4.4 OCEANOGRAPHY OF LIONS LAGOON

Lions Lagoon, is located offshore of the Point Thomson Gas Cycling Project and about 46 mi (74 km) east of Prudhoe Bay. Flaxman Island and a chain of barrier islands known as the Maguire Islands (including Challenge, Alaska, Duchess, and Northstar Islands) forms the lagoon. The Beaufort Sea lies seaward of these islands (see Figure 3-2). Lions Lagoon is approximately 3 to 4 mi (5 to 6 km) long, with water depths typically between 5 and 13 ft (1.5 to 4 m). Passes or gaps between the barrier islands serve to connect the lagoon waters with the Beaufort Sea, and thus waves, storm surges, and other regional oceanographic processes influence the lagoon waters.

4.4.1 Bathymetry

The barrier island complex serves to shelter or partially protect much of the lagoon from exposure to storm waves generated in the Beaufort Sea during the open-water periods. The Mary Sachs Entrance is a broad, 2-mi (3-km) pass between Northstar and Flaxman Islands (see Figure 3-2). The lagoon east of the Mary Sachs Entrance is quite shallow and protected by Flaxman Island, while west of the Mary Sachs Entrance the lagoon is deeper and wider, and open at the west end.

Water depth in the eastern part of the lagoon is quite shallow. Shoals are common near the mouth of the Staines River and western tributary of the Canning River and extend toward Point Brownlow. The pass between the east end of Flaxman Island and Point Brownlow is narrow (1,200 ft [66 m]) and relatively deep (26 ft [8 m]). Historical soundings obtained from the National Oceanic and AtmosphericAdministraion (NOAA) Chart No. 16045, revised in 1996, suggest the lagoon is asymmetrical, with deeper waters near the mainland shore and a gentle slope from the mid-channel north to Flaxman Island. Water depths within the lagoon gently increase towards the west to a depth of 8 ft (2.4 m) approximately mid-length of Flaxman Island and reach 11 ft (3.4 m) immediately northeast of Point Thomson.

Mary Sachs Entrance is a relatively deep pass, with a northeast/southwest-oriented channel that extends toward Point Thomson. Water depths within the channel are typically 9 to 11 ft (2.7 to 3.4 m) with the 10 ft (3 m) isobath approximately 2,400 ft (732 m) north of the mainland shore in the vicinity of Point Thomson. Mary Sachs Entrance provides a break in the protection offered by the barrier islands, exposing the shoreline adjacent to and east of Point Thomson to offshore storm events. The increased exposure to waves is evidenced by the well-developed spit and bar formation along the mainland shore.

The western portion of the lagoon is protected by the Maguire Islands. This portion of the lagoon widens from 1.5 mi (2.4 km) at Point Thomson to 3.5 mi (5.6 km) near Challenge Island. Water depths adjacent to the mainland between Point Thomson and Point Hobson are typically 7 to 10 ft (2 to 3 m) and gently increase to 16 ft (5 m) at the west end of the lagoon.

4.4.2 Physical Oceanography

Several oceanographic studies have been conducted in Lions Lagoon (Kinnetics 1983, Tekmarine 1983, and URS 1999). Understanding of the lagoon dynamics and relation to the adjacent Beaufort Sea is augmented substantially by extensive work done along the Beaufort Sea coast since 1976 and synthesized by Colonell and Niedoroda (1990). The hydrography (temperature, salinity, and water column structure) of summer Beaufort Sea coastal waters is determined by the recent wind velocity (direction and speed) and freshwater input. Circulation within the coastal environment is almost entirely wind driven. Easterly winds effectively lower sea level and initiate regional upwelling, while westerly winds raise sea level and initiate regional downwelling. Local salinity is a function wind direction and distance to the nearest source of freshwater. Local water temperature is a function of solar radiation and, to a lesser extent, distance to nearest freshwater source. Details regarding the oceanography of Lions Lagoon are provided in the following sections.

4.4.2.1 Tides and Storm Surges

As with other areas along the Beaufort Sea coast, astronomical tidal ranges are only about 8 in (20 cm); however, the range of sea level rise and fall due to major storms (storm surge) can be as much as 8 ft (2.4 m) at the shore. Storm surges result from the combined effects of wind and atmospheric pressure changes. Positive surges (water level increases) are associated with westerly winds, and negative surges (water level decreases) are associated with easterly winds.

A Kinnetics study (1983) observed a maximum positive surge of 2 ft (60 cm) in Lions Lagoon, associated with winds up to 35 knots (kts) (65 km/hr) during an ice covered period in October. Reimnitz and Maurer (1978) studied driftwood elevations left by a large gale-force westerly storm, in the Point Thomson region in 1970, that had flooded some low lying inland areas. They estimated the height of the surge in Lions Lagoon to be about 7 to 9 ft (2.1 m to 2.7 m) and projected this incident to have a recurrence interval of about 100 years. Storm surges in the Canadian Beaufort Seaare known to have positive surges of up to 6 ft (2 m) and negative surges of 3 ft (1 m).

4.4.2.2 Waves

Storm waves are generated by wind stress on the water surface. The wind velocity, the duration of the time the wind blows, and the fetch (the extent of open water across which the wind blows) influence wave height and period (Bascom 1980). Another important factor that limits wave height is water depth. As waves move into shallow waters, breakers form and dissipate the wave energy. Thus, storm waves in the shallow lagoon waters tend to be smaller than storm waves generated in the deeper Beaufort Sea waters north of the barrier island complex. Passes between the barrier islands will allow larger waves to enter the lagoon as evidenced by the shoreline near Point Thomson, which is an exposed portion of the lagoon shoreline immediately south of the Mary Sachs Entrance.

Using moored instruments, Kinnetics (1983) measured wave conditions in Lions Lagoon. During the study, waves were found to be relatively small in the lagoon due to a lack of significant strong wind events and the lingering presence of sea ice. The maximum wave heights were generally less than 2 to 3 ft (60 to 90 cm). Significant wave heights and periods (defined as the average of the highest one-third of the waves) were measured at just over 1 ft (30 cm), with significant periods of about 2.5 seconds. One storm event during August 1982 with winds over 20 kts (37 km/hr) produced waves up to 5 ft (1.5 m), significant wave heights of 2.75 ft (83 cm), and periods up to 3.5 seconds.

4.4.2.3 Currents

The nearshore Beaufort Sea has been intensively studied for more than two decades, so the oceanographic behavior of the region is well understood. As with most shallow seas, the wind governs the hydrodynamics (water movement) of the Beaufort Sea almost exclusively such that currents in shallow water are aligned generally with the wind direction. That is, east winds produce westward currents and west winds produce eastward currents.

Three forcing factors drive the circulation of the coastal ocean: wind stress, horizontal pressure gradients, and tides. Along the Beaufort Sea coast, astronomical tides are small (< 8 in [20 cm]) with associated weak currents (< 0.1 kt [5 centimeters per second (cm/sec)]), except in the narrow passes between barrier islands. Winds are typically parallel to the coast, with easterlies (i.e., winds from the east) prevailing about 60 % of the open-water season (July-September). During easterly wind conditions, water enters the lagoon at Mary Sachs Entrance and other passages between the barrier islands, and exits the lagoon via Challenge Entrance (URS 1999). For westerly winds this pattern is reversed, with water entering the lagoon via Challenge Entrance, and exiting through the other passages.

Currents were measured in the passes on each end of Flaxman Island during a 40-day period throughout August and early September 1997 (URS 1999). Typically, currents within the Mary Sachs Entrance were <0.58 kts (<30 cm/sec); however, at the peak of a severe easterly storm during late August, current speeds were nearly 0.97 kts (50 cm/sec). Tidal currents observed in the Mary Sachs Entrance were typically 0.014 to 0.19 kts (7 to 10 cm/sec). Active sediment transport was evident with the burial of the current mooring anchor.

Water movement through the narrow channel between Point Brownlow and the east end of Flaxman Island typically reached speeds in excess of 1.2 kts (60 cm/sec) with a maximum recorded value of 1.7 kts (90 cm/sec); however, the mooring was fouled prior to a late August 1997 storm event in which higher current speeds likely would have been observed (URS 1999).

4.4.2.4 River Input

The Canning and Staines rivers provide freshwater input to the Beaufort Sea in the vicinity of the Point Thomson area. The river outflow into coastal waters provides low saline waters along the coast. From its headwaters to the coast, the Canning River is about 117 mi (188 km) long and has a drainage area of about 2,256 square miles (mi^2) (5,900 km^2). The river has a braided, meandering channel, with low banks and broad floodplains consisting of gravel terraces. The discharge of the Canning River averages 1,125 cubic feet per second (cfs) (32,000 liters/sec) (AEIDC 1974). Large coastal rivers such as the Canning show no measurable discharge from January to early May (MMS 1996). By contrast the Staines River has an annual average flow of 14-cfs (AEIDC 1974). This river is 21 mi (34 km) long and has a drainage area of about 28 mi^2 (73 km^2).

4.4.2.5 Sea Ice

In late winter, first year sea ice in the Beaufort Sea generally is about 6.5 ft (2 m) thick. From the shore to a depth of about 7 ft (2.1 m) the ice is frozen to the bottom, forming the bottom-fast ice zone. The remaining ice in the land-fast ice zone is floating. Onshore movement of the floating ice is relatively common and generates pileups and ride-ups along the coast and on barrier islands. Occasionally, the floating ice sheet is driven up onto the shore a significant distance (>100 ft [30.5 m]) in a phenomenon known as *Ivu* by the Inupiaq inhabitants of the region.

Sea ice forms within Lions Lagoon in September or October, and typically first along shore where water is less saline. Initially the water is covered with brash and pancake ices, that gradually thicken into ice sheets. If storm surges occur during the early stages of freeze-up, the smooth sheet of ice can be broken into blocks, forming a chaotic pattern of ice fragments. As the sea ice develops, the ice fragments freeze into an ice sheet which grows to a thickness of about 7 ft (2.1m) by April or May. Ice blocks and ridges within the sheet may extend to 15 ft (4.6m) or more below the surface.

In spring, melting of the sea ice begins at the surface. During the initial stages of melting brine pockets isolated during freeze-up form vertical channels draining through the sea ice. Meltwater that accumulates on top of the ice eventually drains through these brine channels further eroding the sea ice. River breakup brings freshwater to the coast, which begins to overflow the nearshore sea ice. As the ice melts, freshwater eventually finds channels in the ice. Vortices form as the freshwater flows through the ice layer producing scour pits in the sea floor known as strudel scour.

Breakup of the sea ice usually occurs by June or July. As melting continues most of the sea ice retreats from shore with the pack ice, but occasionally winds may bring ice floes near shore at any time during the open water season. By the middle of July, much of the land fast ice inside the 33 ft (10m) isobath has melted or moved offshore. The area of open water with few ice floes expands along the coast and away from the shore and the pack-ice zone migrates seaward. Winds from the east and northeast, which are common in the summer, tend to drive the ice offshore.

4.4.3 Water Quality

4.4.3.1 Salinity and Temperature

Marine waters are generally cold (30 to 37°F [-1 to +3 °C]) and saline (27 to 32 parts per thousand [ppt]) (Craig 1984; Colonell and Niedoroda 1990). Temperature and salinity within the Central Beaufort Sea nearshore zone are strongly influenced by the prevailing summer wind velocity (direction and speed), the proximity of fresh water discharge by coastal river systems and the availability of sea ice.

Summer Conditions (Open Water)

The open water season typically occurs in late June to early July and, as warming continues into summer, the sea-ice melts, resulting in about 75 days of open water. After sea ice breakup, wind speed and direction become the key factors in determining the fate of freshwater advected along the coast. Wind speed and direction also influence water level variations that, in turn, play a key role in the exchange rates between brackish nearshore and offshore marine waters. Other agents controlling currents include the small (<1 ft [30 cm]) astronomical tide and occasionally large 3 to 7 ft (1 to 2 m) storm surges.

During and immediately after sea ice breakup, there is a freshwater (~3 to 6 ppt) surface layer up to 13 ft (4 m) thick that encompasses the lagoon and covers the marine (~30 ppt) waters. This two-layer or stratified water column is a short-term event, persisting on average for only 1 or 2 weeks. As the sea ice diminishes, winds mix the waters of Lions Lagoon, creating an unstratified (uniform) water column of brackish (~12 to 17 ppt) waters. As summer progresses, the water column typically remains unstratified, with salinity gradually increasing to marine (>30 ppt) conditions by mid-September (URS 1999). These unstratified marine conditions persist into freeze-up.

Wind history (speed and direction) is of prime importance in determining the fate of freshwater advected along the coast by currents during the open-water season. The prevailing summer winds along the Beaufort Sea coast are from the east, so the nearshore currents respond to this wind stress by flowing westward. This current regime transports river discharges westward along shore such that freshwater is mixed with the ambient nearshore waters.

The Canning River is the only significant source of freshwater to Lions Lagoon, east of Flaxman Island; however, once it reaches the Beaufort Sea, the freshwater becomes sufficiently mixed with seawater, resulting in brackish conditions. The pass east of Flaxman Island has a limited opening and thus restricts significant quantities of these well-mixed (brackish) Canning River waters from entering Lions Lagoon. The other freshwater source is the Staines River, located immediately south of Brownlow Point; this river discharges within Lions Lagoon. Freshwater input from the Staines River is small, yet produces a stratified water column adjacent to the river delta (URS 1999).

During west winds, the timing and rate of discharges from the Sagavanirktok and Shaviovik rivers influence the amount of freshwater available for distribution in the marine environment of Lions Lagoon. The Sagavanirktok River delta located approximately 40 mi (64 km) west of Point Thomson, discharges substantial volumes of freshwater into the nearshore environment. Additional freshwater input from the Shaviovik River mixes with brackish Sagavanirktok River plume near Bullen Point. The resulting brackish water tends hug the shoreline, with the difference between surface and bottom salinity decreasing towards Point Thomson.

Upwelling of marine bottom waters creates a stratified water column adjacent to Point Thomson. Under strong easterly winds, regional coastal upwelling draws cold, saline, bottom water into the lagoon through passes between the barrier islands. This results in a temporary stratified, two-layer water column consisting of brackish (~24 parts per thousand [ppt]) surface waters and a bottom layer of cold, saline (>30 ppt) waters (URS 1999). West winds serve to break down this stratification by transporting marine surface water shoreward and mixing it throughout the water column.

Winter Conditions (Ice-Covered)

During winter, the Beaufort Sea is covered by sea ice that begins to form in late September. Freeze-up of the waters is completed by the end of October, with ice growing to a maximum thickness of 7.5 ft (2.3 m) by April (MMS 1996). Ice cover persists on average for 290 days until spring warming results in river breakup, and subsequent sea ice melting near the river and stream deltas. Temperature and salinity profiles collected under the sea ice within the Beaufort Sea exhibit uniform cold, 29°F (-1.5°C), saline (32.4 ppt) marine waters. Under ice observations in the Beaufort Sea indicate very low current speeds aligned with bathymetry, which results in an easterly or westerly flow. The average current speed observed during ice-covered conditions is less than 3 cm/sec (0.06 kts) (Berry and Colonell 1986).

While the current meters employed during under-ice studies are generally insensitive to speeds below 2 cm/sec (0.04 kts), the data do not indicate stagnant conditions. Heavy brine formed by the thickening sea ice could produce a stratified water column in stagnant or near-stagnant conditions; however, low current speeds (e.g., less than 2 cm/sec) are sufficient to disperse any such brine through the water column and minimize or eliminate resulting under-ice vertical stratification. The typical water column structure observed under sea ice in the Beaufort Sea is uniform, with no temperature, salinity, or density stratification (Berry and Colonell 1986).

4.4.3.2 Dissolved Oxygen

During the open-water season, dissolved oxygen levels in Lions Lagoon are usually high, typically above 10 milligrams per liter (mg/L) (URS 1998). Under winter ice-cover, respiration by planktonic and other organisms continues, but atmospheric exchange and photosynthetic production of oxygen cease. Throughout the ice-covered period, dissolved oxygen concentrations in areas with unrestricted circulation seldom drop below 6 mg/L. Under-ice dissolved oxygen concentrations of 7.4 to 13.2 mg/L were measured in Foggy Island Bay, which is immediately west of Lions Lagoon (MW 1997and 1998).

4.4.3.3 Turbidity and Suspended Sediment

Suspended sediment is introduced naturally to the marine environment through river runoff and coastal erosion (MMS 1996) and is re-suspended during summer by wind and wave action. Satellite imagery and suspended particulate matter data suggest that turbid waters are generally confined to depths less than 16 ft (5 m) and are shoreward of the barrier islands. Storms, wind and wave action, and coastal erosion increase turbidity in shallow waters periodically during the open-water season. Turbid conditions persist in areas where the sea floor consists primarily of silts and clays as opposed to areas having a predominantly sand bottom.

During the 1998 open-water season, the average total suspended solids (TSS) value was 43.3 mg/L, with a maximum concentration of 79 mg/L from water samples collected near Point Thomson (URS 1998). In-situ turbidity measurements collected during the 1998 open-water season ranged between 1 and 173 nephelometric turbidity units (NTU). There was no correlation between TSS and turbidity values from samples collected within Lions Lagoon (URS 1998).

In winter the presence of ice cover eliminates external effects that cause turbidity (MMS 1996). However, occasional under-ice water movement can stir bottom sediments into the water column. Under-ice TSS values collected in the western portion of Foggy Island Bay ranged from 2.5 to 76.5 mg/L (MW 1997and 1998). Field-measured turbidity for February and March under-ice conditions ranged from 1 to 35.6 NTU, and laboratory-measured turbidity ranged from 0 to 24 NTU (MW 1997and 1998).

4.4.3.4 Trace Metals

Trace metals are introduced naturally to the central Beaufort Sea through river runoff (relatively unpolluted by humans), coastal erosion, atmospheric deposition, and natural seeps. Since there is little industrial discharge activity in this region, most trace metals concentrations are low in the Beaufort Sea (MMS 1996). Open-water concentrations for arsenic, chromium, lead, and mercury were below detection limits for samples collected near Point Thomson (URS 1998). Barium concentrations were determined to range from 0.015 to 0.020 mg/L (URS 1998).

4.4.3.5 *Hydrocarbons*

Background water hydrocarbon concentrations in the Beaufort Sea tend to be low, generally less than 1 part per billion and appear to be biogenic. Sediment aliphatic and aromatic hydrocarbon levels are relatively high in comparison with other undeveloped outer continental shelf areas. The hydrocarbon composition differs from most other areas because they are largely fossil-derived. The hydrocarbon sources primarily are on the onshore coal and shale outcrops and natural petroleum seeps that are drained by rivers into the Beaufort Sea (Steinhauer and Boehm 1992). The aliphatic hydrocarbons range from 5 to 41 ppt dry weight. Most of these are higher molecular weight alkanes (n-C21 to n-C34) which are characterized by odd-carbon dominance, indicating a biogenic source from terrestrial plant materials. The presence of lower molecular weight alkanes (0.3 to 1.2 parts per million) also suggests widespread presence of naturally occurring petroleum hydrocarbons in the sediments (MMS 1996).

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4.5 MARINE BENTHOS

Most of the nearshore seabed of the Alaskan Beaufort Sea consists of a soft-bottom featureless plain comprised of mud or sand. The benthic communities associated with soft-bottom benthic habitat include microalgae, bacteria, and invertebrates. Benthic invertebrates typically are classified as either epifauna (on or near surface of the substrate) or infauna (within the substrate). The organisms comprising these groups, as well as the general patterns of their distribution and abundance, have been described in the Final Environmental Impact Statements for Sales 97, 109, 124, and 144 (MMS 1987a, 1987b, 1990, and 1996, respectively) and by Thorsteinson (1983).

Epibenthos is defined as benthic invertebrates that reside on or near the surface of the substrate. In general, epibenthic species diversity and abundance increase as water depth increases. The proportion of longer-lived sessile or sedentary species also increases as compared to the more motile and opportunistic species found closer to shore in shallower waters. The presence of the shore-fast ice in the nearshore zone (waters <6 ft (1.8 m) deep) prevents most species from over-wintering in this zone. Therefore, the nearshore benthic community is dominated by motile, opportunistic species that can re-colonize the area after the ice melts in the spring (Broad 1977, Broad et al. 1978, Feder et al. 1976, Grider et al. 1977 and 1978, and Chin et al. 1979). The most abundant groups in this zone include epibenthic amphipods, mysids, and isopods.

Infaunal organisms live within the substrate and, as a result, often are sedentary. As mentioned above, relatively few species are found in nearshore waters with depths less than 2 m (6.6 ft). Any polychaetes and clams found in this zone protect themselves from the harsh and variable substrate conditions by burrowing into the sediment. Other infaunal organisms such as oligochaete worms and clams increase in abundance toward the deeper edge of this zone, reflecting the greater substrate stability found further offshore (LGL et al. 1998). Although shore-fast ice can occur in the shallower end of the inshore zone, the diversity and biomass of infauna increase and species composition changes in the inshore environment where water depths range from 2 to 10 m (6.6 to 33 ft). This zone can support a greater diversity of benthic organisms and up to about 10 times the biomass of the nearshore zone. Polychaetes represent 70 to 80 % of the total infauna at water depths ranging from 15 to 30 ft (4.5 to 9 m) (Carey 1978).

Although there are no studies that have examined the benthic community specifically in Lions Lagoon, information from studies in similar Beaufort Sea habitats can be extrapolated (Carey and Ruff 1977). Based on the results of this study, the benthic community of the lagoon is likely to be composed primarily of infaunal invertebrates (e.g., polychaetes, clams, and various crustaceans) and epifaunal invertebrates (e.g., amphipods, isopods, and mysids). Since depths within Lions Lagoon do not exceed 16 to 20 ft (5 to 6 m), low benthos density and diversity is expected, as is characteristic within the nearshore zone of other areas along the Beaufort Sea coast. Boulder/cobble substrate needed to support boulder patch communities (i.e. large material/boulders) has not been observed at the proposed dock area or elsewhere in Lions Lagoon. However two distinct areas with kelp habitat have been found seaward of the barrier islands (Figure 4-2).

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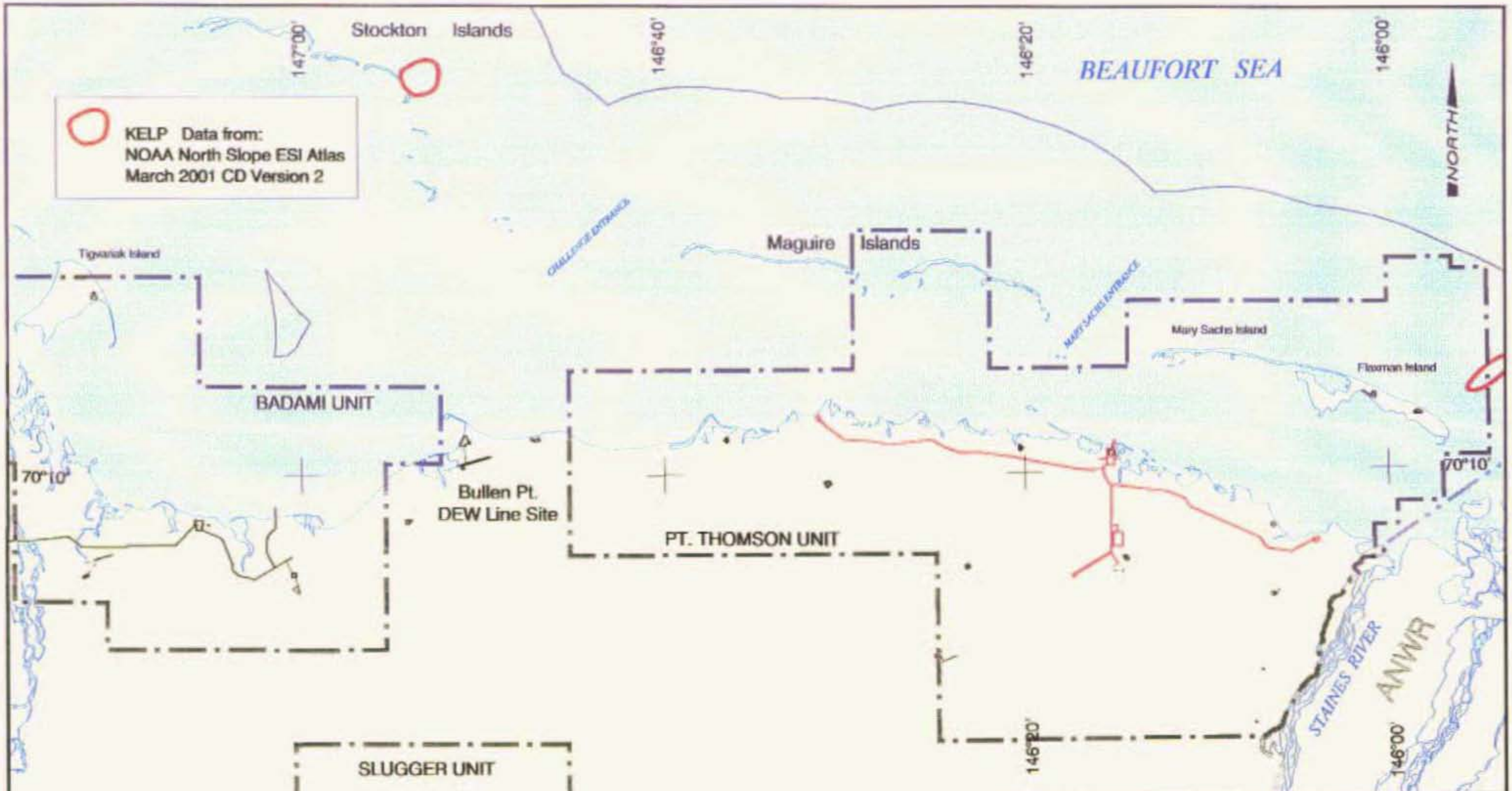

ExxonMobil

POINT THOMSON GAS CYCLING PROJECT
KNOWN DISTRIBUTION OF KELP
ALONG THE COASTAL CENTRAL
BEAUFORT SEA

DATE:	SCALE:	FIGURE:
July 2001	1 : 200,000	4-2

fig4_2.dgn

4.6 VEGETATION AND WETLANDS

The proposed Point Thomson Gas Cycling project is located on the ancient Canning River alluvial fan. The physical environment controls most plant growth and establishment. Geomorphic processes are responsible for initiating open habitats for colonization and succession. Wind-oriented lakes dominate the Canning River coastal zone and the area west of the alluvial fan which starts at the southern limit to Mikkelsen Bay. The shallow thaw-lakes of the northern coastal plain follow a cyclic pattern of formation and drainage. Thaw-lakes originate from low-center polygons and tundra ponds by wind-driven thermokarst erosion during the warm season (Britton 1957; Carson and Hussey 1961; Billings and Peterson 1980). Lakes grow and coalesce until they are captured by a stream and drain out. Following drainage the wet basins are colonized, within a few years, by pioneer graminoid plant and moss species (Ovendon 1986). The floristic composition of the basins changes gradually over time while the ice-wedge polygonization in the permafrost of the underlying sediments re-asserts itself near the surface. One result of this reassertion is the appearance of low center polygons, which is followed by erosion of the polygon rims and the beginning of a new cycle. The time dimension of this cyclic change is variable and essentially unknown. It has been estimated at between 1500 and 2500 years (Billings and Peterson 1980). Initial plant invaders and successional sequences vary within and between regions due to localized aspects of the physical environment. For instance, the degree of drainage varies considerably between individual basins and even within a single basin. Thaw lakes are relatively uncommon on the Canning River inland fan zone where the dominant soil types are more coarsely graded.

The project area has been described as lowland loess with wet minerotrophic tundra (Carter 1988; Walker and Everett 1991). Calcareous loess (pH 6.0 to 8.4) downwind of the Canning River favors the development of minerotrophic plant communities (Walker and Everett 1991). Three gradients associated with loess deposition contribute to the regional soil patterns:

- a gradient of mineral material added to the peat soils downwind of the Canning River
- a gradient of soil particle sizes associated with distance from the loess source
- a pH gradient associated with the carbonate rich aeolian material

The soils in this region have a relatively high silt content, high pH, and lower organic material content when compared with acidic regions of the coastal plain (Tedrow 1977; Gersper et al. 1980). As a consequence of the lowered organic content of the soil, water retention increases downwind from the river. The higher mineral content increases bulk density in the soils which in turn decreases the insulating capacity of the soil and generally results in a greater summer depth of thaw. Loess deposition also influences soil nutrient availability directly by mineral additions and indirectly by altering the cation exchange capacity, which is dependent upon the content of organic material due to the relatively low clay content of these alkaline tundra soils (Bilgin 1975 and Walker and Everett 1991). Phosphorus availability may be particularly affected by pH values in the soil since at low pH (<6) it forms insoluble compounds with iron, aluminum and manganese. At higher pH values (>7) phosphates react with calcium and calcium carbonates to form insoluble calcium phosphates (Schlesinger 1991). These patterns are particularly important because phosphorus has been shown to be the primary limiting nutrient in Prudhoe Bay tundra. It was the only primary nutrient to have significant effects on the recovery of oil-damaged wet tundra and abandoned mesic to dry silt-loam road surfaces (McKendrick and Mitchell 1978 and

McKendrick 1987). The high deposition of loess downwind from the Canning River acts to maintain the vegetation in an early successional state (Walker and Everett 1991). Loess may also have important effects on other ecosystem processes and components, such as production and mineralization rates, invertebrate populations, shorebirds and mammals (Walker and Everett 1991).

A vegetation survey was conducted in the Point Thomson area in 1998 (Noel and Funk 1999). The boundary of the surveyed area runs along the coast from Point Hobson to the western edge of the Staines River, including Point Thomson and Flaxman Island (Figure 4-3). The majority of the southern boundary extends approximately 1 to 2 mi (2 to 3 km) inland. Exceptions are a corridor along the Staines River that extends approximately 7.5 mi (12 km) inland, and the Point Thomson area, where the boundary extends to the southwest up to 3 mi (5 km). A total of 32,990 acres (13,356 hectares [ha]) was mapped. An additional 11-mi (18-km) gap (9091 acres [3681 ha]) between the western edge of the area mapped for Point Thomson and the eastern edge of the Badami map was recently completed. The final vegetation map for the Point Thomson project area (Figure 4-3), which also includes part of the Badami area previously mapped (BPXA 1995), encompasses a total of 52,759 acres (21,287 ha).

Seventy-seven species of vascular plants and 17 non-vascular plants were identified during collection of ground reference data for the Point Thomson vegetation map. No threatened or endangered plant species are known to occur in the proposed project area. Seven species of rare vascular plants occur on the North Slope and may be found within or near the proposed project area (Murray and Lipkin 1987 and 1997). For example, *Mertensia drummondii* is considered a species of concern (formerly a candidate species) under the Endangered Species Act (ESA) and could be present in localized areas of active dunes near the mouths of streams and rivers. This small (12-16 cm tall) vascular plant has been found in areas of moderately active sand dunes on the Meade River at Atkusuk and the Kogusukruk River near Umiat (Murray and Lipkin 1987). *Potentilla stipularis* occurs in sandy substrates, such as sandy meadows and riverbank silts. *Pleuropogon sabinei* is an aquatic grass that rarely occurs between the *Arctophila* and *Carex* zones in lakes and ponds. *Draba adamsii* has been found near Barrow in eroding turfy polygons near the ocean or streams. *Poa hertzii* is a grass known from sites on the Meade River and within ANWR where it occurs on dry sands in active floodplains. *Erigeron muirii* may occur on some drier soils such as ridges along rivers but it has generally been reported at more inland sites near the foothills. *Aster pygmaeus* is known from sites east of the National Petroleum Reserve-Alaska (NPRA) and is found growing on mudflats and saline soils. However, none of these rare plant species were found during collection of ground reference data for the vegetation map.

The project area is mostly covered by water (35.3 %), including subtidal bays and inlets, rivers, streams, lakes and ponds (Table 4-4 and Figure 4-3). Predominant vegetation types are Moist Sedge, Dwarf Shrub/Wet Sedge tundra complexes (30.3 %) and Moist Sedge, Dwarf Shrub Tundra (22.7 %). Moist Sedge, Dwarf Shrub/Wet Sedge tundra complexes are typically found in high- and low-center polygon areas and in weakly developed strangmoor (reticulated tundra). *Salix* spp., *Dryas integrifolia*, mesic *Carex* spp., and a number of forbs dominate the polygon rims or high centers (Table 4-5).

Other vegetation types include Wet Sedge Tundra (2.6 %) and Dry Dwarf Shrub Lichen Tundra, including crustose and fruticose lichens (2.1%), with the remaining vegetation types each account for less than 2% of the study area (Table 4-4). Salt marsh areas cover 2.9% of the study area. Human disturbances (gravel roads and pads and associated washouts) cover 0.2 % of the study area and are confined to exploratory pads constructed in the Point Thomson area.

Most of the vegetation types in the study area are considered to be wetlands (Table 4-5). Exceptions are the well-drained dwarf shrub, crustose and fruticose lichen communities associated with pingos and some high-center polygons, respectively, and partially vegetated sand dunes. Some riparian areas also are likely to be upland due to their gravel substrate and infrequent inundation. Tundra disturbed by gravel fill also may be converted to upland depending on the thickness of the fill.

Table 4-4 Area and Percent of Area Covered by Vegetation Types in the Point Thomson Study Area, Alaska

VEGETATION TYPE[1]	LEVEL C CODES	TOTAL AREA	
		ACRES	PERCENT
Water (bays, lagoons, inlets, subtidal rivers, tidal rivers, streams, lakes, and ponds)	Ia	18,624.4	35.3
Salt Marsh		1511.6	2.9
Wet Graminoid Tundra (wet saline tundra, saltmarsh)	IIIb	*545.4*	*1.0*
Wet Barren/Wet Graminoid Tundra Complex (barren/saline tundra complex, saltmarsh)	IXh	*286.4*	*0.5*
Dry Barren/Forb, Graminoid Complex (saline coastal barrens)	IXi	*679.8*	*1.3*
Aquatic Graminoid Tundra	IIb	228.3	0.4
Water/Tundra Complex	IId	167.4	0.3
Wet Sedge Tundra	IIIa	1383.4	2.6
Wet Sedge Tundra/Water Complex	IIIc	538.0	1.0
Moist Sedge, Dwarf Shrub Tundra/ Wet Sedge Tundra Complex		15,990.5	30.3
Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex (wet patterned ground complex)	IIId	*7010.5*	*13.3*
Wet Graminoid, Dwarf Shrub Tundra/Barren Complex (frost-scar tundra complex)	IIIe	*347.4*	*0.7*
Moist Sedge, Dwarf Shrub/Wet Graminoid Tundra Complex (moist patterned ground complex)	IVa	*8632.6*	*16.4*
Moist Sedge, Dwarf Shrub Tundra		11,961.4	22.7
Moist Sedge, Dwarf Shrub Tundra	Va	*9076.3*	*17.2*
Moist Graminoid, Dwarf Shrub Tundra/ Barren Complex (frost-scar tundra complex)	Ve	*2885.1*	*5.5*
Moist Tussock Sedge, Dwarf Shrub Tundra	Vb	2.3	<0.1
Dry Dwarf Shrub, Crustose Lichens	Vc	689.0	1.3
Dry Dwarf Shrub, Fruticose Lichens	Vd	422.5	0.8
Dry Barren/Dwarf Shrub, Forb Grass Complex	IXb	250.6	0.5
Dry Barren/Forb Complex	IXc	21.5	<0.1
Dry Barren/Grass Complex	IXe	6.1	<0.1
Dry Barren/Dwarf Shrub, Grass Complex	IXf	4.7	<0.1
River Gravels/Beaches	Xa	308.8	0.6
Bare Peat, Wet Mud		565.6	1.1
Wet Mud	XIa	*532.4*	*1.0*
Bare Peat	XIc	*32.2*	*0.1*
Gravel Roads and Pads (and washouts)		84.1	0.2
Barren Gravel Outcrops	Xc	*4.8*	*<0.1*
Gravel Roads and Pads	Xe	*79.3*	*0.2*

Table 4-5 Vegetation and Wetland Types that Occur in the Point Thomson Area, Alaska

VEGETATION TYPE	LEVEL C TYPES[1]	WETLAND TYPE[2]	DESCRIPTION/DOMINANT PLANT SPECIES
Water	Bays, lagoons, inlets, subtidal rivers (Ia)	Estuarine subtidal (E1UBL).	Low energy brackish water.
	Rivers and streams (Ia)	Riverine, permanently and tidally influenced (R1UBV, R2UBH, R3UBH).	Includes tidally influenced rivers upstream from ocean derived salinity.
	Lakes/Ponds (Ia)	Lacustrine (L1UBH, L2UBH) and Palustrine (PUBH) waterbodies.	
Salt Marsh	Wet Graminoid Tundra (IIIb)	Estuarine emergent intertidal (E2EM1N, E2EM1P).	Regularly and irregularly flooded salt marsh. Species present are comparable to those described above.
	Wet Barren/Wet Graminoid Tundra Complex (IXh)	Estuarine intertidal, regularly flooded mud flats (E2USN, E2USP) with emergent intertidal (E2EM1P).	Regularly and irregularly flooded salt marsh with large patches of unvegetated, exposed intertidal sediments. Species include Puccinellia phryganodes, Carex subspathacea, C. ursina, Dupontia fisheri, Stellaria humifusa, Cochlearia officinalis.
	Dry Barren/Forb Graminoid Complex (IXi)	Unknown (original vegetation salt-killed); possibly was saturated scrub shrub emergent wetlands (PSS/EM1B).	Coastal vegetation Intermittently flooded by saltwater resulting in death of original vegetation. New colonizers include Puccinellia spp., Carex ursina, Stellaria humifusa, and Cochlearia officinalis.
Aquatic Graminoid Tundra	Aquatic Graminoid Tundra (IIb)	Lacustrine (L2EM2H) and Palustrine (PEM1H) permanently flooded emergent marshes.	Arctophila fulva occurs in deep water areas, whereas Carex aquatilis, Eriophorum angustifolium and E. scheuchzeri occur in shallow water areas.
Water/Tundra Complex	Water/Tundra Complex (IId)	Lacustrine(L2UB/EM2H) and Palustrine (PUB/EM2H, PUB/EM1H) complexes of open water and emergent vegetation.	Dominated by open water interspersed with patches of emergent Aquatic Graminoid Tundra (see above). Moist microsites are dominated by species found in Wet Sedge Tundra and Moist Sedge, Dwarf Shrub Tundra (see above).
Wet Sedge Tundra	Wet Sedge Tundra (IIIa)	Palustrine PEM1B, PEM1E saturated wet sedge meadows. Some wet sedge meadows also may be permanently or semi-permanently flooded (PEM1H, PEM1F).	Carex aquatilis, C. rotundata, C. saxatilis, and Eriophorum spp. Dupontia fisheri is frequently codominant along the coast.
Wet Sedge Tundra/Water Complex	Wet Sedge Tundra/Water Complex (IIIc)	Lacustrine (L2EM2/UBH) and Palustrine (PEM1/UBH) complexes of emergent vegetation and open water.	Similar to above except that vegetation is dominant and emergent vegetation is not typically found in the open water areas. Wet Sedge Tundra is the dominant community type (see above).

Table 4-5 (Cont.) Vegetation and Wetland Types that Occur in the Point Thomson Area, Alaska

VEGETATION TYPE	LEVEL C TYPES[1]	WETLAND TYPE[2]	DESCRIPTION/DOMINANT PLANT SPECIES
Moist Sedge, Dwarf Shrub Tundra/ Wet Sedge Tundra Complex	Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex (IIId)	Complexes of palustrine scrub shrub, wet sedge meadows (PSS/EM1B) and saturated wet sedge meadows (PEM1B, PEM1E). Some wet sedge meadows also may be permanently or semi-permanently flooded (PEM1H, PEM1F).	Patterned ground dominated by Moist Sedge, Dwarf Shrub Tundra (see above) on low-center polygon rims and high-center polygon centers. Wet Sedge Tundra (see above) occurs in the basins of the low-center polygons and in the troughs of the high-center polygons. Frost-scarred barren areas also are associated with this complex.
	Wet Graminoid, Dwarf Shrub Tundra/Barren Complex (IIIe)	see above	see above
	Moist Sedge, Dwarf Shrub/Wet Graminoid Tundra Complex (IVa)	see above	see above
Moist Sedge, Dwarf Shrub Tundra	Moist Sedge, Dwarf Shrub Tundra (Va)	Palustrine saturated scrub shrub emergent wetlands (PSS/EM1B).	High-center polygons comprising Salix pulchra, S. arctica, S. reticulata, Dryas integrifolia, Carex misandra, C. bigelowii, and C. atrofusca. Frost-scarred barren areas also are associated with this type.
	Moist Graminoid, Dwarf Shrub Tundra/Barren Complex (Ve)	see above	see above
Moist Tussock Sedge, Dwarf Shrub Tundra	Moist Tussock Sedge, Dwarf Shrub Tundra (Vb)	Palustrine saturated emergent and scrub shrub wetlands (PEM/SS1B).	Dominated by tussock cottongrass (Eriophorum vaginatum) with other sedges including E. angustifolium, Carex bigelowii, and C. misandra. Common shrubs include Dryas integrifolia, Salix reticulata, and S. planifolia sp. Pulchra). Dominant forbs include Cassiope tetragona, and Polygonum viviparum. These communities occur between lake-basins and on the sides of pingos, in better-drained soils.
Dry Dwarf Shrub, Crustose Lichens	Dry Dwarf Shrub, Crustose Lichens (Vc)	Upland	Well drained sites (commonly pingos) consisting of Dryas integrifolia, Salix rotundifolia, S. phlebophylla, Carex rupestris, and a diversity of legumes and other forbs. Exposed mineral soil is covered with crustose lichens.

Table 4-5 (Cont.) Vegetation and Wetland Types that Occur in the Point Thomson Area, Alaska

VEGETATION TYPE	LEVEL C TYPES[1]	WETLAND TYPE[2]	DESCRIPTION/DOMINANT PLANT SPECIES
Dry Dwarf Shrub, Fruticose Lichens	Dry Dwarf Shrub, Fruticose Lichens (Vd)	Upland and palustrine emergent moist/wet sedge meadows (PEM1B, PEM1E). Some wet sedge meadows also may be permanently or semi-permanently flooded (PEM1H, PEM1F).	Well-drained high-center polygons with narrow, well-developed polygon troughs. Vegetation on the high centers is similar to Dry Dwarf Shrub (see above), with the addition of Cassiope tetragona and Vaccinium vitis-idaea and mesic forbs (e.g., Saxifraga punctata and Pyrola grandiflora). Exposed peaty soil covered with fruticose lichens.
Dry Barren/Dwarf Shrub, Forb Grass Complex	Dry Barren/Dwarf Shrub, Forb Grass Complex (IXb)	Upland and palustrine, temporarily flooded riparian open shrub (PSS/EM1A)	Diverse assemblage of shrubs, grasses, and forbs on a moderately well-drained gravel substrate. Species include Salix rotundifolia, S. phlebophylla, S. reticulata, Dryas integrifolia, Deschampsia caespitosa, Alopecurus alpinus, Poa glauca, Astragalus alpinus, Epilobium latifolium, and Artemisia arctica.
Dry Barren/ Forb Complex	Dry Barren/ Forb Complex (IXc)	Palustrine partially vegetated emergent persistent well drained (PEM1/USD)	Seasonally flooded, well drained areas on river floodplains that are partially vegetated with Epilobium latifolium, Artemisia arctica, and Wilhelmsia physodes.
Dry Barren/Grass Complex	Dry Barren/Grass Complex (IXe)	Upland	Coastal sand dunes partially vegetated with Elymus arenarius.
Dry Barren/Dwarf Shrub, Grass Complex	Dry Barren/Dwarf Shrub, Grass Complex (IXf)	Upland	Partially vegetated sand dunes. Species include Salix ovalifolia, Artemisia borealis, A. glomerata, Deschampsia caespitosa,Trisetum spicatum.
River Gravels	River Gravels (Xa)	Riverine, seasonally flooded areas (R2USC, R3USC).	
Bare Peat, Wet Mud	Wet Mud (XIa)	Exposed Lacustrine (L2USD) and Palustrine (PUSD) peat and sediments.	Drained lake basins.
	Bare Peat (XIc)	see above	see above
Gravel Roads and Pads (and washouts) (Xe, Xc)	Barren Gravel Outcrops (Xc)	Upland/Unknown	Wetland status of gravel washouts on tundra depends on thickness of gravel fill.
	Gravel Roads and Pads (Xe)	see above	see above

[1] Taken from Noel and Funk (1999) with recent revisions and based on Level C (in parentheses) of *A hierarchical tundra vegetation classification especially designed for mapping in northern Alaska* (Walker 1983).
[2] Study area was not specifically classified and mapped into wetland types, but rather vegetation types were reclassified into wetland types, based on USFWS National Wetland Inventory (NWI) nomenclature (Cowardin et al 1979).

Figure 4-3 is a map located in a pocket at the end of the report.

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4.7 FISH

4.7.1 Fish of the Beaufort Sea

Forty-five species of fish reported to live in the Alaskan Beaufort Sea are listed in Table 4-6. These fish can be classified in terms of three principal life histories: freshwater, diadromous, or marine. As per Gallaway and Fechhelm (2000), the term diadromous is used to describe the ciscoes, whitefish and Dolly Varden char that migrate between freshwater and coastal habitats on an annual basis. The terms "anadromous" and "amphidromous" are more descriptive of the migration pattern, but the generic term diadromous is used here simply to identify those species that migrate through the nearshore lagoon during seasonal movements to and from freshwater and coastal habitats. By definition, most freshwater species spend their entire lives in rivers and lakes of the North Slope and generally avoid saline waters, although some species like Arctic grayling (*Thymallus arcticus*) and round whitefish (*Prosopium cylindraceum*) may move down river and enter low-salinity estuarine waters during early summer. Diadromous species, such as Dolly Varden char (*Salvelinus malma*), arctic cisco (*Coregonus autumnalis*), broad whitefish (*C. nasus*) and least cisco (*C. sardinella*) migrate back and forth each summer between upriver over-wintering areas and feeding grounds in Beaufort Sea coastal waters. Most marine species inhabit deeper offshore waters and are rarely reported in the North Slope coastal zone. Notable exceptions are Arctic cod (*Boreogadus saida),* fourhorn sculpin (*Myoxocephalus quadricornis*) and Arctic flounder (*Pleuronectes glacialis*), which specifically migrate into shallow, low-salinity coastal waters and estuaries during summer.

4.7.2 Diadromous and Freshwater Fish

The distribution of diadromous fish in the Beaufort Sea is primarily from two major population centers—the Mackenzie River system of Canada in the east and the Colville River and ACP systems of Alaska in the west (Craig 1984). Most of the major river systems along the 373-mi (600-km) coastline between the Mackenzie and Colville rivers originate in the Brooks Range and are termed "mountain streams" (Craig and McCart 1975). They are shallow throughout their courses and provide little over-wintering habitat except for that associated with warm-water perennial springs (Craig 1989), or rehabilitated mine sites. Dolly Varden char and Arctic grayling are the two principal species that inhabit these mountain streams, although lakes associated with these drainages may contain lake trout (*S. namaycush*) and grayling. Ninespine stickleback (*Pungitius pungitius*) are also prevalent in drainages within the western portion of the "mountain stream" range. While small runs of pink salmon (*Oncorhynchus gorbuscha*) occur in the Sagavanirktok and Colville rivers, and spawning populations of chum salmon (*O. keta*) inhabit the Colville and Mackenzie rivers (Craig and Haldorson 1986; Moulton 2001), the remaining salmon species consist of individuals from southern populations (e.g., Bering Sea) and are considered incidental visitors to the Beaufort Sea (Craig and Haldorson 1986).

Arctic cisco in the Alaskan Beaufort Sea originate from spawning grounds in the Mackenzie River system of Canada (Gallaway et al. 1983, 1989). Fry emerge by spring break-up in late May to early June and are swept downstream to coastal waters, where they begin feeding in the brackish waters near the Mackenzie Delta. Young-of-the-year are transported away from the Mackenzie region by wind-generated currents. In years with predominant easterly winds, some young-of-the-year are transported westward to Alaska by wind-driven coastal currents (Gallaway et al. 1983, Fechhelm and Fissel 1988, Moulton 1989, Fechhelm and Griffiths 1990, Schmidt et al. 1991, Underwood et al. 1995, and Colonell and Gallaway 1997). They arrive in the Prudhoe Bay area from mid-August to mid-September. In summers with strong and persistent east winds, enhanced westward transport can carry fish to Alaska's Colville River where they take up winter residence. They return to the Colville River every fall for overwintering until the onset of sexual maturity beginning at about age 7, at which point they migrate back to the Mackenzie River to spawn (Gallaway et al. 1983). The rearing Arctic cisco constitute one of the most abundant diadromous species found in the Alaskan Beaufort Sea, so much so that they support a very small commercial fishery in the Colville River and a subsistence fishery at the village of Nuiqsut (George and Kovalsky 1986; George and Nageak 1986; Moulton et al. 1990, 1992, and 1993; Moulton and Field 1988, 1991, and 1994; and Moulton 1994, 1995, 1996, and 1997).

Table 4-6 Species Taken in Nearshore and Offshore Waters of the Western and Central Beaufort Sea

Clupeidae	**Liparidae**
Pacific herring (*Clupea pallas)*	Leatherfin lumpsucker (*Eumicrotremus derjugini*)
Salmonidae	Snailfish (*Liparis sp.*)
Arctic cisco *(Coregonus autumnalis)*	**Agonidae**
Bering cisco (*Coregonus laurettae*)	Arctic alligatorfish (*Aspidophoroides olriki*)
Broad whitefish (*Coregonus nasus*)	**Stichaeidae**
Humpback whitefish (*Coregonus pidschian)*	Slender eelblenny (*Lumpenus fabricii*)
Least cisco (*Coregonus sardinella*)	Stout eelblenny (*Lumpenus medius*)
Pink salmon *(Oncorhynchus gorbuscha*)	Fourline snakeblenny (*Eumesogrammus praecisus*)
Round whitefish (*Prosopium cylindraceum*)	**Pholidae**
Dolly Varden (*Salvelinus malma*)	Rock gunnel (*Pholis gunnellus*)
Arctic grayling (*Thymallus arcticus*)	Anarhichadidae
Osmeridae	Wolf-eel (*Anarrhichtys ocellatus*)
Capeline (*Mallorus villosus*)	**Ammodytidae**
Rainbow smelt (*Osmerus mordax*)	Pacific sandlance (*Ammodytes hexapterus*)
Gadidae	**Gasterosteidae**
Polar cod (*Arctigadus glacialis*)	Threespine stickleback (*Gasterosteus aculeatus*)
Arctic cod (*Boreogadus saida*)	Ninespine stickleback (*Pungitius pungitius*)
Saffron cod (*Eleginus navaga*)	**Pleuronectidae**
Burbot (*Lota lota*)	Arctic flounder (*Liopsetta glacialis*)
Zoarcidae	Starry flounder (*Platichthys stellatus*)
Fish doctor *(Gymnelis viridis)*	Alaska plaice (*Pleuronectes quadrituberculatus*)
Saddles eelpout *(Lycodes mucosus)*	**Hexagrammidae**
Canadian eelpout *(Lycodes polaris)*	Kelp greenling (*Hexagrammos decagrammus*)
Marbled eelpout *(Lycodes raridens)*	
Threespot eelpout (*Lycodes rossi)*	
Cottidae	
Hamecon (*Artediellus scaber*)	
Slimy sculpin (*Cottus cognatus*)	
Arctic staghorn sculpin *(Gymnocanthus tricuspis*)	
Twohorn sculpin (*Icelus bicornis*)	
Great sculpin (*Myoxocephalus polycanthocephalus*)	
Fourhorn sculpin (*Myoxocephalus quadricornis*)	
Ribbed sculpin (*Triglops pingeli*)	

Sources: Frost and Lowry, 1983; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a,b; Reub et al. 1991

4.7.3 Freshwater Habitat

The proposed Point Thomson Gas Cycling Project area is located in the "mountain stream" zone of the North Slope. The principal freshwater habitat consists of the Staines and Canning Rivers immediately to the east and the Shaviovik and Kavik Rivers situated about 31 mi (50 km) to the west. Both systems support populations of Dolly Varden (Inupiaq name Aqalupiaq), grayling (Inupiaq name Sulukpaugaq), and ninespine stickleback, with the Canning River also containing round whitefish, burbot, and slimy sculpin. The coastal tundra ponds and lakes between the Staines and Shaviovik rivers have the potential to contain populations of ninespine stickleback (Ward and Craig 1974). Seven tundra-origin streams between the Staines River and East Badami Creek contain ninespine stickleback (WCC and ABR 1983).

The Staines and Canning river system is considered important summer feeding habitat for Dolly Varden char. Juvenile Dolly Varden char remain within their natal streams for several years prior to their first seaward migration (Craig 1977a, 1977b and 1989). There is also a component of the population that consists of non-diadromous males that remain within their natal rivers for their entire life (Craig 1977a and 1977b). Fish age 2 and younger and non-diadromous males would therefore reside and feed in these riverine environments throughout the summer.

Rivers are the obligatory migratory routes for diadromous Dolly Varden char and ninespine stickleback in spring and late summer. Arctic grayling and round whitefish may also move down river in early summer to brackish-water estuaries and coastal areas while the nearshore region is still relatively fresh from the high runoff associated with breakup (Moulton and Fawcett 1984).

Over-wintering space is limited in North Slope rivers, particularly for Dolly Varden char, which require higher dissolved oxygen levels than arctic grayling. Craig (1989) postulated that the small amount of over-wintering habitat available to diadromous fish could be the most important factor limiting population size and causing cyclical fluctuations in species abundance. Dolly Varden char spawn in the fall and require perennial warm-water springs for successful wintering and reproduction. These springs provide fish with open-water habitat throughout the winter and prevent eggs from freezing (Craig 1984). Craig and McCart (1974) identified numerous Dolly Varden over-wintering areas in the Canning River, and to a more limited extent in the Shaviovik and Kavik rivers. However, the authors note that:

> "...this report concerns only those areas known to be important. Additional spawning and over-wintering sites will undoubtedly be located in the future."

Freshwater species may enter deep-water lakes and isolated river channels during winter. There are two major independent streams that empty into Mikkelsen Bay east of the Shaviovik/Kavik River. Ward and Craig (1974) identified them merely as First Unnamed Stream East of Kavik River and Second Unnamed Stream East of Kavik River. More recently, Hemming (1996) referred to these to drainages as No Name River and East Badami Creek, respectively. This report adheres to the latter nomenclature. Hemming (1996) described No Name River as:

> "...a 42-mi (67-km) coastal system that drains a 147 square mi (380 km^2) tundra area. The river mouth is located 1.6 mi (2.5 km) east of the Shaviovik River. No Name River is a single channel system with extensive gravel bars. Vegetated terraces are found on both sides of the active channel. The active channel is 173 to 330 ft (70 to 100 m) wide in the lower part of the drainage in late summer. Water depth does not exceed 6.5 ft (2 m)"

and East Badami Creek as:

> "...a 15.5 mi (25 km) long single channel system. The active channel is 33 to 50 ft (10 to 15 m) wide in late summer. East Badami Creek has a gravel bar deposit on the inside of meander bends with tundra vegetation occurring on the cutbank side. Cutbanks are less than 6.6 ft (2 m). Water depth does not exceed 6.6 ft and substrate materials are composed of gravel."

Fyke net surveys reported high numbers of ninespine stickleback in both East Badami Creek and No Name River, with catch rates ranging from 243 to 1,525 fish/day (Hemming 1996). A few juvenile Dolly Varden were collected in East Badami Creek ($N = 3$) and No Name River ($N = 9$) and a single grayling and a single round whitefish were reported for No Name River.

Visual surveys of six additional streams between East Badami Creek and the Staines River, ranging in length between 9 and 20 mi (15 and 32 km), found ninespine stickleback in all, and fourhorn sculpin in the estuarine portion of one (WCC and ABR 1983). Sampling results from East Badami Creek and No Name River (Hemming 1996) indicate that juvenile Dolly Varden, and possibly other diadromous species, may enter these streams to feed during early summer when stream flow is high.

Ward and Craig (1974) surveyed some of the larger lakes along the North Slope. Of these, nine were located between the Staines and Kavik Rivers and within 25 mi (40 km) of the coast. Numerous small tundra ponds and drainage streams characterize much of the coastal area between the East Badami Creek and the Staines River. These streams all support ninespine stickleback during summer, but most are shallow and freeze solid during winter; however the occasional deep pool might serve as a limited over-wintering area for a few ninespine stickleback (WCC and ABR 1983). These ponds and streams may be exploited to a greater degree during the open-water summer season. Ninespine stickleback and juvenile Dolly Varden char move up and down the coast in large numbers during summer and could enter and feed in any inland water body that is connected to the sea. Arctic grayling, broad whitefish and least cisco have also been reported to move between North Slope rivers during the summer (Hemming 1993, Moulton; and George 2000). It is probable that fish utilize the smaller tundra ponds and streams between Mikkelsen Bay and the Staines River in a similar manner.

4.7.4 Coastal Habitat

The prominent coastal feature in the Point Thomson area is Lions Lagoon. As in previous nearshore studies conducted in nearshore areas located to the west (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; WCC 1983; Moulton et al. 1986; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a, and 1994b; Reub et al. 1991; and Griffiths et al. 1995, 1996, and 1997), the lagoon exhibits highly variable temperature and salinity through the summer, with lowest salinity and highest temperature early in the summer (LGL 2000b). The water becomes more marine as summer progresses, river flows decrease and offshore water is transported into the lagoon. In early to mid-July 1999, salinity was near 5 parts per thousand (ppt) in the study region (LGL 2000b). Salinity remained low at stations east of Point Thomson, gradually increasing to near 20 ppt by early August and 30 ppt by mid August. In contrast, stations at or west of Point Thomson had salinity increases to 20-25 ppt in mid-July, with salinity generally remaining high for the remainder of the summer. Water temperatures demonstrated the expected inverse trend, with the eastern stations tending to be warmer than the western stations, with temperatures decreasing during summer. In early to mid July, water temperatures ranged to 45 to 46°F (7 to 8°C), decreasing to 37 to 39°F (3 to 4°C) by mid-August (LGL 2000b).

This barrier-island lagoon system is a major migratory pathway for diadromous species, including Dolly Varden char from the Staines/Canning and Shaviovik/Kavik drainages as well as other North Slope river systems. Other abundant diadromous species using the lagoon include Arctic cisco and least cisco, with broad whitefish and humpback whitefish present in lower numbers (LGL 2000b). Sampling in the lagoon during 1999 also revealed some use by Arctic grayling and round whitefish (LGL 2000b). Ninespine stickleback are tolerant of high salinity (Fechhelm et al. 1996) and are found throughout Lions Lagoon regardless of water quality.

4.7.4.1 Arctic Cisco

Despite the inability of the mountain streams between the Colville and Mackenzie rivers to support spawning populations of adult Arctic cisco (Inupiaq name Tipuk), nearly all summer studies conducted along that portion of the coast have caught substantial numbers of these fish (Craig and Mann 1974; Griffiths et al. 1975 and 1977; West and Wiswar 1985; Wiswar and West 1987; Griffiths 1983; Fruge et al. 1989; and Underwood et al. 1995). This coast-wide distribution implies extensive summer dispersal from major over-wintering areas in the Colville and Mackenzie rivers. Lions Lagoon is no exception, although the abundance of adult Arctic cisco tends to fluctuate throughout the summer as schools of fish pulse through the area. During 1999, Arctic cisco were the most abundant fish caught by fyke nets in the lagoon (LGL 2000b).

Data collected over years of study in the Prudhoe Bay region suggest that the mountain rivers east of the Sagavanirktok River do not provide over-wintering areas for large numbers of juvenile Arctic cisco including young-of-the-year (YOY) that are transported westward along the coast (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Moulton et al. 1986; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a and 1994b; Reub et al. 1991; and Griffiths et al. 1995, 1996, and 1997). As a general rule, if there is no recruitment of YOY to the Colville/Sagavanirktok region, there is no appreciable recruitment of that year class (i.e. age cohort) in following summers (Fechhelm and Griffiths 1990). These year-class gaps eventually manifest themselves in the commercial and Native subsistence fisheries of the Colville River (Moulton et al. 1990, 1992 and 1993; Moulton and Field 1988, 1991 and 1994; and Moulton 1994 and 1995).

The unknown entity in this hypothesis has always been the Canning River. It is the third largest drainage on the Alaskan North Slope, which implies some over-wintering capability. However, no major studies have been conducted in the lower delta. Underwood et al. (1995) reported taking substantial numbers of small Arctic cisco (4 to 5 in [100 to 120 millimeters (mm)] in length; approximate size for one-year old fish) at Simpson Cove, located 19 mi (30 km) east of the Canning River, in July of 1988 and 1990. Whether these young fish came from the Sagavanirktok River (81 mi [130 km] west), the Mackenzie River (223.7 mi [360 km] east), or possibly the nearby Canning River is unknown. Results from sampling in 1999 suggested that wintering capacity in the Point Thomson/Canning River area is very limited (LGL 2000b). Few age 1 and age 2 Arctic cisco were caught early in the open-water period. Catches did not increase until after a period of sustained easterly winds, which suggested that the fish moved into the region from areas to the east. Recruitment of these year classes (1997 and 1998) was strong in the Prudhoe Bay region, so if suitable wintering areas were present in the Point Thomson region, the early season catches should have been much higher.

4.7.4.2 Least Cisco

The only source population of least cisco in the region is from the Colville River. Adult least cisco regularly reach the Sagavanirktok Delta during summer (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Moulton et al. 1986; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, and 1994a, 1994b; Reub et al. 1991; and Griffiths et al. 1995, 1996, and 1997). They have also been reported to be extremely abundant in Mikkelsen Bay, 93 mi (150 km) east of the Colville River and 25 mi (40 km) west of Lions Lagoon (LGL and WCC 1996). Underwood et al. (1995) reported substantial numbers of least cisco at Simpson Cove in the summer of 1990 but not in 1988, 1989, and 1991. During 1999, least cisco were fourth in abundance of all species caught in Lions Lagoon. The vast majority of these least cisco were in excess of 10 in (250 mm), which indicates the least cisco reaching this far east were almost all mature adults. A total of 23 tagged least cisco were caught, with all the recoveries coming from fish that had been released in the Prudhoe Bay region from 1990 to 1993. Since least cisco caught in Prudhoe Bay are considered to originate exclusively from the Colville River (LGL 2000b), the capture of these tagged fish is additional evidence that least cisco found in the Point Thomson region are also likely to be from the Colville River.

Juvenile least cisco are not expected in the Lions Lagoon area. Juveniles (<7 in [180 mm]) from the Colville River disperse as far east as the eastern end of Simpson Lagoon, approximately 50 mi (80 km), in only one of every two years (Fechhelm et al. 1994). It is doubtful that the dispersal range of these small fish would extend another 56 to 62 mi (90 to 100 km) eastward to Lions Lagoon. Catches of small least cisco were low in Mikkelsen Bay during the summer of 1995, despite the fact that large catches were reported in the Prudhoe Bay/Sagavanirktok Delta area (Griffiths et al. 1997). Juvenile least cisco were essentially absent from Lions Lagoon in 1999 (LGL 2000b).

4.7.4.3 Broad Whitefish

The potential source populations of broad whitefish (Inupiaq name Kausilik) in this portion of the coastal Alaskan Beaufort Sea region include the Sagavanirktok and Colville rivers. Of the four diadromous species of major interest over the years, broad whitefish have been monitored because they are believed to be the least tolerant of high salinity, and therefore would be sensitive to coastal development. Young fish (age 2 and younger) from the Sagavanirktok and Colville river populations tend to remain near the low-salinity waters of the delta throughout much of the open-water season (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Moulton et al. 1986; Moulton and Fawcett 1984; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a, and 1994b; Reub et al. 1991; and Griffiths et al. 1995, 1996, and 1997). Few young fish were found in Mikkelsen Bay in 1995 (Fechhelm et al. 1996) or in Lions Lagoon in 1999 (LGL 2000b). In 2000, only three broad whitefish of the 491 caught were less than 280 mm.

Older broad whitefish (age 3 and older) disperse farther from their natal rivers than do juveniles, regularly moving between the Sagavanirktok and Colville rivers (Moulton et al. 1986; Cannon et al. 1987; Moulton and Field 1994) through Simpson Lagoon. Adult broad whitefish were also abundant in Mikkelsen Bay in 1995 (Fechhelm et al. 1996) and were caught in Lions Lagoon in 1999. Broad whitefish caught in Lions Lagoon were primarily between 280-480 mm in length.

Fish of this size are consistent with broad whitefish ranging from ages 4 to 15 from the Saganvanirktok River (LGL 2000b). Broad whitefish catches reported for the eastern Alaskan Beaufort Sea have been nominal to nil (Griffiths 1983, West and Wiswar 1985, Wiswar and West 1987, Fruge et al. 1989, and Underwood et al. 1995).

4.7.4.4 Humpback Whitefish

Humpback whitefish (Inupiaq name Qaalriq) in the Alaskan Beaufort Sea are considered to originate from the Colville River. Humpback whitefish were rare in fish monitoring studies in and around Prudhoe Bay from 1981 to 1995 (Griffiths and Gallaway 1982; Critchlow 1983; Griffiths 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Moulton and Fawcett 1984; Fawcett et al. 1986; West and Wiswar 1985; Moulton et al. 1986; Cannon et al. 1987; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a, and 1994b; Reub et al. 1991; and Griffiths et al. 1995, 1996, and 1997), although they had been relatively abundant in limited monitoring efforts prior to the construction of the West Dock causeway, located on the northwest corner of Prudhoe Bay (Furniss 1974). Humpback whitefish catches in Prudhoe Bay increased following construction of a breach in West Dock in winter 1995-1996, leading to speculation that the prior lack of humpback whitefish on the east side of West Dock reflected a restriction of the eastward dispersal from the Colville River (Fechhelm 1999). During sampling in Lions Lagoon in 1999, the mean catch rate of humpback whitefish (0.65 fish per day) exceeded that observed during Prudhoe Bay studies in any year between 1985 and 1995 (maximum = 0.42 fish per day), although the 1999 catch rate was considerably lower than either 1996 or 1997 at Prudhoe Bay (4.1 and 6.2 fish per day). Evidence that humpback whitefish caught in Lions Lagoon are not likely to be from Mackenzie River stocks is provided by results of sampling to the east of the Canning River. Humpback whitefish were not caught in sampling along the Arctic National Wildlife Refuge (ANWR) coast (Camden Bay, Kaktovik/Jago Lagoon, Beaufort Lagoon and Pokok Bay) in 1988 and 1989 (Fruge et al. 1989; andPalmer and Dugan 1990).

4.7.4.5 Marine Species

Fourhorn sculpin, Arctic flounder, and Arctic cod are regularly taken in nearshore coastal waters in virtually all areas of the Beaufort Sea during summer (Craig and Haldorson 1981; Griffiths and Gallaway 1982; Critchlow 1983; Griffiths 1983; Griffiths et al. 1983; Woodward-Clyde Consultants 1983; Moulton and Fawcett 1984; Fawcett et al. 1986; West and Wiswar 1985; Moulton et al. 1986; Cannon et al. 1987; Wiswar and West 1987; Fruge et al. 1989; Dugan and Palmer 1990; Glass et al. 1990; LGL 1990, 1991, 1992, 1993, 1994a, and 1994b; Reub et al. 1991; Griffiths et al. 1995, 1996 and 1997; Underwood et al. 1995; and Fechhelm et al. 1996). They were also abundant in Lions Lagoon in 1999 (LGL 2000b). Fourhorn sculpin was second in abundance behind Arctic cisco. Saffron cod were more abundant that Arctic cod and Arctic flounder, but all were consistently caught in the lagoon.

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4.8 BIRDS

The Point Thomson area, located between the Badami development and the Staines River, has been the site of bird research periodically since the early 1980s. Wright and Fancy (1980) and WCC and ABR (1983) conducted limited ground-based studies of birds in the Point Thomson area. Additional research on bird populations and habitats was conducted to the east of the Point Thomson area in ANWR during the 1002 Area studies conducted from 1984 to 1986 (Garner and Reynolds 1986) and along the Canning River (Martin and Moitoret 1981). More recently, bird studies were conducted inland from Point Thomson at the Yukon Gold exploratory ice pad (TERA 1993) and in the Badami area (TERA 1994). In recent years, LGL (Noel et al. 1999a, 2000), TERA (1999 and 2000), and the United States Fish and Wildlife Service (USFWS) (Petersen et al. 1999; Flint et al. 2001) have conducted aerial surveys for waterfowl, eiders, and ducks in the nearshore and tundra habitats of the Point Thomson area. Local residents (primarily Iñupiaq Eskimos from Kaktovik) hunt birds in the Point Thomson region as an essential element of their subsistence lifestyle.

Johnson and Herter (1989) estimated that approximately 10 million birds of over 240 species occur in the Beaufort Sea region. Nearly all bird use on the ACP of Alaska is concentrated in the summer months (May–September) when snow-free nesting habitats, forage, and open water are available. Only a few species remain in the area during the winter, when food resources are scarce. In the Point Thomson area, WCC and ABR (1983) recorded 57 species of birds using tundra and nearshore habitats (Table 4-7).

Birds occurring in the region can be divided into three major species groups: waterfowl, tundra-nesting birds, and predatory birds. General abundance, distribution, and habitat use are addressed below for the species in each group, based largely on information from baseline studies at Point Thomson and elsewhere on the North Slope (Spindler 1976, Martin and Moitoret 1981, WCC and ABR 1983, Gardner et al. 1986, Garner and Reynolds 1986, Moitoret et al. 1996, Johnson and Herter 1989, Murphy and Anderson 1993, TERA 1993, Noel et al. 1999a and 2000, and Johnson et al. 2000). Most of these studies focused on study areas affected by current or future oil development, but they also include studies conducted in ANWR since the late 1970s.

4.8.1 Waterfowl & Other Waterbirds

The Point Thomson region supports 23 species of waterfowl (tundra swan, geese, eiders, and other ducks) and other waterbirds (loons, grebes, and seabirds) including seven species that breed in the area (Table 4-7).

4.8.1.1 Tundra Swan

Tundra swans are common breeders on the ACP and have been recorded breeding in the Point Thomson area (Johnson and Herter 1989; Byrne et al. 1994; Johnson et al. 1999). Tundra swans have served as indicators of regional ecosystem health since they are sensitive to human disturbance and often nest at the same location year after year (King 1973 and Ritchie et al. 1990). Therefore, changes in their activities and distribution can provide a measure of the effects

Table 4-7 Common and Scientific Names, Status, and Relative Abundance of Birds Occurring on the Arctic Coastal Plain of Alaska and those Species Recorded in the Point Thomson Region, Alaska

COMMON NAME	SCIENTIFIC NAME	INUPIAQ NAME	STATUS[A]	RELATIVE ABUNDANCE[B]
Short-tailed Shearwater	*Puffinus tenuirostris*	--	Visitant+	Uncommon
Red-throated Loon	*Gavia stellata*	qaqsrauq	Breeder*	Common
Pacific Loon	*Gavia pacifica*	malbi	Breeder*	Common
Common Loon	*Gavia immer*	taasifiq	Visitant+	Casual
Yellow-billed Loon	*Gavia adamsii*	tuullik	Migrant+	Uncommon
Horned Grebe	*Podiceps auritus*		Visitant	Casual
Red-necked Grebe	*Podiceps grisegena*	aqpaqsruayuuq, sublitchauraq	Breeder	Uncommon
Greater White-fronted Goose	*Anser albifrons*	niblivik	Breeder+	Common
Emperor Goose	*Chen canagica*	mitilugruaq	Visitant	Accidental
Snow Goose	*Chen caerulescens*	kafuq	Breeder+	Uncommon
Canada Goose	*Branta canadensis*	iqsrabutilik	Breeder*	Common
Brant	*Branta bernicla*	niblinbaq	Breeder*	Common
Tundra Swan	*Cygnus columbianus*	qugruk	Breeder+	Common
American Wigeon	*Anas americana*	kurugabnaq	breeder+	Uncommon
Mallard	*Anas platyrhynchos*	kurugaqtaq	Visitant+	Rare
Northern Shoveler	*Anas clypeata*	alluutaq, qaqjutuuq	Breeder+	Uncommon
Northern Pintail	*Anas acuta*	kurugaq	Breeder+	Common
Green-winged Teal	*Anas crecca*	qaiffiq	Breeder	Uncommon
Canvasback	*Aythya valisineria*		Visitant	Casual
Greater Scaup	*Aythya marila*	qaqjuqpalik	breeder+	Uncommon
Lesser Scaup	*Aythya affinis*	qaqjutuuq	Breeder?	Casual
Steller's Eider	*Polysticta stelleri*	igniqauqtuq	Visitant	Casual
Spectacled Eider	*Somateria fischeri*	qavaasuk	Breeder*	Uncommon
King Eider	*Somateria spectabilis*	qifalik	Breeder*	common
Common Eider	*Somateria mollissima*	amauligruaq	Breeder*	Uncommon
Surf Scoter	*Melanitta perspicillata*	avixuqtuq	Visitant+	Rare
White-winged Scoter	*Melanitta fusca*	killalik	Visitant+	Rare
Black Scoter	*Melanitta nigra*	tuungaagrupiaq	Visitant+	Rare
Long-tailed Duck	*Clangula hyemalis*	aaqhaaliq	Breeder*	Common
Common Goldeneye	*Bucephala clangula*		Visitant	Casual
Red-breasted Merganser	*Mergus serrator*	paisugruk, aqpaqsruayuuq	Breeder+	Uncommon
Bald Eagle	*Haliaeetus leucocephalus*	tifmiaqpak	Visitant	Casual
Northern Harrier	*Circus cyaneus*	papiktuuq	Visitant+	Uncommon
Sharp-shinned Hawk	*Accipiter striatus*		Visitant+	Rare
Rough-legged Hawk	*Buteo lagopus*	qixbiq	Visitant+	Rare
Golden Eagle	*Aquila chrysaetos*	tifmiaqpak	Visitant+	Uncommon
Gyrfalcon	*Falco rusticolus*	aatqarruaq	Visitant	Rare
Peregrine Falcon	*Falco peregrinus*	kirgavik	Visitant+	Rare
Willow Ptarmigan	*Lagopus lagopus*	aqargiq, nasaullik	Resident*	Uncommon
Rock Ptarmigan	*Lagopus mutus*	niksaaktufiq	Resident*	Common
Sandhill Crane	*Grus canadensis*	tatirgaq	Breeder+	Rare
Black-bellied Plover	*Pluvialis squatarola*	tullivak	Breeder*	Common
American Golden-Plover	*Pluvialis dominicus*	tullik	Breeder*	Common
Semipalmated Plover	*Charadrius semipalmatus*	kurraquraq	Breeder+	Rare

Table 4-7 (Cont.)

COMMON NAME	SCIENTIFIC NAME	INUPIAQ NAME	STATUS[A]	RELATIVE ABUNDANCE[B]
Killdeer	*Charadrius vociferus*	taligvak	Visitant	Casual
Lesser Yellowlegs	*Tringa flavipes*	uviñfuayuuq	Visitant	Casual
Wandering Tattler	*Heteroscelus incanus*	sixixisuqtuq	Visitant	Casual
Upland Sandpiper	*Bartramia longicauda*		Visitant	Casual
Whimbrel	*Numenius phaeopus*	sigguktuvak	Visitant+	Rare
Hudsonian Godwit	*Limosa haemastica*		Visitant	Casual
Bar-tailed Godwit	*Limosa lapponica*	turraaturaq	Breeder+	Uncommon
Ruddy Turnstone	*Arenaria interpres*	tullignaq	Breeder*	Uncommon
Black Turnstone	*Arenaria melanocephala*		Visitant	Casual
Red Knot	*Calidris cauntus*		Migrant+	Casual
Sanderling	*Calidris alba*	kimmitquixaq	Migrant+	Rare
Semipalmated Sandpiper	*Calidris pusilla*	livalivaq	Breeder*	Abundant
Western Sandpiper	*Calidris mauri*		Migrant+	Rare
Red-necked Stint	*Calidris ruficollis*		Visitant	Casual
Least Sandpiper	*Calidris minutilla*	livalivauraq	Migrant+	Casual
White-rumped Sandpiper	*Calidris fuscicollis*		Breeder*	Uncommon
Baird's Sandpiper	*Calidris bairdii*	puviaqtuuyaaq	Breeder*	Common
Pectoral Sandpiper	*Calidris melanotos*	puviaqtuuq	Breeder*	Abundant
Sharp-tailed Sandpiper	*Calidris acuminata*		Visitant	Casual
Dunlin	*Calidris alpina*	qayuuttavak	Breeder*	Common
Stilt Sandpiper	*Calidris himantopus*		Breeder+	Uncommon
Buff-breasted Sandpiper	*Tryngites subruficollis*	satqagiixaq	Breeder*	Uncommon
Ruff	*Philomachus pugnax*		Visitant	Casual
Short-billed Dowitcher	*Limnodromus griseus*		Visitant	Casual
Long-billed Dowitcher	*Limnodromus scolopaceus*	kilyaktalik	Breeder*	Common
Common Snipe	*Gallinago gallinago*	saavbaq, aiviqiaq	Breeder+	Uncommon
Red-necked Phalarope	*Phalaropus lobatus*	qayyiubun	Breeder*	Abundant
Red Phalarope	*Phalaropus fulicaria*	auksruaq	Breeder*	Common
Pomarine Jaeger	*Stercorarius pomarinus*	isuffabluk	Migrant+	Common
Parasitic Jaeger	*Stercorarius parasiticus*	migiaqsaayuk	Breeder+	Common
Long-tailed Jaeger	*Stercorarius longicaudus*	isuffaq	Breeder+	Uncommon
Ringed-billed Gull	*Larus delawarensis*		Visitant	Accidental
Herring Gull	*Larus argentatus*	nauyavvaaq	Visitant+	Casual
Slaty-backed Gull	*Larus schistisagus*		Visitant	Casual
Glaucous-winged Gull	*Larus glaucescens*		Visitant	Casual
Glaucous Gull	*Larus hyperboreus*	nauyavasrugruk	Breeder*	Common
Sabine's Gull	*Xema sabini*	iqirgagiaq	Breeder+	Common
Ross's Gull	*Rhodostethia rosea*	qagmaqluaq	Migrant	Rare
Ivory Gull	*Pagophila eburnea*	igirraq	Migrant	Casual
Arctic Tern	*Sterna paradisaea*	mitqutaixaq	Breeder+	Common
Black Guillemot	*Cephus grylle*		Breeder+	Uncommon
Snowy Owl	*Nyctea scandiaca*	ukpik	Breeder+	Uncommon
Northern Hawk Owl	*Surnia ulula*	niaquqtuabruk	Visitant	Casual
Short-eared Owl	*Asio flammeus*	nipaixuktaq	Breeder+	Uncommon
Common Raven	*Corvus corax*	tulugaq	Resident+	Uncommon
Northern Flicker	*Colaptes auratus*		Visitant	Casual
Common Raven	*Corvus corax*	tulugaq	Resident+	Uncommon
Horned Lark	*Eremophila alpestris*	nagrulik	Visitant+	Casual

Table 4-7 (Cont.)

COMMON NAME	SCIENTIFIC NAME	INUPIAQ NAME	STATUS[A]	RELATIVE ABUNDANCE[B]
Tree Swallow	*Tachycineta bicolor*	tulugabnauraq	Visitant+	Casual
Bank Swallow	*Riparia riparia*	tulugabnaq	Visitant	Casual
Cliff Swallow	*Petrochelidon pyrrhonota*	tulugagnauraq	Visitant	Casual
Barn Swallow	*Hirundo rustica*		Visitant	Accidental
Arctic Warbler	*Phylloscopus borealis*	sufaqpaluktufiq	Visitant	Rare
Bluethroat	*Luscinia svecica*		Visitant	Rare
Northern Wheatear	*Oenanthe oenanthe*	tifmiaqpauraq	Visitant	Casual
American Robin	*Turdus migratorius*	kuyapigaqturuq	Visitant	Casual
Varied Thrush	*Ixoreus naevius*	sifutlulluuq	Visitant	Casual
Yellow Wagtail	*Motacilla flava*	piibaq, misiqqaaqauraq	Breeder+	Common
American Pipit	*Anthus rubescens*	piibavik, putukiuxuk	Visitant	Rare
European Starling	*Sturnus vulgaris*		Visitant	Accidental
Orange-crowned Warbler	*Vermivora celata*		Visitant	Casual
Yellow Warbler	*Dendroica petechia*		Visitant	Casual
Black-and-white Warbler	*Mniotilta varia*		Visitant	Accidental
American Redstart	*Setophaga ruticilla*		Visitant	Accidental
Northern Waterthrush	*Seiurus noveboracensis*		Visitant	Accidental
Wilson's Warbler	*Wilsonia pusilla*		Visitant	Casual
American Tree Sparrow	*Spizella arborea*	misapsaq	Breeder	Uncommon
Savannah Sparrow	*Passerculus sandwichensis*	ukpisiuyuk	Breeder+	Common
Fox Sparrow	*Passerella iliaca*	ikxibvik	Visitant	Casual
Lincoln's Sparrow	*Melospiza lincolnii*		Visitant	Casual
White-throated Sparrow	*Zonotrichia albicollis*		Visitant	Casual
Harris's Sparrow	*Zonotrichia querula*		Visitant	Accidental
White-crowned Sparrow	*Zonotrichia leucophrys*	nufaktuabruk	Breeder+	Rare
Golden-crowned Sparrow	*Zonotrichia atricapilla*	qiaranatuuq	Visitant	Casual
Dark-eyed Junco	*Junco hyemalis*	kayatavaurak	Visitant	Casual
Lapland Longspur	*Calcarius lapponicus*	qupaxuk, putukiuxuk	Breeder*	Abundant
Smith's Longspur	*Calcarius pictus*	qalbuusiqsuuq	Visitant	Casual
Snow Bunting	*Plectrophenax nivalis*	amauxxigaaluk	Breeder*	Uncommon
Rusty Blackbird	*Euphagus carolinus*	tulukkatun ittuq	Visitant	Casual
Common Redpoll	*Carduelis flammea*	saksakiq	Breeder+	Uncommon
Hoary Redpoll	*Carduelis hornemanni*	saksakiq	Breeder	Uncommon

[a] Status (Kessel and Gibson 1978): resident — present throughout the year; known to breed
migrant — a seasonal transient between wintering and breeding ranges
breeder — a species known to breed; ? indicates probable or possible breeding
visitant — a nonbreeding species; also, in fall, one not directly en route between breeding and wintering ranges

[b] Abundance abundant — species occurs repeatedly in appropriate habitats, with available habitat heavily used
common - occurs in all or nearly all appropriate habitats, but some areas of presumed suitable habitats are occupied sparsely or not at all
uncommon — species occurs regularly, but uses little of the suitable habitat, not observed regularly even in appropriate habitats
rare — species within its normal range, occurring regularly but in very small numbers
casual —beyond normal range, but not so far that irregular observations are likely over a period of years; usually occurs in small numbers
accidental — a species so far from its normal range that further observations are unlikely; usually occurs singly

Sources: Kessel and Gibson (1978); Wright and Fancy (1980); Martin and Moitoret (1981); WCC and ABR (1983); Johnson and Herter (1989); TERA (1993); Hohenberger et al. (1994); Noel et al. (1999, 2000); Nickles et al. (1987) Field et al. (1988). Common and scientific names follow AOU (1983 and supplements 35–40), and Inupiaq names follow Webster and Zibell (1970), MacLean (1980), Norton et al. (1993), and Kaplan (1996 personal communication). Status: * = confirmed as breeder in Point Thomson study area; + = observed in Point Thomson region but not confirmed as breeding.

of development projects. On the North Slope, tundra swans nest at higher densities on major river deltas (Colville, Sagavanirktok, and Canning Rivers) than across the rest of the coastal plain. The Point Thomson region supports moderate numbers of tundra swans compared to other areas in northern Alaska (Rothe and Hawkins 1982 and Ritchie and King 2000).

Tundra swans inhabit the Point Thomson area from May through September (WCC and ABR 1983). Although the first swans arrive while the tundra is largely snow-covered (mid-May), most arrive 1 to 2 weeks later (Hawkins 1986 and Ritchie and King 2000). As snow melts, pairs move to breeding territories to nest by early June. After eggs hatch in early July, family groups remain together, but often range widely to find food (Johnson and Herter 1989). Before the young fly in mid- to late-September, adults become flightless (molt) for about 3 weeks. During this flightless period, swan broods are sensitive to disturbance. In the Colville delta area, non-breeding swans form large staging flocks (>100 birds), and have been found along river channels (East Channel of the Colville River and lower reaches of the Miluveach and Kachemach Rivers); data are lacking concerning non-breeding swan use of the Staines Canning River area. Fall staging on the coastal plain usually takes place during early to mid-September (Rothe et al. 1983, Smith et al. 1994 and Monda et al. 1994) and fall migration peaks in late September and early October (Johnson and Herter 1989).

Few surveys of nesting tundra swans have been conducted in the Point Thomson region, but nesting density (0.05 nests per square mile [nests/mi^2]) (0.08 nests per square kilometer [nests/km^2]) (Byrne et al. 1994) appears to be lower than has been recorded to the west (0.02–0.10 nests/mi^2 [0.03-0.17 nests/km^2] in the Kuparuk Oil Field, 0.08–0.21 nests/mi^2 [0.13-0.34 nests/km^2] on the Colville River delta, 0.23 birds/mi^2 [0.37 birds/km^2] on the Sagavanirktok River delta [Ritchie and King 2000]). Few swan nests have been found in the Point Thomson area. During ground searches in the Point Thomson area, WCC and ABR (1983) found two nests of tundra swans, both associated with lakes and ponds habitat types. Other swans were seen in June in wet strangmoor habitats (WCC and ABR 1983). During aerial surveys in 1994, Byrne et al. (1994) found that most nesting swans in the region were located between the Sagavanirktok River delta and Mikkelsen Bay and saw only seven swans (and no nests) between Mikkelsen Bay and the Staines River. On the Canning River delta (east of the Point Thomson area), the most common nesting habitat was graminoid-marsh (dominated by *Arctophila fulva* and *Carex aquatilis*), and nests were usually <0.6 mi (<0.97 km) from lakes (Monda et al. 1994).

No surveys have been conducted in the Point Thomson area specifically for brood-rearing swans, but LGL et al. (1999) reported densities of 0.28 swans/mi^2 (0.45 swans/km^2) during aerial surveys of tundra transects in the Point Thomson region. WCC and ABR (1983) recorded no tundra swans during the molting/brood-rearing period (25 July–15 August), but did observe small numbers of swans during staging (19 birds; 23–31 August) and fall migration (42 birds; 12–17 September) in the Point Thomson area. During aerial surveys, WCC and ABR (1983) also noted one staging area for tundra swans in a large lake near the coast southwest of Bullen Point (flocks of 20 and 28 swans with young noted during two aerial surveys). On the Canning River delta, brood-rearing swans occurred primarily in graminoid-marsh, graminoid-shrub-water sedge, and aquatic-marsh habitats (Monda et al. 1994). Other studies on the coastal plain have shown that tundra swans occur frequently in habitats supporting the emergent grass *Arctophila fulva*, which is a primary food for adults and young (Bergman et al. 1977; Derksen et al. 1981). Brood-rearing tundra swans prefer aquatic habitats because they provide food and escape cover, especially for the young.

4.8.1.2 Geese

Four species of geese (greater white-fronted goose, Canada goose, brant, and snow goose) regularly nest on the ACP and have been recorded in the Point Thomson region (Johnson and Herter 1989 and WCC and ABR 1983) (see Table 4-7). The distribution of each species differs across the coastal plain and is influenced by their nesting habits. Greater white-fronted and Canada geese nest in isolated pairs on the tundra or on small islands in lakes and ponds. In contrast, brant and snow geese nest primarily in colonies at traditional sites, ranging from a few to several hundred pairs.

The greater white-fronted goose is the most common goose on the ACP, becoming less common east of Prudhoe Bay (Johnson and Herter 1989). Greater white-fronted geese are present on the coastal plain from approximately mid-May to mid-September. They arrive when open tundra appears and begin nesting within 1 to 2 weeks, usually by late May (Rothe et al. 1983 and Johnson and Herter 1989). Eggs hatch in late June and early July. Before the young can fly, adults (breeding and nonbreeding) molt and are flightless for 2 to 3 weeks. During brood-rearing, family groups form large flocks near deep lakes that provide protection from predators. Once adults and young can fly, they form large staging flocks before the migration, which begins in mid-August and ends about mid-September (Johnson and Herter 1989).

Greater white-fronted geese may breed in low numbers in the Point Thomson region, but were not recorded as nesting by WCC and ABR (1983) or Wright and Fancy (1980). Small numbers of greater white-fronted geese were seen during spring arrival and nesting, but they were most numerous during the staging period, suggesting that the area is more important for staging than nesting (WCC and ABR 1983). This conclusion is supported to some extent by the relatively large density (15.0 birds/mi^2 [24 birds/km^2]) of geese seen during aerial surveys in August and September (LGL et al. 1999).

The Canada goose has a patchy distribution across the ACP, with highest densities in the Prudhoe Bay area (Johnson and Herter 1989). Breeding phenology is similar to that described previously for the greater white-fronted goose. In the Point Thomson region, Canada geese are the primary nesting goose species (Wright and Fancy 1980 and WCC and ABR 1983) and have been commonly observed during the breeding season (WCC and ABR 1983). Eight Canada goose nests were located during ground searches in the Point Thomson area in 1983, all in lake and pond habitat type (WCC and ABR 1983). Wright and Fancy (1980) found two Canada goose nests, one in each of their plots (drilling site south of Point Gordon/control site south of Point Sweeny).

The estimated nesting density (3.9 nests/mi^2 [6.3 nests/km^2]) WCC and ABR 1983) in the Point Thomson area was the highest recorded for study sites from Point Thomson to the Prudhoe Bay area (Table 4-8). During aerial surveys of tundra transects during staging in August–September 1998, LGL et al. (1999) reported densities of 4.2 birds/mi^2 (6.8 birds/km^2). Brant nest in low numbers across most of the coastal plain, with larger nesting colonies found on major river deltas, such as those of the Colville, Kuparuk, and Sagavanirktok Rivers (Johnson and Herter 1989 and Sedinger and Stickney 2000). Brant occur in the Point Thomson region from late May through late August (WCC and ABR 1983). They arrive on the coastal plain in early June and move to nesting colonies soon afterwards (Kiera 1979 and Rothe et al. 1983). Hatching begins in late June or early July and brant form large brood-rearing flocks shortly thereafter. Brant depart the coastal plain soon after the young can fly, usually by mid-August.

Table 4-8 Nesting Density (Nests/mi²) of Birds in the Point Thomson Region and Adjacent Areas on the Arctic Coastal Plain, Alaska

SPECIES	POINT THOMSON (1983)	YUKON GOLD (1993)	CANNING RIVER DELTA (1979–1980)	BADAMI (1994)	KADLER-OSHILIK (1994)	SAGAVAN-IRKTOK RIVER DELTA (1981)	POINT MCINTYRE REFERENCE AREA (1981–1992)
Red-throated Loon				0.8			0.3
Pacific Loon					2.6		3.9
Greater White-fronted Goose					0.8		2.8
Canada Goose	3.9				3.4		0.3
Northern Pintail							0.3
Spectacled Eider					0.8		0.5
King Eider			2.1	1.8	1.8	4.4	3.4
Common Eider	3.9						
Long-tailed Duck	3.9	0.8	2.1	0.8	3.4	4.4	3.4
Willow Ptarmigan							0.3
Rock Ptarmigan			3.9	0.8			0.8
Black-bellied Plover				0.8	1.8	4.4	1.6
American Golden-Plover		2.6	3.9	7.0	4.4	8.5	7.0
Sanderling							0.3
Semipalmated Sandpiper		6.0	25.9	41.4	23.3	30.3	32.4
Western Sandpiper							0.3
White-rumped Sandpiper							1.6
Baird's Sandpiper	50.5			2.6		8.5	1.8
Pectoral Sandpiper	27.2	18.9	31.9	23.3	31.1	4.4	22.5
Dunlin			8.0	8.5	10.4		19.4
Stilt Sandpiper				3.4	3.4		1.8
Buff-breasted Sandpiper			6.0			4.4	2.3
Long-billed Dowitcher	7.8			1.8			1.0
Red-necked Phalarope		1.8	14.0	2.6	8.5	4.4	2.3
Red Phalarope	7.8	3.4	47.7	6.0	19.9	13.0	17.6
Parasitic Jaeger							0.3
Lapland Longspur	62.2	38.1	71.5	90.7	64.8	47.4	38.3
Total Density	167.1	73.3	216.9	192.9	180.3	134.2	166.3
Waterfowl	11.7	0.8	4.2	3.4	12.7	8.8	14.8
Shorebird	93.2	32.6	137.3	97.4	102.8	78.0	111.9
Passerine	62.2	38.1	71.5	90.7	64.8	47.4	38.3
Other Birds	0	0	3.9	0.8	0	0	1.3
Number of Species	8	7	11	15	15	11	26
Source	WCC and ABR (1983)	TERA (1993)	Martin and Moitoret (1981)	TERA (1994) in BP (1995)	TERA (1994) in BP (1995)	Troy (1988)	TERA (1993)

Note: Methods varied among studies but all involved nest searches within transects or plots; for multiple-year studies, average densities are presented.

In the central Beaufort Sea region, brant nest primarily at two large colonies between the Staines and Colville Rivers, one on islands in the East Channel of the Colville River and one on Howe Island in the Sagavanirktok River delta (Sedinger and Stickney 2000). In addition, smaller colonies and single nests are found at scattered locations across the coastal plain in this area. In the Point Thomson area, brant have been found nesting (1 nest) on an island in the Staines River delta (Ritchie et al. 1991). Small numbers of brant have been recorded nesting at locations immediately west of the study area on the Shaviovik and Kadleroshilik River deltas and on Tigvariak Island (Ritchie et al. 1990 and 1991; Stickney et al. 1992 and 1993). Nesting habitats of brant have been described for the Colville River delta and include salt-killed tundra, aquatic sedge with deep polygons, brackish water, salt marsh, nonpatterned wet meadow, and wet sedge-willow meadow (Johnson et al. 1999).

No brood-rearing brant have been recorded in the Point Thomson area, but small flocks have been seen on deltas of the Kadleroshilik and Shaviovik Rivers and on Tigvariak Island to the west (Ritchie et al. 1990, 1991; Stickney et al. 1992, 1993; Noel and Johnson 1997; Noel et al. 1999c). WCC and ABR (1983) reported small numbers (407 birds) of brant in the Point Thomson area during the molting/brood-rearing period (mid July–mid August). Brood-rearing (and molting) flocks have a strong affinity for coastal and salt-affected habitats because brant feed primarily on *Puccinellia phryganodes* and *Carex subspathacea*, which are found only in saline habitats (Kiera 1979). This habitat type is somewhat limited in the Point Thomson area, but small acreages (<2% of total mapped acreage) of this type can be found near Point Thomson and at scattered locations between the Staines River and Mikkelsen Bay (see Section 4.6). The distance of these habitats from known breeding colonies limits their availability for brood-rearing flocks, although they may be used by birds during staging and migration. Large numbers of brant have been recorded moving westward through the Point Thomson area during the staging and fall migration periods, 5959 and 2526 birds, respectively (WCC and ABR 1983). It is not known if any of these birds used salt-marsh habitats in the Point Thomson area. Small numbers of brant (0.36 birds/mi^2 [0.58 birds/km^2]) were recorded during aerial surveys of lagoon transects in the Point Thomson area during August–September 1998 (LGL et al. 1999).

Snow Geese nest in several colonies and in scattered pairs across the ACP; generally west of the Sagavanirktok River delta (Derksen et al. 1981, Simpson et al. 1982, Johnson 2000, and Ritchie et al. 2000). Three small colonies (~50 to ≥400 nests) have been recorded in the Sagavanirktok, Ikpikpuk, and Kukpowruk River deltas (Ritchie and Burgess 1993; Noel et al. 1998; Johnson 2000; Ritchie et al. 2000; Ritchie 2001). No breeding colonies have been reported in the Point

Thomson region (Wright and Fancy 1980 and WCC and ABR 1983), but WCC and ABR (1983) did report sighting of four snow geese during spring arrival (early June). The nesting colony closest to Point Thomson is at Howe Island, on the Sagavanirktok River delta, which has supported limited numbers of nesting snow geese in recent years, due to disruption of nesting by predator/scavengers (Noel et al. 1999c and Noel and Johnson 2001a and 2001b).

Snow geese arrive in coastal nesting areas in late May or early June and young hatch during late June, although breeding phenology can be affected by late snow-melt in nesting areas. Brood-rearing snow geese have been seen in most years immediately west of the Point Thomson area in the vicinity of the Shaviovik River delta and Tigvariak Island (Noel and Johnson 1997 and Noel et al. 1999c). During autumn migration, large numbers (150,000–450,000) of snow geese stage in the eastern coastal plain of ANWR for short periods in early-mid September (Robertson et al. 1997). LGL et al. (1999) did not record any snow geese during aerial surveys of tundra and lagoon transects in the Point Thomson area in August–early September 1998, and WCC and ABR (1983) did not record snow geese during staging or fall migration in the Point Thomson area.

4.8.1.3 Ducks

Ducks on the ACP of Alaska can be separated into three general groups: Arctic breeders (e.g., eiders and long-tailed duck [oldsquaw]); breeders on the edge of their range (e.g., green-winged teal, northern pintail, greater scaup, northern shoveler, American wigeon, and red-breasted merganser); and non-breeders (e.g., scoters and common goldeneye).

Of the 13 species of ducks recorded in the Point Thomson region, four are confirmed breeders: the long-tailed duck, and spectacled, king, and common eiders (Tables 4-7 and 4-8) (Wright and Fancy 1980, WCC and ABR 1983, and TERA 1993). Spectacled eiders are discussed in Section 4.11 Threatened and Endangered Species. King eiders were the most abundant eider seen during aerial surveys for eiders in the Point Thomson region (Byrne et al. 1994 and TERA 1999 and 2000). Northern pintails are common in the Point Thomson area and probably nest in the area, but no nests were found by Wright and Fancy (1980), WCC and ABR (1983), or TERA (1993). Other duck species could potentially be abundant in the Point Thomson region during years when they are displaced by drought from the prairie regions of North America (Derksen and Eldridge 1980). Common eiders nest primarily on the coast and on offshore barrier islands, but breeding pairs also have been recorded at inland sites in the Point Thomson area (TERA 1999 and 2000), suggesting some nesting may occur there. Common eiders regularly nested on the barrier islands between Mikkelsen Bay and the Staines River, with a yearly average of 130 nests total found among the barrier islands searched (Moitoret 1998 and Noel et al. 1999c and 2001). Of the seven major barrier islands in the Point Thomson region, Pole, Alaska, Northstar, and Duchess islands supported the most nesting common eiders (Moitoret 1998 and Noel et al. 1999c).

Like most waterbirds, ducks (including eiders) occur in the Point Thomson region between May and September, when tundra ponds are ice-free. Ducks arrive on the tundra in mid- to late May, begin nesting within 1 to 2 weeks, and depart by late August (Rothe et al. 1983 and North et al. 1984). Male king eiders and long-tailed ducks leave the breeding grounds by mid-June after females commence incubation (Rothe et al. 1983). Duck broods first appear in early to mid-July, and most young can fly by late August (Rothe et al. 1983 and North et al. 1984). Eider broods probably remain in the area longer than other duck species, because their larger size requires more time for young to fledge (become capable of flight).

Information on nesting habitats of ducks in the Point Thomson region is relatively sparse, but WCC and ABR (1983) found breeding pairs in moist and wet tundra habitats and lakes without emergent vegetation. During brood rearing, ducks on the coastal plain primarily use aquatic habitats, particularly those with emergent vegetation. Brood-rearing long-tailed ducks use aquatic sedge and grass marshes, small lakes, and river channels; while molting groups occur more often on large, deep open lakes, tapped lakes, and coastal lagoons. Northern pintails generally use aquatic sedge and grass marshes, flooded tundra, brackish ponds, and salt marshes during brood rearing. In general, all aquatic habitats in the Point Thomson region likely receive some use by ducks for nesting, brood rearing, and foraging.

Aerial surveys for long-tailed ducks have been flown in the Point Thomson region sporadically since 1977 and allow calculations of relative abundance (densities; birds/mi^2 [birds/km^2]) and distribution during the molting (mid-July to 19 August) and post-molting periods (20 August to 20 September) (Noel et al. 1999a and 2000, Petersen et al. 1999, and Flint et al. 2001). During the molting and post-molting periods, long-tailed ducks are abundant along the mainland and in the lagoon system between the Staines River and Mikkelsen Bay, but are less commonly found on the inland tundra (Figures 4-4A and 4-4B). Relative abundance of long-tailed ducks varies among locations along the mainland shore and in the barrier island system of Lions Lagoon. Shorelines immediately east of Point Thomson to a point near Point Gordon received the greatest use during both the molting and post-molting periods (mean = 509 birds/mi^2 [820 birds/km^2]) and 223 birds/mi^2 [360 birds/km^2]), respectively, as calculated from raw data in Noel et al. 1999a and 2000 and Flint et al. 2001), while the shorelines to the east and west of this area were used less. Within Lions Lagoon, the densities of long-tailed ducks varied both from east to west and between the molting and post-molting periods. During the molting period, the density of long-tailed ducks increased from west to east, reaching its highest mean density in the lagoon south of Flaxman Island to Brownlow Point (mean = 102 birds/mi^2 [160 birds/km^2]); calculated from data *in* Noel et al. 1999a and 2000 and Flint et al. 2001). This same general west-east trend also was apparent during post-molting, but the peak abundance shifted westward in the lagoon to the Alaska Island to Flaxman Island area, and the mean density increased three-fold (283 birds/mi^2 [450 birds/km^2]); calculated from data *in* Noel et al. 1999a and 2000 and Flint et al. 2001). Aerial surveys flown at the northern edge of the lagoon in 1999 showed a somewhat similar pattern of distribution and relative abundance, but the post-molting peak abundance had shifted even farther west. Of all the surveys flown, the highest mean densities of long-tailed ducks during both the molting and post-molting periods were recorded on and immediately adjacent to the barrier islands (Noel et al. 1999a and 2000 and Flint et al. 2001). As shown on Figure 4-4A, during molting, the Flaxman Island to Brownlow Point area supported densities (mean = 1001 birds/mi^2 [1600 birds/km^2]); as calculated from data *in* Noel et al. 1999a and 2000 and Flint et al. 2001) about twice those found in transects farther west (means ranged from 356 birds/mi^2 [570 birds/km^2]) to 588 birds/mi^2 [950 birds/km^2]); as calculated from data *in* Noel et al. 1999a and 2000 and Flint et al. 2001). In contrast, offshore (north of the barrier islands) transects had few long-tailed ducks during either the molting or post-molting period (Figure 4-4A and 4-4B).

4.8.1.4 Loons

Three species of loons—yellow-billed, Pacific, and red-throated—breed on the ACP of Alaska. Common loons and two species of grebes are casual visitors or irregular breeders, respectively (see Table 4-7).

Yellow-billed loons are uncommon breeders on most of the ACP and are common breeders only near the Alaktak and Chipp Rivers (Sjolander and Agren 1976 and Johnson and Herter 1989). No nests of yellow-billed loons have been documented in the Point Thomson area, but WCC and ABR (1983) indicated several loons during fall staging (1 bird) and migration (7 birds). Wright and Fancy (1980) also recorded yellow-billed loons at their two study plots near Point Gordon and Point Sweeny. Yellow-billed loons have also been observed on the Canning River delta to the east of Point Thomson (Martin and Moitoret 1981). Low densities (mean density = 0.05 birds/mi^2 [0.08 birds/km^2]) of yellow-billed loons were recorded during aerial transects along the barrier islands of Lions Lagoon in August–September 1998 and 1999 (LGL et al. 1999 and Noel et al. 2000).

Pacific loons are common breeders across the entire coastal plain (Johnson and Herter 1989). They were the most abundant loons observed in the Point Thomson region in 1982 and have been recorded as breeding in the area (WCC and ABR 1983). Pacific loons occur in the project area from early May through September. Pacific loons arrive on the coastal plain in late May as open water appears in river channels and on tundra lakes and ponds; they move to nesting lakes as ice disappears in early to mid-June. After the young hatch in mid-July, they tend to remain in the nesting lake, or move to adjacent lakes. The time required for juveniles to fledge varies among loon species, with the larger yellow-billed and Pacific loons requiring more time than the smaller red-throated loon. Fall migration of loons peaks during early September along the Beaufort Sea (Johnson and Herter 1989), but family groups (adults with young) do not depart until the young can fly, which may be as late as mid-September.

The Pacific loon was the most abundant loon species recorded during aerial surveys in August–September 1998 on tundra transects and second-most abundant on the barrier islands transects in the Point Thomson area (mean density = 0.39 birds/mi^2 [0.63 birds/km^2]) and 0.02 birds/mi^2, [0.03 birds/km^2]) respectively) (LGL et al. 1999). In 1999, Noel et al. (2000) found that Pacific loons predominated in the lagoon system of the Point Thomson area during August–September surveys.

Limited information on habitat use by Pacific loons in the Point Thomson area indicates use of lakes and ponds with and without emergent vegetation, and also wet low-centered polygons (probably in standing water) (WCC and ABR 1983). On the Colville River delta, Pacific loons nested on islands and shorelines of all types of waterbodies and also in terrestrial habitats bordering lakes, such as aquatic sedge, salt marsh, salt-killed tundra, nonpatterned wet meadow, and wet sedge–willow meadow (Johnson et al. 1999b). Broods were observed in the same aquatic habitats where nests were found. Pacific loons feed primarily on aquatic invertebrates available in their breeding lakes (Bergman and Derksen 1977, North 1986, and Kertell 1994) and nearshore marine waters (Andres 1993).

The red-throated loon is a common breeder on the ACP, including the Point Thomson region (Johnson and Herter 1989 and Johnson et al. 1999a). Red-throated loons were less abundant than Pacific loons during all periods of the breeding season in the Point Thomson area (WCC and ABR 1983). Two red-throated loon nests were found in the Point Thomson area, both in the lake and pond habitat type (WCC and ABR 1983).

The breeding cycle and habitat use of red-throated loons differs from that of other loons. Red-throated loons arrive on the coastal plain later than the other species, usually not until early June when open water appears in tundra ponds. The timing of breeding events, however, is similar to that of yellow-billed and Pacific loons. Red-throated loons nest on smaller (often <3 acres [1.2 ha]), shallower ponds than do the other species (Johnson and Herter 1989 and Dickson 1994; McIntyre 1994). On the Colville River delta, habitats used by red-throated loons for nesting and brood-rearing include brackish water, salt-killed tundra, deep open lakes, shallow lakes, aquatic sedge, nonpatterned wet meadow, and wet sedge–willow meadow (Burgess et al. 2000 and Johnson et al. 2000). In other locations on the coastal plain, red-throated loons use both sedge and grass marshes, but they also use basin wetland complexes, especially during brood rearing (Bergman et al. 1977 and Derksen et al. 1981).

In contrast to the other loons, who do most of their feeding in their nesting lakes, red-throated loons fly to nearshore marine waters to hunt fish for their young (Bergman and Derksen 1977).

This behavior may account for the relatively greater abundance of red-throated loons compared to pacific loons in the barrier islands and lagoons in the Point Thomson area during August–September (0.21 birds/mi^2 [0.34 birds/km^2] and 0.10 birds/mi^2 [0.16 birds/km^2], respectively) (LGL et al. 1999). Nesting lakes are not used for feeding, probably because few fish survive when these shallow lakes freeze to the bottom in winter.

4.8.2 Tundra-Nesting Birds

Tundra-nesting birds of the Point Thomson region include shorebirds, ptarmigan, and songbirds (see Table 4-7). These bird species nest primarily in terrestrial habitats, rather than in association with aquatic habitats.

4.8.2.1 Shorebirds

Shorebirds are present on the Point Thomson region from May to September. They begin to arrive in late May, and most are present by mid-June. Nesting usually begins 7 to 10 days after arrival. The young hatch during late June to mid-July, and fledge 3 to 4 weeks later. After the breeding season, many shorebirds move to the coast to feed in shoreline habitats before beginning migration in August (Rothe et al. 1983, Andres 1989 and 1994, and Smith and Connors 1993).

Of the 21 species of shorebirds recorded in the Point Thomson region, 10 are confirmed breeders, based on nests or broods (see Table 4-7). Ground-based studies of shorebirds have been limited in the Point Thomson region but do include surveys for breeding shorebirds (WCC and ABR 1983), and a study at the Yukon Gold ice pad about 6 mi (10 km) south of Point Thomson (TERA 1993). Martin and Moitoret (1981) also conducted a shorebird study on the Canning River delta, east of the Point Thomson area. WCC and ABR (1983) found that the most common nesting shorebirds in the Point Thomson region were the Baird's sandpiper, pectoral sandpiper, red phalarope, and long-billed dowitcher. Both the diversity and density of shorebirds on the Point Thomson region during the breeding season were less than those found elsewhere on the ACP (Table 4-8).

Shorebirds breeding on the Point Thomson region use many habitats for nesting and brood-rearing. Plovers nested on the drier upland habitats, and phalaropes and other sandpiper species nested in wetter tundra habitats, including wet sedge meadows, wet nonpatterned tundra, and aquatic sedge and grass marshes (WCC and ABR 1983). During brood rearing, shorebirds move to tundra and aquatic habitats adjacent to the nest sites. After the young fledge, many shorebirds form large feeding flocks, often of mixed species, that tend to congregate in coastal habitats (Smith and Connors 1993). Large movements of shorebirds to coastal habitats were not seen in the Point Thomson area, although use of coastal marshes has been observed (WCC and ABR 1983). Shorebirds with broods were seen using lakes with and without emergent vegetation, wet strangmoor, and coastal marshes. These habitats, along with the others used for breeding activities, are the primary source of food (insects and other small invertebrates) for the birds (Andres 1989 and Johnson and Herter 1989). The coastal shift in habitat use by shorebirds continued during the staging and fall migration periods in the Point Thomson area (WCC and ABR 1983).

4.8.2.2 Ptarmigan

Rock and willow ptarmigan are widespread on the ACP, particularly inland from the coast (Johnson and Herter 1989). Although both species were seen in the Point Thomson area, only rock ptarmigan were confirmed as breeding (Wright and Fancy 1980 and WCC and ABR 1983) (see Table 4-7). Most rock ptarmigan were seen in the moist non-patterned habitats in the area (WCC and ABR 1983). A few ptarmigan of either species may overwinter in the Point Thomson region, but most winter in the foothills of the Brooks Range (Johnson and Herter 1989).

4.8.2.3 Songbirds

Songbirds occur on the ACP only during summer; with the exception of two redpoll species. Most songbirds winter in temperate and tropical regions of the Americas or southern Asia. Of the eight species recorded in the Point Thomson area, only four are confirmed breeders (Tables 4-7 and 4-8). The other species occur in the region during migration or as summer vagrants. Overall, nest densities of songbirds in the Point Thomson area are near the lower end of nesting densities reported for other locations on the ACP. The most abundant breeding species in the Point Thomson region is the Lapland longspur (see Table 4-8). Lapland longspurs were found nesting in most habitat types in the Point Thomson area, but the majority of nests were found in moist habitats (WCC and ABR 1983), wet sedge meadows, and *Dryas* tundra (Wright and Fancy 1980). In the Prudhoe Bay area, the highest densities of Lapland longspur nests occur in polygonized wet and moist meadows (Troy 1988).

4.8.3 Predatory Birds

Predatory birds recorded in the Point Thomson region include raptors (seven species), gulls (three species), jaegers (three species), arctic tern, and common raven (see Table 4-7). Except for the common raven, which is a year-round resident, all of these species winter farther south (Johnson and Herter 1989).

4.8.3.1 Raptors

None of the raptors (eagles, hawks, falcons, and owls) that occur on the ACP is a regular breeder in the Point Thomson region. Snowy and short-eared owls are locally common breeders on the coastal plain during years when small mammals are abundant (Johnson and Herter 1989). They probably nest in the project area during those times. Most raptors that breed regularly in northern Alaska are more common inland than on the outer coastal plain (Johnson and Herter 1989). Riparian bluffs in the foothills between the Canning and Sagavanirktok rivers offer fair to excellent breeding habitats for diurnal species including peregrine falcons, gyrfalcons, and rough-legged hawks. Many raptors seen near the coast are juveniles, failed breeders, or migrants. Immature golden eagles frequent the coastal plain in summer (Young et al. 1995). A few peregrine falcons and rough-legged hawks do nest in coastal areas and may be attracted to man-made structures for nesting (Ritchie 1991). Rough-legged hawks have nested on an airport tower at the Bullen Point Dewline site (R. J. Ritchie, ABR, Inc., pers. com.). Thus, although the Point Thomson area is used by raptors, it is not an important nesting area.

The Arctic peregrine falcon (*Falco peregrinus tundrius*) was removed from the threatened list by the USFWS on 5 October 1994 (59 FR 50796), and the species has now completed the 5-year monitoring period that follows delisting, when it was treated as a species of concern. Currently, the Arctic peregrine falcon receives no special considerations from regulatory agencies based on the Endangered Species Act, but still receives some protections under the Migratory Bird Treaty Act (16 U.S.C. 703-712). Peregrines generally have been considered as infrequent visitors to the coastal plain (Pitelka 1974 and Johnson and Herter 1989) and regular breeders inland (Cade 1960 and Pitelka 1974). However, recent surveys in the National Petroleum Reserve–Alaska suggest that individuals from the increasing population of peregrines have selected more marginal habitats including low mud bluffs on the ACP (Ritchie and Wildman 2000; Wildman and Ritchie 2000).

The largest concentrations of breeding Arctic peregrine falcons occur along rivers in the northern foothills of the Brooks Range, especially the central Colville River and its tributaries (Cade 1960 and White and Cade 1971), the Sagavanirktok River (Ambrose et al. 1988), and the transition zone between the foothills and coastal plain (Ritchie and Wildman 2000; Wildman and Ritchie 2000). In the Point Thomson region, Arctic peregrine falcons have been located nesting in foothill sections of all major rivers between the Sagavanirktok and Canning rivers (Wildman and Ritchie 2000); the nearest known nest sites occur on the lower Canning and Kavik rivers (Ambrose et al. 1988 and Wildman and Ritchie 2000) and Barter Island (Fran Mauer, USFWS, pers. comm.). Only a few Arctic peregrine falcon sightings have been reported in the Point Thomson area: one near Point Sweeny in 1980 (Wright and Fancy 1980) and one seen during late summer in 1983 (WCC and ABR 1983). Arctic peregrine falcon use of the area probably includes occasional hunting forays during summer by adults, movements of young birds after leaving the nest, and transient and migratory use.

4.8.3.2 Other Species

Other predatory birds that occur in the project area include gulls, jaegers, and the Arctic tern (see Table 4-7). Two species of gulls (glaucous and Sabine's) breed in the region (see Table 4-7); both are common to uncommon breeders on the ACP (Johnson and Herter 1989). Both species nest either as isolated pairs or in small colonies; small colonies of Sabine's gulls have been found on the Canning River delta (Martin and Moitoret 1981). Glaucous gulls also nest on the barrier islands offshore of the Point Thomson area (Noel et al. 1999b).

All three species of jaegers occur in the Point Thomson area (see Table 4-7), but only the parasitic jaeger is a regular breeder (see Table 4-8). Pomarine jaegers are common only during spring migration (early June) in the Point Thomson area (WCC and ABR 1983). Long-tailed jaegers were found nesting in the Kadleroshilik area (Nickles et al. 1987 and Fields et al. 1988) and may nest occasionally elsewhere in the Point Thomson region. Little is known about nesting habitats for jaegers in the Point Thomson area, but on the Colville River delta both parasitic and long-tailed jaegers nested primarily in wet sedge–willow meadows (Burgess et al. 2000; Johnson et al. 2000).

Arctic terns are common breeders across the coastal plain and have been found nesting on the barrier islands in the Point Thomson area (Johnson and Herter 1989; Noel et al. 1999b). WCC and ABR (1983) recorded arctic terns during most periods of the breeding season.

The breeding phenology for all of these birds is similar (May–September) to that described for other species, except that gulls arrive somewhat earlier on the coastal plain than the other species (Johnson and Herter 1989). Food habits differ among species, but all species range widely over the tundra in search of food. Glaucous gulls and jaegers eat small birds, small mammals, and the eggs and young of waterfowl, other waterbirds, and shorebirds. Parasitic and long-tailed jaegers prey on eggs of waterfowl (ducks, geese, and swans) and hunt shorebirds and other small birds (Johnson et al. 1999b, 2000). Sabine's gulls and arctic terns feed on aquatic invertebrates and small Fish in deep open lakes, deep ponds with emergent vegetation, and ponds in basin wetland complexes (Rothe et al. 1983). Gulls, jaegers, and terns occur throughout the Point Thomson area, given their broad habitat use and diverse prey.

Common ravens are uncommon residents on the ACP, where they closely associate with human habitations (Johnson and Herter 1989). Ravens occasionally nest near the coast, primarily on buildings and other structures, including oilfield facilities (Johnson and Herter 1989 and Ritchie 1991). Common ravens occur in the Point Thomson area, and one apparently active nest was found at the Bullen Point Dewline site in 1994 (Day et al. 1995). Small numbers of ravens use the Point Thomson area during summer (WCC and ABR 1983). Common ravens are the earliest breeding species on the coastal plain; nesting begins by early April and young fledge by mid-June (Johnson and Herter 1989). Ravens range widely across the tundra in search of food (bird eggs, small mammals, and carrion) and have been observed taking eggs of waterbirds (ducks or shorebirds) in the oil fields (ABR, unpublished data).

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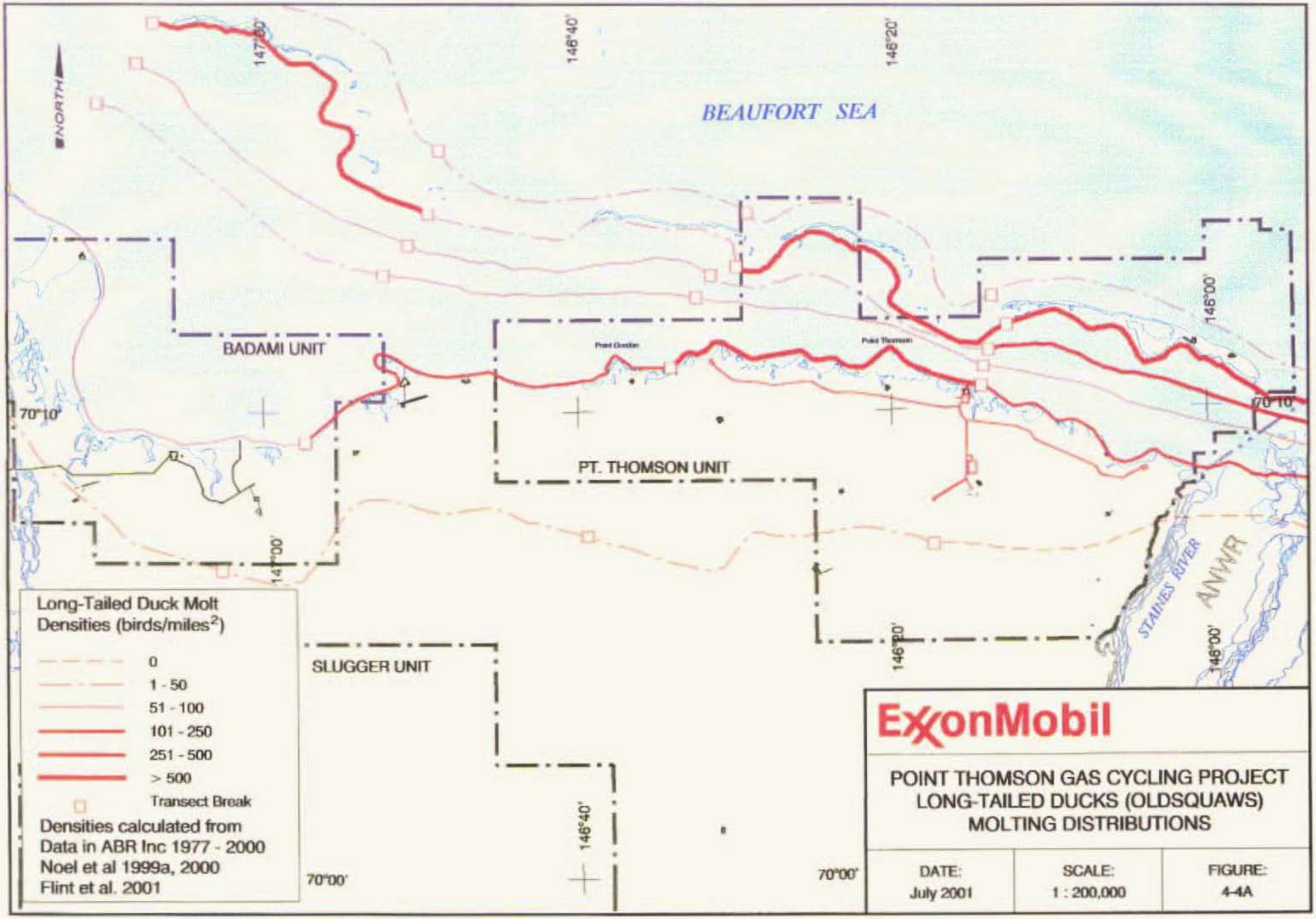
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BEAUFORT SEA
BADAMI UNIT
PT. THOMSON UNIT
SLUGGER UNIT
70°10'
70°00'
STAINES RIVER
ANWR
Long-Tailed Duck Molt
Densities (birds/miles²)
0
1 - 50
51 - 100
101 - 250
251 - 500
> 500
Transect Break
Densities calculated from
Data in ABR Inc 1977 - 2000
Noel et al 1999a, 2000
Flint et al. 2001
ExxonMobil
POINT THOMSON GAS CYCLING PROJECT
LONG-TAILED DUCKS (OLDSQUAWS)
MOLTING DISTRIBUTIONS
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July 2001
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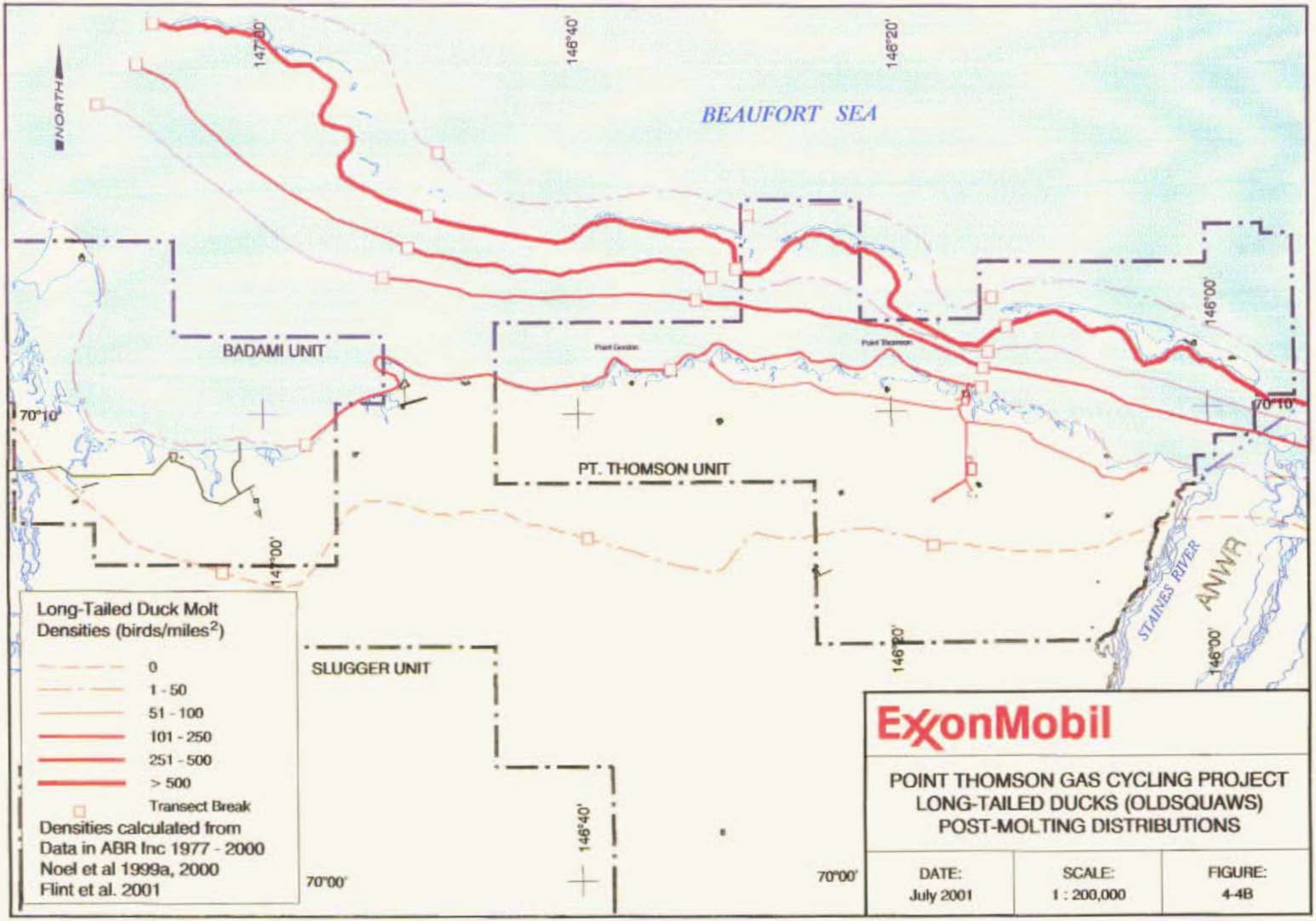
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Long-Tailed Duck Molt Densities (birds/miles²)
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1 - 50
51 - 100
101 - 250
251 - 500
> 500
Transect Break
Densities calculated from
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Noel et al 1999a, 2000
Flint et al. 2001
ExxonMobil
POINT THOMSON GAS CYCLING PROJECT
LONG-TAILED DUCKS (OLDSQUAWS)
POST-MOLTING DISTRIBUTIONS
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July 2001
SCALE:
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FIGURE:
4-4B

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4.9 MARINE MAMMALS

The Beaufort Sea provides habitat for eight species of marine mammals. These include cetaceans (bowhead, gray, and beluga whales), pinnepeds (ringed, bearded, spotted seals, and walrus), and polar bear. Descriptions of marine mammals in the Beaufort Sea have also been presented in Final Environmental Impact Statements for Lease Sales 97, 109, 124, 144, and 170 (MMS 1987a, 1987b, 1990a, 1996a and 1997a, respectively).

4.9.1 Cetaceans

4.9.1.1 Bowhead Whales

The proposed Point Thomson Gas Cycling Project is located inside the barrier islands and south of the usual migration corridor used by bowhead whales (*Balaena mysticetus*). Figure 4-5 depicts this corridor with locations of Bowhead Whale sightings during 1980 to 1995. The Point Thomson Unit Development Area extends beyond the barrier islands; however, development beyond the Barrier Islands is not currently planned.

The western Arctic population of bowhead whales (Inupiaq name Agviq) was estimated to be 8,200 animals in 1993 (Zeh et al. 1995 and Hill et al. 1997). The population appears to be increasing at a rate of 3.2% per year, despite subsistence harvests of 14 to 74 bowheads per year from 1973 to 1993. (Suydam et al. 1995) The bowhead whale population in the western Arctic is currently classified as a strategic stock due to its listing as "Endangered" under the Endangered Species Act of 1973, therefore is designated as "depleted" under the Marine Mammal Protection Act of 1972 by the National Marine Fisheries Service (NMFS 2000). NMFS has issued a petition to designate bowhead whale critical habitat.

Western Arctic bowhead whales winter in the central and western Bering Sea, and spend the summer in the Canadian Beaufort Sea. Bowhead whales are the only baleen whales that spend their entire lives near the sea-ice and do not migrate to warmer waters to calve. Migration through the Alaskan Beaufort Sea takes place in spring and autumn (Moore and Reeves 1993). Spring migration takes place between April and June in a corridor centered at 71° 30' N latitude, and broadly occurring between latitudes 71° 20' N and 71° 45' N. This is located well offshore of Point Thomson (Figure 4-5). Bowheads first arrive in coastal areas of the Canadian Beaufort Sea and Amundsen Gulf in late May and early June (Moore and Reeves 1993). During fall migration, a few bowheads are expected to be offshore of the Point Thomson area in late August during some years; however, the primary fall migration of bowheads begins in early to mid-September and ends in late October (LGL and Greeneridge 1996, Green et al. 1997, and MMS 2001).

Information regarding sexual maturity and mating behavior for bowhead whales is not known with certainty. Most bowheads mate and calve from April through mid June, coinciding with the spring migration. Mating may start as early as January or February, when most of the population is in the Bering Sea, but has also been reported as late as September and early October (Koski et al. 1993). The gestation period is 13 to 14 months, and females give birth to single calves approximately every three to four years. Calving extends from late May to early August, primarily during spring migration (Nerini et al. 1984 and Koski et al. 1993). Newborn whales must begin swimming north with the migrating herd almost immediately (ADNR 1999).

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouths. Bowheads apparently feed throughout the water column, including bottom and near-bottom feeding as well as surface feeding. Bowhead whales feed mainly in the eastern Beaufort Sea in the summer and Chukchi Sea in the fall (Wursig et al. 1984 and 1989 and Schnel and Saupe 1993). Food most commonly found in the stomachs of harvested bowhead whales includes copepods, euphausiids, mysids, and amphipods (Lowry and Frost 1984 and Lowry et al. 1993). Areas to the east of Barter Island often are used for feeding as the whales begin to migrate westward across the Beaufort Sea (Ljungblad et al. 1986 and Thomson and Richardson 1987). While this area is of periodic importance for feeding migrating whales late in the year, not all whales have been observed feeding (ADNR 1999). Bowheads continue to feed opportunistically where food is available as they migrate across the Alaskan Beaufort Sea (LGL et al. 1998 and ADNR 1999).

The auditory sensitivity of bowhead whales has not been specifically measured, but it is thought that they are specialized in low-frequency hearing, with some directional hearing capability (USACE 1999, Wursig and Clark 1983, and Richardson 1997). Bowheads produce vocalizations in the 50 to 400 hertz (Hz) band and their frequency ranges of optimum hearing are believed to overlap broadly with the low-frequency range of many industrial noises (USACE 1999). There is strong evidence that bowheads have very good hearing within these frequencies and could be disturbed by industrial noise sources. Sensitivity to noise is a subject of intense interest, research, and debate, as it affects subsistence whaling and oil and gas operations. The major sources of noise to which bowheads are exposed include aircraft and ship traffic, ice breaking, seismic exploration, marine construction, and offshore drilling. Studies indicate that bowhead behavior is often temporarily affected when exposed to close approaches by ships, seismic vessels, and aircraft. Reactions are less obvious when the noise source is fairly constant, such as with distant seismic or drilling work, but migrating bowheads sometimes adjust their course to divert around stationary sources of man-made noise (Hall et al. 1994, Richardson et al. 1995, and LGL and Greeneridge 1996).

Bowheads are very vocal and are believed use underwater sounds to navigate and communicate between widely separated individuals, mothers and calves, and for various other social functions (Clark et al. 1986, Clark et al. 1991, Ellison, et al. 1987, and Wursig and Clark 1993). Bowhead "songs" can be heard in the spring, but have not been reported in the late summer or fall. They are thought to be especially important during spring migration through areas of extensive ice (LGL et al. 1989 and ADNR 1999).

4.9.1.2 Beluga Whales

The beluga whale (*Delphinapterus leucas*) (Inupiaq name Qilalugaq) is a medium-sized cetacean belonging to the group known as odontocetes (toothed whales), also including sperm whales, killer whales, dolphins, and porpoises. Its closest relative is the narwhal (*Monodon monoceros*). The common name is derived, in part, from the Russian word for white. They are also called "white whales;" however, this is somewhat of a misnomer, since only older animals are actually white. Belugas range widely in Arctic and subarctic waters and are often the most important small cetacean to northern coastal peoples.

The beluga whale stocks in the Arctic and subarctic consist of several subpopulations. The most recent uncorrected aerial census of the Beaufort Sea stock estimates 19,629 individuals, a 95% confidence interval of 15,134 to 24, 125 (Harwood et al. 1996). The Beaufort Sea stock of beluga whales is not classified as a strategic stock and was estimated to be 39,258 individuals, using a sighting correction factor of 2x. (Hill et al. 1997).

Beluga whales migrate into the Beaufort Sea in April or May, although whales may pass Point Barrow as early as late March or as late as July. The spring migration takes place through offshore ice leads similar to those used by bowhead whales (Frost et al. 1988, Moore et al. 1993, and Richardson et al. 1995b). A portion of the Beaufort Sea stock concentrates in the Mackenzie River estuary during July and August, but most of the population remains in offshore waters of the Beaufort Sea and Amundsen Gulf (Davis and Evans 1982 and Harwood et al. 1996) or ranges into the Arctic Archipelago (LGL et al. 1998).

Belugas are rarely seen near the Point Thomson Development area during the summer. During autumn migration, small numbers of belugas are occasionally seen near the coast, east or west of the Point Thomson Unit Development area (Johnson 1979), but most migrate well offshore (Frost et al. 1988, Clarke et al. 1993, and Miller et al. 1997). Fall migration takes place between August and October, with the greatest movement being in September (Moore et al. 1993 and Clarke et al. 1993). Small numbers of beluga whales (up to a few hundred) could move into the waters offshore of the project area in the fall. Belugas are absent from the Alaskan Beaufort Sea from November through March (Seamen et al. 1986).

Beluga whales feed on a variety of fish and invertebrates and their diet varies by season and locale (Burns and Seaman 1985 and Hazard 1988). The Arctic cod (*Boreogadus saida*), is an important food for beluga whales in many parts of the Arctic. Winter foods of beluga whales are virtually unknown. However, in summer they feed on a variety of schooling and anadromous fish which are sequentially abundant in coastal zones. Most feeding is done over the continental shelf and in nearshore estuaries and river-mouths. In the shallow waters of Alaska, most feeding-dives are probably to depths of 20 to 100 ft (6 to 30 m) and last two to five minutes. Satellite tagged beluga whales in Canada were found to dive to depths of 2,000 ft (600 m) (ADF&G Wildlife Notebook Series, last modified 1/31/01).

The hearing of beluga whales is poor below 1 kilohertz (kHz) and their best sensitivity is in the 10 to 100 kHz band (Awbrey et al. 1998 and Johnson et al. 1989). Hearing is most sensitive above 20 kHz, consistent with their use of ultrasonic ecolocation calls. The hearing of belugas at low frequencies is not as sensitive as that of other whale species. Published studies of captive animals show thresholds of 125 decibels (dB) at <0.1kHz and about 100 dB at 1kHz (Awbrey et al. 1998 and Johnson et al. 1989). Recent data suggest that belugas' ability to hear low frequencies in the open sea may be slightly more sensitive than has been reported for captive animals. Beluga hearing thresholds improve greatly as the frequency of the sound increases (LGL et al. 1998).

The beluga's extensive vocal repertoire includes trills, whistles, clicks, bangs, chirps, and other sounds (Schevill and Lawrence 1949, Sjare and Smith 1986a, and Ouellet 1979). Beluga whistles have dominant frequencies at 2-6kHz, and other call types include sounds at mean frequencies ranging upward from 1 kHz (Sjare and Smith 1986a and 1986b). These sounds are above the frequency range produced by most oil production developments. Beluga echolocation signals have most of their energy at frequencies of 40-120 kHz and broadband source levels up to 219 dB. These ultrasonic echolocation calls are far above the frequency range of drilling and production noises, but are within the frequency range of some sonar and navigation transponder signals (LGL et al. 1998).

At birth beluga whales are dark blue-gray in color. They measure approximately 5 ft (1.5 m) long and weigh 90 to 130 pounds (lbs) (41 to 59 kilograms [kg]). The color gradually lightens, and they are usually white by age 5 or 6. Adult males are from 11 to 15 ft (3.5 to 4.5 m) long and weigh 1,000 to 2,000 lbs (450 to 900 kg). Adult females are smaller, seldom exceeding 12 ft (3.7 m) in length. The size to which belugas grow varies in different parts of the range. Individuals more than 20 ft (6 m) long have occasionally been recorded, though not in Alaska.

Beluga calves are typically born between May-August, usually when the herds are near or in summer concentration areas. A single calf usually emerges tail first, and after birth it is guided to the surface and closely attended by its mother. Females become sexually mature at 4 to 5 years old, and males mature slightly later. Breeding takes place in March or April, and the total gestation period is approximately 14 ½ months. Adult females usually produce one calf every three years, which they nurse for about two years. Belugas can live to be nearly 40 years old. Polar bears and killer whales are natural predators of beluga whales.

4.9.1.3 Gray Whales

Gray whales (*Eschrichtius robustus*) (Inupiaq name Agvigluaq) have occasionally been identified in the waters of the Beaufort Sea near Point Barrow during the summer, but are unlikely to be present off of Point Thomson. The gray whale was removed from the endangered species list in 1994 (LGL et al. 1998).

Most summering gray whales congregate in the northern Bering Sea (particularly off St. Lawrence Island, in the Chirikov Basin) and in the Chukchi Sea. Few gray whales live or travel east of 155W in the Beaufort Sea (Clarke et al. 1989). A single gray whale was sighted by MMS on September 3, 1988 in Mickkelsen Bay near Tigvariak Island (Treacy 1989). No gray whales have been sighted by MMS or LGL in the proposed development area from 1979 to 1997 (LGL and Greeneridge 1996, Miller et al. 1997, and Richardson [ed.] 1997).

Gray whale summer feeding areas are in the Bering and Chukchi Seas. Gray whales generally avoid areas with significant ice. This suggests that individuals do not commonly travel through the Alaskan Beaufort Sea during summer. Few, if any, gray whales are expected to be in the Point Thomson area.

4.9.2 Pinnipeds

Pinnipeds are marine mammals such as bearded seals, ringed seals, spotted seals, and walrus. Their name "pinniped" can be broken down into *pinna*, a wing or fin; and *pedis*, a foot, describing their fin-like feet that enable them to easily maneuver through the water. The "ice seals" (ringed, bearded, and spotted seals) are usually observed in open water areas during the summer and into the fall. Spotted seals spend time on the beaches, offshore islands, and sand bars in bays, lagoons, and estuaries. Ringed seals may be found in areas of land-fast ice during the winter, while bearded seals occupy the active ice zone during winter and spring.

Seal surveys were conducted for the Liberty Island project area in spring 1985, 1986, and 1987, and resumed in 1997 (LGL et al. 1998, Frost et al. 1997, and LGL et al. 1997 and 1998), reported small numbers of ringed and bearded seals near the project area in the spring. Spotted seals were not observed during these aerial surveys. Boat-based marine mammal monitoring for an Ocean-Bottom Cable 3-D seismic survey from 25 July to 18 September 1996, in an area to the west of the proposed Point Thomson Gas Cycling Project area, documented the presence of all three seals, with 92% ringed seals, 7% bearded seals, and 1% spotted seals (Harris et al. 1997). BP Exploration-Alaska (BPXA)-sponsored aerial surveys conducted around Liberty Island (west of the proposed Point Thomson Area Cluster Development site) in May/June 1997 over land-fast ice, found ringed seals widely distributed throughout the Liberty area. No other seal species were encountered (LGL et al. 1998).

4.9.2.1 Bearded Seal

The bearded seal (*Erignathus barbatus*) (Inupiaq name Oogruk), the largest of the northern phocids, is found throughout the Bering, Beaufort, and Chukchi Seas. The population has been estimated at 300,000 (MMS 1996b), though current estimates may be unreliable (Small and DeMaster 1995). The Alaska stock of bearded seals is not classified as a strategic stock by NMFS, which is consistent with the recommendations of the Alaska Scientific Review Group (Small and Demaster 1995). They are most abundant in the northern Bering Sea in winter and spring and in the Chukchi Sea during summer and fall (Burns and Frost 1983; Kelly 1988).

The species is less common in the Beaufort Sea, where only a few over-winter. Bearded seals are an important subsistence resource for Alaskan coastal residents. They prefer open water habitats with broken, drifting pack ice, although shore-fast ice is also used (Burns and Frost 1983 and Kelly 1988). Bearded seals are primarily bottom feeders, preying on benthic organisms such as crabs, shrimp, and clams in habitats with water depths less than or 660 ft (201m). They have been found in deeper waters where they feed on organisms associated with sea-ice.

The seasonal movements of bearded seals are related to the advance and retreat of sea-ice and water depth. Some bearded seals overwinter in the Bering Sea. As the ice recedes in the spring, these seals migrate through the Bering Straight (mid-April to June), and summer either along the margin of the multi-year ice in the Chukchi Sea or in nearshore areas of the central and western Beaufort Sea. The observed seasonal decline in sightings during late summer and autumn aerial surveys (LGL and Greeneridge 1996, 1997) indicates that a portion of the Alaskan Beaufort Sea bearded seal population migrates to the Bering Sea during the winter months. Suitable bearded seal habitat may be limited in the Beaufort Sea, where the continental shelf is comparatively narrow and the pack-ice edge frequently occurs seaward of the shelf, over water too deep for feeding (Nelson et al. n.d.). The preferred habitat in the central Beaufort Sea during the open water period is the nearshore area seaward of the scour zone. However, bearded seals are widely distributed over the shelf from nearshore waters out at least as far as the shelf break.

Bearded seals breed in the spring. They depend on underwater communications with their potential mates, and emit distinctive calls, generally starting near 2.5-3 kHz and descending below 1kHz. These calls are believed to be important breeding behavior. Pupping takes place on top of the ice from late March through May, primarily in the Bering and Chukchi Seas, although some pupping takes place on moving pack ice in the Beaufort Sea. Pups are weaned at the end of a 12-18 day nursing period. These seals do not form herds, although loose aggregations of animals may occur (LGL et al. 1998 and MMS 2001).

There are no data on the hearing abilities of bearded seals, but they are probably comparable to other phocid seals (Richardson et al. 1995a). Bearded seals emit distinctive trills, generally starting near 2.5-3 kHz and descending to below 1 kHz (Ray et al. 1969). Source levels are much higher than for ringed seals. These calls are believed to be important in breeding behavior (Ray et al. 1969 and Stirling et al. 1983). Calls are much less common in late summer/early autumn than during the spring mating season.

The number of bearded seals offshore of the Point Thomson area during the open water period is expected to be low. Only a few individuals were seen during boat-based marine mammal monitoring near the project site in late July through early August 1996 (Harris et al. 1997 and unpubl. data). Studies indicate that pups and other young seals up to three years of age comprise 40 to 45% of the population (Nelson et al. n.d.), and that younger animals may be found closer to shore. Although all age and sex classes may be found offshore of Point Thomson during open-water season, many may be young, non-productive animals. Bearded seals are not expected to enter the waters offshore of the development area at all during late autumn, winter, and early spring months when it is covered by fast-ice (LGL et al. 1998 and MMS 2001).

4.9.2.2 Ringed Seals

Ringed seals (*Phoca hispida*) (Inupiaq name Natchiq) are year round residents in the Beaufort Sea and are the most common seal offshore of the proposed development area. The worldwide population of ringed seals is estimated to be 6-7 million (Stirling and Calvert 1979), with the Alaskan portion being 1-1.5 million (Kelly 1988 and Small and Demaster 1995) in the Bering, Beaufort, and Chukchi Seas. Roughly 80,000 ringed seals can be found in the Beaufort Sea during the summer and 40,000 during the winter (Frost and Lowry 1981). During winter and spring, ringed seals spend much of their time on land-fast ice and offshore pack ice. They maintain breathing holes throughout the winter in ice up to 6 ft (1.8m) thick and dig multiple haul-out shelters and nursery lairs beneath the snow (Kelly 1988 and ADNR 1999).

In winter and spring, the ringed seal frequents land-fast ice and offshore pack ice; the highest densities of seals are usually found on stable land-fast ice. In areas with limited shore-fast ice but wide expanses of pack ice, such as the Beaufort Sea, Chukchi Sea, and Baffin Bay, the number of ringed seals on pack ice may exceed that on shore-fast ice (Burns 1970, Stirling et al. 1982, and Finley et al. 1983).

Mating occurs in late April and May, primarily on land-fast ice. Females give birth to a single, white-coated pup in snow-dens on either land fast or drifting pack ice during late March or early April, and are nursed for 4 to 6 weeks. Quantitative surveys of ringed seals conducted during late winter and spring found ringed seal densities on the shore-fast ice between Oliktok Point and Flaxman Island ranging from 2.5 seals/mi^2 (0.97 seals/km^2) to 4.4 seals /mi^2 (1.69 seals/km^2) during the 1985-1987 period (Frost and Lowry 1988). BPXA-sponsored aerial surveys for ringed seals conducted around Liberty Island as well as in fast-ice areas north of the barrier islands in May to June 1997 found densities ranging from 1 seal/mi^2 (0.43 seals/km^2) (maximum survey density) to 1.2 seals/mi^2 (0.48 seals/km^2) (maximum daily density). North of the barrier islands, ringed seal densities were slightly higher, ranging from 1.3 to 1.5 seals/mi^2 (0.51 to 0.58 seals/km^2) (Miller et al. 1998).

Ringed seals are sensitive to underwater sounds in the 1 to 60 kHz band (Terhune and Ronald, 1975). Underwater audiograms have been obtained using behavioral methods for three species of phocid seals, including the ringed seal (reviewed in Richardson et al. 1995a). Below 30-50 kHz, the hearing threshold is essentially flat down to at least 1 kHz. There are few published data below 1 kHz, but a harbor seal's threshold deteriorated gradually to 97 dB 100 Hz (Kastak and Schusterman 1995). If this also applies to ringed seals, they have considerably better hearing sensitivity at low frequencies than do small odontocetes such as beluga whales (for which the threshold at 100 Hz is about 125 dB). No data are available on their reactions to underwater sounds due to the difficulty of observing these animals in water (USACE 1999).

Ringed seals produce clicks with fundamental frequency of 4 kHz and varying harmonics up to 16 kHz (Schevill et al. 1963). Stirling (1973) described barks, high pitched yelps, and low and high pitched growls. Ringed seals appear much less vocal in summer than during the breeding season in spring (Stirling et al. 1983).

The ringed seals molt in May and June. During this time they spend long periods hauled out on the ice basking in the sun. It is thought that warmer skin temperatures cause rapid hair growth. When hauled out on the ice, ringed seals are wary of predators. The amount of time spent on the ice increases as the molt season progresses. In summer, as the nearshore ice melts, most of the adult ringed seals are found along the edge of the ice pack, seaward of the proposed development area.

Ringed seals spend much of the summer and early fall in the water feeding. They eat a variety of invertebrates and fish. The particular species eaten depends on availability, depth of water, and distance from shore. In Alaskan waters, the important food species are Arctic cod, saffron cod, shrimp, and other crustaceans (ADNR 1999). In the eastern Beaufort Sea and Amundsen Gulf, ringed seals concentrate in offshore areas, often in large groups. The groupings appear to be associated with simultaneous populations of various prey species, such as crab and shrimp. Ringed seals offshore of the development area are likely to be individuals or small groups during the summer, as larger groups have not been reported during the summer in the central or western Beaufort Sea (LGL et al. 1998).

4.9.2.3 Spotted Seal

The spotted seal *(Phoca largha)* (Inupiaq name Qasigiaq*)* is found from the Beaufort Sea to the Sea of Japan and is most numerous in the Bering and Chukchi Seas (Quackenbush 1988). The population of spotted seals world-wide has been estimated between 335,000 and 450,000, and the size of the Bering Sea population, including animals in Russian waters, is estimated between 200,000 and 250,000 animals (Bigg 1981). A reliable estimate of the entire Alaskan stock of spotted seals is currently not available (Small and DeMaster 1995).

A few spotted seal haul outs have been documented in the central Beaufort Sea, primarily in the deltas of the Colville and Sagavanirktok Rivers. Historically, these sites have supported as many as 400 to 600 seals. However, since the 1980s, fewer than 10 seals have been seen at any one site (LGL et al. 1998). One spotted seal was identified in Stefansson Sound during boat-based marine mammal monitoring near the Liberty Development Project area in late July through early August 1996 (Harris et al. 1997 and unpubl. data). There are probably only a few spotted seals along the coast of the central Beaufort Sea during summer and early fall, and only a small portion may be visible at any one time (Frost et al. 1993 and ADNR 1999).

During spring, when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea-ice in the Okhotsk and Bering Seas. Pupping occurs in March or April in the Bering Sea wintering areas. A month later mating occurs, followed by molt (Seaman et al. 1981; Quackenbush 1988). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs (Frost et al. 1991). Subadults may be seen in larger groups of up to 200 animals. As the seasonal ice-cover recedes in summer, spotted seals disperse throughout the open waters of the Bering, Chukchi, and Beaufort seas. During summer, spotted seals are found primarily in the Bering and Chukchi seas, but some range into the Beaufort and perhaps into the East Siberian Seas (Lowry n.d.). At this time of year, an unknown number of seals haul out on mainland beaches and offshore islands and bars (Frost et al. 1993). Summer tagging studies at Kasegaluk Lagoon in the Chukchi Sea indicate that spotted seals may travel long distances offshore to feed, and that a very small proportion (<10%) of the local population may be hauled out at any one time (Frost et al. 1993). In summer, spotted seals are rarely seen on the pack ice, except when the ice is very near to shore. They are commonly seen in bays, lagoons, and estuaries. Spotted seals feed on invertebrates, such as shrimp and cephalopods either offshore or in the lower reaches of the rivers or the river deltas and on pelagic and demersal fish, including herring, capelin, sand lance, Arctic cod, saffron cod, and sculpins. Spotted seals migrate out of the Beaufort Sea in the fall (September to mid-October) as the shore-fast ice re-forms and pack ice advances southward. (ADNR 1999).

There are no data on hearing capabilities of spotted seals, but they are probably comparable to those of ringed and harbor seals. Calls of captive spotted seals (Beier and Wartzok 1979) are similar to harbor seals. Both species emit faint clicks near 12 kHz (Schevill et al. 1963 and Cummings and Fish 1971). Captive spotted seals were relatively silent during most of the year, but calls became more common during the mating period (Beier and Wartzok 1979).

4.9.2.4 Walrus

The walrus (*Odobenus rosmarus*) (Inupiaq name Aiviq) is the largest of the Alaskan pinnipeds (ADF&G Wildlife Notebook Series, last modified 1/31/01). The Alaskan Beaufort Sea is outside the principal range of the walrus. However, small numbers of walrus do occur in the Beaufort Sea in some years. The extent of these summer incursions probably varies with annual changes in ice conditions, and possibly with changes in the size of the population. Walrus feed on benthic organisms, primarily bivalves, and typically are found in waters less than or equal to 328 ft (100 m) deep.

There have been at least eight sightings of walrus between 146 W and 150 W in the Prudhoe Bay region during MMS and LGL surveys conducted from 1979 to 1997. All sightings were in waters less than or equal to 131 ft (40 m) deep. Walrus sightings are unusual in the area, which is well to the east of their primary summer range. There have been six sightings north of the barrier islands and two within Stefansson Sound. One sighting was in the lagoons during MMS aerial surveys and another sighting of a single juvenile walrus was made during 1996 boat-based marine mammal monitoring (Richardson [ed.] 1997) near the Liberty Island Development site. Walrus are expected to be rare in the waters offshore of Point Thomson.

4.9.3 Polar Bears

Polar bears (*Ursus maritimus*) (Inupiaq name Nanuq) have a circumpolar distribution throughout most ice-covered seas of the Northern Hemisphere, and are common within 200 mi (322 km) of the arctic coast of Alaska (Amstrup and DeMaster 1988). Within this range, polar bears are divided into five largely discrete populations. The range of the Southern Beaufort Sea population extends from the northwest Chukchi Sea to Cape Bathurst, Canada (Lentfer 1974 and Amstrup et al. 1986) and encompasses the area proposed for the Point Thomson Gas Cycling Project. This population was estimated at 1500-2000 bears in 1994, and has grown at a mean annual rate of 2.4% over the last 20 years (Amstrup 1995). Population density currently appears to be stabilizing or increasing slightly since it is believed to be approaching the carrying capacity of the environment (USFWS 1995).

In the proposed project area, polar bears are present near the coast during the ice-covered period and infrequently during the summer. Polar bear distribution is influenced greatly by prey abundance (particularly ringed seal) on seasonal ice (Smith 1980). As the ice-pack spreads southward in the fall, polar bears move with it, appearing along the Beaufort Sea coast from September to October (Lentfer 1972). Polar bears generally prefer areas of heavy offshore pack ice (Stirling 1988), and adult males usually remain there, rarely coming ashore (Amstrup and DeMaster 1988). During winter and spring, polar bears tend to concentrate in these areas of shore-fast ice with deep drifted snow along pressure ridges, at the floe edge, and on drifting ice with at least 7 to 8 in (18 to 20 cm) of ice cover (Stirling et al. 1975 and 1981). The greatest densities occur in the latter two categories, presumably because these habitats offer bears greater access to seals.

In spring and early summer, polar bears move north with the ice as it recedes from coastal areas. They remain on the drifting pack ice during the summer months. Little has been published about their offshore distribution during this season. Polar bears are typically on land only during the winter denning season. In addition to denning females, females with cubs and subadult males occasionally come ashore. Females with young cubs may hunt in fast-ice areas.

The breeding season is from April through June when both males and females are active on the sea-ice. During the breeding season in late March through May, males actively seek out females by following their tracks on the sea-ice. Bears are polygamous, and the male remains with a receptive female a relatively short time and then seeks another female. Gestation lasts about eight months. Pregnant females enter dens in October or November and give birth in December or January to between one and three cubs. Bears (mother and cubs) emerge from their dens in late March or April when cubs weigh about 15 lbs (6.8 kg), and move out onto the pack ice (Lentfer and Hentsel 1980 and Amstrup and Gardener 1994).

They make short trips to and from the open den for several days as the cubs become acclimated to outside temperatures. They then start traveling on the drifting sea-ice. Females can breed again at about the same time they separate from their young, so normally they can produce litters every third year. Cubs usually stay with their mothers until they are 1½ to 2½ years old, although some may remain into their third or fourth year (Stirling et al. 1975). Adult males and non-pregnant females are active all year using dens only as temporary shelter during severe weather.

Between 1981 and 2001, 49% of polar bear dens found in coastal Alaska and neighboring Canada were on land, barrier islands, or fast-ice (Amstrup, unpublished data). Figure 4-6 shows the known polar bear den sites in the Point Thomson area. The two onshore den sites located within the Point Thomson Unit immediately west of the proposed facilities were active dens in 2001. The other locations have been used historically over the period 1988-1999.

Bears excavate maternity dens in compacted snowdrifts adjacent to bluffs, barrier islands, and other areas of topographic relief (Amstrup and DeMaster 1988). Denning females often use stable sea-ice on the shoreward side of the barrier islands. Flaxman, Pingok, Cross, Cottle, Thetis and other barrier islands in the Beaufort Sea are known to support maternity dens.

Most terrestrial dens are located within a few mi of the coast, although dens as much as 30 mi (48 km) inland have been reported (USFWS 1995). A total of 10 maternal dens have been documented between 1981 and winter of 2000/2001 in the coastal areas between the Canning and the Shaviovik Rivers. Seven of these dens were located on Flaxman Island, one in the Canning River Delta, two along the coast west of Point Thomson, and one on land fast ice offshore of Point Thomson. Flaxman Island would be the only predictable denning area in this region (Ampstrup, unpublished data). The number of polar bears denning in the project area within a particular year cannot be estimated with confidence. However, the proportion of bears denning on land in the Beaufort Sea region appears to be increasing, probably because of hunting restrictions beginning in the early 1970s (Stirling and Andriashek 1992 and Amstrup and Gardner 1994).

Polar bears occasionally congregate on the barrier islands in the fall and winter because of available food such as bowhead carcasses and favorable environmental conditions. In November 1996, a congregation of 28 bears was observed near a carcass on Cross Island, and another 11 were observed within a 2 mi (3.2 km) radius of a carcass on Barter Island (Kalxdorff 1998).

Polar bears are extremely curious and opportunistic hunters, and they have been known to approach facilities in search of food. The main food of polar bears in the Alaskan Beaufort Sea is the ice-inhabiting ringed seal. Bears capture seals by waiting for them at breathing holes and at the edge of leads or cracks in the ice. They also stalk seals resting on top of the ice and catch young seals by breaking into pupping chambers in snow on top of the ice in the spring. Bears prey to a lesser extent on bearded seals, walrus, and beluga whales. They also feed on carrion, including whale, walrus, and seal carcasses they find along the coast. They occasionally eat small mammals, bird eggs, and vegetation when other food is not available. A keen sense of smell, extremely sharp claws, patience, strength, speed, and the camouflaging white coat aid in procuring food (ADF&G Wildlife Notebook Series, Jan 31, 2001).

Cubs weigh between 1 and 2 lbs (0.5-0.9 kg) at birth. An extremely large adult male may weigh 1,500 lbs (680 kg). Most mature males weigh between 600 and 1,200 lbs (273-545 kg), and are between 8 and 10 ft (2 to 3 m) in length. Mature females weigh 400 to 700 lbs (182 to 318 kg). Bears in the wild have been recorded as old as 32 years but most typically do not live beyond 25 years (ADF&G 2001).

Polar bears live in areas under the jurisdiction of five nations--Russia, Norway, Denmark, Canada, and the United States--and also on the high seas where jurisdiction is not clearly defined. Representatives of the five polar bear nations prepared an international agreement on conservation of polar bears in November 1973. The pact was ratified in 1976. It allows bears to be taken only in areas where they have been taken by traditional means in the past and prohibits the use of aircraft and large motorized vessels. The agreement has created a high seas polar bear sanctuary but does not prohibit hunting from the ground using traditional methods.

In Alaska prior to the late 1940s, nearly all polar bear hunting was by Eskimos with dog teams. Sport hunting, sometimes with the use of aircraft, started in the late 1940s and continued through 1972. In 1972, the state of Alaska prohibited the use of aircraft in polar bear hunting. With the passage of the Statehood Act, Alaska began a polar bear management program. State regulations required sealing of skins, provided a preference for subsistence hunters, and protected cubs and females with cubs (ADF&G 2001).

The federal Marine Mammal Protection Act (MMPA) of 1972 transferred management authority from the State to the federal government and placed a moratorium on hunting of marine mammals by people other than Alaskan Natives. This resulted in a reduced total harvest, but an increase in the proportion of female bears and cubs. The MMPA includes provisions that allow for waiver of the moratorium or transfer of management authority back to states. At intervals since 1972, the State of Alaska has made efforts at regaining polar bear management. State management could allow a resumption of sport hunting and produce increased economic opportunities in coastal rural communities. For a variety of reasons, efforts to regain State management have been discontinued. Polar bear meat, other than that of males in the rut, is quite palatable when boiled. It is a favored subsistence food in some areas.

The stocks of polar bear in Alaska are shared with other nations. In 1988, the North Slope Borough Department of Wildlife Management (representing Alaskan Natives) and the Inuvialuit Game Council (representing Canadians) signed an agreement to provide for coordinated management of the Beaufort Sea polar bear stock (ADF&G 2001)

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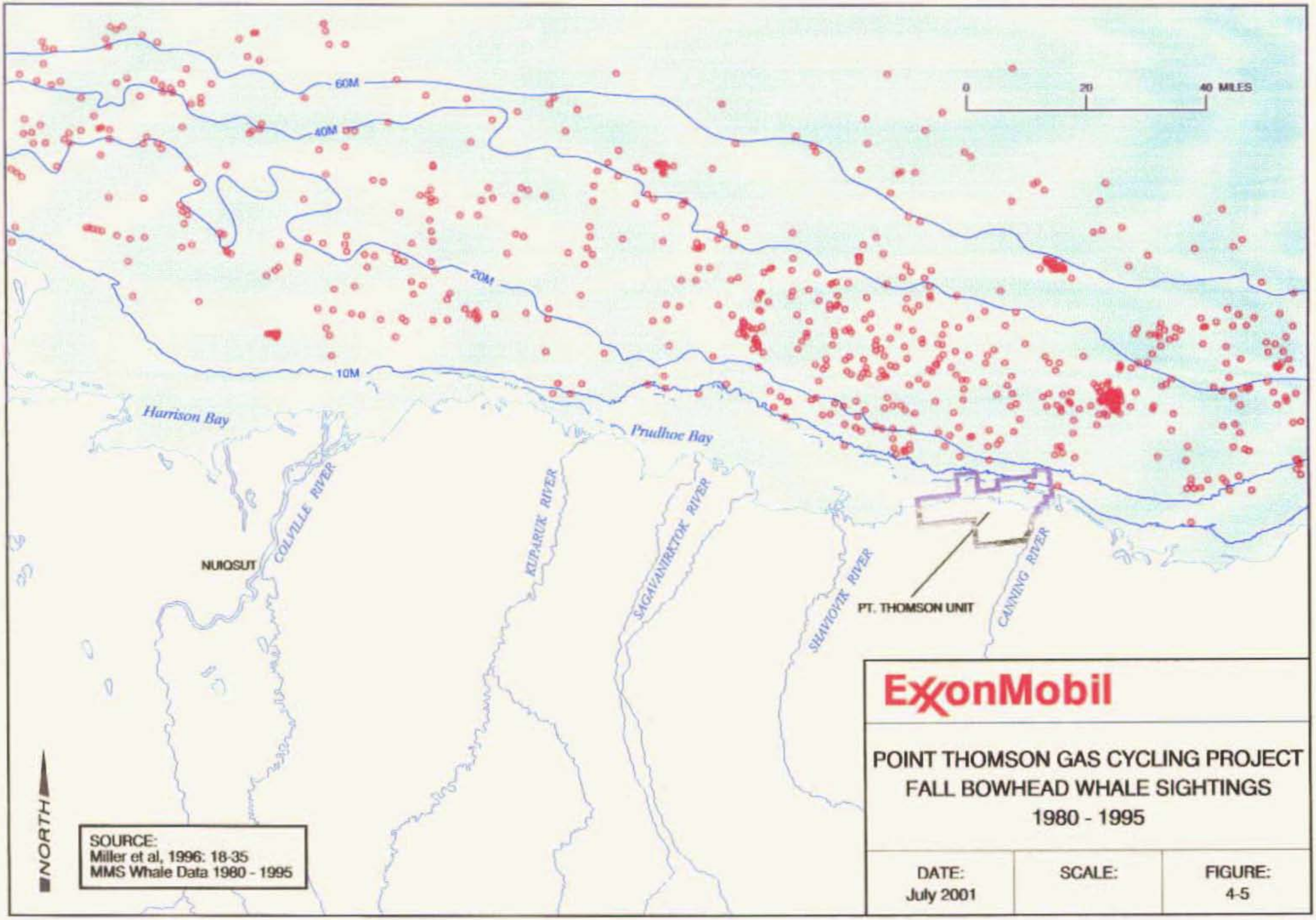
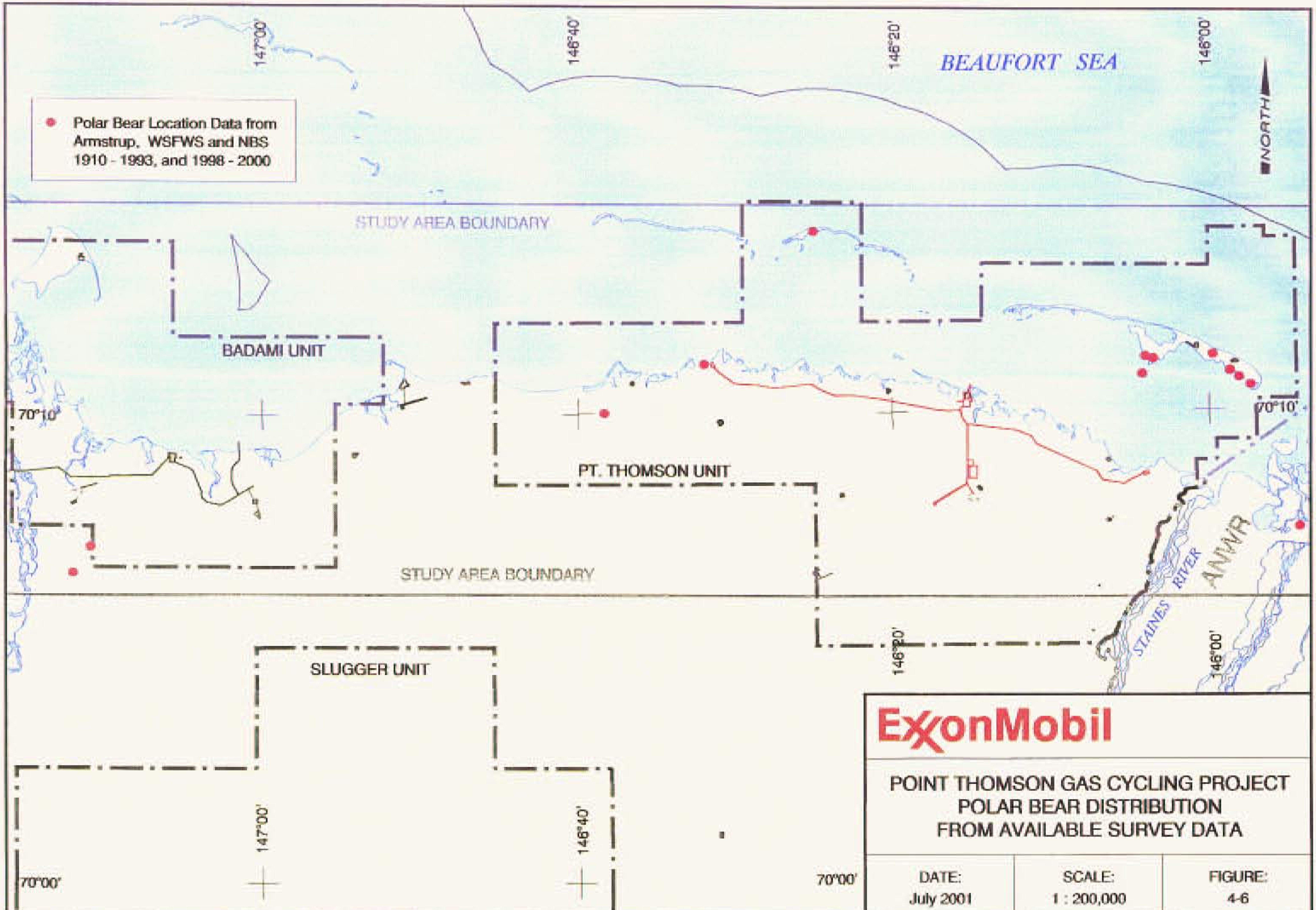


POINT THOMSON GAS CYCLING PROJECT
FALL BOWHEAD WHALE SIGHTINGS
1980 - 1995

DATE:	SCALE:	FIGURE:
July 2001		4-5

fig4_5.dgn



ExxonMobil

POINT THOMSON GAS CYCLING PROJECT
POLAR BEAR DISTRIBUTION
FROM AVAILABLE SURVEY DATA

DATE:	SCALE:	FIGURE:
July 2001	1 : 200,000	4-6

fig4_6.dgn

4.10 TERRESTRIAL MAMMALS

Mammals, especially large mammals and arctic foxes, have been the subject of extensive research in the region of the North Slope oilfields in the last 3 decades. These studies have provided important information for the region as a whole, but only a few have directly addressed terrestrial mammal populations in the proposed Point Thomson Gas Cycling project area. Field investigations of terrestrial mammals in the Point Thomson study area have focused primarily on aerial surveys of caribou (*Rangifer tarandus*). Observations of muskoxen (*Ovibus moschatus*), moose (*Alces alces*), and grizzly bears (*Ursus arctos*) were documented incidentally during those surveys and other fieldwork. The earliest large mammal surveys that included portions of the Point Thomson study area were conducted in the mid- to late 1970s (described in WCC and ABR 1983). More systematic surveys covering some or all of the Point Thomson study area were conducted in 1983 (WCC and ABR 1983, Lawhead and Curatolo 1984), 1984 (Curatolo and Reges 1984), 1987–1990 (Lawhead and Cameron 1988, Smith and Cameron 1992), and 1993–2000 (Pollard 1994, Pollard and Noel 1995, Noel 1998, Noel and Olson 1999a, Noel and King 2000). In addition, the Alaska Department of Fish and Game (ADF&G) conducted surveys of grizzly bears in the Point Thomson study area in 1997 and 1999 (Shideler 1999), and recorded incidental observations in 1998. Surveys of arctic fox (*Alopex lagopus*) dens were conducted in the Point Thomson study area in 1983 (WCC and ABR 1983), 1992 (Burgess et al. 1993), and 1999 (Perham 2000). Table 4-9 lists the terrestrial mammal species expected to occur within the proposed development area and the seasonal time frame in which they are most likely to be present.

4.10.1 Caribou

The Alaska Department of Fish and Game (ADF&G) manages caribou (Inupiaq name Tuttu) and follows Skoog (1968) in identifying herds based on their fidelity to calving grounds. Based on this criterion, four herds are recognized in Arctic Alaska (moving from west to east): the Western Arctic Herd (WAH), the Teshekpuk Lake Herd (TLH), the Central Arctic Herd (CAH), and the Porcupine Herd (PCH). Caribou from both the CAH and the PCH use the Point Thomson study area.

The CAH ranges from the Colville and Itkillik rivers on the west to the Canning and Tamayariak rivers on the east (Figure 4-7). Telemetry studies have shown that about half of the CAH (called the eastern segment) tends to spend the calving and insect seasons east of the Sagavanirktok River. The other half of the CAH (western segment) ranges on the west side of the Sagavanirktok River, including the area occupied by the Prudhoe Bay and Kuparuk oilfields and associated satellite developments (Lawhead 1988, Cameron et al. 1995). The two segments of the CAH are not isolated from each other; some interchange occurs between segments, primarily among years rather than within years (Lawhead and Curatolo 1984).

The CAH increased steadily from about 4,000–6,000 animals in the mid-1970s, when it was first described by ADF&G as a distinct herd (Cameron and Whitten 1979), to a peak of about 23,400 in July 1992 (Woolington 1995) before declining. Between 1992 and 1995, the CAH declined 23%, to about 18,100 caribou (James 1996). The herd subsequently increased to about 19,700 caribou by July 1997 and about 27,100 caribou by July 2000 (E. Lenart, ADFG, pers. comm.), the largest size since it was first described. Figure 4-8 shows the change in size of the CAH since 1972. Hunting mortality of CAH caribou is relatively light, estimated at 200–600 animals annually in recent years (Woolington 1995). It consists mostly of subsistence harvest by villagers from Nuiqsut and, to a lesser extent, Kaktovik, as well as sport harvest along the Dalton Highway. The western segment of the herd regularly encounters oil-field infrastructure (e.g., drill-site pads, roads, pipelines, processing facilities) and industrial activity on its summer range. The eastern segment likely encounters the Badami pipeline each summer. All members of the herd probably encounter the Trans-Alaska Pipeline at some point during their lifetimes.

Table 4-9 Terrestrial Mammals Known or Suspected to Occur in the Point Thomson Area

COMMON NAME	SCIENTIFIC NAME	STATUS
Barrenground Shrew	*Sorex ugyunak*	√
Tundra Shrew	*Sorex tundrensis*	√
Snowshoe Hare[a]	*Lepus americanus*	*
Tundra Hare[a]	*Lepus othus*	*
Arctic Ground Squirrel	*Spermophilus parryii*	√
Northern Red-Backed Vole[a]	*Clethrionomys rutilus*	*
Tundra Vole	*Microtus oeconomus*	√
Singing Vole	*Microtus miurus*	√
Brown Lemming[b]	*Lemmus trimucronatus*[b]	√
Collared Lemming[c]	*Dicrostonyx groenlandicus*[c]	√
Porcupine[a]	*Erethizon dorsatum*	*
Coyote[a]	*Canis latrans*	*
Gray Wolf	*Canis lupus*	√
Arctic Fox	*Alopex lagopus*	√
Red Fox	*Vulpes vulpes*	√
Brown Bear	*Ursus arctos*	√
Ermine, Short-Tailed Weasel	*Mustela erminea*	√
Least Weasel	*Mustela nivalis*	√
Mink[a]	*Mustela vison*	*
Wolverine	*Gulo gulo*	√
River Otter[a]	*Lontra canadensis*	*
Lynx[a]	*Lynx canadensis*	*
Moose	*Alces alces*	√
Caribou	*Rangifer tarandus*	√
Muskox	*Ovibos moschatus*	√

Except where noted, names are from Wilson and Reeder (1993). √ indicates species is documented or very likely in the study area. * indicates species, if present, is rare and at the limits of its range.

[a] These species, although they may occur in some areas of the Arctic Coastal Plain, are unlikely to occur in the Point Thomson study area due to its distance from major riparian corridors.

[b] Name from Chernyavsky et al. (1993)

[c] Name from Jarrell & Fredga 1993

The range of the PCH on the ACP extends east from the western edge of ANWR (the eastern edge of the Point Thomson study area) in northeastern Alaska and into the north-central Yukon and western Northwest Territories in Canada (Figure 4-7). This herd typically calves on the coastal plain and northern foothills of the Brooks Range in ANWR and the Yukon Territory. After increasing about 5% annually during 1976–1989, the PCH decreased 10% from 178,000 in 1989 to 160,000 in 1992 (Whitten 1995). The population was thought to have stabilized at

~160,000 animals after 1992 (K. R. Whitten, pers. comm.), but declined to ~129,000 by 1998 (Stephenson 1999). Throughout its range, the PCH is an important subsistence resource for Inupiat, Inuvialuit, and Gwich'n villages in both northeastern Alaska and northern Yukon, although hunting mortality is considered to be relatively light (1–3% of the herd); the estimated annual harvest has ranged from 1,600 to 4,800 animals in recent years (Stephenson 1999). PCH caribou have no exposure to industrial activity on summer range, although some cross road corridors such as the Dempster Highway in the Yukon during spring and fall migrations.

The annual cycle of CAH and PCH caribou has been subdivided into different phases for descriptive purposes by various authors (Roby 1978, Russell et al. 1993). The greatest use of the Point Thomson study area by caribou occurs in summer, from the calving period (late May–mid-June) through the insect harassment season (late June–August).

4.10.1.1 Calving Season

Most CAH caribou occur on the northern coastal plain during the calving and insect seasons (Lawhead and Curatolo 1984). By May, pregnant cows move north and disperse widely over the coastal plain to calve in late May–early June. Each cow bears one calf. In most years, calving by the CAH is concentrated in two general areas: one west of the Sagavanirktok River, in the vicinity of the Kuparuk oilfield, and the other east of the Sagavanirktok River, south of Bullen Point (Whitten and Cameron 1985; Lawhead and Cameron 1988; Murphy and Lawhead 2000). A substantial amount of effort has been invested in aerial surveys of caribou distribution and abundance in the Bullen–Staines calving concentration area, which was used by the CAH from the late 1970s to mid-1980s (Whitten and Cameron 1985), and which includes the Point Thomson study area. Besides partial coverage annually by ADF&G from the late 1970s to the early 1990s, calving surveys were done in 1983 (WCC and ABR 1983, Lawhead and Curatolo 1984), 1984 (Curatolo and Reges 1984), 1987–1990 (Lawhead and Cameron 1988, Smith and Cameron 1992) and 1993 and 1997–2000 (Noel 1998, Noel and Olson 1999a, Noel and King 2000a). Wolfe (2000) conducted a retrospective Geographical Information System (GIS) analysis of calving habitat selection based on ADF&G radio telemetry from 1980 to 1995.

Calving surveys since the late 1970s show that the Bullen–Staines concentration area was most heavily used for calving before the mid-1980s, in terms of the proportion of the CAH using the area. The area of most concentrated calving activity identified by Wolfe (2000) encompassed the Point Thomson study area in 1980–1982, then shifted inland and to the west during 1983–1989, before shifting back toward the coast west of Bullen Point in 1990–1992 and back inland again in 1993–1995. Recent surveys corroborate the shift of most concentrated calving activity to the southwest of the proposed Point Thomson facilities.

Because of the interest generated by the debate about opening the 1002 are of the ANWR coastal plain to oil exploration and development, calving surveys for PCH caribou have been conducted annually since the mid-1970s. The location and level of annual use of the PCH calving grounds have been described and mapped in detail (e.g., refer to the summary maps on ANWR web site: http://www.r7.fws.gov/nwr/arctic/pchmap2.html#section6). Most of the calving data analyses, based on telemetry using standard and satellite collars, have been summarized by USFWS researchers in a series of publications (e.g., Clough et al. 1987, Russell et al. 1993). Extensive telemetry data demonstrate that very little calving activity by the PCH occurs in the western portion of ANWR coastal plain, in the Tamayariak River drainage east of the Canning River and the Point Thomson study area (Russell et al. 1993). Transect surveys by Pollard and Roseneau

(1991) confirmed that little calving occurred in the Tamayariak drainage. The dearth of PCH caribou calving in that area indicates that the caribou calving in the Point Thomson study area belong to the eastern segment of the CAH. Lawhead and Curatolo (1984) found some radio-collared CAH animals east of the Canning River on a few occasions during the calving season.

4.10.1.2 Insect Season

Following calving, CAH caribou generally stay within 20 mi (32 km) of the Beaufort Sea coast through the insect season (Lawhead and Curatolo 1984). Mosquito and oestrid fly (warble fly *Hypoderma tarandi*; nose-bot fly *Cephenemyia trompe*) harassment strongly influences caribou movements between late June and early August (White et al. 1975, Roby 1978). Warm, calm weather conditions promote insect flight activity (Dau 1986), although insect activity is lowest near the coast (Dau 1986) because of lower air temperatures and higher wind speeds (Brown et al. 1975, Walker et al. 1980). Mosquito-harassed caribou form large groups and move generally upwind toward the coast (Lawhead and Curatolo 1984, Dau 1986) until reaching "relief habitat." Because prevailing winds in July are northeasterly (Brown et al. 1975), the eastern segment of the CAH typically seeks mosquito-relief habitat along the coast east of the Sagavanirktok River delta, regularly moving as far east as the Canning River delta (Figure 4-9) (Lawhead and Curatolo 1984, Pollard and Noel 1995, Noel 1998, Noel and Olson 1999a, Noel and King 2000a).

Telemetry studies show that CAH caribou make extensive east–west movements through the Point Thomson study area in the insect season (Lawhead and Curatolo 1984). These movements account for the large range of variation in distribution and abundance (e.g., 3–5730 caribou in 1993, 1–2714 in 1998, 0–2500 caribou in 1999) documented on periodic surveys during the insect season (Noel and Olson 1999a, Noel and King 2000a). Under mosquito harassment, caribou aggregate and move to the coast to seek relief. Under continuing harassment, they then may move along the coast in large numbers. These coastal aggregations can range from a few hundred to several thousand caribou along the entire stretch of coast between Badami and the Canning River delta, with the areas of specific use depending on the weather and insect conditions in any given year (WCC and ABR 1983, Lawhead and Curatolo 1984, Pollard and Noel 1995, Noel 1998, Noel and Olson 1999a, and Noel and King 2000a). The maximum group size of CAH caribou recorded in the Point Thomson study area during the 1983 insect season was 2600 caribou near Bullen Point in 1983 (WCC and ABR 1983), about 20% of the CAH at that time.

Insect-harassed PCH caribou infrequently move across the Canning River from the east. PCH caribou usually do not remain on the coastal plain during the insect season. The typical pattern is for the largest numbers to approach the Beaufort Sea coast during the post-calving period and beginning of the insect season (Clough et al. 1987, Russell et al. 1993), when mosquitoes predominate. The majority of the herd then moves southeast into the foothills and mountains of the Brooks Range as July progresses. In some years, however, PCH caribou may mix with caribou from the eastern segment of the CAH. In those unusual circumstances, very large numbers of caribou may enter the Point Thomson area. The largest group of caribou documented using the Point Thomson study area was an aggregation of ~20,000 caribou, comprising a mixture of CAH and PCH animals (as confirmed by radio telemetry), that moved west through the study area to within 7 mi (11.3 km) of the Sagavanirktok River Delta during 10–12 July 1988 (Lawhead and Smith 1990). Under mosquito harassment, the aggregation returned eastward into the study area on 13 July 1988 to the vicinity of Point Gordon (Lawhead and Smith 1990). The late 1980s was a period when a substantial amount of mixing of CAH and PCH caribou occurred on the summer range, thwarting attempts to complete a photocensus of the CAH (Woolington 1995).

When temperatures cool and mosquito activity abates, CAH caribou move away from the coast, usually to the south and west. Mosquito harassment declines markedly by late July (Roby 1978, Dau 1986, Lawhead and Curatolo 1984), leaving oestrid flies as the predominant insect pests. By mid-July, oestrid flies drive caribou to seek relief in a variety of unvegetated and elevated sites, such as river bars, mud flats, dunes, pingos, gravel pads, and roads (Roby 1978, Dau 1986). In areas of human activity, relief from flies is often sought in the shade of elevated pipelines, buildings, and even parked vehicles. Fly harassment typically continues into August (Lawhead and Curatolo 1984, Dau 1986), when CAH caribou begin to disperse inland and migrate south off the coastal plain.

4.10.1.3 Migration and Winter

The decline of mosquito activity in late July and early August marks the beginning of a period of inland dispersal. In an intensive telemetry study in 1983, radio-collared CAH caribou that had summered in the Point Thomson area had begun dispersing inland and far to the west by early August, with some crossing the Sagavanirktok River (Lawhead and Curatolo 1984). Although a few caribou breed and winter (October–April) on the outer coastal plain, most of the CAH moves considerably farther south to the foothills and mountains of the Brooks Range during this period (Cameron and Whitten 1979, Carruthers et al. 1987, Murphy and Lawhead 2000). In October 2000, large numbers of CAH caribou were on the south side of the Brooks Range west of Arctic Village (E. Lenart, ADF&G, pers. comm.). No winter survey data of caribou are available for the Point Thomson study area. In contrast to the CAH, which have relatively limited seasonal migrations, PCH caribou undertake extensive migrations (with some exceeding 3,000 mi/yr (4,828 km/yr)) in moving to and from winter ranges well south of the Brooks Range in the Yukon and eastern Alaska (Fancy et al. 1989, Russell et al. 1993).

4.10.1.4 Summary

In summary, the greatest degree of use of the Point Thomson study area by caribou occurs between late June and August during the insect season, when large aggregations form and move to and along the coast under insect harassment. The highest density of caribou calving in the region currently occurs southwest of the study area from late May to mid-June; although relatively few cows calve in the study area. Most CAH caribou and nearly all PCH caribou breed and winter considerably south of the Point Thomson study area.

4.10.2 Muskoxen

Native muskoxen in Alaska were extirpated from the North Slope by the late 1800s (Smith 1989). Muskoxen were reintroduced on the Arctic Coastal Plain at Barter Island (in ANWR) in 1969 and at the Kavik River (between Prudhoe Bay and ANWR) in 1970 from Nunivak Island in western Alaska. The reintroduced population expanded west and east within a decade (Garner and Reynolds 1986). The ANWR population stabilized at 350 to 400 muskoxen after 1986, whereas numbers to the west continued to increase (Reynolds 1992a, 1995). Stephenson (1993) estimated that 165 muskoxen inhabited the region between the Colville River and ANWR, out of a total population exceeding 550 animals in northeastern Alaska and the northern Yukon.

Muskoxen move in response to seasonal changes in snow cover and vegetation but most activities occur in riparian habitats associated with the major river drainages on the coastal plain. During the winter, muskoxen use upland habitats near ridges and bluffs where shallow snow cover allows easy access to forage plants (Klein et al. 1993). During spring, muskoxen use moist tussock tundra and moist shrub tundra habitats, which provide high quality flowering sedges (Jingfors 1980; Reynolds et al. 1986). By summer most muskoxen are found on river terraces, gravel bars, and shrub stands along rivers and tundra streams where forage includes willow leaves, forbs and sedges (Jingfors 1980; Robus 1981, 1984; O'Brien 1988). Muskoxen calving areas are poorly known, but the majority of the population appears to calve in the southern portion of the coastal plain on wind-blown, snow-free banks along rivers, and in upland foothill sites. Studies of muskoxen in the 1002 area of ANWR suggested that calving and winter (November to February) distributions were similar. Reynolds (1992b) reported little movement during winter, although some mixed-sex groups moved relatively long distances. In ANWR, long distance movements from winter to summer ranges were common in mid-to-late June, but were more pronounced in the eastern portion of the ACP in ANWR, while in the western portion, there was less shifting between winter and summer ranges.

Muskoxen groups typically include 10–30 animals and numbers decrease in summer as the breeding season (rut) [Aug.–Sep.] approaches (Reynolds et al. 1986; Reynolds 1992a). Bull muskoxen may move between mixed-sex groups during the summer and form bull groups during the winter. Calving occurs from late April to late June, peaking in mid-May (Reynolds et al. 1986). Cows produce single calves at intervals of one to three years. Few muskoxen calve within the project area and it is probable that most calving occurs at inland sites south of the project area (P. Reynolds USFWS, ANWR, pers. comm.).

Aerial surveys of muskoxen adjacent to the proposed project area were conducted in 1983 (WCC and ABR 1983), from June through September 1993–1995, and 1997–2000 (Pollard 1994, Pollard and Noel 1995, Noel 1998, Noel and Olson 1999a, Noel and King 1999a) (Figure 4-10). No muskoxen were observed in the Point Thomson study area during surveys in 1983 (all muskoxen observations were east of the Staines River) or 1997. However, several animals were observed on Flaxman Island during the summer of 1997 (pers. communication B. Trimm). During other years, the majority of animals observed during surveys were in small mixed-sex groups moving up and down the major rivers in the area. The largest number of muskoxen in the Point Thomson study area was 32 (4 groups) observed during 1999 (Noel and King 2000).

4.10.3 Grizzly Bear

Grizzly bears (Inupiaq name Aglaq) occur throughout northern Alaska from the Brooks Range northward to the ACP. The ADF&G manage grizzly bears by controling hunting seasons and bag limits. Conservative management practices have been implemented since the 1960s, when a statewide decline in bear numbers resulted primarily from aircraft-supported hunting associated with guiding (Hicks 1999). The Point Thomson study area is located is Game Management Unit (GMU) 26B (near 26C) where the long-term trend in grizzly bear population is thought to be stable at about 262 bears (1.7 bears/100 km^2 [1.7 bears/62 mi^2]); Hicks 1999). Densities are highest in the foothills of the Brooks Range and lowest on the ACP, although an artificially high concentration of bears developed near Prudhoe Bay (23 bears/1500 km^2 [23 bears/930 mi^2])

because discarded food was available in dumpsters and at the Borough Landfill (Hicks 1999). Artificial food sources are powerful attractants for grizzly bears and often have resulted in increased density and productivity of bears, including in the Prudhoe Bay oil fields (Shideler and Hechtel 2000). Grizzlies in the Prudhoe Bay and Kuparuk oil fields have larger litters, higher growth rates, and greater body sizes than bears elsewhere on the ACP (Shideler and Hechtel 1993, 1995a, 2000).

Since the 1989-90 hunting season, annual grizzly bear harvest in GMU 26B has ranged between 11 (1995-96) and 26 (1996–97 and 1997–98) (Hicks 1999). The management objective of the ADF&G in GMU 26B is to maintain a population capable of sustaining an annual harvest of 13 bears, with at least 60% males in the harvest. Since 1985, about one-half of the reported bear harvest in GMU 26B was by nonlocal residents and the other half by nonresidents (only one hunter of 176 total during that period was listed as a local resident of GMU 26B) (Hicks 1999). Unreported take by local hunters is unknown, but likely (Hicks 1999). Hunting pressure is higher in GMU 26B than other North Slope units because of the increased access allowed by the Dalton highway. Harvest of grizzly bears in GMU 26B is closely monitored and was subject to emergency closure in 1998 after harvest objectives were exceeded in 1996-97 and 1997-98.

Grizzlies use river drainages on the ACP as primary travel routes and foraging areas (Shideler and Hechtel 1995a; Johnson et al. 1996, 1997). Grizzly bears have large home ranges (1000-2000 mi^2 [1600-3200 km^2]) and may move 30 or more mi (49 km) in one day (Shideler and Hechtel 1995a). Bears move north from denning areas in the foothills in late May, and are most abundant on the coastal plain during June and July when caribou also are present. In late July, after caribou have left, bears gradually return to the foothills (Clough et al. 1987).

Riverine habitats contain preferred foods, such as legumes (flowering plants in the pea family) and ground squirrels. Bears also feed on sedges and other graminoids, root plants, berries, eggs, fox pups, and microtine rodents (Quimby 1974; Garner and Reynolds 1986; Garner et al. 1986).

Frequently used habitats include forb-rich river bars (which contain root plants, bearberry, and ground squirrels), dry shrub tundra along river terraces (with ground squirrels and bearberry), and both coastal and river-delta dunes (having abundant ground squirrels). Within the proposed Point Thomson project area, most grizzly bear foraging habitat is concentrated in riparian areas to the east or west or along the coast. ADF&G suggested that use of the Point Thomson project areas by grizzly bears would comprise mainly movements between preferred riparian areas to the east and west or attraction of bears to carcasses or seaweed along the coast (Shideler 1999).

Grizzly bears in northern Alaska den from early October to late April or early May. One to three cubs (average of two) are born per litter in December or January (Reynolds 1979, Garner and Reynolds 1986, Shideler and Hechtel 1995a). Males and females remain separate for most of the year, coming together only briefly to court and mate between May and July (Garner et al. 1986). Grizzlies dig dens in pingos, banks of rivers and lakes, dunes, and steep gullies in uplands on the coastal plain (Harding 1976; Shideler and Hechtel 1995b; Shideler, ADF&G, pers. comm.). Most of the bears studied by ADF&G in the Prudhoe Bay oil fields denned within 30 mi (48 km) of the oilfields, although a few denned 60 to 100 mi inland (Shideler and Hechtel 1995b; Shideler, ADF&G, pers. comm.). Figure 4-11 shows surveyed grizzly bear dens located in the region. No collared bears have denned in the Point Thomson study area (Shideler 1999).

Little information exists about grizzly bear use of the proposed Point Thomson project area before 1991. However, unconfirmed reports from Bullen Point Distant Early Warning (DEW) station personnel in the 1970s, and the reported harvest of two bears in 1969 from sites along the Kadleroshilik River (ADF&G files) provide some evidence of grizzly bear presence in the region. Figure 4-12 shows locations of grizzly bear sightings over the period 1991 through 1994. In addition, since 1997, ADF&G has reported nine separate observations of bears (two of these females with single cubs) in the Point Thomson study area (Shideler 1999). Other incidental observations include three bears, each about 15 mi (24 km) inland in 1997 (Noel 1998), two bears 8 mi (13 km) south of Bullen Point in 1998 (Noel and Olson 1999a), and two observations of the same bear near the southwestern edge of the study area in 1999 (Noel and King 2000a). In addition, bird survey crews observed several grizzly bears near Point Thomson Unit #3 in the summer of 2001 (pers. communication D. Trudgeon). Grizzly bears have been sighted somewhat more frequently in the adjacent Badami development area, where riparian habitats occur on the Kadleroshilik and Shaviovik rivers (LGL 1993, Pollard 1994, Pollard and Noel 1995, and Noel and Olson 1999b).

4.10.4 Arctic Fox

Arctic foxes (Inupiaq name Pisukkaaq) occur across the ACP including the Point Thomson area. Great temporal fluctuations in populations of arctic foxes are well known from fur harvest data in North America and Russia. On the North Slope, as in other regions, the population cycle (based on fur harvest data) is believed to be 3 to 4 years, fluctuating in response to lemming population cycles (Burgess 2000). However, actual population estimates are difficult to obtain and generally lacking. Arctic foxes are readily attracted to areas of human activity and to artificial food sources, such as dumpsters or open pit garbage dumps (Eberhardt et al. 1982, Burgess et al. 1993, and Burgess 2000). When not harassed, arctic foxes show little natural fear of humans and human structures provide readily used shelter for arctic foxes in all seasons, including use as dens during the breeding season. Development activities in the Prudhoe Bay oil fields have led to increases in fox numbers and productivity (Eberhardt et al. 1983, Burgess et al. 1993, Rodrigues et al. 1994, Burgess 2000, and Ballard et al. 2000a). The average density of dens is three to five times higher in developed portions of the oil fields (one den/4-5 mi^2 [6.4-8.0 km^2]) than in undeveloped areas of the coastal plain (one den/13-28 mi^2 [20-45 km^2) (Garrott 1980, Eberhardt et al. 1983, Burgess et al. 1993, Johnson et al. 1999a, and Burgess 2000). In addition, both the rate of den occupancy and litter sizes are substantially higher in the oil field than in adjacent undeveloped areas (Eberhardt et al. 1983, Burgess et al. 1993, and Rodrigues et al. 1994). These effects have been attributed to the availability of garbage as a food source, especially during winter. Fox extirpation efforts have been undertaken periodically to remove foxes from the oil field when there was a perceived overabundance of foxes (Burgess 2000 and Ballard et al. 2000b). The main concern is that overabundance of arctic foxes, especially those that are habituated to humans, increase the risk to humans of rabies and hydatid disease. An additional concern regarding the higher densities and reduced population fluctuations of fox populations in the oil fields is the potential impact on nesting shorebirds and waterfowl (Burgess 2000).

Arctic foxes are opportunistic predators and scavengers and their movements reflect their ability to exploit locally, seasonally, or artificially abundant food sources. In times of food scarcity, arctic foxes may move long distances in distinct seasonal patterns between dispersed summer breeding territories on the tundra and winter habitats along the coast or on the sea ice (Chesemore 1975 and Clough et al. 1987). Those on the sea ice move back onshore in late winter or early spring and again establish breeding territories (Chesemore 1975). Remarkable long-distance movements by individual arctic foxes have been documented, including movements of 80 to 1,400 mi (129 to 2,253 km) by eight arctic foxes marked and released near Prudhoe Bay (Eberhardt and Hanson 1978 and Burgess, unpub. data). In contrast, when food is locally abundant, arctic foxes may remain resident near their natal dens year around. During summer, territorial aggression between mated pairs tends to disperse foxes on the tundra (Eberhardt et al. 1983 and Burgess 1984). During fall, arctic foxes gradually abandon territorial den defense and, depending on food availability may simply increase their home range sizes or disperse widely. During winter, arctic foxes are less territorially aggressive and usually nonsocial, although they may congregate and interact in areas where food is abundant. Dense aggregations of arctic foxes may occur where food is superabundant during winter, e.g., at marine mammal carcasses and garbage dumps.

Small mammals (mainly collared and brown lemmings but also singing and tundra voles and ground squirrels) are the most important prey of arctic foxes, supplemented by caribou and marine mammal carcasses and, in summer, by nesting birds and their eggs (Chesemore 1968, Garrott et al. 1983, and Burgess 1984). During summers when lemmings are scarce, arctic foxes typically rely on the eggs of ground-nesting birds, sometimes devastating local egg production. When lemmings are scarce during other seasons (i.e., when birds are absent), arctic foxes eat mainly carrion, often on the coast or sea ice, and in late winter they may prey on seal pups in lairs (Smith 1976). When food is abundant during summer, arctic foxes cache many food items; an adaptation to regulate the wide seasonal and annual fluctuations in food abundance that occur in high-latitude environments. In villages, construction camps, and developed oil fields, garbage, and handouts may become important food sources (Urquhart 1973, Eberhardt 1977, Eberhardt et al. 1982, Fine 1980, Burgess et al. 1993, Rodrigues et al. 1994, and Burgess 2000).

Arctic foxes forage in a wide variety of habitats, but they exhibit strong habitat preferences for denning (Johnson et al. 1996 and 1997) and their dens are more or less permanent and widely recognized components of the coastal plain landscape. Preferred sites include pingos, small mounds, low hills, and ridges 3 to 13 ft (1 to 4 m) high – sites that are chosen for their thin snow accumulations, elevations above water tables, deep active (thaw) layers, surface stability, and sandy soils (see Burgess 2000 for review). These typical dens generally are stable structures that persist for decades (Macpherson 1969), and older dens, which are strongly preferred by arctic foxes, are large, conspicuous structures, often with >50 burrow entrances and strongly modified vegetation. However, many dens on the coastal plain are less conspicuous than the large "typical" dens, and these may be newly developing dens or "temporary" dens that are not likely to be used in subsequent seasons (Burgess 2000). Arctic foxes may use the same den site in successive years and, although populations fluctuate widely between years, in general, more dens are available each year than are used. Arctic foxes living in the oilfields have also been reported to den in artificial structures, such as utility corridors, culverts, abandoned vehicles or heavy equipment, and crawl spaces (Burgess 2000) and to use both natural and artificial dens for winter shelter (Eberhardt et al. 1983). Despite strong denning-habitat preferences, the scarcity of "typical" den sites is not likely to limit the abundance of arctic foxes in any area (Macpherson 1969 and Burgess 2000). Arctic foxes are capable of denning in a wide variety of sites and most tundra landscapes on the coastal plain have an abundance of unused dry mounds, vegetated dunes, and low ridges that are suitable for den sites.

The breeding cycle of arctic foxes begins in late winter to early spring, when foxes adopt breeding territories, mate (March-April), and den. Pups are born between May and early July after a seven to eight week gestation. Litter sizes can be remarkably large in arctic foxes and show considerable annual and regional variability. The most comprehensive evaluation reported that litters averaged 10.6 pups at birth and 6.7 pups at weaning (Macpherson 1969). In the Prudhoe Bay region in 1992, the mean litter size in late summer was 4.6 and the largest litters had 13 pups (Burgess et al. 1993). In years of lemming scarcity, the only foxes with litters that survived to late summer were those living near oil-field facilities.

Because most arctic fox den sites have a history of repeated used and because arctic foxes appear to prefer such sites for breeding, den locations can be mapped and censused annually to obtain an index to local arctic fox abundance and productivity. Four separate investigators have surveyed all or portions of the Point Thomson study area for arctic fox dens: Quimby and Snarski (1974), WCC and ABR (1983), Burgess and Banyas (1993), and Perham (2000). Only Perham (2000) conducted systematic surveys of the entire Point Thomson study area (as currently defined). A few arctic fox dens have been located in the Point Thomson study area to date (Figure 4-13):

- Den 99, located by Burgess and Banyas 1993, on a pingo approximately 7.5 mi (12 km) south of the Badami facility;
- Den 203, located by WCC and ABR 1983, on the bank of a small stream about 6.2 mi (10 km) west of the Staines River; and
- Den 204, located by WCC and ABR 1983, on the bank of a small stream about 1.9 mi (3 km) west of the Staines River.

Den identification numbers were taken from the inventory of arctic fox dens in the region, established by Burgess and Banyas 1993 and appended by Perham (2000). Another arctic fox den was recorded on the western end of Duchess Island, offshore of the Point Thomson study area by Noel and Perham (1999). The small number of dens in the Point Thomson study area could be attributed to the lack of relief in the area (i.e., few elevated mounds or pingos) and to inadequate survey conditions (Perham 2000). The Point Thomson study area lies on an alluvial fan of the Canning River, with sand and gravel soils, lack of relief, and lack of riparian habitats (streambanks and river bluffs that also provide relief). These geomorphological factors may not be favorable to the development of "typical" arctic fox dens; i.e., sites with a long history of use and strongly modified vegetation, making them easy to locate during late summer surveys. For this reason, early spring surveys (in which arctic fox dens are located by arctic fox tracks and evidence of recent excavation in a snow-covered landscape) may be more successful at locating arctic fox dens in the Point Thomson study area. However, according to Perham (2000) snow cover was not optimal during the spring surveys conducted in 1999, and even the two dens that were later documented to be active in 1999 (Dens 203 and 204) were not located during that survey (see discussion in Perham 2000).

4.10.5 Moose

Moose are distributed across the North Slope in low numbers, concentrating in all seasons in narrow strips of shrub communities along major river drainages (Mould 1977 and Hicks 1998). Moose on the North Slope are at the limit of their range and are susceptible to nutritional stress and starvation during bad winters (Hicks 1998). Moose populations on the North Slope have fluctuated widely from very low numbers, mainly in the Colville River, in the 1940s, to an estimated 1600 moose in the 1980s. The Point Thomson study area is on the eastern edge of GMU 26B. ADF&G has conducted early winter composition counts in GMU 26B almost annually since 1986 (ADF&G 1996 and 1998). Before 1992, the population was thought to include 1000 to 1200 moose in GMU 26B. In the 1990s, North Slope moose populations experienced a rapid decline; in GMU 26B there was a 75% decline between the late 1980s and 1994, and populations remained at low levels through 2000. Figure 4-10 includes moose sightings recorded in 1994. Calf survival and recruitment have remained extremely low through the 1990s. The causes of population decline on the North Slope remain unknown but predation, insect harassment, and range deterioration all may have contributed. The precipitous decline in numbers led to total closure to moose hunting in GMU 26B (and other North Slope GMUs) in 1996.

Kaktovik and Nuiqsut are the only subsistence communities in the eastern North Slope GMUs 26B and 26C), and residents took 5-10 moose annually prior to season closure (note that Nuiqsut residents hunt mainly in the Colville River drainage, which lies in GMU 26A) (Hicks 1998). Although travel to the area is expensive and logistically difficult, the impacts of sport hunting were considerable prior to closure, particularly near better known aircraft landing sites. The reported moose harvest in Unit 26B ranged from 24 to 52 during 1986-1995 (Hicks 1996). Harvests declined during the early 1990s, apparently due to the decreases in moose numbers that lead to total closure. The concentrated nature of moose distribution and the open habitat create a potential for excessive harvest in accessible areas.

During all seasons, moose activity on the North Slope of the Brooks Range is concentrated in riparian habitats of major rivers. In winter, riparian areas are especially important, as forage is available only in willow stands that are not covered by drifting snow (Mould 1977). Following snow-melt in May, moose may be somewhat more dispersed across the tundra, as casual observations suggest occasional movements between river drainages in snow-free seasons. In the 1002 area of ANWR (east of the Point Thomson study area), moose concentrated in the foothills of the Brooks Range during winter and moved northward along river drainages (including the Canning River) in late spring-early summer (Clough et al. 1987).

Moose calve during mid-May to early June and rut during late September and early October. Gestation is about 243 days. Females typically breed annually and give birth to a single calf, although twins are not uncommon when nutrition is good.

Among all large mammal surveys in the Point Thomson study area conducted during 1993, 1994, 1995, 1997-2000, only four bull moose were sighted during three surveys in 1994 (Figure 4-10) (Pollard 1994, Pollard and Noel 1995, Noel 1998, Noel and Olson 1999a, and Noel and King 2000).

4.10.6 Other Mammals

Wolves (*Canis lupis*) (Inupiaq name Amaruq) occur in low densities on the ACP and are more common in the mountains and foothills. The North Slope population has remained low since federal predator control in the 1950s and 1960s, but reports of local trappers in Nuiqsut suggest that the population may be increasing in recent years (G. Carroll, NSB, pers. comm.). Other canids that may occur in low numbers in the Point Thomson study area include coyotes and red foxes. Both are associated primarily with higher productivity riparian habitats on the North Slope and, therefore, probably rarely occur in the Point Thomson study area.

Wolverines (*Gulo gulo*) (Inupiaq name Qavvik) occur in low numbers on the Arctic coastal plain, but are more common in the Brooks Range and the foothills (Bee and Hall 1956). Denning occurs primarily in the mountains and foothills in areas with deep snow cover. Habitats used most frequently by wolverines include tussock tundra meadows, riparian willow and alpine tundra (USDI 1978). Wolverines are predators and scavengers of caribou and are found in association with caribou calving and post-calving areas, suggesting that they may be present during caribou calving in the Point Thomson study area. Stomach contents of wolverines harvested in the northern NPRA have consisted primarily of caribou (USDI 1978).

The arctic ground squirrel (*Spermophilus parryii*) (Inupiaq name Sigzik) is abundant on the Arctic coastal plain, with highest densities along major river drainages (Bee and Hall 1956). Because they live underground, ground squirrels require unfrozen soils that are deep enough for burrowing. Typical habitats are uplands, such as sand dunes, ridges, riverbanks, bluffs and pingos. On the coastal plain, ground squirrels are most abundant along major river drainages. Ground squirrels hibernate from September to May (McLean and Townes 1981 and Garner and Reynolds 1986). Mating occurs immediately after hibernation and young are born in June following a three to four week gestation. Ground squirrels eat mainly plants (at least 40 species have been documented to be consumed) as well as occasional carrion, lemmings and voles, and eggs of ground-nesting birds (Batzli and Sobaski 1980 and McLean 1985). Squirrels are an important prey species for golden eagles, foxes, and grizzly bears (Garner and Reynolds 1986).

Lemmings are the most common small mammals on the ACP and their numbers fluctuate dramatically in a 3-4 year cycle in most areas. Collared lemmings (*Dicrostonyx torquatus*) prefer drier habitats found in tussock tundra and high center polygons, while brown lemmings *(Lemmus sibiricus*) inhabit wet sedge meadows and polygonized areas. Collared lemmings eat mostly shrubs (willows and *Dryas*) and forbs, while brown lemmings and tundra voles eat sedges and grasses (Pitelka 1957 and Batzli et al. 1983).

The ermine (or short-tailed weasel) (Inupiaq name Itiriaq) and least weasel (Inupiaq name Naulayuq) are relatively common predators of small mammals on the ACP. Little is known of their population sizes or densities, but they are important predators of lemmings and may play a role in population cycles of those species (MacLean et al. 1974). Other mustelids that may occur in low numbers include mink and river otter, both of which are highly associated with major rivers and, therefore, probably very rarely occur in the Point Thomson study area.

Other small mammals likely to be found in the Point Thomson study area include tundra voles, and barren ground and tundra shrews. Tundra voles are less common than lemmings and are patchily distributed on the Arctic coastal plain. Little is known of the abundance or distribution of shrews on the Arctic coastal plain, although they appear to be widely distributed.