1-2) (BLM and MMS 2003; Jensen and Noel 2002). Satellite telemetry data indicate that from 1990 to 1999 TCH calving grounds were in the area surrounding Teshekpuk Lake and between Smith Bay and Harrison Bay, and most calving occurred north, northeast, and southeast of Teshekpuk Lake (Figure 3.3.4.1-2) (Prichard et al. 2001; BLM and MMS 2003). Additionally, Kelleyhouse (2001) summarized ADF&G radiotelemetry data from 1994 to 2000 and showed the calving grounds of the TCH included the western part of the Plan Area. Some concentrated calving occurs in the northwest part of the Plan Area (Figure 3.3.4.1-6). Most calving by the TCH in the Plan Area occurs in the area south of the Kogru River in the western part of the Plan Area (Figure 3.3.4.1-2) (BLM and MMS 2003). Calving surveys in the Northeast National Petroleum Reserve-Alaska (Noel 1999, 2000; Jensen and Noel 2002) recorded few caribou between the Kalikpik River and the Ublutuoch River compared to areas to the west. During these surveys, calving caribou were observed south of the Kogru River and between the Kogru River and Teshekpuk Lake. In the central portion of the Plan Area (approximately 950 $km^2$ in 2001 and 1,300 $km^2$ in 2002 in the vicinity of Fish and Judy creeks), Burgess et al. (2002b, 2003b) estimated moderate numbers of caribou (means of 564 and 958 for two surveys in the calving periods of 2001 and 2002, respectively; Figure 3.3.4.1-7). However, few calves were observed (means of 18 and 12 calves for two surveys in June 2001 and 2002, respectively) suggesting that the area is not heavily used by calving cows. Jensen and Noel (2002) also saw some calves in the Fish and Judy creeks area during the calving period in 2001.

Few caribou use the Colville River Delta during the calving period. Johnson et al. (1998) indicated that few adult caribou and almost no calves were observed on the Colville River Delta during calving surveys conducted in 1992 to 1993 and in 1995 to 1997. Low use of the Colville River Delta during the calving period could reflect avoidance of flooding during spring break-up (Whitten and Cameron 1983; PAI 2002a) or the low availability of tussock tundra, which is preferred by cow caribou during calving (Kuropat and Bryant 1980). The calving areas of the CAH are outside of the Plan Area to the east (Figure 3.3.4.1-1) (PAI 2002a, Appendix B; BLM and MMS 2003).

#### Summer Distribution and Insect-Relief Areas

Caribou from the TCH and the CAH use the Plan Area during the summer insect season, and use by the TCH predominates. The Plan Area is considered peripheral range for WAH and PCH caribou, which may be present during the summer (BLM 2004b).

Satellite telemetry data indicate that the area between Dease Inlet and Harrison Bay is used frequently by the TCH between early July and early August (Prichard et al. 2001; BLM and MMS 2003). During the mosquito season (late June and early July), use of this area by caribou was concentrated in the region between Smith Bay and Harrison Bay and from the north shore of Teshekpuk Lake to the Beaufort Sea Coast. This distribution included the northwest portion of the Plan Area around the Kalikpik and Kogru rivers and Fish Creek (Figure 3.3.4.1-8) (BLM and MMS 2003). These patterns were also seen with aerial surveys (Burgess et al. 2003b; Jensen and Noel 2002).

During the oestrid fly season (mid-July to mid-August), telemetry data showed that caribou were concentrated in the region between Dease Inlet and Teshekpuk Lake and on the east side of Teshekpuk Lake between the Beaufort Sea Coast and the area southeast of Teshekpuk Lake. This distribution includes the northwest portion of the Plan Area in the vicinity of the Kalikpik and Kogru rivers and Fish and Judy creeks (Figure 3.3.4.1-9) (Burgess et al. 2003b; Prichard et al. 2001; BLM and MMS 2003). During the oestrid fly season in the Plan Area, caribou may selectively use riparian areas (Burgess et al. 2003b).

Aerial surveys conducted through the insect seasons (late-June through August) showed variable numbers of caribou in the vicinity of Fish and Judy creeks in the Plan Area (estimated between 20 and 1,394 caribou in 2001 and between 0 and 540 caribou per survey in 2002 [Figure 3.3.4.1-7] [Burgess et al. 2002b, 2003b]). The area surveyed by Burgess et al. (2002b, 2003b) was inland from coastal insect-relief habitats, and the variability in caribou numbers could reflect different insect conditions on different survey days. In 2001, Jensen and Noel (2002) observed few caribou in the period between July 16 and August 7 in the western part of the Plan Area when weather conditions were favorable for parasitic insects. This suggests that caribou are likely to be present in greater numbers in the Plan Area during periods of cool weather when insect harassment abates. The combined survey data suggest that caribou were using insect-relief habitats outside of the Plan Area (Jenson and Noel 2002; Burgess et al. 2002b, 2003b). It is important to note that movements in and out of the Plan Area may be undetected during the limited time in which aerial surveys are done. Areas between Teshekpuk Lake and the Beaufort Sea Coast, along the edges and islands of Teshekpuk Lake, along the Beaufort Sea Coast from Dease Inlet to the Kogru River, and on sand dunes along the Ikpikpuk River and south of Teshekpuk Lake in the Pik Dunes region are potential insect-relief habitats for TCH caribou (Philo et al. 1993d; Carroll 1999a). It has been noted in literature and by local residents that TCH caribou will move into the Colville River Delta from the west under conditions of northeasterly winds, and during periods of intense insect harassment (Smith et al. 1994; PAI 2002a; Mark Wartes 2003**,** pers. comm.). When winds are still, TCH animals will remain in the vicinity of Fish Creek where ice lenses maintain cooler temperatures that provide insect relief (Mark Wartes 2003**,** pers. comm.).

The Colville River Delta is used most heavily by caribou during July when mosquitoes and oestrid flies are active. Thousands of caribou, particularly from the CAH, could use the Plan Area at this time (Johnson et al. 1997; PAI 2002a). Large groups of CAH caribou moved into a westerly wind across the Colville River and into the vicinity of Fish and Judy creeks in late July 2001. During this time at least 10,700 caribou moved west from the Kuparuk River onto the Colville River Delta during a period of warm temperatures and persistent westerly winds (Burgess et al. 2002b; Lawhead and Prichard 2002). Many caribou continued west into the National Petroleum Reserve-Alaska, including approximately 6,000 caribou that moved upstream along Fish Creek on July 23, 2001 (Del Vecchio, pers. comm. cited in Burgess et al. 2002b). Aerial surveys later that same day found only 636 caribou remaining in the vicinity of Fish Creek (Burgess et al. 2002b).

It has been noted that the CD-4 vicinity is less likely to be used for mosquito-relief habitat than the more coastal CD-3 area, but the CD-4 area could be used by caribou when insect harassment abates. A local resident noted that the movement of thousands of CAH caribou into the Plan Area in 2001 included traversing the area between the CD-2 and CD-4 sites. This might not be an annual occurrence, but when the CAH moves westward from the Colville River this is the usual crossing area.

#### Fall and Winter Range Use and Distribution

Distribution (including rutting areas in the fall) of the TCH are annually variable and dispersed east, west and south from summer ranges. Fall ranges include the Plan Area, particularly in the vicinity of Fish and Judy creeks, as observed in 2002 (Burgess et al. 2003b). In mid- to late October of 2001 and 2002, densities of caribou were high in the Plan Area relative to those observed during aerial surveys at other times in the same years (Figure 3.3.4.1-7) (Burgess et al. 2003b). Satellite telemetry data from 2002 indicated that most collared TCH caribou were south and southeast of Teshekpuk Lake during the October rut (Carroll pers. comm. cited by Burgess et al. 2003b). Satellite telemetry data from 1990 to 2001 also indicated there was little use of the Plan Area by TCH caribou during October (Prichard et al. 2001; BLM and MMS 2003). The CAH is not known to use the Plan Area during the fall.

Winter range use by TCH caribou varies within and between years, but could include portions of the Plan Area, particularly the northwest and southeast portions (Figure 3.3.4.1-5) (BLM and MMS 2003). Approximately 1,200 (1.26 caribou per $km^2$) and 800 (0.61 caribou per $km^2$) caribou were estimated within approximately 1,000 $km^2$ centered in the Fish-Judy Creek area during mid-May of 2001 and 2002, respectively (Burgess et al. 2002b, 2003b). Mean group sizes were approximately 5.8 caribou in 2001 and 3.2 caribou in 2002, and no calves were present. These caribou likely overwintered in the area (Burgess et al. 2002b). The CAH is not known to use the Plan Area during the winter.

#### Harvest and Predation

Nuiqsut residents harvest caribou year-round, depending on availability (BLM and MMS 1998a), although most caribou are harvested between mid summer and early winter (July to October) (Prichard et al. 2001). The entire Plan Area falls within defined subsistence land use for caribou harvest (BLM and MMS 1998a). Nuiqsut residents gain access to areas that provide a substantial proportion of their annual harvest via the Colville River Delta and Fish Creek (BLM and MMS 1998a). Approximately 65 percent of 513 caribou harvested by Nuiqsut residents in 1985, of 278 caribou harvested in 1992, 672 caribou harvested in 1993, and 258 caribou harvested in 1994 to 1995 were taken in the Colville River Delta, along Fish and Judy creeks (Figure 3.4.3.2-7), giving an approximate annual harvest in the range of 168 to 468 caribou from the Plan Area.

### MUSKOXEN

#### NORTH SLOPE

Historically, muskoxen occurred in many areas of northern Alaska, but they were extirpated from the Arctic Coastal Plain in the mid-1800s (Hone 1934). Muskoxen were reestablished by translocation of animals from Greenland to Nunivak Island near the western Alaska coast in 1935 and 1936 (Spencer and Lensink 1970). Sixty-four muskoxen from Nunivak Island were subsequently moved to Barter Island and the Kavik River near the ANWR in 1969–1970 (Jingfors and Klein 1982; BLM and MMS 2003). Thereafter, muskox numbers in northeastern Alaska increased, and their range expanded to the Colville River on the west and beyond the Babbage River on the east (Reynolds 1998; BLM and MMS 2003). Reynolds (1998) described three stages of muskox population change on the Arctic Coastal Plain: (1) slow growth for a few years immediately following the release, (2) a phase of rapid growth for approximately a decade, and (3) decline and stabilization in regions first occupied, concurrent with emigration of mixed-sex groups and expansion into additional regions during the second decade. Currently, the muskox population appears to be stable with approximately 672 muskoxen in the North Slope of Alaska and northwestern Canada (Lenart 1999a; Reynolds et al. 2002). Reynolds et al. (2002) noted that a decline in the rate of population growth in ANWR was probably caused by declines in survival and calf production.

Muskoxen occur on the Arctic Coastal Plain year-round and use habitats along river corridors, floodplains, and foothills in all seasons (Reynolds et al. 2002). Summer and winter surveys have shown that riparian corridors and adjacent upland habitats are important to muskoxen (Reynolds et al. 2002; BLM and MMS 2003). Muskox eat mainly sedges in winter and willow leaves, sedges, grasses, and forbs in summer (Klein 2000). During winter, muskoxen usually form larger groups of 6 to 60 animals and remain in one location for longer time periods. During summer, smaller groups of 5 to 20 animals are more common and they move more frequently than in winter (Lenart 1999a). Reynolds et al. (2002) reported that the average size of core areas used by muskoxen in the ANWR in summer (223 $km^2$) were significantly larger than core areas used during winter and the calving season (27 to 70 $km^2$). Grizzly bears kill calf and adult muskoxen, and predation by bears has increased in recent years in both the ANWR and the Colville River drainage near the Plan Area (Reynolds et al. 2002a, 2002b; O'Harra 2003). There has been no state-sanctioned sport harvest of muskoxen in GMU 26A (Hicks 1999).

#### PLAN AREA

Muskoxen expanded their range westward into the National Petroleum Reserve-Alaska from the area of reintroduction in the ANWR (Reynolds 1998; Reynolds et al. 2002). Recently, small numbers of muskoxen have occasionally been observed west of the Colville River (Lenart 1999a). Lawhead and Johnson (2000) observed muskoxen in the Kuparuk and Colville rivers region and reported that most sightings were recorded on the Kuparuk River floodplain. Other sightings were near the Itkillik River and uplands. During surveys in the Fish-Judy Creeks Facility Group, Burgess et al. (2002, 2003) recorded one small group of five or six adult muskoxen in 2001 and none in 2002. Johnson et al. (1999) and PAI (2002) summarized muskoxen sightings from 1992 to 1993 and 1995 to 2001 in the Colville River Delta and Kuparuk area. Most sightings were on the east side of the Delta north of the Alpine pipeline and along the Kachemach, Itkillik, and Kuparuk rivers and uplands (Figure 3.3.4.1-10). In 1995 and 1996, muskoxen were seen between the Colville River and the Dalton Highway, and in 2001 several breeding groups were seen along the Colville River and Fish Creek (BLM and MMS 2003). Muskoxen are not abundant in the Plan Area, but they might continue to expand westward into the Plan Area.

## MOOSE

### NORTH SLOPE

Moose occur at low densities on the Arctic Coastal Plain, which is the northern limit of moose range in Alaska. Habitat limits the size of the moose population in this area (Carroll 2000b). Moose are widely distributed during the summer, ranging from the northern foothills of the Brooks Range to the Arctic Coast. As snow accumulates during fall, moose move to riparian corridors of large river systems, where they concentrate in winter. The largest winter concentrations of moose occur in the inland portions of the Colville River drainage (Carroll 2000b). As snow cover in the foothills decreases in April, moose begin to move away from winter concentration areas but generally remain in riparian areas.

Late winter surveys conducted in concentration areas in the western North Slope and Brooks Range (GMU 26A) in 1970, 1977, 1984, 1991, 1995, 1999, and 2002 documented 1,219, 1,258, 1,447, 1,535, 757, 326, and 576 moose, respectively (BLM and MMS 2003; Carroll 2000b). It appears that poor nutrition, disease, predation, and hunting are important influences on North Slope moose population (Carroll 2000b). Trends during 1997 to 2002 indicated that the moose population has been increasing in recent years. Low adult mortality and high calf survival have contributed to this population increase (Carroll 2000b). This increase followed a decline of more than 50 percent between 1991 and 1997 (Carroll 2000b; BLM and MMS 2003). Because of low population densities, in 1996 GMU 26A was closed to moose hunting, except for the portion of the Colville River downstream of the Anaktuvuk River (Carroll 2000). For at least 4 years, all legal harvest was to occur in August without use of aircraft. During that time, all successful and most unsuccessful hunters were local residents reporting 6 to 20 moose-kills per year (Carroll 2000b). In 2002, moose hunting regulations were changed to include an annual harvest of one bull per hunter for only Alaska residents in GMU 26A.

### PLAN AREA

Within the Plan Area, moose use primarily riparian habitats in the Colville River Delta and have occurred at densities of 0.25 to 1.0 moose per square mile (Figure 3.3.4.1-10) (BLM and MMS 1998a, 2003). Johnson et al. (1999) reported that moose were rare on the Colville River Delta in summer. No moose were observed from 1992 to 1996, two moose were observed in 1997, and one moose was observed in 1998. An adult female and young male moose were present at the Colville Village site on July 17, 2001 (T. Helmericks 2004, pers. comm.). Moose occur at higher densities upstream of the Plan Area along the Colville River (BLM and MMS 1998a, 2003), which is primarily where Nuiqsut residents hunt them.

## GRIZZLY BEAR (BROWN BEAR)

### NORTH SLOPE

The coastal plain is the northern limit of grizzly bear range in North America. It is considered marginal habitat because of the severe climate, short growing season, and limited food resources (Shideler and Hechtel 2000). There are relatively low densities of grizzly bears (0.5 to 2.0 bears per 1,000 $km^2$) on the coastal plain, including habitats in the Prudhoe Bay and Kuparuk oilfield region. Densities of grizzly bears are greater in the mountains and foothills of the

Brooks Range in areas such as the Itkillik Hills and Franklin Bluffs and along riparian corridors (Reynolds 1979; Young and McCabe 1998; Shideler and Hechtel 2000; Carroll 1998b; BLM and MMS 2003; Shideler 2003, pers. comm.). Recent estimates suggest that 60 to 80 bears use the region between the Colville and Canning rivers (Shideler and Hechtel 2000; Shideler 2003, pers. comm.). Because of the presence of permafrost, grizzly bear dens on the coastal plain are usually restricted to well-drained sites such as pingos, riverbanks, and sand dunes. These sites are often with a southwest aspect in the lee of prevailing winds where snow tends to accumulate the most in winter. Dens are typically used once (Shideler and Hechtel 2000). Since 1996 the grizzly bear harvest in the western North Slope and Brooks Range has remained well below the management objectives of 31 bears per year in GMU 26A and 20 bears per year in GMU 26A West (Carroll 1999b). Most reported takes are by nonresident sport hunters. Residents of Nuiqsut harvested 10 grizzly bears in 1985, three in 1992, 10 in 1993, and none in 1994 to 1995 (ADFG CPDB; Fuller and George 1999; Brower and Opie 1998). These numbers represent the subsistence harvest for all grizzly bears taken by residents of the village. An unknown number of these bears were taken in the Plan Area.

#### PLAN AREA

Twenty-five marked grizzly bears and their dens have been found in the Colville River Delta, the Fish Creek/Judy Creek area, other riparian areas in the Plan Area, and the Colville-Kuparuk region (Figure 3.3.4.1-11) (PAI 2002a; ADFG unpublished data 2003). In general, the entire Colville River Delta is potential denning habitat for grizzly bears (PAI 2002a; BLM and MMS 2003). However, more dens have been found southeast of the Delta in the upper reaches of the Kachemach and Miluveach river drainages than on the Delta itself (Johnson et al. 1999). In and near the Plan Area, recent observations indicate that riparian areas are used frequently by grizzly bears, and more than ten dens of marked bears have been found in such habitats (Shideler 2004, pers. comm.). In the Northeast National Petroleum Reserve-Alaska, grizzly bears and dens have been observed incidentally during surveys for caribou and fox dens (Noel 1999; Noel 2000; Burgess et al. 2002b; Jensen and Noel 2002; Burgess et al. 2003b). Within the vicinity of Fish and Judy creeks in 2001, Burgess et al. (2002b) recorded seven observations of grizzly bears and documented three dens, and in 2002 Burgess et al. (2003b) documented two observations of grizzly bears and three more dens (Figure 3.3.4.1-10). Additionally, in summer 2001, during six full-coverage aerial surveys north of Fish Creek within the National Petroleum Reserve-Alaska Plan Area, Jensen and Noel (2002) observed five grizzly bears on or adjacent to the Kalikpik River, northwest of the confluence of Judy and Fish creeks, approximately 3.5 miles south of the Kogru River mouth, and south of Harrison Bay in the vicinity of the Kalikpik and Kogru rivers (Figure 3.3.4.1-10). In general, the Plan Area and adjacent northeastern National Petroleum Reserve-Alaska appear to be better grizzly bear habitat, with proportionally more well-drained potential denning habitat and ground squirrel habitat, than areas of the coastal plain east of the Colville River (Shideler 2004, pers. comm.).

### GRAY WOLF

#### NORTH SLOPE

Wolf numbers on the Arctic Coastal Plain and Brooks Range (GMU 26) have fluctuated since the 1900s in response to changes in prey populations (caribou and moose), a federal wolf control program in the 1950s, and aerial and snowmobile hunting by the public since the 1960s (Carroll 2000a; Shideler 2000). After prohibitions of aerial wolf hunting in 1970 and land-and-shoot hunting in 1982, the wolf population increased, especially in the mountains and foothills of the Brooks Range. In general, wolves are more abundant in the Brooks Range than on the Arctic Coastal Plain. This could be because of better prey availability and denning habitat in the Brooks Range, and rabies outbreaks and hunting pressure on the coastal plain (BLM and MMS 2003). In 1982, the wolf population in the western North Slope and Brooks Range (GMU 26A) was estimated at 144 to 310 animals (Carroll 2000a). In 1993, the population estimate increased to 240 to 390 wolves in 32 to 53 packs (Carroll 2000a).

The highest wolf densities in the National Petroleum Reserve-Alaska are along the Colville River. Surveys near Umiat showed that the density of wolves increased from 2.6 wolves per 1,000 km$^2$ in 1987 to 4.1 wolves per 1,000 km$^2$ in 1994 (Bente 1998). A survey in 1998 estimated 1.6 wolves per 1,000 km$^2$ and indicated that a substantial decline had occurred since 1994 (Bente 1998). This decline might have been related to the decrease in the moose population, which declined by 75 percent between 1992 and 1996 (BLM and MMS 2003).

The subsistence harvest of wolves is greatest in the southeastern portion of GMU 26A, where residents of Anaktuvuk Pass and Nuiqsut hunt and trap wolves throughout the winter (Carroll 2000a). The annual subsistence harvest throughout GMU 26A has ranged from approximately 50 to 120 wolves (Carroll 2000a).

#### PLAN AREA

There are no data for wolves specifically for the Plan Area, but they are believed to be uncommon (Table 3.3.4-1) (PAI 2002a). A wolf pack was observed occasionally during seismic exploration in the northwestern portion of the Plan Area in late winter 2003.

### WOLVERINE

#### NORTH SLOPE

Wolverines occur throughout the Arctic Coastal Plain but are more common in the mountains and foothills of the Brooks Range (Bee and Hall 1956; BLM and MMS 1998a, 2003). Magoun (1984) estimated a fall population size of 821 wolverines for the western North Slope (GMU 26A), based on a density of 1 wolverine per 54 square miles ($mi^{2)}$. Wolverines require large territories and have a low reproductive rate. They use a broad range of habitats, frequently occurring in tussock meadow, riparian willow, and alpine tundra habitats (BLM and MMS 1998a, 2003). The stomach contents of wolverines harvested from the National Petroleum Reserve-Alaska included caribou, ground squirrels, ptarmigan, and eggshells (Magoun 1979; BLM and MMS 1998a, 2003). Wolverines may kill prey or scavenge carrion, so this does not necessarily reflect predation by wolverines. From 1991 to 1994, 2 to 14 wolverines were harvested in GMU 26A; however, it is likely that more animals are harvested and not reported (Carroll 2000b). Most harvest of wolverines is by residents of the North Slope.

#### PLAN AREA

Wolverines are uncommon in the Plan Area, having been observed rarely in the northeast National Petroleum Reserve-Alaska, on the Colville River Delta, and east to the Kuparuk River during extensive wildlife surveys in that region from 1992 through 2002 (Figure 3.3.4.1-10) (Smith et al. 1993; Johnson et al. 1999; PAI 2002a; Burgess et al. 2002b; PAI 2002a; BLM and MMS 2003). Adult wolverines were observed along the Tamayagiaq Channel in June 1993 (Smith et al. 1994), near the mouth of the Kachemach River in June 1998 (Johnson et al. 1999), south of Fish Creek in September 2001 (Burgess et al. 2002b), and south of the Ublutuoch River in October 2002 (Burgess et al. 2003b). Additionally, two wolverines were observed adjacent to Fish and Judy creeks in April to July 1977 and 1978 (Figure 3.3.4.1-10) (BLM and MMS 1998a)

### ARCTIC FOX

#### NORTH SLOPE

The arctic fox is the most common furbearer on the Colville River Delta and adjacent coastal plain. Population estimates are not available for arctic foxes on the western North Slope (Carroll 1995). However, arctic fox populations fluctuate in response to prey population cycles (Macpherson 1969; Chesemore 1975), and populations may be larger where human garbage provides food (Burgess, 2000). Lemmings and voles are important prey year-round for arctic foxes. Foxes also forage on carcasses of caribou and marine mammals. During summer, nesting birds, eggs, and ground squirrels are important prey for arctic foxes (Chesemore 1968; Garrott et al. 1983). Rabies is common in arctic foxes on the North Slope and could be a source of mortality (Ballard et al. 2001, and references therein). Adult foxes excavate dens on raised landforms with well-drained soils, including riverbanks, mounds, pingos, ridges, dunes, and shorelines. Dens could be used during the summer breeding season for many years. Pups are born in early summer and are fed by the male and female. The pups begin to hunt on their own at approximately 3 months, and family units gradually disband and disperse in September and October. During winter, some arctic foxes move out onto the sea ice where they scavenge on the remains of polar bear kills. Arctic foxes are generally solitary during winter, although they sometimes congregate at food sources such as carcasses or garbage. Harvest data for the arctic fox are not available, but low fur prices in the mid-1990s resulted in relatively few foxes being trapped (Carroll 1998).

#### PLAN AREA

Arctic foxes prefer riparian or upland shrub habitats for denning; however, these habitats are rare on the Colville River Delta (Burgess et al. 2002b; Johnson et al. 2002; PAI 2002a). To date, 17 arctic fox dens have been documented on the Colville River Delta from surveys conducted in 1992 to 1993 and 1995 to 2002 (Figure 3.3.4.1-12) (Burgess et al. 2002b; Johnson et al. 2002; PAI 2002a). Total density (occupied and unoccupied) and occupied den densities on the Colville River Delta in 2001 were estimated to be one den per 12.5 $mi^2$ and one occupied den per 35.5 $mi^2$, respectively. Burgess et al. (2002b, 2003b) documented a total of 34 arctic fox dens (one den per 7.8 $mi^2$) in the Fish-Judy Creeks Facility Group in 2001 to 2002 (Table 3.3.4-2 and Figure 3.3.4.1-12). Eberhardt et al. (1983) reported one den per 13.1 $mi^2$ for a study area of 656 $mi^2$ in the Colville region. Densities reported for the Prudhoe Bay oilfield region ranged from one den per 4.6 $mi^2$ to one den per 5.8 $mi^2$ (Eberhardt et al. 1983; Burgess et al. 1993; Rodrigues et al. 1994; Ballard et al. 2000).

### RED FOX

#### NORTH SLOPE

No quantitative population information is available for red foxes on the western North Slope (Carroll 1995), but the species is considerably less common than arctic foxes. Red foxes are mainly found in the mountains and foothills of the Brooks Range. On the coastal plain, they are found mostly along major rivers. Important prey species and denning habitat requirements for red foxes are similar to those of arctic foxes, as described above. Red foxes are generally aggressive toward arctic foxes and could displace them. Harvest data for red foxes is not available, but low fur prices in the mid-1990s resulted in relatively few foxes being trapped (Carroll 1998).

#### PLAN AREA

In recent years, four to six red fox dens have been used annually on the Colville River Delta (Figure 3.3.4.1-12) (Johnson et al. 2003a); all of these dens were located in sand dunes in riverine or upland shrub habitats. In the vicinity of Fish and Judy creeks, Burgess et al. (2002b, 2003b) reported a single red fox den on a sand dune bordering Fish Creek. This den was unoccupied in 2001 and 2002 (Table 3.3.4-2 and Figure 3.3.4.1-12).

### SMALL MAMMALS

#### NORTH SLOPE

Small mammals that could be found in the Plan Area include arctic ground squirrel, ermine (short-tailed weasel), least weasel, tundra hare (or Alaskan hare), snowshoe hare, two species of lemming, three species of vole, and two species of shrew (Table 3.3.4-1) (BLM and MMS 2003; PAI 2002a). Small mammals are important prey for grizzly bears, foxes, wolves, wolverines, and birds of prey. Many small mammals undergo cyclic population fluctuations. Arctic ground squirrels are widely distributed and dig burrow complexes in well-drained soils on stream banks, dunes, and pingos where they hibernate during winter. The tundra hare occurs in western coastal Alaska from the Alaska Peninsula north to the Kotzebue region, but its occurrence on the North Slope has not been verified in many years (Bee and Hall 1956; Best and Henry 1994; Klein 1995). It probably does not occur in the Colville River region because its range has contracted (Klein 1995). In the mid-1990s, the population of snowshoe hares increased in the central Colville River drainage (ARCO et al. 1997). In June 1997, two snowshoe hares were seen on the Colville River Delta (Johnson et al. 1998). Lemmings are known for wide fluctuations in population numbers. Brown lemmings peak in abundance in the Barrow region at intervals averaging 3 to 5 years (ADF&G 1994; BLM and MMS 2003), but lemming cycles appear to be less frequent on the coastal plain along the central Beaufort Sea Coast (Feist 1975). Lemmings, voles, and shrews are active throughout the year and are important food for predators.

### TABLE 3.3.4-2 LANDFORMS, ACTIVITY STATUS, AND NUMBER OF PUPS COUNTED AT ARCTIC AND RED FOX DEN SITES IN THE NATIONAL PETROLEUM RESERVE-ALASKA STUDY AREA, ALASKA, 2001-2002

| Site No. | Landform | 2002 Status | 2002 Pup Count | 2001 Status | 2001 Pup Count |
|---|---|---|---|---|---|
| **Arctic Fox** | | | | | |
| 200 | DLB bank | inactive | unknown | inactive | unknown |
| 201 | DLB bank | inactive | unknown | inactive | unknown |
| 202 | lake bank | active | 0 | natal | 2 |
| 203 | low ridge | inactive | unknown | inactive | unknown |
| 204 | lake bank | active | 0 | inactive | unknown |
| 205 | river bank | inactive | unknown | inactive | unknown |
| 206 | stream bank | active | 0 | inactive | unknown |
| 207 | DLB bank | inactive | unknown | inactive | unknown |
| 208 | lake bank | active | 0 | natal | ≥2 |
| 209 | low mound | inactive | unknown | inactive | 0 |
| 210 | Pingo | inactive | unknown | inactive | unknown |
| 211 | lake bank | active | 0 | inactive | unknown |
| 212 | lake bank | inactive | unknown | inactive | unknown |
| 213 | lake bank | inactive | unknown | inactive | unknown |
| 214 | DLB bank | inactive | unknown | inactive | unknown |
| 215 | lake bank | inactive | 0 | natal | 5 |
| 216 | stream bank | active | 0 | inactive | 0 |
| 218 | low ridge | inactive | unknown | inactive | 0 |
| 219 | DLB bank | inactive | unknown | inactive | unknown |
| 220 | low ridge | inactive | unknown | active | 0 |
| 221 | low ridge | active | 0 | inactive | unknown |
| 222 | DLB bank | inactive | unknown | active | 0 |
| 223 | lake bank | natal | ≥1 (dead) | inactive | unknown |
| 225 | DLB bank | inactive | unknown | unknown | unknown |
| 226 | low mound | inactive | unknown | unknown | unknown |
| 227 | low mound | inactive | unknown | unknown | unknown |
| 228 | DLB bank | inactive | unknown | unknown | unknown |
| 229 | lake bank | active | 0 | unknown | unknown |
| 230 | old beach ridge | inactive | 0 | unknown | unknown |
| 231 | stream bank | inactive | unknown | unknown | unknown |
| 232 | low ridge | inactive | unknown | unknown | unknown |
| 233 | lake bank | inactive | unknown | unknown | unknown |
| 234 | sand dune | inactive | unknown | unknown | unknown |
| 235 | stream terrace | inactive | unknown | unknown | unknown |
| **Red Fox** | | | | | |
| 217 | sand dune | inactive | unknown | inactive | unknown |

Notes:
DLB – drained-lake basin
Zero (0) indicates that den was observed but no pups were seen

#### PLAN AREA

There are few data for small mammal numbers or distribution in the Plan Area but all species are probably present in the Plan Area to some extent (Table 3.3.4-1).

### 3.3.4.2 Marine Mammals

Most of the species of marine mammals that occur regularly in the Beaufort Sea offshore from the Plan Area have holarctic distributions that include multiple geographic stocks. Species inhabiting the Beaufort Sea include ringed seal, spotted (or largha) seal, bearded seal, polar bear, bowhead whale, and beluga (or belukha) whale. Table 3.3.4-3 lists the marine mammal species of the Beaufort Sea including their status under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Ringed seals, bearded seals, and polar bears are present year-round and move extensively throughout the Beaufort Sea region. Bowhead and beluga whales are normally present from April to October, and spotted seals are present from July through mid-October. Bowhead whales, bearded seals, ringed seals, and polar bears are important subsistence species for hunters from Barrow, Nuiqsut, and Kaktovik. Inupiat hunters take beluga whales sporadically when they are available.

**TABLE 3.3.4-3 MARINE MAMMAL SPECIES OF THE BEAUFORT SEA INCLUDING COMMON AND SCIENTIFIC NAME, ABUNDANCE AND RESIDENCY CLASSIFICATION, AND STATUS UNDER THE MMPA AND ESA**

| Common Name | Scientific Name | INUPIAQ Name | Abundance[a] | Seasonal Residency | Status under MMPA[b] | Status under ESA |
|---|---|---|---|---|---|---|
| Ringed seal | *Phoca hispida* | qayabulik, natchiq | abundant | year-round | protected | Not listed |
| Spotted (Largha) seal | *Phoca largha* | qasigiaq | common | seasonal | protected | Not listed |
| Bearded seal | *Erignathus barbatus* | ugruk | abundant | year-round | protected | Not listed |
| Ribbon seal | *Phoca fasciata* | | occasional | seasonal | protected | Not listed |
| Polar bear | *Ursus maritimus* | nanuq | abundant | year-round | protected | Not listed |
| Beluga (Belukha, white) whale | *Delphinapterus leucas* | qixalugaq, sisuaq | abundant | seasonal | protected | Not listed |
| Bowhead whale | *Balaena mysticetus* | abviq | abundant | seasonal | depleted | Endangered |
| Gray whale | *Eschrichtius robustus* | | occasional | seasonal | protected | Delisted |
| Killer whale | *Orcinus orca* | | occasional | seasonal | protected | Not listed |
| Pacific walrus | *Odobenus rosmarus* | aiviq | occasional / rare | seasonal | protected | Not listed |
| Narwhal | *Monodon monoceros* | qixalugaq tuugaalik | rare | unknown | protected | Not listed |

Notes:
[a] Modified from Morris et al. (1983) and Calkins (1986).
[b] Marine Mammal Protection Act. Endangered species are classified automatically as depleted; all stocks of depleted species are strategic stocks.

Other marine mammal species that occasionally occur in the Beaufort Sea include gray whale, killer whale, harbor porpoise, and ribbon seal. These species reach the northern limits of their summer distributions in the northeastern Chukchi Sea, and their occurrence in the Beaufort Sea is in low numbers and irregular. Walrus occur regularly in the western Beaufort Sea, but decrease markedly to the east, being found mainly as individual stragglers east of Pitt Point (Burns et al. 2001). These species will not be considered further.

No marine mammals that occur in the Beaufort Sea are listed by the BLM as Species of Concern in Alaska. The bowhead whale is listed as depleted under the MMPA and as endangered under the ESA and is discussed in Section 3.3.5, Endangered and Threatened Species.

### RINGED SEAL

Ringed seals are the smallest and most abundant of the arctic ice seals (Kingsley 1986; Smith and Hammill 1981). Ringed seals have a circumpolar distribution, occurring in all areas of the Arctic Ocean, and range from approximately 35°N to the North Pole (Kingsley 1986). The Alaska stock of ringed seals occurs in the Bering, Chukchi, and Beaufort seas. The size of the Alaska population is not currently known (Anglis and Lodge 2002), but estimates range from 1 million to 3.5 million individuals (Frost et al. 1988). The Beaufort Sea population could range from 80,000 in the summer to 40,000 in the winter (Frost and Lowry 1981).

#### NORTH SLOPE

Densities of ringed seals in the Alaska nearshore Beaufort Sea averaged 0.93 seals per $km^2$ and were higher to the east of Flaxman Island (1.19 seals per $km^2$) than to the west of Flaxman Island (0.81 seals per $km^2$) (Bengtson et al. 2000). These estimates are not corrected for the number of seals that are not visible to observers because they were underwater or in lairs under the snow[CHECK REF].

Densities of ringed seals near Prudhoe Bay between 1997 and 2002 ranged from 0.39 to 0.72 seals per $km^2$ (Moulton et al. 2003). These are lower than densities calculated in the same area during the 1980s. The differences could be due, in part, to differences in the timing of surveys, the timing of lair abandonment (Kelly et al. 2002a, 2002b), or a decrease in the abundance of seals since the 1980s. Seal densities reported for other areas of the Beaufort Sea range from 0.233 to 2.580 seals per $km^2$ (summarized in Stirling and Øritsland 1995).

The preferred breeding habitat for ringed seals is thought to be thick, consolidated landfast ice, but several studies have also identified breeding populations on drifting pack ice (Finley et al. 1983; Wiig et al. 1999). It is not known whether ringed seals breed in pack ice in the Beaufort Sea. Ringed seals begin using a series of breathing holes in the ice as soon as ice begins to form in autumn, and they maintain some holes through the winter (Smith and Stirling 1975). Lairs are excavated beneath the snow adjacent to some breathing holes in areas where ice topography creates snowdrifts at least 20 centimeters (cm) thick (Smith and Stirling 1975). Pregnant females give birth to pups within some of these lairs in late March through April. Ringed seals that breed in the pack ice could move to the shorefast ice after the breeding season (Smith and Lydersen 1991), and aerial counts of seals basking on landfast ice in spring (especially in areas near the ice edge and along cracks) might not accurately reflect the number of seals that use the nearshore environment through the winter.

Ringed seals are an important subsistence resource for the Inupiat of Alaska's North Slope. The number of seals harvested by Alaskan Inupiat was between 7,000 and 15,000 animals per year from 1962 to 1972 and declined to 3,000 in the 1980s (Kelly 1988). There is currently no reliable estimate of the total number of ringed seals harvested by Alaska Natives for subsistence use.

#### PLAN AREA

The density of ringed seals near the Plan Area probably depends on a variety of factors including food availability, water depth, ice stability, and ice topography. There have been no studies of ringed seals in Harrison Bay or the Plan Area specifically. However, ringed seals would be expected in areas with water depths greater than 3 meters (Moulton et al. 2002).

### SPOTTED (LARGHA) SEAL

Spotted seals are medium-sized pinnipeds that range along the continental shelf from the central Beaufort Sea through the Chukchi, Bering, and Okhotsk seas to the Sea of Japan. The Alaska stock of spotted seals occurs from the Bering Sea to the Beaufort Sea in the Arctic Ocean. There is no reliable estimate of the numbers of spotted seals in Alaska (Rugh et al. 1995; Angliss and Lodge 2002). However, estimates of the worldwide population ranged from 335,000 to 450,000 seals, with 200,000 to 250,000 spotted seals in the Bering Sea, including Russian waters (Burns 1973). There are no reliable data from which to determine population trends, but the population of spotted seals in Kasegaluk Lagoon in the northeast Chukchi Sea appears to have been stable from at least the late 1970s to the early 1990s (Frost et al. 1993).

### NORTH SLOPE AND WINTERING AREAS

Spotted seals are not common in the Beaufort Sea and are present only during the ice-free summer season. Spotted seals haul out on barrier islands, beaches, and sand bars on river deltas but do not follow the receding pack ice edge. Spotted seals migrate west and south from the Beaufort and Chukchi seas in October and pass through the Bering Strait in November (Lowry et al. 1998). Spotted seals overwinter in the Bering Sea along the ice edge and make east-west movements along the ice edge (Lowry et al. 1998). Spotted seals in the Alaska Bering Sea preferred nearshore areas from September to December, offshore habitat in January and February, and pack ice during March and April (Lowry et al. 2000). Spotted seals give birth in March or April on the Bering Sea pack ice and mate approximately 1 month after giving birth (Seaman et al. 1981).

Spotted seals feed on a variety of fishes and pelagic crustaceans; composition of the diet varies by season and location. During winter, fishes such as pollock and capelin at the ice front dominate the diet. During spring and summer, young animals prey on smaller fishes and crustaceans, while adults consume larger fishes, crustaceans, squid, and octopus (Lowry 1985).

Spotted seals are an important subsistence resource for Alaska Natives, particularly in the Yukon-Kuskokwim and Bering Strait regions, although they are less important to the Inupiat on the North Slope.

### PLAN AREA

Spotted seals regularly haul out in the main (east) channel of the Colville River, and some also are seen in the Nigliq Channel and in the Fish Creek Delta. The Colville River Delta is now the easternmost concentration area for spotted seals in the Alaskan Beaufort Sea (Seaman et al. 1981). Spotted seals have been observed in the Colville River as far upstream as Ocean Point and occur regularly as far as the mouth of the Itkillik River (Reed 1956; Seaman et al. 1981). Historically, as many as 400 spotted seals were estimated to have used the Colville River and the Sagavanirktok River deltas in the 1960s, although the number fell to 150 to 200 in the 1970s, after the village of Nuiqsut was reestablished (Seaman et al. 1981). In 1996 and 1998, as many as 24 spotted seals were seen at haulouts in the main channel of the Colville River Delta (Johnson et al. 1997, 1999; PAI 2002a). In September 2002, at least 30 spotted seals were seen at these same haulouts (ABR, unpublished data).

## BEARDED SEAL

### NORTH SLOPE AND WINTERING AREAS

Bearded seals are present throughout the year in the Beaufort Sea. They are considered common, but not abundant, during late spring through early autumn, and less common during the months of heavy ice cover. In general, this species prefers to overwinter in areas of unstable or broken sea ice, where break-up occurs early. In Alaska, bearded seals overwinter infrequently in the fast-ice zone (Cleator and Stirling 1990). No reliable estimate of the abundance of bearded seals in the Beaufort Sea is currently available (Angliss and Lodge 2002). Their densities in the Western Beaufort Sea are highest during the summer and lowest during the winter (MMS 2002). The population in Alaska waters is largely migratory, with its center of abundance in the Bering Sea. Their most important habitat during winter and spring is active ice or offshore leads. Farther north, they are restricted to areas in the pack ice where conditions create persistent openings such as leads, polynyas (areas of open water in the pack ice), and flaw zones. These conditions become progressively more limited north of the Bering Strait and especially in the Beaufort Sea (Burns 1967; Burns and Frost 1979; Kelly 1988).

Bearded seals are the largest of the phocid seals, with adults weighing up to 800 pounds. Pupping takes place on the ice from late March through May, primarily in the Bering and Chukchi seas. However, some pupping occurs in the Beaufort Sea (MMS 2002).

Bearded seals are an important subsistence resource for Alaska Natives. The Inupiat of the North Slope use bearded seal skins to cover the *umiat* (skin boats used for spring whaling). There are currently no reliable estimates of the subsistence harvest, but from 1966 through 1977 Alaska Native hunters harvested an average of 1,784 bearded seals per year (Burns 1981).

#### PLAN AREA

There are no reliable estimates of bearded seal abundance in the Plan Area. They could occur up the Colville River Delta during the open-water season when bearded seals are distributed from shore to the pack ice. In early autumn, juveniles occasionally occur in river mouths and lagoons where low-salinity water freezes prior to the more salty waters of other nearshore areas (Burns et al. 2001).

### POLAR BEAR

Polar bears are present in the Beaufort Sea year-round. They make a seasonal shift away from land as the landfast ice melts every summer. The Beaufort Sea stock has increased in number at an estimated annual rate of 2 percent or more during the past three decades (Amstrup et al. 2001). The Beaufort stock now numbers more than 2,000 animals and appears to be stable, showing little growth since the early 1990s (Angliss and Lodge 2002). Polar bear density in the region from Point Barrow to Cape Bathurst was estimated to be 1 bear per 197 $km^2$ to 1 bear per 284 $km^2$ (McDonald et al. 1999).

#### NORTH SLOPE

During late autumn to spring, polar bears are distributed widely, occurring on pack ice, landfast ice, and land. They are most abundant in the active flaw zone, where ringed seals, their principal prey, are most available (Burns et al. 2001). During the open-water season, polar bears are usually associated with the pack ice, although they could be seen on land or swimming in open water at considerable distances from the ice. As the pack ice comes closer to the coast during autumn, polar bears commonly swim ashore and scavenge beachcast carcasses or the remains of bowhead whales taken by subsistence hunters (Kalxdorff and Proffitt 2003).

Unlike other bears, male and non-pregnant female polar bears are active all winter. Pregnant females make maternal dens in deep snowdrifts during late October to early November (Durner et al. 2003; Amstrup and Gardner 1994). Between spring 1982 and spring 2003, 186 maternal dens were discovered between 137°W and 167°W longitude. Of those, 52 percent were on land or landfast ice and 48 percent were on pack ice (USGS 2002). Female polar bears produce one or two cubs (usually two) that are born in dens in December to January. The mothers and their cubs emerge from maternal dens in late March to early April, and those that were on land typically go to sea (Amstrup 2000).

Historically, polar bears have been hunted for subsistence, as well as by sport hunters. Between 1960 and 1972, an average of 260 polar bears were harvested annually from the Beaufort Sea, including both subsistence and sport hunters (Amstrup et al. 1986; Schliebe et al. 1995). In 1972, sport hunting in Alaska stopped, and the subsistence harvest in the Beaufort Sea averaged 111 bears annually between 1980 and 1996 (Schliebe et al. 1995). Between 1995 and 2000, the average annual harvest from the Beaufort Sea stock was 32.2 bears (Angliss and Lodge 2002).

#### PLAN AREA

Historically, polar bears have denned in the Colville River Delta region in low numbers. The USFWS maintains records of historical den locations, which are shown on Figure 3.3.4.2-1.

### BELUGA WHALE

#### NORTH SLOPE

Beluga whales from two stocks, the Beaufort Sea and the eastern Chukchi Sea, could be found in North Slope waters during the summer (Angliss and Lodge 2002). Starting in early spring, beluga whales of the Beaufort Sea stock migrate north from wintering areas in the Bering Sea and are usually seen at Point Barrow by mid-April. Belugas often travel near bowhead whales through the same leads and cracks. Once in the Beaufort Sea, most belugas travel through offshore leads to the eastern Beaufort Sea and Amundsen Gulf, where they spend part or all of the summer (Burns et al. 2001). Whales of the Beaufort Sea stock are found in the Mackenzie Delta intermittently throughout the summer and occur throughout the region until September (Richard et al. 2001). Satellite-tagging studies have shown that the males travel far northeast in late summer. Young are usually born from mid-June to mid-July and nurse for 12 to 18 months (Burns and Seaman 1985).

The Beaufort Sea stock of beluga whales is estimated to include more than 39,000 animals, based on data from an aerial survey conducted in 1992 (Angliss and Lodge 2002). During the summer, most members of the Beaufort Sea stock are found in the eastern Beaufort in Canadian waters, although a few are found in low density throughout the western Beaufort (Burns et al. 2001).

Return migration from Canadian waters during the late summer and autumn is primarily through offshore waters near and beyond the edge of the continental shelf. Belugas travel west both in and near the pack ice front and through open water south of the pack ice (Burns and Seaman 1985; Treacy 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2002a, 2002b). Westward migration begins in mid-summer and continues for an extended period into the autumn. Migration of satellite-tagged whales through Alaskan waters lasted from 8 to 19 days (Richard et al. 2001).

The eastern Chukchi stock summers primarily in the Kasegaluk Lagoon system near Point Lay, Alaska, but satellite tagging studies have confirmed that many of these whales move north into offshore waters of the Beaufort Sea during late July and early August (Suydam et al. 2001). This is about the same time the belugas of the Beaufort Sea stock begin migrating west (Frost et al. 1993; Burns and Seaman 1985). The eastern Chukchi belugas are found in offshore waters and are unlikely to be found in Harrison Bay or near the Plan Area.

Inupiat hunters take belugas from the Beaufort Sea stock in low numbers. The Alaska Beluga Whale Committee (ABWC) reports that between 1993 and 1997, Inupiat hunters took an annual average of 61 belugas (range 42 to 85) (Frost and Suydam 1995; Frost 1998). During the same time, Canadian Inupiat hunters harvested an average of 123 (106 to 140) whales from the Beaufort Sea stock (Norton et al. in press ).

#### PLAN AREA

There are limited records of coastal sightings of beluga whales near the Colville River Delta. Helmericks (cited in Hazard 1988) reported that belugas were common near shorefast ice in the Colville River Delta region until ice moved offshore in July. Seaman et al. (1981) reported sightings of a few groups (ranging up to 100 belugas) during fall migration north and east of the Colville River Delta near Jones, Pingok, and Thetis islands. Recently, Nuiqsut hunters have reported that belugas have been seen in the Nigliq Channel in the Colville River and were seen stranded in shallow water in the Fish Creek Delta (Lampe 2003). In general, nearshore waters are ice covered during the spring migration, and belugas come nearest the Colville River Delta during the fall migration. However, during both spring and fall migrations, the numbers that could occur near the Delta are only a small proportion of the main migration that occurs farther offshore

### 3.3.5 Endangered and Threatened Species

Three species listed as endangered or threatened under the ESA occur in the Plan Area or in the waters of Harrison Bay offshore of the Plan Area. These species are the bowhead whale (*Balaena mysticetus*) and two bird species, the spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*). Bowhead whales are uncommon in Harrison Bay but have been observed there. The spectacled eider is more common than Steller's eider in the Plan Area and has been recorded on aerial surveys in the Colville River Delta and throughout the area proposed for the ASDP (Burgess et al. 2003a, 2003b; Johnson et al. 2003b). Steller's eider is an uncommon or rare species in the Prudhoe Bay and the eastern National Petroleum Reserve-Alaska areas, although a few sightings have been recorded in the Plan Area (Johnson and Stickney 2001; Johnson et al. 2003b).

This section describes the occurrence of the three ESA-listed species in the Plan Area, as well as general information for the entire North Slope. Additional information is available in recent EISs, environmental assessments, and planning documents, including the Liberty Development and Production Plan (MMS 2002b), the Beaufort Sea Oil and Gas Development/Northstar Project (USACE 1999), the Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a), and the Environmental Report for the TAPS ROW Renewal (TAPS Owners 2001a).

#### 3.3.5.1 Bowhead Whale

The bowhead whale is classified as endangered under the ESA and as depleted under the MMPA. The bowhead whale was listed as endangered in 1970, but no critical habitat has been designated for this species. Recently Shelden et al. (2001) suggested that the Bering/Chukchi/Beaufort Sea (BCBS) stock of bowheads should be delisted under the ESA.

##### NORTH SLOPE

The BCBS stock of bowhead whales is the largest of the five stocks that occur in the Arctic and subarctic. The size of the stock was estimated at 10,400 to 23,000 animals in 1848, before commercial whaling decreased the stock to between 1,000 and 3,000 animals by 1914 (Woodby and Botkin 1993). This stock has slowly increased since 1921 when commercial whaling ended, and now numbers approximately 10,020 whales (George et al. 2003). The population has increased at an annual rate of 3.3 percent from 1978 to 2001 (George et al. 2002).

Bowhead whales occur in seasonally ice-covered seas, generally remaining close to the packice edge. Most of the BCBS bowheads winter in open water areas amid sea ice and along the edges of the pack ice in the western and central Bering Sea (Braham et al. 1984). BCBS bowheads are distributed in summer in a broad area from Amundsen Gulf and the Eastern Beaufort Sea to the eastern part of the East Siberian Sea.

###### MIGRATION

The spring migration typically begins in late March to early April, depending on ice conditions. During the spring migration, bowheads follow predictable leads that form along the coast of western Alaska to Point Barrow. From Point Barrow eastward to Amundsen Gulf, the leads and the migration occur farther from shore. From April to June most bowheads are distributed along a migration corridor that extends from their Bering Sea wintering grounds to their feeding grounds in the eastern Beaufort Sea (Moore and Reeves 1993). An unknown and probably variable number of bowhead whales could migrate westward to feeding grounds in the western Chukchi Sea (Bogoslovskaya et al. 1982).

BCBS bowheads migrate in pulses, which are groups migrating at different times (Ljungblad et al. 1986). Inupiat traditional knowledge (summarized in Braham et al. 1980) holds that the pulses are segregated by age and sex. The first two pulses are generally adults without calves or subadults, while cows with calves and large males do not arrive until the third and final pulse. The first migrants are usually seen near Point Barrow in mid-April but may arrive later in heavy ice years (Krogman et al. 1989). After passing Point Barrow, most of the bowheads travel east through offshore leads in the continuous pack ice to feeding grounds in the eastern Beaufort Sea (Richardson and Thomson 2002).

Bowheads that have summered in the eastern Beaufort Sea begin the fall migration in late August to September and are usually out of the Beaufort Sea by late October (Treacy 1988-1997, 2000, 2002a, 2002b; Moore and Reeves 1993). The fall migration route extends from the eastern Beaufort Sea, along the continental shelf across the Chukchi Sea, and down the coast of the Chukchi Peninsula (Moore and Reeves 1993). Bowheads often feed opportunistically during the westward migration, sometimes close to shore (Richardson and Thomson 2002; Treacy 2002b).

The bowhead migration route across the Chukchi Sea to the Chukchi Peninsula is less well defined than across the Beaufort Sea. Most whales swim southwest to the coast of Chukotka (Moore and Clarke 1990), but a few sightings north of 72°N suggest that some whales take a more northerly route, perhaps toward Herald and Wrangel islands (Braham et al. 1984).

### FORAGING

Examination of stomach contents from whales taken in the Inupiat subsistence harvest indicates that bowhead whales feed on a variety of invertebrates and small fishes (Lowry 1993). A minimum of 62 species of animals were identified, with crustacean zooplankton, primarily copepods and euphausiids, being the most important foods of bowheads in Alaskan waters (Lowry 1993). Generally, bowheads feed preferentially in areas with a higher than average zooplankton concentration (Griffiths et al. 2002b). Bowheads feed throughout the water column in the Beaufort Sea (Würsig et al. 1985).

Feeding in BCBS bowheads appears to be concentrated in the Eastern Beaufort Sea (mostly in the Canadian Beaufort Sea) in the summer and in the Bering Sea in the winter (Würsig et al. 1985; Schell et al. 1987; Schell and Saupe 1993). They appear to feed only occasionally during the spring (Carroll et al. 1987) and fall (Richardson 1987; Richardson and Thomson, 2002) migrations, and it is unclear how important feeding during the migration is. Richardson and Thomson (2002) estimated that bowheads derive, on average, 2.4 percent of their annual energy requirements from the Eastern Alaska Beaufort Sea, where they spend relatively little time. However, the total contribution from this area is highly variable (from <2 percent to 16 percent) , depending on the year and the individual whale. Several other aspects of bowhead whale foraging are described by Richardson and Thomson (2002).

### REPRODUCTION

BCBS bowheads mate and calve during the spring migration from the Bering Sea to the Beaufort Sea (Nerini et al. 1984), although sexual activity has been observed as early as January and as late as October (Koski et al. 1993; Würsig et al. 1993). Female bowheads probably become sexually mature when they are approximately 13.5 to 14.0 meters long and males when they are 12 to 13 meters long (Koski et al. 1993). The calving interval for bowhead whales appears to be at least 3 years, but could be longer (Koski et al. 1993).

### SURVIVAL AND MORTALITY

Commercial and subsistence whaling have been the greatest causes of bowhead mortality for the last several centuries. Currently, Alaskan Inupiat are allowed 67 strikes per year, which, if all were fatal, would result in 0.6 percent mortality of the stock from subsistence activity. The International Whaling Commission considers any strike to be fatal and counts the strike against the quota issued to Inupiat whalers. The Inupiat preferentially hunt immature whales (Philo et al. 1993c). Natural annual mortality in bowheads has been estimated at 3 to 7 percent (Breiwick et al. 1984; Chapman 1984), although it is difficult to estimate natural mortality since few bowheads that die of natural causes are seen.

## PLAN AREA

Bowheads are not found in the immediate Plan Area. The residents of Nuiqsut hunt bowheads from camps on Cross Island east of the Plan Area during the fall migration (see Section 3.4.3).

During the spring migration eastward through the Beaufort Sea, the nearshore waters of Harrison Bay are completely ice-covered and bowheads are far offshore of the Colville River Delta following open leads in the sea ice. In years with heavy ice in the fall, bowheads are generally > 60 km offshore and in the years with light or moderate ice conditions bowheads generally occur >30 km from shore (CPAI 2002a, BLM and MMS 2003a).

During the fall migration, bowheads may occur closer to shore than during the spring migration, depending on ice conditions. During annual aerial surveys from 1987 to 2000 in the Beaufort Sea, a few bowheads were sighted in Harrison Bay, shoreward of a line between Oliktok Point and Cape Halkett (Treacy 1988, 1997, 2000, 2002a, 2002b). Other surveys have also shown that bowhead whales are rare nearshore in Harrison Bay and along the barrier islands east of the Colville River Delta (CPAI 2002a, Seaman et al. 1981, Moore and Reeves 1993). In years with light ice in the fall, surveys showed that bowheads occur in waters deeper than 10 meters (33 feet) (BLM and MMS 2003a, Miller, Elliot, and Richardson 1996). Other reports show bowheads are generally restricted to waters 60 feet (18 m) depth (CPAI 2002a, Seaman et al. 1981). The area offshore of the Plan Area is shallow, with the 30 foot depth contour more than three miles offshore of the Colville Delta. The aerial survey data and preference for deeper water indicate that bowhead whales are unlikely to occur in the shallow nearshore areas north of the Plan Area.

### 3.3.5.2 Spectacled Eider

The spectacled eider was listed as a threatened species in May 1993 (58 FR 27474) under the ESA throughout their range in the United States and Russia. Areas in Alaska designated by the USFWS as critical habitat include molting areas at Norton Sound and at Ledyard Bay in the southeast Chukchi Sea, the wintering area south of St. Lawrence Island, and the Yukon-Kuskokwim Delta breeding area (66 FR 9146-9185). There are no critical habitats on the North Slope designated by the USFWS for this species.

#### NORTH SLOPE

##### POPULATION STATUS AND RANGE

The spectacled eider was listed as a threatened species because of significant declines in the North American breeding population, particularly on the Yukon-Kuskokwim (Y-K) Delta. From the early 1970s to the early 1990s, numbers of pairs on the Y-K Delta declined by 96 percent from 48,000 to 2,000, apparently stabilizing at that low level (Stehn et al. 1993;Ely et al. 1994). On the North Slope, the minimum population estimate of breeding spectacled eiders based on aerial surveys between 1993 and 2002 ranged from a high of almost 9,300 birds in 1993 to a low of 5,800 birds in 1996 and back up to 6,662 birds in 2002 (Larned et al. 2001a; Larnedet al. 2003). A minimum (uncorrected for detection bias) long-term average (1992 to 2002) of 6,896 spectacled eiders occupied the surveyed portion of the Arctic Coastal Plain of Alaska (Larned et al. 2003), approximately 2 percent of the estimated 375,000 world population (Larned and Tiplady 1999). High-density nesting areas for spectacled eiders on the Arctic Coastal Plain are generally west of Dease Inlet (Figure 3.3.5.2-1). Nesting concentrations of spectacled eiders in the Plan Area are located in the Colville River Delta and south of Harrison Bay (Figure 3.3.5.2-1).

Most of the world spectacled eider population breeds in arctic Russia. Nonbreeders are not included in the Alaska estimate. They are assumed to remain at sea throughout the year until they attempt to breed at the ages of 2 to 3 years. The size of this population segment is unknown, as is their location during this period. Available life-history information for this species indicates they are long lived with relatively high adult survival and delayed sexual maturity. The North Slope population has shown a nonsignificant decreasing trend of approximately -1.26 percent (slope) from 1993 to 2002 with a corresponding mean growth rate of 0.99 (Larned et al. 2003). Additional details on population status and annual cycle may be found in Petersen et al. (2000).

During the nonbreeding season, from October/December to April, the only known spectacled eider wintering area is among leads in the pack ice southwest of St. Lawrence Island in the Bering Sea (Petersen et al. 1999). Eiders forage there principally by diving to obtain benthic invertebrates at varying depths less than 80 meters. In the marine environment, they feed primarily on clams, but also feed on snails, a variety of crustaceans, and members of various other taxa (Petersen et al. 2000). In recent studies in the northern Bering Sea wintering area, esophagi of sampled eiders contained only clams, mostly *Nuculana radiata*, with no trace of the once-dominant *Macoma calcarea* (Lovvorn et al. 2003). Changes in density of the latter species in the Bering Sea were coincident with an oceanic regime shift to warmer conditions.

Climate change at northern latitudes and associated changes in marine invertebrate communities and ice dynamics in spring may have had important impacts on the spectacled eider population, whose declines of 90 percent or more in western Alaska is essentially unexplained. Reasons for this decline are unknown but may be related to parasites and disease, subsistence harvest, predation, and potential alterations of Bering Sea food resources related to climatic regime shifts. Numerous studies have been conducted to investigate the potentail effects of spent lead shot on the Y-K Delta spectacled eider population (Franson et al. 1995; Flint and Grand 1997; Flint et al. 1997; Flint 1998; Grand et al. 1998).

Because few eiders are observed in marine areas along the Beaufort Sea Coast in spring, a majority could migrate to the nesting areas overland from the Chukchi Sea (TERA 2002). Although their location during the 1 to 2 month period between departure from the wintering area (April) and arrival in the breeding areas (early June) is unknown, it likely contains leads and polynyas nearest to the breeding areas (Lovvorn et al. 2003).

Routes traveled by spectacled eiders during spring migration are not well known. Generally, they have been recorded passing Point Barrow and/or arriving at the breeding areas in late May to early June (Johnson and Herter 1989). Although leads are important for many species migrating in this region, few spectacled eiders have been recorded using the lead system 5 to 6 km offshore extending eastward from Point Barrow (Woodby and Divoky 1982; Suydam et al. 2000). Suydam et al. (1997) recorded 55 spectacled eiders among 213,477 king and common eiders passing Point Barrow in spring 1994. Low numbers (0.5 to 0.7 birds per hour) have been recorded at several points in Simpson Lagoon (Johnson and Richardson 1981), but some of these probably were movements of local birds rather than migrants. Thus, because relatively few spectacled eiders are seen in marine areas, spring migration could be primarily overland from the Chukchi Sea (TERA 2002). Local observations that spectacled eiders flew inland north of Wainwright, reported by Myres (1958), support this view. They arrive on the breeding areas paired, often traveling in small flocks in late May and early June. Spectacled eiders have been observed to fly generally at altitudes less than 50 meters when over (marine) water (Petersen et al. 2000).

#### HABITAT

Spectacled eiders use a variety of habitats on the North Slope including the Plan Area. The USFWS identified five primary constituent elements considered to be important to this threatened species that could require special management considerations or protection: (1) all deep water bodies; (2) all water bodies that are part of basin wetland complexes; (3) all permanently flooded wetlands containing either *Carex aquatilis*, *Arctophila fulva*, or both; (4) all habitat immediately adjacent to these habitat types; and (5) all marine waters out to 25 miles from shore, the associated aquatic flora and fauna in the water column, and the underlying benthic community (65 FR 6114). However, large-scale landscape features that provide protection from predators such as the arctic fox could be more important indicators of nesting habitat than small-scale habitat features (Pearce et al. 1998).

#### NESTING, BROOD-REARING, STAGING, AND FALL MIGRATION

Currently the known primary nesting grounds are the Y-K Delta, the Arctic Coastal Plain (Kasegaluk Lagoon to the Sagavanirktok River) of Alaska, and in the Chaun Gulf and the Kolyma, Indigirka, and Yana river deltas of arctic Russia. With the exception of a few scattered areas in the Northwest National Petroleum Reserve-Alaska, spectacled eiders occur at low density on the Arctic Coastal Plain (Larned et al. 2001a, b; Ritchie and King 2002). The highest densities determined from FWS aerial surveys in 1998 to 2001 were found within 70 km of the coast between Barrow and Wainwright, with smaller areas northeast of Teshekpuk Lake (Figure 3.3.5.2-1). Overall density was determined to be 0.24 birds per $km^2$ in the Eider Survey area, based on observations of 304 birds in 2001 (Larned et al. 2001a, b), and 0.22 in 2002 (Larned et al. 2003). Before nesting, eiders occupy a variety of wetland and aquatic habitats (Anderson et al. 1996). Available information suggests female spectacled eiders return to the vicinity of previous nests. Spectacled eiders are dispersed nesters (Derksen et al.1981; Warnock and Troy 1992), occurring at a low density of 0.03 to 0.79 birds per $km^2$ (Larned and Balogh 1997) within approximately 70 km of the coast. Higher density nesting and broodrearing areas occur south of Peard Bay, including the Kugrua and Kungok river drainages, south of Barrow; and adjacent to Dease Inlet, including the Meade, Chip, and Inaru river drainages. Tundra-nesting habitat most often includes extensive wetlands (large shallow lakes, lake-basin wetland complexes) with emergent sedges and grasses and vegetated islands (Larned and Balogh 1997; Anderson et al. 1996). On the Colville River Delta, nearly half of the nests located were in salt-killed tundra and aquatic sedge with deep polygons (ABR, Inc. 2002). On the Arctic Coastal Plain, nesting begins in mid-June. Incubation lasts 20 to 25 days (Dau 1974; Kondratev and Zadorina 1992; Harwood and Moran 1993; Moran and Harwood 1994; Moran 1995), and eggs hatch from mid- to late July (Warnock and Troy 1992). Broodrearing in the central Arctic Coastal Plain occurs primarily in waterbodies with margins of emergent grasses and sedges, basin wetlands, and deeper lakes (ARCO Alaska, Inc. et al. 1997). Fledging occurs approximately 50 days posthatch.

On the nesting grounds, spectacled eiders occupy terrestrial wetlands and feed primarily by dabbling in shallow freshwater or brackish ponds, or on flooded tundra (Dau 1974; Kistchinski and Flint 1974). Food items include mollusks; insect larvae such as craneflies, trichopterans, and chironomids; small, freshwater crustaceans; and plants or seeds (Cottam 1939; Dau 1974; Kistchinski and Flint 1974; Kondratev and Zadorina 1992; Petersen et al. 2000).

Most male spectacled eiders depart the nesting areas from early June to early July (median date June 22 ±11 days) typically soon after females begin incubating. The number of pairs peaks in mid-June, and the number of males declines 4 to 5 days later (Anderson and Cooper 1994; Anderson et al. 1995; Smith et al. 1994). Males migrate a median distance of 6.6 km (average 10.1 km) offshore, spending up to a week in marine waters (Petersen et al. 1999a). Locations of satellite-transmitter-equipped males (Petersen et al. 1995) in the Beaufort Sea have been primarily in the western Harrison Bay and western Simpson Lagoon areas. A molt-migration is undertaken to Ledyard Bay molting area along the Chukchi Sea Coast southwest of Point Lay (Larned et al. 1995), and flocks of molting and staging eiders have been observed in Peard Bay, Norton Sound, south of St. Lawrence Island, and the Russian Far East prior to moving to the Bering Sea wintering area from October to December. Initial locations for many of the birds that were captured initially in the Prudhoe Bay area have been in the Chukchi Sea, suggesting they migrated overland or occupied the Beaufort Sea only briefly (TERA 2002). Although most males might make relatively little use of the Beaufort Sea prior to their molt-migration, at least in part due to the existence of little open-water habitat this early in the summer (TERA 2002), for some individuals the Beaufort Sea could be an important staging and migration route for as much as a week or two (Petersen et al. 1999a).

After nesting, most spectacled eider females with broods occupy coastal plain lakes with emergent grasses and sedges, or deep, open-water lakes. Departure from broodrearing sites for marine areas takes place on average August 29 (±10.5 days). However, departure of females takes place over an extended period from the third week of June through September, because females that fail to breed leave the nesting area early, those that lose their nests leave somewhat later, and those that lose broods leave still later (TERA 2002). When females depart the Arctic Coastal Plain, much more of the nearshore zone is ice free than when males depart; this open water in marine habitat allows extensive use of the western Beaufort Sea. Locations of females equipped with satellite transmitters in the Prudhoe Bay area indicate they stage and migrate in the Beaufort Sea and, like some males, use Smith and Harrison bays. Aerial surveys in late August 1999 recorded four spectacled eiders, a female with two young and an individual of unspecified sex in western Harrison Bay (Stehn and Platte 2000). In 2000, 13 female spectacled eiders tracked via satellite telemetry primarily used the western Beaufort (71 percent of all bird-days); however, areas near Stockton Island also were used extensively (17 percent of all bird-days) (Troy 2003). Half the tagged Prudhoe females were relocated twice in the Beaufort Sea, indicating a residence time of at least 4 days. Most previously were thought to spend relatively little time in the Beaufort (TERA 2002); however, these recent satellite-transmitter locations suggest they could remain in the Beaufort Sea for approximately 2 weeks (range 6 to 30 days) (Troy 2003). Although satellite-tagged females have been relocated more than 40 km offshore in the Beaufort Sea (TERA 2002), the median distance for migrating individuals is 16.5 km offshore (average 21.8 km) (Petersen et al. 1999a).

Numbers of spectacled eiders staging in the Beaufort Sea before southward migration generally are unknown. It is likely that relatively few birds occupy this area at any given time. This is suggested by relatively low numbers of birds counted on offshore aerial surveys (estimated densities of 0.01 to 0.16 birds per $km^2$) (Fischer 2001; Stehn and Platte 2000), as well as by the relatively low proportion of initial and repeat locations in the Beaufort Sea (once movement of an individual began) of transmitter-equipped birds that were captured initially in the central Beaufort Sea area. Aerial surveys in the central Beaufort Sea in July 2000 located 143 eiders in the deeper waters of Harrison Bay, including one flock of 100 birds (Fischer et al. 2002). A less intensive USFWS survey (flight lines twice as far apart), covering the entire Beaufort coastline from Point Barrow to Demarcation Point in July 2001, located 15 spectacled eiders off western Simpson Lagoon, in outer Smith Bay, and off the Plover Islands east of Point Barrow (Fig. 3.3.5.2-1) (Fischer 2001). These studies suggest that relatively low numbers of spectacled eiders would be expected to be found in either Beaufort or Chukchi seas during the staging/migration period from late June to September. However, these observations could underestimate numbers, because the limited aerial surveys could not accurately assess use of the entire area, and a substantial proportion of the "unidentified" eiders could have been spectacled. Observations made offshore in the Beaufort Sea by Divoky (1984) suggested that larger flocks might contain hundreds of individuals of this species. Divoky found the largest sitting flocks to contain more than 100 birds and flying flocks more than 300 individuals. During a late June to early July aerial survey in the Chukchi Sea between Peard Bay and Smith Bay, Dau and Anderson (2001) observed 40 spectacled eiders in nearshore waters. In 2002, they observed 10 in this area (Dau and Anderson 2001), and Dau and Hodges (2003) observed 1 in 2003.

## PLAN AREA

### POPULATION STATUS AND RANGE

A minimum estimated population of 7,149 spectacled eiders were on the Arctic Coastal Plain during 2003 (Larned et al. 2003b). An estimated 92 spectacled eiders used the Plan Area during 2003 (Colville River Delta extrapolated based on reported densities of 0.07 and 0.04 birds/km$^2$ [Johnson et al. 2004] and the National Petroleum Reserve-Alaska extrapolated based on a reported density of 0.02 birds/km$^2$ [Johnson et al. 2004]). Similar to the trend on the Arctic Coastal Plain, the numbers of nesting spectacled eiders in the Kuparuk oilfield area, just east of the Colville River Delta and the National Petroleum Reserve-Alaska, has remained relatively constant from 1993 to 2003 (Anderson et al. 2003). In contrast, numbers of spectacled eiders in the northeastern portion of the Colville River Delta declined by about 90 percent from 1987 to the mid-1990s (Helmericks 2004).

Spectacled eiders are found throughout the Colville River Delta from late May to early June (Figure 3.3.5.2-2), but most nesting and brood-rearing has been concentrated in the northwest portion of the outer Delta in recent years (Figure 3.3.5.2-3). Studies in Colville River Delta between 1996 and 2003 indicate that spectacled eiders nest primarily on the outer Delta (Figure 3.3.5.2-2) (PAI 2002a; Johnson et al. 2003a, 2004; Burgess et al. 2003a). Spectacled eiders nested historically in the Anachlik Colony and on Dune Island just east of the mouth of the Miluveach River (Helmericks 2004). Spectacled eider surveys during mid June 1993 to 2003 in the National Petroleum Reserve-Alaska portion of the Plan Area indicated that fewer eiders used this area than use the Colville River Delta (Figure 3.3.5.2-4). Spectacled eider nests have been located during ground-based searches at CD-5 (Figure 3.3.5.2-5). Eiders are harvested in the Colville River Delta (28 percent of eider harvest) during spring subsistence hunting primarily using boats to access the Delta and Harrison Bay (Figure 3.4.3.2-18).

### NESTING, BROOD-REARING, AND STAGING

Pre-nesting eiders preferred Brackish Water, Salt Marsh, Salt-Killed Tundra, Deep Open Water with Islands, Shallow Open Water with Islands, and Aquatic Sedge Marsh with Deep Polygons in the Colville River Delta (Johnson et al. 2004). Nesting habitats used in the Colville River Delta (greater than or equal to 10 percent of observations) were Aquatic Sedge with Deep Polygons, Unpatterned and Patterned Wet Meadows (Johnson et al. 2004). Nesting habitats historically used in the Anachlik Colony area were Aquatic Sedge with Deep Polygons, Non-patterned Wet Meadow, and Patterned Wet Meadow (Helmericks 2004). Pre-nesting eiders preferred Salt Marsh, Shallow Open Water with Islands and Old Basin Wetland Complex and avoided Moist Tussock Tundra habitats within the portion of the proposed development in the National Petroleum Reserve-Alaska (Johnson et al. 2004). Nesting habitats used in the National Petroleum Reserve-Alaska were Deep Open Water with Islands, Shallow Open Water with Islands, Old Basin Wetland Complex, and Patterned Wet Meadow (Johnson et al. 2004).

Male spectacled eiders begin molt migrations during late June, with few birds (29 percent) using the nearshore Baufort Sea during molt-migration (Troy 2003). Male spectacled eiders spent a median of 10 days using the area of river discharge offshore of the Colville River Delta (Troy 2003). Female spectacled eiders move from tundra to marine waters in mid to late July, with all females using the Beaufort Sea for an average of almost two weeks, although few remained in the Colville River Delta area for more than a few days (Troy 2003). Few flocks of spectacled eiders were reported during summer offshore surveys between Cape Halkett and Brownlow Point; however, densities were highest in the deep and shallow water Harrison Bay areas in July 2000 and August 2000 (Figure 3.3.5.2-1) (Fischer et al. 2002). Flock sizes ranged from 1 to 100 birds, with the largest flocks in the deep areas of Harrison Bay (Fischer et al. 2002).

The proposed CD-3 area is in the outer Colville River Delta that is used most heavily by spectacled eiders (Johnson et al. 2003b). This area supports some of the highest densities of pre-nesting, nesting, and brood-rearing spectacled eiders in the Colville River Delta (Figure 3.3.5.2-2 and 3.3.5.2-3) (Johnson et al. 2003b, 2004). During pre-nesting, densities of spectacled eiders in the CD-3 area in 2002 (0.20 indicated birds/km$^2$) (Johnson et al. 2003b) were comparable to densities recorded across the Arctic Coastal Plain (0.23 indicated birds/km$^2$) (Larned et al. 2003). Spectacled eiders were reported in 14 of 21 habitats available during the pre-nesting period. 7 to 14 spectacled eider nests were found during nest searches in the proposed CD-3 area during 2000 to 2002, with a mean density of 0.6

nests/$km^2$ (Johnson et al. 2003b). A total of 10 nests had been found during ground searches of this area conducted in four previous years (Johnson et al. 2003b). Nests were found in most of the habitat types used during pre-nesting, with 39 percent of all nests in Salt-Killed Tundra, 21 percent in Aquatic Sedge with Deep Polygons, 18 percent in Patterned Wet Meadow, and 11 percent in Nonpatterned Wet Meadow. Surveys for spectacled eider broods have been conducted with less intensity than other surveys, but eiders use the same areas of the Colville River Delta during brood-rearing as during pre-nesting and nesting.

Studies in the CD-4 area in the inner Colville River Delta, as well as CD-5, CD-6, and CD-7 in the National Petroleum Reserve-Alaska, indicate much lower use of these areas by spectacled eiders during pre-nesting, nesting, and brood-rearing periods (Table 3.3.5-1) (Burgess et al. 2003a, 2003b, Johnson et al. 2004). The density of pre-nesting spectacled eiders in the CD-4 area averaged less than 0.01 indicated birds/$km^2$. The density of pre-nesting spectacled eiders in the National Petroleum Reserve-Alaska study area (0.02 to 0.04 indicated birds/$km^2$) was 25 to 50 percent of the density in the Kuparuk Oilfield and 10 to 20 percent of the density in the CD-3 area (Burgess et al. 2003b). One nest has been found each year in the CD-4 area for 2 of 3 years of nest searching (Burgess et al. 2003a). Seven nests were found at the National Petroleum Reserve-Alaska sites, four nests at CD-5 in 2002 and 2003, and three nests in a wetland basin in the northwest corner of the National Petroleum Reserve-Alaska study area during 2001 (Figure 3.3.5.2-5) (Burgess et al. 2003b; Johnson et al. 2004). One spectacled eider brood was observed in the National Petroleum Reserve-Alaska area northeast of CD-7 (Figure 3.3.5.2-5) (Burgess et al. 2003b; Johnson et al. 2004).

**TABLE 3.3.5-1 GROUND-BASED SPECTACLED EIDER NEST DENSITIES (NEST/$KM^2$) IN THE PLAN AREA**

| | | CD North | CD South | Alpine West | Lookout | Spark | |
|---|---|---|---|---|---|---|---|
| Spectacled Eider | Alpine (6-year mean) | CD-3 (4-year mean) | CD-4 (3-year mean) | CD-5 (2-year mean) | CD-6 (2-year mean) | CD-7 (2-year mean) | National Petroleum Reserve-Alaska Area (2003) |
| **Nest Densities** | | | | | | | |
| 2000 | | 1.1 | 0.2 | | | | |
| 2001 | | 0.4 | 0.1 | | | | |
| 2002 | | 0.4 | 0 | 0.2 | 0 | 0 | |
| 2003 | | 0.7 | | 0.2 | 0 | 0 | 0.1 |
| **Average** | **0.04** | **0.65** | **0.09** | **0.21** | **0** | **0** | **0.1** |

### 3.3.5.3 Steller's Eider

The Alaska breeding population of Steller's eider was listed as threatened on June 11, 1997 (62 FR 31748-31757). Historically, this species nested throughout much of western and northern coastal Alaska and in arctic Russia (Kertell 1991; Quakenbush and Cochrane 1993). However, the principal nesting areas now are in arctic Russia, with relatively few Steller's eider nests in Alaska on either the Arctic Coastal Plain or the Y-K Delta (Kertell 1991; Quakenbush and Cochrane 1993; Flint and Herzog 1999). Estimates of nesting Steller's eiders are complicated by the association of nesting with high lemming years (Quakenbush and Suydam 1999), but the numbers of Steller's eiders nesting in Alaska during suitable years is probably on the order of hundreds to 1,000 (Larned et al. 2003).

Areas in Alaska designated by the USFWS as critical habitat for the Alaska-breeding population of Steller's eiders include breeding habitat on the Y-K Delta and molting, wintering and spring staging habitats in marine waters including the Kuskokwim Shoals, Seal Islands, Nelson Lagoon and Izembek Lagoon (66 FR 8849-8884). There are no critical habitats on the North Slope designated by the USFWS for this species.

## NORTH SLOPE

### POPULATION STATUS AND RANGE

The Alaska-breeding population of Steller's eider was listed as threatened based on a substantial decrease in the species' nesting range in Alaska, a reduction in the number of Steller's eiders nesting in Alaska, and the resulting increased vulnerability of the remaining breeding population to extirpation. Historically, Steller's eiders nested in Alaska in two general regions: western Alaska where the species has been nearly extirpated, and the Arctic Coastal Plain where the species still occurs. In western Alaska, Steller's eiders occurred primarily in the coastal fringe of the Y-K Delta where the species was common at some sites in the 1920s, was still present in the 1960s, but was not recorded as breeding from 1976 to 1994 (Kertell 1991; Flint and Herzog 1999). In 1994 and 1996 to 1998, one to two nests were found at either or both the Tutakoke River and Hock Slough study sites on the Y-K Delta (Flint and Herzog 1999).

On the Arctic Coastal Plain, Steller's eiders historically occurred from Wainwright east, to nearly the United States-Canada border (Brooks 1915). The species might have abandoned the eastern Arctic Coastal Plain in recent decades, but it still occurs at low densities (0.01 per $km^2$) (Larned et al. 2001a; Larned et al. 2003) from Wainwright to at least as far east as Prudhoe Bay (Fig. 3.3.5.3-1). The majority of sightings in the last decade have occurred east of Point Lay, west of Nuiqsut, and within 90 km (56 miles) of the coast (Barrow Triangle). Near Barrow, Steller's eiders still occur regularly, although they do not nest annually. In some years, up to several dozen pairs could breed in a few square km. The species has been found at highest density (0 to 3.0 pairs per $km^2$) during road surveys in the core nesting area near Barrow (Quakenbush, et al. 1995). Intensive aerial surveys in the area between Admiralty Bay and the Chukchi Sea from 1999 to 2001 recorded densities of 0.02 to 0.08 birds per square kilometer (44-112 birds observed during 3 years) (Ritchie and King 2002). In 2002 and 2003, respectively, these investigators recorded an indicated total of 4 birds and 8 birds and a density of less than 0.01 birds per $km^2$ (Ritchie and King 2003).

Contemporary aerial breeding-pair surveys conducted in late June indicate a population averaging approximately 1,000 birds from 1986 to 2000 (Mallek 2001). A separate set of aerial surveys, timed in mid-June, indicates a smaller population, averaging approximately 200 birds from 1993 to 2001 (Larned et al. 2001a). These surveys likely underestimate actual population size because an unknown proportion of birds are missed when counting from aircraft, and no species-specific correction factor has been developed and applied. Nonetheless, these observations indicate that hundreds or low thousands of Steller's eiders occur on the Arctic Coastal Plain. These surveys do not demonstrate a significant population trend over the last decade. However, based on the observed interannual variability, it is estimated that it would take 14 years to detect a trend equivalent to a 50 percent change over 10 years (Larned et al. 2001b). Current sampling intensity is too low to provide useful trend data for this very rare species. There is some support for the hypothesis that Steller's eiders have abandoned formerly occupied areas and have reduced their breeding frequency in eastern portions of the Arctic Coastal Plain; if true, this likely indicates that the Alaska breeding population is in decline (Quakenbush et al. 2002).

Steller's eiders spend most of the year in marine habitats. During winter, most of the Steller's eiders concentrate along the Alaska Peninsula from the eastern Aleutian Islands to southern Cook Inlet in shallow, nearshore marine waters (Jones 1965; Petersen 1980). They also occur in the western Aleutian Islands and along the Pacific coast, occasionally to British Columbia, along the Asian coast (from the Commander Islands to the Kuril Islands), and some are found along the north Siberian coast west to the Baltic States and Scandinavia (Palmer 1976; Cramp et al. 1977). In spring, large numbers concentrate in Bristol Bay before migration; in 1992, an estimated 138,000 Steller's eiders congregated there before sea-ice conditions allowed movement northward (Larned et al. 1994).

### NESTING HABITAT

In arctic Alaska, Steller's eiders nest and raise broods in areas dominated by low-centered polygons and shallow ponds with emergent grasses and sedges, wet sedge meadows, lakes, and lake basins (Fredrickson 2001). The presence of emergent plants seems to be important to brood-rearing Steller's eiders (Quakenbush and Cochrane 1993). In the Barrow area, water bodies with pendant grass (*Arctophila fulva*) had considerable use by Steller's eiders during pre-nesting, nesting, and brood-rearing periods (Quakenbush et al. 1995). Steller's eiders nest in association with snowy owls and pomarine jaegers (Quakenbush et al. 2002).

The USFWS identified the primary constituent elements of the proposed critical habitat as "small ponds and shallow water habitats (particularly those with emergent vegetation), moist tundra within 326 feet of permanent surface waters including lakes, ponds, and pools, the associated fauna, and adjacent nesting habitats" (65 FR 13267).

#### NESTING, BROOD-REARING, STAGING, AND FALL MIGRATION

Steller's eiders arrive paired on the Arctic Coastal Plain in early June. Nesting effort varies widely from year to year. In the 12 years from 1991to 2002, there were 6 "nesting years" (1991, 1993, 1995, 1996, 1999, 2000) when typical breeding activities occurred, and 6 "non-nesting years" (1992, 1994, 1998, 2001, 2002) when birds appeared in early summer, but no nests were found and Steller's eiders are believed not to have nested (Quakenbush et al. 1995; Rojek and Martin 2003). Four nests were found in 1997, but these were initiated late (early July) and none survived past mid-incubation (Rojek and Martin 2003). The reasons for the observed variation in nesting effort are unknown, but an association has been noted between nesting years and years of lemming abundance. Nest success could be enhanced in years of lemming abundance, because predators are less likely to prey on eider nests when small mammals are abundant. It also has been hypothesized that avian predators such as pomarine jaegers (*Stercorarius pomar*inus) and snowy owls (*Nyctea scandiaca*), which nest at high densities only when lemmings are abundant, could provide protection for nearby eider nests incidental to defense of their nesting territories (Quakenbush and Suydam 1999). If this hypothesis is correct, the presence of avian predators is an essential element of breeding habitat.

In nesting years, initiation dates are typically in the first half of June (Quakenbush et al. 1995), and hatching dates range from 7 July to 3 August (Quakenbush et al. 1998). Nests in Barrow are located in wet tundra, in areas of low-center polygons or low (indistinct flat-centered) polygons, frequently within drained lake basins (Quakenbush et al. 1998). Average clutch sizes at Barrow ranged from 5.3 to 6.3 in five different years, with clutches of up to eight reported (Quakenbush et al. 1995). Nest success (proportion of nests at which at least one egg hatched) at Barrow averaged approximately 18 percent from 1991 to 2003 (Rojek and Martin 2003). Egg loss was attributed mostly to predation by predators including jaegers, common ravens (*Corvus corax*), and possibly glaucous gulls (*Larus hyperboreus*) and arctic foxes (*Alopex lagopus*) (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). The fledging period is not known, but is estimated to be 37 days (Obritschkewitsch et al. 2001). Broods most often used ponds with emergent grass (*Arctophila fulva*) (Quakenbush et al. 1998). Broods were reared close to their nest site; eight broods tracked near Barrow in 1995 remained within 650 meters of their nest sites during the first 32 days after hatching (Quakenbush et al. 1998).

Males typically depart the breeding grounds after females begin incubating. Based on observations in the Barrow area, and on a small sample of birds equipped with satellite transmitters, males depart Barrow around the end of June or early July (Quakenbush et al. 1995; Obritschkewitsch et al. 2001). Both males and females tracked with satellite transmitters in a nonbreeding year dispersed across the area between Admiralty Inlet and Wainwright in late June and early July, with most birds entering marine waters by the first week of July. The satellite-tracked birds used coastal locations from Barrow to the Bering Straits and made extensive use of lagoons and bays on the north coast of Chukotka (P. Martin, USFWS 2004, pers. comm.). Females that fail in breeding attempts could remain near Barrow later in the summer; a single failed-breeding female equipped with a transmitter in 2000 remained near the breeding site until the end of July and stayed in the Beaufort Sea off Barrow until late August. Females and fledged young depart the breeding grounds in early to mid-September.

In mid-August, Alaska-breeding Steller's eiders migrate to molting areas, where they congregate in large flocks in protected waters. Concentrations of molting Steller's eiders have been noted in Russia on the Chukchi and Bering sea coasts, near St. Lawrence Island in the Bering Sea, and along the northern shore of the Alaska Peninsula (Kistchinski 1973; Fay 1961; Jones 1965; Petersen 1981). Satellite-tracked birds from Barrow molted at Nunivak Island, Cape Avinof (Kuskokwim Shoals), Nelson Lagoon/Port Moller, and Izembek Lagoon (USFWS, unpublished data).

### PLAN AREA

Steller's eiders periodically are found on and near the Colville River Delta and the Plan Area (PAI 2002a). There have been a small number of sightings in the Plan Area in recent years (Noel et al. 2001; Noel et al. 2002c; Burgess et al. 2003b). Steller's eiders are rare in this area and extremely rare farther east (Figure 3.3.5.3-1) (Larned et al. 2003; Mallek et al. 2003).

## 3.4 SOCIAL SYSTEMS

This section describes the social, economic, cultural, infrastructure, and other elements of the North Slope environment related to human development. The assessment of the impacts on social systems in the North Slope is unique because of the presence of a single dominant resource extraction industry—the oil and gas industry—and a relatively small indigenous Native population that continues to practice subsistence living.

For this EIS, the discussion of social systems has been organized to include the following topics:

| Topic | DEIS Section |
|---|---|
| Socioeconomic | **Socio-Cultural** – A description of the North Slope, overwhelmingly Native**,** communities and their culture (Section 3.4.1).<br><br>**Regional Economy** – A description of regional economy and its relationship to the state economy (Section 3.4.2).<br><br>**Subsistence Harvest and Uses** – A description of the local harvest of subsistence foods as a cultural and economic activity (Section 3.4.3).<br><br>**Environmental Justice** – A determination if any of the local communities are environmental justice populations for which an assessment of disproportionate impacts must be made (Section 3.4.4). |
| Cultural Resources | **Cultural Resources** – A description of the pre-history and general presence of cultural resource sites within the Plan Area (Section 3.4.5). |
| Infrastructure | **Land Uses and Coastal Management** – A description of the land use management programs that govern use of lands within the Plan Area. Also includes a description of specific designations that pertain to lands within the Plan Area (Section 3.4.6)<br><br>**Transportation** – A description of the systems that provide transportation to and within the Plan Area (Section 3.4.9) |
| Non-Subsistence Human Use | **Recreation** – A description of the types of recreation activities likely to occur in the Plan Area and the expected level of use (Section 3.4.7)<br><br>**Visual** – A description of the landscape within the Plan Area from the perspective of visual resources management (Section 3.4.8) |

### 3.4.1 Socio-Cultural Resources

The North Slope includes two relatively distinct populations: local residents who are predominately indigenous Inupiat Natives, and the oil and gas industry workers who rotate on a regular schedule and are temporary worker/residents in the region. As temporary residents, the oil and gas industry workers have limited participation in the local economy, and their needs for most services are provided by industry. On the other hand, full-time residents of the region form the primary social structure and the local economy. The assessment of impacts in this EIS focuses on the full-time residents of the North Slope. The degree to which the proposed expansion of the oil and gas industry could have direct and indirect effects on the culture of the Native population is assessed as impacts on the socio-cultural characteristics of affected North Slope communities.

#### 3.4.1.1 Cultural History and Cultural Values

The north coast of Alaska has had human population for a long period of time. The earliest known site associated with earlier inhabitants of this region dates to approximately 6,000 years ago. Human prehistory is represented by isolated localities along the coast of the Beaufort Sea from Point Barrow to the Canadian border near Demarcation Point. Knowledge of human occupation has been recorded for approximately 150 years, and development of an understanding of the cultural history of the region began in the early twentieth century (Lobdell 2000). A more complete description of the cultural prehistory of the region can be found in Section 3.4.5, Cultural Resources.

At present there are four communities in or adjacent to the Plan Area. They include Nuiqsut, Barrow, Atqasuk, and Anaktuvuk Pass. These communities are part of the NSB, a home rule municipal subdivision of the State of Alaska. The majority of the population is Inupiat Eskimo.

Traditionally, the cultural values of the Inupiat focused on their close relationship with natural resources, specifically game animals upon which they depended on for subsistence and survival. The Inupiat also had a close relationship to the supernatural, with specific beliefs in animal souls and beings controlling the movements of animals. Other values included a strong emphasis on the community, its needs, and the support of other individuals. Although there have been substantial social, economic, and technological changes in Inupiat lifestyle, subsistence continues to be the central organizing value of Inupiat socio-cultural systems. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. Indeed, "most Inupiat still consider themselves primarily hunters and fishermen" (Nelson 1969) — a refrain North Slope residents voice repeatedly (Kruse et al. 1983; ACI, Courtnage, and Braund 1984; IAI 1990a, 1990b; MMS 1994). Task groups are still organized to hunt, gather, and process subsistence foods. Cooperation in hunting and fishing activities also remains an integral part of Inupiat life, and a major component of significant kin ties is the identity of those with whom one cooperates (Heinrich 1963). Large amounts of subsistence foods are shared within the community, and the people one gives to and receives from are major components of what makes up significant kin ties (Heinrich 1963; ACI, Courtnage, and Braund 1984).

On the North Slope, "subsistence" is much more than an economic system. The hunt, the sharing of the products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Generous hunters are considered good men, and good hunters are often respected leaders. Good health comes from a diet derived from the subsistence hunt. Young hunters still give their first game to the community elders, and generosity brings future success.

The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and subsistence activities occurring in Inupiat society. However, cultural value is also apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations (some families will dominate one type of government administration or one organization, for example, the Village Corporation), employment, sports activities, and membership in voluntary organizations (Mother's Club, Search and Rescue, etc.) (ACI, Courtnage, and Braund 1984).

### 3.4.1.2 Social Organization

The social organization of Inupiat communities is strongly based on kinship. Kinship forms "the axis on which the whole social world turn[s]." (Burch 1975a, 1975b) Historically, households were composed of large extended families, and communities were kinship units. Today, there is a trend away from the extended-family household because of increased mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Inupiat society continue to be important and remain a central focus of social organization.

The social organization of North Slope Inupiat encompasses not only households and families, but also wider networks of kinsfolk and friends. These types of networks are related through overlapping memberships, and they are embedded in those groups responsible for hunting, distributing, and consuming subsistence resources (Burch 1970). An Inupiat household on the North Slope could include a single individual or group of individuals who are related by marriage or ancestry. The interdependencies among Inupiat households differ markedly from those found in the United States as a whole. In the larger non-Inupiat society, the demands of wage work emphasize a mobile and prompt workforce. While modern transportation and communication technologies allow for contact between parents, children, brothers, sisters, and other extended-family members, more often than not, independent nuclear households (father, mother, and children) or conjugal pairs (childless couples) form independent "production" units that do not depend on extended-family members for the day-to-day support of food, labor, or income. In contrast to the non-Native culture, in the Inupiat culture individual family groups depend on the extended family for support and provision of day-to-day needs.

Associated with these differences, the Inupiat hold unique norms and expectations about sharing. Households are not necessarily viewed as independent economic units, and giving—especially by successful hunters—is regarded as an end in itself, although community status and esteem accrue to the generous. The sharing and exchanging of subsistence resources strengthen kinship ties (Nelson 1969; Burch 1971; Worl 1979; ACI, Courtnage, and Braund 1984; Luton 1985; Chance 1990).

### 3.4.1.3 Economic Organization

The potentially affected communities within the region—Barrow, Nuiqsut, Atqasuk, and Anaktuvuk Pass—are inhabited predominantly by Inupiat residents. These residents have a historical and cultural tie to subsistence production and consumption as one of their main economic activities. There is a dual subsistence/cash composition to the overall economic structure of the communities. Barrow, with its role as the regional economic hub of the NSB, has the greatest opportunities for residents to find and engage in employment. Income and employment opportunities are much less prevalent in the more remote villages.

Subsistence production does not have a direct market value since harvested resources are not bought and sold in markets. However, it does have an economic value and is one of the main economic activities for residents of North Slope communities. Subsistence production has value both in consumption and in cultural activities of residents. Production of subsistence food can be viewed as an import substitute for food shipped into the community that is both very expensive and less culturally attractive to residents. To assess the level of economic activity represented by subsistence production an economic value could be assigned by assuming the local cost of substitute foods as an equivalent value. However, this method does not consider the cultural value and benefits inherent in the production and consumption of subsistence foods.

### 3.4.1.4 Institutional Organization and Community Services

Community services in all North Slope communities are primarily provided by the NSB. However, village municipal governments, regional and village tribal governments and regional and village ANCSA corporations also play a role in community services.

Among the services provided by the NSB to Nuiqsut, Barrow, Atqasuk, Anaktuvuk Pass, and other North Slope communities. These services include public safety, public utilities, fire protection, and some public health services. The NSB was incorporated on July 1, 1972, and adopted its Home Rule Charter on April 30, 1974. With approximately 94,000 square miles, the NSB is the largest borough in Alaska. It encompasses eight villages: Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright.

Revenues primarily from the taxation of oil industry facilities fund NSB services. These revenue sources are currently stable and the borough's permanent fund account continues to grow, as does its role as primary employer in the region. However, as North Slope oil production continues to decline, future fiscal and institutional growth of the NSB can also be expected to slow since the borough is highly dependent upon property taxes for oil-related facilities. This slowing would be caused by economic constraints on Inupiat participation in oil-industry employment, growing constraints on the statewide budget, and the Alaska legislature's threat to limit the NSB's bonding authority (Kruse et al. 1983; Harcharek 1992, 1995).

The ASRC, formed under ANCSA, runs several subsidiary corporations. Most of the communities also have a village corporation, a Traditional Village orIndian Reorganization Act (IRA) Council, and a city government. The IRA and village governments have not provided much in the way of services, but village corporations have made many service contributions. The ICAS, the regional tribal government, has recently taken on a more active and visible role in regional governance.

#### 3.4.1.5 Community Health and Welfare

The EISs for MMS prepared for Lease Sales 97, 124, 144, 170; the Northstar and Liberty projects; and the National Petroleum Reserve-Alaska detail issues about changes in employment, increases in income, decreases in fluency in Inupiaq, rising crime rates, and substance abuse (MMS 1987a, 1990b, 1996a, 1998; MMS Alaska OCS Region 2002b; BLM and MMS 1998a; USACE 1996). These documents also discuss the fiscal and institutional growth of the NSB. These discussions are incorporated by reference and summarized below. In addition, Smythe and Worl (1985) and Impact Assessment, Inc. (IAI) (1990a) detail the growth and responsibilities of local governments.

Recent statistics on homicides, rapes, and wife and child abuse present a sobering picture of some aspects of life in NSB communities. Violent deaths account for more than one-third of all deaths on the North Slope. The Alaska Native Health Board notes the "overwhelming involvement of alcohol (and drug) abuse in domestic violence, suicide, child abuse, birth defects, accidents, sexual assaults, homicide and mental illness." (Alaska Native Health Board 1985) The lack of comparable data makes it impossible to compare levels of abuse and violence between aboriginal (before contact with Caucasians), traditional (from the time of commercial whaling through the fur trade), and modern (since World War II) Inupiat populations. Nonetheless, it is apparent from reading earlier accounts of Inupiat society that there has been a drastic increase in these social problems, although a study conducted in the early 1980s on the North Slope indicates that no direct relationship was found between energy development and "accelerated social disorganization." (Kruse et al. 1982, cited in IAI 1990b) Studies in Barrow (Worl and Smythe 1986) detail the important changes in Inupiat society occurring in the last decade as a response to these problems. Services from outside institutions and programs have recently begun to assume a greater responsibility for functions formerly provided by extended families. There is an array of social services available in Barrow that may be more extensive for a community of this size than anywhere in the United States. (Worl and Smythe 1986). The health and welfare of North Slope village residents has benefited from the construction of community facilities, modern water and sewer systems, and village clinics. Oil and gas development on the North Slope has provided funding for child emergency shelters, behavioral outpatient and residential programs providing mental health care and counseling from substance abuse and domestic violence, and assisted-living services for elders (NRC 2003). At the same time, oil and gas development has also contributed to negative health effects by contributing to stress and anxiety about subsistence. Disruption of traditional social systems and subsistence practices has coincided with increased incidence of cancer, diabetes, alcoholism, drug abuse, and child abuse. Residents also express concern that smog and haze near some villages may be causing an increase in asthma.

Recent health effects studies related to the Native population have shown that:

- One of the leading causes of mortality in the North Slope Native population continues to be cancer. Among the various forms, lung cancer rates are 50 percent higher than Alaska's general population and twice as high as the U.S. population. The 2000 update of the Alaska Native tumor registry showed that the rate for lung cancer in Alaska Natives exceeds the U.S. rate among both men and women by 48 percent (Lanier et al, 2001). Lung cancer is associated with smoking; survey data from 1994 to 1996 shows that the prevalence of smoking among the Alaska Native population is 40.6 percent for women and higher for men (Office of Women's Health 2001).
- Asthma prevalence has increased nationally 75 percent since 1980 and rates for children have risen 86.8 percent between 1982 and 1995. Local community members working in health care have cited increased asthma rates among the local population. The USEPA has found that children who breathe second-hand smoke are more likely to suffer from: bronchitis and pneumonia, wheezing and coughing spells, more ear infections, and more frequent and severe asthma attacks. According to the National Cancer Institute, there is a connection between second-hand smoke and Sudden Infant Death Syndrome (SIDS), new cases of childhood asthma, and behavioral and cognitive problems in children.
- Local site specific studies have not been performed to determine if there is a link between air quality (both outdoor and indoor) and health effects. Existing air quality on the North Slope and in Nuiqsut is well within national and state standards for all criteria pollutants, including particulate matter ($PM_{10}$), which is the pollutant most associated with asthma and other respiratory ailments. Local ambient air quality monitoring has recorded occasional short term episodes of increased particulate from wind-born dust but annual particulate concentration is less than 20 percent of the allowable standards. The 2003 NRC report recommended that studies be undertaken to distinguish between locally derived emissions and long-range transports of air contaminants from other regions.

The baseline of the present socio-cultural system includes change and strain. The very livelihood and culture of North Slope residents come under increasing scrutiny, regulation, and incremental alteration. Increased stresses on social well-being and on cultural integrity and cohesion come at a time of relative economic well-being. The expected stresses on the culture by the decline in Capital Improvements Program (CIP) funding from the state have not been as significant as once expected. The buffer effect has come mostly through the dramatic growth of the borough's own permanent fund, the NSB taking on more of the burden of its own capital improvement, and its emergence as the largest employer of local residents. However, borough revenues from oil development at Prudhoe Bay are declining, and funding challenges (and subsequent challenges to the culture) continue as the state legislature alters accepted formulas for borough bonding and funding for rural school districts.

### 3.4.1.6 Population and Employment

A summary of the socioeconomic characteristics of the communities in and adjacent to the Plan Area is shown in Table 3.4.1-1. The 2000 census counted 7,385 residents within the NSB. The largest component of the population, 68.4 percent, is Alaska Native/Native Americans. This is much higher than in the State of Alaska as a whole, with Alaska Natives/Native Americans comprising 15.6 percent of total residents statewide. In 2000, the average per capita income for the NSB was $20,540, which is approximately 10 percent less that the statewide average per capita income. The NSB resident median age was 27.0, which is 5 years younger that the statewide average age, and the average household size was 3.45, which is larger that the statewide average. The percentage of households in poverty status was 8.6 percent, approximately 2 points higher than the statewide average, and 17.3 percent of households earned less than $25,000 per year, which was less than the statewide average.

**TABLE 3.4.1-1 SUMMARY OF SOCIOECONOMIC CHARACTERISTICS**

| | Population | Median Age | Native Residents | Average Household Size | Per Capita Income | Families in Poverty Status | Households Earning <$25,000/ year |
|---|---|---|---|---|---|---|---|
| State of Alaska | 626,932 | 32.4 | 15.6 % | 2.74 | $22,660 | 6.7 % | 20.9 % |
| NSB | 7,385 | 27.0 | 68.4 % | 3.45 | $20,540 | 8.6 % | 17.3 % |
| Barrow | 4,581 | 28.8 | 57.2 % | 3.27 | $22,902 | 7.7 % | 16.9 % |
| Nuiqsut | 433 | 23.8 | 88.2 % | 3.93 | $14,876 | 3.2 % | 14.2 % |
| Atqasuk | 228 | 26.3 | 94.3 % | 4.15 | $14,732 | 25.0 % | 19.6 % |
| Anaktuvuk Pass | 302 | 25.7 | 87.6 % | 3.36 | $15,283 | 3.2 % | 11.1 % |

Source: U.S. Bureau of the Census, Census 2000

Figure 3.4.1.6-1, North Slope Employment By Sector for 2001, shows North Slope employment for 2001, which is the most recent year available, by nine employment sectors. This employment profile includes all wage employment within the NSB and includes both residents and nonresident workers. The largest employment sector for the NSB is mining, which consists almost entirely of oil and gas production. This sector accounts for 46.2 percent of total employment. The next largest sector is government, with 22.5 percent of total jobs. The service sector is the third largest, with 11.3 percent. Trade accounts for 6.3 percent of jobs, while the combined transportation/ communications/utilities sector accounts for 5.2 percent of total North Slope employment. Construction accounts for 6.4 percent, and the combined sector of financial/insurance/real estate accounts for 2 percent. Manufacturing is the smallest sector, accounting for 0.1 percent of total jobs. This employment profile is very different from the State of Alaska as a whole, where mining accounts for only 3.9 percent of total jobs (Bureau of the Census 2003) and the largest sectors are government at 27.1 percent and services at 25.2 percent.

The combined communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut had a workforce of 2,929, or 77 percent of the total NSB workforce. Nuiqsut, the one community within the Plan Area, had 176 workers, or approximately 5 percent of the regional workforceworkforce. The overall composition of the local workforce is shown in Table 3.4.1-2.

**TABLE 3.4.1-2 LABOR WORKFORCE BY COMMUNITY – 1998**

| Employment Status | Total NSB Labor Force | Anaktuvuk Pass | Atqasuk | Barrow | Nuiqsut |
|---|---|---|---|---|---|
| Labor Force | 3,823 | 147 | 98 | 2,508 | 176 |
| Permanent/ Full-time | 2,114 | 58 | 45 | 1,565 | 85 |
| Temporary/ Seasonal | 523 | 21 | 11 | 287 | 56 |
| Part-time | 222 | 12 | 8 | 91 | 13 |

Source: NSB, 1999.

According to State figures, unemployment in the NSB ranged from 3.5 to 9.4 percent during the period of 1975 to 2001 (www.labor.state.ak.us/research). The rate of unemployment for the NSB workforce in 1998 is shown in Table 3.4.1-3. Table 3.4.1-3 shows that within the NSB, unemployment ranges from a low of 7 percent at Anaktuvuk Pass to a high of 40 percent at Atqasuk. The unemployment rate for three of the four communities was less than the overall rate for the NSB, which was 16 percent. These rates of unemployment were considerably higher that the overall State of Alaska unemployment rate.

In addition to higher rates of unemployment, rates of less than full-time employment (employment less than 40 weeks per year) were also high. As shown in Table 3.4.1-3, the underemployment rate for the NSB was 27 percent. Within the four communities, this rate varied from 23 to 62 percent in 1998. Table 3.4.1-3 also shows the percentage of people who believe they were underemployed. In this case, of the four communities, only Nuiqsut had a rate higher than the NSB average. Twenty-seven percent of the workforce in Nuiqsut believe they were underemployed compared to 13 percent for the NSB as a whole.

**TABLE 3.4.1-3 UNEMPLOYMENT AND UNDEREMPLOYMENT BY COMMUNITY – 1998**

| Employment Status | NSB Labor Force | Anaktuvuk Pass | Atqasuk | Barrow | Nuiqsut |
|---|---|---|---|---|---|
| Unemployment (%) | 16 | 7 | 40 | 10 | 10 |
| Underemployment (%) | 13 | 7 | 6 | 12 | 27 |
| (Those who believe they were unemployed) | | | | | |
| Underemployment (%) | 27 | 23 | 44 | 24 | 62 |
| (Those who worked less than 40 weeks in 1998) | | | | | |

Source: NSB 1999

Some Alaska economists believe that Alaska's rural communities have a large percentage of "discouraged workers," or those who are involuntarily unemployed but are not counted in the state or federal unemployment data (Windisch-Cole 1996, pers. comm.). Other economists do not think the discouraged-worker hypothesis applies to the NSB, as it is believed that in a mixed cash-subsistence economy, people who do not have cash jobs for part of the year may not take one if offered to them (Berman 1997, pers. comm.).

A limited number of North Slope Alaska Natives have been employed in the oil-production facilities or associated work in and near Prudhoe Bay since production started in the late 1970s. In addition, Alaska Natives who reside on the North Slope are not inclined to relocate for employment (MMS 1993). This historical information is relevant to assessing potential economic effects of oil and gas exploration and development on the North Slope's Native population. A 1993 study contracted by the MMS found that the 34 North Slope Natives who were interviewed accounted for half of all North Slope Natives who worked at Prudhoe Bay in 1992. The study also found that the North Slope Natives employed at Prudhoe Bay made up less than 1 percent of the 6,000 North Slope oil-industry workers (MMS 1993). This pattern is confirmed by data from 1998 that found that 10 NSB Inupiat residents were employed in the oil industry that year**;** this employment pattern has continued (BLM and MMS 2003, Table III-13).

A primary goal of the NSB has been to create employment for Alaska Native residents. Many Natives have been hired for the NSB's construction projects and operations. In contrast, only a few who are NSB residents hold jobs at the Prudhoe Bay industrial enclaves, indicating a bias by Native residents toward NSB employment. Pay scales for jobs provided by the NSB have parity with those offered by industry, while the working conditions and flexibility offered by the borough are considered by Native employees to be superior to those in the oil and gas industry. This seems to be especially important to community members who participate in subsistence hunting and require flexible work schedules during the subsistence harvest.

The NSB has tried to facilitate employment of Alaska Natives in the oil industry at Prudhoe Bay. However, greater participation of Alaska Natives from local communities in the oil and gas industry workforce is expected to require job skills training and work schedule flexibility to allow participation in subsistence activities. The NSB is also concerned that the oil industry recruits with methods common to western industry. The NSB would like the industry to make serious efforts to increase hiring of borough residents (Nageak 1998). One industry participant, BPXA, has established the Itqanaiyagvik Program whose purpose is to increase British Petroleum's (BPs) hire of Natives who are NSB residents. This joint venture between the ASRC and its oilfield subsidiaries is coordinated with the borough and the NSB School District (BPXA 1998b). Another industry participant, ConocoPhillips, has partnered with ASRC and offered training programs for North Slope residents interested in oilfield maintenance and heavy equipment maintenance. Twenty North Slope residents spent their summer in 2002 working and training in these areas. ConocoPhillips has worked closely with Kuukpik Corporation, ASRC, and other companies to hire and train Alaska Natives. ConocoPhillips, in cooperation with Kuukpik Corporation, sponsors mentoring and training at the Alpine Field for North Slope residents (Mr. Wheathall, Nuiqsut Public Hearing 2003).

#### NUIQSUT

In April 1973, 27 families began the 150-mile move from Barrow to the Colville River (Brown 1979). These families re-established the village of Nuiqsut, named for earlier camps and settlements on the main channel of the Colville River. In the 1940s, most families that had been living in the lower Colville River and nearby coastal areas were forced to relocate to Barrow so that children could attend school. Upon their return, the families located the village of Nuiqsut on the Nigliq Channel of the Colville River to allow easy access to the river's main channel for fishing and hunting. The return to Nuiqsut in 1973 was motivated by a desire to revive traditional Inupiat values of hunting and fishing, and experience Inupiat social and cultural life.

The importance of Nuiqsut's cultural landscape to its people and the approaching oil and gas development in the Arctic triggered completion of a cultural plan in 1979. This plan was intended to be integrated at both planning and political levels to help the Nuiqsut people protect their traditional landuse area and perpetuate their subsistence way of life (Brown, 1979). The Nuiqsut cultural plan defined the cultural landscape by describing historic resources, hunting areas, and fishing sites (subsistence use areas) in the area. It also cited critical concerns of village residents and defined desired land use management roles of the NSB and the ASRC. Although subsistence use has changed since 1979, the village residents have many of the same concerns and priorities regarding preservation of historical, cultural, and subsistence resources.

Nuiqsut is undergoing rapid social and economic change with a new hotel, the influx of non-Inupiat oil workers from the nearby Alpine Field, the potential for further oil development, and a proposed state road to the community.

The population trend in Nuiqsut in recent years is shown on Figure 3.4.1.7-1. Between 1990 and 2000, the population of Nuiqsut grew at a rate of 2.2 percent per year, a rate that was slower than during the previous decade and slower than the growth of Barrow. However, Nuiqsut grew faster than both Anaktuvuk Pass and Atqasuk during this period.

Table 3.4.1-1 shows selected socioeconomic characteristics for Nuiqsut. In 2000, the average per capita income was $14,876, roughly two-thirds that of the State of Alaska as a whole and the NSB. The median age for Nuiqsut residents was 23.8, approximately 9 years younger than the state average and 3 years younger than the NSB as a whole. Average household size was 3.93, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 3.2 percent, and 14.2 percent of households earned less than $25,000 per year. The household poverty rate was less that the NSB average but more that the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Some initial results from an ongoing study, Local Control and Impacts of Oil and Gas Development: Nuiqsut Case Study (Haley 2004), indicates that residents of Nuiqsut have a trend of increased per capita and household incomes, beginning in 1998 as a result of Alpine Field-related activities. This increasing trend is not shared by other North Slope communities according to the preliminary results of the study. More detailed information may come available when the full study is published.

As shown in Table 3.4.1-3, unemployment in Nuiqsut was 10 percent in 1998. While Nuiqsut had a similar unemployment rate to Barrow (10 percent) and somewhat higher than Anaktuvuk Pass, Nuiqsut had a much higher underemployment rate than any of the communities and the NSB as a whole. Many of the job opportunities in Nuiqsut are provided by the Kuukpik Native Corporation, the NSB, state employment associated with the school, and the village store. In 1998, 176 residents were employed out of a total workforce (age 16 and over) of 264. The highest number of jobs is in government (city, borough, state, and federal), with 91 jobs identified in the 2000 census. The next largest job category is in construction, with 53 jobs.

As a result of current development of the Alpine Field, Nuiqsut has received a number of economic benefits and employment opportunities, including the following:

Contracts totaling approximately $250 million were awarded to Kuukpik (the Nuiqsut Village Corporation) and its joint-venture businesses. CPAI currently has contracts with several Kuukpik Corporation joint ventures, including Nanuq (construction); Kuukpik/Arctic Catering (catering); Kuukpik/Fairweather (seismic); Kuukpik/LCMF (surveying); Kuukpik/Carlisle (trucking), and Kuukpik/Purcell (security).

As of June, 2003 four Nuiqsut residents were working full-time in the Alpine Field operations group and six full-time in the construction group.

Seasonal work opportunities have been made available to residents of Nuiqsut and other communities in the area. During the first 5 months of 2003, CPAI reported that it employed approximately 100 local residents, predominantly Inupiat.

Ongoing jobs are held by Nuiqsut residents, including one monitor for the CPAI air quality/meteorology monitoring station in Nuiqsut; two ice road monitors (during the winter ice road season), and two environmental studies assistants (typically subsistence representatives during the summer.) “Stickpickers” are also employed during the summer to collect debris at the edge of production pads and along ice road routes.

Increased economic activity within Nuiqsut related to ongoing Alpine Field operations includes increased occupancy at the Kuukpik Hotel, an office space lease from the City of Nuiqsut for the CPAI liaison, and storage of ice road equipment.

### BARROW

Barrow, the northernmost community in North America, is the seat for the NSB. From 1975 to 1985, Barrow experienced extensive social and economic transformations. The NSB CIP projects stimulated a boom in the Barrow economy and an influx of non-Natives to the community. Between 1980 and 1985, Barrow’s population grew by 35.6 percent (Kevin Waring Associates 1989). Inupiat women entered the labor force in the largest numbers ever known, and they achieved positions of political leadership in newly formed institutions. The proportion of Inupiat women raising families without husbands also increased during this period, a noticeable alteration in a culture where the extended family, operating through interrelated households, is salient in community social organization (Worl and Smythe 1986). During this same period, the social organization of the community became increasingly diversified, with the proliferation of formal institutions and the large increase in the number of different ethnic groups. As a consequence of the changes it has already sustained, Barrow could be more capable of absorbing additional change resulting from oil exploration and development than would smaller, homogeneous Inupiat communities such Nuiqsut, Atqasuk, and Anaktuvuk Pass.

The 2000 population in Barrow was 4,581. The largest component of the population (57.2 percent) is Alaska Native/Native American. Of the four communities in proximity to the Plan Area, Barrow has the largest non-Native population segment. Figure 3.4.1.7-1 shows the population growth trend for the period from 1960 through 2000. From 1980 to 2002, Barrow’s population grew at an annual rate of 5 percent.

Table 3.4.1-1 shows selected socioeconomic characteristics for Barrow. In 2000, the average per capita income for Barrow was $22,902, roughly equivalent to the State of Alaska as a whole and approximately 10 percent greater than the rest of the NSB. The median age for Barrow residents was 28.8, approximately 5 years younger than the state average but similar to the NSB as a whole. Average household size was 3.27, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 7.7 percent, and 16.9 percent of households earned less than $25,000 per year. The household poverty rate was less that the NSB average but more that the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Barrow is the economic hub of the NSB. In 2000, total employment in Barrow was 1,986 jobs. State, local, and federal government workers accounted for 1,176 jobs, or 59.2 percent of the total. As shown in Table 3.4.1-3, unemployment in Barrow was 10 percent in 1998. While Barrow had an unemployment rate similar to that of Nuiqsut (10 percent) and somewhat higher than Anaktuvuk Pass, it had a much lower underemployment rate than Atqasuk and the NSB as a whole.

### ATQASUK

Atqasuk is a traditional Inupiat village approximately 60 miles south of Barrow on the Meade River. Atqasuk's inland location dictates its subsistence preferences, with caribou and fish being the primary subsistence resources. Social ties between Barrow and Atqasuk remain strong, with men from Atqasuk traveling to Barrow to join bowhead-whaling crews. Atqasuk has largely avoided the rapid social and economic changes experienced by Barrow and Nuiqsut brought on by oil development activities, but future change could accelerate as a result of oil exploration and development in the Northwest National Petroleum Reserve-Alaska Planning Area.

The community was repopulated after declining to zero residents in the 1970 census. In 1980, there were 107 residents; the population increased to 216 residents in 1990 and 228 in 2000. Figure 3.4.1.7-1 shows population growth at a rate similar to that of Barrow and Nuiqsut during the period of 1980 to 1990. However, after 1990, growth slowed considerably.

Table 3.4.1-1 shows selected socioeconomic characteristics for Atqasuk. In 2000, the average per capita income for Atqasuk was $14,732, approximately two-thirds that of the State of Alaska and the rest of the NSB. The median age for Atqasuk residents was 26.3, approximately 6 years younger than the state average but similar to the NSB as a whole. Average household size was 4.15, which was larger than the state average but about the same as the NSB. The percentage of households in poverty status was 25 percent, and 19.6 percent of households earned less than $25,000 per year. The household poverty rate was three times the NSB average and four times the statewide average. The percentage of households earning less than $25,000 was less than both the statewide and NSB averages.

Atqasuk had the smallest labor force of the four communities, with only 98 workers. Both the unemployment and underemployment rates in the workforce were the highest of the four communities. Unemployment was 40 percent in 1998 compared to the NSB average of 16 percent, and underemployment was 44 percent.

### ANAKTUVUK PASS

Anaktuvuk Pass is a traditional Inupiat village, situated in the central Brooks Range on a divide between the John River and the Anaktuvuk River. Its elevation is 2,200 feet. The community has limited employment opportunity because of its remote location. A high proportion of residents participate in subsistence activities, and caribou is the primary source of meat. Population figures before 1950 show no residents in Anaktuvuk Pass. In 1949, several families returned to repopulate the community.

Table 3.4.1-1 shows selected socioeconomic characteristics for Anaktuvuk Pass. In 2000, the average per capita income for Anaktuvuk Pass was $15,283, approximately two-thirds that of the State of Alaska and the rest of the NSB. The median age for Anaktuvuk Pass residents was 25.7, approximately 6 years younger than the state average but similar to the NSB as a whole. Average household size was 3.36, larger than the state average but about the same as the NSB. The percentage of households in poverty status was 3.2 percent, and 11.1 percent of households earned less than $25,000 per year. The household poverty rate was less than one-half the NSB average and approximately one-half the statewide average. The percentage of households earning less than $25,000 was significantly lower than both the statewide and NSB averages.

Total employment (full-time, temporary, and part-time) in Anaktuvuk Pass is 91 out of the potential workforce of 147. The largest employment category is for government workers, with 69 jobs.

## 3.4.2 Regional Economy

The economic characteristics of the communities closest to the Plan Area have been described in Section 3.4.1 Socio-Cultural Resources. This section describes the relationship of the oil and gas industry to the North Slope economy, the economy of the State of Alaska, and the nation’s economy.

### 3.4.2.1 Role of Oil Production

Economic activity generated by North Slope crude oil production, transportation, and marketing is the largest sector of the North Slope economy, the second largest sector of the Alaskan economy (after government expenditures), and is an essential element of the national economy.

Oil production from North Slope fields offsets imports of foreign oil and generates substantial tax revenues and royalties for federal and state governments. In addition, North Slope oil supports the marine tanker transportation sector of the economy, since the vast majority of Alaskan oil is delivered to west coast United States ports for refining and distribution.

The United States was able to satisfy domestic demand for oil from domestic supplies until 1950, when the country became a net oil importer. With the continued growth in crude oil demand, dependence on foreign oil has increased; the United States now relies on imported sources for more than 60 percent of domestic demand from other countries (DOE 2001c). The continued development of domestic sources of oil is a national policy.

North Slope production has regularly constituted more than 15 percent of U.S. domestic crude production. Throughout the late 1980s, the fields contributed more than 20 percent, peaking at approximately 25 percent in 1988 (DOE 2001c). Dependence on foreign oil also has implications for the nation’s balance of trade with the rest of the world. North Slope production has reduced the U.S. balance of trade deficit by an average of 21 percent over the period 1977 to 2001, reducing the overall trade deficit by an average of 12 percent, with approximately $446 billion (in 2000 dollars) saved on the cost of U.S. oil imports (DOE 2001c).

Oil production is the dominant revenue-producing sector of the economy of the North Slope. Revenue returned to the NSB and local communities from oil production plays a significant role in the fiscal support of these local governments. Development of the ASDP could increase revenues and employment associated with this sector or extend current levels of revenue and employment into future years. This section describes the relationship of this industry to the state and North Slope economy.

The effects of oil production on the regional and statewide economy are primarily driven by the rate of production and transportation. Alaska state oil exports are dominated by production from the North Slope fields. Minor production also occurs in Cook Inlet, but only averaged 2.5 percent of total Alaska oil production between 1990 and 2000 (Alaska Department of Revenue 2002). Production from the North Slope oilfields and the transportation of crude to Valdez through the TAPS began in 1977. Production and transportation peaked at 2.038 MMbbl per day in 1988; it continues at an average daily production rate of 1.045 MMbbl, approximately 51 percent of its 1988 peak level (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-1).

Oil production and the development of new reserves is highly sensitive to crude oil prices. After peaking in early 1981 at $70 bbl in 2000 dollars ($37/bbl in 1981 dollars), oil prices have fluctuated, reaching an all-time low in 1998 of $13/bbl (in 2000 dollars; $12/bbl in 1998 dollars), 18 percent of the 1981 peak level (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-1).

Oil prices have rebounded slightly since1998 and currently stand at $29/bbl (October 2003).

### 3.4.2.2 Revenues

Activities of the oil and gas industry provide revenues to federal, state, and regional governments, as well as direct and secondary employment. The sources, and in some cases, the amounts of these revenue streams are listed below.

#### FEDERAL GOVERNMENT

- Corporate Income Taxes – TAPS pipeline owners, oil producers, and oil industry service companies
- Royalties – oil producers
- Estimated Revenues – Total federal Outer Continental Shelf (OCS) revenues for the Beaufort Sea, including bonuses, royalties, and rents were 1995 – $1.1 million; 1996 – $16.1 million; 1997 – $1.1 million; 1998 – $7.4 million; 1999 – $1.4 million; and 2000 – $1.4 million. The 1999 National Petroleum Reserve-Alaska lease sale resulted in first-year bonus bids of $114.6 million and the 2002 lease sale in the Northeast National Petroleum Reserve-Alaska resulted in $31.9 million in first-year bonus bids for the federal government. The 2003 MMS lease sale for the Beaufort Sea resulted in total lease revenue of $8.9 million.

#### STATE GOVERNMENT

- Production Severance Tax – oil producers
- Property Tax – oil producers
- Income taxes – oil producers and oil industry service companies
- Royalties, bonuses, lease payments – oil production on state leases
- Distribution of OCS revenues (rents, bonuses, royalties, escrow funds, and settlement payments) – federal government (OCS distribution from Beaufort Sea Lease Sales were 1995 – $9.4 million; 1996 – $9.5 million; 1997 – $17.3 million; 1998 – $13.6 million; 1999 – $14.7 million; 2000 – $13.7 million; and 2001 – $13.4 million.)

#### NORTH SLOPE BOROUGH

##### PROPERTY TAX – OIL PRODUCERS WITH LEASES ON NSB LANDS

The fiscal health of Alaska is closely tied to the fortunes of the oil industry in the state, although that dependence is declining. The balance of general fund revenues comes from corporate income taxes, fees, and licenses. Currently no state income tax or sales tax is levied in Alaska.

State revenues from oil industry activity represented 47 percent of total state revenue in 2002 and are projected to be 35 percent in 2003, as shown in Table 3.4.2-1. This is consistent with the oil industry contribution to state revenues over the past decade. The percent contribution in 1990 was 43 percent, and in 2000 it was 34 percent (DOI 2002, TAPS EIS, Vol. 2 Chapter 3.23, Table 3.23-7.) However, in the period of 1980 to 2000, the oil industry contribution to state revenues has fallen at an average annual rate of -2.9 percent from a high of 82 percent to 34 percent, reflecting the overall decline in oil production.

**TABLE 3.4.2-1 ALASKA STATE REVENUES (IN MILLIONS OF DOLLARS)**

| Revenue Source | Actual FY 2002 | Projected FY 2003 |
|---|---|---|
| Oil revenue | $1,676 | $1,860 |
| Investment revenue | $442 | $260 |
| Other revenue | $756 | $802 |
| Federal revenue | $1,572 | $2,322 |
| Total state revenues | $3,562 | $5,244 |
| Oil revenue percent | 47 % | 35 % |

Source: Fall 2002 Revenue Sources Book, Alaska Department of Revenue, Tax Division, November 2002.

General purpose expenditures by state government have tended to exceed revenues collected from the various sources available, meaning that the state has had to draw on cash surpluses accumulated from oil revenues in earlier years (TAPS Owners 2001a). As revenues from oil production fell with declining production and lower world oil prices, the state established the Constitutional Budget Reserve Fund (CBRF) in 1991 to cover year-to-year deficits. The CBRF consists of settlements from oil and gas tax and royalty disputes. In recent years, the gap between state revenues and the budget expenditures has been filled by withdrawals from the CBRF, and those withdrawals are depleting this reserve fund.

While oil industry revenues continue to remain a significant source of income for the state, the reduction in these revenues has been partially offset in some years by the contribution of earnings from the investment of oil revenues. These investment earnings have grown at an average of almost 15 percent each year since 1980. Also offsetting the loss of oil revenues has been the growth in federal grants to Alaska, which increased at an annual average rate of 3.1 percent between 1980 and 2000, and non-oil revenues, which increased at an annual rate of 2.2 percent over the same period. Overall, the state budget grew at an annual rate of 1.4 percent between 1980 and 2000.

NSB revenues from 1992 through 2001 have varied between a low of $292 million in 2000 and a high of $320 million in 1996. Revenues by year were (NSB 2001):

- 1992 – $321 million
- 1993 – $331 million
- 1994 – $311 million
- 1995 – $313 million
- 1996 – $320 million
- 1997 – $315 million
- 1998 – $331 million
- 1999 – $291 million
- 2000 – $282 million
- 2001 – $298 million

Sources of revenue are listed in Table 3.4.2-2. The largest share of NSB revenues comes from general property taxes, mostly from oil production-related real property. The real property assessed valuation of NSB property has steadily declined from 1992 ($11.5 billion) through 2001 ($9.4 billion) as a result of depreciation of assets. The NSB has the highest per capita level of bonded indebtedness in Alaska by far, at $59,439 per capita (ADCED 2003). The borough with the next highest per capita bonded indebtedness is the Northwest Arctic Borough, with $5,035 per capita. The revenue figures shown in Table 3.4.2-2 include intergovernmental revenues, such as school funding.

The largest share of revenues to the NSB comes from general property taxes. In 2001, more than 94 percent of total property tax revenues were attributed to oil and gas-related property (ADEC, Alaska Taxable, 2001).

**TABLE 3.4.2-2 NORTH SLOPE BOROUGH GENERAL GOVERNMENT REVENUES BY SOURCE: 2001**

| Category | Annual Revenue |
|---|---|
| General property tax | $201,963,000 |
| General sales/economic impact assistance | $4,500,000 |
| Intergovernmental revenues | $32,816,000 |
| Charges for service | $9,726,000 |
| Miscellaneous | $49,505,000 |
| Total general government revenues | $298,510,000 |

Source: Comprehensive Annual Financial Report of the North Slope Borough, Alaska, July 1, 2000 – June 30, 2001.s

### 3.4.2.3 North Slope Borough Government Expenditures

Including debt service, capital programs, and transfers, state expenditures grew at an average rate of 1.9 percent during the period between 1980 and 2000, although overall expenditures fell in the 1990s. Expenditures per capita have fallen significantly since 1990 and are currently lower than they were in 1980, as population growth in the state has outpaced the ability of the state to fund expenditure programs. Nevertheless, state expenditures per capita still are currently the highest in the nation, primarily because the harsh climate, low population density, and the inaccessibility of many communities make the services provided by state agencies very costly. The largest component of state government expenditures is social services, which grew at an average rate of 11 percent between 1980 and 2000 and now constitutes 45 percent of overall state expenditures. Expenditures in other areas, such as public safety, have grown fairly rapidly, while state funding of other areas, such as transportation and environment and housing, have fallen.

NSB expenditures have remained relatively constant during the period from 1992 ($300 million) through 2001 ($320 million).

### 3.4.2.4 Employment and Personal Income

A profile of Alaska's economy is presented on Figure 3.4.2.4-1, State of Alaska 2001 Employment by Sector. Compared with Alaska's early days, the state's current economy is more diverse and mature, with a large proportion of overall employment in the service sector. The largest employment sector shown on Figure 3.4.2.4-1 is the government sector, with 27.1 percent of the 290,000 total wage and salary jobs for 2001. The government sector comprises federal employment (16,800 jobs), state employment (22,900 jobs), and local government (38,800 jobs). The service sector is the next largest, with 73,000, 25.2 percent of total jobs. Trade is the third largest employment sector with 58,200, or 20.1 percent. The fourth largest employment sector is the combined transportation/communications/utilities, which accounts for 28,000 jobs, or 9.6 percent of total employment. Construction contributes 5.1 percent. Manufacturing and the combined financial/insurance/real estate sectors contribute 4.7 percent and 4.4 percent, respectively, to total employment. Mining, which is predominantly oil and gas extraction, is the smallest sector and accounts for 11,200 jobs, or 3.9 percent of the total (ADOL 2003b).

While mining (primarily oil and gas extracting) is one of the smallest sectors of the economy, it has the highest hourly earnings rate. In 2002, average hourly wages for mining were $28.37 per hour, compared with $27.67 per hour in construction, $21.37 per hour for Transportation/Communication/Utilities, $16.77 per hour for Manufacturing, $14.70 per hour for Trade, and $18.58 per hour for Finance/Insurance/Real Estate (ADOL 2003c).

In 2001, Alaska's per capita income was $30,936, placing fifteenth in the national ranking with all states (Bureau of Economic Analysis 2003). During the past several decades, Alaska's per capita incomes have declined relative to those of other states. In 1960, Alaska's per capita income ($2,815) was fourth among all states. In 1980, Alaska's per capita income ($13,875) was first in the nation. By 1990, Alaska's per capita income ($21,073) had declined to ninth among all states (ADOL 2000).

Employment and income data for the NSB and the four communities in or near the Plan Area were discussed in Section 3.4.1.

## 3.4.3 Subsistence Harvest and Uses

### 3.4.3.1 Introduction

This section describes subsistence harvest and uses in the ASDP Area. The methodology and sources of data, the regulatory definition of "subsistence," and the importance and context of subsistence to past and present resource users are also discussed.

The methodology for evaluating subsistence resource use employed in this analysis includes a review of available literature and data related to communities using the Plan Area for subsistence or using wildlife resources that spend time in the Plan Area.

Data sources for this section include subsistence resource reports published by the NSB Department of Wildlife Management and the ADF&G Division of Subsistence, published and unpublished harvest data from these agencies, technical reports published by the MMS, the general ethnographic and historical literature, relevant correspondence between Inupiat organizations and agencies (Kuukpik Corporation 2002), and the results of field interviews. For quantitative measures of use, the best available and/or most recent subsistence harvest data were acquired from ADF&G, NSB, and MMS reports. These data include information about the number of and amount of subsistence species harvested, the location and timing of subsistence harvests, the extent of past and present subsistence land use, and the cultural importance of subsistence uses. Historical and ethnographic literature from academic and historical sources, published and unpublished, provides additional qualitative data about the use and social context of subsistence resources in the recent past. Fieldwork information derived from key informant interviews provides additional information regarding subsistence resource use and harvest areas in the present and the recent past.

As subsistence is a contentious issue and land ownership in the Plan Area is state, federal and Native, definitions of subsistence used by each of these entities is provided below. Both federal and state statutes govern subsistence activities in Alaska. Under state law "subsistence uses means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural [sic] area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption, and for customary trade, barter, or sharing for personal or family consumption." (A.S. 16.05.940[32])

Under federal law, "subsistence uses means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade." (ANILCA Title VIII Section 803)

The Alaska Federation of Natives (AFN) describes subsistence as "the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, tribal cultures, and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans. Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical." Subsistence activities could include hunting, fishing, trapping, wood gathering, and berry picking.

Subsistence is part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (ADF&G 2000). Fishing and hunting for subsistence provide a reliable economic base for many rural regions. Domestic family groups who have invested in fish wheels, gill nets, motorized skiffs, and snowmobiles conduct these important activities. Subsistence is not oriented toward sales, profits, or capital accumulation (commercial market production), but is focused on meeting the self-limiting needs of families and small communities. Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, and/or wages from public sector employment, construction, fire fighting, oil and gas industry, or other services) provides the means to purchase the equipment, supplies, and gas used in subsistence activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including the North Slope Inupiat. These customs and traditions encompass sharing and distribution networks, cooperative hunting, fishing, and ceremonial activities. Subsistence fishing and hunting are important sources of non-traditional employment and nutrition in almost all rural communities. The ADF&G estimates that the annual wild food harvest in the arctic area of Alaska is approximately 10,507,255 pounds, or 516 pounds per person per year. Subsistence harvest levels vary widely from one community to the next. Sharing of subsistence foods is common in rural Alaska (ADF&G 2000).

### 3.4.3.2 Patterns of Subsistence Resource Use

Communities whose residents harvest or rely on subsistence resources in the ASDP Area include Barrow, Nuiqsut, Atqasuk, and Anaktuvuk Pass. Barrow and its environs have a long history of use by Inupiat hunters, with numerous archaeological deposits attesting to a long and continuous occupation. Atqasuk and Nuiqsut represent traditional subsistence use areas and were reestablished more recently as sedentary villages as people who had moved to Barrow from these areas before World War II returned to places where they had historic connections. A large part of these connections was knowledge of the land and subsistence resource availability in those formerly used areas (IAI 1990). This section describes subsistence land uses for the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut for historic and contemporary times.

#### NUIQSUT SUBSISTENCE ACTIVITIES

A diverse seasonal abundance of terrestrial mammals, fish, birds, and other resources is available in the immediate area surrounding Nuiqsut. Traditional subsistence activities in the Nuiqsut area revolved around caribou, marine mammals, and fish. Moose, waterfowl, and furbearers were secondary but important supplementary resources. Nuiqsut's location on the Colville River, some 35 miles upstream from the Beaufort Sea, has been a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (ADCED 2003). The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish (Craig, 1989).

Twenty-seven families from Barrow permanently resettled Nuiqsut in 1973. The site of Nuiqsut was formerly a place where Inupiat people gathered to trade and fish, maintaining connections between the Nunamiut of the inland areas and the Taremiut of the coast (Brown 1979). ANCSA allowed Inupiat from Barrow who wished to live in a more traditional fashion to select the site for resettlement, and many of those who moved there had some family connection to the area (IAI 1990). Easy access to the main channel of the Colville River for fishing, hunting, and ease of movement between upriver hunting sites and downriver whaling and sealing sites was the primary reason for selection of the site (Brown 1979).

Nuiqsut is one of 10 Alaska Eskimo whaling communities. Many of those who resettled Nuiqsut were experienced whalers and crew who remembered past whale harvests before the temporary abandonment of the settlement (IAI 1990). Nuiqsut whale hunting is based from Cross Island, approximately 70 miles northeast of Nuiqsut and approximately 15 miles from West Dock on the west side of Prudhoe Bay. Nuiqsut whalers travel approximately 100 miles from Nuiqsut to the Cross Island whaling camp. Nuiqsut whaling occurs in the fall when the whales migrate closer to shore, because the spring migration path is too distant from shore for effective hunting with small boats. Nuiqsut residents can also participate in Barrow's spring whale hunt through close family ties in that community (Fuller and George 1999).

Nuiqsut is situated closer to current and foreseeable areas of petroleum development than any other community on the North Slope. This development has deterred subsistence resource users from hunting, fishing, and gathering in their former traditional harvest areas east of the Colville River and at coastal areas such as Oliktok Point (Fuller and George 1999; IAI 1990). According to Circumpolar Research Associates [(CRA) 2002)], during 2000, unemployment appears to have increased, reinforcing the importance of subsistence resource harvests for local residents who have lived there for more than 10 years (since Nuiqsut residents who lived in the community the longest time consumed larger quantities of traditional foods [CRA 2002]). However, a determinative link between household wage income and household subsistence productivity has not been demonstrated; the former was dependent on education levels, and the latter on the number of capable producers in the household (Pederson et al. 2000).

### CONTEMPORARY SEASONAL ROUND

The seasonal availability of many important subsistence resources directs the timing of subsistence harvest activities. Fishing occurs year-round, but is most common from break-up (June) through November (Fuller and George 1999). Beginning in March, Nuiqsut residents hunt ptarmigan. Waterfowl hunting begins in the spring, and hunters typically harvest ducks and geese while participating in other subsistence activities such as jigging for burbot or lingcod (IAI 1990). Caribou are harvested primarily during the late summer and fall months but are hunted year-round. Moose hunting takes place in August and September in boat-accessible hunting areas south of Nuiqsut (Fuller and George 1999). August is the primary harvest month for caribou and moose, because water levels are right for traveling upriver or on the coast by boat, and the animals are usually in their best condition. Many Nuiqsut residents participate in subsistence fishing. If weather and ice conditions permit, summer net fishing at fish camps begins in June or July. Bowhead whaling usually occurs in September when the whales migrate closer to the shore. Nuiqsut hunters harvest few polar bears, but if they are harvested it is often during the fall whaling season. Gill netting at campsites is the most productive between October and mid-November. Jigging for grayling and burbot also occurs in the fall. Trappers pursue wolves and wolverines through the winter months, primarily in March and April. Trapping can be undertaken anytime during the winter; however, most hunters avoid going out in the middle of winter because of poor weather conditions and lack of daylight (IAI 1990). Table 3.4.3-1 summarizes Nuiqsut's annual cycle of subsistence activities.

**TABLE 3.4.3-1 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – NUIQSUT**

| | Winter | | | | | Spring | | Summer | | | Fall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct |
| Fish | ■ | | ▒ | ▒ | ▒ | ▒ | ▒ | ■ | ■ | ■ | ▒ | ■ |
| Birds/Eggs | ▒ | ▒ | ▒ | ▒ | ▒ | ■ | ■ | ■ | ■ | ▒ | ▒ | ■ |
| Berries | | | | | | | | ▒ | ▒ | ■ | | |
| Moose | | | | | | | | | ▒ | ■ | ▒ | |
| Caribou | ▒ | ■ | ▒ | ▒ | ■ | ■ | ■ | ▒ | ■ | ■ | ▒ | ■ |
| Furbearers | ▒ | ▒ | ▒ | ▒ | ▒ | ■ | ▒ | | | | | ▒ |
| Polar Bear | ■ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | | | | ▒ | ▒ |
| Seals | ▒ | ▒ | | | ▒ | ■ | ▒ | ■ | ■ | ■ | ■ | ▒ |
| Bowheads | | | | | | | | | | ▒ | ■ | |

Source: Impact Assessment Inc. 1990; Research Foundation of the State University of New York 1984; SRB&A 2003

Notes:

| | |
|---|---|
| (blank) | No to Very Low Levels of Subsistence Activity |
| ▒ | Low to Medium Levels of Subsistence Activity |
| ■ | High Levels of Subsistence Activity |

### SUBSISTENCE HARVESTS

The ADF&G collected subsistence harvest data for Nuiqsut in 1985 and 1993. The ADF&G chose 1993 as the most representative year for subsistence harvest data in Nuiqsut (Tables 3.4.3-1 and 3.4.3-2). Nuiqsut's total annual subsistence harvests ranged from 160,035 pounds in 1985 to 267,818 pounds in 1993 (Table 3.4.3-2). The 1993 harvest of 742 pounds per capita of wild resources represents approximately two pounds per day per person in the community. In 1985, fish and land mammals accounted for 86 percent of Nuiqsut's subsistence harvest and marine mammals contributed eight percent. In 1993, fish, land mammals, and marine mammals accounted for approximately one-third each (Table 3.4.3-2). The importance of subsistence to Nuiqsut residents is further reflected in the high participation rates in households that use (100 percent), harvest (90 percent), try to harvest (94 percent), and share (98 percent) subsistence resources (Table 3.4.3-2).

**TABLE 3.4.3-2 NUIQSUT SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES FOR 1985, 1992, AND 1993**

| | Percentage of Households | | | | | Estimated Harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Resource** | **Use** | **Try to Harvest** | **Harvest** | **Receive** | **Give** | **Number** | **Total Pounds** | **Mean HH Pounds** | **Per Capita Pounds** | **% Total Harvest** |
| **1985** | | | | | | | | | | |
| All Resources | 100 | 98 | 98 | 100 | 95 | | 160,035 | 2,106 | 399 | 100 |
| Fish | 100 | 93 | 93 | 78 | 83 | 68,153 | 70,609 | 929 | 176 | 44 |
| Salmon | 60 | 43 | 40 | 23 | 23 | 441 | 1,366 | 18 | 3 | 1 |
| Non-Salmon | 100 | 93 | 93 | 75 | 83 | 67,712 | 69,243 | 911 | 173 | 43 |
| Land Mammals | 100 | 95 | 93 | 70 | 85 | 1,224 | 67,866 | 893 | 169 | 42 |
| Large Land | 98 | 90 | 90 | 70 | 80 | 536 | 67,621 | 890 | 169 | 42 |
| Small Land | 65 | 63 | 58 | 13 | 23 | 688 | 245 | 3 | 1 | <1 |
| Marine Mammals | 100 | 48 | 23 | 100 | 30 | 59 | 13,355 | 176 | 33 | 8 |
| Birds and Eggs | 98 | 95 | 95 | 60 | 80 | 3,952 | 8,035 | 106 | 20 | 5 |
| Vegetation | 38 | 50 | 18 | 20 | 10 | | 169 | 2 | 0 | 0 |
| **1992** | | | | | | | | | | |
| All Resources | | | | | | | 150,196 | 1,430 | 359 | 100 |
| Fish | | | | | | | 51,955 | 495 | 124 | 35 |
| Land Mammals | | | | | | | 41,503 | 395 | 99 | 28 |
| Marine Mammals | | | | | | | 52,749 | 502 | 126 | 35 |
| Birds and Eggs | | | | | | | 3,924 | 37 | 9 | 3 |
| Vegetation | | | | | | | 65 | 1 | 0 | |
| **1993** | | | | | | | | | | |
| All Resources | 100 | 94 | 90 | 98 | 92 | | 267,818 | 2,943 | 742 | 100 |
| Fish | 100 | 81 | 81 | 94 | 90 | 71,897 | 90,490 | 994 | 251 | 34 |
| Salmon | 71 | 45 | 36 | 47 | 39 | 272 | 1,009 | 11 | 3 | <1 |
| Non-Salmon | 97 | 79 | 79 | 90 | 87 | 71,626 | 89,481 | 983 | 248 | 33 |
| Land Mammals | 98 | 77 | 76 | 94 | 82 | 1,290 | 87,390 | 960 | 242 | 33 |
| Large Land | 98 | 76 | 74 | 92 | 82 | 691 | 87,306 | 959 | 242 | 33 |
| Small Land | 53 | 45 | 42 | 18 | 27 | 599 | 84 | 1 | 0 | <1 |
| Marine Mammals | 97 | 58 | 37 | 97 | 79 | 113 | 85,216 | 936 | 236 | 32 |
| Birds and Eggs | 90 | 77 | 76 | 69 | 73 | 3,558 | 4,325 | 48 | 12 | 2 |
| Vegetation | 79 | 71 | 71 | 40 | 27 | | 396 | 4 | 1 | 0 |

Sources: ADF&G Community Profile Database Version 3.11, March 2001 (for 1985 and 1993); Fuller and George 1999 (for 1992); SRB&A 2003.

In 1985, Nuiqsut did not land any bowhead whales. The community harvested two bowheads in 1992 and three bowheads in 1993. Caribou, whitefish, and bowhead whales contributed 88 percent of Nuiqsut's annual subsistence harvest in terms of edible pounds in 1993 (Table 3.4.3-3).

In 1992, marine resources dominated the subsistence harvest (35.1 percent of the total harvest), largely as the result of a successful bowhead hunt at Cross Island (Tables 3.4.3-2 and 3.4.3-3) (Fuller and George 1999). Other harvested marine mammals included polar bear and bearded and ringed seals. Fish (broad whitefish and least and arctic cisco) comprised 34.6 percent of the total harvest for Nuiqsut in 1992. Approximately 28 percent of the total harvest in 1992 was land mammals (caribou and moose). The harvest of birds (geese and eiders) was approximately 3 percent of the total harvest in 1992. The highest Nuiqsut household participation rates were in fishing, caribou hunting, moose hunting, and bear hunting (Fuller and George 1999).

The data for 1994 to 1995, collected by the NSB Division of Wildlife, were presented in a different format from that used by ADF&G (Brower and Hepa 1998). This was an exceptional year in that Nuiqsut crews harvested no whales. Caribou contributed 58 percent of edible pounds of wild foods for the sampled period, with fish contributing 30 percent, moose and birds each 5 percent, marine mammals 2 percent, and wild plant foods less than 1 percent of edible pounds harvested (Brower and Hepa 1998, p. 15). Nuiqsut residents participating in subsistence harvest activities were in the majority, with 66 percent successful, unsuccessful, or out hunting at the time of the interviews, 21 percent not attempting to harvest, and the balance not wishing to be interviewed (5 percent), out of town (7 percent), or unable to be contacted (1 percent) (Brower and Hepa 1998). Eighty-seven percent of harvest instances resulted in resource sharing (Brower and Hepa 1998).

### CONTEMPORARY SUBSISTENCE USE AREAS

Pedersen documented Nuiqsut "lifetime" (Pedersen 1979) and 1973 to 1986 land uses areas (Pedersen, in prep.) (Figure 3.4.3.2-1). Brown (1979) and Hoffman et al. (1988) also documented Nuiqsut subsistence use areas in the 1970s, which are incorporated within the lifetime use areas depicted in Pedersen (1979). Comparing Pedersen's Nuiqsut lifetime use areas (1979) and other earlier documentation of Nuiqsut subsistence use areas (Brown 1979; Hoffman et al. 1988) with Pedersen's (in prep.) 1973 through 1986 subsistence land uses documentation, as depicted on Figure 3.4.3.2-1, shows Nuiqsut resource harvesters using a larger area offshore, a larger area to the west including northwest to Barrow, going to the south to Anaktuvuk Pass, and changes around industrial development to the east. It should be noted that when the 1970s research (for example, Pedersen 1979, and Brown 1979) was conducted, Nuiqsut had only been resettled for a few years (since 1973) and hunters "were relearning the land to a large extent" (IAI 1990) and were not using the entire area formerly used by people originally from the Colville River Delta. Thus, Pedersen (in prep.) shows a larger Nuiqsut subsistence use area for 1973 through 1986 than either Pedersen (1979) shows for lifetime use areas or Brown (1979) depicts for his limited interviews. This change likely reflects Pedersen's continuing research, as well as Nuiqsut hunters' expanding use as residents resettled their traditional area.

Stephen R. Braund & Associates (SRB&A) conducted 21 interviews with subsistence resource users in Nuiqsut in June and July of 2003. SRB&A interviewed a variety of currently active resource users including persons of both genders and several ages, from young hunters starting out, through increasingly active and productive middle-aged hunters, to the active elders who still harvest subsistence foods and train the younger hunters. Figure 3.4.3.2-2 shows the recent (last ten years) subsistence use areas for all resources for the 21 Nuiqsut residents interviewed in 2003.

The 2003 information and the earlier documented Nuiqsut use areas depict a similar use area with some variation. The 2003 interviews did not focus on the area west of Barrow and hence did not capture the travel between Nuiqsut and Barrow and associated hunting. The western extent is similar, with some minor variation that likely reflects the different hunters that were interviewed. During the 2003 interviews, it became apparent that southern extent of Nuiqsut's land uses extended beyond the map used for the interviews. Some formerly used areas depicted in lifetime use area maps and the 1973 through 1986 use areas (for example, the Prudhoe Bay area) are perceived by some residents as being no longer accessible and by many residents as being undesirable because of industrial development, as noted in Pedersen et al. (2000), SRB&A interviews (2003), scoping testimonies, and in ADF&G (2001, Issues section).

**TABLE 3.4.3-3 SELECTED NUIQSUT SUBSISTENCE HARVESTS FOR 1985, 1992, 1993, AND 1994-1995**

| | Estimated Harvest | | | | |
|---|---|---|---|---|---|
| **Resource** | **Number** | **Total Pounds** | **Mean HH Pounds** | **Per Capita Pounds** | **% of Total Harvest** |
| **1985** | | | | | |
| Caribou | 513 | 60,021 | 790 | 150 | 38 |
| Whitefish | 58,733 | 59,701 | 786 | 149 | 37 |
| Bowhead[1] | 0 | 7,458 | 98 | 19 | 5 |
| Geese | 1,345 | 6,045 | 80 | 15 | 4 |
| Moose | 13 | 6,650 | 88 | 17 | 4 |
| Seals | 57 | 4,431 | 58 | 11 | 3 |
| Burbot | 669 | 2,675 | 35 | 7 | 2 |
| Char | 1,083 | 3,060 | 40 | 8 | 2 |
| Grayling | 4,055 | 3,650 | 48 | 9 | 2 |
| **1992** | | | | | |
| Bowhead | 2 | 48,715 | 464 | 117 | 32 |
| Caribou | 278 | 32,551 | 310 | 78 | 22 |
| Arctic cisco | 22,391 | 22,391 | 213 | 54 | 15 |
| Broad whitefish | 6,248 | 15,621 | 149 | 37 | 10 |
| Moose | 18 | 8,835 | 84 | 21 | 6 |
| **1993** | | | | | |
| Caribou | 672 | 82,169 | 903 | 228 | 31 |
| Bowhead | 3 | 76,906 | 845 | 213 | 29 |
| Whitefish | 64,711 | 77,671 | 854 | 215 | 29 |
| Seals | 109 | 8,310 | 91 | 23 | 3 |
| Grayling | 4,515 | 4,063 | 45 | 11 | 2 |
| Moose | 9 | 4,403 | 48 | 12 | 2 |
| Burbot | 1,416 | 5,949 | 65 | 16 | 2 |
| Char | 618 | 1,748 | 19 | 5 | 1 |
| Geese | 1,459 | 2,314 | 25 | 6 | 1 |
| **1994-1995** | | | | | |
| Caribou | 258 | | | | |
| Whitefish | 14,532 | | | | |
| Seals | 24 | | | | |
| Grayling | 462 | | | | |
| Moose | 5 | | | | |
| Burbot | 91 | | | | |
| Char | 8 | | | | |
| Geese | 457 | | | | |
| Berries | 14 | | | | |

Source: ADF&G Community Profile Database Version 3.11, March 2001 (for 1985 and 1993); Fuller and George 1999 (for 1992); Brower and Opie 1997 (for 1994-1995); SRB&A 2003.
Notes: [1] No bowhead were harvested by Nuiqsut in 1985. Pounds of bowhead in 1985 are from receiving shares from other communities.

The 2003 information and the earlier documented Nuiqsut use areas depict a similar use area with some variation. The 2003 interviews did not focus on the area west of Barrow and hence did not capture the travel between Nuiqsut and Barrow and associated hunting. The western extent is similar, with some minor variation that likely reflects the different hunters that were interviewed. During the 2003 interviews, it became apparent that southern extent of

Nuiqsut's land uses extended beyond the map used for the interviews. Some formerly used areas depicted in lifetime use area maps and the 1973 through 1986 use areas (for example, the Prudhoe Bay area) are perceived by some residents as being no longer accessible and by many residents as being undesirable because of industrial development, as noted in Pedersen et al. (2000), SRB&A interviews (2003), scoping testimonies, and in ADF&G (2001, Issues section).

### CARIBOU USE AREAS

Harvest location data for caribou collected by the NSB (Brower and Hepa 1998; NSB 2003) and ADF&G (2001, 2003) and hunting area interviews conducted in Nuiqsut for this project indicate that there are several primary harvest areas for caribou (*tuttu*) (Figure 3.4.3.2-3). Going north, these harvest locations include the Nuiqsut area, the Colville River Delta, the Nigliq Channel, and the Fish and Judy creeks area. To the south of Nuiqsut, the Colville River provides access to areas and sites such as Itkillikpaat, Ocean Point, Itkillik River, Umiat, and the confluences of the Anaktuvuk and Chandler rivers. These areas are usually associated with Traditional Land Use Inventory (TLUI) sites, cabins, camps, and native allotments with harvest locations for other species nearby. These harvest locations can be used in winter (October through May), summer (June through September), or both, and they can be accessed by foot, boat, all-terrain vehicle, and snowmobile.

Figure 3.4.3.2-3 shows the recent harvest areas of interviewed hunters for caribou, and Figure 3.4.3.2-4 shows the winter and summer caribou hunting areas. Summer hunting is done by boat after the river ice breaks up, and hunters proceed along the coast from Smith Bay east to the Sagavanirktok River, including Oliktok Point, several barrier islands, and in all channels of the Colville River Delta, Fish Creek, and Judy Creek. Hunters also go south on the Colville River beyond Umiat, passing Itkillikpaat, Ocean Point, Signal Hill, and Umirak en route. These trips upriver are taken by boat in the summer, in the fall when moose and caribou can be harvested, and by snowmobile in the winter in pursuit of caribou and furbearers. Nuiqsut hunters also travel up the Itkillik, Chandler, and Anaktuvuk rivers by boat and snowmobile. There are many camps and cabins in the area of Fish and Judy creeks, throughout the Colville River Delta, and up the Colville River to the south that are used for summer and winter caribou hunting. These camps often have drying racks and ice cellars for processing and storing harvested game, as well as caches of survival gear and supplies.

Cumulative Nuiqsut caribou harvests by month for 1993, 1994 through 1995, 2000, and 2001 are shown on Figure 3.4.3.2-5. There are monthly and seasonal differences in the proportion of caribou harvested, with summer (defined as the open water period, including June, July, August, and September) harvests providing approximately 60 percent of the harvested caribou. For the four data years, July (23 percent) and August (24 percent) are the months with the greatest cumulative caribou harvests. According to several hunters, October (16 percent) is a preferred month for hunting caribou, because the caribou have by then accumulated a thick layer of fat for the winter. September (8 percent) is normally consumed with whaling activity, and meat from caribou hunted in August is provided to whaling crews. March (6 percent) represents the beginning of spring, with longer days and warmer weather encouraging hunters to go out on the land again and harvest caribou.

Summer is the major caribou harvest season by proportion of individual caribou taken, and hunting is undertaken by boat. Large numbers of caribou migrate to the coast and shallow waters of Harrison Bay, and to the Colville River Delta in July to get away from mosquitoes. This behavior allows subsistence hunters to harvest numbers of caribou adequate for subsistence in a relatively short amount of time. Because of the risk of spoilage, the harvested caribou must be processed and stored quickly, whether in ice cellars at camps or brought back to Nuiqsut and put in freezers. Outboard boats provide rapid transportation for the hunters and their harvest. August is a time of increased bot and warble fly activity, and the caribou disperse into smaller groups and go south, as coastal winds provide little relief from flies (SRB&A 2003).

Winter harvests take place after the rivers and lakes have frozen over and snow covers the tundra, allowing for a greater overland hunting range using snowmobiles. Interviewed hunters have ranged from the vicinity of Admiralty Inlet and Teshekpuk Lake in the west, to the Franklin Bluffs area east of the Dalton Highway, south to Anaktuvuk Pass, and along the northern foothills of the Brooks Range (Figure 3.4.3.2-4). Caribou are hunted as needed while hunters pursue wolves, wolverines, and foxes southeast of Teshekpuk Lake, in the Brooks Range foothills, the

Kuparuk Hills, and east of the Colville River. Subsistence caribou hunting independent of the furbearer harvest continues all winter throughout the Fish and Judy creeks area, along the Nigliq Channel, and south along the Colville and Itkillik rivers. During the coldest months, many hunters stay closer to Nuiqsut, venturing farther out as spring approaches (SRB&A 2003).

March represents the beginning of spring as the days grow longer and temperatures increase. Preparations for Nalukataq begin in March as senior whaling crew members hunt caribou and other resources. In April, the snow is often "too rotten" to travel over the tundra, limiting overland travel by snowmobile. Caribou are harvested near the village and along frozen waterways at this time, but as spring approaches the caribou are often thin and not in the best condition (SRB&A 2003).

Figure 3.4.3.2-6 shows harvest locations by season for caribou harvested at known locations in 1993, 1994 through 1995, 2000, and 2001. The greatest proportion of caribou, both summer and winter, were harvested at Fish and Judy creeks, in the Nuiqsut area, and in the Colville River Delta including Nigliq and the Nigliq Channel. The Nuiqsut area itself is the second largest winter harvest location and fourth largest summer harvest location.

There are several reasons for this, including expedience, accessibility in both summer (boat) and winter (snowmobile), coordination with work obligations, efforts to avoid spoiling the meat, lack of transportation or gas money, general availability of caribou in both seasons, and a desire to combine caribou harvesting with fishing, waterfowl hunting, and berry picking. More distant harvest locations for caribou are associated with camps, cabins, and allotments (Figure 3.4.3.2-2) where caribou can be hunted, processed, and stored while other subsistence tasks are undertaken, such as fishing and berry picking. During the summer and winter it is common practice for experienced Nuiqsut hunters to take younger, less experienced hunters to Fish or Judy creeks, Nigliq, the Colville River Delta, or Itkillikpaat to fish and harvest caribou. They stay at a cabin or campsite of their own, or at one that belongs to a friend or relative. These activities provide multiple traditional foods for the community through sharing and distribution upon the hunters' return. Furthermore, they serve to transfer to younger hunters a multi-generation knowledge of and identification with specific harvest, processing and storage methods, and traditional harvest locations. In summary, these subsistence activities in these specific locations reinforce the cultural identity of the community and residents' identification with their unique history. As shown on Figure 3.4.3.2-7, 41 percent of the caribou harvested during the 1993, 1994 through 1995, 2000, and 2001 study years were harvested in the Colville River Delta and 25 percent harvested in the Fish and Judy creeks area. Thus, 66 percent of the caribou harvested in this time period were harvested in these two areas.

#### FISH USE AREAS

Nuiqsut resource users have a long history of subsistence fishing in the Colville River and its tributaries from the Colville River Delta to the confluence with the Ninuluk Creek, the Nigliq Channel and nearby Fish and Judy creeks, and innumerable lakes in the region. Nuiqsut fishermen also use coastal areas east to the Kuparuk River and fish around several barrier islands, including Thetis and Cross islands (Figure 3.4.3.2-8). Many families set nets near Nuiqsut in the Nigliq Channel when time, transportation needs, or funds do not permit longer trips from town, particularly during the school and work year. Cooperative arrangements are made between resource users wherein resources (such as time, equipment, gas, and labor) are pooled in exchange for shares of the harvest. Resource users often fish in conjunction with other subsistence activities, such as caribou and moose hunting and berry picking, especially in harvest areas with camps and cabins. Certain species of fish are only seasonally available, and must be harvested when present in the area. Nuiqsut fishers freeze or dry these fish for later use and barter. Other fish species are available year-round and provide a welcome change in diet and fresh food during the winter and spring (SRB&A 2003).

Fish comprise approximately one-third of the subsistence harvest of Nuiqsut residents (Table 3.4.3-2). This percentage varies with fish availability and the availability of other resources, such as caribou and bowhead whales (Brower and Hepa 1998). Subsistence fishing in Nuiqsut has been the subject of scientific research since 1985, when studies were undertaken in response to harvest failures that resource users associated with the construction of nearshore infrastructure for oil development (Moulton 2000). In addition, the NSB Department of Wildlife

Management has also collected information on Nuiqsut subsistence fish harvests for the years 1994 through 1995, 2000, and 2001 (Brower and Hepa 1998; NSB 2003 [unpublished]).

There are significant differences in sampling in the last 3 years of the 17-year Moulton studies (Moulton 2000, 2002), and in methodology and sampling between the Moulton studies and the NSB studies. From 1985 to 1998, Moulton collected data from five net sites (Upper Nigliq, Nanuq, Nigliq Delta, Outer Delta, and the Main River) in the Colville River Delta on subsistence harvests of Arctic cisco, least cisco, broad whitefish ), and humpback whitefish).

Moulton did not conduct the studies in 1999. The Moulton studies resumed in 2000, but in that and subsequent years only the subsistence harvest on the Nigliq Channel sites (for example, Upper Nigliq, Nanuq, and Nigliq Delta) were reported.

The data collected by the NSB is broader in scope, geographically and by species, than the Moulton data. Harvest information collected by the NSB includes data for char (iqalukpik), burbot (tittaaliq), pike (siulik), salmon, and grayling (sulukpaugaq), in addition to the cisco and whitefish species addressed by Moulton. The NSB harvest locations reflect those reported in the 2003 Nuiqsut SRB&A interviews, with summer and winter fishing taking place in the Nigliq Channel, Colville River and Delta, and in Fish and Judy creeks, as well as other locations in specific seasons using both nets and angling gear (Brower and Hepa 1998; SRB&A 2003; Figure 3.4.3.2-8). The relative value of different species to local resource users reported in interviews ranged from valued staples (for example, cisco and whitefish) to the highly prized (such as burbot). Burbot, which are caught by jigging through holes in the ice in the Nigliq Channel and other Colville River Delta channels, the Colville River, and Fish and Judy creeks, are highly prized for their large livers and high fat content in the winter but are harvested in numbers that do not compare with the volume of some other species (SRB&A 2003).

The Moulton data show the highly variable nature of the subsistence fish harvest in the Colville River Delta and Nigliq areas. Arctic cisco harvests range from approximately 6,100 in 1988 to nearly 47,000 in 1993, approximately 7.5 times as many as the low, as shown on Figure 3.4.3.2-9. Fishing effort in net days ranged by area from 19 to 1,407 net days (Figure 3.4.3.2-10), although there is no clear correspondence between the harvest and harvest effort, because low efforts brought more fish, as in 1993, while high efforts as in 2002 resulted in few fish harvested even considering the reduced number of sites sampled.

The NSB subsistence harvest data for 1994 through 1995, 2000, and 2001 show the greatest proportion of fish are harvested in October (54 percent), November (13 percent), July (11 percent), December (4 percent) and September (4 percent) (Figure 3.4.3.2-11). Undated fish harvests (9 percent) are the fourth largest group. The large number of fish harvested reflects the importance of the resource in general, but in particular demonstrates the numerical dominance of Arctic cisco to the fall and winter harvest, as shown on Figure 3.4.3.2-12. The variability in Arctic cisco harvest as shown on Figure 3.4.3.2-9 demonstrates the importance of having alternative species and harvest strategies available should poor fish harvests coincide with reduced terrestrial or marine mammal harvests.

Key fishing areas measured by total harvest for all species, shown on Figure 3.4.3.2-13, include areas around Nuiqsut and throughout the Colville River Delta, including Nigliq and the Nigliq Channel. Arctic cisco harvests were removed from the analysis because of their large proportion in order to examine fish harvested in smaller proportions. Figure 3.4.3.2-14 shows that the Colville River Delta remains an important Nuiqsut fish harvest location, even excluding Arctic cisco. In addition, Nanuq Lake, Fish Creek, and upriver locations are also important for harvesting of fish other than Arctic cisco.

Resource users set nets in the Nigliq Channel for broad whitefish in June and July, as the fishery is accessible on foot, by boat, truck, or all-terrain vehicle. Several interviewed resource users stated that “everybody in town goes down there if they can.” In August and September, fishers set nets and angle in the Nigliq Channel, Nanuq Lake, Fish Creek, and the Colville River Delta, or travel by boat up the Colville River up to and beyond Umiat for grayling, chum salmon, silver salmon, and arctic char. Some fish in the nearshore waters inside the barrier islands, and this is often done by Nuiqsut bowhead whaling crews to support them while they are at Cross Island (Figure 3.4.3.2-8). In the fall and early winter, grayling gather at river mouths, and nets are set under the ice for other fish migrating out of the rivers for the winter, including whitefish and cisco. Jigging through the ice continues until the coldest months of winter for burbot, grayling, and rainbow trout (SRB&A 2003).

Fishing is an important family activity and is an opportunity for several generations to gather at camps for cooperative fishing and other resource harvests. Elders from the area know the most productive fishing spots, which species are available at which locations, and the best times to fish for them. Angling and jigging is done by children, as well as elders in all seasons, and species harvested by these methods are highly valued. For example, one Nuiqsut resident spoke of the high local value placed on burbot livers when he said, “We all eat that! We get them for the liver; it is rich and the meat is rich.” Net fishing along the Nigliq Channel and at cabins and camps on Fish Creek in the summer are highly valued family activities, as Nuiqsut families cooperate for weeks at camp, catching and drying whitefish for later consumption and distribution. Family members with year-round wage jobs work in town while other family members of all ages work at the camps, with wage workers returning in the evenings or weekends to bring supplies, visit, and participate in subsistence activities (SRB&A 2003).

#### WATERFOWL USE AREAS

Waterfowl harvested by the Inupiat of Nuiqsut occupy two habitats in the greater area. Ducks, geese, and brant nest and molt in the wet tundra to the north. Eiders nest on the sandy areas of the Colville River Delta and the barrier islands, and molt after their arrival. Both groups of waterfowl raise their young in the area until fall, when they migrate south. Nuiqsut hunters harvest waterfowl in May and June during the migration using snowmobiles and boats. Geese hunting areas include the Fish and Judy creeks area, the Colville River Delta, the area around Nuiqsut extending to the Fish and Judy creeks area, along the Colville River up to Sentinel Hill, the area around Ocean Point, and along the Itkillik River (Figure 3.4.3.2-3).

The hunters harvest the migrating birds from snow blinds built to the south, near Sentinel Hill and Ocean Point, or at Fish Creek. Once the river breaks up, hunters look for birds by boat, and start to look for eiders in the delta and in Harrison Bay at the ice edge as summer approaches. Hunters end the waterfowl harvest when the birds are on their nests (SRB&A 2003).

In earlier times, Inupiat resource users harvested flightless molted birds by cooperatively “herding” them into creeks, then dividing the harvest between the work group members. One resident remembered doing this as recently as the late 1940s at Oliktok Point. Nuiqsut people in the past gathered and stored eggs from waterfowl nests on the tundra. Twenty-one Nuiqsut harvesters interviewed in 2003 stated that they no longer gather eggs, and that they do not harvest certain species of waterfowl for various reasons. Some residents indicated that they do not eat certain varieties of ducks (e.g. old squaws, pintails), while many chose to avoid harvesting black brant and spectacled eiders because they are endangered. Nearly all interviewed resource users harvested geese in May, and most harvested some eiders (SRB&A 2003).

The NSB collected waterfowl harvest data for 1994 through 1995, 2000, and 2001 (Brower and Hepa 1998, NSB 2003). Figure 3.4.3.2-15 shows that 79 percent of geese, including white fronted and Canada, were harvested in the Fish and Judy creeks area (63 percent) and the Colville River Delta (16 percent). Of the remaining 21 percent, most were harvested up the Colville River from Ocean Point to Umirak. A more specific view of goose harvest locations is shown on Figure 3.4.3.2-16, with 47 percent of harvested geese coming from Fish Creek alone, and many of the rest harvested in the Colville River Delta and Nuiqsut areas.

Figures 3.4.3.2-17, 3.4.3.2-18, and 3.4.3.2-19 show harvest locations that reflect the more specialized habitat of eiders. More than half (53 percent) were harvested in the ocean, with Thetis Island, Atigaru Point, and Point Barrow as other maritime harvest locations. The Colville River Delta and its channels were the major freshwater harvest areas for eiders, accounting for 28 percent of the eider harvest. The Kogru-Kalikpik River area comprised 2 percent of the eider harvest.

Waterfowl are an important subsistence food and are the first fresh meat in the spring. Waterfowl are an important food for Nalukataq celebrations held by whaling captains in the early summer, and whaling crew members spend considerable effort in harvesting them. Waterfowl are harvested by hunters walking down the Nigliq Channel after work or school without investing in fuel and equipment. Waterfowl hunting trips also are sometimes the last overland trips made to cabins and camps on Fish and Judy creeks and along the Nigliq Channel before conditions make it impossible to use snowmobiles for the season. The first boat trips of the year are taken to harvest seals and eiders (SRB&A 2003).

#### FURBEARER USE AREAS

During the 2003 interviews, Nuiqsut hunters described three species of terrestrial furbearers as being especially important: wolf, wolverine, and fox. Once there is adequate snow in the winter for snowmobile travel, generally by November, hunters begin the pursuit of wolf and wolverine in earnest. The harvest area for furbearers extends from the eastern edge of the Colville River Delta along the coast almost to Admiralty Bay, south along the Ikpikpuk River to the Colville River and eastward to the Toolik River, north and acrossthe Dalton Highway to Franklin Bluffs, and west and north back to the Colville River Delta. The southern extent, in some cases, extended off of the map used for the interviews (Figure 3.4.3.2-8).

A typical furbearer hunt involves one to three hunters who travel over this vast area looking for wolf and wolverine tracks and signs. When the hunters spot tracks, they follow them until the animal can be harvested. Foxes are sometimes trapped, but only a few of the hunters interviewed still set traps. Several hunters considered fox furs harvested inland to be of better quality than those on the coast, particularly those of arctic fox, which feed on seal scraps left by polar bears and get greasy, thus staining their fur (SRB&A 2003).

Wolverine harvest locations reported for 1994 through 1995, 2000, and 2001 are divided evenly between the Colville River Delta and Fish and Judy creeks (48 percent) and other areas (52 percent), as shown on Figure 3.4.3.2-20. Similarly, 55 percent of wolves harvested during these years were harvested in the Fish and Judy creeks area, with the balance harvested elsewhere (Figure 3.4.3.2-21). One hunter, explaining where wolves and wolverines could be found, said, “Wolf, wolverine, and caribou go to the lowest levels, which have the best hiding spots. These are rivers, bluff bases, creeks, frozen ground, and low level places that allow them to hide.” (SRB&A 2003)

The relatively small numbers of wolves and wolverines harvested belies their importance to the community in several ways. The pursuit of furbearers is a friendly, competitive pursuit both within the village and between villages, primarily for males, and has important functions in teaching younger hunters the landmarks and resources of a very large area. Occasionally furbearer hunters will encounter people from other villages on the tundra also engaged in furbearer hunting, fostering connections between villages in a mostly male social context. Wolf and wolverine fur continues to be an important and highly valued component in Inupiat clothing. There is an economic interest in fur hunting despite the relatively poor commercial market for fur, with one fur hunter stating that he received $450 for a good wolverine pelt, and $600 for a wolf pelt. This allowed him to pay for enough gas for a trip to Barrow (SRB&A 2003).

#### MOOSE USE AREAS

As depicted on Figure 3.4.3.2-22, moose (are hunted from the Colville River Delta area upstream to Ninuluk Creek, up the drainages of the Itkillik River and Fish and Judy creeks, and up some side streams off the Colville River. One hunter mentioned going almost to the Killik River confluence looking for moose, while several others reported Fish and Judy creeks, the Chandler and Anaktuvuk river confluences, several side streams and channels of the Colville River, and the Itkillik River area as prime moose hunting areas (SRB&A 2003). Although few moose are harvested, they are a valued component of the subsistence harvest in Nuiqsut, and hunters spend considerable effort in their pursuit. From 1994 through 1995, five moose harvests were reported (Brower and Hepa 1998). Moose offer a significant amount of meat per animal harvested because of their relatively large size compared to other terrestrial mammal subsistence resources.

August is the only month for Nuiqsut residents to harvest moose according to subsistence regulations. Many hunters plan their work schedules around this harvest period in order to participate. Moose meat is often supplied to whaling crews who usually head for Cross Island in early September. Trips including extended families and friends, as many as six boats full, travel at this time to Fish and Judy creeks, up the Colville River to the general area of Umiat, or up the Itkillik River. Camps are set up and cabins and caches cleaned. As with other subsistence activities, these trips provide opportunities for other harvest activities including caribou hunting, fishing, and berry picking. Evenings at camp are a time for visiting, telling stories, and teaching younger people about subsistence practices (SRB&A 2003).

#### SEAL USE AREAS

Ringed, spotted, and bearded seals are important subsistence resources for Nuiqsut hunters. As depicted on Figure 3.4.3.2-22, seals are harvested along the coast and offshore from Cape Halkett in the west to Foggy Island Bay in the east. In the summer, Nuiqsut hunters harvest ringed and spotted seals in the Colville River as far south as Ocean Point. Hunters usually shoot seals in the water and on the ice edge in the spring (SRB&A 2003).

In April and May, hunters ride out to Harrison Bay on snowmobiles and look for breathing holes, cracks in the ice, and open water where seals could surface to breath. By the second week in June, open waters on the Colville River and much of Harrison Bay allow hunters to take boats out on a route locally called “around the world,” following the Nigliq Channel to Harrison Bay, west to Atigaru Point, then along the ice edge out as far as 28 miles, then to Thetis Island, east to Oliktok Point, then back south through the main channel of the Colville River. Thetis Island is used as a shelter should the weather turn bad, as it is crescent shaped and provides protection from wind in three directions. This route is also used to harvest eiders and occasionally walrus (SRB&A 2003).

Seals are a culturally important subsistence species for food, skin, and barter. In historic times, seal oil lamps provided heat and light for Inupiat dwellings and was used as a condiment for dried foods. Seal is still locally consumed and traded to Anaktuvuk Pass residents for dried caribou and other products. Seal skins are used for handicrafts and other articles, bartered, or sold (SRB&A 2003).

#### BOWHEAD WHALE USE AREA

The recent Nuiqsut subsistence bowhead whale hunting area is depicted on Figure 3.4.3.2-17. The general Nuiqsut harvest area for bowhead whales is located off the coast between the Kuparuk and Canning rivers. Nuiqsut has been a bowhead whaling community since its reestablishment in 1973. Whalers currently travel to Cross Island to conduct fall bowhead whaling. They have also used Narwhal Island as a base, and still have structures there. Cross Island has cabins and equipment for hauling and butchering the whales. Nuiqsut hunters typically travel out either the Nigliq or the main Colville channel of the Colville River Delta depending on water levels, and travel along the coast inside or just outside the barrier islands. Often they will stop at West Dock for coffee before heading due north for Cross Island. Whalers opportunistically harvest seals, caribou, and polar bears en route. After setting up camp, work groups will start fishing and hunting other species to support the whalers.

#### BERRIES USE AREA

Berries and plants, as shown on Figure 3.4.3.2-17, are a widely dispersed resource available for a very short time. Berries of numerous varieties are harvested in the Fish and Judy creeks area, and along the Colville, Chandler, Anaktuvuk, and Itkillik rivers. Plants such as masu (Eskimo potato), medicinal plants, and greens are harvested at the same time, usually when families are out at camp hunting and fishing in the late summer. Berry picking is still considered a job primarily for women and children, but many men mentioned picking berries as well. Berry varieties include salmonberries and blueberries. Berries are primarily harvested in August, when many families are moose hunting near the creeks and rivers in the area, and often they will fill buckets or large freezer bags of berries. These are taken home and stored in ice cellars or freezers for later use in akutuq (Eskimo ice cream) made from whipped seal or other fat, sugar, plants, and berries.

### SUBSISTENCE USER AVOIDANCE OF DEVELOPED AREAS

Following the reestablishment of Nuiqsut in the Colville River Delta in 1973, community residents began to refamiliarize themselves with the subsistence resources of the area based on the knowledge of elders that had remained in the area or continued to use the area while living in other communities. Their subsistence harvest and use areas for this period are documented in *Nuiqsut Paisaŋich* in a series of maps (Brown 1979), by the NSB as part of its program of traditional land use documents (Hoffman, Spearman, and Libby 1988), and by Pedersen (1979 and In Prep). At that time, oil development was some distance from the community, but its impacts were felt by residents who had ties to the developed area and by residents who wished to use subsistence areas on the east side of the developed area (Brown 1979; Appendix A). These issues and concerns were documented in the early 1980s by researchers working under contract to the MMS for the Social and Economic Studies Program (Institute for Social and Economic Research [ISER] 1983). Chapter 6 of the report documented that the Iñupiat subsistence users perceived that there was a high potential for conflicts between industrial and Inupiat land uses and subsistence access. Figures 7 and 8 of the report showed subsistence use areas overlain on industrial areas closed to subsistence and the vast expanse of land potentially offered for lease. Chapter 7, *Perceived Threats of Oil Development,* outlines the conflicts and concerns between Inupiat subsistence uses and industry (ISER 1983:181-250). No other community in Alaska is as close as Nuiqsut to intensive oil exploration and development, and this proximity is reflected in residents' increased concerns about reduced subsistence access through increased regulations, competition with outsiders, and the imposition of physically obstructive facilities in traditional use areas (ISER 1983:223-225).

Through the 1980s, the industrial developed area expanded overland west from Prudhoe Bay, and the possibility of nearshore and offshore development near Nuiqsut was impending (IAI 1990a). By 1985, development encompassed subsistence and traditional use areas from Oliktok Point south along the Kuparuk River (Pedersen, Wolfe, Scott, and Caulfield 2000: Figure 4). The harvest of marine resources at specific locations was complicated or prevented by onshore development at traditional camps (e.g., Oliktok Point, Niakuk) and by offshore activity (e.g., drilling, seismic testing, and sealift) (Pedersen et al. 2000).

By 1990, Galginaitis wrote in MMS SESP Special Report 8 that, "Perhaps the most obvious effect of oil development in the Nuiqsut area has been that it has effectively removed certain areas from the Nuiqsut subsistence land uses area." (IAI 1990a:1-43) Subsistence users' reasons for avoiding or not avoiding areas in response to oil development in the late 1980s were similar to those noted in the 1983 ISER study and included regulatory contraints (real or perceived), a perception of restriction, lack of cultural privacy, notice or belief that a resource is contaminated, and physical obstacles and barriers such as low pipelines and steep gravel road sideslopes (IAI 1990a: 1-43-44, ISER 1983).

As shown on Figure 3.4.3.2-2, Nuiqsut subsistence use areas have retreated from the east as development moved westward from Prudhoe Bay to Oliktok Point, particularly in the area of the Kuparuk field. Onshore development displaced subsistence uses east of the Colville River for the majority of Nuiqsut users, and the few who continued to use the area did so primarily for political purposes and did not take many caribou there (IAI 1990a: 1-44). By 1990, the concern in the community of Nuiqsut was that development would continue to encroach on their shrinking subsistence and traditional use areas on the Itkillik and Colville rivers and the Colville River Delta (IAI 1990a: 1-46). At that time, some hunters noted that further development in these subsistence use areas would impose a severe hardship on the community of Nuiqsut (IAI 1990a: 1-46).

In 1993, onshore subsistence harvests and uses east of the Colville River and north of Nuiqsut declined to near zero, and development activity was encroaching on valued traditional use areas (Pedersen et al. 2000). Whaling at Cross Island, the use of onshore camps, and storage of the bowhead harvest at Oliktok Point became deeply entwined with oil company personnel and oversight, as companies sought to minimize the time spent by Iñupiat hunters in the developed areas and to avoid attracting polar bears to Oliktok Point by shipping whale meat and *maktaq* by air to Nuiqsut (Pedersen et al. 2000). This assistance has some advantages in time and convenience for subsistence users; however, this practice reduced the autonomy of the hunters and subjected them to scrutiny and regulation throughout the whaling process, which eliminated the perception of cultural privacy (Pedersen et al. 2000).

The 1993 Nuiqsut caribou harvests within the developed area were at or near zero, four percent were within five miles of developed areas, 17 percent were harvested from six to 15 miles, and 79 percent were harvested more than 16 miles from development (Pedersen et al. 2000:18). The 1994 caribou harvest data were similar (Pedersen et al. 2000) in terms of the percent of caribou harvested in relation to harvest proximity to development. Key informants noted in a 1998 Nuiqsut group session that they no longer used the developed area northeast of Nuiqsut as intensively as they had in the past due to difficulties of access, lack of privacy, loss of cultural landmarks, uncertainty regarding regulations, and oilfield security enforcement (Pedersen et al. 2000:18).

Harvest locations and amounts for caribou for the study years reported in Pedersen et al. 2000 (i.e., 1993 and 1994) are consistent with the published and unpublished harvest location data from the North Slope Borough Division of Wildlife Management for 1994-95, 2000 and 2001 (Brower and Hepa 1998; North Slope Borough Department of Wildlife Management 2003). Thus, the NSB data and Pedersen et al. (2000) findings support that Iñupiat subsistence users harvest most of their caribou in locations that are distant from developed areas east of the Colville River. This shift applies to most subsistence resources, these changes are ongoing in response to industrial encroachment, and are similar to those predicted in 1990 (Pedersen et al. 2000, IAI 1990a). The main reasons for this avoidance of previously used areas east of the Colville River cited by Pedersen et al. include "difficulties of access, lack of privacy when hunting, loss of cultural landmarks, uncertainty regarding regulations in the area, and oilfield security enforcement" (Pedersen et al. 2000:18).

Pedersen and Taalak (2001) conducted a survey of Nuiqsut households for the June 1999 through May 2000 time period. Caribou were the most widely used terrestrial big game resource in Nuiqsut, with an average of four caribou per household when averaged for all community households. According to an open file draft report by Pedersen and Taalak (2001), 75 percent of the 371 caribou harvested by Nuiqsut hunters from June 1999 through May 2002 with known harvest locations were harvested west of Nuiqsut, 11 percent in the immediate vicinity of the community and only 14 percent to the east. Seventy-eight percent of all known caribou harvests occurred away (6 to greater than 16 miles) from oil production facilities in 1999 and 2000. Twenty-two percent were reported harvested in peripheral areas (0 to 5 miles) to development and there were no reports of harvests during this time period inside the industrial developed area. In general, these findings are consistent with the earlier conclusions for the 1993 and 1994 caribou harvests (Pedersen et al. 2000). However, the 1999 and 2000 caribou harvest distances greater than 16 miles from oil development dropped to 51 percent compared to 79 percent in 1993 and 77 percent in 1994. This change is the result of oil development (Alpine Field) moving west into the Colville River Delta, an area of focused Nuiqust caribou harvests, especially June through September. Development in this area is too recent and there are insufficient data available to conclude whether or not harvesters will increase their distance from development in response to this relatively new facility. Furthermore, in 1999 and 2000, the Alpine Field footprint was relatively small compared to larger development east of the Colville River, and CPAI has made efforts to work with Nuiqsut to accommodate hunters. Systematic, time series monitoring of subsistence harvests and locations to document any changes to subsistence harvest patterns is being undertaken in Nuiqsut, Barrow, and Atqasuk by the ADF&G and the ICAS (Pedersen 2004:personal communication). Based on Pederson et al. (2000) and Pedersen and Taalak (2001) data, as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 78 percent of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River and 51 percent of the 1999 and 2000 harvests occurring greater than 16 miles, and 27 percent occurring 6 to 15 miles from Alpine Field development.

Further development anticipated in Pedersen et al. (2000) has come to pass with the development of the Alpine Field Meltwater, Tarn, Fiord, and other oilfields in the vicinity of Nuiqsut. This ongoing development has contributed to a feeling of being "boxed in" for Nuiqsut subsistence users (Pedersen et al. 2000:4, 19). The Committee on the Environmental Effects of Oil and Gas Activities on Alaska's North Slope recently concluded in a National Research Council report that,

> "On-land subsistence activities have been affected by the reduction in the harvest area in and around the oilfields. The reductions are greatest in the Prudhoe Bay field, which has been closed to hunting, and in the Kuparuk field, where the high density of roads, drill pads, and pipelines inhibits travel by snow machine. The reduction in area used for subsistence is most significant for Nuiqsut, the village closest to the oilfield complex. Even where access is possible, hunters are often reluctant to enter oilfields for personal, aesthetic, or safety reasons. There is thus a net reduction in the available area, and this reduction continues as the oilfields spread." (National Research Council 2003:156)

## BARROW SUBSISTENCE ACTIVITIES

The Inupiat name for the Barrow area is Utqiagviq, meaning “the place where we hunt snowy owls.” Barrow is situated on a point of land where the sea ice is prone to cracking. The main subsistence focus, however, has been marine mammal hunting, in particular, whaling. Barrow is one of 10 Alaska Eskimo bowhead whaling communities. Bowhead whale hunting is the key activity in the organization of social relations in the community and represents one of the greatest concentrations of effort, time, money, group symbolism, and significance (SRB&A and ISER 1993). Other harvested resources, such as caribou, waterfowl, and several varieties of fish, are vital for subsistence and available near Barrow but have less influence on the organization of social relations. The reliance on subsistence activities remains a key component of the Barrow economy and the local Inupiat culture.

### CONTEMPORARY SEASONAL ROUND

Barrow’s seasonal round is related to the timing of subsistence resources. Preparation for bowhead whaling occurs year-round. Barrow hunters harvest caribou in April; however, because of pre-calving and calving, hunters usually refrain from taking caribou until late June. The harvest of eiders and geese begins in early to mid-May, weather and ice conditions permitting. Spring bowhead hunting occurs during April and May, with May generally being the most successful month (SRB&A and ISER 1993). In the past, as they hunted whales, crew members also opportunistically hunted a number of other marine mammals, such as seals and polar bears. Beginning with the whaling season of 1978, bowhead whale quotas instituted by the International Whaling Commission altered traditional spring whaling activities by reducing opportunity for harvesting bowheads and limiting the pursuit of other marine mammals so as not to jeopardize the bowhead hunt.

Once the spring whaling season is over, usually late May or early June, subsistence activities diversify. Some hunters turn their attention to hunting seals, walrus, and polar bears, while others go inland to hunt for waterfowl. In June, Inupiat hunters continue to hunt geese and opportunistically harvest caribou, ptarmigan, and eiders. Barrow residents harvest caribou in July and August when they are available to people hunting from boats. In addition, caribou are in peak condition in August, and Barrow hunters prefer to harvest them at that time (Fuller and George 1999). Barrow hunters also harvest marine mammals, eiders, and fish, and caribou in August, depending on the weather and ice conditions. Bearded seals are harvested principally for their blubber, which is rendered into oil, and for their skins, which are used for boat coverings. Barrow hunters harvest ringed seals primarily for their meat. Walrus are harvested in July and August when they drift north with the floe ice and if the pack ice moves close enough to Barrow. Freshwater fishing occurs from break-up (June) through November (Fuller and George 1999). Residents fish for arctic cod year-round, but broad whitefish, the most heavily harvested species, are harvested from June to October (Fuller and George 1999). Fish harvested in August include whitefish, grayling, salmon, and capelin. When the weather turns warm, Barrow hunters typically harvest caribou by boat along the coastal areas as the caribou move to the coast to escape the heat and insects. Residents of Barrow harvest eiders during the “fall migration” in July at Pigniq or “Duck Camp.” Families may go up the Colville River to harvest moose and berries during moose hunting season in August and early September (Fuller and George 1999).

If ice conditions are favorable, fall bowhead whaling can occur as early as mid-August and continue into October. More recently, Barrow whalers have agreed to start the fall whaling season in early October in order to harvest the smaller preferred whales. Residents of Barrow who have remained inland hunt caribou if the animals are accessible; otherwise, they concentrate on fishing for broad whitefish. The subsistence fish harvest generally peaks in October (under-ice fishery), when whitefish and grayling are concentrated at overwintering areas (Fuller and George 1999). Barrow residents also harvest ground (or parka) squirrels and ptarmigan, and, if weather and ice conditions permit and the animals appear close to town, seals and caribou are harvested during November and December (SRB&A and ISER 1993). During the winter months, residents of Barrow harvest furbearers. Table 3.4.3-4 summarizes Barrow’s annual cycle of subsistence activities.

**TABLE 3.4.3-4 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – BARROW**

| | Winter | | | | | Spring | | Summer | | | Fall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct |
| Fish | ▒ | | | | | | | ▒ | ■ | ■ | ■ | ■ |
| Birds | | | | | | | ▒ | ■ | ■ | ■ | ▒ | ▒ |
| Berries | | | | | | | | | | ■ | ■ | |
| Furbearers | ▒ | ▒ | ▒ | ■ | ■ | | | | | | | |
| Caribou | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | | ▒ | ■ | ■ | ■ | ■ |
| Polar Bear | | | ▒ | ▒ | ▒ | | ■ | ▒ | | | | |
| Seals | ■ | ▒ | ■ | | | ▒ | ■ | ■ | ■ | | | |
| Walrus | | | | | | | | ▒ | ■ | ▒ | | |
| Bowhead | | | | | | ■ | ■ | ▒ | | ■ | ■ | ■ |

Sources: SRB&A & ISER 1993; SRB&A 2003.
Notes:

| | |
|---|---|
| | No to Very Low Levels of Subsistence Activity |
| ▒ | Low to Medium Levels of Subsistence Activity |
| ■ | High Levels of Subsistence Activity |

### SUBSISTENCE HARVEST ESTIMATES

SRB&A collected Barrow subsistence harvest data for 1987, 1988, and 1989 (SRB&A and ISER 1993). Barrow's total annual subsistence harvests ranged from 621,067 pounds in 1987 to 614,669 pounds in 1988, and 872,092 in 1989 (Table 3.4.3-5). The 1989 harvest of 289 pounds per capita of wild resources represents nearly 1 pound per day per person in the community. Barrow residents rely heavily on large land and marine mammals and fish (Table 3.4.3-5). Marine mammals comprised approximately 55 percent of the total for the three study years, and land mammals contributed 30 percent of the total.

Bowhead whales, caribou, walrus, and whitefish accounted for approximately 85 percent of Barrow's annual subsistence harvest in terms of edible pounds in 1989 (Table 3.4.3-6). In 1992, the total harvest of marine mammals (bowhead whales, walrus, and ringed and bearded seals) accounted for approximately 72.5 percent of the total village harvest of all species, and bowhead whales provided the single greatest contribution of food to the community (Tables 3.4.3-5 and 3.4.3-6) (Fuller and George 1999). The success of bowhead whaling in 1992 resulted in a relative decrease in the harvest of other resources such as fish. Land mammals (caribou, moose, and Dall sheep) contributed approximately 18.5 percent of the total harvest in Barrow in 1992, and caribou was the principal terrestrial resource. Nearly half (45 percent) of Barrow households participated in caribou hunting in 1992 (Fuller and George 1999). In general, caribou is one of the most consistently eaten subsistence resources in Barrow (Fuller and George 1999). In 1992, fish constituted approximately 7 percent of the total harvest in Barrow, with broad whitefish being the most important fish resource. Birds (eiders and geese) contributed less than 2 percent of the total harvest by weight; however, participation in bird hunting was high (Fuller and George 1999).

**TABLE 3.4.3.5 BARROW SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES, 1987-1992**

| | Percentage of Households | | | | | Estimated Harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Resource** | **Use** | **Try to Harvest** | **Harvest** | **Receive** | **Give** | **Number** | **Total Pounds** | **Mean HH Pounds** | **Per Capita Lbs.** | **% Total Harvest** |
| **1987** | | | | | | | | | | |
| All Resources | | | 58 | | | | 621,067 | 663 | 206 | 100 |
| Fish | | | 33 | | | 45,563 | 68,452 | 73 | 23 | 11 |
| Salmon | | | 3 | | | 196 | 1,190 | 1 | 0 | <1 |
| Non-Salmon | | | | | | 45,367 | 67,262 | 72 | 22 | 11 |
| Land Mammals | | | 30 | | | 1,893 | 213,835 | 228 | 71 | 34 |
| Large Land | | | | | | 1,660 | 213,777 | 228 | 71 | 34 |
| Small Land | | | | | | 233 | 58 | 0 | 0 | <1 |
| Marine Mammals | | | 41 | | | | 316,229 | 337 | 105 | 51 |
| Birds and Eggs | | | 36 | | | 10,579 | 22,335 | 24 | 7 | 4 |
| Vegetation | | | 3 | | | | 216 | 0 | 0 | <1 |
| **1988** | | | | | | | | | | |
| All Resources | | | 50 | | | | 614,669 | 656 | 204 | 100 |
| Fish | | | 18 | | | 38,085 | 51,062 | 54 | 17 | 8 |
| Salmon | | | 1 | | | 80 | 490 | 1 | 0 | <1 |
| Non-Salmon | | | 14 | | | 38,005 | 50,571 | 54 | 17 | 8 |
| Land Mammals | | | 27 | | | 1,751 | 207,005 | 221 | 69 | 34 |
| Large Land | | | 27 | | | 1,599 | 207,005 | 221 | 69 | 34 |
| Small Land | | | | | | 152 | 0 | 0 | 0 | <1 |
| Marine Mammals | | | 39 | | | 654 | 334,069 | 357 | 111 | 54 |
| Birds and Eggs | | | 34 | | | 9,183 | 22,364 | 24 | 7 | 4 |
| Vegetation | | | 2 | | | | 169 | 0 | 0 | 0 |
| **1989** | | | | | | | | | | |
| All Resources | | | 61 | | | | 872,092 | 931 | 289 | 100 |
| Fish | | | 29 | | | 68,287 | 118,471 | 126 | 39 | 14 |
| Salmon | | | 10 | | | 2,088 | 12,244 | 13 | 4 | 1 |
| Non-Salmon | | | 13 | | | 66,199 | 106,226 | 113 | 35 | 12 |
| Land Mammals | | | 43 | | | 1,774 | 214,683 | 229 | 71 | 25 |
| Large Land | | | 39 | | | 1,705 | 214,676 | 229 | 71 | 25 |
| Small Land | | | 2 | | | 68 | 7 | 0 | 0 | <1 |
| Marine Mammals | | | 45 | | | | 508,181 | 542 | 169 | 58 |
| Birds and Eggs | | | 41 | | | 12,869 | 29,446 | 31 | 10 | 3 |
| Vegetation | | | | | | | 1,312 | 1 | 0 | <1 |
| **1992** | | | | | | | | | | |
| All Resources | | | | | | | 1,363,736 | 1,190 | 349 | 100 |
| Fish | | | | | | | 96,003 | 84 | 25 | 7 |
| Land Mammals | | | | | | | 252,661 | 220 | 65 | 18.5 |
| Marine Mammals | | | | | | | 989348 | 863 | 253 | 72.5 |
| Birds and Eggs | | | | | | | 23,866 | 21 | 6 | 2 |
| Invertebrates | | | | | | | 694 | 1 | 0 | <1 |
| Vegetation | | | | | | | 1,164 | 1 | 0 | <1 |

Sources: SRB&A and ISER 1993 (for 1987-1989); Fuller and George 1999 (for 1992); SRB&A 2003.

## TABLE 3.4.3-6 SELECTED BARROW SUBSISTENCE HARVESTS FOR 1987, 1988, 1989, AND 1992

| Resource | Estimated Harvest | | | | |
|---|---|---|---|---|---|
| | Number | Total Pounds | Mean HH Pounds | Per Capita Pounds | % of Total Harvest |
| **1987** | | | | | |
| Caribou | 1,595 | 186,669 | 199 | 62 | 30 |
| Bowhead | 7 | 184,629 | 197 | 61 | 30 |
| Seal | 704 | 61,194 | 65 | 20 | 10 |
| Walrus | 84 | 64,663 | 69 | 21 | 10 |
| Whitefish | 27,367 | 51,253 | 55 | 17 | 8 |
| Moose | 52 | 25,786 | 28 | 9 | 4 |
| Geese | 2,873 | 12,740 | 14 | 4 | 2 |
| Grayling | 12,664 | 10,131 | 11 | 3 | 2 |
| Polar Bear | 12 | 5,744 | 6 | 2 | 1 |
| Duck | 5,252 | 7,878 | 8 | 3 | 1 |
| **1988** | | | | | |
| Bowhead | 11 | 233,313 | 249 | 77 | 38 |
| Caribou | 1,533 | 179,314 | 191 | 59 | 29 |
| Seal | 570 | 47,890 | 51 | 16 | 8 |
| Walrus | 61 | 47,215 | 50 | 16 | 8 |
| Whitefish | 20,630 | 39,766 | 42 | 13 | 6 |
| Moose | 53 | 26,367 | 28 | 9 | 4 |
| Geese | 3,334 | 14,672 | 16 | 5 | 2 |
| Polar Bear | 11 | 5,650 | 6 | 2 | 1 |
| Duck | 4,498 | 6,747 | 7 | 2 | 1 |
| Grayling | 8,684 | 6,947 | 7 | 2 | 1 |
| **1989** | | | | | |
| Bowhead | 10 | 377,647 | 403 | 125 | 43 |
| Caribou | 1,656 | 193,744 | 207 | 64 | 22 |
| Whitefish | 38,054 | 92,399 | 99 | 31 | 11 |
| Walrus | 101 | 77,987 | 83 | 26 | 9 |
| Seal | 440 | 33,077 | 35 | 11 | 4 |
| Geese | 3,944 | 16,289 | 17 | 5 | 2 |
| Moose | 40 | 20,014 | 21 | 7 | 2 |
| Polar Bear | 39 | 19,471 | 21 | 6 | 2 |
| Duck | 8,589 | 12,883 | 14 | 4 | 1 |
| Grayling | 8,393 | 6,714 | 7 | 2 | 1 |
| **1992** | | | | | |
| Bowhead | 22 | 729,952 | 637 | 187 | 54 |
| Caribou | 1,993 | 233,206 | 203 | 60 | 17 |
| Walrus | 206 | 159,236 | 139 | 41 | 12 |
| Bearded Seal | 81,471 | 463 | 71 | 21 | 6 |
| Broad Whitefish | 59,993 | 23,997 | 52 | 15 | 4 |

Source: SRB&A and ISER 1993 (for 1987-1989); Fuller and George 1999 (for 1992); SRB&A 2003

### CONTEMPORARY SUBSISTENCE USE AREAS

The community of Barrow incorporates residents from throughout the NSB. Many residents tend to hunt in the areas where they were raised, which could include the subsistence harvest areas of other communities. Barrow residents may receive subsistence foods from areas outside of Barrow. Former residents and family members who now reside in Anchorage or Fairbanks may receive subsistence foods from Barrow. Pedersen (1979) documented Barrow subsistence use areas in the 1970s (Figure 3.4.3.2-23) and SRB&A and ISER (1993) conducted a 3-year subsistence harvest study in Barrow for the 1987 to 1989 harvest years (Figure 3.4.3.2-24). With a few exceptions that are generally associated with offshore and furbearer use, the harvest locations for the 1987 to 1989 study period are located within Pedersen's (1979) Barrow lifetime community land uses area, depicted on Figure 3.4.3.2-25. The documented Barrow subsistence use area represents a large geographic area, extending from beyond Wainwright in the west to the Kuparuk River in the east and south to the Avuna River. Inland use areas go beyond the Colville River to the foothills of the Brooks Range. The Barrow subsistence harvest data from both the 1970s and 1980s show Barrow residents using the Colville River Delta area for subsistence activities.

#### CONTEMPORARY SUBSISTENCE USE AREAS EAST OF THE COMMUNITY

In August 2003, SRB&A interviewed eight subsistence harvesters in Barrow. One purpose of these interviews was to learn whether and to what extent Barrow subsistence harvesters use the Kogru and Kalikpik rivers, Fish and Judy creeks, and Colville River Delta area for subsistence activities. These interviews focused on these three areas and did not represent a comprehensive discussion of Barrow subsistence use areas. SRB&A coordinated these interviews with the ICAS, which identified Barrow subsistence users for these interviews. ICAS chose subsistence hunters who either traveled far to the east of Barrow or who had been raised east of Barrow and returned to their "homeland" for subsistence activities.

As shown on Figure 3.4.3.2-25, the area currently used by the eight interviewed hunters generally coincided with the Barrow lifetime community land uses area east and southeast of Barrow with some exceptions: the interviewed hunters generally did not utilize the formerly used area east of the Itkillik River; they traveled farther south in the vicinity of the Anaktuvuk River; and they made expanded use of the area near the Titaluk and Kigalik rivers approximately 120 miles south of Barrow.

Generally, the interviewed Barrow hunters used the area east of Cape Halkett to pursue wolf, wolverine and caribou. The winter wolf, wolverine and caribou hunting area overlapped, as hunters looking for wolf and wolverine tended to travel over great distances and also harvested caribou on their travels. In summer, the caribou use area extended down the coast from Smith Bay to Cape Halkett, across the coastal areas of Harrison Bay, to the Colville River Delta and up the Colville River as far as Ocean Point. One Barrow interviewee indicated he had hunted moose in the Colville River from south of Umiat to approximately Ocean Point. The interviewed Barrow hunters indicated that they fished as far east as the lakes in the vicinity of Cape Halkett.

Several families now living in Barrow have elders who were born and raised along the coast between Smith Bay and the Colville River Delta. These families had moved to Barrow primarily because of the requirement that children attend school, with some moving to take jobs or access medical care. Most moved to Barrow in the late 1940s. Once they resided in Barrow, each family made special efforts to return to the Smith Bay to Cape Halkett area to continue traditional subsistence activities at traditional family harvest areas. Currently, the third generation of these families continues to use the area, often harvesting resources that are not as available in the Barrow area. These include furbearers (wolf, wolverine, fox, and arctic ground squirrels), caribou, and moose. Seals and fish are harvested closer to Barrow. A Barrow hunter described a recent summer caribou hunt:

> "When the Western Arctic Herd are further west from Barrow in Point Lay or Point Hope, that's too far to travel. We had to go east through the ocean to the Cape Halkett area and go into creeks looking for caribou. On nice warm days, you find caribou on the coast and in the water, in the end of July or the first part of August. We go for one week. My uncle has a cabin near Cape Halkett." (SRB&A 2003)

Furbearer hunts are unlike subsistence food resource hunts in that they are competitive but friendly. Furs are not shared in the same way as food resources, and the hunts are conducted over much larger areas. One hunter clearly stated this, saying, in good humor, "We fish closest to our own area, we do not try to step on each others toes with fish, but we have no respect [for territory] when it comes to wolf and wolverines!" Barrow residents from the same families noted for their connections with the Cape Halkett area use a vast area to the south and east of Teshekpuk

Lake for furbearer hunting and go into the Fish and Judy creeks, Ublutuoch River, Itkillik River, and Umiat areas while looking for wolves and wolverines (Figure 3.4.3.2-25). One hunter interviewed said, “I like to go to the south side of Teshekpuk Lake, Inigok, and Umiat before the snow is too soft, to get wolves and wolverines for clothing.” Another hunter, explaining his winter hunting by snowmobile, said,

> “From February through March, I travel to the east for furbearers. I go down to Price River, then to Fish and Judy Creek, then through Inigok to the Ikpikpuk, back over to the Colville to Umiat, down through the Itkillik, back and forth in a circle, then up to Teshekpuk Lake. I go on both sides of the river. By April the fur isn’t so great, so I go home.” (SRB&A 2003)

Several Barrow families have relatives living in Nuiqsut, and people move back and forth between the two communities. Barrow residents have ancestral ties to areas between Barrow and Nuiqsut, and people continue to return to those areas for subsistence activities at traditionally used places. Barrow hunters use the Plan Area primarily for caribou, moose, and furbearers (wolf and wolverine). This area is used in both summer (boat) and winter (snowmobile).

According to the 2003 interview data (SRB&A 2003), Barrow hunters occasionally use the Kalikpik-Kogru rivers area for caribou, especially if caribou are not available closer to Barrow. The interviewed hunters traveled by boat as far as the Kogru River. It is likely that other Barrow hunters travel further east. This area is both an historic and current use area for several Barrow families. The Colville River Delta is on the eastern edge of use area. Barrow residents make use of the Fish and Judy creeks area for caribou, wolf, wolverine, and fox. Access to this area is primarily by snowmobile in winter. Hunters use cabins and camps near Teshekpuk Lake and along the Ikpikpuk and Chipp rivers as bases for snowmobile travel.

In addition to the harvest of resources, use of these areas is important to Barrow residents for maintaining connection to family history, graves, structures, caches, ice cellars, campsites and traditional harvest areas. Although there are high costs in fuel, time, equipment, and effort for these trips, the cultural connection to these traditional areas is strong.

## ATQASUK SUBSISTENCE ACTIVITIES

The village of Atqasuk is situated on the banks of the Meade River, 60 air miles south of Barrow. Near the site of several former settlements used in prehistoric and historic times, the current village is situated near a coal mine that provided fuel for Barrow during and after World War II, when the village was known as Meade River. The area is rich in caribou, fish, and waterfowl, and hunters access areas of the coast for seals and other marine resources. Some Atqasuk hunters are members of Barrow and Wainwright whaling crews and take part in bowhead whaling and festivities, returning with shares after a successful harvest.

### CONTEMPORARY SEASONAL ROUND

Atqasuk subsistence harvests rely on a diversity of seasonally abundant resources that hunters must harvest when available. Some species, like ptarmigan, could be present year-round, but are only harvested when encountered. December and January are often not productive months for subsistence resource pursuits because of the winter weather and seasonal darkness. Between February and April, fur trappers travel along trapline routes to harvest wolves, foxes, and wolverines. In late February and through March, some residents begin fishing under the ice on the Meade River, its tributaries, and any lakes that do not freeze completely. Hunters may harvest caribou if they are encountered at this time, and the need to harvest more caribou could increase through March as late fall supplies are depleted. The harvest of caribou increases as daylight increases and the weather becomes increasingly moderate. Some residents may travel to Barrow or Wainwright to participate in spring whaling. Beginning in May, hunters pursue migrating birds and caribou. The break-up of river ice and lack of snow in June make travel difficult. After the ice goes out, gill-netters harvest fish near the community as the fish move upriver to spawn. The high water on the rivers and lakes of the area in late spring and early summer allows the most extensive boat travel. Later in the summer, the water levels could be too low to allow long-range travel, so community residents plan their travels for late June through July. Subsistence resources are particularly abundant from July through September. Hunters harvest caribou, grizzly bears, moose, squirrels, and migratory birds throughout the summer. By October, migratory birds have left the area, and hunters shift their focus to caribou and fish. In November, hunters attempt to harvest enough caribou for the upcoming winter, and fish have left most of the lakes for the deep river channels to overwinter. Table 3.4.3-7 depicts the annual cycle of subsistence activities at Atqasuk.

**TABLE 3.4.3-7 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – ATQASUK**

| | Winter | | | | | Spring | | Summer | | | Fall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** |
| Fish | ▒ | | | | | | | ▒ | █ | █ | █ | █ |
| Birds/Eggs | ▒ | ▒ | ▒ | ▒ | ▒ | █ | █ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Berries | | | | | | | ▒ | ▒ | ▒ | ▒ | | |
| Moose | | | | | | | ▒ | █ | █ | █ | ▒ | |
| Caribou | █ | ▒ | ▒ | █ | █ | █ | █ | ▒ | ▒ | █ | █ | █ |
| Furbearers | ▒ | ▒ | █ | █ | █ | ▒ | | | | | | |

Source: Schneider et al. 1980; SRB&A 2003.
Notes:

| | |
|---|---|
| | No to Very Low Levels of Subsistence Activity |
| ▒ | Low to Medium Levels of Subsistence Activity |
| █ | High Levels of Subsistence Activity |

### SUBSISTENCE HARVESTS

Atqasuk is similar to Nuiqsut in that residents harvest caribou, fish, and birds locally; however, Atqasuk is more connected to Barrow and Wainwright for marine mammal harvests and membership in whaling crews (Hepa et al. 1997). Limited subsistence harvest data are available for Atqasuk (Tables 3.4.3-7 through 3.4.3-9). Neither the ADF&G nor the MMS have reported these data, and the NSB Department of Wildlife Management has reported only harvest data for one harvest year (1994 to 1995) (Hepa et al. 1997) and only participation data for 1992 (Fuller and George 1999). The NSB has collected 3 years of additional harvest data for Atqasuk that have not been published to date. A final report is expected by the spring of 2005. For 1994 to 1995, 57 percent of the harvest by edible pounds consisted of caribou, with 37 percent fish, 3 percent birds, 2 percent marine mammals, and 1 percent plants. Atqasuk residents harvested caribou primarily within 10 miles of Atqasuk, with the majority harvested between July and December (Hepa et al. 1997, Figures 6 and 8, Appendix 7). Residents harvested fish between June and November, with the greatest number of fish harvested between August and October (Hepa et al. 1997). Subsistence hunters at Atqasuk harvested 279 birds in May, 8 seals in July, and 84 gallons of berries between July and September (Hepa et al. 1997) (Table 3.4.3-8). Other subsistence foods could be received as shares, traded, or bartered within the community and with other villages (Hepa et al. 1997). In 1994 to 1995, 91 percent of Atqasuk households shared their harvested resources (Table 3.4.3-9). Between October and May, hunters of furbearers harvested 2 wolves, 10 wolverines, and 6 ground squirrels (Hepa et al. 1997).

Most Atqasuk residents participated in subsistence activities and shared subsistence resource harvests. Of the interviewed households in 1994 to 1995, 77 percent of residents attempted and/or succeeded in harvesting subsistence resources (Hepa et al. 1997). Fuller and George (1999) report similar participation rate information for the 1992 harvest year. Of those successfully harvesting subsistence resources in 1994 to 1995, 91 percent shared their resources with others and four percent did not. It was not known if the remaining 5 percent of Atqasuk households shared subsistence resources (Hepa et al. 1997).

**TABLE 3.4.3-8 ATQASUK SUBSISTENCE HARVEST TOTALS, ACTUAL AND ESTIMATED FOR 1994-1995**

| Harvest Items | Total Number Harvested for 40 Households | Estimated Total Number Harvested for 56 Households |
|---|---|---|
| Whitefish | 1,400 | 1,960 |
| Broad Whitefish | 1,630 | 2,282 |
| Burbot | 162 | 227 |
| Grayling | 5,716 | 8,002 |
| Humpback Whitefish | 500 | 700 |
| Rainbow Trout | 15 | 21 |
| Silver Salmon | 10 | 14 |
| Salmonberries (Gal) | 72 | 101 |
| Blueberries (Gal) | 12 | 17 |
| White Fronted Goose | 76 | 106 |
| Goose Unidentified | 168 | 235 |
| Canada Goose | 2 | 3 |
| Brant | 5 | 7 |
| Eider Unidentified | 12 | 17 |
| Ptarmigan | 16 | 22 |
| Caribou | 187 | 262 |
| Ground Squirrel | 6 | 8 |
| Wolf | 2 | 3 |
| Wolverine | 10 | 14 |
| Ringed Seal | 4 | 6 |
| Bearded Seal | 4 | 6 |

Sources: Hepa et al. 1997; SRB&A 2003.

**TABLE 3.4.3-9 ATQASUK SUBSISTENCE HARVESTS PARTICIPATION FOR 1994-1995**

| Harvest Participation | | Harvest Instances Resulting in Sharing | |
|---|---|---|---|
| Successful Harvest | 74% | Shared | 91% |
| Attempted, not Successful | 3% | Did Not Share | 4% |
| Did not attempt | 23% | Unknown | 5% |

Sources: Hepa et al. 1997; SRB&A 2003.

### CONTEMPORARY SUBSISTENCE USE AREAS

Subsistence hunters at Atqasuk use harvest locations relatively close to the village, with some use of the coast west of Barrow and of Dease Inlet (Hepa, Brower, and Bates 1997: Appendix 7; Schneider, Pederson, and Libbey 1980). The main advantages of Atqasuk's location are access to riverine and lacustrine resources, and position in the migration path of the Teshekpuk caribou herd (Schneider, Pederson, and Libbey 1980: 78-80). Based on Pedersen (1979), Atqasuk's 1970s subsistence use area is shown on Figure 3.4.3.2-26 and extends from northeast of Wainwright to Barrow, along the coast to the vicinity of Smith Bay, south along the Ikpikpuk River to the Titaluk River, and west and north to Peard Bay.

### ATQASUK SUBSISTENCE USE AREAS EAST OF THE COMMUNITY

In August 2003, SRB&A interviewed seven subsistence harvesters in Atqasuk. One of the purposes of these interviews was to learn if Atqasuk residents currently used the Kogru and Kalikpik rivers, Fish and Judy creeks, or Colville River Delta for subsistence activities. SRB&A coordinated the interviews with the ICAS, which identified knowledgeable Atqasuk subsistence users for these interviews. The interviews focused on areas east of Atqasuk and did not specifically address current subsistence uses north, south, or west of Atqasuk.

Based on SRB&A interviews of subsistence users in Atqasuk, the recent (last 10 years) use area has expanded as compared to the use area depicted by Pedersen (1979) and extends from the eastern edge of Teshekpuk Lake in the east to the Kaolak River in the west, the Inaru River in the north, and beyond the Colville River in the south (Figure 3.4.3.2-27). Several Atqasuk residents have ties to the Smith Bay-Cape Halkett–Kogru River areas, and some of these residents intensively used the area north and southeast of Teshekpuk Lake in their youth. One hunter stated that there were "numerous small camps and villages along the coast between Drew Point, Smith Bay, and Dease Inlet. It was a [caribou] grazing area." He explained that there were a lot of ice cellars at spot between Ikpikpuk River and Teshekpuk Lake at a spot named Shubjat. Several families had ice cellars in this area because it was high, dry ground and away from the coast where polar bears, with their keen sense of smell, would dig up the coastal ice cellars (SRB&A 2003).

Based on the 2003 interviews, Atqasuk hunters traveled east as far as Fish and Judy creeks (Figure 3.4.3.2-27). Resources sought in the eastern portion of the current Atqasuk use area include fish in the Ikpikpuk River and lakes west of Teshekpuk Lake, in the winter, and winter wolf, wolverine, and caribou. The harvest of caribou in this eastern area is incidental to the pursuit of wolves and wolverines. This pursuit of wolf and wolverine with incidental caribou harvests takes Atqasuk hunters far from the community on several extended trips each winter. During the summer and fall, subsistence use areas for caribou, fish, berries, and waterfowl are primarily centered around Atqasuk, generally within 50 miles of the community. The harvest of resources near Atqasuk, both in the summer and winter, consists of day trips involving snowmobiles, all-terrain vehicles, and boats, dependent on season. However, one subsistence user who was interviewed said he would go to one harvest area for a week, and then he would go home for a week or two, gas up and go to another harvest area.

It is not uncommon for winter hunters on snowmobiles to encounter hunters from other communities. At these junctures, the hunting area of one community overlaps with the hunting area from another community. One Atqasuk hunter who took several long winter hunting trips said that he does not go to the area above Umiat. He stated that he leaves "that country to those guys in Nuiqsut. They come up and hunt all over that area in moose season." (SRB&A 2003) The limited Atqasuk interviews indicated that Atqasuk hunters do not hunt currently in the Nuiqsut or Colville River areas but only travel to Nuiqsut for special occasions, such as funerals, and do not use that area for subsistence purposes.

Atqasuk residents harvest most resources near their community. Furbearer hunters travel the furthest from Atqasuk and also harvest incidental caribou during these trips. Atqasuk hunters encounter furbearer and caribou hunters from other communities on these extensive travels. The area of the Kalikpik and Kogru rivers is occasionally used by Atqasuk hunters traveling by snowmobile primarily in search of wolf and wolverine in winter. The area is "homeland" for several Atqasuk families, and in the past they traveled by boat and harvested caribou, birds, and fish in this area. According to the interviews, Atqasuk residents make little use of the Colville River Delta. Atqasuk hunters occasionally use the Fish and Judy creeks area primarily for wolf and wolverine hunting in winter. Caribou could be taken incidental to furbearer hunting. Hunters make use of camps and cabins belonging to hunters, often relatives, from other communities to support their hunting trips.

## ANAKTUVUK PASS

Anaktuvuk Pass is just south of the continental divide in a low pass connecting the drainages of the Anaktuvuk and John rivers, 60 miles west of the Dalton Highway. The area has been used by the interior Inupiat people called the Nunamiut for at least 500 years and by Inupiat predecessor groups for at least 4,000 years. The modern village began in 1949 with the establishment of a trading post, followed by a post office in 1951 and a church in 1958.

Residents incorporated as a fourth class city in 1959. A permanent school was established in 1961, and the community was reclassified as a second-class city in 1971 (Hall, Gerlach, and Blackman 1985).

The Nunamiut people of Anaktuvuk Pass are among the few in the NSB without direct access to marine mammals. As a consequence, the Inupiat of this village rely heavily on terrestrial mammals and fish for subsistence. Caribou is the main terrestrial mammal resource, with moose and Dall sheep also important species for hunters. Freshwater fish from area lakes and streams are an important supplement to terrestrial mammals. Terrestrial resources are often bartered with other communities, particularly Nuiqsut and Barrow, for marine resources (Brower and Opie 1996, Fuller and George 1999).

Hall, Gerlach, and Blackman (1985) have divided the history of the people of Anaktuvuk Pass into seven periods: prehistoric (before 1860), protohistoric (1860-1890), pre-removal historic (1890-1920), the coastal hiatus (1920-1934), the return (1934-1949), settlement (1949-1960) and mechanization (1960-1984). This structuring of events revolves around the arrival of Euro-Americans, the historic depopulation of the Brooks Range and interior in response to environmental and historical events, and the resettlement of those areas.

Euro-American contact beginning in the nineteenth century and the cyclical nature of the environment (e.g. fluctuations in caribou herds) worked together to change the Nunamiut way of life from the protohistoric through the coastal hiatus periods. A caribou population crash and the advent of commercial whaling in the latter half of the nineteenth century; sustained contact with Euro-Americans; the introduction of new technology (such as rifles), trade goods (flour, tea, sugar, coffee), and diseases, and the integration of Inupiat people into the world economic system (commercial whaling and later fur trapping) all had effects on the Inupiat of the interior. The result of these changes was that many were drawn to the coast through the Colville River area. Many Nunamiut dispersed along the coast to participate in commercial whaling and fur trapping, and to access the greater abundance and diversity of subsistence and imported resources in the coastal areas. Others moved towards Fort Yukon and the Mackenzie River area, where the porcupine herd was more numerous than the western arctic caribou herd (Hall, Gerlach, and Blackman 1985).

Following the decline of commercial whaling that ended by 1910, falling fur prices in the 1930s, and the steady rebound in western arctic caribou populations, Inupiat people returned to the Brooks Range in the late 1930s. Many followed the Colville River back to Anaktuvuk Pass, a location preferred by Nunamiut people for its ready access to caribou, moose, Dall sheep, and fish. A trading post was built in Anaktuvuk Pass, and then a school, which became the nucleus of a community that drew in Nunamiut people from several communities in the Brooks Range. The maintenance of the subsistence way of life from a sedentary village was partially facilitated by the use of a variety of all terrain vehicles to replace pack dogs. These all terrain vehicles include snowmobiles, four-, six-, and eight-wheeled vehicles, and tracked vehicles (Hall, Gerlach, and Blackman 1985).

#### CONTEMPORARY SEASONAL ROUND

Caribou hunting is the mainstay of the Nunamiut subsistence hunt, and caribou are hunted year-round as needed, but in particular August through November. The caribou migrate through the Anaktuvuk Pass area twice a year, in the spring and fall, but the number and timing of the caribou migrating through the area vary from year to year. The 1994 to 1995 harvest year was one such anomalous yearwhen the migrations were small and the summer availability was high—a time when the caribou are normally out on the coastal plain for insect relief (Brower and Opie 1996). Dall sheep, brown bear, and moose are hunted in August, September, and October some distance from the village, with Dall sheep the main target and the others secondary (Brower and Opie 1996). Birds and fish are supplementary to terrestrial mammals, but are harvested when available and are more important if caribou numbers are low (Brower and Opie 1996). Berries are seasonally important, with salmonberries and blueberries providing the majority of vegetable foods (Brower and Opie 1996). Table 3.4.3-10 depicts the annual cycle of subsistence activities at Anakluvuk Pass.

**TABLE 3.4.3-10 ANNUAL CYCLE OF SUBSISTENCE ACTIVITIES – ANAKTUVUK PASS**

| | Winter | | | | | Spring | | Summer | | | Fall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct |
| Caribou | ░ | ░ | | | ░ | ░ | ░ | ░ | █ | █ | ░ | ░ |
| Sheep | | | | | | | | | | █ | ░ | |
| Moose | | | | | | | | | | █ | | |
| Ptarmigan | ░ | | | █ | █ | █ | | | | | | |
| Furbearers | | ░ | ░ | █ | █ | | | | | | | |
| Fish | | | | | | ░ | ░ | ░ | █ | █ | ░ | |
| Berries | | | | | | | | | | █ | | |

Source: Brower and Opie 1996; SRB&A 2003a.
Notes:

| | |
|---|---|
| | No to Very Low Levels of Subsistence Activity |
| ░ | Low to Medium Levels of Subsistence Activity |
| █ | High Levels of Subsistence Activity |

**SUBSISTENCE HARVESTS**

As mentioned previously, Anaktuvuk Pass is unlike the other NSB communities in that resource users there have no direct access to the marine mammal resource that in many ways defines the Inupiat of the coast. The data below indicate that terrestrial mammals are the most important resource, with nearly three-fourths of the community participating in the harvest of land mammals, which compose 88 to 95 percent of the harvest (Table 3.4.3-11) Caribou are the main terrestrial mammal species harvested, with moose and sheep also harvested in small numbers (Table 3.4.3-12). Fish are a smaller component of the subsistence diet by weight but are an important food source. Fish species harvested include grayling, arctic char, lake trout, burbot, and pike. Birds harvested during the brief migration include a variety of geese and ducks. Preferred species are white-fronted and Canada geese and several species of small ducks such as pintails. Vegetation harvested includes berries and *masu*, or "Eskimo potatoes." (SRB&A 2003)

**TABLE 3.4.3-11 ANAKTUVUK PASS SUBSISTENCE HARVESTS AND SUBSISTENCE ACTIVITIES**

| Resource | Percentage of Households | | | | | Estimated Harvest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Use | Try to Harvest | Harvest | Receive | Give | Number | Total Pounds | Mean HH Pounds | Per Capita Pounds | % Total Harvest |
| **1992** | | | | | | | | | | |
| All resources | | | | | | | 85,040 | 1,076 | 315 | 100 |
| Fish | | 67 | | | | 4,892 | 6,897 | 87 | 26 | 8 |
| Land mammals | | 74 | | | | 771 | 74,412 | 942 | 276 | 88 |
| Marine mammals | | 1 | | | | 0 | 0 | 0 | 0 | 0 |
| Birds/eggs | | 21 | | | | 733 | 913 | 12 | 3 | 1 |
| Vegetation | | 68 | | | | 607 | 2,818 | 36 | 10 | 3 |
| **1994-1995** | | | | | | | | | | |
| All resources | | 62 | 61 | | 75 | | | | | 100 |
| Fish | | | | | | 1,282 | | | | 4 |
| Land mammals | | | | | | 424 | | | | 95 |
| Marine mammals | | | | | | 0 | | | | 0 |
| Birds/eggs | | | | | | 196 | | | | >1 |
| Vegetation | | | | | | 21 | | | | >1 |

Source: Brower and Opie 1996; Fuller and George 1999; SRB&A 2003

**TABLE 3.4.3-12 SELECTED ANAKTUVUK PASS SUBSISTENCE HARVESTS**

| Study Year | Resource | Estimated Harvest | | | | |
|---|---|---|---|---|---|---|
| | | Number | Total Pounds | Mean HH Pounds | Per Capita Pounds | % Total Harvest |
| 1990[a] | Caribou | 592 | 69,964 | 985 | 223 | |
| 1991[a] | Caribou | 545 | 66,712 | 940 | 245 | |
| 1992[a] | Caribou | 600 | 70,222 | 889 | 260 | 83 |
| | Dall sheep | 32 | 3,168 | 40 | 12 | 4 |
| | Grayling | 3709 | 2,967 | 38 | 11 | 4 |
| | Lake trout | 531 | 2,124 | 27 | 8 | 3 |
| | Arctic char | 640 | 1,791 | 23 | 7 | 2 |
| 1993 | Caribou | 574 | 67,713 | 846 | 219 | |
| 1994-1995 | Caribou | 322 | | | | 83 |
| | Dall sheep | 27 | | | | 13 |
| | Grayling | 931 | | | | 1 |
| | Lake trout | 80 | | | | 1 |
| | Arctic char | 215 | | | | 1 |

Source: ADF&G, 2001; Brower and Opie 1996; Fuller and George 1999; SRB&A 2003
Note: [a] ADF&G surveys for 1990, 1991, and 1993 were confined to caribou.

### SUBSISTENCE USE AREAS

Anaktuvuk Pass hunters rely heavily on terrestrial mammals and to a lesser extent on fish. One of the important factors contributing to the resettlement of the area was the seasonal migration of caribou through the pass. A formerly used harvest strategy was herding small groups of the migrating caribou into lakes, streams, or valleys to limit their mobility and then harvesting and processing the caribou in a cooperative group undertaking (Spearman 1979). While waiting for the caribou to be herded through these areas, members of the group would fish in the streams and lakes. Anaktuvuk Pass hunters bartered furs and dried caribou for other resources, such as marine mammal fats and hides, with coastal people at trade fairs in the Colville River Delta, Barrow, and Barter Island. Anaktuvuk Pass people trade subsistence resources and access to traditional subsistence use areas with Nuiqsut people in much the same manner as they did during traditional times, only now they use contemporary transportation (Ahtuangaruak 2001 [Liberty scoping]; Hall, Gerlach, and Blackman 1985; Spearman 1984).

Harvest areas indicated in the most recent data from the NSB emphasize use areas within approximately 20 miles of Anaktuvuk Pass, with most trips taken in the immediate vicinity of the community (Brower and Opie 1996). Lifetime subsistence use areas (as depicted in Hall, Gerlach, and Blackman 1985) encompass the entire NSB from Aklavik, Canada, to Kivalina and Kotzebue Sound, and north to Point Barrow and Wainwright. Some traveled to Fort Yukon, Wiseman, and Old Crow trapping and working seasonal jobs (Brower and Opie 1996). Travel corridors and trapping areas included the Sagavanirktok and Colville rivers and the coast between the Colville River Delta and Demarcation Point (Hall, Gerlach, and Blackman 1985, Volume II).

In August 2003, SRB&A interviewed 12 subsistence harvesters in Anaktuvuk Pass. One purpose of these interviews was to learn if Anaktuvuk Pass residents used the Colville River Delta area for subsistence activities. SRB&A coordinated with the City of Anaktuvuk Pass, which identified knowledgeable Anaktuvuk Pass subsistence users for these interviews.

Resource users interviewed by SRB&A in Anaktuvuk Pass used the valleys and slopes of the Brooks Range Mountains between the Killik River valley and Itkillik Lake, with some resource users having gone farther east and west on occasion. Most resource users did not go farther south than the Alatna, Hunt Fork, and North Fork Rivers, although some had made trips to Bettles in the past. North of the Brooks Range, resource users traveled by snowmobile and all-terrain vehicle along the front slope of the mountains east to Itkillik Lake, west to Chandler

River, north to Rooftop Ridge, and parallel the Colville River past Umiat to the Chandler and Killik rivers, then headed back south into the mountains. Periodic trips to Nuiqsut were made along the east or west side of the Anaktuvuk River almost to its confluence with the Colville, then headed east towards the Kuparuk hills, and north to Nuiqsut along the cat trail that roughly parallels the Itkillik River (Figure 3.4.3.2-28).

### CONTEMPORARY CONNECTIONS TO NUIQSUT, THE COLVILLE RIVER AREA, AND THE BEAUFORT SEA COAST

Anaktuvuk Pass residents have numerous connections to Nuiqsut, the Colville River area, and the Beaufort Sea. These connections include relatives who live in Nuiqsut, persons or persons with relatives who were born and raised along the Colville and now reside in Anaktuvuk Pass, hunting for caribou in the Nuiqsut area during times of scarcity at Anaktuvuk Pass, hunting for wolf and wolverine during trips to Nuiqsut, trading and exchanging with coastal residents, and attending funerals.

Many residents have relatives and friends residing in Nuiqsut, Kaktovik, and Barrow, as well as other North Slope communities. Some Anaktuvuk Pass residents moved into the community at different ages and maintained connections to the communities they came from, including Fort Yukon, Shungnak, Barrow, and Fairbanks. Others grew up or had relatives who grew up along the Colville River and the Beaufort Sea coast and moved to Anaktuvuk Pass after the community was established. Two lifetime Anaktuvuk Pass residents described their several trips to Nuiqsut in the 1970s. They said they mostly went to Nuiqsut for funerals. One of these persons stated, “Our fathers grew up in the flat country, we didn’t, but our fathers did. They could travel anytime, even at night and never get lost. We never grew up in the flats; we are mountain men.” (SRB&A 2003)

Coastal residents trade food, furs, and other goods with Anaktuvuk Pass residents in exchange for dry meat and other Nunamiut specialties. Some Anaktuvuk Pass residents receive marine mammal products from friends and relatives in coastal communities as “care packages.” (SRB&A 2003) Anaktuvuk Pass ties to the coast were particularly evident with one harvester who was born in Barrow and had lived the last 30 years in Anaktuvuk Pass. This person said, “I eat both foods: coastal (seal oil, seal, walrus, white fish) and Nunamiut/inland food (caribou, moose, freshwater fish [grayling, char, lake trout, ling cod], edible plants, and berries.” (SRB&A 2003)

Periodic shortages of caribou and other game have made living inland a difficult proposition for Inupiat people for centuries and required them to follow the caribou migration year-round. In the late 1940s, the Nunamiut settled into Anaktuvuk Pass from Chandler Lake, Killik River, and Tuluġaq Lake partially in response to the requirement for children to attend school. A result of sedentary life was the increased difficulty resource users experienced in harvesting adequate amounts of subsistence foods, even with modern transportation and other equipment. An added complication was the establishment of the Gates of the Arctic National Park and Preserve, which has restricted the use of certain all-terrain vehicles (such as Argos and four-wheelers) at certain times of the year (snow-free). This has restricted Nunamiut from accessing subsistence areas in snow-free months that they formerly occupied and used (SRB&A 2003).

Several times in the 1970s and 1980s, and as recently as 1994 and 1998, Anaktuvuk Pass residents found it necessary to travel great distances to procure enough caribou to feed their community. The NSB has paid for some trips, using charters and float planes to fly hunters from Anaktuvuk Pass to places like Umiat and Schrader Lake (located approximately 60 miles southwest of Kaktovik) (SRB&A 2003). More recently, hunters have traveled to Nuiqsut to harvest caribou for Anaktuvuk Pass (Figure 3.4.3.2-28), and on other occasions Nuiqsut hunters have provided caribou, fish, and other coastal foods during lean times. Anaktuvuk Pass resource users reciprocate with gifts of dry meat and other Nunamiut specialties.

A lifetime Anaktuvuk Pass hunter, describing his winter trail to Nuiqsut, indicated he traveled in February or March and hunted as he traveled. He said that he generally hunted along the trail and did not go back and forth hunting off the trail, but used his binoculars to look out to the sides of the trail for game. He said he went to Nuiqsut once or twice a year and indicated that he did not do any fishing on the way to Nuiqsut; just wolf and wolverine hunting. He said his trips had a dual purpose: to hunt and to visit relatives that include cousins, aunts, and uncles in Nuiqsut. He generally stayed in Nuiqsut less than a week. He said that he put 6,000 miles on his snowmobile in six months.

Another Anaktuvuk Pass hunter harvested 15 to 20 caribou on a trip to Nuiqsut in 1998. He indicated that he harvested considerable caribou each year and said, "I hunt mostly in the winter time; it is easier. That is when the caribou are pretty fat. I hunt mostly in winter when there is snow on the ground; you can go further. The summer time you cannot go too much unless you have a good Argo. My dad has one." He said that he received marine mammals from Nuiqsut and Barrow when they send them up. He stated, "Also from Wainwright when they catch a whale; they send some in a box." (SRB&A 2003)

There is competition between hunters and communities in the pursuit of wolves, wolverines, and foxes. Several Anaktuvuk Pass hunters have traveled north to Nuiqsut, and along the route they hunt wolf, wolverine, and caribou. One hunter said, "I hunted everything on my trip to Nuiqsut." This hunter described the trip to Nuiqsut as "one camp" away. In other words, he left Anaktuvuk Pass, made camp for one night, and went to Nuiqsut the next day. He said, "It is not that far." Other hunters remarked similarly on the route, noting important landmarks and features along the way. One hunter had harvested wolf and wolverine near Ocean Point in 1998. While residents of several communities encounter each other while hunting furbearers, it was often noted that "it is better for them to see your tracks than for you to see theirs," as often the tracks of other hunters was a sign that the animal being sought had already been taken or run off by the other hunter (SRB&A 2003).

In summary, Anaktuvuk Pass residents have hunted caribou, wolf, and wolverine along their winter travel routes north from near the confluence of the Anaktuvuk and Colville rivers all the way to Nuiqsut (Figure 3.4.3.2-28). In summer, Anaktuvuk Pass residents have hunted for caribou along the Colville River, past Ocean Point, and down the Nigliq Channel to the Beaufort Sea. They have also hunted summer caribou down the main channel of the Colville River to Anajuk Point. They have fished in the main channel of the Colville near Itkillikpaat (Figure 3.4.3.2-28).

### 3.4.4 Environmental Justice

Environmental Justice (EJ) refers to the considerations mandated by Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-income Populations. The Executive Order requires analysis to identify communities characterized by minority and low-income populations that could be subject to disproportionate human health or environmental effects of a proposed federal action, which in this case is approval of the development of the ASDP. Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut are North Slope communities that are in proximity to and could be affected by the proposed ASDP.

To determine if the population of these communities would be characterized as minority and low-income populations, the USEPA has defined guidelines for comparing socioeconomic characteristics of the potentially affected communities to a reference population. If the local potentially affected communities have minority or low-income characteristics that are higher than the reference population, then they are further evaluated to determine if potential impacts of the proposed project are disproportionately borne by these same local communities (or populations). Because there are no other larger population centers on the North Slope to serve as a reference population, State of Alaska average socioeconomic characteristics were selected as the reasonable reference population.

The USEPA guidelines suggest that if a community exhibits ethnic or economic characteristics that are a minimum of 1.2 times the state average for these same characteristics, that the community or local population is considered an EJ population (EPA 1998). The ethnic composition of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut are shown in Table 3.4.4-1. This table shows that all four communities would be classed as minority communities on the basis of their proportional American Indian and Alaska Native membership. The statewide population is 15.4 percent American Indian and Alaska Native. The communities considered range from 56 percent in Barrow to 94 percent in Atqasuk, or from approximately 4 to 6 times greater minority composition than the State of Alaska as a whole. This ratio is considerably greater than the minimum guideline of 1.2 suggested by the USEPA. On the basis of the much higher percentage of minority composition in the communities of Anaktuvuk Pass, Atqasuk, Barrow, and Nuiqsut than in the state as a whole, an evaluation of disproportionate impacts of the ASDP is required.

**TABLE 3.4.4-1 ETHNIC COMPOSITION OF ANAKTUVUK PASS, ATQASUK, BARROW, AND NUIQSUT IN 2000 – PERCENT BY RACE**

| | State of Alaska | | Anaktuvuk Pass | | Atqasuk | | Barrow | | Nuiqsut | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Population | Percent | Population | Percent | Population | Percent | Population | Percent | Population | Percent |
| Total | 626,932 | 100.0% | 282 | 100.0% | 228 | 100.0% | 4,581 | 100.0% | 433 | 100.0% |
| Hispanic or Latino | 25,852 | 4.1% | 2 | 0.7% | 0 | 0.0% | 153 | 3.3% | 1 | 0.2% |
| Not Hispanic or Latino: | 601,080 | 95.9% | 280 | 99.3% | 228 | 100.0% | 4,428 | 96.7% | 432 | 99.8% |
| Population of one race: | 570,626 | 91.0% | 280 | 99.3% | 227 | 99.6% | 4,063 | 88.7% | 429 | 99.1% |
| White | 423,788 | 67.6% | 27 | 9.6% | 11 | 4.8% | 972 | 21.2% | 44 | 10.2% |
| Black or African-American | 21,073 | 3.4% | 4 | 1.4% | 0 | 0.0% | 44 | 1.0% | 1 | 0.2% |
| American Indian or Alaska Native | 96,505 | 15.4% | 247 | 87.6% | 215 | 94.3% | 2,558 | 55.8% | 382 | 88.2% |
| Asian | 24,741 | 3.9% | 0 | 0.0% | 1 | 0.4% | 429 | 9.4% | 2 | 0.5% |
| Native Hawaiian and Pacific Islander | 3,181 | 0.5% | 0 | 0.0% | 0 | 0.0% | 59 | 1.3% | 0 | 0.0% |
| Some other race | 1,388 | 0.2% | 2 | 0.7% | 0 | 0.0% | 1 | 0.0% | 0 | 0.0% |
| Two or more races | 30,454 | 4.9% | 2 | 0.7% | 1 | 0.4% | 365 | 8.0% | 3 | 0.7% |

Source: ADOL 2000, Census Table SF-1.

## 3.4.5 Cultural Resources

### 3.4.5.1 Introduction

This section discusses cultural resources of the Arctic Coastal Plain, with particular emphasis on the Colville River Delta and the eastern National Petroleum Reserve-Alaska area. Cultural resources include sites and materials of prehistoric Native American, historic European and Euro-American, and historic Inupiat origin (for example, traditional cabin sites, camp sites, and burial grounds). The Cultural Resources section also includes a discussion of cultural resources of the Arctic Coast including traditional subsistence harvest sites and other traditional land uses areas, landscapes, symbols, and place names. This section also discusses continued access to archaeological and historical sites.

This analysis relies on the following sources:

- Alaska Heritage Resource Survey (AHRS) files located at the Office of History and Archaeology
- The NSB's TLUI (NSB 1980)
- An assessment of literature pertaining to cultural resources in the proposed project area

The discussion of prehistoric and historic resources in the Plan Area will be divided into three facility group areas that include (1) the Colville River Delta Facility Group including Nuiqsut; (2) the Fish-Judy Creeks Facility Group, which includes Fish and Judy creeks and the National Petroleum Reserve-Alaska planning area to the south and southeast of these creeks; and (3) the Kalikpik-Kogru Rivers Facility Group, which encompasses the west and northwest area of the northeast portion of the National Petroleum Reserve-Alaska planning area.

The analysis of cultural resources is based on the following:

- Cultural resources are generally assumed to be eligible or potentially eligible for the National Register of Historic Places (NRHP) unless stated otherwise.
- Information for this section relies on available information from existing literature and database resources and inventories.
- From a regulatory perspective, "historic properties" meet the criteria for inclusion in the NRHP by the National Historic Preservation Act (NHPA). Many sites meet the broader definition of "cultural resources," such as AHRS and TLUI sites, which individually would or would not be NRHP-eligible or listed but are nevertheless of cultural importance.

### 3.4.5.2 Cultural Resources Environment

Knowledge of northern human inhabitants has been recorded for approximately 150 years, and attempts at understanding cultural history of the area began in earnest at the turn of the twentieth century (Lobdell and Lobdell 2000). The Arctic Coastal Plain and the Beaufort Sea coastline have been the subjects of intensive archaeological investigations since 1979. During this time, it has been noted that interior portions of the Arctic Coastal Plain are relatively stable; however, the Beaufort Sea coastline has been subject to fairly rapid change, with an average of 3 m per year succumbing to erosion (Lobdell and Lobdell 2000). In the interior portions of the Arctic Coastal Plain, landforms that could encourage human habitation have yielded evidence of prehistoric and historic occupation. These landforms include pingos, south-facing bluff overlooks above narrow valleys or canyons adjacent to major river systems, and wet or moist meadow tundra (Lobdell and Lobdell 2000). Riverine and stream localities with pronounced banks and terraces and lakeshores of especially large lakes (such as Teshekpuk Lake) or lakes with well-developed basin ridges have proven to be places of past human use (Lobdell and Lobdell 2000).

## PREHISTORIC ENVIRONMENT (BEFORE 11,000 YEARS AGO TO AD 1827)

Beginning approximately 12,500 years ago, a warming period brought increased moisture, vegetation, and dune stabilization to the North Slope. During this time, cottonwood trees and shrub tundra vegetation expanded beyond their modern limits. This warm period was interrupted approximately 11,000 years ago by a return to ice-age conditions. This period, termed the Younger Dryas interval, is marked in arctic Alaska by the reactivation of the dune fields, a retraction of cottonwood trees, and a lowering of lake levels. Vegetation was likely cold steppe, and the climate was colder and drier than current conditions. Large mammals that are now extinct in the area (mammoth, horse, bison, lion) dominated the landscape. By 10,000 years ago, the climate began to return to that of before the Younger Dryas interval. The large mammals that had dominated the landscape became extinct, lake levels rose, the ranges of peat and vegetation such as cottonwood expanded, and numerous thaw-lakes developed. By 8,500 years ago, the dune fields were stable and poorly drained, and peaty modern soils were established (Mann et al. 2002, in Reanier 2002).

## OVERVIEW OF REGIONAL PREHISTORY

Human prehistory on the north coast of Alaska is represented by isolated localities along the coast of the Beaufort Sea from Point Barrow to the Canadian border near Demarcation Point. The oldest archaeological site that has been documented near the project area was discovered on a pingo frost feature southwest of Deadhorse, Alaska. This archaeological site is associated with the Northern Archaic culture and dates to approximately 6,000 years ago. The earliest sites in the Plan Area are undated and have been assigned to the prehistoric period. These include Puriksuk (HAR-165), Nigliq (HAR-169), and two lithic sites (HAR-022 and HAR-009). The following descriptions outline prehistoric traditions in the region which, based on locations of their documented remains, have potential for occurring in the project area. The cultural history and human development sequences of northern Alaska are incomplete. Table 3.4.5-1 depicts a provisional cultural sequence for Northern Alaska.

### PALEOINDIAN/PALEO-ARCTIC (11,000 B.P. TO 7,000 B.P.)

The earliest sites in northern Alaska date to the end of the Pleistocene and beginning of the Holocene, approximately 11,000 years ago, and can be placed in two categories, Paleoindian and Paleo-Arctic. The early prehistory of the North Slope area has been documented at the Putu and Bedwell sites on the North Slope of the Brooks Range. The cultural remains from these sites were initially designated as two separate entities; however, the sites appear to be segments of a single site (Reanier 1996). Putu/Bedwell contain the first Paleoindian-related artifacts to be discovered in Alaska, as well as Paleo-Arctic artifacts (Reanier 1996). The Hilltop site is above the Atigun River and contains Paleoindian artifacts similar to those found at the Mesa site. The site dates to 10,400 years ago (Reanier 1995, in Reanier 2000). Available dates indicate that the early occupation of Putu/Bedwell could be 9,000 to 10,000 years in age. Dates from the Mesa site, 200 miles to the west and south of Putu/Bedwell, corroborate this age range. Close parallels can be seen in the artifact types found at the Putu/Bedwell and Mesa sites. In addition, the range for the Mesa artifacts of 9,700 to 11,700 years ago substantially overlaps with the problematic dates from Putu/Bedwell (Kunz and Reanier 1996). Sites such as Putu/Bedwell and Mesa contain cultural remains that could contribute to research questions associated with the ways in which humans adapted to environments of the high latitudes in North America and the arrival of humans in the region at the Pleistocene-Holocene boundary.

**TABLE 3.4.5-1 PROVISIONAL CULTURAL SEQUENCE FOR NORTHERN ALASKA**

| Tradition | Date | Finds | Representative Sites |
|---|---|---|---|
| Historic Inupiat | A.D. 1826 | Stone, metal, trade goods, organic artifacts plus historic, ethnographic and informant accounts | Historic Coastal and Riverine Inupiat |
| Late Prehistoric (Birnirk, Thule) | 2,000 B.P.-A.D. 1826 | Lithic, wood, leather, bone artifacts, house ruins | Pingok Island, Thetis Island, Niglik, Birnirk, Walakpa, Point Hope, Cape Krusenstern, Nunagiak, Utqibġvik, Nuwuk |
| Arctic Small Tool (Denbigh, Choris, Norton, Ipiutak) | 4,500-1,200 B.P. | Diminutive lithic microtools, cores, burins, blades | Putuligayuk River, Central Creek Pingo, Onion Portage, Mosquito Lake, Choris, Walakpa, Iyatayet, Point Hope, Coffin, Jack's Last Pingo |
| Northern Archaic | 6,000-3,000 B.P. | Side-notched points, microblades, bone tools | Putuligayuk River, Kuparuk Pingo, Kurupa Lake, Tuktu |
| Paleo-Arctic | 10,000-7,000 B.P. | Cores and blades, microcores, microtools, bifaces | Putuligayuk River, Jones Pingo, Gallagher Flint Station, Lisburne, Tunalik |
| Paleoindian | 12,000-9,800 B.P. | Extinct fauna, large lanceolate points, bifaces | Mesa, Bedwell, Putu, Hilltop |

Source: Lobdell and Lobdell 2000: Table 2; Reanier 2002: Table 1
B.P. = Before Present

#### NORTHERN ARCHAIC (6,000 B.P. TO 3,000 B.P.)

The Northern Archaic culture appeared approximately 6,000 years ago in many areas of Alaska (Reanier 2002; Lobdell and Lobdell 2000). Most Northern Archaic artifacts found throughout the Arctic Foothills and the Brooks Range are surface finds (Lobdell and Lobdell 2000). Northern Archaic groups are believed to have been primarily hunters of large terrestrial animals.

Northern Archaic sites in the vicinity of the project area include the Putuligayuk River Delta Overlook site at Prudhoe Bay, the Kuparuk Pingo site, Kurupa Lake in the foothills of the Brooks Range, and the Tuktu site north of Anaktuvuk Pass (Lobdell 1995; Lobdell and Lobdell 2000; Reanier 2002). The Putuligayuk River Delta Overlook site contains artifacts associated with the Northern Archaic culture. The Kuparuk Pingo site is within a few miles of the Beaufort Sea shore and approximately 30 miles west of the Putuligayuk River Overlook site. This pingo location is unusual because these ice core hill features on the Arctic Coastal Plain landscape were not believed to persist for more than a "few millennia" from the time of their initial development until they submerged into the plain (Lobdell 1995, p. 62). However, evidence provided by radiometric age determination and artifacts associated with the Northern Archaic culture indicates that the landform has been in existence for at least 6,000 years. The location of the site adjacent to the north Alaska coast indicates that Northern Archaic people possibly used coastal resources in addition to the terrestrial fauna long believed to be the primary focus of Northern Archaic subsistence (Lobdell 1995).

Northern Archaic remains in the Brooks Range include an assemblage from the Tuktu site north of Anaktuvuk Pass that is designated as the Tuktu complex and dates to as early as 6,500 years in age (Lobdell 1995). The occurrence of Northern Archaic remains at Anaktuvuk Pass indicates that Northern Archaic people used the Arctic Coastal Plain, as well as the mountain passes through the Brooks Range. The Kurupa Lake site is in the foothills of the Brooks Range and dates to as early as 6,600 years ago (Schoenberg 1995, in Reanier 2002).

### ARCTIC SMALL TOOL TRADITION (4,500 B.P. TO 1,200 B.P.)

The Arctic Small Tool Tradition (ASTt) initially appeared in Alaska approximately 4,800 years ago at Cape Denbigh and Kuzitrin Lake in the central Seward Peninsula (Harritt 1994). ASTt is generally believed to be the earliest archaeological tradition associated with modern Inupiat people (Reanier 2002). Several cultures are associated with ASTt including Denbigh, Choris, Norton, and Ipiutak.

Denbigh is the earliest component of ASTt and dates to 4,800 years ago on the Seward Peninsula (Harritt 1994). The youngest date for Denbigh, approximately 2,000 years ago, comes from the Mosquito Lake site in the northern foothills of the Brooks Range. Denbigh houses are similar to the contact-period Inupiat houses observed by contact-period Russian and American explorers. Denbigh people hunted large game and harvested the salmon that appeared in the streams during the summer runs. Coastal Denbigh sites, and some of the technology associated with them, indicate that Denbigh people hunted seals as well (Anderson 1984, Giddings 1964). Denbigh sites near the project area are documented from northern coastal areas to the Arctic Foothills and pass through the Brooks Range (Lobdell 1995).

Denbigh-related sites occur near Prudhoe Bay at the Putulagayuk River Delta Overlook site (Lobdell 1995). A Denbigh-related site also occurs at Central Creek Pingo, an ancient ice core mountain on the Arctic Coastal Plain, approximately 3 miles from Prudhoe Bay and a mile inland from the Beaufort Sea coast (Lobdell 1995). Radiocarbon dates from this location range from 4,000 to 3,500 years ago (Lobdell 1995).

Denbigh occurrences at locations between the northern coast and the Brooks Range have been termed "tundra Denbigh." Denbigh is documented at Mosquito Lake, near Galbraith Lake on the northern slopes of the Brooks Range. The age of Mosquito Lake Denbigh is placed at approximately 2,500 years, based on three radiometric determinations (Kunz 1977). This age appears to some researchers to be too young for Denbigh culture in northern Alaska. However, radiocarbon dates of Denbigh components from Tukuto Lake, in the Arctic Foothills, range from roughly 4,400 to 3,300 and 2,200 to 1,600 years in age. The Tukuto Lake Denbigh dates define a temporal range into which the Mosquito Lake occupation fits and indicate that Denbigh culture persisted in the area between the northern coast and the passes through the Brooks Range from 4,400 to 1,600 years ago.

Following Denbigh, the Choris culture appeared in coastal areas of northwest Alaska from 3,700 to 500 years ago. Choris cultural remains have been documented on the North Slope of the Brooks Range dating from 2,700 to 2,500 years in age. Elements of the Choris culture, named after the type site in eastern Kotzebue Sound, have been documented as far inland as Anaktuvuk Pass and Galbraith Lake (Anderson 1984). Assigning Choris origins to the northern interior Alaskan occurrences is less certain than is desirable, and there remains a possibility that the assemblages represent an unnamed cultural tradition (Anderson 1984). Other Choris sites on the North Slope include the Walakpa site, which has been dated to between 3,400 and 2,300 years ago, and the Coffin site (Stanford 1976, in Reanier 2002).

The Norton culture was first defined at the Iyatayet site on Norton Sound and spans a time period from approximately 2,500 to 2,000 years ago. Cultural remains documented at Norton sites suggest that the Norton culture has its origins in the Choris culture (Giddings 1964). At Point Hope, cultural remains identified as Near Ipiutak were found that are identical to those associated with the Norton culture.

The Ipiutak culture is believed by some prehistorians to have contributed to the development of Thule culture. The Ipiutak site at Point Hope was characteristic of the Ipiutak culture. Ipiutak lacked pottery, ground slate tools, and stone lamps, which are associated with the earlier Norton culture and later Inupiat cultures. Ipiutak sites have been documented both coastal and inland. The presence of Ipiutak sites in the Brooks Range and its temporal position immediately preceding Thule indicate that Ipiutak culture played a significant role in the prehistory of the area. Inland Ipiutak persisted substantially longer than the presence of the culture in coastal areas. Coastal age ranges fall within the period from 2,000 to approximately 1,100 years ago, while those of the interior fall within the period from 1,350 to 550 years ago (Gerlach and Hall 1988, Giddings and Anderson 1986). Ipiutak remains in the Brooks Range and in Anaktuvuk Pass are predominantly those of temporary encampments, but sparse occurrences of small settlements are known, such as those represented by houses at Etivluk and Feniak lakes and the Toyuk site southwest of Anaktuvuk Pass.

### LATE HOLOCENE ORIGINS OF THE HISTORIC CULTURES (2,000 B.P. TO A.D. 1827)

Beginning approximately 2,000 years ago, ancestral forms of the historic Native cultures emerged and underwent the final stages of development leading up to the cultural forms that were encountered by European explorers in the nineteenth century.

From the Birnirk period onward, the cultural continuity of arctic peoples into the twenty-first century is well established. The Birnirk phase, a direct ancestor of the historic Thule culture, appears in the Bering Strait by 1,600 years ago. Birnirk peoples lived in semisubterranean winter houses and engaged in the harvest of marine and land mammals, birds, and fish. The Birnirk type-site is located near Barrow at the base of the Barrow spit. Other sites that contain Birnirk cultural remains include Walakpa, Point Hope, and Cape Krusenstern. Birnirk-style artifacts have been found from northeastern Siberia to northwestern Canada, indicating a large trade network reminiscent of the extensive Inupiat trade network in place in the nineteenth century.

Thule is the immediate prehistoric ancestor of the various historic Inupiat groups. Approximately 1,000 years ago, a favorable climate coupled with technological innovations such as the umiaq (a large skin boat), the qataq (cold trap door for winter houses), and the umiat (dog sled) resulted in the rapid expansion of Thule populations from the Bering Strait along the shores of the Beaufort Sea to Greenland, and southeast around the shores of the Bering Sea ultimately to Kodiak Island and Prince William Sound. Developed Thule appeared by 1,000 years ago and persisted in the North American Arctic to historic contact, between 1800 and 1850 (Collins 1964, Giddings and Anderson 1986). When the early explorers and whalers arrived on the Beaufort Sea coast in 1826, they encountered the Thule people. Thule people hunted sea mammals, including whales, as well as terrestrial game such as caribou. In many Thule areas, salmon were also an important subsistence resource. Thule sites at Barrow include Nuvuk, Utkiagvik, Thetis Island (destroyed), Pingok Island, and Nigliq.

## PREHISTORIC RESOURCES IN THE PLAN AREA

Four prehistoric sites are within the project area. These resources are described in Table 3.4.5-2 and discussed by facility group area below. It should be noted that the lack of documented prehistoric sites in these facility group areas does not preclude the existence of undocumented prehistoric sites in those areas.

### COLVILLE RIVER DELTA FACILITIES GROUP

There is one documented prehistoric site in the Colville River Delta Facility Group. The site of Nigliq (HAR-169, TLUI-58, TLUIHAR-084) contains prehistoric artifacts, as well as historic artifacts. Nigliq means “goose,” and this site was a vital link in the aboriginal trade and commerce network from prehistoric times (Hoffman et al. 1988). Trade fairs at this site continued into the early twentieth century.

### FISH-JUDY CREEKS FACILITIES GROUP

There is one documented prehistoric site in the Fish-Judy Creeks Facility Group. The site of Puviksuk (Puviqsuq) (HAR-165, TLUI 76) is first mentioned in Nunamiut creation mythology as the knoll where the giant Ayagumaphaq (Aiyagomahala) built his snow house so that he would be remembered through the generations. The snow house turned into a small knoll with a hollow on top where he left his pack (Hoffman et al. 1988). Prehistoric artifacts, including a lithic component, fire-cracked rock, and hearths, as well as historic sod house ruins and a shaman’s grave, are present at the site. Puviqsuq means “it’s swelling up.” The site has also served as a travel landmark over the generations.

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP

| AHRS # | TLUI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Colville River Delta Facility Group** | | | | | | | | | |
| HAR-008 | | | | | | | grave | grave | |
| HAR-052 | | | | | | Historic, Euro-American (post AD 1951-1972) | sod house foundation or tent ring with modern debris that could relate to temporary navigation system set up at VABM Nehi | sod house foundation/ tent ring with modern debris (electrical wire, copper antenna ground rod) | |
| HAR-054 | | | | Nechelik Channel Lifeboat | | Historic | | | |
| HAR-055 | | | | | | | isolated find | caribou bone | 3 |
| HAR-056 | | | | Ivik Grave | | Historic | Ivik grave (1924) | grave | 2 |
| HAR-155 | 63 | TLUIHAR-080 | Hall #2264 | Uyagagvik | "place where one can get many rocks" | Historic and contemporary Inupiat | site, quarry, fish camp | none | 4,5,6 |
| HAR-156 | 60 | TLUIHAR-083 | Hall #2263 | Nanuk | "polar bear" | Historic Inupiat, first half of 20th century | site, reindeer herding station, sod houses, storage pits, sod quarries | sod houses, ice cellars, reindeer corral | 3,4,6,8 |
| HAR-157 | 45 | | Hall #2273 | Niglivik 2 | | Historic Inupiat | site, sod house, cache pit, sod quarry | sod house, cache pit | 3 |
| HAR-158 | 80 | | | Putu | "hole" | Historic and contemporary Inupiat | site, hunting camp, settlement, sod houses, sod quarry, cellar | sod houses, ice cellar | 2,3,6,7 |
| HAR-159 | 88 | | Campbell (#33) | Nuiqsutpiat | | Historic and contemporary Inupiat | site, fishing/trapping camp, sod houses, ice cellar, sod quarries, tent area | sod houses, ice cellar, sod quarries, tent area | 1,2,3,4,5 |
| HAR-160 | 89 | | Campbell (#32) (Also in AHRS as HAR-043) | Niglinaat | "place of the white-fronted geese" | Historic (1930s) and contemporary (1970s) Inupiat | fishing, trapping camp | sod houses | 2,3,4,6,8 |

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

| AHRS # | TLUI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Colville River Delta Facility Group (cont'd)** | | | | | | | | | |
| HAR-162 | | | | Aanayyuk (Anajuk, Anayuk) | Anajuk means "a man who died there" | Historic Inupiat | | | |
| HAR-169[a] | 58, 6 | TLUIHA R-084 | | Niglik/Woods Inaat (Camp) | Nigliq means "goose" | Prehistoric, historic, and contemporary Inupiat | site, trading settlement, burials, fish camp | sod houses, smokehouse, cabins, storage pits, grave | 2,3,4,5,6,7,10 |
| | 57 | | | Tulagvik | "where a boat goes ashore" | | fishing, hunting, trapping area | | 4,5,6 |
| | 59 | | | Apkugaruk | "old trail" | | fishing area | | 4 |
| | 61 | | | Nuiqsut | | | fishing, trapping, hunting, camping area, graves (cemetery) | graves/cemetery | 2,4,5,6 |
| | 62 | | | Tulugaluk | "old raven" | | fishing, hunting, camping, trapping area | | 4,5,6 |
| | 79 | | | Sigiaruk | | | fishing, hunting, and camping area | | 4,6 |
| | 82 | | | Napaun | | | fishing, hunting, and camping area, sod house ruins | sod house ruins | 3,6,8 |
| | 85 | | | Milugiak | name of a fish or "fish with mouth under" | | fishing, nesting, hunting, root harvesting area | | 4,8 |
| | 86 | | | Illaktugvik | | | fishing and nesting area, cabins, graves | cabins, graves | 1,2,4,8 |
| | 87 | | | Nauyaatuuq | "seagulls" | | fishing and nesting area | | 4,8 |

**TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)**

| AHRS # | TL UI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Colville River Delta Facility Group (cont'd)** | | | | | | | | | |
| | | TLUIHAR-075[b] | | | | | | | |
| | | TLUIHAR-077[b] | | | | | | | |
| | | TLUIHAR-078[b] | | | | | | | |
| | | TLUIHAR-079[b] | | | | | | | |
| | | TLUIHAR-081[b] | | | | | | | |
| | | TLUIHAR-082[b] | | | | | | | |
| | | TLUIHAR-085[b] | | | | | | | |
| **Fish and Judy Creeks Facility Group** | | | | | | | | | |
| HAR-004 | 70 | TLUIHAR-067 | | Kitik (Qitiq) | "pulverized stone" | Historic Inupiat | site, quarry | | 8 |
| HAR-005 | | | | | | | sod house and boat on Fish Creek | | 3 |
| HAR-010 | | | | Kikkaq | "gully" | Historic Inupiat (AD 1970s) | site, camp site, marker | marker (wood and stone) | 6 |
| HAR-028 | 55 | TLUIHAR-086 | NSB CRSI #2250, Hall #2250 | Nukruapaitch (Niaquqturuq) | | Historic Inupiat (20th century) | site, hunting and camping area (site could have been destroyed), sleds, beluga butchering locality | sleds, upright poles, beluga bones | 3,6 |
| HAR-044 | | | | | | Recent Inupiat | recently attended grave (reburial of surface-scattered human remains) marked and outlined (remains of old coffin a few meters east of the grave), mound of unexplained origin, driftwood marker | grave/reburial marked and outlined, remains of old coffin, mound, driftwood marker | 2 |

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

| AHRS # | TLUI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Fish and Judy Creeks Facility Group (cont'd)** | | | | | | | | | |
| HAR-053 | | | | | | Historic Inupiat | site, isolated surface find, human remains | isolated surface find, human remains | 2 |
| HAR-163 | 3 | | | Itkillikpaat, Itqilippaa | "at the mouth of the Indian River" | Historic and contemporary Inupiat | site, fish camp, sod house ruins, sod house, cemetery, sod quarries, tent rings, storage pits | sod houses, storehouses, cemetery | 2,3,4,5,6 |
| HAR-164 | 77 | TLUIHA R-072 | Hall #2268 | Tiragroak, Tirragruaq | "large sandbar" | Historic and contemporary Inupiat | site, fish camp, camp, sod houses, cache pits, historic remains | sod houses, storage pits | 3,4,7 |
| HAR-165 | 76 | TLUIHA R-071 | Hall#2267 | Puviksuk, Puviqsuq | "it's swelling up" | Prehistoric/Historic Inupiat | creation site, hunting, camping, fishing | sod house ruins, lithics, grave | 2,3,4,6,10 |
| HAR-166 | 75 | TLUIHA R-070 | Hall#2266 | Aki, Agki Creek | "the other side" (of a lake or river) | Historic and contemporary Inupiat | site, hunting, camping, fishing | sod house ruins | 3,4,6 |
| HAR-167 | 74 | TLUIHA R-069 | Hall #2265 | Kayukisiluk, Kayuqtusilik | Kayuqtusilik means " a place where there are red foxes" | Historic Inupiat/Euro-American, first half of 20th century | site, trading post, storehouse, sod house ruins, graves, tent rings, ice cellars, refuse mounds | wood frame trading post storehouse, sod house ruins, ice cellars, graves, tent rings, refuse mounds | 2,3,7 |
| HAR-168 | | | | Aqsiataaq Inaat | | Historic Inupiat (A.D. 1930s-1940s) | site, camp, moss house, historic remains | moss house, historic remains | 3,6 |
| | 1 | TLUIHA R-088 | Hall #2237 | Ugiin | | Historic | cabins, sod house ruins, winter furbearer hunting | cabins, sod house ruins | 1,3,6 |
| | 54 | | | Niaquqturuq | | | fishing, duck hunting and nesting area, sod house ruins | sod house ruins | 3,4,6,8 |
| | 68 | | | Kastialurak | | | fishing, berry harvesting and hunting area | | 4,6,8 |

**TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)**

| AHRS # | TLUI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Fish and Judy Creeks Facility Group (cont'd)** | | | | | | | | | |
| | 71 | | | Kuugruachiak | | | fishing, hunting and camping area | | 4,6 |
| | 72 | | | Illanikruak, Ilannik | | | fishing and trapping area | | 4,5 |
| | 78 | | | Kayaktuagiak | | | fishing, hunting and camping area | | 4,6 |
| | 81 | | | Ittigiak | Ocean Point | | hunting, berry harvesting | | 6,8 |
| | | TLUIHA R-040 | | Ayuvioa | Place name derived from a person | | hunting area | | 6 |
| | | TLUIHA R-041 | | Silulium Paawa | Entry or mouth of the Siulik River | | fishing and hunting area | | 4,6 |
| | | TLUIHA R-044 | | Ikpitchiaq | "a newly formed hill" | | hunting area | | 6 |
| | | TLUIHA R-063[b] | | | | | | | |
| | | TLUIHA R-064[b] | | | | | | | |
| | | TLUIHA R-065[b] | | | | | | | |
| | | TLUIHA R-068[b] | | | | | | | |
| | | TLUIHA R-073[b] | | | | | | | |
| | | TLUIHA R-087[b] | | | | | | | |

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

| AHRS # | TL UI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Kalikpik and Kogru Rivers Facility Group** | | | | | | | | | |
| HAR-002 | | | Hall #2278 | | | Prehistoric | site, lithic remains (destroyed?) | | |
| HAR-007 | | TLUIHA R-061 | | | | | reindeer herding driftwood fence and tent platform | reindeer fence, tent platform | 6,11 |
| HAR-009 | | | | | | Prehistoric | site, isolated find (lithic) | | |
| HAR-012 | 46 | TLUIHA R-029 | Hall #2244 | Aki, Agki | | Historic Inupiat (AD - 1920s) | site, sod house ruins (one belonged to Ugruaq) | sod house (3) ruins | 3 |
| HAR-013 | | | | Uguak | | Historic Inupiat | site, sod house, house pits, cabins | sod house, house pits, cabins | 1,3 |
| HAR-014 | | | Hall #2279 | | | Historic Inupiat (AD - 1930s) | structure, reindeer corral, house pit | structure, reindeer corral, house pit | 3,11 |
| HAR-018 | | | | Ahsogeak Site | | Historic Inupiat | site, habitation, historic remains | | 6 |
| HAR-022 | 49 | TLUIHA R-016 | NSB CRSI #2245, Hall#2245 | Saktui, Sakitui, Saktuina Point, Saktui Islands | | Historic | former site of Edwardsen's Trading Post, sod houses and graves, site of former fishing area | sod houses and one or more graves (most of site destroyed by erosion) | 2,3 |
| HAR-024 | 50 | TLUIHA R-090 | Hall #2246 | Qiqiktag | | Historic Inupiat | Site, tent site | tent site | 6 |
| HAR-025 | 51 | | Hall #2247 | Tikigaqmiut (Tikiragmiut, Eskimo Islands) | | Historic Inupiat | site, "old cemetery of Point Hope people…" | | 2 |

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

| AHRS # | TL UI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Kalikpik and Kogru Rivers Facility Group (cont'd)** | | | | | | | | | |
| HAR-026 | 52 | TLUIHAR-091 | Hall #2248 | Atigaru Point (Atigruk Point, Amaulik) | | Historic Inupiat | site, graves, sod house ruins, tent sites | | 2,3,6 |
| HAR-027 | 53 | | NSB CRSI #2249, Hall #2249 | Kanigluq | | Historic Inupiat | site, sod houses (1977 TLUI 7 sod house ruins), ice cellar | sod houses, ice cellar | 3,7 |
| HAR-029 | 56 | | NSB CRSI #2251, Hall #2251 | Ikkalipik | | Historic Inupiat | site, sod house, ruins (destroyed/ not located – see HAR-030) | none | |
| HAR-030 | | | | | | Historic Inupiat (20th century) | site, settlement, sod house (may be actual location of Ikkalikpik [HAR-029]) | sod house (4 x 2.5m), stakes and posts (boat rack), caribou bones, hearth | 3 |
| HAR-045 | | | | | | Historic Inupiat (20th century) | site, camp site, racks and old boats (mostly destroyed), possible sod removal area | campsite, boat racks, old boats (mostly destroyed), upright tentstakes, sod removal area | 6 |
| HAR-046 | | | | | | Historic Inupiat (20th century) | site, campsite, boat rack and old boats, possible tenting area | campsite, boat rack and old boats (Nantucket-style whaling long boat), tenting area | 6 |

## TABLE 3.4.5-2 ALASKA HERITAGE RESOURCES SURVEY AND TRADITIONAL LAND USES INVENTORY – CULTURAL SITES BY ASDP FACILITY GROUP (CONT'D)

| AHRS # | TL UI # | TLUI # (2003) | Other Site # | Site Name | English Translation | Time Period | Site Type/Description | Cultural Remains | TLUI Legend |
|---|---|---|---|---|---|---|---|---|---|
| **Kalikpik and Kogru Rivers Facility Group (cont'd)** | | | | | | | | | |
| HAR-051 | | | | | | Historic Inupiat (20th century) | Site, historic remains | historic remains (stove parts, driftwood posts, rusted steel cans, caribou bones, hide pegs) found on stabilized sand dunes west of the creek on which HAR-030 is located (may be associated) | 6 |
| HAR-058 | | | | USC&GS memorial | | Historic | USC&GS bronze memorial for Kay, Grenell, and Roberts (lost at sea) | | |
| | 48 | TLUIHA R-013 | | Nuyapisut | | | trapping and hunting area, place for gathering driftwood | | 5,8 |
| | | TLUIHA R-014 | | Kiputit | | | fishing, trapping, nesting, and hunting area | | 4,5,6,8 |
| | | TLUIHA R-021 | | Kuugruk | Kuugruk River | | fishing, hunting, and eider nesting area | | 4,6,8 |
| | | TLUIHA R-036 | | Kuugruk | Kuugruk River | | fishing, hunting, and eider nesting area | | 4,6,8 |
| | | TLUIHA R-038 | | Savikpaligauram Ioitublia | | | fishing and hunting area | sod house ruins | 3,4,6 |
| | | TLUIHA R-039 | | Sikulium Kuuwa | Sikulik River | | fishing and hunting area | | 4,6 |
| | | TLUIHAR-059[b] | | | | | | | |
| | | TLUIHAR-060[b] | | | | | | | |
| | | TLUIHAR-062[b] | | | | | | | |
| | | TLUIHAR-089[b] | | | | | | | |

Source: Department of Natural Resources, Office of History and Archaeology 2003; NSB 2003
Notes: (see next page)

[a] National Register of Historic Places
[b] No information available
USC&GS = U.S. Coastal and Geodetic Survey
Traditional Land Use Inventory (TLUI) Legend (Based on NSB template):
1 = Cabins/Shelter Cabins Today
2 = Graves/Cemetery
4 = Fishing
3 = Ruins/Sod Houses/Bones
5 = Trapping Area
6 = Hunting/Camping Area
7 = Cellars
8 = other/Nesting Area, Seals, Roots
9 = Whaling Settlement
10 = Important Event/Old Site
11 = Reindeer Herding Area

#### KALIKPIK-KOGRU RIVERS FACILITIES GROUP

There are two documented prehistoric site in the Kalikpik-Kogru Rivers Facility Group. One prehistoric site (HAR-002) contained lithic cultural remains, as well as cut antler, bird bone, and an ivory harpoon head, and may have been destroyed by erosion (Ito-Adler and Hall 1986). The second prehistoric site (HAR-009) consisted of an isolated lithic cultural remain.

### 3.4.5.3 Overview of Regional History

#### EUROPEAN/EURO-AMERICAN EXPANSION, EXPLORATION, AND ETHNOGRAPHIC RESEARCH

The exploratory period on the North Slope began in 1826 with the first Franklin expedition. Sir John Franklin and his crewmembers sailed westward from the Mackenzie River to the Return Islands just west of Prudhoe Bay and spent 1825 through 1826 at Herschel and Barter islands. That same year, Frederick William Beechey's expedition sailed north from the Bering Strait to Point Barrow. Franklin, as well as other early explorers, noted that the presence of European trade goods (such as tobacco, iron, and copper) preceded their arrival among the Inupiat on the North Slope. In 1837, Thomas Simpson of the Hudson's Bay Company traveled from the east to Point Barrow. In 1849, Lieutenant W.J.S. Pullen, of the *HMS Plover*, surveyed the Arctic coast from Wainwright Inlet to the McKenzie River. Between 1847 and 1854, contact between Europeans and the Inupiat increased because of the influx of whalers to the region, and exploration of the region increased as ships searched for the lost Franklin expedition. From 1852 to 1853, R. Maguire, of the *HMS Plover*, wintered at Point Barrow. Richard Collinson, a captain on one of the search ships looking for Franklin's lost expedition, collected Inupiat place names for areas along the coast from Barrow to the Mackenzie River while wintered off the ice of Camden Bay between 1853 and 1854 (Schneider and Libbey 1979).

During the commercial whaling period, items such as metal and firearms became increasingly important as part of Inupiat material culture. By the 1850s, guns were in use by local Inupiat people; and by the 1880s, Inupiat whalers were using commercial whaling darting guns and bombs. Beginning in 1881, J. Murdoch and Lieutenant P.H. Ray, members of the International Polar Expedition, collected ethnographic information over the course of 2 years at Point Barrow. During the last quarter of the nineteenth century, epidemic diseases caused a severe population decline among the North Slope Inupiat. By the end of the nineteenth century, major population shifts occurred as a result of disease and famine. Declines in caribou populations resulted in famine that caused inland Inupiat to leave their homes and relocate to coastal communities such as Barrow, where coastal Inupiat populations had declined from diseases such as smallpox and influenza (Reanier 2002).

Interest in the geology and history of the early culture of the area began in earnest at the beginning of the twentieth century, but was limited by access to coastal areas. Vilhjalmur Stefansson conducted ethnographic studies along the coast east of Barrow between 1906 and 1907, 1908 to 1912, and 1913 to 1918. Between 1906 and 1914, Ernest de Koven Leffingwell conducted geographical place name research in the Arctic. As an extension of the Fifth Thule Expedition, Knud Rasmussen crossed into Alaska from Canada in 1924. He compiled ethnographic data on the Alaskan Inupiat and their camps and recorded place names on the Utukok River. In 1952, Robert F. Spencer investigated the ecological relationship between inland and coastal Inupiat groups. Various researchers, including Rausch, Ingstad, Gubser, and Binford, studied the Nunamiut (or inland Inupiat).

The initiation of petroleum development led to intensive investigations of cultural resources on the North Slope. These investigations occurred after World War II in the Naval Petroleum Reserve No. 4 (currently designated the National Petroleum Reserve-Alaska), which was created in 1923, and before and during construction of the TAPS. The NSB Commission on History and Culture began the TLUIs for the North Slope in the 1970s in anticipation of and in response to increased resource development on the North Slope (Schneider and Libbey 1979). This program is discussed in greater detail below.

### MISSIONARY EFFORTS, TRADING POSTS, AND REINDEER HERDING

Christian missionaries first arrived in Barrow in 1890. Because of the efforts of Christian missionaries and evangelization by the Inupiat, Christianity was nearly universal by 1910 (Reanier 2002). Mission schools were established between 1890 and 1910 at Wales, Point Hope, and Barrow, as well as other places that were not previously occupied year-round. Eventually, the original mission schools split into separate entities—government schools and church-operated missions. Trading posts were set up near the missions and schools. These areas became focal points for the Native population, and settlements grew up around each one (Schneider and Libbey 1979).

At the end of the nineteenth century, Sheldon Jackson, a Presbyterian missionary, introduced reindeer herding to Alaska Natives. Following the collapse of the commercial whaling industry, the people of Wainwright and Barrow developed and maintained large herds of reindeer. Reindeer herds were maintained by Inupiat in the vicinity of Wainwright, Barrow, and Nuiqsut, as well as other settlements on the North Slope (Schneider and Libbey 1979). Reindeer herding ended in 1938 because of the collapse of the market for meat and hides (Reanier 2002).

At the beginning of the twentieth century, whale oil, and whalebone (baleen) decreased in importance. The fur trade filled some of the economic gap left by the collapse of the whalebone market and the subsequent demise of commercial whaling. In 1915, the Barrow whaler and trader Charles Brower ceased commercial whaling operations to begin fur trading operations. It was common practice for white traders to fund Natives in the establishment of outposts. For example, the trading post at Kayiktusiluk on the Colville River was financed by Jack Smith and operated by Thomas Ichuagak, a Colville River Delta Inupiat (Schneider and Libbey 1979). For the Inupiat, trading traditionally has had social and economic importance. Trading posts in the area began to cease operation in the 1930s as a result of the Great Depression and reduced fur demand, and many were replaced by village stores. Most of the trading posts had ceased operations by the 1940s (Schneider and Libbey 1979).

## 3.4.5.4 Community History

### NUIQSUT

Nuiqsut is on the Nigliq Channel on the west side of the Colville River Delta. The Nuiqsut area provides a diverse seasonal abundance of terrestrial mammals, fish, birds, and other resources and is a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (ADCED 2003). The name Nuiqsut recalls prehistoric and historic camps and settlements occupied by many families on the main channel of the Colville that had been used traditionally as an area for hunting, fishing, trapping, and trading. The people of Nuiqsut call themselves Kukpikmiut, or the People of the lower Colville River (Brown 1979). Most residents in the area moved to Barrow when the Bureau of Indian Affairs mandated school attendance for children in the 1940s. However, former residents continued to use the Colville River area for subsistence purposes. The passage of ANCSA in 1971 led to the reestablishment of the community. In April 1973, the community of Nuiqsut was resettled by 27 families who embarked on a 150-mile trek from Barrow to the Colville River. Many of these people had lived in the Colville River area 25 to 30 years earlier and were "seeking an alternative to the accelerating urbanization of Barrow." (Libbey et al. 1979)

### BARROW

Barrow has been occupied for approximately 4,000 years, with continuous occupation for the last 1,300 years (Dumond 1977). The earliest occupants of the Barrow area were bearers of the Birnirk culture. The Inupiat name for the Barrow area is Utqiagviq, meaning "the place where we hunt snowy owls." Because Barrow is situated on a point of land where the sea ice is prone to cracking, the main subsistence focus has been marine mammal hunting, particularly whaling. In recent years, Barrow has been the social and economic center for the North Slope Inupiat (with trade, commercial whaling, schools, NSB administration, and wage employment).

### ATQASUK

The village of Atqasuk is on the banks of the Meade River, 60 air miles south of Barrow. The Atqasuk area is rich in caribou, fish, and waterfowl, and hunters access areas of the coast for seals and other marine resources. The Atqasuk area is the location of several former settlements used in prehistoric and historic times. The current village site is near a coal mine that provided fuel for Barrow during and after World War II. At that time, the village was known as Meade River.

#### HISTORIC RESOURCES/TLUI SITES IN THE PLAN AREA

In general, coastal Inupiat from the prehistoric period and later (through current times) have settled in small villages on peninsulas or points of land where conditions are ideal for sea mammal hunting and have traveled inland for caribou, fish, and furbearers on the river systems. The relationship of the Inupiat to their natural environment remains a cornerstone of their personal and group identity (NSB 1979). Signs of past occupation (such as remains of camps or houses) generally mark historical places of significance. Old occupation sites are not regarded by the Inupiat as being truly abandoned, but are valued by the Inupiat as the living and dying places of ancestors "no longer recalled but still a part of the surrounding world" (NSB 1979), and could have supernatural associations that affect the way they are used by modern populations. Cultural associations with the land could be contained in recollections of the recent past, stories of remote history or "folklore," and in supernatural beliefs (NSB 1979). Oral traditions and supernatural beliefs are connected to specific features of the landscape or "connected to locations where remote historical events involving the people, the animals and the landforms took place." The Inupiat believe that "each place is entirely unique and imbued with its own importance." (NSB 1979, p. 29)

Historic resources located in the area potentially affected by the proposed project or near the Plan Area are listed and briefly described in Table 3.4.5-2. There are 11 documented historic sites (listed as "Historic" under the Time Period subheading) in the Colville River Delta Facility Group area; 11 documented historic sites in the Fish-Judy Creeks Facility Group area; and 15 documented historic sites in the Kalikpik-Kogru Rivers Facility Group area. It should be noted that undocumented historic sites might be located in these areas.

#### TRADITIONAL LAND USES INVENTORY

Place names and traditional land uses sites in the mid-Beaufort Sea region generally refer to locations where important events or activities, frequently subsistence use, took place (Lobdell and Lobdell 2000, NSB 2003). Lobdell and Lobdell (2000, p. 35) state that place names "reflect an 'ethnohistoric present' or a living memory of the past. Without written records, this rich component of oral tradition may extend back three to four generations or even beyond."

A description of TLUI sites is provided in Table 3.4.5-2. There are 25 documented TLUI sites in the Colville River Delta Facility Group; there are 29 documented TLUI sites in the Fish-Judy Creeks Facility Group; and there are 21 documented TLUI sites in the Kalikpik-Kogru Rivers Facility Group. The existing literature that describes TLUI sites in the mid-Beaufort Sea region is not consistent in how TLUI sites and their associated numbers are expressed. Thus, Table 3.4.5-2 lists a variety of numbers for each TLUI (for example, TLUI [1979], TLUI [2003], AHRS #, and Other Site #). The table provides a description of the TLUI sites using the TLUI (1979) and TLUI (2003) numbers, AHRS number, and the site name/place name (Inupiat and English) where applicable.

## 3.4.6 Land Uses and Coastal Management

### 3.4.6.1 Land Ownership

Land ownership on the North Slope and within the Plan Area has been affected by several land laws including the Native Allotment Act, Alaska Statehood Act, ANCSA, ANILCA, and the Naval Petroleum Reserves production Acto of 1976 (NPRPA). Table 3.4.6-1 shows the approximate acres for the different ownerships in the Plan Area and Figure 3.4.6.1-1 depicts land status.

#### FEDERAL LANDS

The BLM manages 560,900 acres within the National Petroleum Reserve-Alaska. Management responsibilities for this land was transferred to the DOI and delegated to the BLM in 1976 by the NPRPA. Under ANCSA, as amended, Kuukpik and ASRC have selection rights within the National Petroleum Reserve-Alaska.

#### STATE LANDS

The State of Alaska owns 103,220 acres and has selected an additional 1,280 acres for a total of 104,500 acres in the Plan Area. Most of these lands occur in the lower portion of the Colville River Delta. Alaska Department of Natural Resources (ADNR) manages the state lands within the Plan Area.

#### NATIVE LANDS

Kuukpik Corporation owns approximately 222,100 acres within the Plan Area. ASRC holds the subsurface estate under these lands and must consult with Kuukpik prior to sale or lease of any subsurface resources. These lands are located in both the Colville River Delta, along the main and Nigliq channels, and in the eastern portion of National Petroleum Reserve-Alaska.

#### OTHER PRIVATE LANDS

There are approximately 2,500 acres of privately owned lands in the Plan Area, most of which are Native allotments. The Plan Area also includes almost 80 acres patented to the Helmericks family in 1984.

**TABLE 3.4.6-1 APPROXIMATE ACRES FOR DIFFERENT OWNERSHIPS IN THE PLAN AREA**

| Land Status | Acres |
|---|---|
| BLM-managed | 560,900 |
| State[1] | 104,500 |
| Kuukpik Corporation[2] | 222,100 |
| Other private[1] | 2,500 |
| **TOTAL** | **890,000** |

Note: Ownership reflects surface ownership. Numbers are rounded.
[1]Represents selected and conveyed lands.
[2] All lands conveyed.

### 3.4.6.2 Current Land Uses

Land uses on the North Slope is regulated by different entities in different areas. Land uses within the National Petroleum Reserve-Alaska is regulated by the BLM through identification of special land uses areas and through lease or permit conditions. Land uses outside the National Petroleum Reserve-Alaska is subject to local government land use regulations adopted by the NSB (Title 19), as well as by coastal management programs at the state and local level. The Alaska Coastal Zone Management State Coastal Zone regulations (6 AAC 80) and the NSB Coastal Management Plan Enforceable Policies (19.70.050) regulate coastal uses in the area consistent with the federal Coastal Zone Management Act (CZMA) (16 USC 1456). Land uses on state-owned lands is further restricted via lease or permit conditions from the ADNR.

The poor soil conditions and lack of access in the Plan Area limit uses of these lands. Of the approximately 890,000 acres in the Plan Area, the Alpine Field development accounts for approximately 100 acres, the village of Nuiqsut accounts for approximately 5,900 acres, and the remaining area is undeveloped, with the exception of that used for subsistence-related camps and cabins, and that owned by the Helmericks family in the northeast part of the Colville River Delta. Oil exploration and scientific research activities occur in various locations throughout the Plan Area. Limited recreational activity occurs in the study area, as discussed further in following sections. North Slope Alaska Natives, particularly those in Nuiqsut, use the study area extensively for subsistence hunting and gathering, as previously described.

The BLM has historically authorized short-term land use permits for the following types of land uses in the portion of the Plan Area within the National Petroleum Reserve-Alaska:

- Annual overland resupply transport that uses track- or low-pressure equipped vehicles between various North Slope villages
- Activities allowed by Minimum Impact Permits, including the off-season staging of seismic equipment, clean-up of old military sites, and paleontological digging in the Colville River drainage at Ocean Point
- Annual winter geophysical research conducted by companies throughout the Plan Area
- Continued authorized research (such as revegetation at well sites and climatic studies)
- Various communications- and navigation-related activities authorized for federal agencies and private companies
- Commercial and guided hunting

In addition to these authorized uses, a number of unauthorized uses occur within the study area. These uses primarily consist of cabins and camp sites that are not on Native allotments or other Native lands. Although these cabins are not protected under any existing laws, the BLM has been consulting with the NSB about the identification and regulation of these areas.

### SPECIAL AREAS, SPECIAL MANAGEMENT ZONES, AND LAND USES EMPHASIS AREAS

Certain areas of the Plan Area within the National Petroleum Reserve-Alaska have been classified as special land uses areas. Under the NPRPA, the Secretary of the Interior has broad authority to designate areas within the National Petroleum Reserve-Alaska as Special Areas. Special Areas were designated by the Secretary of the Interior pursuant to the NPRPA because they contained significant subsistence, recreational, fish and wildlife, or historical or scenic values. Petroleum exploration in the Special Areas was to be conducted in a manner that would ensure maximum protection of these values to the extent consistent with the requirements of the NPRPA (BLM and MMS 1998a).

Special Management Zones (SMZs) were a product of the BLM’s 1983 Final EIS and ROD on oil and gas development in the National Petroleum Reserve-Alaska (BLM 1983b). The 1983 FEIS and ROD identified four SMZs, three of which occur within the Plan Area: the Teshekpuk Lake SMZ; the Colville River SMZ; and the Beaufort Sea Coast SMZ. The first two of these had boundaries similar to designated Special Areas. The Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and ROD (BLM and MMS 1998b) did not retain the SMZs. The 1983 EIS also deferred leasing in the Fish Creek Delta and adjacent salt marshes to allow for further ecological study and along the Colville River to allow for a wild and scenic rivers (WSR) study.

During the planning process for the northeast portion of the National Petroleum Reserve-Alaska, the BLM identified specific areas with significant resources and designated these areas as Land Use Emphasis Areas (LUEAs). The BLM used LUEAs in the Northeast National Petroleum Reserve-Alaska IAP/EIS to identify geographic areas with important specific resources where the BLM considered management emphasis to meet its responsibilities (BLM and MMS 1998a). Several stipulations from the Northeast National Petroleum Reserve-Alaska Final IAP/EIS ROD discuss restrictions associated with LUEAs (see Appendix D). The LUEA classification is not an administrative or legislative designation and does not carry regulatory authority. Figure

1.1.1-3 shows the Special Areas, Figure 3.4.6.1-2 shows the LUEAs, and Figure 3.4.6.1-3 provides a graphic representation of the oil and gas leasing stipulations.

SMZs and LUEAs are similar to Special Areas in that they were designated to identify and protect specific surface resources. They differ from Special Areas in that SMZs and LUEAs are not legislative designations and carry no regulatory authority.

#### SPECIAL AREAS AND SPECIAL MANAGEMENT ZONES

The 1983 Final EIS (BLM 1983a) and ROD (BLM 1983b) described the following areas in the ASDP Area:

- The TLSA had been established by the Secretary of the Interior in 1977 to minimize impacts on waterfowl.
- The CRSA had been established by the Secretary of the Interior in 1977 to minimize impacts on peregrine falcons.
- The Beaufort Sea Coast SMZ, including barrier islands within the National Petroleum Reserve-Alaska and 2 miles onshore at Elson Lagoon, the mouth of the Kalikpik River, and the Fish Creek Delta and salt marsh area, was established in the 1983 EIS to minimize impacts on waterbirds.
- In the ROD for the 1983 EIS, 200-meter setback zones were established for all rivers with subsistence fisheries.
- In the ROD for the 1983 EIS, leasing was deferred until July 1987 in the Fish Creek Delta and adjacent salt marshes to allow the USFWS the opportunity to complete ecological studies.
- In the ROD for the 1983 EIS, a 4-mile-wide corridor centered on the mid-stream of the Colville River was withdrawn from mineral development until September 1984 while Congress evaluated a recommendation to give the river WSR status.

#### LAND USES EMPHASIS AREAS

The 1998 Northeast National Petroleum Reserve-Alaska Final IAP/EIS (BLM and MMS 1998a) and ROD (BLM and MMS 1998b) described the following areas in the ASDP Area. These documents superseded the decisions in the 1983 ROD (BLM 1983b). Excerpts from the 1998 ROD (BLM and MMS 1998b), including stipulations for the following areas, can be found in Appendix D of this FEIS.

- The TLSA was described as an area that encompasses important goose molting areas, caribou calving and insect-relief habitat, and all of Teshekpuk Lake. The 1998 IAP/EIS (BLM and MMS 1998a) stated that the TLSA is a long-standing subsistence area of special importance to subsistence users because of the caribou and fish resources. LUEAs within the TLSA include the Teshekpuk Lake Watershed, Goose Molting Habitat, Spectacled Eider Breeding Range, TLCH, and the portion of the Fish Habitat LUEA associated with Teshekpuk Lake and the Miguakiak River.
- The CRSA was described as an area encompassing up to 14 miles north and west of the Colville River (within the boundary of the National Petroleum Reserve-Alaska). It was created to protect the arctic peregrine falcon, listed as an endangered species when the 1983 Final EIS was published. LUEAs within the CRSA include the Colville River Raptor, Passerine, and Moose Area; the portion of the Fish Habitat LUEA associated with the Colville River; the Umiat Recreation Site; Scenic Areas; and potentially the Colville River WSR, if this designation were to be established.
- The boundary of the Teshekpuk Lake Watershed LUEA coincides with that of the TLSA within the Plan Area. This LUEA was set aside because this region is one of the most productive, diverse, and unique wetland ecosystems on the North Slope. Within the northwest portion of the Plan Area, the attributes of the Teshekpuk Lake Watershed LUEA include a complex shoreline that features bays, spits, lagoons, beaches, and shoal areas; complex water flow patterns in an extraordinarily flat landscape; deep lakes that provide overwintering habitat for fish; and numerous small streams.

- The Spectacled Eider Breeding Range LUEA, encompassed by the TLSA, was established to protect nesting and brood rearing areas for the threatened spectacled eider. Approximately 16 percent of the North Slope population of spectacled eiders nest near Teshekpuk Lake within this LUEA. The Spectacled Eider Breeding Range LUEA occurs in the northwest portion of the Plan Area.
- The TLCH LUEA, encompassed by the TLSA, was established to protect calving and insect relief habitat important to the Teshekpuk Lake caribou herd. The TLCH LUEA occurs in the northwest portion of the Plan Area.
- The Fish Habitat LUEA contains numerous water bodies that provide important spawning, migration, rearing, and overwintering habitat for anadromous and resident fish species. Within the Plan Area, the Fish Habitat LUEA includes corridors extending 0.5 mile from the west bank of the Colville River (including the river) and 0.25 mile from either bank of Fish and Judy creeks. It includes the beds of these two creeks, as well as the shores and beds of Teshekpuk Lake and other lakes west of the ASDP Area.
- The Colville River Raptor, Passerine, and Moose LUEA, within the Plan Area, extends from the eastern boundary of the National Petroleum Reserve-Alaska at approximately Ocean Point upstream to 1 mile west of the bluffs of the Colville River.

### 3.4.6.3 Coastal Management

Coastal management on the North Slope is governed several ways through the following: the federal CZMA (16 USC 1456), the NSB Coastal Management Program (CMP) and Land Management Regulations (LMR), and the ACMP, which includes the NSB CMP.

#### COASTAL ZONE MANAGEMENT ACT

The CZMA, enacted in 1972, has been amended several times, most recently in 1996. The act encourages states to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife that use those habitats. The federal program was designed to provide states an ability to participate in federal decisions for activities proposed by federal agencies, as well as activities proposed by private applicants that require a federal permit. Although participation by states is voluntary, once approved, states must implement their programs. To encourage states to participate, the act makes federal financial assistance available to any coastal state or territory that is willing to develop and implement a comprehensive coastal management program.

#### ALASKA COASTAL MANAGEMENT PROGRAM

The Alaska State Legislature enacted the ACMP in 1977. Since enactment, the program has been amended a number of times, including amendments passed by legislature in 2003 and submitted to the Office of Ocean and Coastal Resource Management for approval as a Routine Program Change. These most recent changes require all coastal districts to review and revise their CMPs to meet the new requirements of the ACMP, and to submit their revised CMP to ADNR by July 1, 2005. Until the revised CMP is approved by ADNR, the existing CMP remains in effect.

One of the purposes of the ACMP is to provide balanced use and protection of resources in the coastal area. The ACMP includes local coastal district programs such as the NSB CMP. Regulations provide guidelines for the program including development of local coastal district programs (6 AAC 85), reviews for consistency with the ACMP (6 AAC 50), and statewide standards (6 AAC 80). Formerly housed in the Governor's Office, the ACMP is now the responsibility of the Office of Project Management and Permitting in the ADNR.

Projects situated in coastal areas must be consistent with enforceable policies of the ACMP. These enforceable policies include the statewide standards found in 6 AAC 80 and the enforceable policies included in coastal district programs that have been approved by the ADNR and the Office of the Ocean and Coastal Resource

Management of the U. S. Department of Commerce (USDOC.) Enforceable policies of the NSB are found in Chapter 2 of the NSB's CMP.

The entire Plan Area lies within the boundaries of the NSB. Although federal lands, including those managed by the BLM in the Plan Area, are excluded from the coastal zone under the CZMA, uses and activities on federal lands that affect state coastal zones and their resources must be consistent with the state management programs. The ACMP requires that project activities within the geographic boundaries of the state's coastal zone, including coastal areas of the National Petroleum Reserve-Alaska, must be consistent with the enforceable policies. A description of the NSB's enforceable policies follows the discussion of ACMP statewide standards below.

#### USES AND ACTIVITIES

Nine statewide enforceable policies are listed under the heading of Uses and Activities in the ACMP:

- Coastal development (6 AAC 80.040)
- Geophysical hazard areas (6 AAC 80.050)
- Recreation (6 AAC 80.060)
- Energy-facility siting (6 AAC 80.070)
- Transportation and utilities (6 AAC 80.080)
- Fish and seafood processing (6 AAC 80.090)
- Timber harvesting and processing (6 AAC 80.100)
- Mining and mineral processing (6 AAC 80.110)
- Subsistence (6 AAC 80.120)

#### RESOURCES AND HABITATS

Three statewide standards address resources and habitats: Habitats; Air, Land, and Water Quality; and Historic, Prehistoric, and Archaeological Resources.

#### Habitats (6 AAC 80.130)

The ACMP habitat standards apply to eight coastal habitats, as listed below:

- Offshore
- Estuaries
- Wetlands and tideflats
- Rocky islands and sea cliffs
- Barrier islands and lagoons
- Exposed high-energy coasts
- Rivers, streams, and lakes
- Important uplands

The habitat standards call for the maintenance or enhancement of the biological, physical, and chemical characteristics of these habitats. It is possible for uses and activities that do not maintain or enhance these habitats to be permitted if (1) there is a significant need; (2) there is no feasible or prudent alternative that will conform with the standard; and (3) steps are taken for maximum conformance with the standard.

#### Air, Land, and Water Quality (6 AAC 80.140)

This standard addresses air, land, and water quality concerns through the standards, regulations, and procedures for protecting air, land, and water quality of the ADEC. The 2003 legislation exempts the ADEC from the coordinated ACMP process for activities affecting air, land, and water quality that is subject to AS 46.40.040(b)(1). The issuance of an ADEC authorization establishes consistency with the air, land, and water quality standards in 6 AAC 80.140. For reviews of activities on federal lands and waters where the ADEC does not have an authorization, the ADNR issues the ADEC's consistency finding.

### Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150)

This standard requires the identification of the areas of the coast that are important to the study, understanding, or illustration of national, state, or local history or prehistory. The State Historic presernvation Office (SHPO) interprets this standard to mean that if an area has, or is determined likely to have cultural resources, these areas must be identified. This is accomplished through archaeological surveys, interviews with local citizens, and other research means.

The CZMA and ACMP require that the coastal uses that raise state or federal concerns be addressed as stated in the CZMA, Section 303(2)(C), AS 46.40.060, and AS 46.40.070. Under the ACMP, these activities cannot be arbitrarily or unreasonably restricted or excluded through local district management programs. Uses relevant to activities within the Plan Area include coastal development, recreation, energy facility, transportation and utilities, and subsistence.

## NORTH SLOPE BOROUGH COASTAL MANAGEMENT PROGRAM

In 1984 the NSB adopted its CMP. The NSB CMP was then approved by the Alaska Coastal Policy Council in April 1985 and finally by the federal Office of Ocean and Coastal Resource Management in May 1988. Several revisions occurred between the adoption of the NSB CMP by the NSB and by the Alaska Coastal Policy Council. The most recent changes to the ACMP require all coastal districts to review and revise their CMPs to meet the new requirements of the ACMP, and to submit their revised CMP to ADNR by July 1, 2005. Until the revised CMP is approved by ADNR, the existing CMP remains in effect.

The NSB CMP is applicable inland to approximately 25 miles and beyond along the full length of all major river corridors, including the Colville River. The goals and objectives of the NSB CMP cover a broad range of cultural, economic, subsistence and resource issues. The CMP was developed to protect the subsistence lifestyle and culture of the Inupiat people, and to protect the natural environment, while allowing for compatible resource development to increase economic opportunities. The NSB CMP contains four categories of enforceable policies to help achieve this delicate balance:

Standards for development that prohibit severe harm to subsistence resources or activities and disturbance of cultural historic sites (CMP 2.4.3). The standards specifically state that development shall not preclude reasonable subsistence user access to subsistence resources (CMP 2.4.3(d)) nor deplete subsistence resources below the needs of the local community (CMP 2.4.3(a)). In addition, the standards require cultural resources to be avoided if possible, and require consultation and archeological investigations for those areas that cannot be avoided (CMP 2.4.3e-g).

The enforceable policies on required features for development address use of vehicles, vessels, and aircraft; engineering criteria for structures; drilling plans; oil spill control and cleanup plans; pipelines; causeways; residential development associated with resource development; air quality; water quality; and solid waste disposal. Specifically, CMP 2.4.4(a) calls for vehicles and aircraft to avoid areas where noise sensitive species are concentrated and calls for horizontal and vertical buffers where appropriate. Other sections of CMP 2.4.4 call for development to comply with state and federal regulations regarding water and air emissions, solid waste disposal, and sewage disposal (CMP 2.4.4c-e).

Best effort policies that address uses allowed if there is “significant public need for proposed use and activity” (NSB CMP 2.4.5(1)) and only if developers have “rigorously explored and objectively evaluated all feasible and prudent alternatives” and documented the reasons for elimination of other alternatives (NSB CMP 2.4.5(2)). Under the NSB CMP, development that may adversely affect resources will be allowed only if “all feasible and prudent steps to avoid the adverse impacts” have been taken (NSB CMP 2.4.5.1). This category contains policies that restrict development that could significantly affect and decrease the productivity of subsistence resources or restrict access to these resources unless they meet the conditions described above (NSB CMP 2.4.5.1a-b). Under this category, restrictions are also placed on transportation, mining development, and construction in floodplains and geological-hazard areas. Finally, the best effort policies include requirements to locate, design, and operate facilities in a manner that prevents adverse impacts on fish and wildlife and their habitats; to consolidate facilities to the greatest extent possible; to comply with State coastal management policies; to avoid impacts to cultural use areas; and to avoid impacting transportation to subsistence use areas (NSB CMP 2.4.5.2).

Minimization of negative impact policies require development to limit the amount of adverse impacts of recreational use, transportation and utility facilities, and seismic exploration on the natural environment, wildlife and subsistence. This includes maintaining natural permafrost (2.4.6c), minimizing impacts of transportation on wildlife and habitats (2.4.6b,d,e), and minimizing potential risks associated with geologic hazards (flooding, ice gouging, etc.).

In an effort to implement the coastal management policies described above, the NSB has in place a comprehensive plan and an administrative procedure established under Title 19 of the NSB Land Use Regulations that incorporate parts of the NSB CMP.

#### 3.4.6.4 North Slope Borough Land Management Program

The North Slope Borough Comprehensive Plan and Land Management Regulations (LMRs) were first adopted in December 1982. The LMRs were later revised on April 12, 1990. As part of the 1990 amendments, the NSB incorporated the enforceable policies of the NSB CMP into the LMRs in Section 19.70.050. Other 1990 revisions included the addition of the following policy categories: Village Policies, Economic Development Policies, Offshore Development Policies, and Transportation Corridor Policies. Policies include information about both onshore and offshore oil and gas leasing activities.

These regulations are again undergoing review, and additional revisions are expected to be completed and adopted in 2004. The NSB has indicated that the revisions are being undertaken with the goals of making the regulations more reflective of local concerns and clarifying the permitting process. With the pending revisions, the NSB also proposes the addition of Subsistence Policies to the LMRs.

The NSB requires land use permits for any project that involves ground disturbance. Ground disturbance includes such things as sediment sampling, vegetation sampling, core sampling, mechanized transportation (excluding snowmobiles and four-wheelers), field camps, or any activity that is determined by the NSB Planning and Community Services Department, Permitting and Zoning Division, to constitute a ground disturbance. The applicable NSB permit within the Plan Area is the LMR permit. The LMR categorizes uses into three areas: (1) administratively approved without public review, (2) requiring a development permit and public review before they can be administratively approved, and (3) considered to be conditional development requiring approval by the Planning Commission.

The NSB LMR is considered to the extent practical in any decision by the BLM regarding federal lands. Although the local land use plans are acknowledged, they cannot prohibit activities on federal lands. All activities on federal lands must be authorized by the BLM.

### 3.4.7 Recreation Resources

#### 3.4.7.1 Recreation Setting

The Plan Area is within a vast region of the Arctic and is well suited for non-winter outdoor recreation activities such as backpacking, float boating, fishing, hunting, wildlife viewing, and birding. The Colville River is known for being a gentle, slow-moving river, enabling visitors to enjoy the various scenery and wildlife along its course.

There is no developed road system into or through the Plan Area. As a result, summer recreation access to the area is almost exclusively by charter aircraft from regional locations including Deadhorse, Umiat, Barrow, and Bettles (BLM 2003). Natural features within the Plan Area such as lakes, rivers, gravel bars, and ridges serve as airstrips for these aircraft. The village of Nuiqsut has a maintained landing strip that can by used by the public (via charter flights) but is not promoted for use by nonresidents (BLM 2003). Commercial air flights are conducted by Cape Smythe Air and Frontier Flying Service, Inc. Both services have one flight per day into and out of Nuiqsut all days of the week except Sunday.

The Plan Area is vast and remote, with somewhat primitive recreational opportunities. Most of the Plan Area has characteristics of wilderness such as pristine, natural, and undisturbed landscapes. The opportunity to be isolated from the sights and sounds of other people and to feel a part of the natural environment is quite high. The area is primarily characterized by an unmodified natural environment (no developed recreation sites) with a very low concentration of recreation users and minimal interaction between groups of recreation users. There are no federal, state, or NSB recreational developments or structures in the Plan Area.

#### 3.4.7.2 Recreation Opportunity Spectrum (ROS)

The Recreation Opportunity Spectrum (ROS) was developed for use by both the BLM and the USFWS. The BLM has adopted the ROS to recognize the different types of recreation opportunities on lands under their management. Because the use of snowmobiles and motorized boats is allowed throughout the Plan Area and because the Plan Area is located within the National Petroleum Reserve-Alaska (which is set aside for oil and gas development), the recreation experience in the Plan Area would be classified under the ROS as "semi-primitive motorized" (SPM.) (Delaney 2003, pers. comm.) This classification is characterized by predominantly natural or natural-appearing landscapes; areas that are large enough to impart a strong feeling of remoteness; few user facilities; low road density; and infrequent interaction with other visitors. (BLM 2003).

#### 3.4.7.3 Recreation Activities and Use in the Plan Area

Little is known about specific recreation trends within the Plan Area. To obtain current recreational use information, telephone interviews were conducted with registered outfitter-guides operating within or near the Plan Area. Past or present outfitter guides were contacted to obtain information on the types of recreation occurring in the Plan Area, specifically along the Colville River, and to estimate the number of people traveling to the area in a particular recreation season.

Visitors interested in recreational opportunities choose the Colville River area for a variety of reasons, including vast wildlife populations (especially birds of prey); remoteness; the slow, meandering flow of the Colville River; fossils and geology; and general beauty. Additionally, visitors often participate in more than one activity (such as backpacking and wildlife viewing), making it difficult to estimate exact use numbers for each activity. Overall, the Colville River area is fairly unknown among recreationists who visit Alaska, and many visitors are repeat visitors from outside the state (van den Berg 2003, pers. comm.).

Length of trips in the Plan Area varied between a minimum of 3 to 4 days to a maximum of 3 weeks. The limited amount of recreation that occurs in the southern portion of the Plan Area (Ocean Point and southward) originates outside of the Plan Area and takes place mostly along the Colville River itself. For example, both Ocean Point and Nuiqsut are popular pull-out destinations for outfitter-guides operating from south of the Plan Area. Most of these guides use Umiat as the launching point. Even less recreation occurs in the northern portion of the Plan Area (north of Nuiqsut), and only one outfitter guide (Golden Plover Guiding Company) is actually based within the Plan Area.

It is difficult to accurately estimate the exact level of recreation that occurs within the entire Plan Area. On the basis of conversations with outfitter-guides, estimated summer recreation in the Plan Area is approximately 150 visitors per season.

## RECREATION ACTIVITIES SEASONAL RECREATION

### SUMMER ACTIVITIES

Summer recreation occurs mainly between the warmer months of June and August, with some guides operating into September (mostly for hunting purposes). Although conditions during the summer season can also be harsh, most notably because of the abundance of mosquitoes, June through August tend to be prime months for fishing and birdwatching. At least two outfitter-guides surveyed have traveled as far north as the Colville River Delta toward Harrison Bay, but such trips are much more expensive.

### WINTER ACTIVITIES

Very little winter recreation is known to occur in the Plan Area beyond the immediate area of Nuiqsut. More distant travel is usually associated with subsistence hunting and fishing and with visiting other villages. The gentle terrain and wind-packed snow throughout much of the Plan Area create favorable snow conditions for snowmobile use, dog sledding, and possibly cross-country skiing. The best skiing is in the river and creek drainages where snow is deeper and the hard-packed surfaces are more level. The winds in the Arctic can be a serious deterrent to any recreational activity, particularly when wind blows loose snow that restricts visibility and creates severe wind-chill hazards. The most favorable months for winter recreation activities are April and May, when temperatures are usually higher and periods of daylight are longer (BLM 2003). Actual winter use estimates were not obtained, but use is presumed to be less than 50 participants during the winter season.

## SPECIFIC RECREATION ACTIVITIES IN THE PLAN AREA

The most popular organized recreational activities in the Plan Area are described below, with most information provided from outfitter-guides contacted.

### BIRDING

Birding is by far the most popular reason people visit the Plan Area, especially the areas along the Colville River. Of those outfitter-guides contacted who provide birding tours, all offer between one and two trips per season, with group sizes averaging between 4 and 10 participants. Outfitter-guides offering only one trip per season usually averaged slightly larger group sizes of between 6 and 10 participants. Most visitors participate in birdwatching while either backpacking or boating in the Plan Area (van den Berg 2003, pers. comm.).

Some of the most popular birding locations in the Plan Area include the bluffs along the Colville River (for peregrine falcons and gyrfalcons) and the Colville River Delta area. Although the Delta area is known for its birding potential, many visitors want to simultaneously experience the wilderness and opt for more remote birding locations such as the bluffs along the Colville River (van den Berg 2003, pers. comm.).

Among the most popular species of birds in the Plan Area are the raptors (including the rough-legged hawk and peregrine falcon) and other birds such as the bluethroat and arctic warbler. Outfitter-guides operating birding tours in the Colville River area consider it to be a world-class birding area, both because of its density of birds and because of the various species of birds found there. Although the potential for birdwatching within the Plan Area is considered high by local outfitter-guides, there is almost no promotion of the area for birdwatching, except by the outfitter-guides. On the basis of conversations with local outfitter-guides operating in the Plan Area, birding trip levels are estimated to be approximately 50 participants per season.

### FLOAT TRIPS

Guided float trips along the Colville River area are among the most variable organized activities in the Plan Area because they usually include other activities. Outfitter-guides who offer float trips usually incorporate specific themes into their trips, including natural history, backpacking, birding, and photography. Trips last between 1 and 3 weeks, range from 2 to 10 participants, and usually include kayaks, canoes, and/or rafts. The majority of float trips begin south of Umiat and extend to or just north of Umiat, depending on the number of participants and the predetermined time frame of the trip.

Many outfitter-guides contacted offer only one float trip during the summer recreation season, with several offering at least two trips during a season. The total number of float trips in the Plan Area is difficult to estimate, in part because many visitors who come to the area partake in other recreational activities that are related to float trips. For example, many guides who offer bird tours use boats to access birding areas, as do guides who promote photography or backpacking. On the basis of conversations with outfitter-guides and including other related activities, the estimated participation in float trips in the Plan Area is approximately 50 people per season.

#### SPORT FISHING

Most sport fishing in the Plan Area occurs as part of other activities such as big game hunting and float trips. None of the outfitter-guides contacted gave sport fishing as a primary activity they lead or promote. Much of the fishing occurs during the ice-free summer months (BLM 2003), although the fishing season is open all year. No organized sport fishing occurs during the winter. The winter fishing that does occur is by residents of Nuiqsut and others who reside within the Plan Area.

Fish species sought by visitors include the arctic char, arctic grayling, lake trout, northern pike, whitefish, and various species of salmon (Andreis 2003, pers. comm.). Specific locations for sports fishing in the Plan Area depend mostly on the species of fish being sought. No specific use numbers for sport fishing are available for the Plan Area.

#### OTHER RECREATION ACTIVITIES

Other guided recreation in the Plan Area includes natural history tours, backpacking, fossil tours, photography, scenic overflights, and general scenic viewing. Most of these activities are combined with one or more activities in a typical trip. For example, backpacking and wildlife photography are often combined and offered for a guided tour, depending on the wildlife of interest. Most outfitter-guides offering these types of activities operate only one trip during the season, with group sizes ranging between four and eight participants and trips averaging between 5 days and 3 weeks. As with other guided activities, specific locations for such activities range from both south and north of Umiat, with very few outfitter-guides offering travel north of Nuiqsut.

Limited organized sport hunting occurs along the Colville River. Moose, caribou, and grizzly bears are the most sought-after big game animals. Aircraft are required to access most of if not all of the hunting areas along the Colville River, and boats are used to travel from location to location along the river. Overall, recreational hunters account for only a small fraction of big game animals harvested in the area. Hunting guides operating in the Plan Area average only one or two trips per season, with an average group size between two and six people.

The estimated participation in trips in the Colville River area for these various activities, based on conversations with outfitter guides, is approximately 40 people per season.

### Wild and Scenic Rivers (WSR)

The Wild and Scenic Rivers Act (WSRA) (16 USC 1271-1287), PL 90-542, was approved on October 2, 1968. The act established the National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers could be identified and added to the system. The act authorized the Secretary of the Interior and the Secretary of Agriculture to plan areas and submit proposals to the president and Congress for addition to the system. Rivers are classified as wild, scenic, or recreational. Hunting and fishing are permitted in components of the system under applicable federal and state laws (USFWS, not dated).

A study completed in July 1972 by the Bureau of Outdoor Recreation (Alaska Task Force Report on Potential Wild and Scenic Rivers as part of the Native Claims Settlement Act) identified the Colville River (as well as the Ikpikpuk) as a WSR and recommended further review. The second WSR inventory was conducted in 1978 and again identified the Colville River as a candidate for WSR designation. The report (Section 105[c]) stated: “The Colville River from its headwaters to Umiat meets the criteria established by the WSRA for inclusion into the National WSR system as a wild river area. Outstanding values associated with the river area are: wildlife, geologic, recreational, and possible archeological.”

Under provisions of the WSRA, Congress had a time frame of 3 years after submission of the latest study to address designation of the Colville as a WSR but failed to make any decision on the river’s status. Because the 1978 study was found to be sufficient for congressional purposes, the Colville was placed under a protective management status. Protective management limits projects that would adversely affect the free-flowing nature of the river and provides for the enhancement of the outstanding values that made the river eligible for WSR status. Interim protection of the WSR values for the Colville River remained in effect until September 1984 (BLM 2003).

Although the physical characteristics and associated resource values make the Colville River eligible for designation, the river has been determined not “suitable” for WSR designation. This decision was based on the fact that other landowners within the potential WSR corridor did not support this action and, without their cooperation, management as a WSR would be ineffective (BLM 1998a). The current ASDP EIS is tiered to the Northeast National Petroleum Reserve-Alaska IAP/EIS, which considered WSR status for watersheds in the planning area. There is no new information regarding the river’s “suitability” for inclusion as a WSR since the 1998 analysis was completed. In addition, the WSR status is outside of the scope of this specific development plan; therefore, it is not considered further in this EIS.

### 3.4.8 Visual Resources

#### 3.4.8.1 Overview of Visual Resource Management (VRM) System

Visual resources are described below in the context of the Visual Resource Management (VRM) system. The VRM is the system used by the BLM to inventory visual resources. It also provides a way to analyze potential visual impacts and apply visual design techniques to ensure that surface-disturbing activities are in harmony with their surroundings. However, it should be noted that the Plan Area includes non-federal lands, that is, State of Alaska lands and Kuukpik Corporation lands. Neither of these entities has a system or methodology to assess the impacts of projects to the visual resources of the landscape. While the BLM cannot apply stipulations to non-federal lands, the VRM system will be applied to the entire project area. Implementing VRM involves two steps: conducting an inventory and providing an impact assessment. During the inventory stage, data are collected to identify the visual resources of an area and identify an inventory class.

VRM classes are used to define minimum management objectives. Each class describes the degree of modification allowed in the basic elements of the represented landscape type in question. The VRM system provides a way to identify and evaluate scenic values to determine the appropriate levels of management. The VRM recognizes the following classes.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.
- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer.
- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract the attention but should not dominate the view of the casual observer.

- Class IV Objective: To provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high and may dominate the view and be the major focus of viewer attention.

Inventory classes are informational in nature and provide the basis for considering visual values in the Resource Management Plan (RMP) process. The data used to develop visual classes include scenic quality, visual sensitivity, and distance zones. Scenic quality data needed to help establish VRM classes were collected as part of the 1979 105c report. A summary of these data is found in the project file, and distance zones are discussed in the context of impact assessment in Section 4 of this EIS.

#### VISUAL SENSITIVITY

Visual sensitivity is a key component in identifying VRM classes. In the 1979 105c report, visual sensitivity used two factors: the amount of use an area receives and viewers' expressed attitudes toward what they see. The report mapped areas of visual concern, delineating them as high, moderate, or low concerns for changes in scenic quality and for prevention of visible change in the landscape. Additional data used to determine sensitivity were obtained from meeting notes from subsistence advisory council meetings, written comments on the draft of the Northeast National Petroleum Reserve-Alaska IAP/EIS, and from conversations with agency staff knowledgeable about use within the study area. Areas identified as sensitive included known travel routes, areas of human habitation, areas of traditional use, and Native allotments. Relative to the ASDP, numerous areas were noted to have potentially high visual sensitivity.

### 3.4.8.2 Interim Visual Resource Management Classes in the ASDP Area

Classes in VRM were not established in the Northeast National Petroleum Reserve-Alaska IAP/EIS. It is BLM policy that interim VRM classes be established when a project is proposed for which no VRM objectives have been approved. Using scenic quality, sensitivity, and distance zones, as well as other management factors, the project area was assigned three VRM classes. The Colville River from the southern project boundary to Harrison Bay, including the Delta area, is VRM Class II. Fish Creek, Judy Creek, and the Ublutuoch River are VRM Class III. The rest of the project area is VRM Class IV (Figure 3.4.8.2-1).

Most of the project area falls within the scenic category identified as wet plains. This scenic unit is composed of flat plains near the coast, which includes thousands of small lakes, as well as small streams and rivers. The distinguishing features are its vastness and flatness. The landform is described as a flat continuous plain, displaying little relief other than a few stream corridors and pingos. Variation in elevation is approximately 2 meters. The casual observer sees little contrast in the vegetation because the tussock-forming species that compose the tundra are short and matted. A few larger plants (willow) are found along stream and river channels but are not evident enough to create interest. Notable contrast occurs between vegetated and nonvegetated areas along rivers and streams in the gravel bars and bluffs. The composition of the vegetation produces little variation in form, texture, and pattern. Water is the dominant visual element whether it be lakes, slow-moving streams, or meandering rivers. Colors provide contrast between the greens and browns of vegetation and barren soils and the blues and grays of the water bodies. Cultural modifications include manmade structures associated with Nuiqsut, isolated camps, and oil and gas facilities.

A small portion of the project area is described as coast offering broad and far horizons and big skies. Here the landform offers little physical relief. There is little contrast in vegetation, with the most contrast between vegetated and nonvegetated areas, and little variation in form, texture, and patterns. The Colville River Delta is the dominant element in this coastal landscape with numerous channels creating contrast between the water and land. Changes in color hue, value, and intensity are subtle. Again, the contrast is created between the vegetation, barren ground, and water bodies. Only a small part of the area has been modified by man. These cultural modifications include camps and oil and gas facilities.

#### 3.4.8.3 Establishing Key Observation Points

During a four-day period in July 2003, BLM and ENTRIX staff visited many areas identified as sensitive and established 24 key observation points (KOPs) based on known travel routes and areas where people live. Locations of those KOPs are depicted on Figure 3.4.8.2-1. Six of these KOPs, considered representative of existing visual conditions in the Plan Area, are described in the following sections.

## COLVILLE RIVER DELTA FACILITY GROUP KOPS

### EXISTING CONDITIONS AT CD-1 AND CD-2

The total for CD-1 including an airstrip is 68.6 acres, while the total footprint for CD-2 including an access road is 24.6 acres. A boat launch pad associated with the Alpine Field is 0.1 acres. The total acreage permitted by USACE to be covered by gravel at CD-1 and CD-2 is 112.302 acres. CD-1 consists of numerous buildings (maintenance, storage, hazardous waste, worker dormitories), and the tallest buildings at CD-1 are approximately 75 feet tall, including 10-foot pillars. Several structures are found at CD-2, including wellhead houses, pig launcher/receiver building, a communications building, and a drill rig. At 205 feet in height, the drill rig is the tallest structure at CD-2. Drill rigs are temporary structures that are active (drilling) during different times of the year. For example, for the sites in the Colville Delta area, as displayed in Table 2.4.1-5, CD-3 will be drilled in the winter for several years, whereas CD-4 would be drilled in the summer. According to Table 2.4.1-5, CD-3 drilling could occur in the winter through 2011, and drilling at CD-4 could occur through the summer of 2009. CD-1 and CD-2 are connected by a 50-foot-wide gravel road that is 3 miles long. Additionally, CD-1 has an airstrip, which is 5,900 feet in length. Figures 3.4.8.3-1 and 3.4.8.3-2 show views of CD-1 and CD-2 from 5 and 15 miles south, respectively.

### VIEWS LOOKING WEST-NORTHWEST, CONFLUENCE OF COLVILLE AND ITKILLIK RIVERS, KOP #3

This KOP is near the confluence of the Colville and Itkillik rivers close to water level, below the level of the surrounding terrain (N 70.13623°, W 150.98245° WGS84, as shown on Figure 3.4.8.3-3).

The site is representative of flat horizontal lines along the horizon with rounded curves and irregular lines along the gravel bars on the Colville River. Vegetation at the site is mainly woody shrubs such as willow. The vegetation is fairly dense and of uniform smooth texture on the uplands but has a scattered coarse texture on the gravel bars. The dominant landform color is a blend of grays and greens, with vegetation of various hues of green, while grays and browns/tans are visible in the barren ground of gravel bars and short bluff areas along the river, with blues and grays in the water.

### VIEWS LOOKING NORTH FROM VILLAGE OF NUIQSUT, KOP #12

Nuiqsut is approximately 8 miles southeast of CD-1 and 9 miles from CD-2, which are both in the background zone. The population of this community is approximately 450 people. Meeting notes from recent scoping efforts indicate the area around Nuiqsut is of high visual value to residents of this community. KOP #12 is on the north side of the village of Nuiqsut (N 70.23092°, W 151.01349° WGS84, as shown on Figure 3.4.8.3-4).

Cultural modifications visible from this KOP include the community of Nuiqsut, the landfill, and associated access roads, all in the foreground-middleground zone. CD-1 and CD-2 are observable to the north in the background zone. A pipeline is visible running north to south within the foreground zone. There is a strong contrast between the horizontal lines of the natural environment shown in the northward view of Figure 3.4.8.3-4 and the vertical lines seen from other perspectives of buildings and other structures associated with the community, CD-1, and the CD-2 drillrig. Color contrast is introduced through the gravel road, pipelines, culverts, and other structures that have different colors than the various hues of green associated with the vegetation. Some contrast in texture occurs in the immediate foreground between smooth structures and the coarse vegetation. The community profile introduces a coarse texture in contrast to the smooth texture of the vegetation.

#### VIEWS LOOKING SOUTH FROM NIGLIQ CHANNEL, KOP #20

KOP #20 is near the Nigliq Channel (N 70.31232°, W 151.03888° WGS84, Figure 3.4.8.3-5). This KOP represents views from water level and not from the uplands. The landform of this KOP is a wide and flat river channel with low horizons. The uplands rise less than 2 m above the river level. The predominant color of the foreground-middleground zone is brown and gray from the river rocks and silt along the Nigliq Channel. The vegetation presents a variety of hues of green. The background and seldom seen zones present as smooth and flat. However, the foreground-middleground zones transition from irregular coarse to regular smooth as distance increases and the shapes of vegetation become blurred. The river channel presents grays and blues of the water with irregular curved lines while the gravel bars and river banks have various shades of browns and grays.

Several permanent structures were visible from KOP #20. These cultural modifications include CD-2, the CD-1 (4 miles), and pipelines. The buildings, pipeline supports, and drill rig introduce regular horizontal and vertical lines into a predominantly irregular horizontal landscape in the background zone. The existing facilities, with white, blue-green, and orange buildings, create an overall strong contrast with the natural colors of their surroundings.

#### VIEWS LOOKING NORTHEAST FROM NIGLIQ CHANNEL, KOP #21

KOP #21 is near the Nigliq Channel in view of cabins on the west side of the channel (N 70.39138°, W 151.08667° WGS84, Figure 3.4.8.3-6). This KOP is along the uplands above river level.

The landform of KOP #21 is flat, open tundra near the Bering Sea (Harrison Bay), which presents as low horizontal lines. The foreground-middleground has curved and some irregular lines because of water bodies. The predominant color of the foreground-middleground is various shades of green with uneven, random browns associated with unvegetated areas. The water adds blues and grays, while the river channel adds browns and tans from rocks and silt. The foreground-middleground vegetation has a medium texture and is uneven and random because of the types of vegetation growing on the tundra, giving a mottled appearance. The background, seldom-seen zones have a smooth texture. Several cultural modifications were visible from KOP #21. These included cabins on the west side of the Nigliq Channel and CD-2 to the northeast (4 miles) and CD-1, also to the northeast (5 miles). These structures introduce vertical lines into a predominately horizontal landscape. Contrast is also present in the whites and orange colors of the structures.

#### VIEWS LOOKING WEST FROM NORTHWEST FROM A POINT WEST OF THE LOWER NIGLIQ CHANNEL, KOP #18

KOP #18 is near a cabin (N 70.31593°, W 151.35501° WGS84, Figure 3.4.8.3-7). This KOP is near water level, slightly lower than the surrounding terrain. One permanent structure, a cabin, is visible from KOP #18. The vertical lines of the structure contrast with the horizontal lines associated with the natural surrounding vegetation and water. The structure is visible in the foreground-middleground zone and could attract the attention of a casual observer. The landform is very flat, with brown sand and blue to gray water bodies. In general, the landform texture is rough as a result of the barren ground visible alongside the creek. The remaining landform is covered with two-toned vegetation that is light and dark green in color. The vegetation is a grass and woody shrub mixture that is rough and patchy rather than evenly distributed and smooth in texture.

### FISH-JUDY CREEKS FACILITY GROUP KOPS

#### VIEWS LOOKING WEST FROM NEAR THE CONFLUENCE OF FISH AND JUDY CREEKS, KOP #14

KOP #14 is near the confluence of Fish and Judy creeks (N70.24977°, W 151.90631° WGS84, Figure 3.4.8.3-8). This KOP is situated above the river plain on the uplands, resulting in a view of both the immediate river valley and extended views of the coastal plain. The landform is mostly flat and low with simple horizontal lines in the foreground. Irregular line contrast is created between the vegetated and nonvegetated areas in the foreground. Exposed bluffs along the creek create a contrast between the vegetation and barren ground in color and texture. The line form of the bluffs is irregular diagonal. Continuous stretches of sandbars and beaches are observable in the foreground, creating smooth rounded lines in contrast to the flat horizontal lines of the horizon. Vegetation creates an irregular texture in the foreground transitioning to smooth fine textures in the background. No permanent structures are present.

#### KALIKPIK-KOGRU RIVERS FACILITY GROUP KOPs

No KOPs were established for the Kalikpik-Kogru Rivers Facility Group.

## 3.4.9 Transportation

Alaska's transportation system consists of roadways, railroads, air facilities, and marine facilities. Because of the large size, small population, and extreme climatic conditions of the state, marine and air transportation play a large role in the transport of materials and people throughout the state and particularly to facilities on the North Slope. In addition to these transportation systems, oil and gas products are transported throughout the North Slope and from the North Slope to market through a series of pipelines. Transportation facilities associated with activities in the Plan Area are discussed in the following sections (Figure 3.4.9.1-1).

Although the Federal Highway Administration (FHWA) and the FAA control construction of public roads and airports, these agencies do not typically regulate traffic levels on facilities once those facilities are constructed. There are no regulatory programs that control construction or use of private transportation facilities, although land management agencies, such as the state and the BLM can limit construction and use of transportation facilities on their lands through permit or lease conditions.

### 3.4.9.1 Road Systems

#### STATE ROADS

The Dalton Highway provides road access to the North Slope. This 415-mile gravel highway from Livengood to Deadhorse was constructed to support oil development on the North Slope and was originally limited to authorized commercial traffic beyond the Yukon River Bridge (Figure 3.4.9.1-1). Since 1994, the entire Dalton Highway has been open to the public. Traffic on the road now consists of a mixture of commercial trucks, private vehicles, and commercial tour operators. Commercial trucks still composed almost 40 percent of the vehicle traffic on the Dalton Highway in 2000 (ADOT&PF 2003a). In 2002, 549 loads of freight totaling approximately 14 million pounds arrived by road to the North Slope for operations at the Alpine Field (CPAI 2003b). Noncommercial traffic occurs primarily during the summer and on the southern portion of the highway. Recent traffic levels reported by the Alaska Department of Transportation and Public Facilities (ADOT&PF) are listed in Table 3.4.9-1

**TABLE 3.4.9-1 ADOT&PF HISTORIC TRAFFIC LEVELS FOR THE DALTON HIGHWAY**

| | Annual Average Daily Traffic (vehicles) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Yukon River Checkpoint | 291 | 385 | 398 | 490 | 388 | 410 | 266 | 266 | 223 |
| Bonanza River Checkpoint | 211 | 220 | 320 | 302 | 293 | 240 | 283 | 283 | NA[a] |
| Dietrich River Checkpoint | 205 | 210 | 185 | 254 | 232 | 172 | 207 | 207 | 254 |
| Kuparuk Checkpoint | 174 | 205 | 182 | 301 | 240 | 191 | 230 | 230 | 274 |

Source: ADOT&PF 2003a
Note:
[a] Bridge under construction; numbers not available
NA = not available

The Dalton Highway is typically 28 feet wide; however, the ADOT&PF is in the process of upgrading the highway to a uniform width of 32 feet. The road is also being resurfaced with a high-float emulsion to improve road quality and reduce vehicle fugitive dust emissions. The ADOT&PF expects 90 to 95 percent of the highway to be resurfaced by the end of 2006 (ADOT&PF 2001b, in TAPS EIS).

Although the Dalton Highway is currently the only state road providing access to the North Slope, the ADOT&PF is currently evaluating the potential to construct additional roads in this area. In particular, the Colville River Road has been identified as one of the ADOT&PF's top priorities for road construction (ADOT&PF 2003b, 2003c). The proposed 18-mile road would start at the southwestern end of the existing Spine Road and would extend west to a proposed Colville River bridge site. The proposed bridge site is located 3 miles south of Nuiqsut and approximately 11 miles upstream from the Alpine Field. The Colville River Road would continue another 2.3 miles after crossing the proposed Colville River bridge, to connect to a BIA-proposed road to Nuqusit. The State of Alaska has also indicated a desire to construct additional roads in the National Petroleum Reserve-Alaska. Access on these roads could be limited to oil industry traffic and residents of Nuiqsut (ADOT&PF 2003b).

### OIL INDUSTRY ROADS

The oil industry has developed an extensive network of access roads to facilities on the North Slope. Almost 350 miles of roads have been developed to serve existing production fields on the North Slope (BLM 1998a). These roads are restricted to authorized traffic, which includes some use by local residents. The main road within the Prudhoe Bay and Kuparuk operations area is the Spine Road. This gravel road provides access from the Dalton Highway at Deadhorse to oil facilities from Endicott in the east to Kuparuk in the west. Most oil facilities on the North Slope are connected to Spine Road by gravel roadways that are typically 30 to 35 feet wide and approximately 5 feet in elevation.

The existing Alpine Field, in the Colville River Delta west of concentrated oil industry development in the Prudhoe Bay and Kuparuk areas, provides an exception to the typical infrastructure for oilfield access. Although the Alpine Field has a road connecting the two production facilities, there is no all-season road that connects the Alpine Field with oil industry infrastructure to the east. Access to the Alpine Field occurs by air or by ice road or low ground pressure vehicle in the winter.

### ICE ROADS

Alaska Natives have historically used frozen rivers and other waters as ice roads for winter travel and for transporting supplies, such as fuel. Winter ice roads now provide access to oil industry roads and the Dalton

Highway for Nuiqsut residents. Oilfield development on the North Slope has also relied on ice roads to provide access for facility construction.

#### WINTER VEHICLE AND LOW GROUND PRESSURE VEHICLE TRAVEL

In addition to the use of ice roads, winter overland access on the North Slope also occurs by low ground pressure vehicles. These vehicles are used to transport goods and materials over land during the winter and after July 15 on state lands.

### 3.4.9.2 Aviation Systems

#### AVIATION FACILITIES

Air transportation is critical in Alaska because of the distances involved and the limited road access available. Air transportation provides year-round access to remote communities and oil industry facilities for goods and people. It also provides cargo transport. The primary state international airports are in Anchorage, Fairbanks, and Juneau. Alaska also has an extensive network of state owned and operated rural airports, including the airports at Deadhorse and Barrow. Nuiqsut has a public airport owned and operated by the NSB. In addition, the oil industry has developed private airstrips to support facilities. Dozens of airstrips, both paved and unpaved, exist within the National Petroleum Reserve-Alaska and the Plan Area (Figure 3.4.9.1-1).

##### STATE AIRPORTS

The state owned and operated Deadhorse Airport has an asphalt runway (Rwy 04/22) that is 6,500 feet long and 150 feet wide (FAA 2003a). FAA records indicate that five aircraft and two helicopters are based at the airport, although the number of aircraft operating out of this airport changes by season depending upon oil industry activity levels (FAA 2003a). This airport serves an essential role in moving goods and people from Alaska and the Lower 48 states to the North Slope. The latest annual operations estimate for Deadhorse was 19,600 operations (takeoffs or landings), with almost half of these operations being general aviation, rather than air carrier, commuter, or air taxi operations (FAA 2003a). Alaska Airlines provides scheduled public air carrier operations into Deadhorse; other operations are chartered and primarily related to transporting oil industry personnel and goods (Alaska Airlines 2003, Deadhorse Airport 2003c). The oil industry's Shared Services Aviation organization provides at least two Boeing 737 jet flights to Deadhorse every weekday and one on Sunday. In addition, Shared Services Aviation provides jet service from Deadhorse Airport to Kuparuk, as well as multiple weekday and Sunday flights from Deadhorse to the Alpine Field, Badami, and Kuparuk by Twin Otter or CASA plane.

The state also owns and operates the Wiley Post-Will Rogers Memorial Airport in Barrow. The runway at Barrow is 6,500 feet long and 150 wide and is surfaced with asphalt (FAA 2003b). A total of 16 aircraft and 3 helicopters are reportedly based at this airport. Annual operations are estimated at 11,750, of which 1,200 are air carrier operations, 2,000 are commuter aircraft operations, and 4,000 are air taxi operations. The remaining operations are general aviation, except for 50 operations listed as military. Alaska Airlines provides scheduled passenger operations into Barrow with two flights per day.

##### OTHER PUBLIC AIRPORTS

The NSB owns and operates the Nuiqsut Airport, which has a 4,343-foot gravel runway that is 90 feet wide (FAA 2003c). No aircraft are based at this airport. The Nuiqsut Airport has annual operations of 1,500 flights, of which 1,200 are classified as air taxi operations. There are no scheduled air carrier operations at the airport, although there are scheduled air taxi and commuter operations, chartered passenger and cargo operations, and private general aviation.

#### OIL INDUSTRY AIRPORTS

The oil companies operating on the North Slope operate and maintain one primary airstrip at Kuparuk. This airstrip is approximately 6,500 feet long and 150 feet wide. Additional airstrips are located at the Badami and Alpine Field production sites. Shared Services Aviation provides air transportation services to CPAI, BPXA, and Alyeska Pipeline Service Company. Shared Services Aviation operates Boeing 737 jet aircraft to transport personnel to and from the North Slope. Shared Services Aviation also operates a Twin Otter and a CASA 212 to transport personnel to various operations sites within the North Slope area. In addition, the oil industry charters Twin Otter and Convair aircraft for flights along the TAPS and uses charter helicopter support as required.

Shared Services Aviation provides up to five daily jet flights to and from the North Slope, as well as multiple daily flights between various North Slope operations sites. For example, an estimated two to six daily Twin Otter flights and one to three daily CASA flights are currently scheduled into the Alpine Field (CPAI 2003a). These flight schedules are subject to change depending on passenger demands at the various sites.

### 3.4.9.3 Marine Transportation

Marine transportation is vitally important to the oil industry because of the cost-effectiveness of transporting heavy equipment and cargo with a low value-to-weight ratio by barge. Alaska's major ports are in Anchorage, Seward, Valdez, and Whittier, and much of the cargo shipped to the North Slope passes through these ports. Some cargo is transferred from barge to railroad at the ports; other cargo continues by barge to the North Slope.

There is no deepwater port on the North Slope; facilities are limited to shallow-draft docks with causeway-road connections to facilities at Prudhoe Bay and beach landing areas at some local communities. Freight is typically offloaded from cargo ships and barges to shallow-draft ships for lightering to shore. Smaller craft are sometimes used to transport cargo upriver to communities that are not situated on the coast, such as Nuiqsut. Ice conditions in the Beaufort Sea limit marine shipments to the North Slope to a very short period from late July through early September.

Five docks are located within the oil industry facilities on the North Slope: East Dock, two at West Dock, one at Badami, and one at Oliktok Point (Figure 3.4.9.1-1 ). The East Dock facility at Prudhoe Bay is no longer in operation. West Dock at Prudhoe Bay is a 13,100-foot-long by 40-foot-wide, solid fill, gravel causeway, along the northwest shore of Prudhoe Bay east of Point McIntyre. The causeway has breeches required for fish passage, and bridges span the breeches. Transportation of vary large equipment (such as drill rigs) over these bridges is limited due to width and weight restrictions. Heavier equipment delivered to West Dock can be staged there until winter when the equipment can be transported by ice roads to the desired location. Water depths around the causeway average 8 to 10 feet (BLM 1998a). West Dock has two unloading facilities, one 4,500 feet from shore with a draft of 4 to 6 feet and another 8,000 feet from shore with a draft of 8 to 10 feet. Badami's solid fill gravel dock is 1,000 feet long and has a maximum water depth of 6.4 feet. Use of the dock is limited to light barges and small craft. The dock at Oliktok Point extends 750 feet from shore and has a draft of 5 feet at the bottom of the dock boat ramp and a draft as deep as 10 feet at the dock face (BLM 1998a).

Primarily, the oil industry uses marine transportation to transport oversize equipment, such as large drilling modules, during exploration and construction of operations facilities. Marine transportation is rarely used for supplies during normal operations of individual fields, such as the Alpine Field (CPAI 2003a).

### 3.4.9.4 River Transportation

Multiple waterways in the Colville River Delta are used for transportation inland from coastal areas. The most commonly used waterways in the plan area include the Ublutuoch River and the Nigliq, Sakoonang, Tamayayak, and Ulamnigiaq channels. As shown on Figure 2.4.1.1-1, the later three channels are in the delta between CD-1 and CD-3. Both the oil industry and local residents use boats on these waterways.

Industry boat usage in the area is limited to spill response training by Alaska Clean Seas. This oil spill response cooperative, whose membership includes oil and pipeline companies, is responsible for providing personnel, material, equipment, and training response capability for responding to and cleaning up an oil spill on the North Slope. Due to existing operation of oil production facilities at CD-1 and CD-2, as well as the Alpine Pipeline that crosses under the Colville River, Alaska Clean Seas must train in nearby waterways. Navigation through the Sakoonang, Tamayayak, and Ulamnigiaq channels is achieved using various vessels including a twin-engine freighter, single-engine airboats, Athebasan outboard jet boats, and Klamath outboard jet boats (CPAI 2004).

Alaska Clean Seas performs navigation training for spill response teams with the vessels several times during open water. Personnel travel the northern channels in the spring to check remote connexs containing spill response equipment and to place navigational buoys around the entrance areas to each channel. Absorbent boom is deployed in the spring and removed each fall. Permits issued by the ADF&G generally limit air boat traffic to a two-week window in the spring and then several week in the fall to mitigate impacts to waterfowl (CPAI 2004). Mid-summer training on the northern channels is limited to jet boats.

The largest vessel that would be used by Alaska Clean Sea in the Nigliq Channel is the Agviq, measuring 55 feet long and 12 feet wide. This landing craft is used for equipment transport and skimming operations. The Agviq's 26-foot mast height would require that the mast be removed for the vessel to fit under a 20-foot bridge (CPAI 2004). However, it is likely that smaller boats would be used in the northern channels rather than the Agviq. The Agviq is the only Alaska Clean Seas vessel that would require any modifications to pass beneath a 20-foot bridge.

The village of Nuiqsut lies approximately 18 miles upriver of the Beaufort Sea on the Nigliq Channel of the Colville River. Villagers use small watercraft for transportation along the rivers and channels to access hunting and fishing areas and to travel to marine areas for whaling and marine hunting. Some boats have shelters, which bring the height of the boats to about 10 feet above the water level. Some residents' flat-bottom and V-bottom boats have aerials that go up to about 20 feet above the water level; however, they are easily retractable and do not inhibit travel under a 20-foot bridge (Tukle et al., 2004). Village boats typically travel on the Nigliq Channel and Ublutuoch River, as well as on the Tamayayak and Ulamnigiaq channels from Nuiqsut to areas past the proposed location of CD-3 (Nukapigak 2004). Boats cannot typically navigate the Sakoonang Channel (Nukapigak 2004).

#### 3.4.9.5 Pipeline Systems

Oil produced on the North Slope is transported to Valdez through the TAPS. This system includes 800 miles of 48-inch-diameter crude oil pipeline, as well as pump stations, communications sites, and other support facilities. The pipeline delivers oil to the marine terminal at Valdez where it is transferred to oil tankers for delivery to final markets. The TAPS was designed to allow a maximum throughput of 2.2 MMbbl a day and averaged 2 MMbbl a day at peak oil production in 1988. Production more recently has dropped to just under 1 MMbbl a day (Alyeska Pipeline Service Company 2003).

Oil is transported from various oil production facilities on the North Slope to Pump Station 1 of the TAPS through various pipelines. Seven major trunk pipeline systems carry crude oil to the TAPS, and numerous production pad feeder pipelines carry oil from production facilities to these trunk lines. Crude and noncrude pipelines serving existing North Slope production facilities include approximately 415 miles of pipeline corridor (with some corridors including multiple pipelines bundled together) and are elevated above ground on VSMs (BLM 1998a). Access roads have been constructed adjacent to the pipelines to allow for inspections, maintenance, and repairs.

Oil produced from the existing Alpine Field is transported to the main sales oil pipeline through a 35-mile-long pipeline that is 14 inches in diameter. The pipeline is primarily located above ground, except where it crosses the Colville River and oilfield roads. This pipeline from the APF at CD-1 currently carries 100,000 barrels of oil a day to Kuparuk and then on to TAPS Pump Station 1. There is also a three-phase line going from CD-2 to CD-1 that carries produced fluids (oil, gas, and water) to CD-1 for processing (removing gas and water).

#### 3.4.9.6 Alaska Railroad Corporation

The Alaska Railroad provides freight service between ports at Anchorage, Seward, and Whittier and to Fairbanks. The railroad serves an important role in transporting incoming freight, particularly during periods when barges cannot reach the North Slope. Cargo from barges can be off-loaded at these ports and transported by rail to Fairbanks, where freight for the North Slope can be off-loaded onto commercial trucks for delivery. Rail shipments of Oil Country Tubular Goods (or drilling pipe) ranged from 21 to 67 railcar loads over the past 4 years (CPAI 2004). These goods were offloaded from the Alaska Railroad in Fairbanks for ground shipment to the Alpine Field. Although rail transport plays a minor role in overall transportation of materials to the North Slope, it is an economical means of shipping large, heavy goods and is used for these goods on a regular basis.