Alaska Habitat Management Guide

Arctic Region
Volume II:

Distribution, Abundance, and Human Use of Fish and Wildlife

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Belukha Whale Distribution and Abundance

I. REGIONWIDE INFORMATION

Information on belukha whale distribution and abundance in Alaska has been collected by three methods: 1) aerial surveys conducted in areas where belukhas are known to occur (Braham and Krogman 1977); 2) a combination of aerial surveys and shore-based observation stations; and 3) information from local residents about belukha distribution (Harrison and Hall 1978, Burns et al. 1985).

The western arctic belukha whale population winters along the sea ice edge and in areas of active sea ice movement from the southcentral Bering Sea north to Bering Strait and into the southern Chukchi Sea (Burns et al. 1985). A large segment of this population migrates north from the wintering areas, passing through Bering Strait, and summers in the Beaufort and Chukchi seas. Other belukhas migrate less extensively and are found in coastal waters of the Bering Sea along western Alaska (ibid.).

For an extensive discussion and review of belukha distribution in Alaskan waters, see Burns et al. (1985).

A. Regional Distribution

Portions of the western arctic belukha population undertake extensive seasonal migrations. These belukhas begin their migration north in early spring (April), passing through Bering Strait into the Chukchi and Beaufort seas (ibid.). They migrate eastward through offshore leads in the Beaufort Sea to Amundsen Gulf, then move southwest and arrive at the MacKenzie River delta in late June (Sergeant and Hoek 1974, Fraker et al. 1978, Fraker 1980). The largest concentration of western arctic belukhas occurs in the MacKenzie River estuary, although concentrations are also found along the northern Alaska coast (Burns et al. 1985).

1. Beaufort Sea. Fraker (1979) and Ljungblad (1981) have observed migrating whales in late May and June utilizing offshore leads in pack ice that extends northeast past Barrow into the Beaufort Sea. Continuing east, many whales appear to congregate in the leads, polynyas, and open water west of Banks Island and in Amundsen Gulf in May and early June. By late June, most of these whales have moved to the shallow, warmer waters of the MacKenzie River estuary, where concentrations in excess of 2,000 whales have been observed in some of the bays (Fraker et al. 1978).

   In late August and September, belukhas in the Beaufort Sea begin their migration back to their wintering area (Burns et al. 1985). It appears that most whales move offshore during this time, because few are seen in nearshore waters, and large numbers have been seen along the ice edge north of Point Barrow and Prudhoe Bay (ibid.).

2. Chukchi and Bering seas. Some belukhas move from the Bering Sea wintering areas to the nearshore zone following ice withdrawal in the spring. Timing of this movement varies with latitude, with whales appearing at various areas between April and July. This movement is believed to be at least partially associated with seasonally abundant food sources available in many coastal areas at this time. Belukhas occur along the entire western Alaska coast, with particular concentration areas in Norton and Kotzebue sounds and Kasegaluk Lagoon (Burns et al. 1985).

   a. Kotzebue Sound. Belukhas first appear in Kotzebue Sound in late May to mid June, usually during or shortly after ice breakup (ibid.). Eschscholtz Bay, in the southeastern corner of Kotzebue Sound, is a major concentration area and may be a favored feeding area and possible calving area (ibid.). Large populations of herring (*Clupea harengus* spp.), smelt (*Osmerus* spp.), char (*Salvelinus alpinus*), salmon (*Oncorhynchus* spp.), and saffron cod (*Eleginus gracilis*) occur in Eschscholtz Bay (Barton 1979; Burns, Frost, Seaman, pers. comm.), and belukha distribution is probably associated with them. Calving has been reported in all coastal regions of the sound; however, most observations are from near Sheshalik and the eastern end of Eschscholtz Bay (Burns et al. 1985).

   b. Kasegaluk Lagoon. During June and July, belukhas extensively use the coastal area adjacent to and including Kasegaluk Lagoon (ibid.). Belukhas may be found both outside the barrier islands and in deeper portions of the lagoon itself, although nearshore waters outside the lagoon are used most extensively. They are usually concentrated in and outside of major passes, particularly Kukpowruk, Utukok, Icy Cape, Akoliakatat, and, to a lesser extent, Akunik (ibid.).

      Belukhas are known to calve in the lagoon and also in the adjacent coastal region. Neonates have been observed in the lagoon during aerial surveys (Seaman, pers. comm.). Belukhas usually leave the Kasegaluk Lagoon area by late July, although they have been seen as late as the middle of August (Burns et al. 1985).

   c. Norton Sound. Belukhas utilize the coastal areas of Norton Sound during the entire ice-free period, usually from May or June until October or November (ibid.). The earliest sightings have been offshore near Shaktoolik in early April. The beginning of this utilization period corresponds with the arrival of migratory and anadromous fishes (ibid.). Belukhas have been observed feeding near Golovnin Bay, Cape Denbigh, and Point Dexter (Frost et al. 1982). Calving occurs in Norton Sound, although specific calving areas have not been identified (Burns et al. 1985).

During spring and summer, belukhas are occasionally present along the coast from Cape Nome to Wales, sometimes foraging along the way but not forming any major local concentrations. Near Cape Nome in spring, early summer, and fall, they feed on schools of saffron cod (Frost et al. 1982). Belukhas have also been observed following schools of herring in this area (Barton, pers. comm.). The relationship between the belukhas of Norton Sound and those seen along the outer coast between Cape Nome and Wales is unknown, but they may be the same whales moving back and forth or animals passing through the area (Burns et al. 1985).

B. Areas Used Seasonally and for Life Functions

For information concerning seasonal use areas and areas used for specific life functions, see the 1:250,000-scale reference maps available in area offices of the ADF&G, and the 1:1,000,000-scale maps in the Atlas to the Alaska Habitat Management Guide for the Arctic Region. Categories available on these maps include the following:

- Known major concentration areas
- Known movements associated with feeding
- Known summer use areas
- Known migration patterns

C. Factors Affecting Distribution

The distribution of belukhas is most affected by seasonal ice conditions, availability and distribution of prey species, risk of predation and, possibly, water temperatures. Belukhas are limited to areas where there is sufficient open water to allow surfacing for breathing. Their winter distribution is therefore associated with areas where geographic, oceanographic, or meteorologic factors cause ice motion and the formation of openings (leads and polynyas) (Kleinenberg et al 1964, Burns et al. 1981).

Some belukhas begin a shoreward movement as areas become ice-free, usually in late March or April, and remain nearshore throughout the summer. At this time, they are frequently seen in large groups at or near the mouths of large rivers. These groups are probably feeding on seasonally abundant food species such as eulachon, herring, salmon smolts and adults, and others (Brooks 1956, Frost et al. 1982).

In late spring or early summer (May-June), belukhas are associated with river estuaries and shallow bays, feeding on abundant food sources. Sergeant and Brodie (1975), however, have suggested that at this time the warmer water temperatures (up to 18°C) in estuaries offer thermal advantages to all sex/age groups. This may be especially important to calves, because of their thin blubber layer and large surface-to-volume ratio.

D. Movements Between Areas

The western arctic stock of belukha whales winters in areas near the active ice edge or in the drifting ice of the Bering Sea (Fay

1978, Seaman and Burns 1981, Burns et al. 1985). As the ice recedes in spring (March-April), a large segment of the population moves northward, utilizing a complex of leads and polynyas that develop both offshore and near shore (Fraker et al. 1978). This part of the population moves through Bering Strait into the Chukchi and Beaufort seas, passing Point Hope and Point Barrow during April to June (Braham and Krogman 1977, Fraker 1979). Their distribution extends into the east Siberian Sea in the west, the eastern Beaufort Sea-Amundsen Gulf area in the east, and along the permanent summer ice fringe (Seaman and Burns 1981, Fraker et al. 1978).

Belukhas in the northern part of their range move southward ahead of and with the advancing ice pack, passing through Bering Strait and entering the Bering Sea.

Another segment of the western arctic belukha population enters nearshore areas after ice breakup and remains in the coastal zone during summer. Areas utilized extend from Bristol Bay north along the entire western Alaska coast. These belukhas leave the coastal zone from late summer to late fall (August-October), depending on latitude. Belukhas that summered in the coastal waters of the Western Alaska/Bering Sea area move seaward, rejoining other portions of the population to winter in the Bering Sea (Seaman and Burns 1981, Fraker et al. 1978).

E. Population Size Estimation

Belukha whale population estimates have been made from information collected from aerial surveys (Braham and Krogman 1977, Braham et al. 1982, Frost et al. 1982, Sergeant and Hoek 1974) and shore observation counts made from camps established next to nearshore leads.

Estimates of whales made from aerial surveys are adjusted by correction factors to account for whales not at the surface during the aircraft's passage. These factors vary according to the speed of the survey aircraft, water clarity, and other factors (Frost et al. 1984). Brodie (1971) concluded that dark-colored neonates and yearlings were not adequately counted during aerial surveys, and he computed the total number of whales by increasing survey estimates by 8% for yearlings and 10% for neonates.

Problems exist with estimates made from ice-based observations. Belukhas migrate in leads offshore as well as those nearshore. Therefore, an unknown number are unavailable to ice-based observers and are not counted. Accurately counting large pods of belukhas is difficult because whales are constantly surfacing and submerging (Braham and Krogman 1977).

F. Regional Abundance

Based on the above methods and additional personal observations, estimates of the number of belukha whales in various areas are as follows: Norton Sound-Yukon Delta - 1,000 to 2,000 (Burns et al. 1985); Chukchi Sea coast, Kotzebue Sound - 500 to 1,800; Point Hope-Point Barrow, especially near Kasegaluk Lagoon - 2,000 to 3,000; Eastern Beaufort Sea and Amundsen Gulf - 11,500 minimum (estimate ranges from 13,500 to 18,000) (Davis and Evans 1982). Burns et al. (1985) estimate the western arctic belukha population, including animals in Soviet waters, to be in excess of 25,000 animals.

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Bowhead Whale Distribution and Abundance

I. REGIONWIDE INFORMATION

Bowhead whales are distributed in arctic and subarctic waters adjacent to the northern and western coasts of Alaska. They migrate in association with the seasonal movement of sea ice, traveling from wintering areas of the west central Bering Sea through the eastern Chukchi Sea and Beaufort Sea into summering areas in Alaskan and Canadian waters (Krogman 1980).

Interest in this species has increased in recent years because of its endangered status, its importance to subsistence hunters, and the large increase in exploratory and industrial activities in arctic waters.

Information presented here is based on environmental studies conducted in Alaska and Canada and from data collected on animals harvested by Eskimo subsistence hunters.

A. Regional Distribution

The western arctic bowhead population (the Bering, Chukchi, and Beaufort seas stock) ranges from the west central Bering Sea north of 60° latitude throughout the eastern Chukchi Sea and eastward throughout the United States Beaufort Sea to Banks Island and Amundsen Gulf, Northwest Territories, Canada (ibid.).

B. Areas Used Seasonally

For information concerning seasonal use areas and areas used for specific life functions, see the 1:250,000-scale reference maps in ADF&G area offices, and the 1:1,000,000-scale maps in the Atlas to the guide for the Arctic Region. Map categories available on these maps include the following:

- Known feeding concentration areas
- Known migration patterns

1. Winter. The specifics of winter bowhead distribution are poorly known, and additional research is necessary to determine areas of use. The following account presents current knowledge of bowhead distribution. Most bowheads of the western arctic population probably winter (January-March) in the west central Bering Sea adjacent to the pack ice edge, which usually occurs between St. Lawrence and St. Matthew islands (Braham et al. 1980a, Brueggeman 1982). During years of extensive ice formation, bowheads have been observed as far south as the Pribilof Islands (Braham et al. 1980a).

   A portion of the western arctic population winters west of St. Lawrence Island in the Gulf of Anadyr. The size of this portion of the population is unknown (Brueggeman 1982).

   Bowhead distribution in the wintering areas appears to be influenced primarily by ice coverage. Leads or corridors consistently develop between St. Matthew and St. Lawrence islands in spring (April). Bowhead whales are usually associated with this lead system and are found to congregate south of St. Matthew Island prior to development of this lead system (ibid.).

2. Summer. The summer range (June-August) of the bowhead whale extends throughout the eastern Beaufort Sea; major concentrations occur in Amundsen Gulf and the Canadian Beaufort Sea east of Herschel Island and northward (Fraker and Bockstoce 1980).

   Bowhead summer distribution also includes areas in Prince of Wales Strait, M'Clure Strait, and Viscount Melville Sound (Fraker et al. 1978).

   Some bowheads do not complete the spring migration into Canadian waters and instead spend the summer months in the northern Chukchi Sea and/or the western Beaufort Sea (Braham et al. 1980a). These whales are suspected to be late migrants from wintering areas that feed and summer in Alaskan waters (Ljungblad 1983).

   Beginning in late July and August, there is usually a shift in bowhead distribution from deeper waters offshore towards shallow waters (less than 15 m in some cases) off the MacKenzie River delta and Tuktoyaktuk Peninsula. The timing of this movement and the locations of concentrations varies from year to year (Richardson et al. 1983). This seasonal shift in concentration from offshore in June to nearshore in August is thought to be related to peaks in primary productivity resulting in subsequent peaks of primary and secondary consumers that bowheads utilize for food (Ljungblad et al. 1983, Schell et al. 1982).

3. Autumn. In September to October, bowheads begin to migrate westward over a broad front along the Alaskan coast, sometimes in shallow, nearshore waters (10-50 m), apparently feeding along the way (Ljungblad et al. 1983).

   Autumn feeding concentration areas are 1) east of Barter Island to at least the United States-Canada demarcation line (141°W) and 2) east of Barrow to Pitt Point (Lowry and Frost 1984).

C. Factors Affecting Distribution

1. Ice. The bowhead whale is one of the few marine mammals that spends all or most of its life in or near the edge of the arctic ice pack, migrating north in the spring as the ice recedes and moving south as pack ice reforms in winter. The migration route, their distribution along the migration pathway, and the rate of migration are influenced primarily by ice conditions and the presence or absence of open water areas (Braham et al. 1980a).

2. Food. The predominant activity of bowheads in summer and autumn is feeding (Richardson et al. 1983). Analyses of food abundance in relation to energy demands show that bowheads must concentrate their feeding in areas of above-average plankton abundance (Brodie 1980, Griffiths and Buchanan 1982). The latter authors have demonstrated that copepod

abundance in areas with bowheads tends to exceed that in other areas nearby. Copepods and euphausiids are the main food items for bowheads in the Alaskan Beaufort Sea during early autumn (Lowry and Burns 1980) and presumably are also important to bowheads in summer. Thus, factors affecting the availability of these and other food organisms in the eastern Beaufort Sea probably have a strong influence on the distribution of bowheads. (For further information on factors affecting bowhead whale distribution, see the Life History and Habitat Requirements volume of this series.)

3. MacKenzie River influence. Geographic and temporal variations in zooplankton abundance are especially likely in the nearshore area most strongly influenced by freshwater input from the MacKenzie River. The river water affects the salinity, temperature, turbidity, and nutrient content over a wide area of the southeastern Beaufort Sea. Each of these can affect zooplankton abundance, and, as mentioned above, zooplankton abundance may affect bowhead distribution (Richardson et al. 1983).

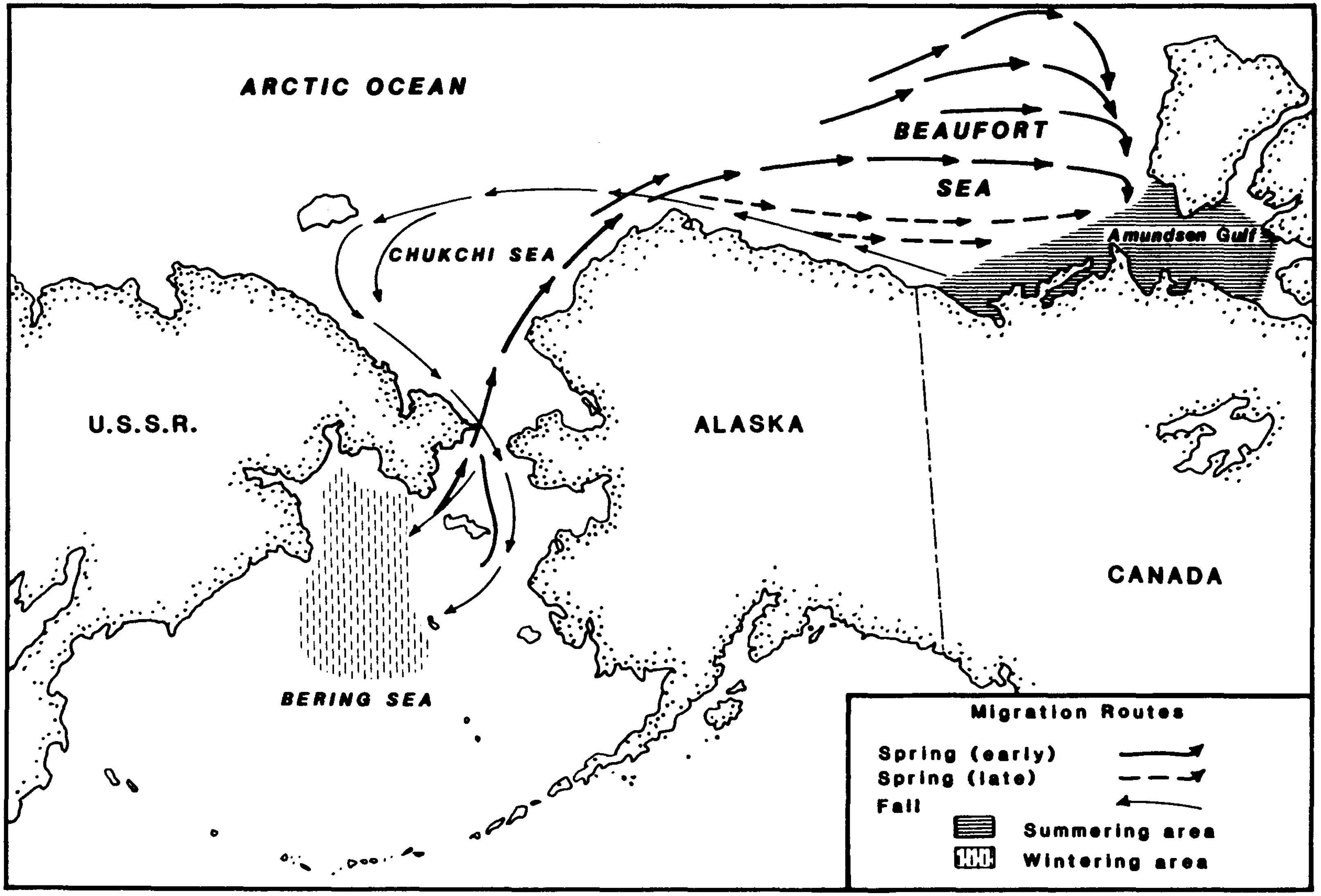
D. Movements Between Areas

1. Spring. Bowhead whales of the western arctic population begin to leave their wintering areas between St. Lawrence and St. Matthew islands in the central Bering Sea in early spring (April and May). The northward movements appear to be timed with the development of shore leads and the breakup of pack ice, and they vary considerably from year to year. Dates given for migration past certain points are only averages and change according to ice conditions (Durham 1979). Migration occurs along at least two routes to the Bering Strait (map 1): one route close to the western end of St. Lawrence Island and another farther offshore (Braham et al. 1980a). A smaller number of bowheads may travel past the eastern end of St. Lawrence Island, but this route does not appear to be a major one (ibid.).

   Most bowheads have arrived at Bering Strait by early May, depending upon ice conditions. North of Bering Strait, bowheads move northeast across outer Kotzebue Sound, with some utilizing a recurring polynya between Kivalina and Point Hope and others travelling up to 45 km offshore. Bowheads follow open leads north past Cape Thompson and then northeast past Cape Lisburne, utilizing the nearshore lead (ibid.).

   The principal migration period past Barrow occurs from the last week of April through May. The earliest and latest recorded dates of bowhead northward migration past Barrow are 29 March and 19 June, respectively (ibid.).

   Past Point Barrow, bowheads migrate northeast, utilizing the extensive lead system and shear zone in the northern Beaufort Sea. This system may occur up to 600 km north of the Canadian Beaufort Sea coast (map 1), and therefore whales may migrate well offshore. Bowheads reach Banks, Prince Albert,



Map 1. General pattern of seasonal movements of the western arctic population of bowhead whales (Fraker 1984, Fraker and Richardson 1980).

and Victoria islands in Canadian waters in late May and early June (ibid.), and as the ice further recedes they move south and east as far as Amundsen Gulf (map 1)(Ljungblad 1981).

The spring bowhead migration past Point Barrow appears to occur in three or four pulses. Younger individuals are the earlier migrants, and larger, older males and females with calves compose the later waves (Durham 1979). Braham et al. (1977) suggest that these pulses in migration are closely related to weather and ice conditions. Whales appear to congregrate in open water areas until leads in the ice appear offshore. Whales then migrate through in what might appear as pulses or waves.

2. Summer. In July, bowheads are present throughout the Amundsen Gulf area (map 1); however, current information is insufficient to precisely identify bowhead distribution in this area (Fraker and Bockstoce 1980). Bowheads also occur in the eastern Beaufort Sea waters of Prince of Wales Strait between Banks and Victoria islands and may occur in M'Clure Strait and Viscount Melville Sound (Fraker et al. 1978). They have been observed in water depths of 50 m near Cape Bathurst (Northwest Territories) (ibid.). There appears to be a southwestward shift in the bowhead range during August, with many whales occurring in the shallow waters of the Mackenzie River delta region (Fraker and Bockstoce 1980, Richardson et al. 1983).

Bowheads begin to move out of their summering grounds in the Canadian Beaufort Sea in mid August, with the major portion of the migration occurring in September (Fraker 1979, Richardson et al. 1983). This westward movement occurs over a broad front, with swimming speeds estimated at up to 4 km/hr (Ljungblad 1983).

Bowheads are found at all depths during this time; however, a shift in distribution occurs in mid September as more bowheads are found in shallower water (20-50 m) nearshore (ibid.). It has been suggested that this nearshore movement occurs because of pelagic prey concentrations found at this time (Ljungblad 1981, Ljungblad et al. 1983).

E. Population Size Estimation

Estimates of the bowhead whale population are made from data collected at counting stations established in spring on shore-fast ice near Barrow, and from aerial surveys of the eastern Beaufort Sea during summer.

Spring counting stations were operated by the National Marine Fisheries Service (NMFS) from 1979 to 1981 (Krogman et al. 1982). In 1982, similar camps were established and operated by the North Slope Borough (NSB) (Dronenburg et al. 1983). Each year, two camps were established near the edge of shore-fast ice to search continuously for bowhead whales. One camp served as a check on the other to determine the number of whales passing by unseen (Krogman et al. 1982). All whales observed were counted, and a correction factor for uncounted whales was included in the total (ibid.). The estimate derived from this program is considered to be a minimum population number only because it does not include migrating whales passing prior to or after the census period, migrating whales passing by too far offshore to be viewed, and whales within viewing range but not observed by either camp (Dronenburg et al. 1983).

Between July and mid September 1981, extensive aerial surveys were conducted of bowhead summer range in the eastern Beaufort Sea (Davis et al. 1982). Bowheads were censused on four separate occasions during the summer of 1981 and showed variation in distribution and numbers. Weather factors were responsible for data gaps in these surveys, preventing a precise population estimate. However, these surveys did result in a minimum population estimate for the western arctic bowhead population (ibid.).

F. Regional Abundance

Based on the 1981 aerial surveys of the eastern Beaufort Sea and data collected from shore-fast ice counting stations, the International Whaling Commission (IWC) in 1982 established a minimum population estimate for the western arctic bowhead whale at 3,857 animals (Dronenburg et al. 1983). The 1985 IWC official estimate was 4,417 whales, with a 95% confidence interval (2,613-6,221) (Fraker, pers. comm.).

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Pacific Walrus Distribution and Abundance

I. REGIONWIDE INFORMATION

Data are presented for the whole population of Pacific walrus rather than by game management unit (GMU) or region, because of the available information.

A. Regional Distribution

During winter, Pacific walruses are concentrated in two main breeding areas of the Bering Sea, one southwest of St. Lawrence Island and the other in northern Bristol Bay and outer Kuskokwim Bay (Fay 1982, Fay et al. 1984). From late March to June, as the pack ice recedes, the population divides into summering groups. Groups consisting almost entirely of males move into the Bristol Bay area, northern Alaska Peninsula, St. Matthew, Hall, Punuk, and Diomede islands, and several haulouts in Anadyr Gulf (ibid.). Other groups, consisting mostly of adult females, immature animals, and a few adult males move northward into the Chukchi Sea, where they summer along the southern edge of the ice near the Siberian and Alaskan coasts and occasionally as far north as 75° N. In October and November, the northern summering groups swim southward, usually ahead of the advancing ice, joining adult males moving north to terrestrial haulouts in the Bering Strait region (ibid.). By December and January, walruses again concentrate in the two main breeding areas (ibid.). (See section D. Movements Between Areas for more details.)

B. Areas Used Seasonally and for Life Functions

For more information about seasonal and life function use areas, see the printed 1:1,000,000-scale Map Atlas to the Alaska Habitat Management Guide for the Arctic Region and 1:250,000-scale reference maps located in ADF&G area offices. The following categories have been used to describe walrus distribution:

° Known haulout concentration areas
° Known migration patterns

C. Factors Affecting Distribution

In Alaska, two main factors affecting the distribution of walruses are water depth and the characteristics of sea ice (Lowry 1984). Walruses are primarily benthic feeders and, in the Bering-Chukchi region, seldom remain in water too deep for efficient feeding; they are rarely seen in water deeper than 100 m (ibid.). When the summer pack ice edge is over the deep water of the continental slope and the sea bed is not accessible to the benthic-feeding walruses, many animals may use terrestrial haulouts such as Cape Lisburne and Wrangel Island (Fay 1982). During much of the year, walruses are found in association with sea ice but are generally not found in areas where thick ice covers more than 80% of the sea surface (ibid.). The distribution of Pacific walruses has changed as their numbers have changed in response to exploitation and recovery (table 1, Fay et al. 1984). Disturbance by humans can affect distribution: increased vehicle traffic has apparently caused abandonment of a traditional terrestrial haulout in the Gulf of Anadyr (ibid.); the Pribilof Islands haulout areas have never been reoccupied following extirpation of the walrus herds by commercial hunters; and King Island, although not used as a haulout when the village on the island was inhabited, was used by thousands of walruses in summer (Frost et al. 1982) until increasing disturbance caused them to again abandon the island (Nelson, pers. comm.). (See the Life History and Habitat Requirements narrative in volume 1 of the guide for the Arctic Region for more information.)

D. Movements Between Areas

Fay's (1982, Fay et al. 1984) summarizations of walrus distribution by month are the basis of the following section.

1. January. Because of the lack of daylight and storms, few data are available for this month except from inhabitants of Diomede, St. Lawrence, and Nunivak islands and from an aerial survey of the Bristol Bay area. Most of the reported walruses from near the islands are subadult and adult males; the location of females and young is not known for this month but is assumed to be similar to that of February.
2. February. From aerial surveys and icebreaker cruises, it appears that animals are regularly clumped in two main areas, from the St. Lawrence polynya southward and in the area south of Nunivak Island and Kuskokwim Bay. Adult males and females, subadults, and young are found in these groups; the adult ratio is about 1 male to 10 females in areas where breeding activity has been observed.
3. March. Early in March, distribution is similar to that of February, with the main breeding herds still in place. Some animals begin the northward migration by the end of the month in some years, depending on ice conditions. Fay and Lowry (1981) found that although breeding activity continued south of Kuskokwim Bay, over 700 males had moved south into Bristol Bay in March, a large increase over the two months before. Small groups of subadult males were found nearer the southern edge of the pack ice.
4. April. Although two main groups are still distinguishable in April, the northward migration is clearly underway, and the two groups appear to spread and merge to a greater extent. Animals wintering near St. Lawrence begin to move north by the thousands through Anadyr Strait, between Gambell and Cape Chaplin, and females and young from the southern group move north around Nunivak Island. Adult and subadult males, presumably from the southern wintering group, congregate at terrestrial haulouts in the Bristol Bay area.
5. May. Females and young from the St. Lawrence wintering group continue passing through Bering Strait and appear to concen-

Table 1. Use by Walruses of Haulout Areas on Alaskan Shores of the Northern Bering Sea and Chukchi Sea in the Present Century

Haulout	1920's	1930's	1940's	1950's	1960's	1970-80's
Egg Is.	Unk.	Unk.	Unk.	None	None	Irreg.
Besboro Is.	Unk.	Unk.	Unk.	None	Irreg.	Irreg.
Cape Darby	Unk.	Unk.	Unk.	Unk.	None	Irreg.
Sledge Is.	Irreg.	Irreg.	None	None	None	Irreg.
Punuk Is. (summer)	Irreg.	Irreg.	Irreg.	Irreg.	None	Reg.
(fall)	None	Irreg.	Irreg.	Reg.	Reg.	Reg.
St. Lawrence Is. Kialegak Pt.	None	None	None	None	None	Irreg.
N.E. Cape	None	None	None	None	None	Irreg.
Salghat	Irreg.	Irreg.	None	None	None	Irreg.
C. Chibukak	Irreg.	Irreg.	None	Irreg.	Reg.	Reg.
King Is.	Unk.	Unk.	Unk.	None	None	Irreg.
Little Diomede	Unk.	Irreg.	None	None	Reg.	Reg.
Cape Thompson	Unk.	Irreg.	Unk.	None	None	None
Pt. Hope	Unk.	Irreg.	Unk.	None	None	None
Cape Lisburne	Unk.	Irreg.	Irreg.	None	None	Irreg.

Source: Fay et al. 1984.

trate along the Alaskan Chukchi Sea coast, although data from the Siberian coast are lacking. Males move only as far as Anadyr Gulf and the Chirikof Basin, where they congregate on the remaining ice long after the females and young have passed. Females from the southern wintering group are still moving up the eastern side of the Bering Sea to eastern St. Lawrence Island and Norton Sound. Males still occupy haulouts in the Bristol Bay area; another smaller group of males reoccupied the St.Matthew-Hall islands area in 1980, apparently for the first time in about 50 years.

6. June. Most females, young, and a few subadult and adult males have moved through Bering Strait by the end of June. Animals remaining behind are mainly adult males that summer principally in Anadyr Gulf, Bristol Bay (mainly in the Walrus Islands), eastern Navarin Basin (St. Matthew and Hall islands), and the Bering Strait area (the Punuk Islands). Walruses haul out intermittently on these islands during the summer between long feeding excursions that take them far out to sea (Fay, pers. comm.). Again, the concentration of sightings only along the Alaskan Chukchi coast may be due to a shortage of data from Soviet waters.
7. July-September. Virtually all female and young walruses are in the Chukchi Sea by July and remain there until October, separating into two main summering groups, one from about 170°W to the vicinity of Point Barrow, and the other along the northern coast of Chukotka to Long Strait and Wrangel Island. Although many of the animals as far west as Inchoun and Kolyuchin Bay are males, animals farther west and north are mostly females and young. Animals remaining in the Bering Sea and Bristol Bay are virtually all males.
8. October. Nearly all the animals summering in both the eastern and western Chukchi Sea converge on the northern coast of Chukotka in October before moving southeastward into Bering Strait ahead of the pack ice. The number of males in Bristol Bay declines and the number on the Punuk Islands increases as males summering in the Bering Sea move northward to meet the southward-moving females and young.
9. November. Overall walrus distribution in November is not well known, but thousands of walruses continue to haul out on the Punuk Islands until late November in most years.
10. December. Very little is known of walrus distribution in December. One cruise found walruses associated with the ice edge in the Bering Strait-Anadyr Gulf area; females and young were primarily along the coast, whereas adult males were found only in the strait between Cape Chaplin and St. Lawrence Island.

E. Population Size Estimation

Lowry (1984) reports:

Estimation of the actual abundance of walruses is complicated

> by many factors. The best method presently available is extrapolation of numbers counted from aircraft flown along transects over walrus range. Problems encountered include inaccuracies in the counts by observers, the vast size of the area to be covered, the unknown number of animals which are below the surface and therefore not counted, and the tendency of walruses to be clumped rather than randomly or uniformly distributed. The problems can, in part, be overcome by taking aerial photographs of large groups, organizing surveys properly in relation to known walrus behavior and distribution, and using statistical techniques for survey design and analysis . . . . Aerial surveys can and have provided reasonable estimates of abundance and clear indications of trends in numbers.

Soviet surveys have resulted in generally lower estimates than United States surveys. In Soviet surveys, walruses were counted or photographed along the Siberian coast, and a correction factor was added for walruses at sea and in American waters. About 60% of their estimate was based on actual counts from photographs of large herds on the ice and on terrestrial hauling grounds (Fay et al. 1984). Although statistical confidence limits are not available for Soviet estimates, techniques remained virtually unchanged through 1980, allowing more direct comparison of results from different years.

American estimates are based on strip surveys, which result in large variability and wide confidence limits. Techniques have changed over the years; some of the increase in population estimates may be due to change in coverage and refinement of technique.

F. Regional Abundance

The Pacific walrus population is being considered as a whole; regional abundance will be discussed in section II. A. Present Abundance.

II. PACIFIC WALRUS POPULATION

A. Present Abundance

Estimates of walrus abundance have changed drastically over the last 15 years, reflecting rapid growth of the population. The population was estimated at 101,000 in 1970 and at 136,000 in 1972 (Lowry 1984). Combined results of Soviet and American surveys in 1975 resulted in a mean estimate of 232,000 (Fay et al. 1984). Preliminary data from a coordinated Soviet-American survey conducted in September 1980 indicate that the population then numbered 246,000 walruses (Lowry, pers. comm.). Interpretation of survey data and population estimates are currently being reexamined by statistical experts, and new figures may be available soon (Lowry, pers. comm.).

Fay et al. (1984) report:

> Since the late 1970's, the walruses have shown distinct signs of decreased fertility, highly variable fecundity, poor

recruitment, declining physical condition, change in feeding habits, increase in average age, and increased natural mortality, all of which are characteristic of stabilization or decline (Eberhardt and Siniff 1977). We think that the population already reached its peak in the late 1970's and that it is on the way down again at this time. That its decline already has begun is suggested by the somewhat larger cohorts of young since the nadir in 1980, by the Eskimos' reports of increasing fatness, and by an apparently declining annual mortality on the Punuk Islands. We think that the population will continue to decline for some years, because the recruitment still is very low, the catches on both sides of the Bering Sea are still going up, and many of the adults are nearing the end of their natural life-span. The fecundity rate probably will continue to decrease for some years yet, for the majority of females are well past their prime and capable only of producing less, not more each year. But calf survival probably will rise markedly and soon result in substantial increases in recruitment. Meanwhile, the population will continue in a downward trend, until the new recruits are abundant enough to produce cohorts sufficiently large to counterbalance the high mortality.

B. Historic Distribution and Abundance

The Pacific walrus population before the arrival of Europeans in the Bering Sea must have comprised at least 200,000 animals to have withstood the harvests that followed (Fay 1957). By the mid nineteenth century, the large herds of bull walruses that summered in Bristol Bay and about the Pribilof Islands were nearly extirpated by hunters for the Russian-American Company; herds on the ice to the north were probably little affected (ibid.). From 1848 through 1880, Yankee whalers took more and more walruses as whale populations declined until 1880, when the walrus population was reduced to about half its former size (Nelson and True 1887). Yankee whalers directed their hunting mainly toward females and young in the pack ice north of Bering Strait; hence their harvest was much more depletive than that of the Russians. Whalers continued to harvest walruses, although at a reduced rate, until about 1914, when the world market for walrus products collapsed (Fay et al. 1984). Walruses continued to be harvested by natives of both Alaska and Siberia and by "arctic traders" who again virtually extirpated the southern herds of summering males in the Bering Sea, reducing the population still further. Walrus numbers increased to an estimated 250,000 by 1931 (Kibal'chich and Borodin 1982). The poorly regulated Soviet harvest from 1931 through 1956 again resulted in depletion of the walrus herds. Based on harvest levels, the population may have reached its lowest historical level in the mid 1950's (Fay 1982). Kleinenberg (1957) noted that of 33 former coastal concentration areas on the Chukchi Peninsula, only 3 remained in 1954. The population in 1960 was estimated at 70,000-100,000 (Fay 1982). Soviet walrus harvest from government-operated vessels was halted in 1962. The population has probably been increasing fairly steadily since the early 1960's.

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Polar Bear Distribution and Abundance

I. REGIONWIDE INFORMATION

The information is organized and presented for the northern Alaska subpopulation and the western Alaska subpopulation rather than by game management units. Based on tagging study results, morphometrics, and tissue contaminant levels, Lentfer (1974, 1976) concluded that polar bears in Alaska belong to two at least partially discrete subpopulations, with the dividing line extending northwest from about Point Lay. Amstrup (pers. comm.), basing his conclusion on results of radio-tracking studies and several more years of tagging data, agrees that there are two populations but feels the placement of a dividing line is still uncertain.

A. Regional Distribution

1. Arctic Region:

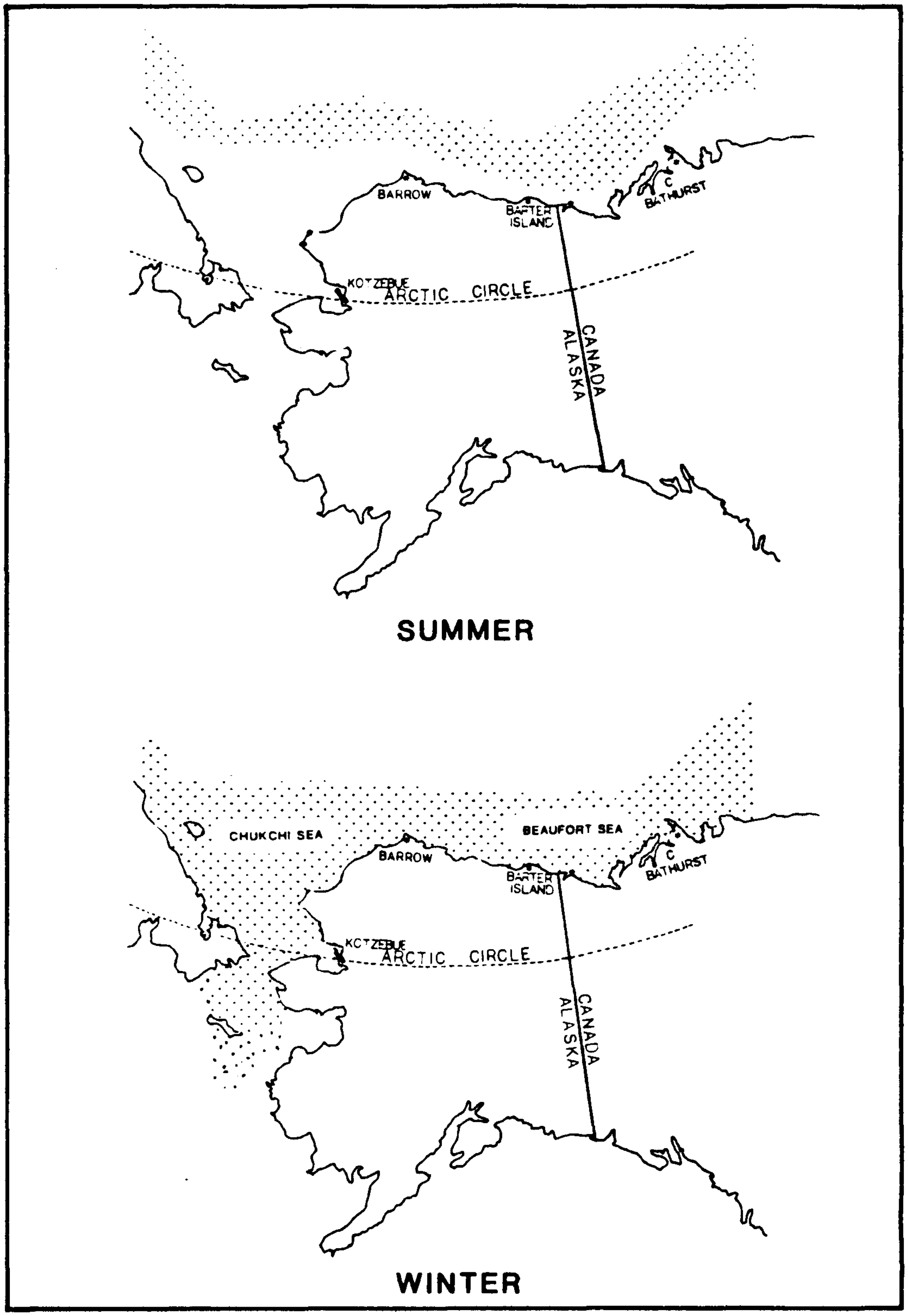
a. Northern Alaska subpopulation. This subpopulation ranges from Cape Bathurst, N.W.T., Canada, to just west of Barrow, and from the drifting pack ice 200-300 km north of the coast south to about 50 km inland (map 1) (Lentfer 1983; Amstrup, pers. comm.). The farthest inland record is of a female killed in September 1944 on the West Fork of the Sagavanirktok River at 148°55'00"N, 68°55'30"W (about 200 km from the coast)(Bee and Hall 1956). Tagging studies show that exchange of Alaskan bears with Canadian populations is limited to bears caught along the mainland coast; no exchange is reported between the Banks Island, N.W.T., breeding area and the Alaskan Beaufort Sea area (Stirling et al. 1981, Lentfer 1983).

b. Western Alaska subpopulation. This subpopulation probably ranges from west of Barrow to Wrangel Island, although its distribution and degree of interchange with bear populations in Soviet waters is not well known (Lentfer 1983, Amstrup 1984). In winter, they regularly range as far as St. Lawrence Island and farther south, depending on the extent of the ice (Fay 1974).

B. Areas Used Seasonally and For Life Functions

See the printed 1:1,000,000-scale Map Atlas to the Alaska Habitat Management Guide for the Arctic Region and the 1:250,000-scale reference maps located in ADF&G area offices. The following categories have been used to describe polar bear distribution:

- General distribution
- Confirmed coastal denning areas
- Potential coastal denning areas



Map 1. Average seasonal range of polar bears. Range in any given year depends on sea ice (Amstrup et al. in press).

C. Factors Affecting Distribution

The distribution and types of ice affect the ability of polar bears to hunt, the availability of seals, and the movements of bears (Lentfer 1972). Changes in ocean currents and climate affect sea ice (Vibe 1967) and therefore the distribution of bears (Lentfer 1972). Polar bear seasonal and life function use areas are primarily determined by sea ice characteristics in conjunction with ringed seal populations. (See the polar bear Life History and Habitat Requirements narrative in volume 1, and the Sea Ice narrative in volume 2 of the Alaska Habitat Management Guide for the Arctic Region for more information.)

Stirling (1974) stated:

> When possible, polar bears remain with the ice because of the greater accessibility of seals there. With the exception of females giving birth to cubs, polar bears do not den for the winter as do grizzly or black bears. Thus, they feed throughout the year and must, if possible, remain on ice near their food source. During the summer, the southern Beaufort Sea becomes ice-free so that the bears are forced to move long distances in order to remain with the pack ice.

In years of low ringed seal productivity or when ice conditions reduce the availability of seals, bears may temporarily disperse from commonly used areas. For example, bears moved out of the Alaskan Beaufort Sea in the spring of 1971, and they left the Canadian Beaufort Sea in the winters of 1974 and 1975 (Lentfer 1983). Sex, age, reproductive status, suitable denning habitat, human hunting pressure, and habitat alteration all may affect polar bear distribution (Lentfer 1982, 1983). (See the polar bear Life History and Habitat Requirements narrative in volume 1 of the Alaska Habitat Management Guide for the Arctic Region for more detailed information.)

D. Movements Between Areas

Although previous mark-and-recapture studies yielded data on fidelity to particular areas in spring, the degree of intermixing between populations, and several population estimates, they did not give much information on seasonal movements and migration patterns; ongoing radio-tracking research should provide a clearer picture (Lentfer 1983, Amstrup 1984).

Lentfer (1972) described autumn polar bear movement patterns in Alaska:

> Polar bears generally first appear along Alaska's north coast in October, when shore-fast ice enables them to travel from drifting pack ice to the beach. The first bear sightings are reported to the east of Point Barrow and then to the southwest in the same sequence that fast ice forms. Eskimos indicate that polar bears travel from north to south in the fall, along the coast between Point Barrow and Cape Lisburne. Considering the two most productive bear hunting areas along this section of coast, bears are first taken by Eskimos in the northernmost Point Franklin area and then in the Icy Cape

area to the south. Eskimos also report that, traditionally, bears are more numerous along the coast in years when winds from the north and west bring old ice to the coast than in years when newly frozen ice drifts in. Bailey and Hendee (1926) verify this and report that in the fall of 1921, old ice failed to come in and new ice formed for miles out from the shore. Consequently, few polar bears were killed between Barrow and Point Hope. In the fall of 1967, ADF&G personnel observed that winds brought more heavy ice than usual, and there were more bears along the coast than usual.

During winter, bears (except pregnant females) of the Northern Alaska subpopulation range throughout the Beaufort Sea from Cape Bathurst to somewhere west of Barrow (Lentfer 1972) and tend to concentrate in areas where the combination of currents and wind periodically causes the formation of open water (Stirling 1974). Bears of the western Alaska subpopulation range from west of Barrow to the southern edge of the seasonal ice (Lentfer 1982). As breakup proceeds in late spring, bears along Alaska's northern coast tend to move generally east (Lentfer 1983), while those from Canada's mainland move west with breakup from the Cape Bathurst polynya (Stirling et al. 1981). Bears of the western subpopulation move generally north with the receding ice, although some may be stranded on land (Stirling et al. 1981; Patten, pers. comm.).

Polar bear distribution is poorly known between breakup and freeze-up, but bears probably remain near the edge of the pack ice (Lentfer 1972, Stirling 1974). Frame (1972) cruised the edge of the summer pack and observed 13 bears in 2,160 mi of cruise track in ice-covered seas. All bears were sighted on seas with an ice cover of 65 to 95% (ibid.). Individual ringed seals were commonly seen in areas of broken ice, and 11 of the 12 bears sighted in the Beaufort Sea were 0 to 14 mi from the place where seals were sighted; neither seals nor bears were seen in the nearly unbroken ice, north of the pack fringe zone (ibid.).

Mark-and-recapture studies from 1967 through 1976 indicate limited interchange between Alaska and the northwest mainland coast of Canada but not between Alaska and the rest of Canada, Greenland, or Svalbard (Lentfer 1983). Recovery of marked animals indicates some tendency for the same bears to occur in the same general area in late winter and early spring each year (ibid.). The rate of movement and distances travelled between marking and recovery sites, as well as the proportion of animals that move to a different area, are not significantly different for males and females or adults and subadults (ibid.). Recoveries indicate that a few marked bears have moved between Alaska and Siberia, but more work needs to be done in this area (Lentfer 1983, Amstrup 1984).

E. Population Size Estimation

Four principal sources of information have been used to derive population estimates for Alaskan polar bears: 1) multi-year mark-and-recapture data from 1967 through 1976 and from 1980 to the present; 2) single season mark-and-recapture estimates that are available for several years; 3) catch-and-effort records from aerial trophy hunting; and 4) catch, effort, and aerial observation records kept in conjunction with mark-and-recapture work (Amstrup 1984).

Tovey and Scott (1958) were the first to report an estimate of the Alaskan polar bear population. Their estimate was based on the number of bears seen in the number of hours of aerial hunting time reported by aerial trophy hunters in 1956 and 1957, assuming an average flying speed and observation track width. Other estimates based on similar catch/effort data share the same potential biases (Amstrup et al. in press); all bears within the assumed 1/4 mi track width may not have been seen; search was not random in that both biologists and trophy hunters tended to concentrate search time in areas known to have high densities of bears; and much of the flying time recorded was spent following bear tracks, yielding higher encounter rates than random searches (ibid.). In spring, when most hunting and tagging studies were done, bears may be segregated by age, sex, and reproductive status; no effort was made to sample all segments of the population (ibid.).

Although estimates based on mark-and-recapture techniques provide probably the best population estimates of polar bears in Alaska, many of the assumptions for statistical treatment of the data are violated (Amstrup et al. in press, DeMaster et al. 1980). Annual rates of mortality for various age classes are not well known; bear movements and the area to which population estimates apply are not well understood; therefore, random mixing and equal probability of being marked cannot be assumed. Annual sample sizes have been small and variable, and variances of resulting estimates are large (Amstrup et al. in press).

F. Regional Abundance

See sections II.A. and III.A., below.

II. NORTHERN ALASKA SUBPOPULATION

A. Present Abundance

Hearings on a proposal to waive the moratorium on taking polar bears imposed by the Marine Mammal Protection Act of 1972 (MMPA) resulted in several estimates of the size of Alaskan polar bear populations. The conservative estimate finally adopted was 5,700, with approximately one-third of these (1,900) in the northern stock and two-thirds in the western stock (Schreiner 1979). Amstrup et al. (in prep.) cited four separate data sources that suggest that approximately 2,000 polar bears occupy the area from Cape Bathurst to Point Barrow, from shore to 150 mi north of the coast (one bear per 137-240 km^2 sea ice habitat). The subpopulation is about the same size now as it was in the late 1950's and is generally stable (Amstrup 1984).

B. Historic Distribution and Abundance

No information was found.

III. WESTERN ALASKA SUBPOPULATION

A. Present Abundance

Hearings on a proposal to waive the moratorium on taking polar bears imposed by the MMPA resulted in several estimates of the size of Alaskan polar bear populations. The conservative estimate finally adopted was 5,700, with approximately one-third of these in the northern stock and two-thirds (3,800) in the western stock (Schreiner 1979). Amstrup (1984), from earlier work by Eley (1976) and Amstrup (1981), calculated density figures of 70 km^2 per bear sighted in 1976 and 113 km^2 per bear sighted in 1981. Although many of the bears of the western subpopulation range into the Bering and southern Chukchi seas, most do not reside in those areas year-round and go north with the ice as it recedes in the spring. The amount of interchange with Soviet populations and the importance of the Wrangel Island core denning area to the population are not known (ibid.). Although it is possible to say that polar bears occur seasonally in the Chukchi Sea at densities at least comparable to those estimated for the Beaufort Sea, data are too few to give a more accurate estimate for the subpopulation than the one given in Schreiner (1979). Although Amstrup (1984) does not refer specifically to the western subpopulation, he states that the polar bear population in Alaska is about the same size as it was in the late 1950's and is generally stable.

B. Historic Distribution and Abundance

No information was found for the portion of the Western Alaska subpopulation found in the Arctic Region.

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Ringed Seal Distribution and Abundance

I. REGIONWIDE INFORMATION

Because of the widespread distribution of ringed seals in marine waters of the Arctic Region and their affinity for sea ice they will be discussed on a regionwide basis only, with seasonal variations noted when appropriate.

A. Regional Distribution

During winter and spring, ringed seals range as far south as Nunivak Island and Bristol Bay, depending on ice conditions in a particular year, and are abundant in the northern Bering Sea, Norton and Kotzebue sounds, and throughout the Chukchi and Beaufort seas. Most ringed seals are associated with sea ice year-round (Frost 1984).

B. Areas Used Seasonally and for Life Functions

1. Winter and spring. During winter and spring, the highest densities of breeding adult seals occur on stable land-fast ice. During spring, subadults are the most numerous age group in the adjacent flaw zone (McLaren 1958, Burns 1970, Smith 1973). Throughout the pack ice, seals of all ages are found at low densities (Frost 1984). The importance of drifting pack ice as pupping habitat is unknown; however, ongoing research indicates it may be more important than once thought. At or around ice breakup females abandon their pups. The pups frequently remain in the vicinity of the collapsed birth lair, basking in the sun (Frost and Lowry 1981).
2. Late spring and early summer. During late spring and early summer, ringed seals use ice as a solid substrate on which to haul out and complete their annual molt. They use the fast ice as well as relatively large flat floes in the pack ice and are usually seen near cracks, leads, or holes, where they have rapid access to water (Frost 1984). The amount of time spent on the ice increases as the molt season progresses (Frost and Lowry 1981).
3. Summer. In summer, most ringed seals of all age classes and both sexes are found along the edge of the permanent ice pack in the northern Chukchi and Beaufort seas and in nearshore ice remnants in the Beaufort Sea (Frost and Lowry 1981, Frost 1984). A small portion of the population, mainly subadults, may remain in ice-free areas (Frost 1984).
4. Fall. With the onset of freeze-up in fall, many ringed seals migrate southward and move toward the coast. They are abundant in grease and slush ice in areas south of the advancing pack (ibid.). (See the Sea Ice narrative in volume 2 of the Alaska Habitat Management Guide for the Arctic and Western and Interior regions.)

C. Factors Affecting Distribution

Sea ice provides a stable platform on which to bear and nurse young and to haul out to complete the annual molt cycle. The ice also provides protection from predators and exposure to severe weather conditions. Ringed seals require regular access through the ice to air and water. Because they maintain breathing holes by frequent use and abrasion of the ice by the claws of the front flippers, they are able to occupy areas of heavy unbroken ice unsuitable for other northern pinnipeds (Burns 1978, Frost 1984). These holes are maintained throughout the winter and have been measured in ice over 2 m thick (Smith and Stirling 1975).

Temporal and spatial differences in seal abundance from winter to early spring are probably related to differences in distribution of arctic and saffron cods, their primary prey at that time. Observations also suggest that in summer and early fall seals are concentrated in areas of abundant prey (Lowry et al. 1980). Year to year differences in abundance in the same geographic area are probably related to the availability of food (Stirling et al. 1977, Frost and Lowry 1981).

During spring, subadults may be excluded from fast ice where adults, which may be territorial, are numerous during the pupping and breeding season. Subadults are the most numerous age group in the adjacent flaw zone (McLaren 1958, Burns 1970, Smith 1973).

D. Movements Between Areas

The only substantial study of ringed seal movements based on marking has been conducted in northwestern Canada. Of over 300 seals marked at Herschel Island and Cape Parry, only four recoveries were made (Lowry et al. 1980). Of the recoveries, two were essentially local and two indicated substantial movement westward to Point Barrow, Alaska, and East Cape, Siberia.

In summer, all age classes and both sexes of ringed seals are found along the edge of the permanent ice pack and in nearshore ice remnants. This requires a migration of hundreds of kilometers by seals wintering in the Bering Sea (ibid.).

E. Population Size Estimation

Currently, there is no completely satisfactory method of accurately censusing ringed seals, primarily because it is not known what portion of the total population is counted during aerial surveys. Estimates of population size have been derived from counts of animals hauled out on the ice in June during the peak of the annual molt. Conversion factors that estimate the proportion of animals not hauled out during surveys are then applied to derive minimum estimates of actual abundance (Frost and Lowry 1981, 1984). Most surveys have been conducted from fixed-wing aircraft flying over fast ice during the first two weeks of June.

F. Regional Abundance

Densities from Alaskan surveys, when applied to estimates of available habitat of various types, produce estimates of at least

250,000 ringed seals on the shore-fast ice and a total population of 1-1.5 million in Alaskan waters. The density of seals observed during aerial surveys over the fast ice of the Beaufort and Chukchi seas in June 1975-1977 and 1981-1982 ranged from a low of 0.4 seals/nm² between Flaxman and Barter islands in 1976 to a high of 6.2 seals/nm² between Wainwright and Barrow in 1975 (Burns and Eley 1978, Burns et al. 1981). Estimates of annual mortality, based on predation rates by polar bears, suggest that the present population estimate may be quite low (Frost 1984).

G. Historic Distribution and Abundance

Nothing is known of historical population levels of ringed seals. Indications are, however, that present levels are not much different from during the eighteenth and nineteenth centuries (ibid.).

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Terrestrial Mammals

Brown Bear Distribution and Abundance

I. REGIONWIDE INFORMATION

The following information will be presented on a regionwide basis, with area-specific information noted where appropriate. Three game management units (GMUs) are contained within the Arctic Region: GMUs 22, 23, and 26 (map 1).

A. Regional Distribution

Brown bears can be found throughout the Arctic Region in varying densities. The lowest densities occur along the coastal plain, with higher densities occurring in coastal locations south of the Brooks Range. In the Arctic Region, brown bears are at the northern limits of their range; the period of food availability during the summer is short, and reproductive potential is low, compared to areas further south (ADF&G 1976).

B. Areas Used Seasonally and for Life Functions

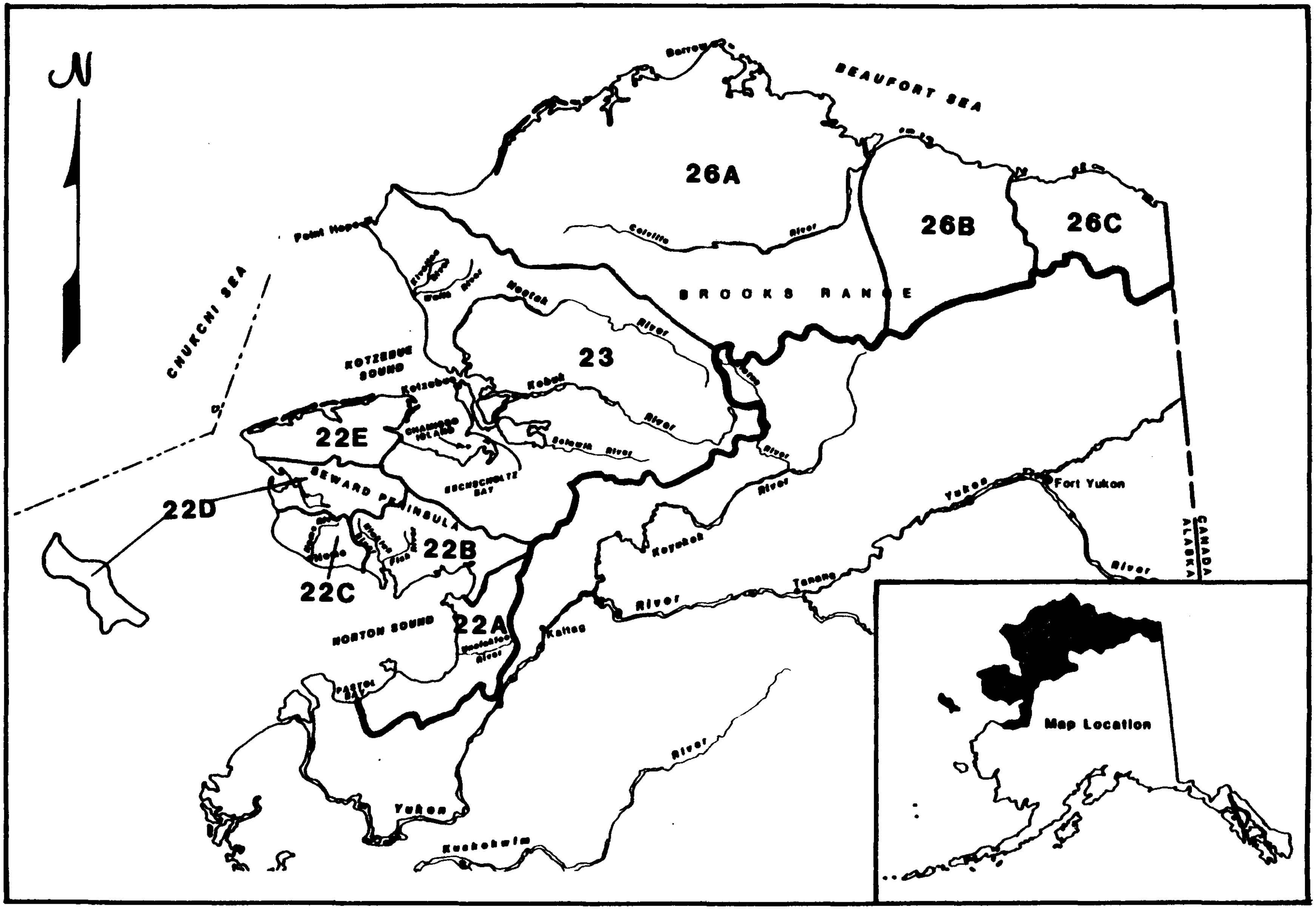
For information concerning seasonal use areas and areas used for specific life functions, see the 1:250,000-scale reference maps, available in ADF&G area offices, and the 1:1,000,000-scale Atlas to the Alaska Habitat Management Guide for the Arctic Region. Map categories for brown bear are as follows:

- General distribution
- Known spring concentration areas
- Known concentrations along fish streams
- Known concentrations in berry areas
- Known denning concentration areas
- Known concentrations associated with mammalian food sources

C. Factors Affecting Densities

Brown bear populations in the western Brooks Range appear to occur at greater densities and to be more productive than those in the eastern Brooks Range (Reynolds 1976, 1980). This may be a localized phenomenon due to the proximity of the bear population studied in the western Brooks Range to the caribou calving grounds of the Western Arctic Herd (WAH). These caribou may provide a protein source unavailable to other bear populations whose range does not overlap a caribou calving area. Because brown bear population size and productivity are undoubtedly closely related to food availability, relatively high densities and reproduction in an area of high protein availability would be expected (Reynolds 1980).

The low survival rates of some cohorts in the western Arctic, however, may dampen the effect of high productivity. Mortality of cubs of the year appears high. Although all causes of mortality have not been definitively identified, it appears that adult males may be the major cause (ibid.). Limited data suggests that survival of bears from ages 3.5 through 4.5 years is also low, because it is at these ages when the young are weaned and are



Map 1. Game management units in the Arctic Region.

beginning to seek home ranges of their own without the protective influence of the mother (ibid.).

Human harvest of brown bears can also affect the densities of brown bears, especially on a local scale (Reynolds 1984). Historically, it appears that harvest by miners and reindeer herders may have kept the bear population low in portions of the region (Nelson 1984). Although bears returned to former numbers in most areas by 1960, increased demand in recent years has caused some local subpopulations to decline (Grauvogel, pers. comm.).

D. Movements and Home Ranges

Factors responsible for the size of home ranges are not completely understood, although the availability, quality, and quantity of food sources likely plays a major role. Home ranges of brown bears in the Arctic Region are large, reflecting the low quality and short period of availability of forage in the region (Reynolds 1980). In the western Brooks Range, reported home range sizes averaged 1,350 km^2 for males and 344 km^2 for females, with a range of 142 to 4,167 and 93 to 873 km^2, respectively (ibid.). Individual home range sizes are also dependent upon the sex, age, and reproductive status of the bear. In general, home range sizes decrease in order from breeding males, breeding females, subadult females, and females with offspring (sufficient information about home range size was not available for subadult males) (ibid.).

Care should be taken when comparing home range sizes reported in different studies. At least two different methods of calculating home range size were noted in the literature. Most studies utilize the minimum area polygon method (Craighead and Craighead 1972, 1976; Pearson 1975, 1976); that is, home ranges are calculated by plotting the observations of radio-collared bears on topographic maps, connecting the peripheral location sites, and calculating the area enclosed for each year of observation. This was the method used to calculate the home range sizes given above. The second method, the modified exclusive-boundary-strip-method (Berns and Hensel 1972, Curatolo and Moore 1975, and Reynolds 1976), is based on the approximate size of daily movements, and use of the method excludes large expanses of area in which no observations or assumed movements would have occurred. This method was used in the eastern Brooks Range because bears traveled primarily along river valleys and did not use the country separating adjacent river valleys (Curatolo and Moore 1975, Reynolds 1976).

Reynolds (1980) calculated home range sizes in the western Brooks Range based upon up to three years observation of individual bears. The size of home ranges varied from year to year, and the home ranges calculated for the entire study period were greater than for any one year. For instance, one male had home range sizes of 603, 231, and 508 km^2 over a three-year period, but the total area occupied when all years were combined was 924 km^2. Comparison of one study to the next should therefore take into account both the method or methods used and the number of years the studies included.

Although brown bears in the Arctic Region may travel long distances during short periods of time, their average daily movements are relatively small (Reynolds 1976, 1980). Movements within home ranges tend to be concentrated in certain areas. These movements are usually due to the bears' response to food sources, the reproductive condition of the animals, or seasonal habits, including denning (Lentfer et al. 1966, 1967; Craighead and Craighead 1967; Glenn 1972, 1973).

In the western Brooks Range, brown bears tended to concentrate their activities in the calving grounds and migration corridors of the WAH. It had been assumed that some bears may move long distances to reach the calving area; however, data collected by Reynolds (1980) did not support this assumption. He indicated that it was more probable that bears whose home ranges overlap caribou calving areas or migration corridors concentrated in these areas during the calving and postcalving migration periods. Similar movements to food sources were observed in the eastern Brooks Range when up to 17 bears were observed feeding on soapberry (*Shepherdia canadensis*) in the upper Canning River drainage (Reynolds 1974). It should be noted, however, that in other portions of Alaska it does appear that some bears will make long movements to food sources, as in the upper Susitna Valley (Miller 1984). Bears residing in coastal areas south of the Brooks Range may move long distances to take advantage of seasonally abundant foods such as salmon and berries (Grauvogel, pers. comm.).

Reynolds (1980) reported that in 1978 four radio-collared bears in the western Brooks Range denned from 16 to 44 km outside of their spring, summer, and fall ranges.

E. Population Size Estimation

Currently the best method of determining brown bear densities and population size in the Arctic Region has been a direct count in conjunction with an intensive individual marking program over a period of years (Reynolds 1974, 1976; Pearson 1975, 1976). Because of the lack of escape cover in the Arctic Region and the extensive aerial surveys conducted over two years, Reynolds (1980) estimated that at least 95% of all bears in his intensive study area in the Western Brooks Range had been located. Other means of estimating brown bear populations in areas not under intensive study have not been successful because of the bears' low densities, sparse distribution, and solitary habits (Reynolds 1980). Although the direct count method is thought to provide accurate results in some places in the Arctic Region, its use is limited primarily to treeless areas and requires at least two years of intensive study to achieve meaningful results (Reynolds and Hechtel 1984).

F. Regional Densities

Based on studies conducted in the southwestern National Petroleum Reserve-Alaska (ibid.), the central Brooks Range (Crook 1971), and the eastern Brooks Range (Curatolo and Moore 1975, Reynolds 1976), estimated densities of brown bears have been established for four elevational strata in the northern portion of the Arctic Region. The four areas extend from the Brooks Range north to the coast and include the following: 1) the coastal plain (sea level to 50 m mean elevation); 2) the low foothills (305 to 610 m); 3) the high foothills (610 to 914 m); and 4) the mountains (elevations over 914 m). The estimated densities of bears in these strata are as follows: coastal plain - 1 bear/777 km^2; low foothills - 1 bear/91 km^2; (range 1/52-1/129 km^2); high foothills - 1 bear/129 km^2; and mountains - 1 bear/259 km^2. Densities and productivity of bears may vary within these strata. Comparison of the brown bear population in the eastern Brooks Range (Reynolds 1974, 1976; and Curatolo and Moore 1975) with that in the western Brooks Range (Reynolds 1980) indicates that both population productivity and density are much greater in the western Brooks Range. Bear densities south of the Brooks Range are probably higher in many areas. In GMU 22, bear densities were crudely estimated to range from one bear/52 km^2 to one bear/205-260 km^2 (Grauvogel 1985). For comparison of brown bear densities reported elsewhere, table 1 presents data from several studies conducted in North America.

Table 1. Reported Brown Bear Densities in North America

Bear/km^2	Location	Source
1.6	Kodiak Island, Alaska	Troyer and Hensel 1964
16	Alaska Penin., Alaska	Miller and Ballard 1982
21	Glacier National Park, Montana	Martinka 1974
23-27	Southwestern Yukon Territory	Pearson 1975
28	Glacier National Park, B.C.	Mundy and Flook 1973
41	Upper Susitna River, Alaska	Miller and Ballard 1982
260	Eastern Brooks Range, Alaska	Reynolds 1976
288	Western Brooks Range, Alaska	Miller and Ballard 1982

Population trends vary in the Arctic Region. The bear population in GMU 22 is probably stable or decreasing, following several decades of increasing numbers (Grauvogel, pers. comm.); in GMU 23, the bear population appears to have recently stopped increasing and may be stable (Quimby 1984); in Game Management Subunit (GMS) 26B, bears appear to be increasing and recovering from previous overharvest; in GMSs 26C and western 26A, bear numbers are probably increasing, and in western GMS 26A, the population is stable or increasing slightly (Reynolds 1984).

G. Historic Densities

In GMU 22, hunting pressure by miners and reindeer herders during the early 1900's probably kept brown bear numbers on the Seward Peninsula very low. The population is thought to have increased during the next 50 years and to have reached densities near carrying capacity 15 to 25 years ago (Nelson 1984).

In GMU 23, it appears that brown bears were common during the 1950's, after increasing from low numbers as the result of heavy hunting in the early 1900's. During the 1960's, guides offered combination hunts for polar and brown bears, resulting in an increased brown bear harvest that likely kept the population from increasing. Since polar bear hunting by non-Natives became illegal in 1972, the associated decrease in brown bear harvest allowed the population to increase until recent years (ADF&G 1976, Quimby 1984). Although knowledgeable local residents believe the population has increased substantially during the past 20 years, liberalized hunting regulations and increased harvest by non-resident, guided hunters since 1977 has probably kept the population from increasing (Quimby 1984).

In GMU 26, little is known about the historic densities of brown bears.

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Caribou Distribution and Abundance

I. REGIONWIDE INFORMATION

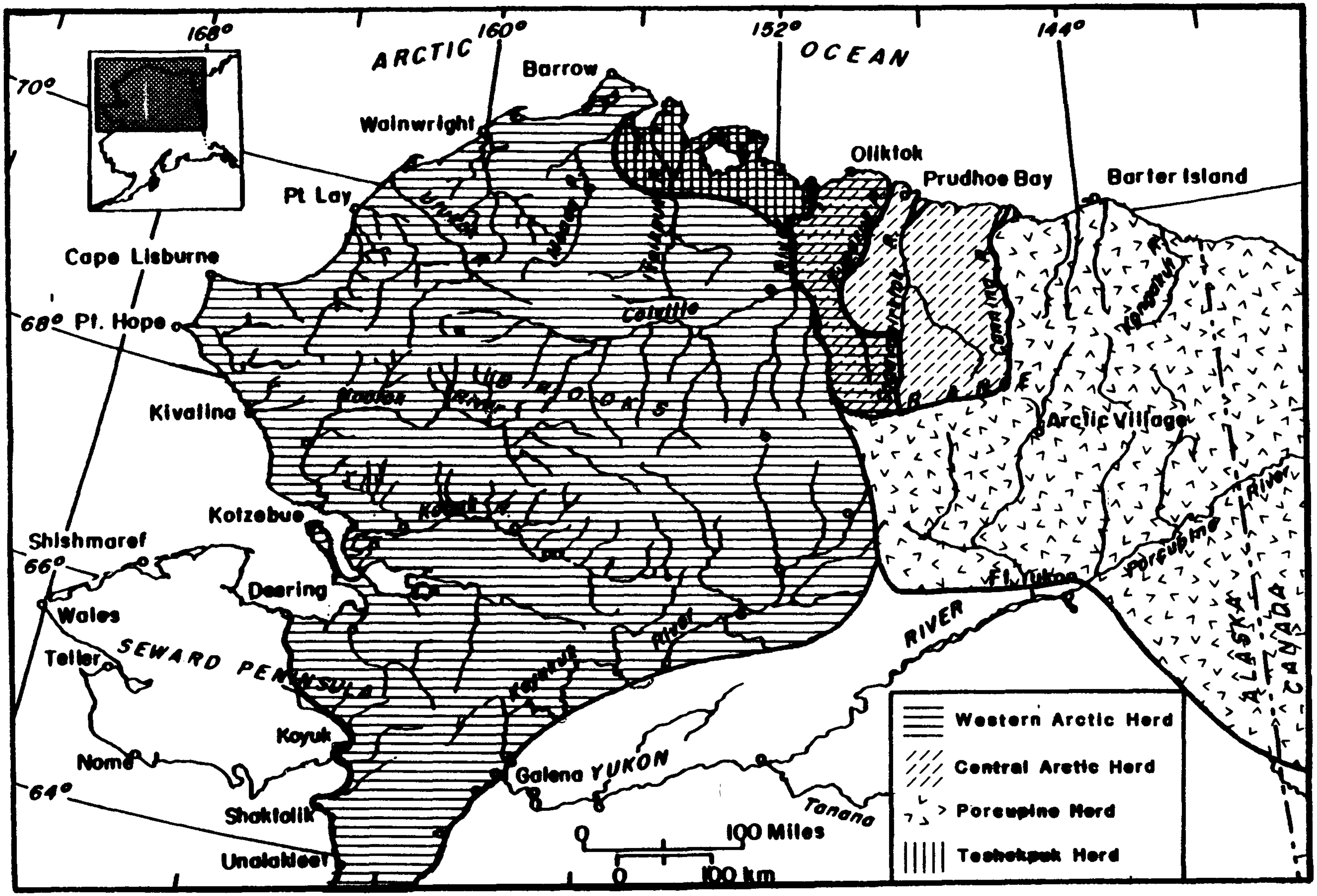
Information herein is organized and presented by individual caribou herds, because many caribou migrations cross state, regional, and game management unit (GMU) boundaries. These jurisdictions usually exist to expedite administrative, enforcement, and managerial concerns. In reality, the biological reason(s) for some management strategies, such as bag limit and season length, may extend well beyond the boundaries of a jurisdictional unit.

A. Regional Distribution

1. Porcupine Herd. The Porcupine Herd (PH) is one of four caribou herds (map 1) utilizing portions of the Arctic Region. Major herd movements occur regularly at least twice per year between Canada and Alaska.

a. Calving area. Historically, the calving grounds of the PH have included the arctic coastal plain and foothills up to 1,100 m (3,600 ft) in elevation from approximately the Canning River to the Babbage River in Canada (Calef and Lortie 1973). For most Alaskan caribou herds, calving areas have been characterized by gentle slopes, an absence of trees and brush, and comparatively early snow melt-off (Skoog 1968). Calef and Lortie (1973), as did others, described the coastal plain as gently rolling terrain with two major plant communities: a cottongrass (*Eriophorum* spp.) tussock-dominated plant community and a wetter, sedge-dominated community. The foothills are drier, with more diverse plant communities, large areas of flat ridge tops, and long valleys characterized by vegetation similar to that of the coastal plain (ibid.).

Lent (1980), using remote sensing imagery, demonstrated that the general location of traditional calving areas in the arctic was based mainly in response to long-term snowcover ablation patterns. Lent (1980) also documented a specific area of early snow-melt along the arctic foothills from Herschel Island to the Canning River that coincided approximately with the historic calving areas for the PH. This portion of the calving grounds is wind-swept and has very little spring fog cover, resulting in an earlier snow-melt than on the frequently fog-covered coastal plain (Calef and Lortie 1973). The microtopography of the *Eriophorum* spp. tussock communities, which predominate in the foothills, promotes melting and evaporative loss of snow (Lent 1980).



Map 1. Approximate ranges of arctic caribou herds (adapted from Davis 1980; Anderson, pers. comm.; Cameron, pers. comm.).

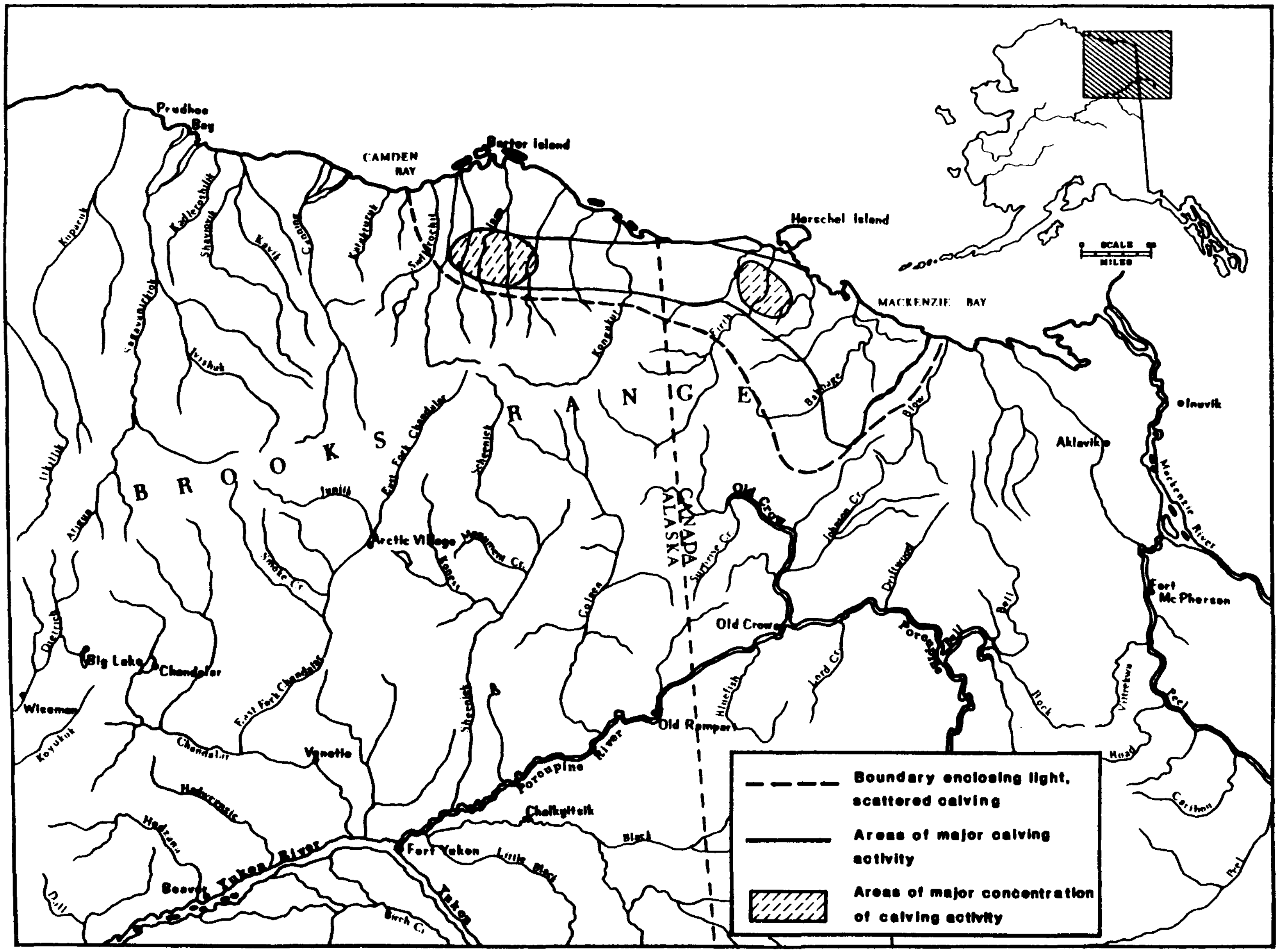
It appears, then, that the location of major calving activity may depend on the distribution of snow. Arriving caribou cows generally prefer the snow-free upland tussock meadows as calving sites (USFWS 1982). Calving activities occur on the coastal plain area later in the calving season as that area becomes increasingly snow-free (Roseneau et al. 1974).

The first groups of pregnant cows generally cross the Alaska-Canada border by mid-to-late May. This date can vary widely, depending on snow conditions along the migration route and the location of that year's wintering area. For example, in 1971, a heavy snow year, caribou left the Ogilvie Mountains and did not arrive in Alaska until May 30, whereas, in 1974, a light snow year, caribou again wintered in the Ogilvie Mountains and arrived in Alaska as early as May 5 (McCourt et al. 1974, Jakimchuk et al. 1974).

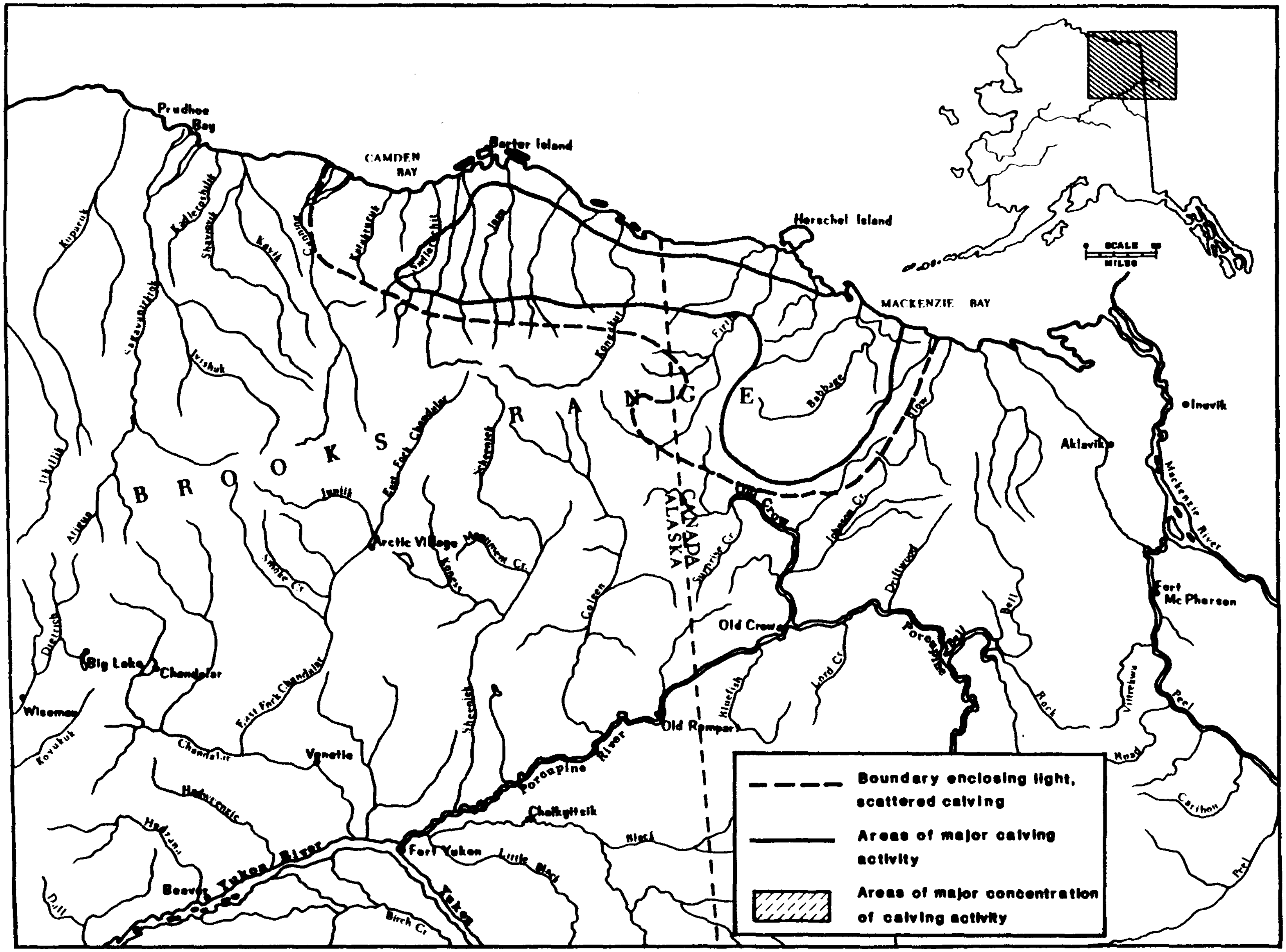
Skoog (1962) noted that the peak of calving for the PH occurred on approximately May 28. From 1971 to 1976, Curatolo and Roseneau (1977) reported that the calving peak occurred between June 5 and June 9, with the majority of calving completed by June 18. The locations of major calving activity on the traditional calving grounds can vary widely because of annual differences in snow cover depth and distribution. Maps 2-14 depict the variation in annual calving areas for the PH from 1973 to 1984.

b. Wintering area. The PH utilizes two principal wintering areas: the central portion of Yukon Territory (map 15) and, in Alaska, the area in the vicinity of Arctic Village between the Chandalar River and Sheenjek River drainages (map 15). Some animals occasionally winter in the headwaters of the Hodzana River, the Coleen River drainage, and on the arctic slope. Canadian wintering areas (map 16) include the Peel River-Hungry Lakes region, the northwest Ogilvie Mountains, the Richardson Mountains, the Old Crow area, the Bell River drainage, and the arctic coastal plain (USFWS 1982).

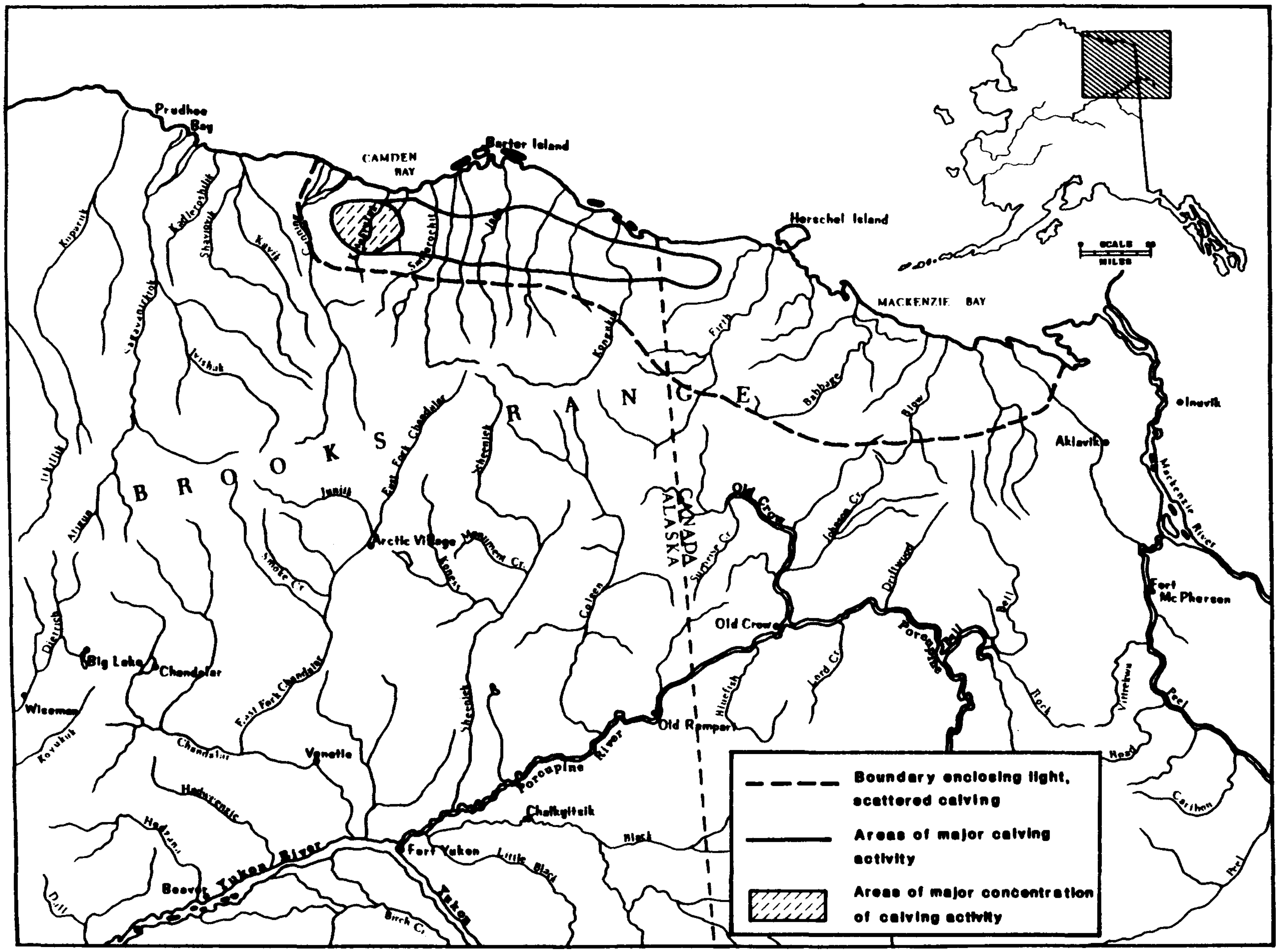
Caribou from the PH usually reach their wintering areas by early November and remain until March (Hemming 1971). Henshaw (1968) concluded that winter movements by caribou were nonrandom and that animals responded consistently to forage availability and snow conditions. Caribou groups generally do not stay in one feeding area throughout the winter season and frequently make short-distance movements. Pruitt (1959) described ideal snow conditions for a caribou winter range in northern Saskatchewan: 1) snow of low hardness value, 2) light, low-density forest snow, 3) snow depths of less than 50 to 60 cm, and 4) continuous low temperatures (no



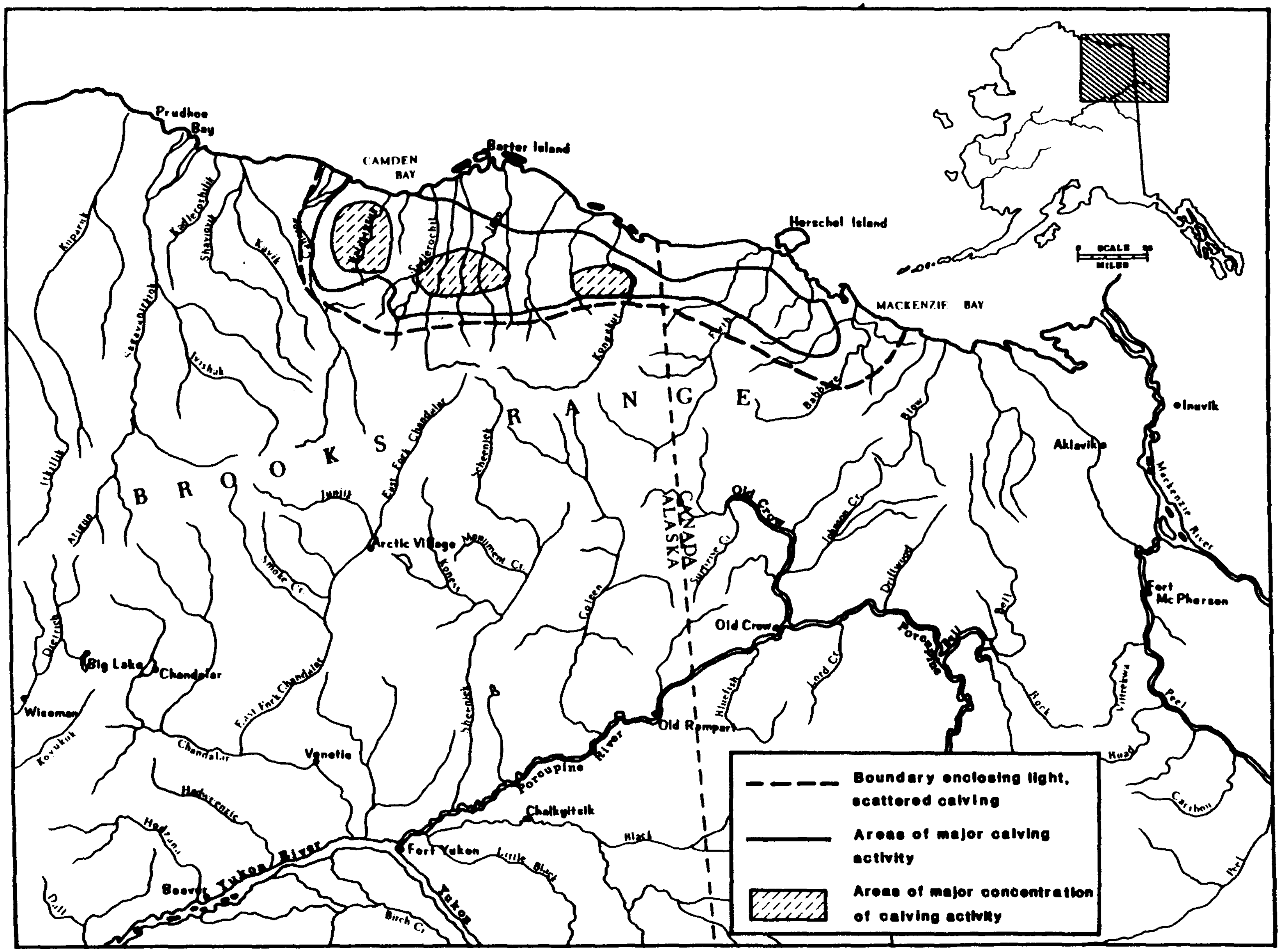
Map 2. Calving grounds of the Porcupine Herd, 1972 (modified from USFWS 1982).



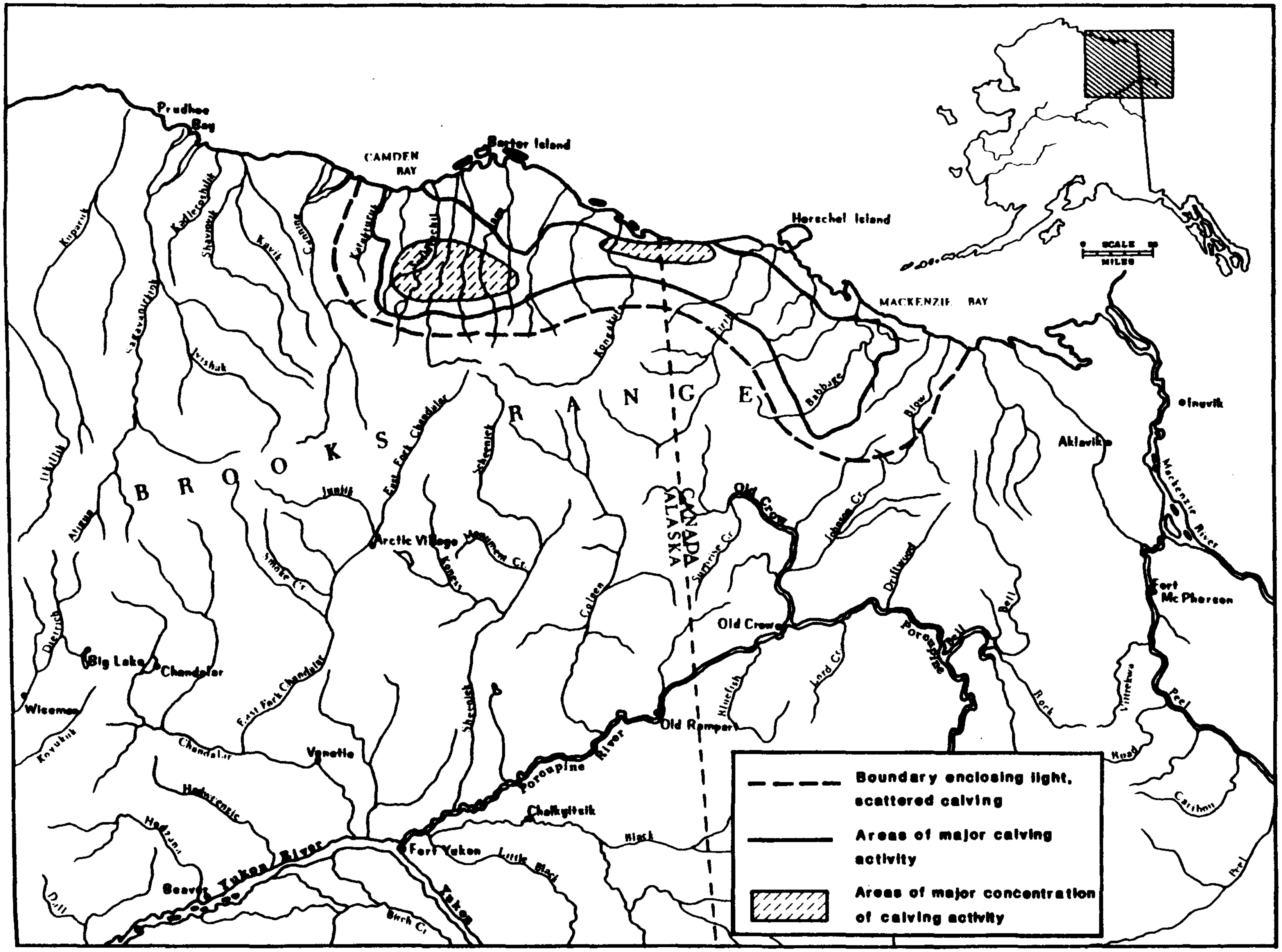
Map 3. Calving grounds of the Porcupine Herd, 1973 (modified from USFWS 1982).



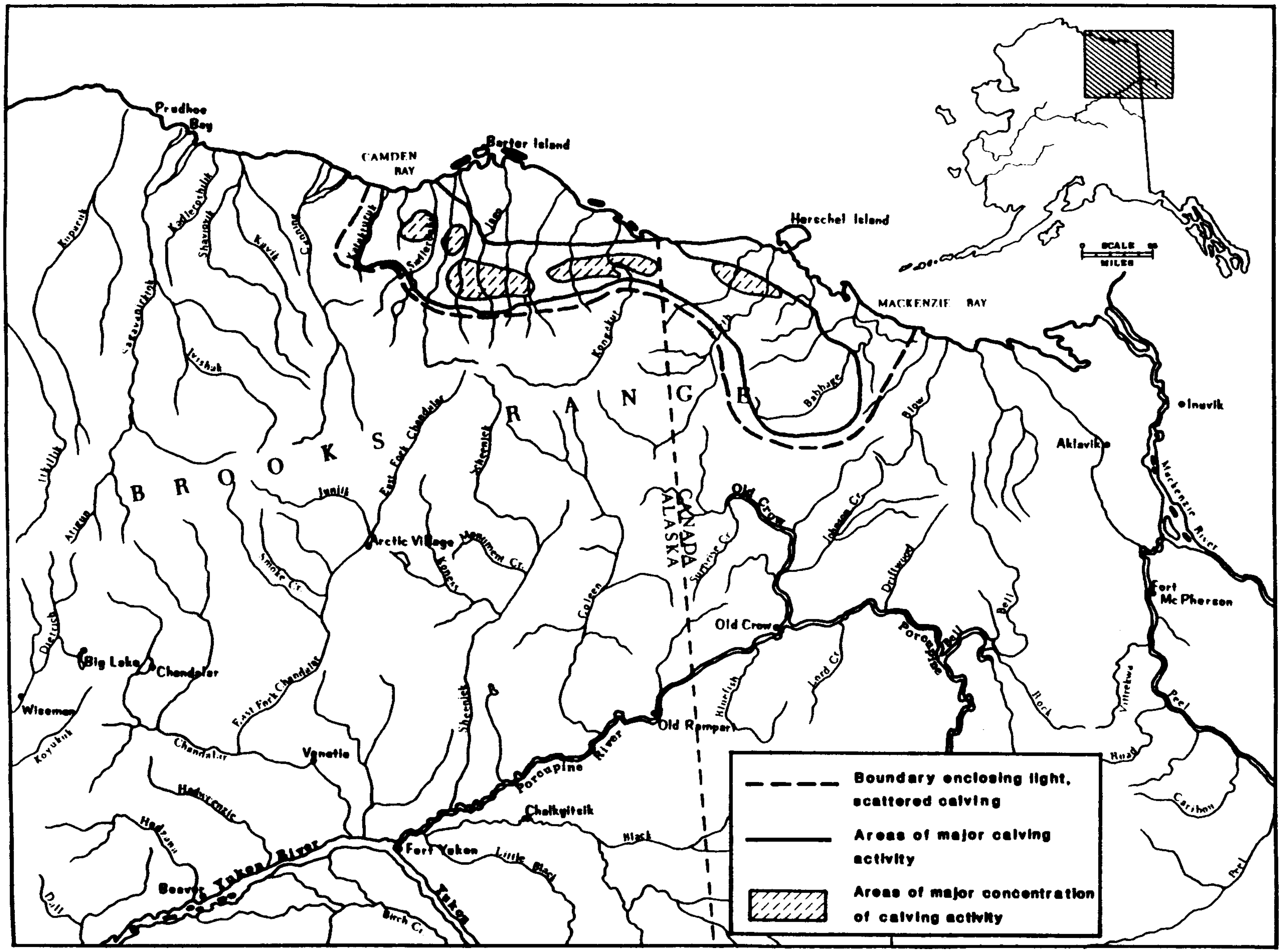
Map 4. Calving grounds of the Porcupine Herd, 1974 (modified from USFWS 1982).



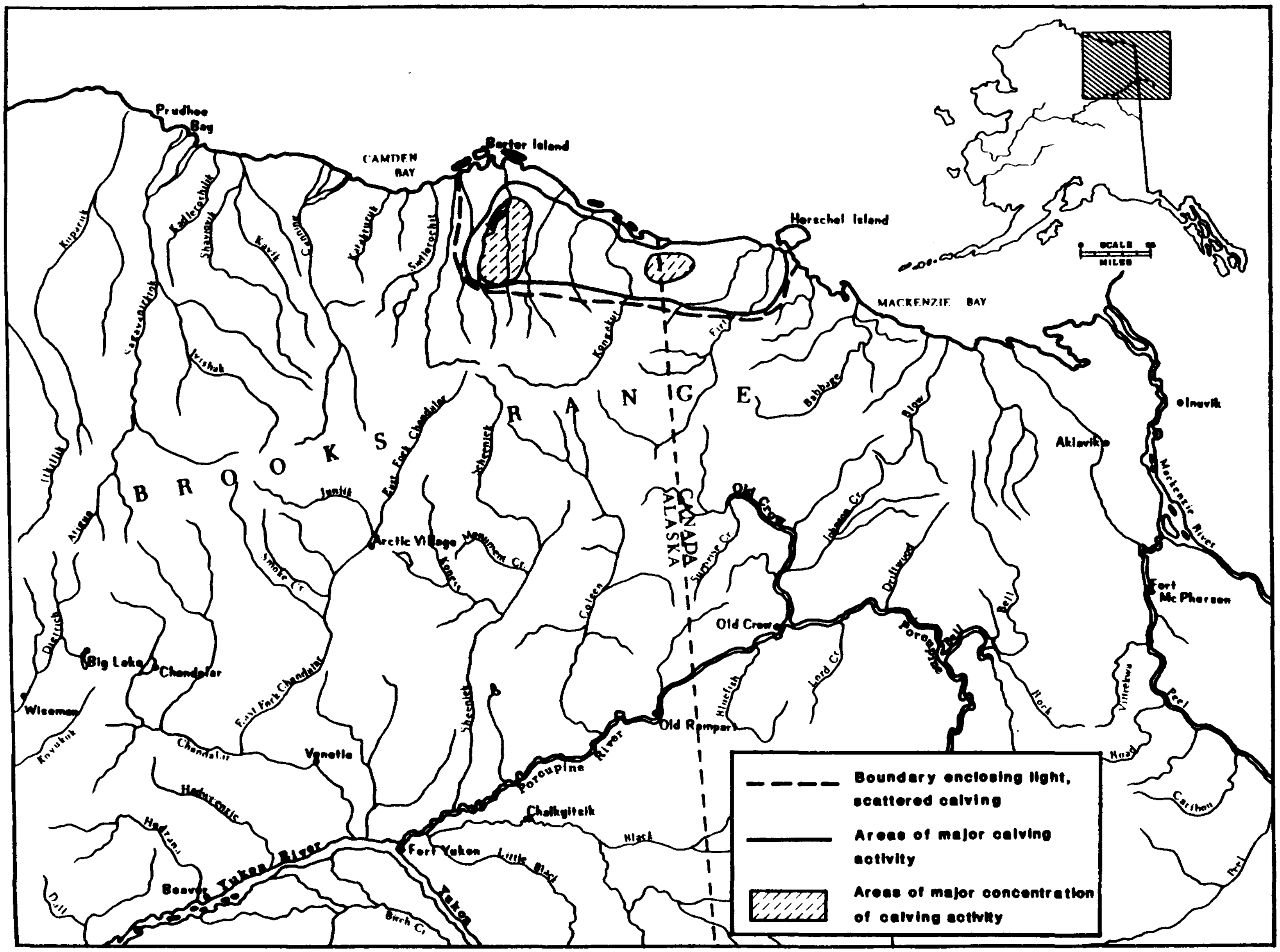
Map 5. Calving grounds of the Porcupine Herd, 1975 (modified from USFWS 1982).



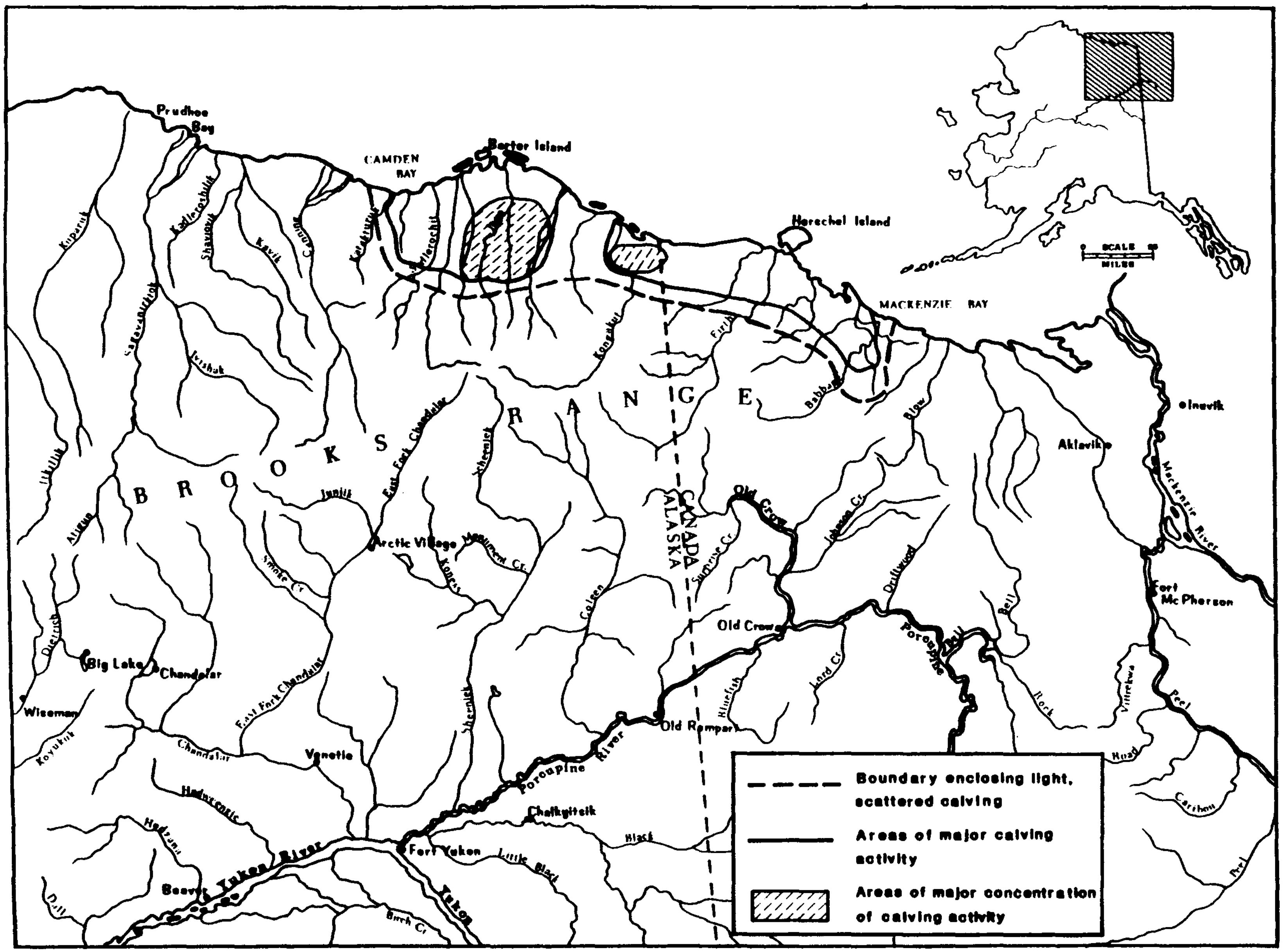
Map 6. Calving grounds of the Porcupine Herd, 1976 (modified from USFWS 1982).



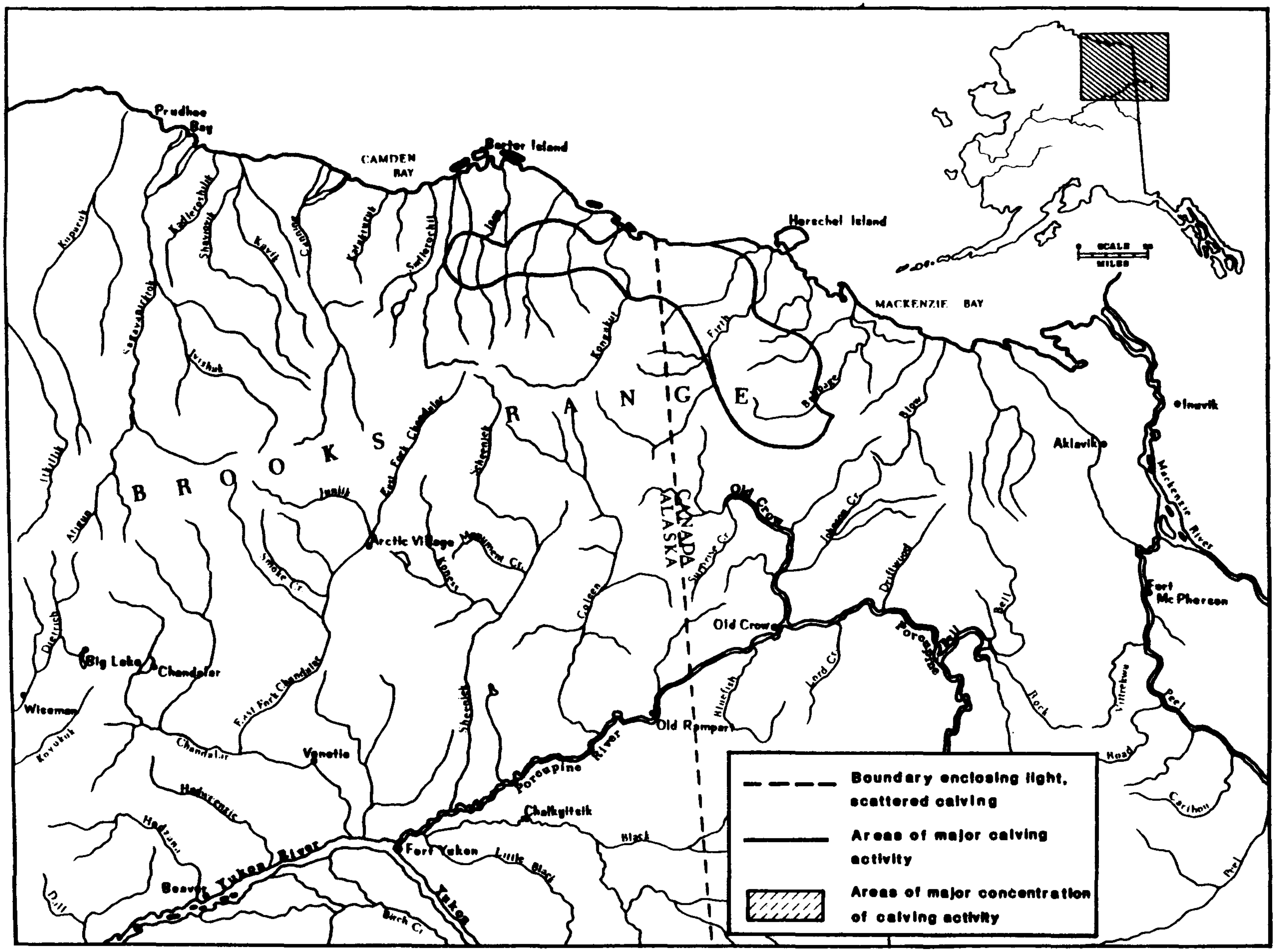
Map 7. Calving grounds of the Porcupine Herd, 1977 (modified from USFWS 1982).



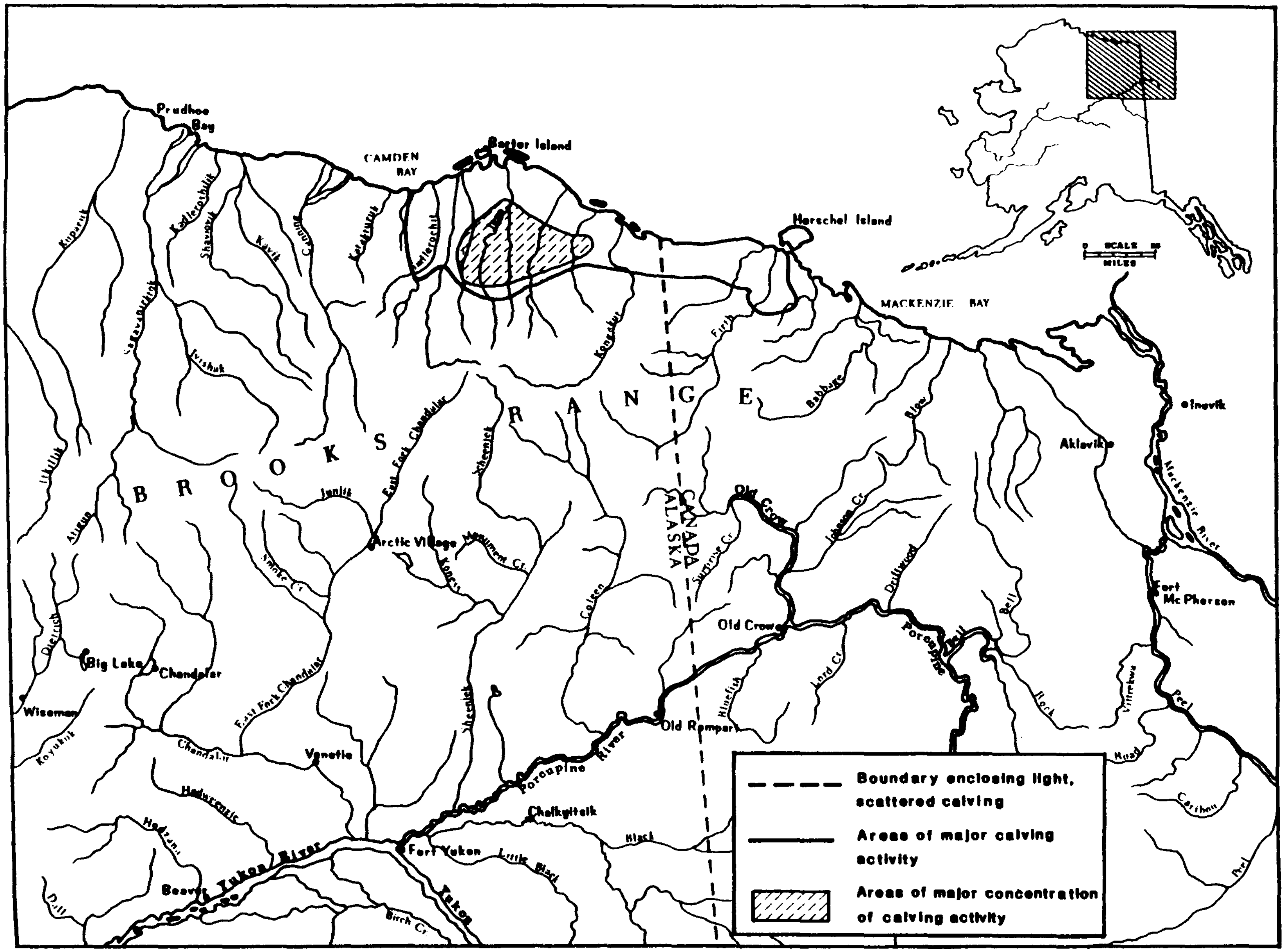
Map 8. Calving grounds of the Porcupine Herd, 1978 (modified from USFWS 1982).



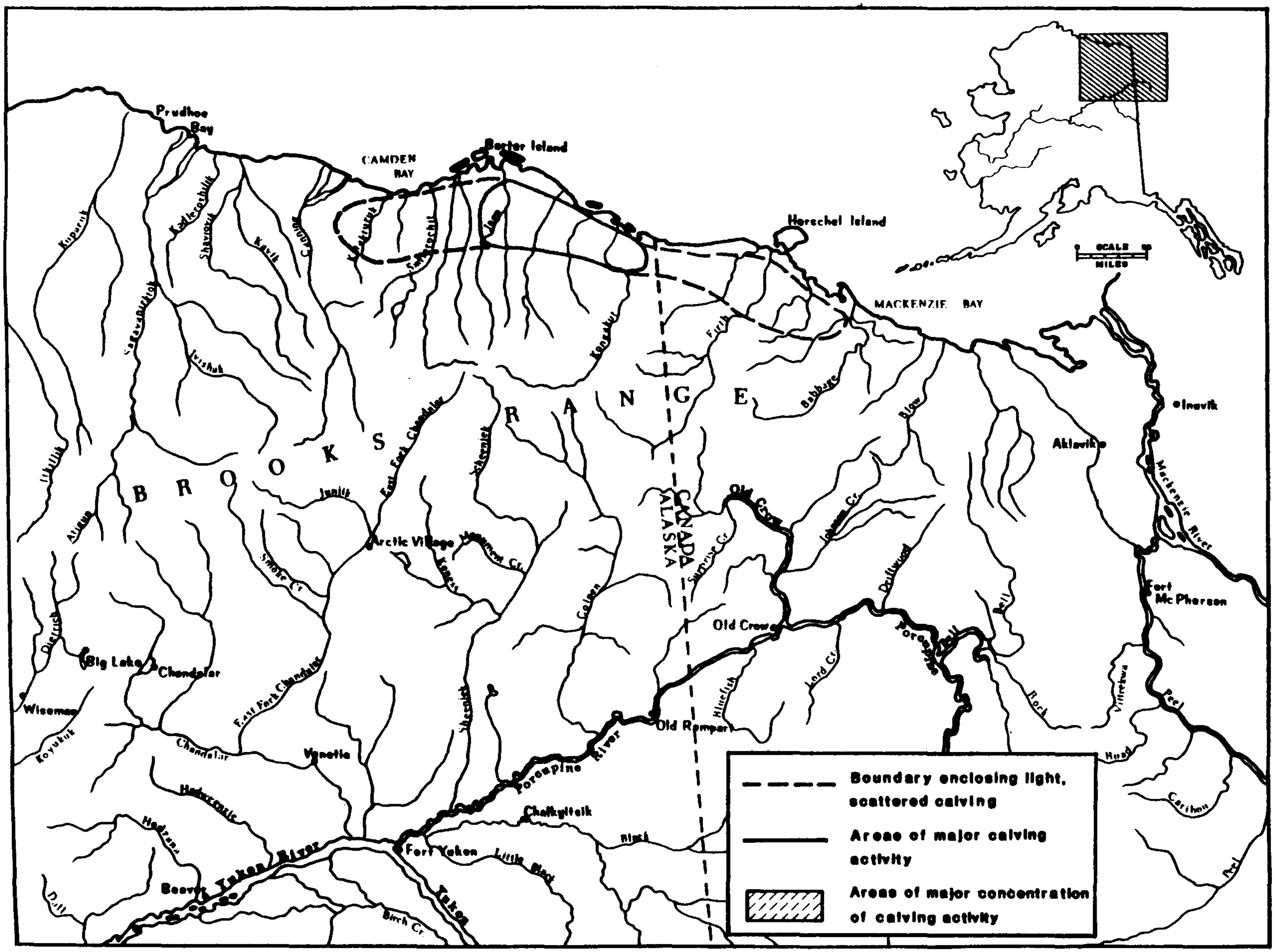
Map 9. Calving grounds of the Porcupine Herd, 1979 (modified from USFWS 1982).



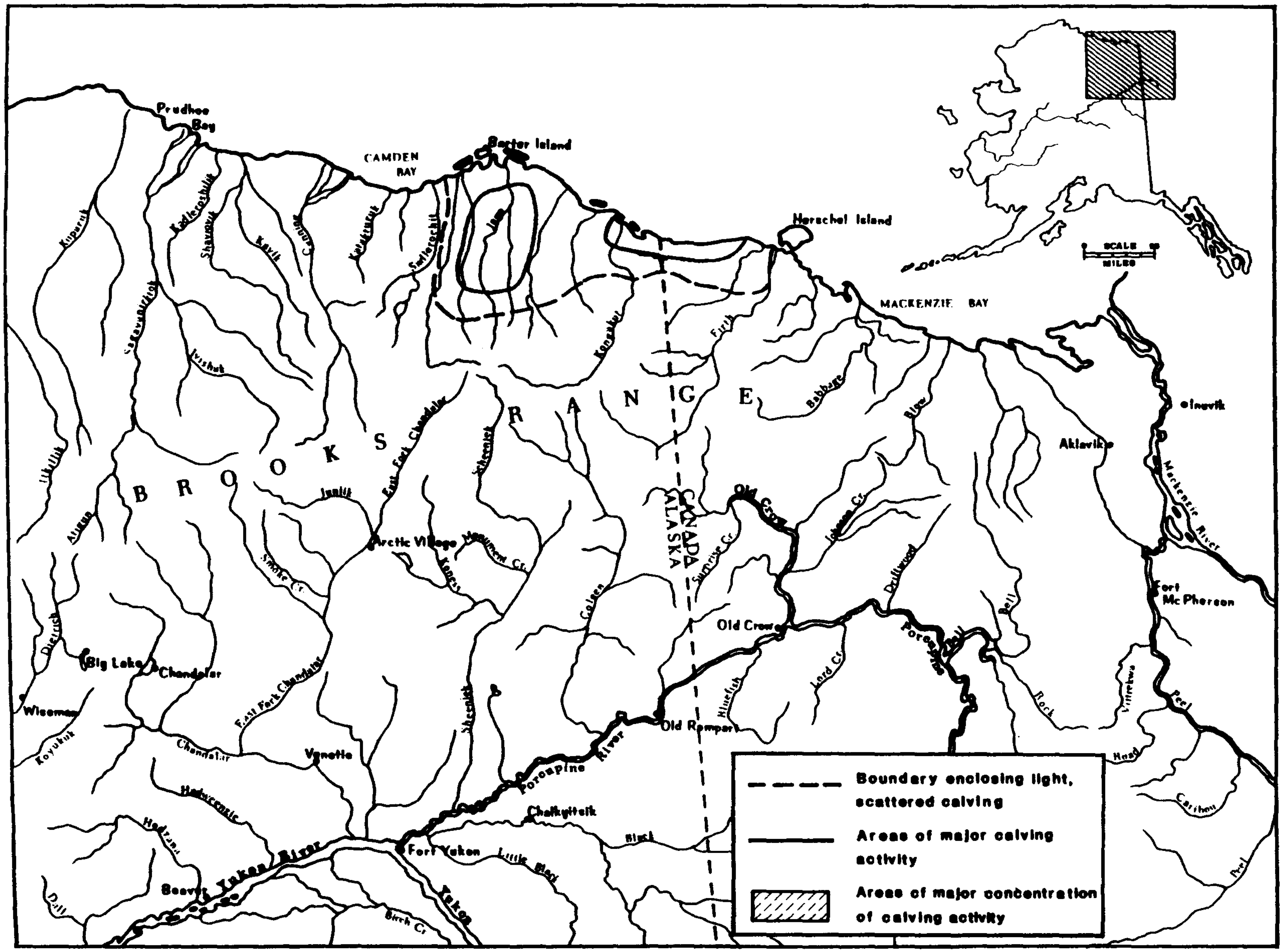
Map 10. Calving grounds of the Porcupine Herd, 1980 (modified from USFWS 1982).



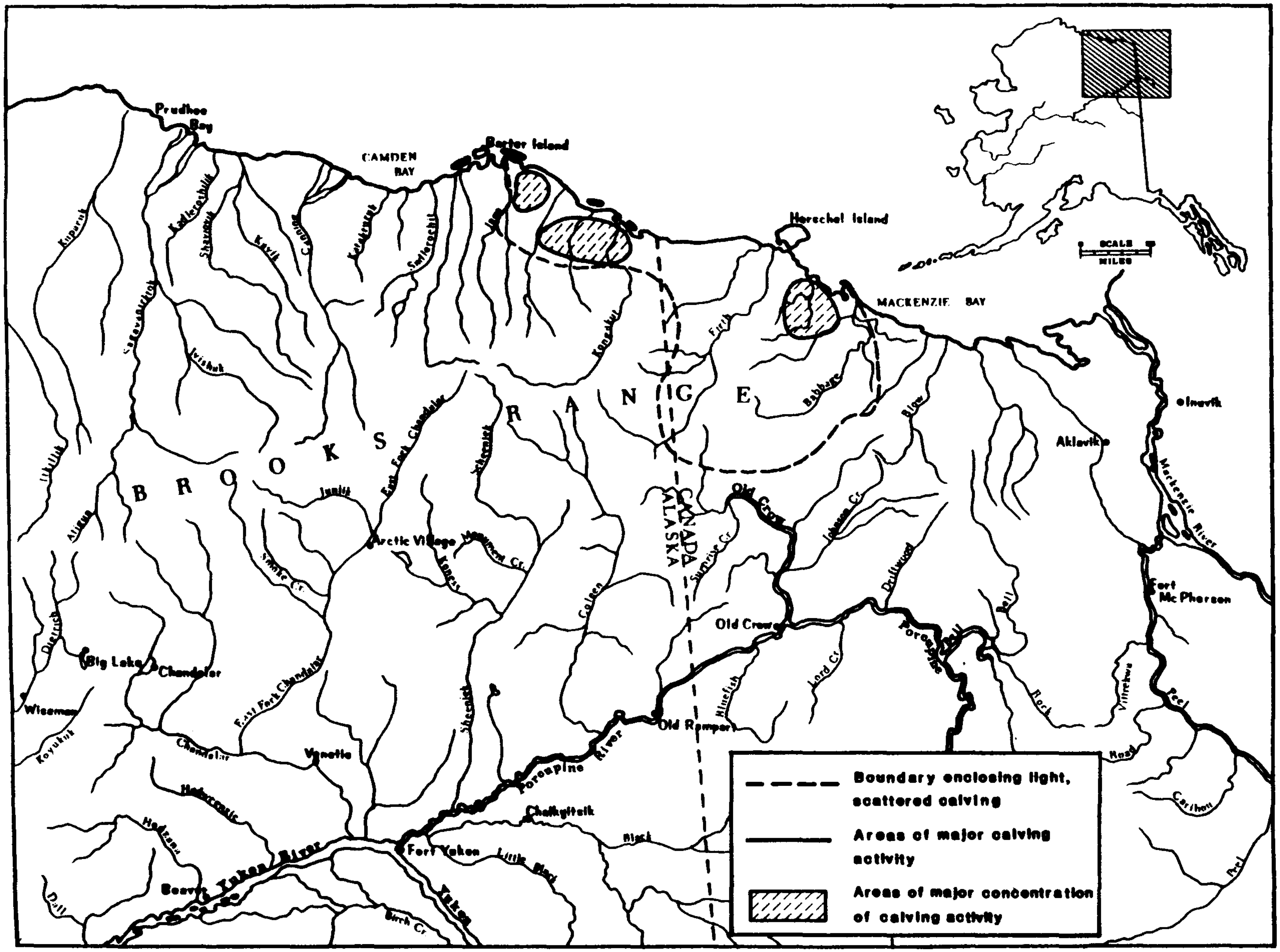
Map 11. Calving grounds of the Porcupine Herd, 1981 (modified from USFWS 1982).



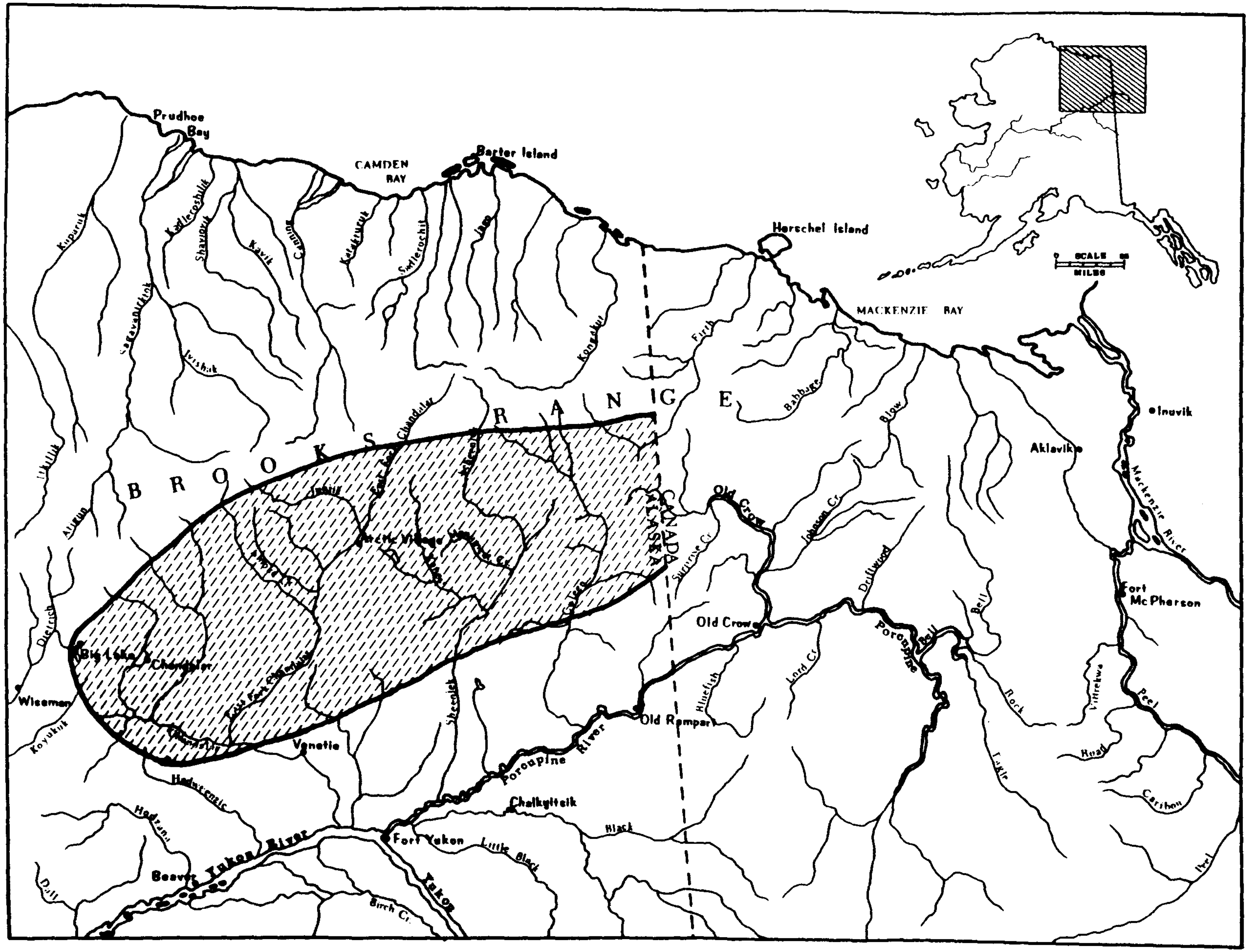
Map 12. Calving grounds of the Porcupine Herd, 1982 (from Whitten and Cameron 1983).



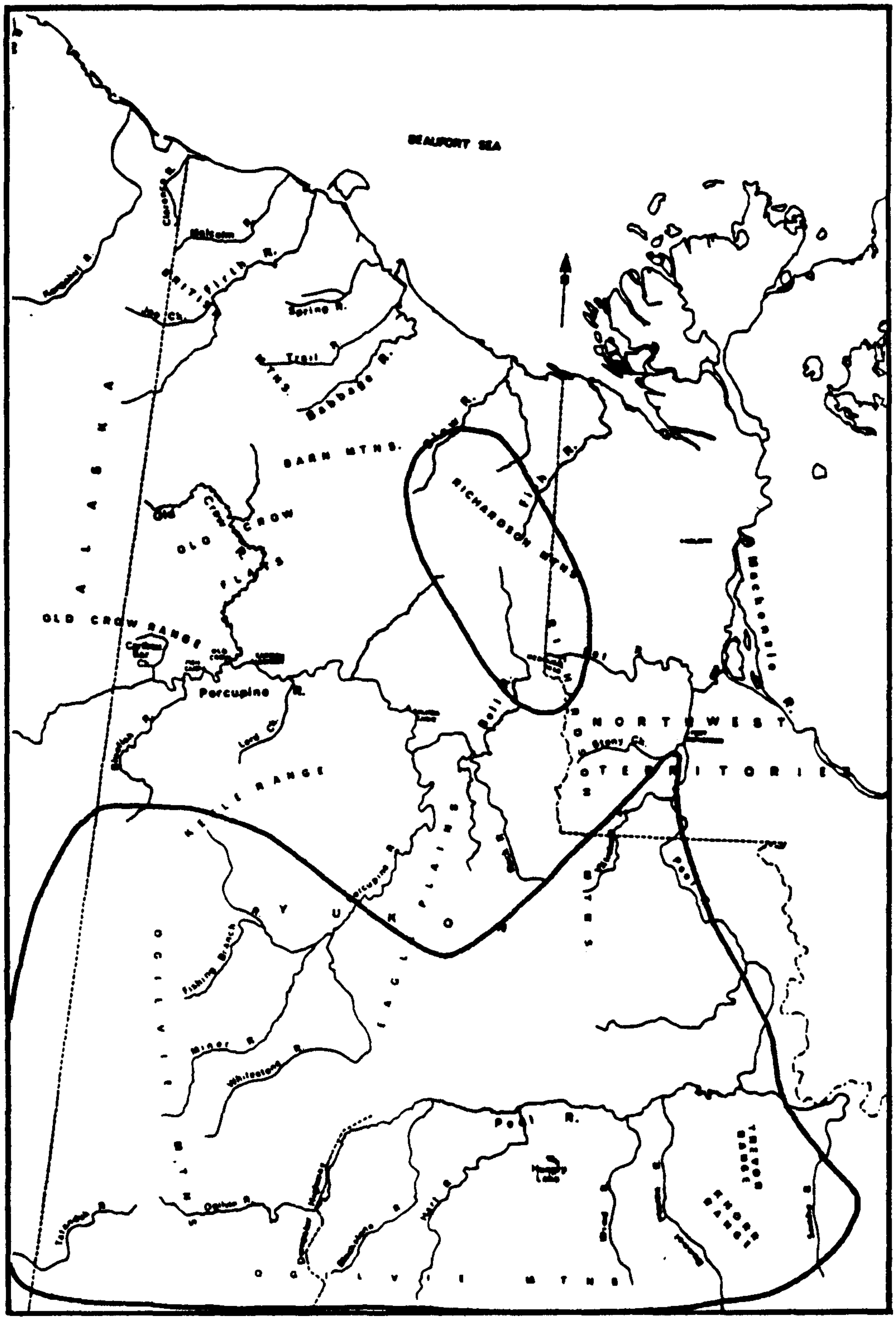
Map 13. Calving grounds of the Porcupine Herd, 1983 (from Whitten et al. 1984).



Map 14. Calving grounds of the Porcupine Herd, 1984 (from Whitten et al. 1985).



Map 15. Primary winter range of the Porcupine Herd south of the Brooks Range in Alaska (Whitten pers. comm.).



Map 16. Principal Canadian wintering areas for the Porcupine Caribou Herd, (1972-1980) (adapted from USFWS 1982, Whitten pers. comm.).

periodic invasions of moist tropical air) and low wind speeds. Otherwise, caribou tend to move to areas where acceptable snow conditions are present. However, many Alaskan herds use areas where high winds blow snow away (Whitten, pers. comm.).

Table 1 describes annual use of wintering areas within Alaska. In most years since 1971, 20 to 40% of the PH has wintered in Canada (Whitten, pers. comm.). In the winter of 1972-1973, however, 50,000-60,000 caribou were found in the vicinity of the East Fork of the Chandalar River, with dense concentrations near Arctic Village (Roseneau and Stern 1974). Table 1 and map 15 point out the extensive geographic area of the wintering grounds in Alaska and the large amount of variability in annual use of each of these areas. Use of specific wintering areas may be influenced by snow conditions or may also be a function of the migration route taken in the fall (Whitten and Cameron 1982).

c. Insect relief habitat. Literature describing caribou-insect interactions and insect relief habitats has been reviewed by Pank et al. (1984) as part of a study of the spatial and temporal distribution of insects on the ANWR and how they influence PH caribou distributions. Preliminary conclusions from 1984 data indicate that the coastal insect relief habitat zone extended at least 7.5 km (4.5 mi) inland during summer 1984 and provided the greatest relief from harassment (Pank et al. 1985). Areas of low mosquito activity occurring within riparian corridors, especially gravel bars and *Dryas* river terraces, also provide insect relief to caribou (ibid.). Mosquitoes emerged earlier in the foothills than on the coast (ibid.). The level of mosquito activity increased from the coast to the foothills (ibid.). The period of mosquito activity during a day was shorter on the coast than on the plains (ibid.).

2. Central Arctic Herd (CAH):

a. Calving areas. Until 1978, the detailed delineation of the CAH calving grounds was unknown. Gavin (1979) identified two calving concentration areas between 1969 and 1977, one near the coast between the Shaviovik and Canning rivers and another between the Colville and Kuparuk rivers. Very few calving females were observed by Gavin in the coastal portion of the area between the Kuparuk and Sagavanirktok rivers. Cameron and Whitten (1978) also noted the scarcity of neonatal calves in that region. Calving activity has also been observed in the White Hills and Franklin Bluffs areas (Gavin 1979, Cameron et al. 1983).

Table 1. Annual Variation in Use of Alaskan Wintering Areas for the Porcupine Caribou Herd, 1970-84

Winter Range Area	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79[a]	1979-80[a]	1980-81	1981-82	1982-83	1983-84
Chandalar R.-Skeenjek R. (Arctic Village area)	1,000	1,400-2,500	30-40,000	10,000	10-15,000	---	100	100-1,000+	---	---	20,000	20,000	10,000	20-40,000
Coleen R. drainage	---	---	1,000+	1,200-2,400	16	---	200	1,000-1,500	---	---	---	Several 100's	---	---
Upper Hodzana R.	---	900	2-3,000	---	---	---	---	---	---	---	---	---	---	---
Arctic slope	---	2-400	Few 100's	1-2,000	200	---	---	---	---	---	---	---	---	---
Estimated total in Alaska	1,000	2,500-4,000	50-60,000	13-14,000	10-15,000	3,000	300	2,400	---	---	20,000	20,000+	10,000	21-41,000

Sources: Roseneau and Stern 1974; Roseneau et al. 1974; Roseneau et al. 1975; Curatolo and Roseneau 1977; Thompson and Roseneau 1978 (as cited in USFWS 1982); USFWS 1982, 1983, 1985; Whitten 1981, 1984a.

--- means no data were available. (Assumption is made that significant numbers of caribou were not present in this area.)

A No data were available at all upon which to make any assumptions as to the possible presence of caribou in significant numbers in these wintering areas.

Lower density calving concentrations have been observed in several inland areas by Cameron et al. (1983) and Lawhead and Curatolo (1984):

- Low hills east of the Kavik River, approximately 30-40 km south of Mikkelsen Bay
- Low hills between Franklin Bluffs and the Kadleroshilik River
- A well-drained, hilly area near the head of the Milveach River drainage

The density of calving caribou diminished greatly beyond 40 km from the coast.

During June 1969-1977, more than 80% of all caribou observed by Gavin were east of the Sagavanirktok River. The distribution of calving caribou using the coastal plain is greatly influenced by spring weather patterns. In 1978 and 1980, for example, years of substantial snow/ice cover and extensive spring flooding in the coastal plain, low numbers of caribou were found in coastal calving areas (Cameron and Whitten 1979b, Cameron et al. 1981). In 1979 and 1981, however, coastal areas, well-drained and snow-free, were heavily used for calving (Cameron and Whitten 1980, Cameron et al. 1983). The relative distribution of caribou using these calving areas has remained constant over time, with caribou numbers greatest in the Kuparuk and Canning rivers calving areas and only minimal use being made of the Prudhoe Bay area (Cameron et al. 1981).

From 1981 to 1983, the largest concentrations of calving activity occurred on or immediately west of the Canning River delta, northwest of Franklin Bluffs, and between Oliktok Point and the northern White Hills (Carruthers et al. 1984, Whitten and Cameron 1985). Roby (1978) noted that bulls prefer seral riparian habitats and speculated that the difference in behavior was due to the increased susceptibility of calves to predation in riparian areas.

When cows arrive on the coastal plain between late April and early June, very little nutritious forage is available, and snow is usually deeper than in the foothills. Males tended to move north following the phenological development of nutritious food plants, primarily <u>Eriophorum</u> spp. buds, and remained in areas with less snow cover than females. Whitten and Cameron (1980b) also reported that males followed the vegetation phenology more closely than females by moving with the northward shift of the peak in forage quality from late May to early July. This delayed northward movement allows bulls to arrive at the coast (insect relief areas) at the time of mosquito emergence (Roby 1978). The increased vulnerability of calves born in the foothills to wolf predation and the availability of nearby insect relief areas may cause parturient cows to favor coastal areas for calving, even though the foothills may have less snow and more forage.

b. Wintering areas. The CAH generally winters in the northern foothills of the Brooks Range. More favorable snow conditions and greater forage availability apparently dictate this pattern of winter distribution (Roby 1978). However, overwintering use of the coastal plain by small numbers of caribou is common, and, occasionally, large numbers have wintered in areas normally considered summer range (Cameron and Whitten 1978, Skoog 1968).

As many as 300 caribou may winter near the arctic coast around Prudhoe Bay (White et al. 1975). This area was considered to have a low winter carrying capacity. The option of nonmigratory behavior could involve a trade-off of lower forage quality for the reduced energy expenditures of a comparatively sedentary existence. Surveys by Cameron and Whitten (1976) indicated approximately 400 caribou were year-round residents of the coastal area. The use of coastal tundra for winter range in other geographic areas is well documented (Kelsall 1968, Roseneau et al. 1975, Jakimchuk 1980, Carruthers and Jakimchuk 1981). During the winter of 1958, Olson (1959) reported a concentration of 150,000 caribou occupying the "Central Arctic Region." Approximately 30% of these animals were located in coastal areas near the Sagavanirktok River. We cannot document whether this concentration was a rare event or an extension of summering in that area.

In the winter of 1973-1974, Roseneau et al. (1975) observed early winter concentrations of caribou in the upper Kavik and Juniper Creek drainages. Late winter use was observed in the hills surrounding the upper Juniper Creek, Pagopuk Creek, and Kavik River headwaters. It appeared that caribou were most concentrated in the foothill regions between the Canning and Kavik rivers and between the Sagavanirktok and Ivishak rivers.

c. Insect relief areas. Insects, primarily mosquitoes and oestrid flies, can profoundly influence the distribution of caribou (Curatolo 1975). Insect emergence occurs first in the foothills of the Brooks Range and progresses northward to the coast (Roby 1978). Mosquitoes are usually active on the arctic coastal plain from very late June through early August, and oestrid flies are present from mid July through late August (White et al. 1975, Roby 1978, Murphy 1984).

Insect activity, especially mosquitoes, varies directly with ambient temperature and inversely with wind velocity (White et al. 1975).

During periods of severe insect harassment, CAH caribou move rapidly upwind to coastal sand dunes and beaches, sand or gravel bars, river deltas, shorefast ice, barrier islands, and promontories. Coastal areas often include areas of sparce vegetation and offer cool onshore winds. Caribou (mainly bulls) located farther inland seek relief on permanent or existing snow patches, areas of aufeis, and river gravel bars (Carruthers et al. 1984, Skoog 1968, Roby 1978). Preferred mosquito relief areas are characterized by scarce or nonexistent vegetation (Roby 1978). Thus, caribou tend to avoid lake edges and sedge-grass marshes where mosquitoes are most numerous. Lawhead and Curatolo (1984) and numerous other biologists found that during periods of severe mosquito harassment, caribou used river deltas, especially the Kuparuk, Shaviovik, and Canning deltas.

According to Cameron (pers. comm., cited in ADF&G 1981) and Lawhead and Curatolo (1984), most mosquito relief areas occurred within 3.2 km (2 mi) of the coast. The exact location, however, depends on the severity of harassment (Whitten, pers. comm.).

Although there is considerable overlap of the mosquito and oestrid fly seasons, making distinctions between the responses of caribou to these two insects is difficult. Nevertheless, by late July, oestrid flies replace mosquitoes as the dominant insect pest. There is minimal effective oestrid fly escape terrain on the coastal plain (Roby 1978). Thus, caribou tend not to aggregate in the coastal area and disperse inland into small groups to unvegetated gravel bars or varied elevated sites, such as pingos, ridges, banks, and gravel pads (Lawhead and Curatolo 1984). During oestrid fly season, the mean distance from the coast of radio-collared caribou locations was 30 km (18.6 mi), as compared with 7 km (4.1 mi) throughout the mosquito season and 3 km (1.7 mi) when mosquitoes were actually present (ibid.).

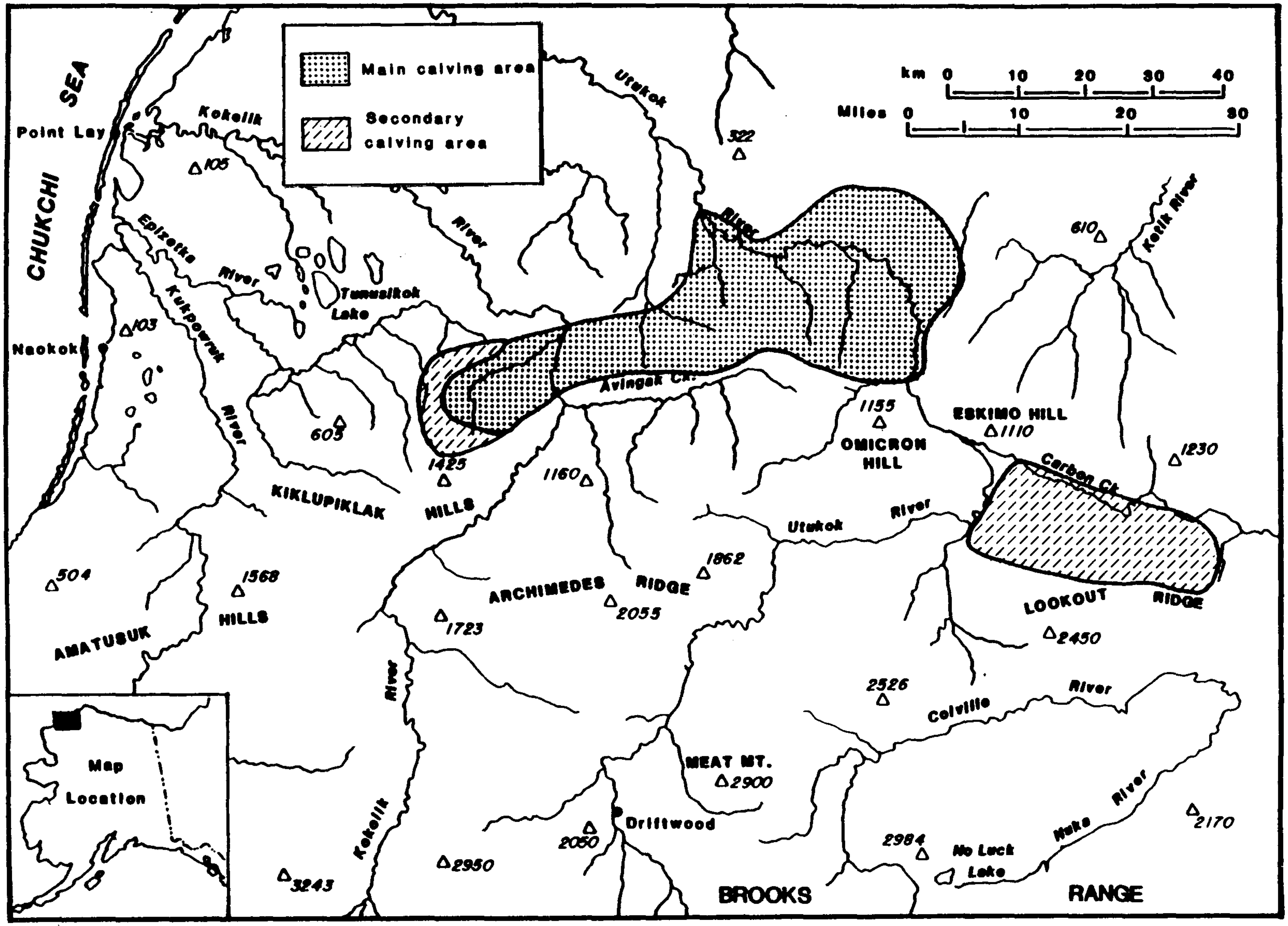
3. Western Arctic Herd (WAH):

   a. Calving areas. The primary calving area for the WAH consists of the middle and upper Utukok River, the middle Kokolik River, and the headwaters of the Ketik and Colville rivers. This area, referred to as the Utukok calving grounds (UCG), has been used consistently for calving since the late 1800's (Lent 1966, Skoog year 1978 established a calving peak around June 6-8. Anderson and James (1984) reported a calving peak occurring sometime prior to June 9 during the 1982 and 1983 calving seasons. In 1985, the calving peak was reached prior to June 6 (Anderson, pers. comm.). By mid June 1978, WAH caribou moved to the southwest to the upper Kokolik River, as had frequently occurred in previous years, where many barren cows, yearlings, and bulls join the cow-calf segment (Davis and Valkenburg 1979). In most years, WAH caribou move from the calving grounds in a counter-clockwise direction toward the Lisburne Hills and then southwest along the foothills of the Brooks Range (Anderson, pers. comm.).

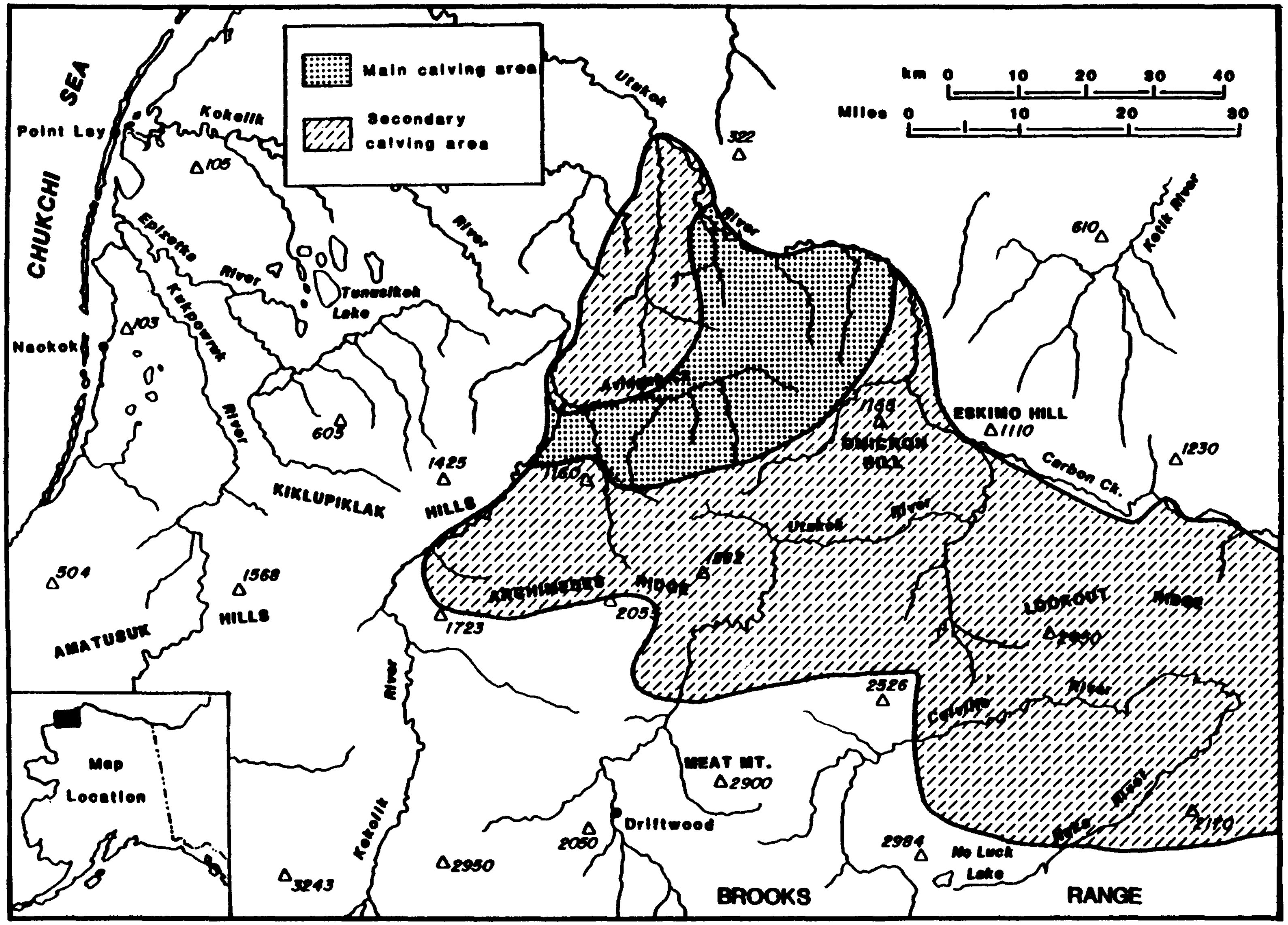
Maps 17-23 describe annual use of the UCG from 1975 to 1982. Valkenburg et al. (1983), Anderson and James (1984), and Anderson (1985) also describe use of the UCG in greater narrative detail.

b. Wintering areas. Since the early 1970's, the three most frequently used wintering areas for the WAH have been the Selawik Flats-Buckland River area (including the Selawik Hills and portions of the eastern Seward Peninsula), the arctic coastal plain, and the central Brooks Range (Davis et al. 1982). Prior to 1945, the WAH generally wintered north of the Baird Mountains and on the coastal plain (Skoog 1968). Since the late 1940's, varying portions of the herd have wintered in an area south of the Brooks Range, from the Waring Mountains and lower Koyukuk River eastward to the Wiseman area (ibid.). Skoog thought that increasing population size caused the herd to fragment, resulting in the utilization of several wintering areas and expansion of the existing range to the south and east. Valkenburg et al. (1983) reported that regular winter use of the Buckland River-Selawik drainage began in 1955. The majority (ca. 150,000) of caribou still wintered north of the range, on the coastal plain and in the foothills, particularly in the Etivluk-Chandler rivers area, during the winters of 1956-1957 and 1957-1958. Davis and Valkenburg (1978), however, still stated that since 1950 the Selawik area (Selawik Hills, Selawik Flats, and Buckland lowlands) has been the most important wintering area for the WAH.

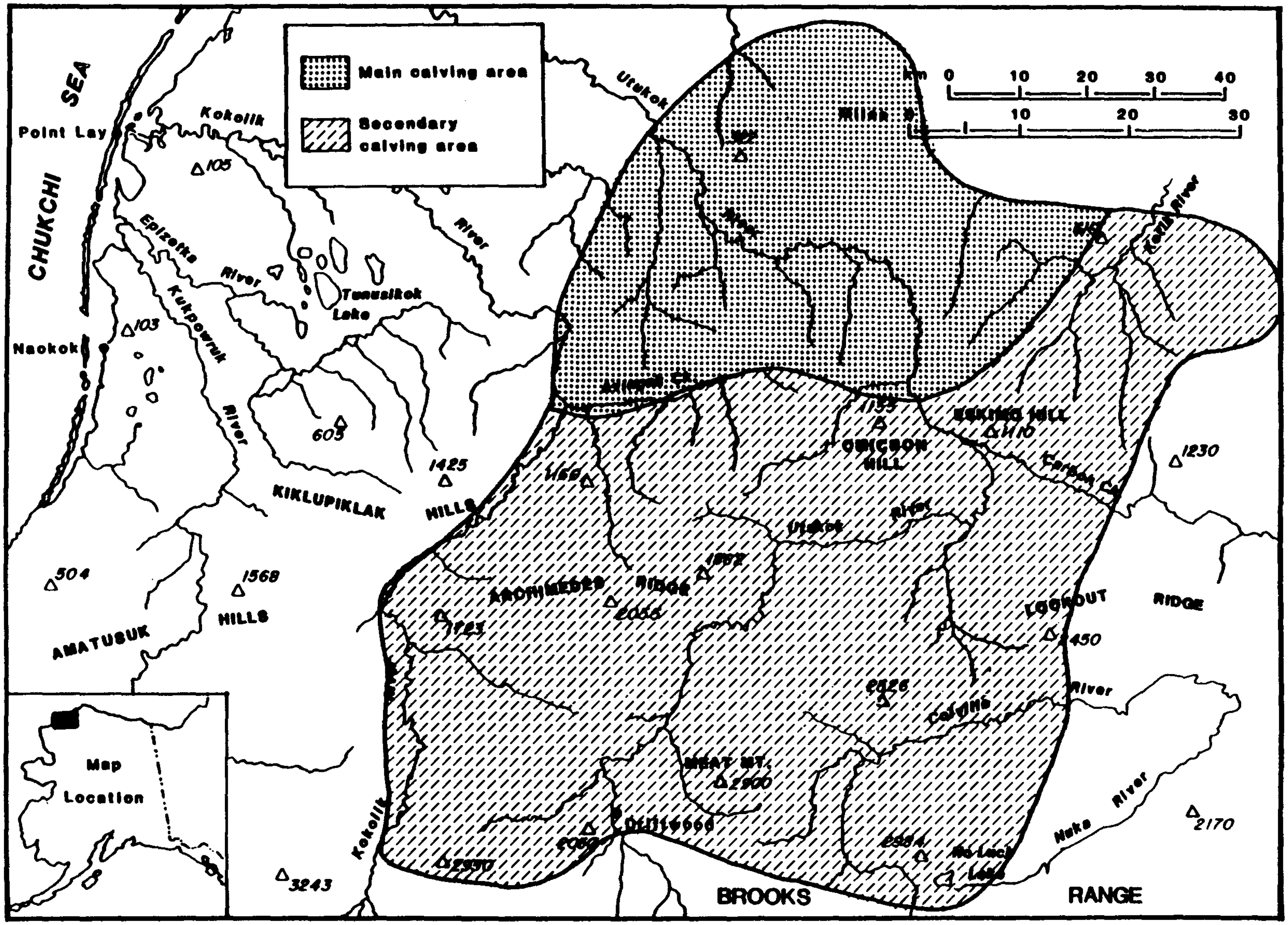
The WAH wintering area south of the Brooks Range (actually south of the Kobuk River) does include the northern edge of the boreal forest zone. It is generally a semiopen area of broad, lowland flats, lake-dotted plains, compact groups of hills, ridges, and low mountains surrounded by rolling plateaus (Hemming 1971), and, in most years, relatively free of snow. Caribou feed on horsetails (*Equisetum* sp.), sedges (*Carex* sp.),



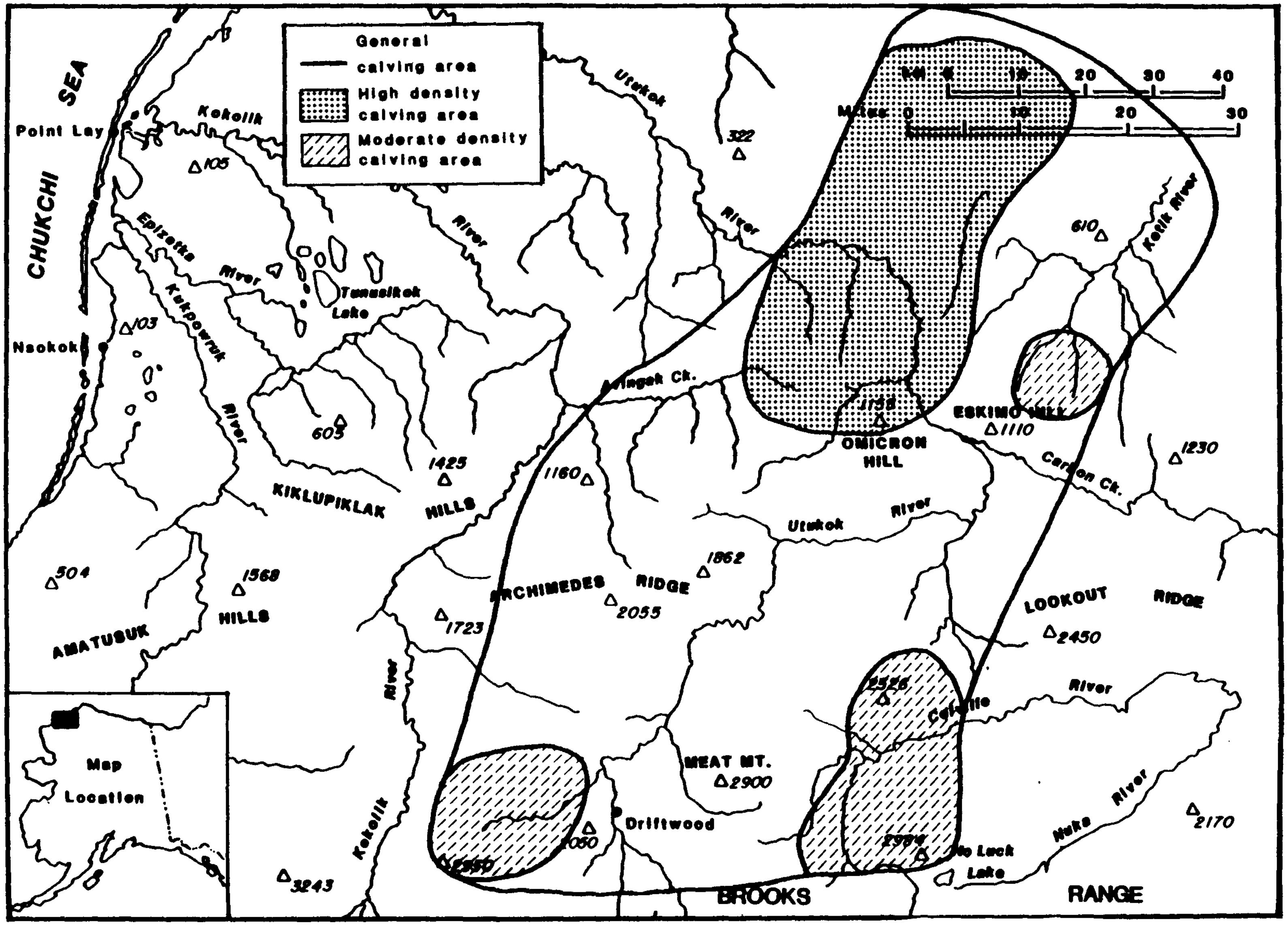
Map 17. Calving areas of the Western Arctic Herd, 1975 (from Valkenburg et al. 1983).



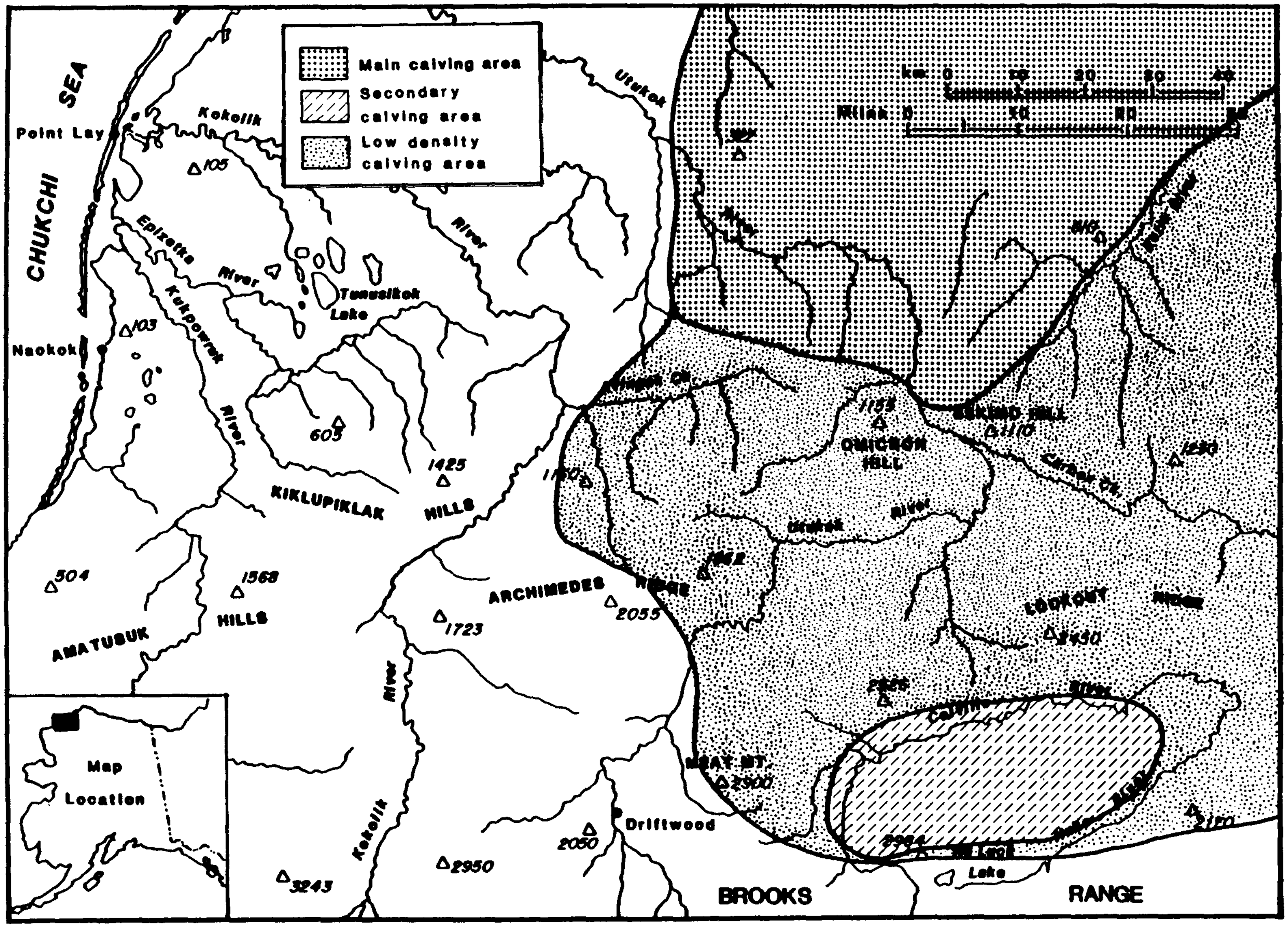
Map 18. Calving areas of the Western Arctic Herd, 1976 (from Valkenburg et al. 1983).



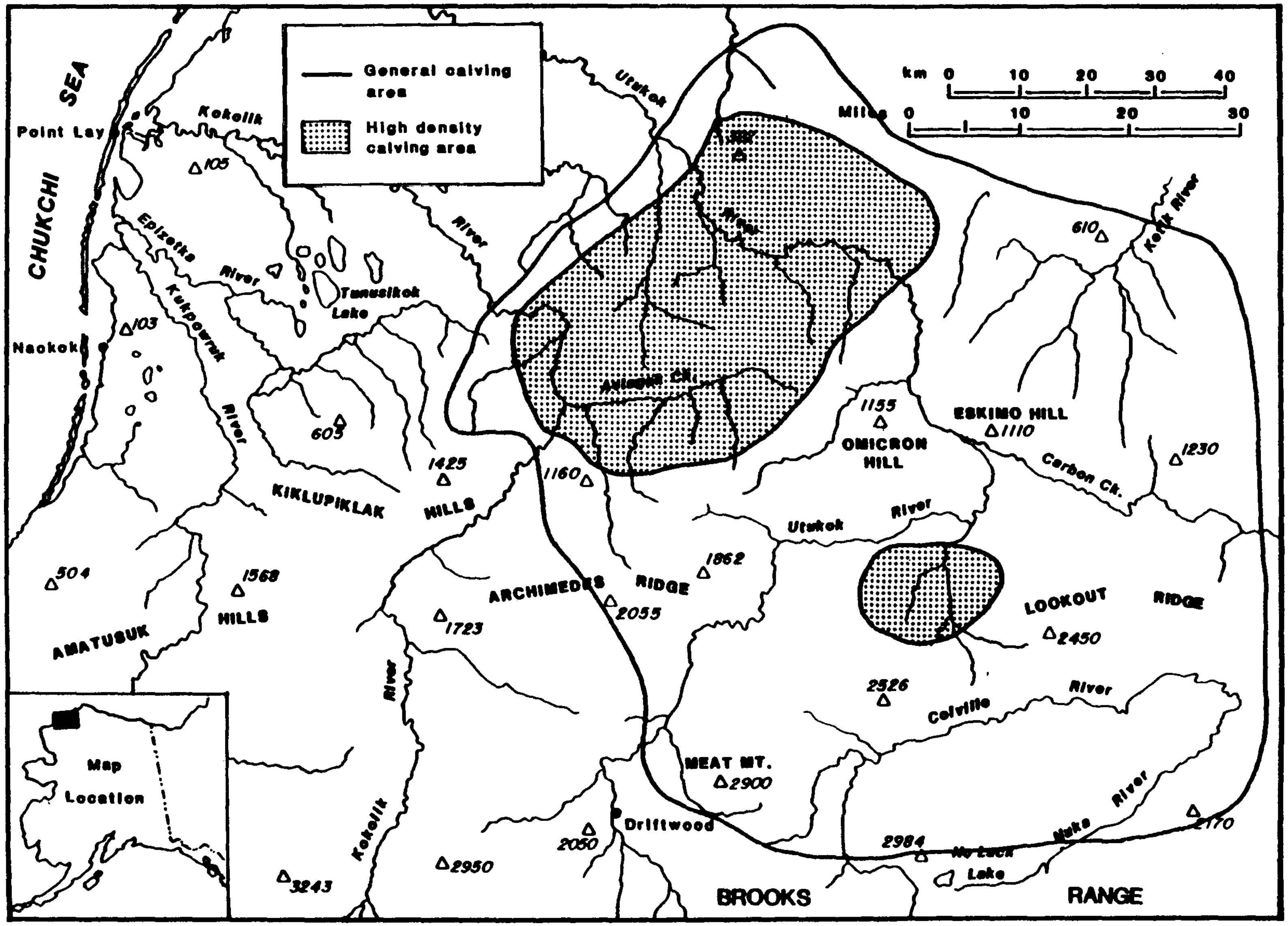
Map 19. Calving areas of the Western Arctic Herd, 1977 (from Valkenburg et al. 1983).



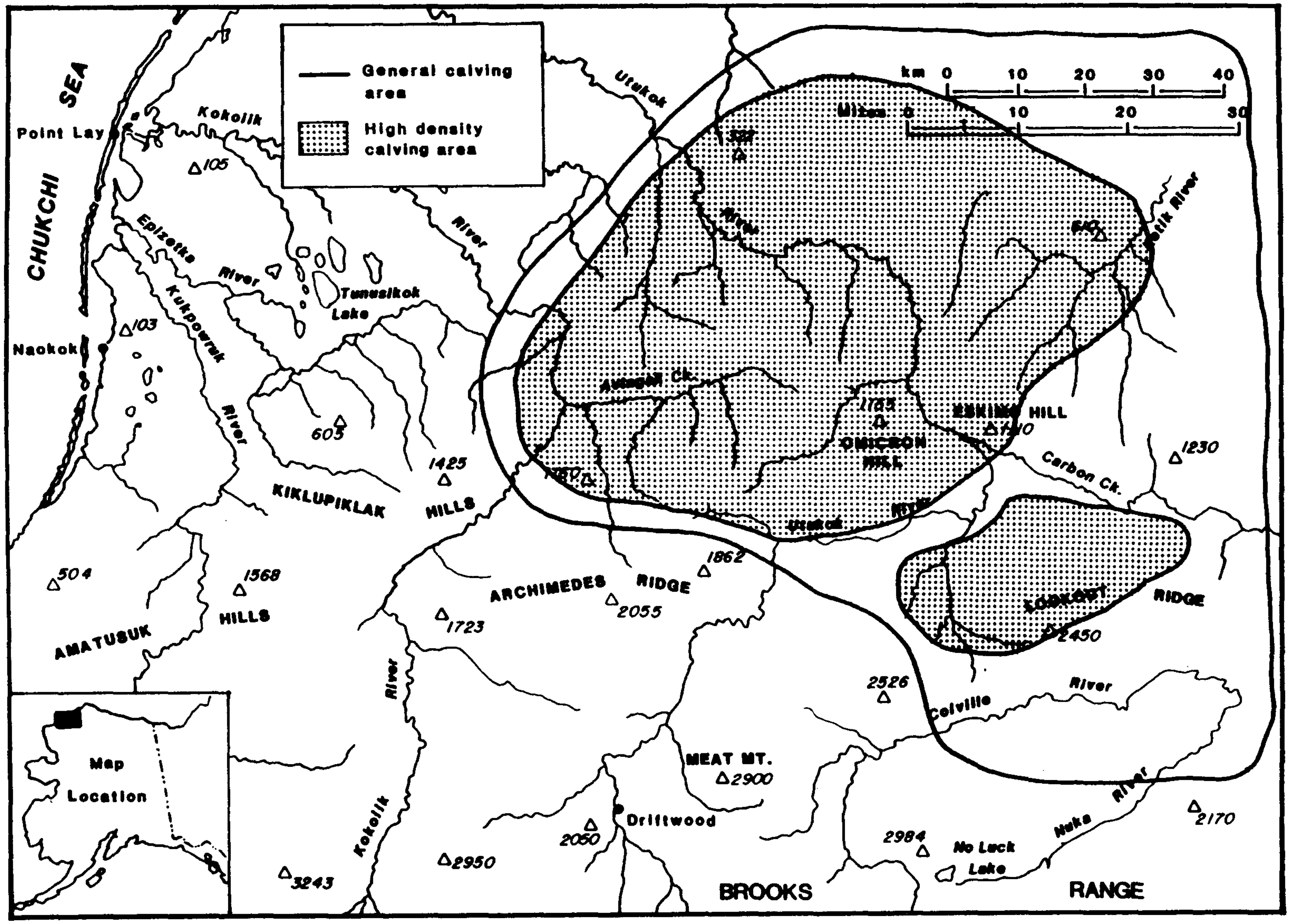
Map 20. Calving areas of the Western Arctic Herd, June, 1978 (from Davis and Valkenburg 1979).



Map 21. Distribution of calving for the Western Arctic Herd, 1979 (from Valkenburg et al. 1983).



Map 22. Distribution of calving of the Western Arctic Herd, 1980 (Valkenburg et al. 1983).



Map 23. Distribution of calving of the Western Arctic Herd, 1981 (from Valkenburg et al. 1983).

shrubs (primarily *Vaccinium* sp.) and lichens (*Cladonia* sp. and *Cetraria* sp.), which can be found on mountain slopes, lake margins, stream banks, marshy meadows, ridges, and windblown hills.

Valkenburg et al. (1983) concluded that WAH caribou prefer the windblown, open, wintering areas over the more forested taiga areas. This preference pattern is probably governed more by forage availability relative to snow conditions at a critical time period than by forage quantity or quality. Caribou may also be responding to greater predation pressure in forested environments. Biologists also noted that the geographic extent of range utilization depended upon herd size.

During the winter of 1982-1983, Anderson and James (1984) reported heavy concentrations of caribou in the upper North Fork of the Buckland River extending northward into the Mangoak River pass. Caribou occupied the entire area between the Tagagawik and Buckland rivers below the 75 m (250 ft) contour line. Radiotelemetry data indicated that WAH caribou were almost equally distributed in the three main wintering areas (table 2). It appeared, however, that caribou on the arctic coastal plain left that area and moved south into the northern foothills of the Brooks Range between the Killik River and Nanushuk River (Valkenburg et al. 1983, Anderson and James 1984). All surveyed portions of the upper Killik River drainage indicated intensive winter use. The Chandler-Anaktuvuk rivers area was heavily cratered, and the extensive network of trails suggested heavy winter use. In the following winter (1983-1984), range expansion and increasingly heavier use of the southern wintering area (particularly the eastern Seward Peninsula) continued (Anderson 1985). At least 20,000 animals wintered near Talik Ridge at the headwaters of the West Fork of the Buckland and the East Fork of the Koyuk River (ibid.). Another large group (several thousand) wintered in the area consisting of the headwaters of the Kateel, Ungalik, Inglutalik, and Buckland rivers (ibid.). A group of as many as 10,000 caribou were observed in the upper Koyuk River area east of Imuruk Lake on the Seward Peninsula. These movements suggest a trend of increasing use, range expansion, and westward movements onto the Seward Peninsula reindeer range. However, during the winter of 1984-1985, significantly fewer caribou occupied the eastern Seward Peninsula and southern ranges than in 1982 through 1984 (Anderson, pers. comm.).

Table 2. Winter Distribution of WAH Caribou, 1978 through 1985[a]

Year	Selawik/Kobuk	Central Brooks Range	Arctic Coastal Plain	Other Areas
1978-79	30	25	30	15
1979-80	50	20	20	10
1980-81	60	5	30	5
1981-82	20	10	40	30
1982-83[b]	30	30	30	10
1983-84	50	35	25	10
1984-85	17	7	47	30

Source: Anderson, pers. comm.

a Percentage data reflect the distribution of radiocollars and varied observations of wintering caribou.

b In February 1983, many caribou moved south from the coastal plain into the foothills.

c. Insect relief areas. There is insufficient published information to adequately describe insect relief habitat for the WAH.

4. Teshekpuk Herd (TU):

a. Calving areas. Most caribou calving activity occurred southwest of Teshekpuk Lake in 1976 and 1977 (Davis and Valkenburg 1979). In 1978, calving activity shifted to an area northeast of the lake (ibid.) and has remained in the area between the northeast shore of the lake, Cape Halkett, and the Kogru River since that time (Reynolds 1982, Silva 1985). In 1981, most calves had been born by June 11, and the majority of the cows had shed their antlers by this time (Reynolds 1982). Historical data indicate that the calving area southwest of Teshekpuk Lake was used during the 1930's and early 1940's (Silva 1985). Although the calving area northeast of the lake is considered more important now, this does not preclude the possibility that the area southwest of the lake could be used again in the future.

b. Winter use areas. Accurate winter distributions of the TH have not yet been determined. From September to April, many caribou radiate out from the Teshekpuk Lake area in easterly and westerly directions (Silva 1985). Radio-collared caribou from the TH have ranged as far west as Barrow but stay mainly around the Dease Inlet area (ibid.). Some caribou range as far east as the Fish Creek area, with many observations of TH caribou north and south of the lake (ibid.).

c. Insect relief areas. Sparsely vegetated river deltas, beaches, spits, lake margins, and lagoons are used from late June through late July to avoid insect harassment (Silva 1985). Since 1982, caribou have been observed using the following areas for insect relief: Ikpikpuk River delta, Kealok Creek delta, the shorelines north and south of the Kogru River east to Atigaru Point, and the Beaufort Sea coastline from Cape Halkett to Saktunic Point (ibid.).

B. Areas Used Seasonally and for Life Functions

See the 1:250,000-scale maps in the Reference Atlas, available in ADF&G offices, and the 1:1,000,000-scale Map Atlas to the Alaska Habitat Management Guide for the Arctic Region. The maps show the following categories:

- General distribution
- Known calving areas
- Known winter use areas
- Known migration patterns
- Known insect relief areas

C. Factors Affecting Distribution

The following factors appear to affect the distribution of caribou:

- Availability of insect relief areas
- Human activity (development projects, hunting)
- Predation
- Availability of preferred forage
- Winter conditions (duration, snow depth and hardness, temperature)
- Summer forest fires
- Population size of individual herds
- Domestic reindeer herding practices

D. Movements Between Areas

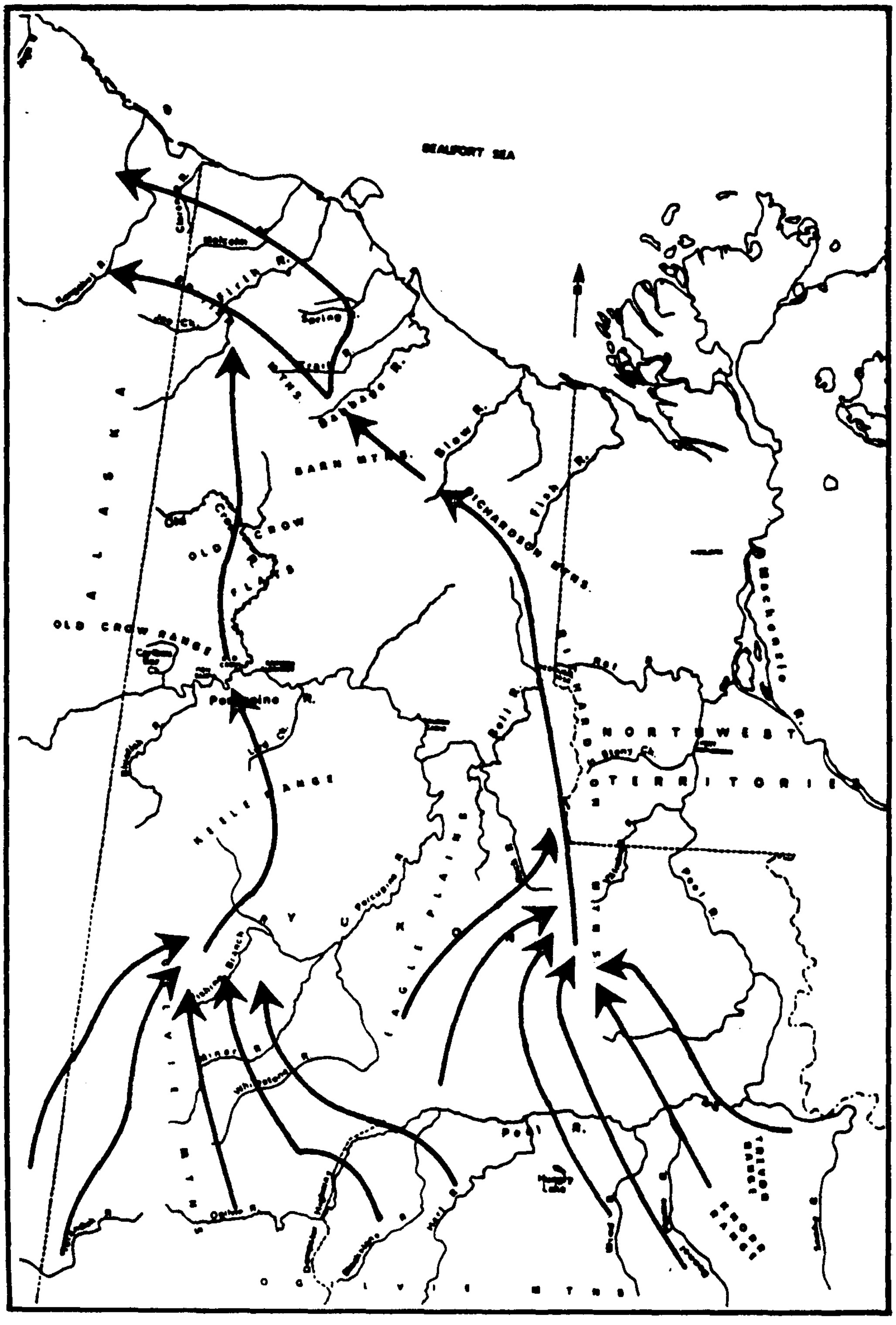
One of the most important aspects of caribou ecology is survival through movements and migrations. Sinclair (1983) proposed that the varying movement patterns of migration in vertebrates have evolved in response to predictably changing food resources. It appears that caribou move to exploit optimal environmental conditions. Some migrations may have evolved to take advantage of favorable habitats, such as calving and breeding areas, or simply to find mates. Bergerud (1974) suggested that caribou interactions with wolves led to their gregarious nature and patterns of movement. As a result, behavioral adaptations such as migration developed so that caribou could sustain themselves in relation to their varying forage supplies and avoid predation.

Because caribou frequently are on the move and the distances animals travel vary from herd to herd and frequently from year to year, no home range or life-function area size has been determined.

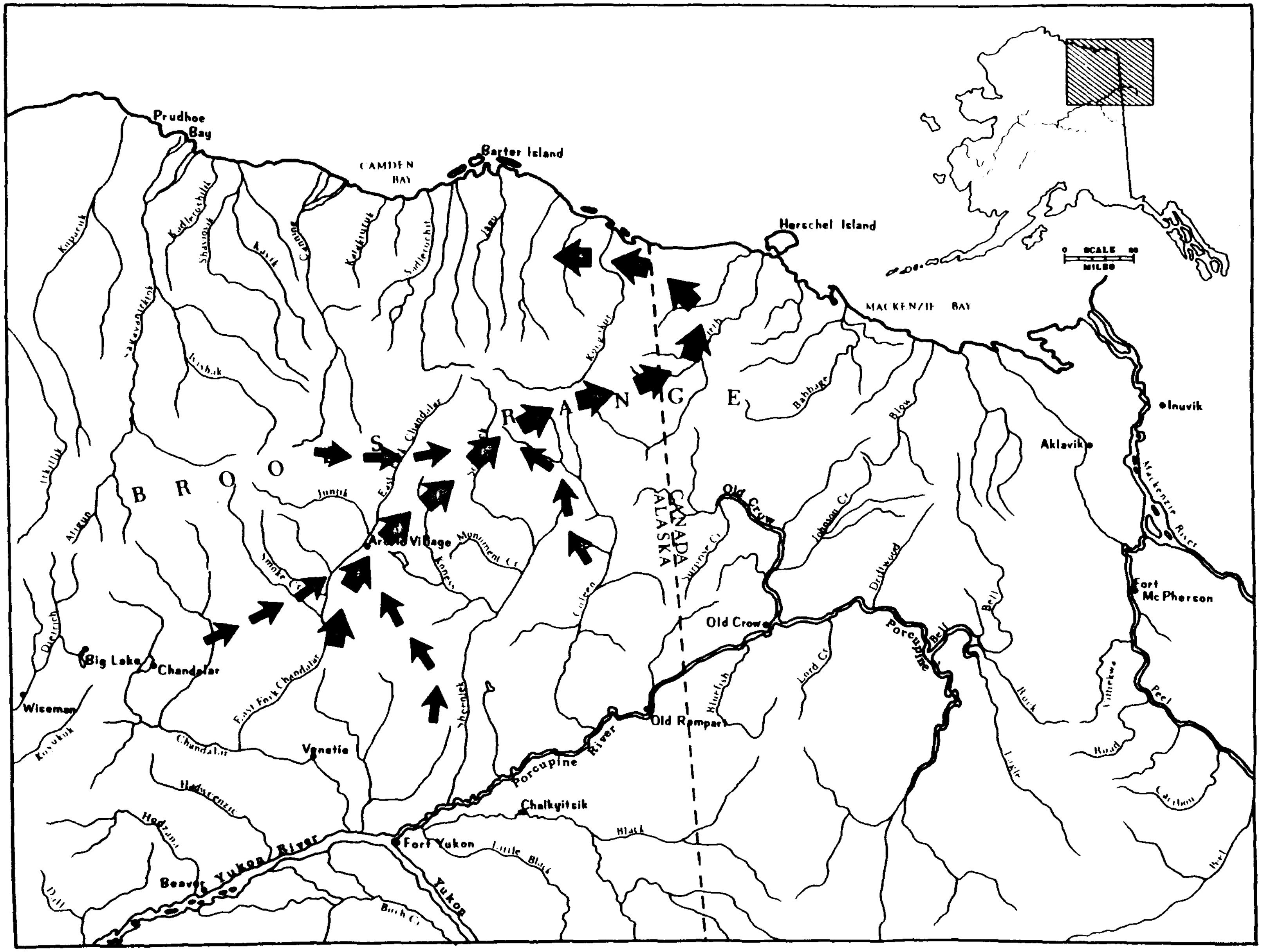
1. Porcupine Herd:
   a. Spring migration routes used:
      1) Richardson route. This route is used by caribou groups wintering in the Peel River Basin, Eagle Plains, Trevor Range, Knorr Range, and the Wind River-Bonnett Plume area (Roseneau et al. 1974, Roseneau and Curatolo 1976). Caribou using the Richardson route move northward along the long axis of the Richardson Mountains (map 22). Upon reaching the most northern portions of the Richardsons and the headwaters of the Blow River, caribou move to the northwest through the Barn Mountains to the British Mountains where they enter Alaska.

         Depending on snow conditions, by the time caribou have passed the Babbage River, they may move into the lower Firth River and enter Alaska along the coastal plain or the foothills of the Brooks Range. In most years, they then proceed rapidly westward to the primary calving grounds.
      2) Old Crow route. This route is used by caribou wintering in the Ogilvie Basin and Ogilvie Mountains and includes the Hart, Blackstone, Ogilvie, Tatanduk, Nation, and Kandik drainages (map 24).

         These wintering groups migrate north through the Keele Mountains and cross the Porcupine River at several traditional crossing sites in the Old Crow vicinity. Caribou groups continue to move north through the Old Crow Flats, over the British Mountains and into the Firth River valley (Jakimchuk and McCourt 1975, Roseneau et al. 1974, Roseneau and Curatolo 1976).
      3) Chandalar-South Brooks route. When caribou winter in the Arctic Village-Chandalar Lake area, this route is used to reach traditional calving areas in the northern foothills of the Brooks Range and the coastal plain (map 25). The direction of travel is northeast and crosses the East Fork of the Chandalar River near Arctic Village. Caribou then move through the headwaters of the Koness River and Old Woman Creek and cross the upper Sheenjek River between Double Mountain and Table Mountain.



Map 24. Spring migration routes from the primary wintering areas in Canada for the Porcupine Herd (Roseneau et al. 1974, Roseneau and Curatolo 1976, Roseneau and Stern 1974, Jakimchuk and McCourt 1975).



Map 25. Spring migration route for Porcupine caribou wintering south of the Brooks Range (Roseneau et al. 1974, Whitten and Cameron 1982, Roseneau and Stern 1974).

Caribou enter the upper Coleen River drainage and move through passes in the Davidson Mountains, east of the Kongakut River, reaching the Firth River. Caribou follow the Firth River into Canada, where they join migrating caribou from the Old Crow route (Roseneau et al. 1974, Whitten and Cameron 1982, Roseneau and Stern 1974).

In years of light snow, some caribou migrate directly north through passes in the Brooks Range to reach the arctic coast (Roseneau et al. 1974). However, many passes in the Brooks Range located west of the Kongakut River are generally precipitous, covered with deep snow and difficult to pass during the spring migration period.

Caribou from the major migration routes tend to coalesce in the area between the Babbage River and the Malcolm River and move in small scattered groups westward along the northern foothills to reach the main calving grounds.

b. Timing. Both timing of the onset of spring migration and the specific migration routes taken each year are highly variable for arctic caribou. Historical evidence indicates that initiation of spring migration can occur between mid March and mid May. In most years, however, caribou begin slowly drifting to the northern edges of their respective wintering areas by the middle of March (Calef and Lortie 1973). These movements are predominantly by pregnant females; bulls, yearlings, and barren cows remain longer on winter range and arrive at the calving grounds later than the females. LeResche (1975) noted that bulls in 1972 arrived on the coastal plain more than a month later than the females.

Bergerud (1974) suggested that some physiological drive associated with parturition stimulates spring migratory behavior, inasmuch as pregnant females lead the way to the calving grounds. Bergerud also noted that caribou in Newfoundland became more mobile when areas of bare ground appeared. However, because movements were seemingly nondirectional and there was no indication that animals had left the wintering area, Bergerud concluded that there was no specific extrinsic stimulus in the spring as in the fall.

Several caribou researchers have proposed that snow conditions are the primary factor triggering spring movements (Pruitt 1959, Roseneau and Stern 1974, Jakimchuk et al. 1974).

Jakimchuk et al. (1974) reported that spring migratory movements occurred when snow had crusted sufficiently to allow travel over snow and that when snow depths had decreased, movements were concerted and direct.

It appears that the Old Crow Flats-southern British Mountains-Barn Range area serves as a staging area for PH caribou for movements to wintering areas. By mid September many small groups begin to coalesce in the Old Crow Flats (USFWS 1982).

Autumn snow storms can often accelerate southward migrations over the Brooks Range of caribou groups remaining on the North Slope and seem to influence directional movements toward the primary wintering areas (ibid.).

Bergerud (1974) proposed that photoperiodism and hormonal changes probably prime the animals physiologically and result in increased aggregation and premigration restlessness. The final threshold stimulus is usually a heavy snowfall. Kelsall (1968) and Skoog (1968) both noted the correlation between snow and the initiation of migratory behavior. Lent (1966) also reported the onset of movement was stimulated by the first snows of the autumn in northwest Alaska.

PH caribou follow approximately the same migration routes used during spring migration (Roseneau et al. 1975). Caribou tend to move toward regular major crossing points on the Porcupine River, such as Rampart House near the United States-Canadian border and traditional crossing points above and below Old Crow and in the vicinity of the mouth of the Bell River (Surrendi and DeBock 1976).

2. Central Arctic Herd:

   a. Insect-induced movements (summer). Midsummer movements of CAH caribou are strongly influenced by the degree of insect harassment. An oscillatory movement pattern occurs between insect relief areas on or near the coast and inland feeding sites (White et al. 1975, Roby 1978). During warm, calm days, caribou move in large groups to relief areas along the coast. When mosquito harassment abates, caribou disperse inland to feed. Cameron and Whitten (1980) reported that movements in response to changing weather and insect density can be quite extensive and rapid; in a 24-hour period caribou have moved as much as 40 km (24 mi).

   Cameron and Whitten (1980) noted that, depending on wind conditions, insect-induced movements to the coast were routed predominantly along the north-south river drainages and occurred rapidly, whereas inland movements were often more leisurely and involved smaller groups. Rapid movements paralleling the coast are common during the height of the insect season.

   The dominant direction of travel varied with insect conditions. Murphy (1984) reported that when insects were absent, the main direction of travel (49%) was south; when only mosquitoes were present, the direction of travel was north (42%) and east (31%); in response to oestrid flies, caribou groups tended to move north (38%); when mosquitoes and oestrid flies were both present, travel was mainly north (50%) and east (25%), as was the case when only mosquitoes were present. As temperatures rise inland, mosquitoes become more active, forcing caribou to travel toward the coast, where windier and cooler conditions prevail. Caribou move upwind only as far as necessary to escape harassment (Lawhead and Curatolo 1984). These workers concluded that the location of mosquito-relief areas was a dynamic situation dependent upon climatic conditions. White et al. (1975) reported that when caribou reached the coast they continued to travel into the wind, especially when under intense insect harassment. The coastal movements are generally eastward because of the prevailing winds. White et al. (1975) noted significant differences in the mean daily rates of movement under differing degrees of insect harassment. In insect-free conditions, caribou averaged 0.53 km (0.33 mi)/hr; during mild harassment, 1.36 km (0.84 mi)/hr; and during episodes of severe harassment, 3.14 km (1.95 mi)/hr. Fancy 1983 also showed significant increases in rates of movement from low to high insect harassment levels. If caribou groups were harassed for 8 out of 24 hours, they could move from 14 km (8.7 mi) to 42 km (26 mi) in a day, depending on conditions (ibid.). Fancy (1983) observed a cow-calf group in early August moving at 22 km (13.6 mi)/hr between two points.

b. Fall migration. Roseneau et al. (1974), using casual aerial observations, described a pattern of southerly and southeasterly movements from the Prudhoe Bay and Colville River delta areas toward the Brooks Range. Caribou moved into most major river valleys of the northern Brooks Range, including the Canning River, Juniper Creek, Echooka, Ivishak, Saviakviayak, Lupine, Ribdon, and Sagavanirktok rivers. Some caribou choose to winter on the coastal plain and do not migrate. Most animals, however, move south into the foothills zone of the Brooks Range, the Canning-Ivishak river headwaters, or may even cross the Continental Divide into the Chandalar drainage (ibid.). Cameron and Whitten (1979) confirmed these casual observations and noted that the fall migration occurred over a six-week period during September and October. Carruthers et al. (1984) also described a southerly movement of caribou.

c. Spring migration. Roseneau et al. (1974) described a northward movement into the foothills zone of the Brooks Range and the coastal plain area. Cameron and Whitten

(1979) depicted spring migration as a leisurely northward shift occurring between March and May, as opposed to the relatively rapid fall migration movement.

3. Western Arctic Herd:

   a. Spring migration. Caribou leaving the wintering areas south of the Kobuk River usually cross the Kobuk River between Ambler and Kiana and move north up several tributaries, cross the Baird Mountains, the Noatak River, and the DeLong Mountains (western Brooks Range) to reach the calving grounds in the foothills south of the arctic coastal plain (Lent 1966).

      Caribou may also cross Selawik Lake and move north nearer to the coast. Hemming (1971) presents a summary of spring migration patterns throughout the 1960's.

      In 1976, Valkenburg et al. (1983) reported that animals wintering in the Kiana Hills traveled up the Noatak River past the mouth of the Kelly River and then probably moved up the Kugururok or Nimiuktuk rivers to reach the calving grounds. Caribou from the Norutak Lake-Alatna Hills region began to move west by late March, then north via Walker Lake and/or the Reed River to reach the headwaters of the Noatak, and then proceeded to the Utukok River calving grounds. In 1980, most caribou used the Hunt River and its adjacent ridges, with many caribou migrating through the Redstone, Miluet, and Ambler rivers. In fact, Davis et al. (1982) mentioned that caribou generally cross in the vicinity east and west of Ambler and continue moving up the Hunt and Redstone river valleys into the Cutler River drainage, crossing the Noatak and moving up the Anisak River valley and across the DeLong Mountains. The Hunt River drainage has been the primary migration route to the Selawik-Buckland winter range, with the Squirrel and Redstone river drainages considered secondary migration routes (ibid.).

   b. Fall migration. Migratory activity is usually stimulated in late August or early September by the first snowfall (Lent 1966, Pruitt 1960). Lent (1966) reported that the main groups of WAH caribou primarily used Howard Pass as well as the passes north of Desperation and Feniak lakes and Inyoruruk Pass to cross the DeLong Mountains. Caribou then moved west down the Noatak River valley, with some (ca. 20,000-40,000) caribou traveling south into the Baird Mountains through the Cutler River drainage. The valleys of the following south-flowing Kobuk River tributaries are used by WAH caribou: the Squirrel, Salmon, Hunt, Redstone, Ambler, Mauneluk, and Reed rivers (Lent 1966). The most heavily used pathways were the Hunt and Salmon rivers or Nakolik Pass to Timber Creek and down the Squirrel

River. Most caribou reach the Kobuk River and cross by early October, or they may wait for several days if the river ice is not sufficiently thick to support their weight. Valkenburg et al. (1983) reported extensive use of a coastal route between Point Hope and Kotzebue during 1963, 1964, and 1968. Lent (1966) described such a movement occurring in 1960, where an estimated 10,000 caribou left the Cape Lisburne-Pitmegea River area in mid August, crossed the Ipewik and Kukpuk rivers, passed through Kivalina, and moved up the Wulik River in mid September. Most of these animals reached the Noatak drainage through the Kugururok River and then moved through Nakolik Pass to arrive in the Kobuk Valley. This coastal route was not used again until 1975, when about 30,000 caribou migrated south along the coast, reaching the Cape Krusenstern area in mid October (Valkenburg et al. 1983). This group crossed the mouth of the Noatak and moved into the Kiana Hills, where about 10,000 animals wintered.

Overall, in the last 10 to 15 years, fall migration pathways resembled those occurring during the spring period (i.e., Squirrel, Hunt, and Redstone river drainages).

E. Population Size Estimation

Hemming and Glenn (1968) first developed the "Aerial Photo-Direct Count-Extrapolation (APDCE)" technique to census the Nelchina herd in 1967. After some refinements, the technique was first used in the arctic on the WAH in 1970 (Pegau and Hemming 1972). LeResche (1975b) conducted the first rigorous APDCE census of the PH in 1972. A second "standard" APDCE census was completed in 1977 to determine any population changes in the PH since 1972 (Bente and Roseneau 1978). In 1978, a second APDCE census of the WAH was used to test modifications in that technique (Davis et al. 1979). Whitten and Cameron (1980a, 1983a) described results of using the "modified" APDCE method on the PH in 1979 and 1983 and made several recommendations for improvements.

F. Regional Abundance

Population estimates for caribou are usually not computed at the regional level. Table 3 is a summary of the most recent published population estimates and caribou survey data by herd for the Arctic Region. By summing the most recent abundance estimates for the individual herds, a minimum regional estimate of 330,088 and a maximum of 351,000 caribou were obtained.

All caribou herds in the Arctic Region are currently increasing in number (Davis 1980).

Table 3. Most Current Survey Results (Modified APDCE Technique) for Arctic Caribou Herds

Herd	Date	Number Counted	Number Estimated	Source
Porcupine	July, 1983	135,284	140,000	Whitten 1984a
Central arctic	21 July, 1983	12,905	13,000	Smith 1985
Western arctic	July, 1982	171,699	187,000	Anderson and James 1984
Teshekpuk	July, 1984	10,200	11,000	Silva 1985

II. PORCUPINE CARIBOU HERD (PH)

A. Present Abundance

Table 4 summarizes all available abundance estimates and count data for the PH. Based on the last census, this herd numbered almost 140,000 animals. According to Whitten (1984a), results of this census indicated an annual growth rate of 6-8% since 1979. Currently, the herd contains about 40% of the estimated total caribou within the Arctic Region and about 31% of the estimated 1983 statewide caribou population (450,000) (Hinman 1984). This herd is exceeded in size only by the WAH.

B. Historic Distribution and Abundance

Information describing caribou associated with the present range of the PH dates from the early explorations of the arctic coastal area throughout the mid-to-late 1800's. The detailed historical examination by Skoog (1968), along with the more recent updates by Hemming (1971) and LeResche (1975a,b), summarize the available information on distribution and abundance of this herd. Detailed information describing the distribution and numbers of caribou within the overall range of the PH was not available until the late 1940's and early 1950's. At this time, biologists began to use aircraft to survey and map the distribution of caribou populations in Alaska and Canada (Scott et al. 1950).

When large oil and gas reserves were discovered in the Prudhoe Bay area, as well as in the western Canadian arctic, in the late 1960's, possible future impacts on the large PH from large-scale industrial development became a concern. As a result, major biological investigations were initiated by government and industry.

Based on an extensive review of historical records, Skoog (1968) concluded that caribou numbers in the northeast Alaska-northern Yukon area were at high levels prior to 1900. Seasonal distribution patterns in the late 1800's were apparently similar to those currently observed. In the early 1900's, however, these caribou

Table 4. Population Estimates for the Porcupine Caribou Herd

Survey Date	Number Estimated	Number Observed	Type of Survey	Comment	Sources
1962	110-120,000				Skoog 1962, 1963
1964	140,000				Lentfer 1965
1972	93,096-103,400		Std. APDCE	Minimum estimate	Pegau & Hemming 1972
	110,000-120,000			Best estimate	Pegau & Hemming 1972
	101,000			Minimum estimate	LeResche 1975b
1972	90,565-107,065		Std. APDCE	Minimum estimate	Roseneau & Stern 1974
	110,000-115,000			Maximum estimate	Roseneau & Stern 1974
1977	105,000		Std. APDCE		Bente & Roseneau 1978; Davis 1978
1979	110,000	105,683	Modified APDCE	Minimum estimate	Whitten & Cameron 1980a
1982	137,264	125,174	Modified APDCE		Whitten 1984a
1983	135,284	135,284	Direct count		Whitten 1984b, 1985

expanded and/or shifted their range to the southwest away from the arctic coastal plain to the central Brooks Range (Hemming 1971, LeResche 1975a). Murie (1935) reported that caribou were numerous in the Koyukuk-Chandalar area from 1917 to 1930 and were actually harvested at Fort Yukon in 1925 for the first time in a hundred years. Skoog (1968) hypothesized that the present-day herd was actually two smaller herds at that time: a central Brooks Range group and a northeast Alaska group. In any case, it appears that the PH continued to increase in numbers until the early 1940's, when Skoog (1968) reported a "drastic" decline in the mid 1940's. Skoog (1968) attributed this decline to emigration to the WAH and migration across the MacKenzie River into the Northwest Territories.

In the early 1950's, Scott (1953) was the first to recognize the interrelationships of caribou groups from the Big Lake-Chandalar River region, the arctic coastal plain, the British Mountains, and the Richardson Mountains; they were all considered part of the same herd. Porcupine Herd numbers continued to increase gradually throughout the 1950's and early 1960's. In general, early reports of changes in herd size should be viewed very skeptically because formal censuses were never conducted and aircraft were not used. Changes in distribution could have been interpreted as population increases or decreases (Whitten, pers. comm.).

III. CENTRAL ARCTIC HERD (CAH)

A. Present Abundance

Table 5 summarizes available abundance information for the CAH. These data point out the steady growth of the CAH since 1975. Whitten and Cameron (1983a) reported an annual growth rate of 13% from 1978 to 1981. The relatively high growth rate of the CAH can be accounted for by high rates of calf production and survival combined with low adult mortality. Neither the standard nor the modified APDCE census techniques could be used to estimate CAH numbers, because composition counts of sufficient accuracy were difficult to obtain, and/or postcalving aggregations dispersed into peripheral areas.

B. Historical Distribution and Abundance

Information describing historical utilization by caribou of the central arctic area between the Colville and Canning rivers is very limited. In the recent past, most observers had recognized only two distinct caribou subpopulations on the North Slope, the PH in northeast Alaska and the WAH in northwest Alaska. Summer ranges of the WAH and PH were thought to overlap at the Sagavanirktok and Atigun drainages, with occasional movements of the WAH as far east as the Canning River (Hemming 1971, LeResche 1975).

In 1956, Olson (1959) described the spring movements of about 25,000 caribou between the Anaktuvuk and Canning rivers. Widely scattered groups of caribou numbering well over 100,000 animals

Table 5. Population Estimates for the Central Arctic Caribou Herd, 1969-84

Year	Number Estimated	Sources
1969	26,000[a,b]	Gavin 1973
1970	26,000[a,b]	Gavin 1973
1971	15,000[a,b]	Gavin 1973
1972	2,500[b]	Gavin 1973
1972	3,000[b]	Child 1973
1975	5,000[b]	Cameron and Whitten 1976
1977	4,800-6,000	Cameron and Whitten 1978
1978	5,300-5,800	Whitten and Cameron 1983a
1981	8,537-9,000	Whitten and Cameron 1983a
1983	13,000	Smith 1985

a Probably includes animals from WAH.

b Rough estimates - no systematic census method used.

wintered (1956-1957) in what Olson called the Central Arctic area of the arctic slope. The following winter, the number of caribou increased to over 150,000 animals. Although most of these caribou (ca. 125,000) moved west just prior to calving, 10,000-12,000 animals were observed just south of Oliktok Point during that summer.

Skoog (1968) described the existence of two distinct subpopulations in northeast Alaska during the 1920's and 1930's. One of these, the Central Brooks Range Herd (CBRH), occupied the central arctic area, while the other occupied the range of the present-day PH. The CBRH was thought to be a remnant of the WAH and possibly the PH, left behind in that area when the WAH declined in the 1890's. In the early 1950's, the CBRH either temporarily disappeared as a separate entity or could not be found, while at the same time the WAH was experiencing rapid growth. Skoog (1968) assumed the herd had lost its identity and was probably absorbed by the WAH, which had grown to 300,000 animals in 1964. Comparatively large numbers of caribou from the WAH apparently continued to use the range of the CBRH during the 1960's.

Gavin (1979) reported that in 1969 and 1970 25,000 caribou were found between the Colville and Canning rivers, 20,000 of which migrated into this area, with 25-80% of them having arrived via Anaktuvuk Pass, and were believed to be part of the WAH. The WAH rapidly declined in the early 1970's from 200,000-240,000 head in 1970 (Hemming 1971, Pegau and Hemming 1972) to 75,000 in 1976

(Davis and Valkenburg 1978). Child (1973) reported that a small caribou subpopulation of approximately 3,000 animals had been observed calving within and using the Prudhoe Bay area for summer range in the early 1970's. Roseneau et al. (1974) believed that these caribou calved in the central Arctic Region and were the first researchers to refer to this subpopulation as the CAH. Cameron and Whitten (1976, 1979a), using Skoog's (1968) herd identification criteria, identified a discrete subpopulation of 4,000-6,000 caribou and called them the CAH because of their fidelity to a particular calving ground in the central arctic and their repeated use of certain portions of their range.

IV. WESTERN ARCTIC HERD (WAH)

A. Present Abundance

The WAH is the largest caribou herd in Alaska and one of the largest in North America. Table 6 summarizes all available abundance estimates and count data for the WAH since 1970. From 1976 to 1980, the WAH increased at an annual rate of 14 to 16%, but the mean annual growth rate declined to 11.5% (based on the actual number counted, not on the maximum population estimate) from 1980 to 1982 (Anderson and James 1984). The July 1985 population, assuming a growth rate of 11 to 14%, would number 235,000 to 254,000 animals. A photocensus was scheduled for the summer of 1985 but was not completed because of unfavorable weather. The WAH population status is a very dynamic situation, and population estimates and growth rates may change significantly in the future.

B. Historical Distribution and Abundance

The first signs of caribou population recovery of the WAH since its decline in the 1880's were reported to occur in the early 1920's (Bailey and Hendee 1926, Murie 1935). Lent (1966) cited the cessation of intensive whaling activities, a decline in the Eskimo population, and the movement to the coast by most inland Eskimos, who had previously been almost entirely dependent on caribou for survival, as important factors aiding the recovery of the WAH caribou population. During the fall of 1927, Frank Glaser reported a large portion of the McKinley herd migrated north passing through Nenana, crossed the Yukon River, wintered in the headwaters of the Koyukuk River and then moved north in the following spring (Olson 1959:26). Skoog (1956) presented data describing an increasing pattern of caribou movements from the interior to the arctic during the late 1930's and early 1940's. Caribou were again commonly harvested by most coastal villages from Kotzebue to Point Barrow during the 1940's (Lent 1966). In 1943, caribou reappeared in the Noatak River drainage and in 1946, for the first time since the turn of the century, were available to hunters from the Selawik area (Scott et al. 1950). Valkenburg et al. (1983) mentioned that caribou presence in the Kobuk River

Table 6. Population Estimates for the Western Arctic Caribou Herd

Year	Estimated Population Size	Number Counted
1961	175,000-200,000	---
1964	300,000[a]	---
1970	242,000	179,843
1975	102,704	69,000
1976	75,000[b]	60,757-61,728
1978	106,635	97,742
1980	139,629	---
1982	187,000[c]	171,699[b]

Sources: Davis et al. 1979, Davis and Valkenburg 1978, Anderson and James 1984, Lent 1965, Skoog 1968.

a Based on harvest data only.

b Minimum estimate.

c Maximum estimate.

--- means no data were available.

drainage also resumed during the 1940's. A large herd (ca. 250,000 animals) was observed north of the Baird Mountains in 1947, and in August 1949, Scott et al. (1950) described a similar migration across the Noatak River into the DeLong Mountains. From 1949 to 1954, WAH caribou wintered in the Kobuk valley, the area between Kotzebue and Kivalina, and in the central Brooks Range (Valkenburg et al. 1983). Scott et al. (1950) presented census data derived for the first time using aircraft. Of the five designated caribou herds in the arctic, four were probably WAH caribou and together numbered 119,000 animals. Skoog (1968) recognized the biases and inaccuracies of Scott et al.'s estimation methods and utilized more recent knowledge of caribou survey techniques (Watson and Scott 1956) to revise their statewide population estimate from 160,450 to 325,000. Based on Skoog's revision, the number of caribou in the present range of the WAH in 1950 would have been proportionately adjusted to 242,000 animals. In 1955, the expanding periphery of the WAH reached the Buckland and Selawik river drainages, where approximately 50,000 caribou wintered in 1956-1957 and 1957-1958, with the remaining larger portion of the herd wintering in the northern foothills of the Brooks Range and on the coastal plain. In January 1958, an estimated 150,000 caribou were using this area. The first systematically designed aerial census of the WAH was completed in the summer of 1958, with an estimated 225,000 animals on the calving grounds (Valkenburg et al. 1983). Lent (1966) censused the WAH in 1961 using a technique similar to the aerial photo-direct count-extrapolation (APDCE) method developed by the ADF&G in the late 1960's. The minimum precalving population was estimated at 130,000 animals in late June 1961, and the total July population was calculated to be 156,000. However, after identifying some small missing calving groups, Lent felt that the total population was probably between 175,000 and 200,000 animals. In 1964, Skoog (1968) estimated 300,000 caribou in the WAH, based on the size of the village harvests and herd movement patterns. Table 5 summarizes APDCE censuses of the WAH since 1970.

V. TESHEKPUK HERD

A. Present Abundance

In July 1984 the first systematic photographic census (APDCE) was conducted in the Teshekpuk Lake area. This census indicated that at least 11,800 caribou were present in the Teshekpuk Lake area. Table 7 describes population estimates for the Teshekpuk Herd (TU) since 1976. The dramatic three-fold increase in caribou numbers in 1984 is a common occurrence in areas where population estimates were made using nonphotogrammetric methods prior to a systematic photographic census (Silva 1985). The 1984 increase probably reflects past counting inaccuracies as well as increased caribou numbers (ibid.).

Table 7. Population Estimates for the Teshekpuk Caribou Herd, 1976-84

Year	Number Estimated	Sources
June, 1976	2,000	Sappington 1976
June, 1977	2,000+	Davis and Valkenburg 1979
July, 1977	2,500*	Davis and Valkenburg 1979
June, 1978	3,100**	Davis and Valkenburg 1979
July, 1978	4,000	Davis and Valkenburg 1979
1981	3,000	Reynolds 1982
July 1982	4,000	Reynolds 1982
July 1984	11,800	Silva 1985

* Including almost 600 calves.

** Did not include entire Teshekpuk Lake area.

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Dall Sheep Distribution and Abundance

I. REGIONWIDE INFORMATION

In Arctic Alaska, Dall sheep are distributed along the north slope of the Brooks Range from the Canadian border to the Wulik Peaks area in the extreme western end of the range. Distribution along the southern slope and in some western areas of the range is not continuous, and sheep populations may be separated by areas with few or no sheep.

The Arctic Regional boundary includes Game Management Units (GMUs) 23, 26A, B, and C. Dall sheep habitat in GMUs 24 and 25A, although not within the Arctic Regional boundary, will be included in this discussion because they are part of the Brooks Range.

Sheep populations in Alaska are recognized and managed on the basis of mountain ranges. Therefore, for ease of discussion and data presentation, arctic sheep distribution and abundance information presented here will be for the Brooks Range as a whole, which includes GMUs 23, 26A, B, and C as well as portions of 24 and 25A (map 1).

Information on Brooks Range Dall sheep populations is available from aerial surveys conducted by the ADF&G, the NPS and USFWS.

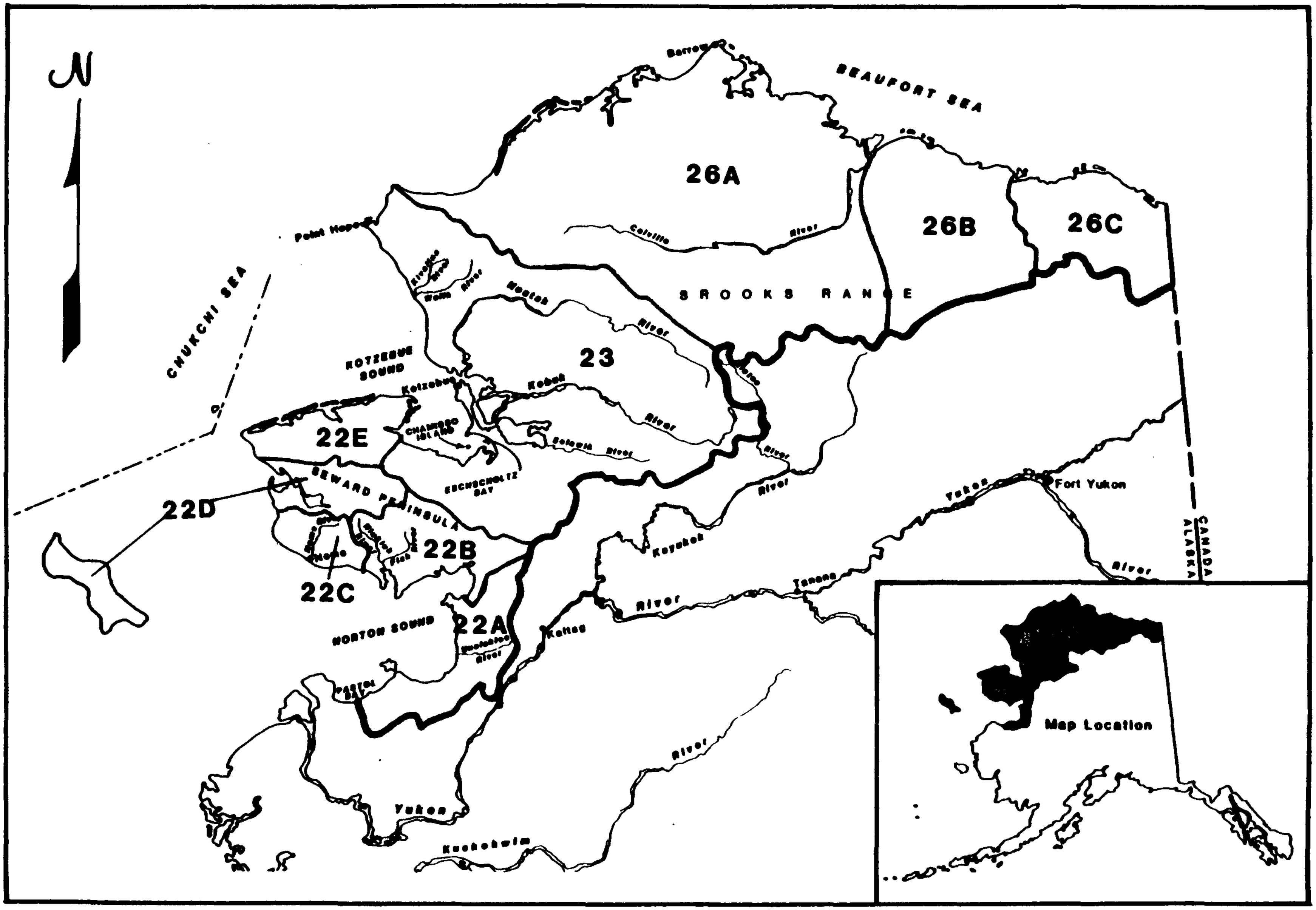
A. Regional Distribution

Dall sheep in the Arctic Region are found in suitable habitat throughout the Brooks Range. Dall sheep densities vary between areas in the mountain range. Generally, sheep densities are lower in GMU 23, the central portions of GMU 24, and GMU 25. Western portions of GMU 24 support relatively moderate densities of sheep, and the eastern portions contain higher densities. GMU 26 populations have a high density in the eastern portion (26C), decreasing to low numbers in the western portion (26A) (Heimer 1982).

During most of the year, Dall sheep are generally found at elevations above 2,500 ft throughout their range. In some areas of the Brooks Range, especially the western extreme, the topography is less steep and generally lower in elevation than other areas of typical sheep habitat. Dall sheep utilize these lower elevation areas and are often seen along bluffs and other steep escape terrain areas adjacent to the Noatak River canyons. Singer et al. (1983) observed sheep as low as 700 ft elevation; most observations, however, were between 1,200 and 2,500 ft elevation. Sheep are regularly observed in the early fall at low elevations along the Noatak River (James, pers. comm.).

B. Areas Used Seasonally and for Life Functions

Dall sheep utilize different ranges at different times of the year. Most populations have a winter and a summer range (Heimer 1973), although some researchers have identified several seasonal use areas for mountain sheep (Geist 1971). Winter range is characterized by areas of low snow accumulation, higher elevations, wind-swept ridges, or other areas protected from snow. The



Map 1. Game management units in the Arctic Region.

entire mountain block that sheep inhabit is available to sheep populations for summer range. Mineral licks are visited by some, if not all, Dall sheep populations (Heimer 1973). (For further information, see the 1:250,000-scale reference maps, available in ADF&G offices, and the 1:1,000,000-scale maps in the Atlas to the Alaska Habitat Management Guide for the Arctic Region.) The distribution of sheep on the Wiseman, Chandalar, and Christian quads is included in the map series for the Western and Interior regions. These maps indicate the general distribution, known mineral licks, and known winter use areas of sheep in the Arctic Region.)

C. Factors Affecting Distribution

As previously mentioned, sheep are found in steep, mountainous terrain, usually above 2,500 ft, throughout the year. The rugged terrain provides readily available escape cover from predators. Also, the higher windblown slopes provide snow-free areas where forage is available during winter. Deep snow in other feeding areas prevents sheep from reaching forage.

Summer range use in some areas is affected by winter snow deposition and the timing of the snow-melt. Specific geographic areas tend to have deeper snow accumulations because of weather conditions and physiographic features. These areas are unavailable to sheep during winter and can provide summer range only after snow-melt (ibid.). (See the Life History and Habitat Requirements volume of this series for specific information.)

D. Movements Between Areas

In many areas, movements by Dall sheep between seasonal use areas are associated with mineral lick use (ibid.). In these areas, sheep travel from their winter range to the mineral lick, then continue to their summer range. The movement of sheep to a mineral lick area on the Hulahula River in the eastern Brooks range was observed to occur as early as April (Spindler 1983), with peak use occurring in June. Lick use by sheep extended through October, with limited evidence of year-round use (ibid.). A study of seasonal movement patterns in the Atigun Pass area indicated that lick use varied but generally began in late May and peaked in June (Summerfield 1974).

E. Population Size Estimation

Dall sheep distribution and abundance information is obtained from aerial surveys conducted by biologists during mid summer (July). Aerial surveys are flown in predetermined areas of known sheep habitat. Surveys are conducted similarly, in attempts to ensure that results are comparable to previous years. Weather is an uncontrollable factor in these surveys and sometimes causes partial or complete cancellation. All areas are not surveyed every year, primarily because of budgetary and weather constraints. Instead, most areas are surveyed every other year or at longer intervals. Sheep populations can fluctuate 15 to 20% annually, primarily because of natural conditions. It would therefore be preferable to survey sheep populations more frequently to establish when these fluctuations occur (Heimer, pers. comm.).

Aerial survey information on population composition collected by the ADF&G is presented in the form of total sheep observed, total lambs observed, lambs per 100 "ewes," total ram numbers, and percentage of legal rams. The last two categories are sometimes not available because of the difficulty in determining legal rams from the air. The ewe/lamb groups contain animals of both sexes and many age classes and are difficult to classify accurately. Therefore, all ewe-like animals (ewes, yearlings of both sexes, and young rams) are designated as "ewes" (Heimer 1984a).

During NPS helicopter surveys, attempts are made to classify sheep into more specific sex and age classes: ewe, yearling, two-year-old ewe, lamb, 1/4 curl, 1/2 curl, 3/4 curl, 7/8 curl, and 4/4 curl rams (Singer et al. 1983). The ability of the helicopter survey crew to correctly differentiate between younger sex and age classes has never been tested, and some errors may be present in these classifications (ibid.).

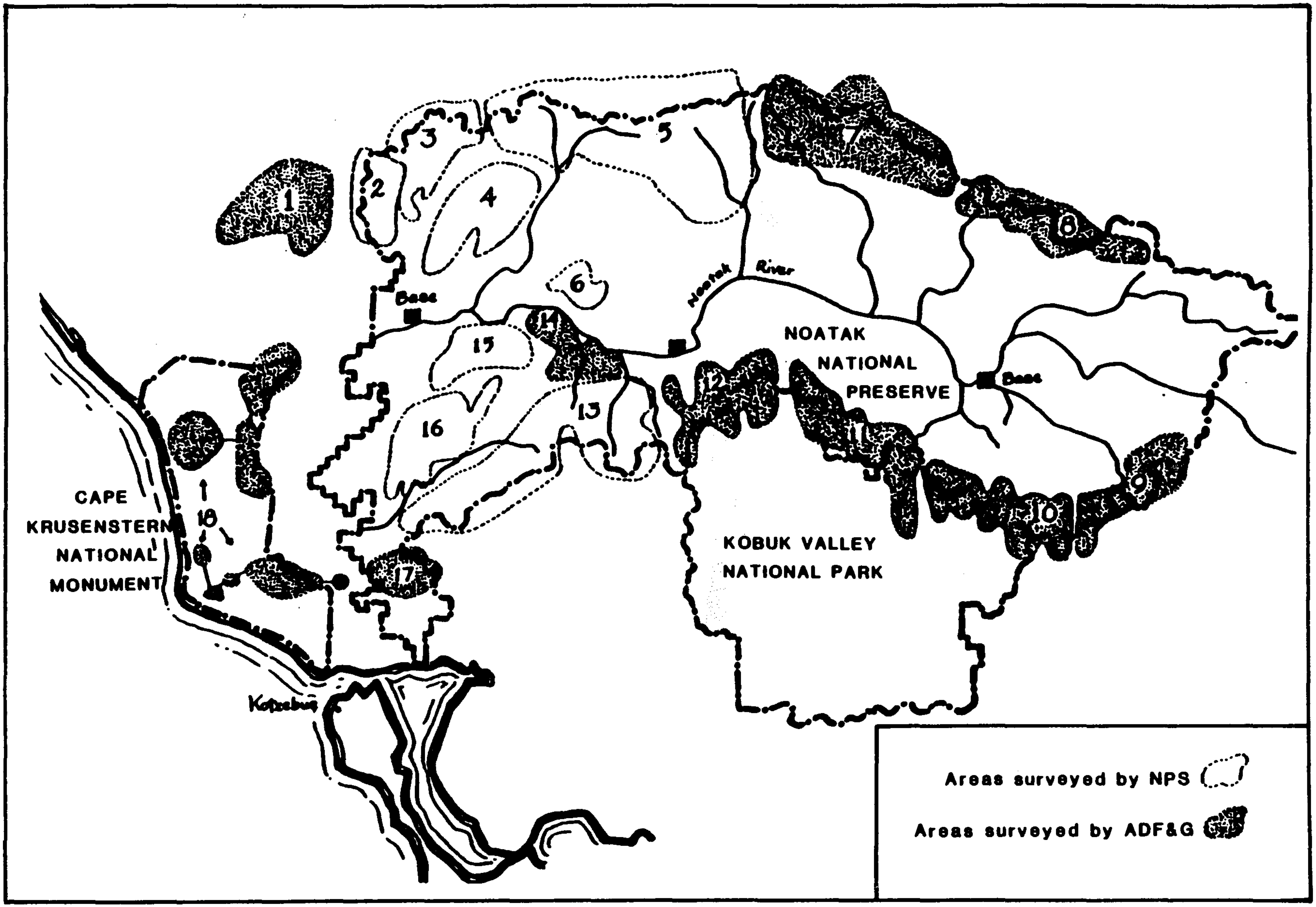
During 1983, the NPS and ADF&G combined efforts to survey sheep populations in GMU 23 of the Brooks Range. The areas surveyed were within the boundaries of three NPS-administered areas; Noatak National Preserve, Kobuk National Park, and Cape Krusenstern National Monument. Map 2 presents the areas surveyed. Six of the 15 areas were survey by the ADF&G in fixed-wing aircraft, and the remaining 9 were surveyed by NPS personnel utilizing helicopter techniques. One additional area was surveyed by the ADF&G in 1982 (Singer et al. 1983). Results among count areas are comparable, although more specific sex and age classes are believed to be possible utilizing helicopter techniques (ibid.).

F. Regional Abundance

At least 70,000 Dall sheep are currently estimated to be present in the Alaskan sheep population (Heimer 1984a). Approximately 30,000 sheep are present in the Arctic Region (ibid.). Densities and population composition vary by area. Specific abundance information by GMU is given in the following sections.

II. GMU 23

In 1983, the GMU 23 sheep population was estimated to be 3,000 to 3,500 sheep (Quimby 1984). As previously mentioned, this estimate resulted from surveys conducted by NPS and ADF&G personnel. The last previous complete survey of this area was accomplished in 1977, although that effort was not as extensive as the 1983 work. Partial surveys were conducted in 1978, 1981, and 1982. The population appears to have increased considerably since 1977; however, direct comparisons between years is only possible for certain portions of the area. Table 1 lists the areas from these surveys that have been reflown and presents the observed increase in the population. A portion of the increase can be attributed to more effective observation techniques (fixed-wing vs.



Map 2. GMU 23 sheep aerial survey areas (Singer et al. 1983).

Table 1. Trends in Dall Sheep Numbers in the Lower Noatak Drainage from 1977-82 to 1983

Count Unit	Year of Last Count	Sheep in Last Count	1983 Count	Percent Change
1 + 2	1982	120	170(s)	+ 42
3	1977	34	54(h)	+ 59
4	1977	42	49(h)	+ 17
5	1977	214	311(h)	+ 45
6	1981	52	67(h)	+ 29
13	1978	56	18(s)	- 32
15	1982	392	441(s)	+ 13
16	1978	60	79(s)	+ 32
Total		970	1,189	+ 23

Source: Singer et al. 1983.

s = super cub; h = helicopter. The 1977 counts were conducted with a heliocourier.

helicopter). Variations in lamb production, resulting from favorable climatic conditions, could also produce changes of this magnitude (Heimer, pers. comm.).

A series of mild winters, lower predator densities, and improved compliance with regulations by hunters are also possible reasons for the observed increase (ibid.).

B. Historic Distribution and Abundance

No pertinent information was found.

III. GMU 24

A. Present Abundance

GMU 24 is located in the central portion of the Brooks Range and encompasses the majority of the Gates of the Arctic National Park (GAAR). Surveys of sheep populations in this area are very limited. In 1983, the NPS conducted Dall sheep population surveys within GAAR, counting a total of 9,057 sheep (Heimer 1984b). Based on these surveys, the sheep population within GAAR, including some portions of GMU 23 in the upper Noatak River, is estimated to be 15,000 animals (ibid.).

Sheep populations in the Brooks Range tend to be relatively stable, except for some local variations (ibid.). Past estimates of sheep numbers in these unsurveyed areas appear to have been low, and the recent surveys have resulted in acceptable estimates.

B. Historic Abundance
No pertinent information was found for this section.

IV. GMU 25A

A. Present Abundance

GMU 25A is located on the south slope of the Brooks Range, in the northeastern corner of the state. Sheep populations in this inaccessible, remote area have only recently been studied, and population data is limited. Sheep densities in this unit are relatively low compared to other areas of the Brooks Range.

Estimates of sheep populations in portions of GMU 25A are presented in table 2. The 1977 estimates are based on ADF&G aerial surveys and, in some cases, on ground observations or miscellaneous observations. These figures should be viewed only as preliminary base-line population estimates. Further observations of sheep populations in this area are needed.

During a 1980 study of Dall sheep habitat selection activity patterns, an estimated 250-300 sheep utilized the upper Sheenjek River drainage (Curby 1981).

B. Historic Distribution and Abundance
No pertinent information was found.

Table 2. Dall Sheep Populations Estimates for Portions of GMU 25A, 1977

Locations	Estimated Sheep Population
North Fork of Chandalar River	650*
Your Creek	300*
Middle Fork of Chandalar River	200
Wind River	400
Junjik River	200**
Sheenjek River	300**
East Fork of Chandalar River	200
Colleen-Mancha-Joe Creek	150**
Total	2,400

Source: Smith 1977.

* Estimates based on intensive low-level surveys.

** Estimates based on ground observations, guide reports, and/or miscellaneous aerial observations.

V. GMU 26C

A. Present Abundance

GMU 26C is located in the extreme northeast corner of Alaska and includes the northern portion of the Arctic National Wildlife Refuge (ANWR). Aerial surveys have been conducted, and population estimates have been made for some major river drainages in this GMU, including the Hulahula, Kongakut, and Sadlerochit rivers. A minimum Dall sheep population estimate for GMU 26C of 6,000 animals has been derived from these surveys (Heimer 1982).

There is little information available on sheep population trends in this area (Heimer 1984b). No change in sheep abundance was observed in most areas surveyed both in 1976 and 1979. However, in the Katak Creek drainage in the lower Hulahula River, surveys revealed a decrease of 44% in the number of adult sheep observed in 1979 compared to 1976 (ibid.). This area is immediately adjacent to the traditional camp site for the village of Kaktovik, and reported harvest is localized in this area (ibid.).

1. <u>Hulahula River</u>. During 1982, a population estimate of 2,700 sheep for the Hulahula River drainage was derived from an aerial survey conducted by ADF&G personnel (Heimer 1983). This compares well with the previous estimates generated in 1976 and 1979 of 2,000 and 2,279 sheep, respectively (Spindler 1979).

   The population trend of the Hulahula River sheep is either stable or not detectable, and differences between years seems to be related to lamb production rather than to changes in adult numbers (Heimer 1983).

2. <u>Kongakut River</u>. Very little specific information is available for this drainage. In 1972, a minimum population estimate of 200 sheep was made for this drainage (Roseneau and Stern 1974). This estimate was derived from miscellaneous observations and was considered very conservative by the authors (ibid.).

   In 1977, an estimate of 800 sheep was derived for this drainage, based on available habitat and densities of sheep in adjacent areas (Smith 1977). This estimate was also probably conservative, and additional survey work was determined to be necessary.

   The sheep population estimate for this drainage has been placed at 2,000 animals (Watson 1985). This estimate was based on aerial surveys of sheep habitat in adjacent areas and data re-analysis. The current population trend and status of sheep in this area is unknown (ibid.).

3. <u>Sadlerochit River and Mountains</u>. The relatively small sheep population inhabiting the eastern end of the Sadlerochit Mountains represents the northernmost population of Dall sheep found in North America (Roseneau and Stern 1974). Smith (1977) estimated the sheep population in this area to be about 400 animals. This estimate was based on fixed-wing aerial surveys conducted by ADF&G personnel. The trend of

this population is unknown, but is probably relatively stable.

B. Historic Distribution and Abundance

No pertinent information was found.

VI. GMU 26B

GMU 26B is located on the north slope of the Brooks Range between the Canning River and the eastern bank of the Colville River. Previous sheep population estimates for this area have been conservative (Heimer 1985). Based on 1984 survey efforts in adjacent areas, the sheep population in GMU 26B has been estimated to include 2,500 animals (ibid.).

1. Atigun Pass-Upper Sagavanirktok River. In 1970, a minimum of 432 sheep were observed by ADF&G personnel during aerial surveys (Jakimchuk et al. 1984). In 1983, the population was observed to be a minimum of 545 sheep (ibid.). These figures represent only the animals actually observed, and the real population was estimated to be larger (ibid.). Under good survey conditions with experienced observers, 65-90% of the sheep present can be expected to be observed (Heimer 1982). If observers saw 85% of the sheep, the population in this area can be estimated to consist of about 650 sheep.

   The population in this area appears to be stable compared to sex:age ratios from other Alaskan sheep populations (ibid.). Table 3 lists sex and age class distribution of sheep observed from aerial surveys during 1982-1983.

2. Canning River. A minimum estimate of 500 sheep was derived for the Canning River drainage in 1972 (Roseneau and Stern 1974). This estimate was based on miscellaneous sightings of sheep obtained during other studies in the area and, compared to more recent information, appears to be too low.

   Helicopter surveys in 1973 produced a sheep population estimate of 1,125 animals (Klingel et al. 1974). This figure compared favorably to an estimate of 1,200 animals derived from ground and other miscellaneous observations made in 1977 (Smith 1977). Sheep research biologists have reviewed the population estimates for several areas in the Brooks Range, including the Canning River drainage. Based on 1984 survey efforts in adjacent areas, it was determined that population estimates for the Canning River and GMU 26B, in general, were too low. The revised sheep population estimate for the Canning River is 1,500 sheep (Heimer 1985). The Canning River sheep population appears to be relatively stable. Continued heavy hunting pressure could influence this population by reducing the number of mature rams (Klingel et al. 1974).

VII. GMU 26A

Estimates for Dall sheep populations in this area are not available. Generally, Dall sheep are present on the north slope of the Brooks Range, but have low densities in the western portions of GMU 26A (Heimer 1982). Population surveys need to be conducted in this area.

Table 3. Distribution of Age and Sex Classes of Sheep Observed on Aerial Surveys in Atigun Pass-Sagavanirktok River Area

	Summer					
	1981		1982		1983	
	No.	%	No.	%	No.	%
Ewes	106	(28.4)	182	(33.4)	194	(35.7)
Lambs	63	(16.9)	108	(19.8)	100	(18.4)
Yearlings	21	(5.6)	30	(5.5)	40	(7.4)
1/4 curl rams	22	(5.9)	48	(8.8)	33	(6.1)
1/2 curl rams	35	(9.4)	31	(5.7)	29	(5.3)
3/4 curl rams	26	(7.0)	21	(3.9)	36	(6.6)
4/4 curl rams	6	(1.6)	4	(0.7)	9	(1.7)
Unclassified rams	0	(0.0)	10	(1.8)	25	(4.6)
Unclassified sheep	94	(25.2)	111	(20.4)	78	(14.3)
Total	373	(100.0)	545	(100.0)	544	(100.1)

Source: Jakimchuk et al. 1984.

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Moose Distribution and Abundance

I. REGIONWIDE INFORMATION

Information will be organized and presented by game management units or subunits, where they exist within the Arctic Region (map 1).

A. Regional Distribution

Moose occur throughout most of the Arctic Region. Moose can be found throughout the Seward Peninsula, where they were almost nonexistent in the late 1950's (Grauvogel 1984). Pruitt (1966) reported observations of moose at Cape Thompson, Kivalina, Point Lay, and the upper Colville River. Moose were regular inhabitants of the lower Noatak River (ibid.). Moose are also seasonally distributed over the entire arctic slope of Alaska (LeResche et al. 1974) and have been counted on most major streams from the Kongakut River in the east to the Utukok River in the west (Coady 1979).

B. Areas Used Seasonally and for Life Functions

See the 1:1,000,000-scale printed maps in the Map Atlas of the Alaska Habitat Management Guide for the Arctic Region and the 1:250,000-scale reference maps located in ADF&G offices. The maps show the following categories:

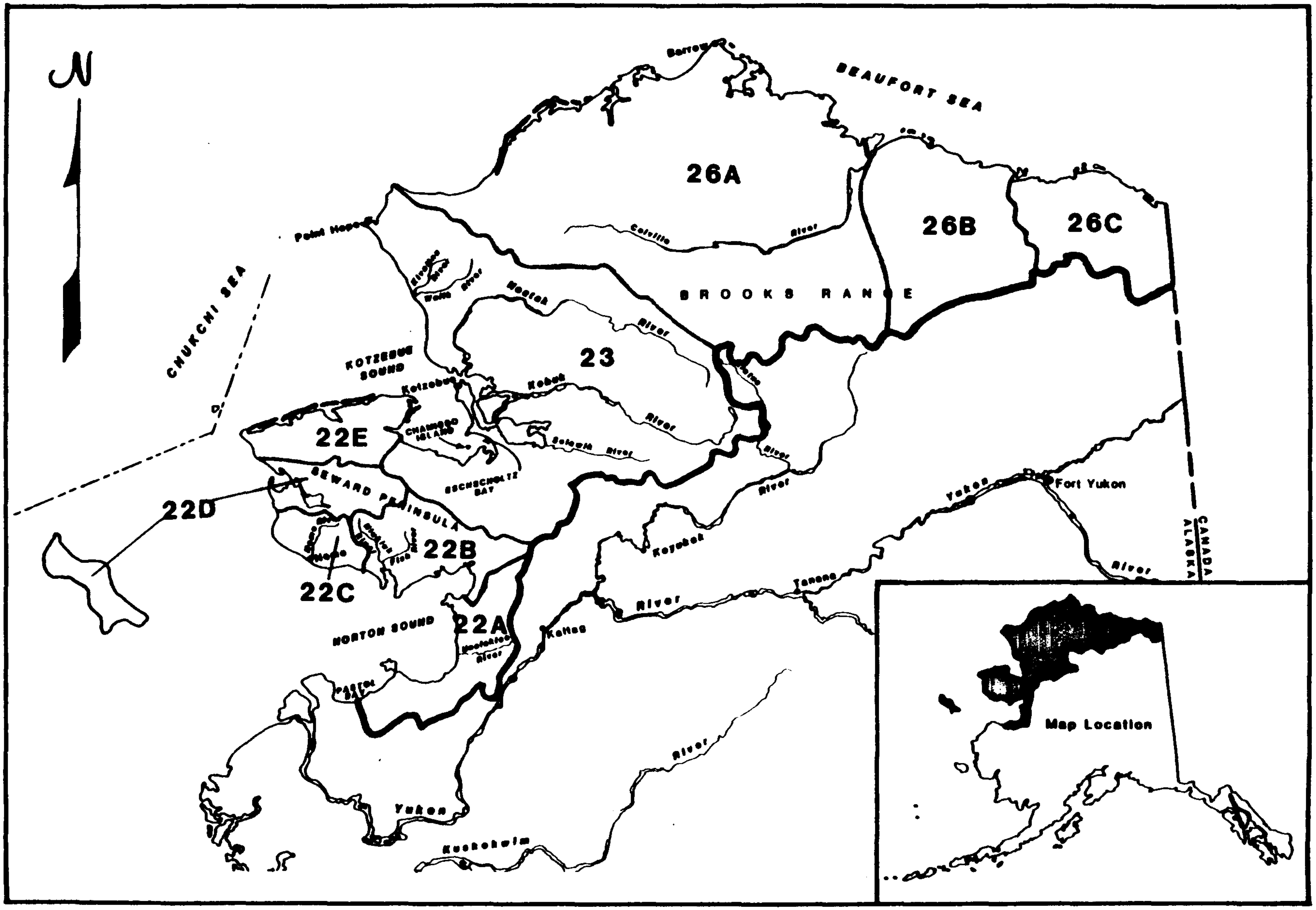
- ° General distribution
- ° Known winter concentration areas

C. Factors Affecting Distribution

- ° Quantity and quality of areas of riparian willow for use as winter habitat (Coady 1979, LeResche et al. 1974)
- ° Winter snow conditions (Coady 1979)
- ° Insect harassment (Mould 1979)
- ° Frequency of wildfires and suppression policy
- ° Industrial development (mining, oil, etc.)

D. Movements Between Areas

Except for a portion of the Seward Peninsula, little is known about moose movements in the Arctic Region. Grauvogel (1984) studied the seasonal movements of moose on the central Seward Peninsula in the Kuzitrin and Agiapuk drainages and found two types of patterns. Sedentary, or nonmigratory moose, included animals who, during an annual cycle moved less than 24 km (15 mi) from their capture point on winter range. These moose generally moved to a different elevation or vegetation type. Highly migratory moose covered large distances, greater than 32 km (20 mi). According to these criteria, 19% (n=37) of the moose were sedentary, 59% were highly migratory, and 22% were intermediate. Moose on the Seward Peninsula remain on winter range until May, when warming temperatures and the emergence of willows from snow cover appear to stimulate movement from winter range. By late May or early June, migratory moose were found in summer range. These animals often traveled 50-100 km (31-62 mi) in less than 20 days.



Map 1. Game management units in the Arctic Region.

Sedentary and intermediate moose often took two to six weeks to move from winter to summer range. Moose movements back to winter range generally began in early November, lasting through January. Snow accumulation was the most important factor determining the timing and duration of these movements.

Distances between winter and summer ranges varied from 6 to 80 km (4 to 50 mi), with a mean distance of 13 km (8 mi) for sedentary/intermediate moose and 48 km (30 mi) for migratory moose. These distances are in the middle-to-high range when compared to other populations in Alaska. Seasonal fidelity to the same winter range was high; 29 of 32 moose (91%) returned to the winter range of capture. Twenty-two moose (69%) returned to within 6 km (4 mi) of their point of capture. Annual home range size was highly variable, ranging from 91 to 1931 km^2 (35 to 746 mi^2), with the mean at 748 km^2 (289 mi^2) for bulls and 606 km^2 (234 mi/) for cows. For more specific information on the movements and home ranges of Seward Peninsula moose, see Grauvogel (1984).

E. Population Size Estimation

Abundance esitmates are based on several techniques or a combination of techniques. Gasaway et al. (1981) have developed a sampling procedure for estimating moose abundance based on a stratified sampling design, which includes estimating the sightability of moose under different environmental conditions. Such censuses have been conducted in portions of some GMUs within the Southcentral Region. Based on results from censuses combined with fall composition counts in specific areas, gross population estimates can be made for individual composition count areas. In some instances, gross estimates are extrapolated for the subunits in which they are located. Some gross abundance estimates are based on a combination of data from fall composition counts and the experience of area management biologists responsible for the particular GMU or subunit.

Abundance estimates should be interpreted cautiously. There are great differences in sampling intensity, experience of pilots and or observers, habitats, light conditions, and so forth, all of which can drastically alter estimates and comparisons between areas. Determining the number of moose present but not observed during aerial surveys is a major obstacle to making accurate estimates of a population size (Coady 1981). The sightability of moose is influenced not only by the habitat they are using but also by the climatic conditions prevailing at the time the surveys are made. When the snow cover is not complete, for example, bare patches of vegetation make observation of moose difficult. Or if the snow cover is old, an abundance of tracks may indicate only that moose have been in the area but are not necessarily present at the time of the survey, whereas fresh snow would permit an observer to "read" the tracks more clearly and to locate the moose more readily.

F. Regional Abundance

Abundance estimates will be discussed by game management unit and/or subunits.

II. GMU 22

A. Present Abundance

Based on a total count of 2,727 moose, fall composition surveys, and reported harvest data, an estimate of 3,260-4,150 moose was calculated (Grauvogel, pers. comm. and in press).

B. Historic Distribution and Abundance

Historical records suggest that moose did not occupy the Seward Peninsula (most of GMU 22) until the mid 1930's, when a few moose immigrated westward onto the peninsula from various Yukon River drainages (Grauvogel 1985). The number of moose began to increase in the 1950's (Coady 1980). However, an aerial survey conducted by the ADF&G in the spring of 1960 revealed only 13 moose, all in the eastern portion of the peninsula (Grauvogel 1984). Moose probably occurred for some time in small, disjunct groups along streams flowing into Norton Sound south of the Seward Peninsula in Game Management Subunit (GMS) 22A (LeResche et al. 1974).

Tree line extends to the coast along many streams in this area. During the early 1960's, moose numbers gradually increased, and by the late 1960's, aerial surveys revealed that the moose population had increased dramatically (Grauvogel 1984). By this time, moose had expanded their distribution into all areas containing suitable winter habitat. Grauvogel reported that by the mid 1970's the population growth rate had declined and that moose numbers had stabilized in some areas at this time.

Coady (1980) hypothesized that neither lack of suitable habitat nor excessive predation appeared to be important factors in preventing the establishment of moose populations on the Seward Peninsula. However, hunting by widely dispersed miners, winter trappers, and reindeer herders may have kept the numbers of immigrant moose from populations east of the area at low levels. In the 1940's, these activities declined, and most miners left the interior areas of the peninsula. The resulting decrease in hunting of immigrant moose probably allowed the species to become established during the 1950's and 1960's (ibid.).

1. GMS 22A:
   a. <u>Present abundance</u>. In Subunit 22A, Grauvogel (in press) estimated 250-400 moose in 1984, based on a partial count of 69 animals.
   b. <u>Historic distribution and abundance</u>. See GMU 22 summary.
2. GMS 22B:
   a. <u>Present abundance</u>. Grauvogel (in press) estimated 1,000-1,400 moose in Subunit 22B, based on a count of 820 animals in 1984.
   b. <u>Historic distribution and abundance</u>. See GMU 22 summary.

3. GMS 22C:
   a. Present abundance. In Subunit 22C, Grauvogel (in press) counted 149 moose in 1984 and estimated 160-200 moose in the area.
   b. Historic distribution and abundance. See GMU 22 summary.
4. GMS 22D:
   a. Present abundance. Grauvogel (1985) reported that over the last decade the highest moose density of all the subunits has occurred in this area. In 1984, 1,487 moose were counted and resulted in a population estimate of 1,600-1,800 animals (ibid.).
   b. Historic distribution and abundance. See GMU 22 summary.
5. GMS 22E:
   a. Present abundance. In Subunit 22E in 1984, there were 250-350 moose estimated, based on a count of 202 animals (Grauvogel, in press).
   b. Historic distribution and abundance. See GMU 22 summary.

III. GMU 23

A. Present Abundance

Quimby and James (1985) completed winter moose surveys in March 1984 and made a conservative estimate of 5,000 moose to be used as a basis for management until better data become available. They also estimated a maximum population size of 7,000 moose at that time. Spring 1985 moose density surveys conducted within a 5,478 sq km² (2,115 mi²) area in the Noatak drainage resulted in a population estimate of 2,227 ± 26% at the 90% confidence level. This demonstrates the extremely conservative nature of some but not all estimates in GMU 23 (James, pers. comm.).

Table 1 describes the status of various moose subpopulations in GMU 23. These subpopulations, however, are not very discrete, and movements between groups occur regularly.

B. Historic Distribution and Abundance

The accounts of most travelers and explorers passing through GMU 23 point out the scarcity of moose in this region during the late 1800's. A few reports note the occurrence of moose at this time in the upper Kobuk River valley only (Coady 1980). Quimby and James (1985) mentioned that some moose were taken as early as the 1920's in the upper Noatak River drainage. By the late 1930's, moose were harvested on a more regular basis in this area, and by the late 1940's moose were found in low numbers throughout most of GMU 23 except the northern drainages of the Seward Peninsula (ibid.). Moose increased rapidly and attained maximum numbers in the mid 1970's because of the availability of excellent habitat, predator control programs of the USFWS, and intense law enforcement by territorial game wardens (ibid.). Since that time, the population has remained stable except for some minor increases and declines in selected areas.

Table 1. Status of Moose Subpopulations in GMU 23 Based on Winter 1984 Aerial Surveys

Drainage	Number Counted	Estimated Subpopulation Size	Percent Calves	Trend
Wulik-Kivalina	158	175	22	Increasing moderately
Noatak	1,120	1,900	14	Stable or slowly increasing
Kobuk	641	1,600	23	Stable or declining slowly
Selawik-Tagagwik-Mongook-Kauk	428	1,000	20	Increasing slowly
Buckland	67	175	9	Declining
Kiwalik-Kugruk-Inmachuk-Goodhope	483	700	16	Increasing moderately
Totals	2,897	5,550	17	Stable

Source: Quimby and James 1985.

IV. GMU 26

A. Present Abundance

Aerial surveys were conducted to enumerate moose populations on most major streams south of 70° north latitude between the Utukok and Kongakut rivers in 1970 and 1977. Between 1,550 and 1,700 moose were observed in a similar distribution pattern for both years (Coady 1981). Results of unitwide surveys completed in late winter 1984 revealed an increase to 2,329 moose (Trent 1985). Differences in survey conditions, geographical coverage, and methodologies, as well as an increase in moose numbers, should be considered in evaluating the survey results.

B. Historic Distribution and Abundance

Peterson (1955) suggested that moose were able to survive the late Pleistocene glaciations in major refugia in central Alaska. When conditions were more favorable, postglacial emmigration of moose occurred from these refugia into other areas of Alaska (ibid.). Coady (1980), in a detailed historical review, reported that moose were not observed north of the Brooks Range before 1880 and were considered scarce until the 1940's. This does not suggest a total absence of moose on the North Slope, because Hall (1973) described prehistoric evidence of moose at several archaeological sites in that area. He suggested the expansion of moose range into that

part of Alaska over time. By the early 1950's, moose were regularly observed and considered common but were limited mainly to an area east of the Colville River.
Chesemore (1968) described several observations of moose in the Barrow area and Meade River between 1958 and 1963. LeResche et al. (1974) reported increased numbers of moose on the arctic slope from the early 1950's to the early 1970's, with little changes in distribution. Moose population densities appeared highest between the Colville and Canning rivers, and LeReshe et al. (1974) noted that moose do occur outside this area along almost all major streams.

1. GMS 26A:
   a. Present abundance. In Subunit 26A in 1984, Trent (1985) observed 1,429 moose and estimated a maximum number of 1,786, based on an estimated 89% sightability index. Highest wintering moose densities occurred in the middle Colville River region. The 1984 counts along the entire Colville River indicated a 13% increase over those made in 1977 (1,418 vs. 1,257). The central Colville River trend count area contains the best winter habitat in GMS 26A. The 1984 count of 756 moose was a 10% increase over the mean of the nine previous counts made from 1970 through 1982, and indicated that population size and calf survival had returned to the previous high levels observed between 1977 and 1980.
   b. Historic distribution and abundance. See GMU 26 summary, Coady 1980, Mould 1977, and LeResche et al. 1974.
2. GMS 26B:
   a. Present abundance. All major and most minor drainages were surveyed during late winter 1984 in good weather conditions. Boertje (1985) reported a count of 569 moose in this subunit and estimated total numbers of moose at 600-650 animals, based on his knowledge of moose habitat in areas not surveyed, experience with the survey technique, and survey conditions. Moose populations were considered stable or increasing slowly.
   b. Historic distribution and abundance. See GMU 26 summary, Coady 1980, LeResche et al. 1974, and USFWS 1982.
3. GMS 26 C :
   a. Present abundance. All major and most minor drainages were surveyed during late winter 1984 in good weather conditions. Boertje (1985) reported a count of 321 moose in this subunit and estimated total numbers of moose at 330-360 animals. Compared to data collected by USFWS biologists, Boertje's (1985) counts indicated that moose numbers had increased by 29% in the Kongakut drainage and remained stable in the Canning River drainage.

b. Historic distribution and abundance. See GMU 26 summary, Coady 1980, and LeResche et al. 1974.

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Birds

Ducks and Geese Distribution and Abundance

I. REGIONWIDE INFORMATION

Estimates of waterfowl distribution and abundance in Alaska are made annually by the USFWS. Alaska is divided into 11 survey strata, with 224 survey segments (map 1).

Aerial surveys along standard predetermined flight lines are conducted during mid May to mid September. Because of the consistent nature of these surveys, data obtained are comparable to previous surveys and provide a reliable index of duck abundance in large units of habitat in Alaska.

The USFWS aerial surveys are designed for estimating numbers of ducks, and in most strata goose sightings are too few to make a statistically significant sample. Goose distribution and abundance estimates are therefore not specifically made during these surveys but are generally compiled from USFWS observations in conjunction with the reports of other researchers and observers (King and Conant 1983). Because of this survey design, distribution and abundance data presented in this narrative will be for waterfowl as a group, with area- and species-specific information provided where available. The data are obtained primarily from the annual USFWS survey, with other information sources noted. Information is organized by area, with separate discussions of the arctic slope and Seward Peninsula/Kotzebue Sound areas.

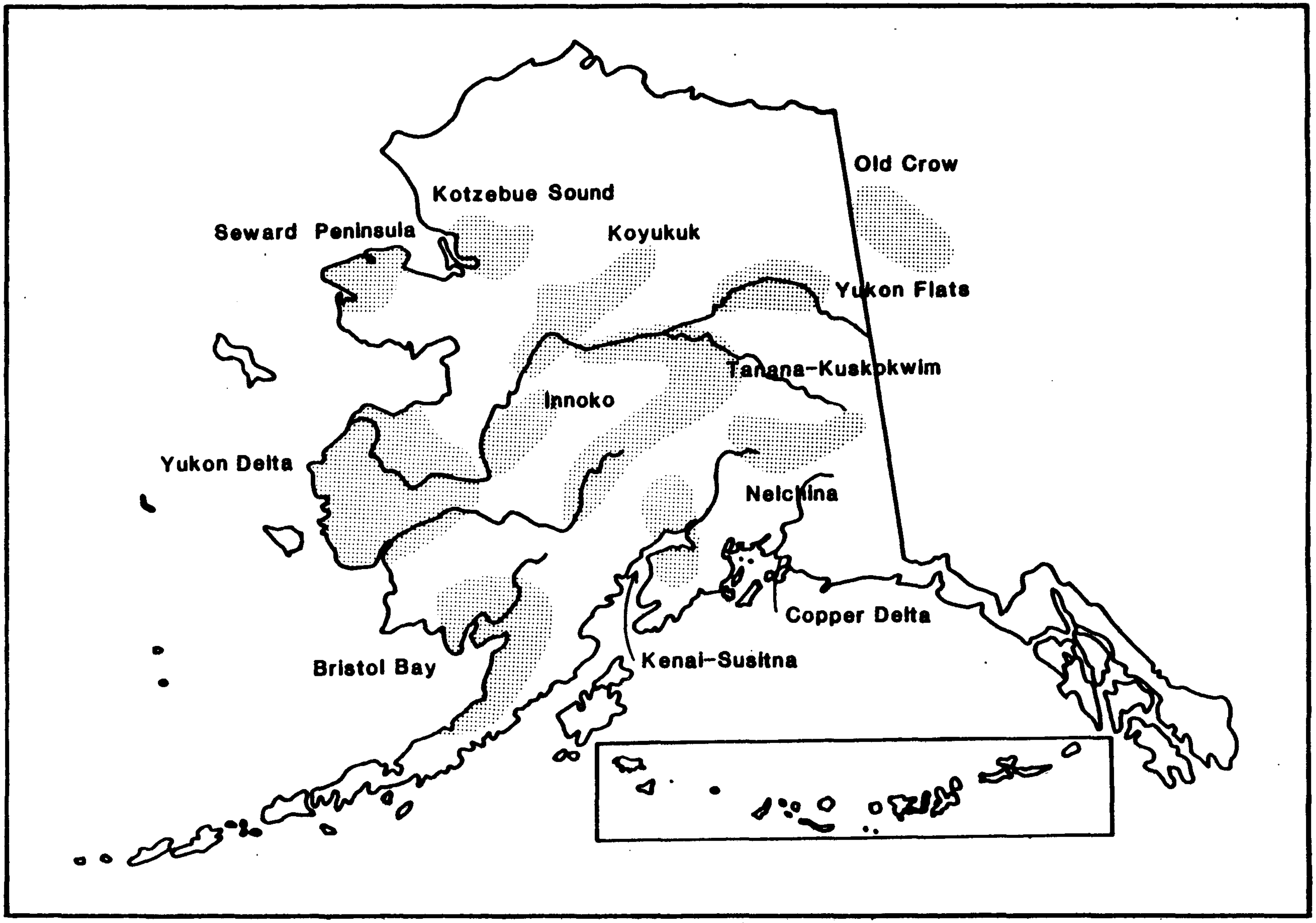
A. Regional Distribution

As a result of its unique geographical position and regional variations in topography and climate, Alaska's avian populations are impressively large and varied. Waterfowl using Alaskan habitat have an average fall population of about 13 million and migrate to all states and many foreign countries (King and Lensink 1971).

Alaskan bird habitat falls into six basic regions. The southeast coastal rain forest, the Alaska Peninsula and Aleutian Islands west of Kodiak, the boreal forest region in the solar basins of the great river valleys of the interior, the western tundra areas, the arctic slope along the Arctic Ocean, and the marine waters of the continental shelf adjacent to Alaska.

This narrative covers the arctic slope area of Alaska and the tundra areas of the Seward Peninsula/Kotzebue Sound area north to the arctic slope.

1. Arctic slope. On the north side of the Brooks Range foothills give way to rolling uplands and then an almost level plain liberally sprinkled with lakes and ponds that extends to the arctic coast (ibid.). Much of the coastline is protected by a chain of flat barrier islands composed largely of gravel (ibid.). The climate here in the farthest north portion of the North American mainland approaches high arctic conditions by comparison with the milder climate of



Map 1. The USFWS Alaska waterfowl breeding population survey strata (Conant and Hodges 1984).

the rest of Alaska (ibid.). The waterfowl habitat consists of about 23,000 mi^2 of lowland and has an estimated spring breeding population of nearly one-half million ducks and geese (ibid.). Perhaps of even greater importance than this breeding habitat is the migration route along the coast (ibid.). The king eider migration alone has been estimated at one million birds passing Point Barrow (ibid.). Two-thirds of the bird fauna of the Canadian arctic islands pass this way, including large numbers of black brant and oldsquaw (ibid.). The barrier islands are important for nesting eider, shorebirds, and gulls and are thought to have been the site of a former breeding colony of snow geese (ibid.). An area near Cape Halkett is a molting resort for more than 100,000 lesser Canadas, black brant, whitefronts, and snow geese (ibid.). Oldsquaw ducks and Canada geese use the protected area between the barrier islands and the coast for molting (ibid.).

More than half the waterfowl habitat of the North Slope is within the Naval Arctic Petroleum Reserve #4. In addition, there is a considerable amount of good habitat within the Arctic National Wildlife Range (ibid.).

2. Seward Peninsula. The Seward Peninsula contains several small but productive units of habitat, which contain a breeding population of about 231,000 ducks (ibid.). Population densities for ducks, about 60/mi^2, are higher than for the average of any other habitat in western Alaska, although large portions of the Yukon delta are superior. Pintail and greater scaup are the most important species, forming about half of the population (ibid.). Goose populations are relatively less important than on the Yukon delta (ibid.); lesser Canada geese are dominant, followed by black brant and emperor geese. White-fronted geese populations are low or rare (Grauvogel, pers. comm.) . Coastal lagoons provide important habitat during migration, providing the only significant sheltered waters along the coast between the arctic and the Yukon delta (ibid.).

   Historical information, including reports by local residents and the evaluation of the available habitat, suggests that goose populations of the area have been seriously depleted by subsistence hunting of Eskimo residents (ibid.). Potential threats to waterfowl populations, however, are primarily related to possible developments of the petroleum industry (ibid.).

3. Kotzebue Sound. Waterfowl habitat of Kotzebue Sound is located primarily in the valley of the Noatak River, the Kobuk River valley and delta, and a lake region inland from Selawik Lake along the Selawik River (ibid.). The summer season in this coastal area is slightly shorter than that of the Yukon delta, but inland, along the Kobuk River, climate and vegetation are similar to that of interior habitats

(ibid.). The breeding population averages about 44 ducks/mi^2, only slightly lower than densities on the Yukon Delta (ibid.). Pintail, greater scaup, and widgeon form more than two-thirds of the population (ibid.). Goose populations are generally low, except in the Selawik area where Taverner's Canada geese and white-fronted geese are common (ibid.).

Significant waterfowl breeding as well as critical migratory/staging habitat occurs in the wetland forelands of Koyuk, Golovin Bay, Port Clarence, Wales to Shishmaref, Espenberg to Nugnugaluktuk River, Spafarief Bay to Eschscholtz Bay (including the Kauk River basin lakes), and the lagoon/wetland system from Sheshalik to Point Hope (King 1983). (For detailed descriptions of specific species distributions see I.F., below.)

B. Areas Used Seasonally

Large numbers of waterfowl utilize the arctic slope and western coastal areas during spring and fall migration and during summer brooding and molting. For more specific information on waterfowl distribution in Arctic Alaska, see the 1:1,000,000-scale index maps in the Atlas to the guide for the Arctic Region and the 1:250,000-scale reference maps in ADF&G offices, which list specific waterfowl use areas. Use categories for these maps are listed below:

- General distribution
- Known spring concentrations
- Known fall concentrations
- Known nesting concentrations
- Known molting concentrations
- Known winter concentrations

In addition, migratory routes are noted.

C. Factors Affecting Distribution

Several factors influence distribution of waterfowl. Most waterfowl are migratory to some degree, and timing and general tendencies for movement may be initially transmitted from generation to generation. Also a considerable portion of the specific migration pattern depends on migration "traditions" learned by younger birds from older birds (Johnsgard 1975). Such traditions can result in overuse of traditional breeding habitat areas and nonuse of apparently satisfactory potential breeding habitat. If a population traditionally utilizing an area is extirpated for some reason such as overpredation, disease, or pollution, the result may be nonuse of quite good breeding habitat for an indefinite time. The reduction of the breeding range of snow geese levels on the North Slope may be such an example (Andersen 1973, Bailey 1948, Gabrielson and Lincoln 1959). (See explanation under III.B.1. below.) Other factors influencing distributions of breeding populations are suitable nesting habitat and, for both breeding and nonbreeding individuals, suitable feeding habitat, which varies from species to species. Shifting food availability may also influence distribution. Spindler (1979), for instance, attributes local changes in bird (predominantly oldsquaw) distribution in Simpson Lagoon to changing location of invertebrate concentrations, which in turn were controlled by many interrelated biophysical factors. Bird use of individual lagoons varied annually as well as seasonally. Weather conditions may also influence waterfowl distribution by their effect on the timing of migration to northern breeding areas, and early cold in the fall may hasten winter migration. Other factors, such as drought in the southern prairie of the United States, which reduces available habitat, particularly of dabblers such as pintails, appear to cause a large population shift to arctic wetlands (Hansen and McKnight 1964). The arctic coastal plain wetlands, with their rich invertebrate food resources and stable water levels, are an important alternative habitat during years of drought in the more southern prairie regions (Derksen and Elridge 1980). (For habitat preferences of specific waterfowl species, see the Life History and Habitat Requirements narrative in volume one of the Alaska Habitat Management Guide for the Arctic Region.)

D. Movements Between Areas

Tremendous numbers of arriving and migrating birds move into the coastal areas of arctic Alaska in the spring. Timing of migration is related to the pattern of spring breakup, and birds move into the nesting area via the MacKenzie and Yukon rivers and along the coastlines. Around mid July, many waterfowl species shift from breeding areas to lakes, ponds, and coastal areas to molt. As freeze-up approaches, birds move out of the north along the water routes used in spring (King and Lensink 1971).

E. Population Size Estimation

1. USFWS waterfowl surveys. The USFWS conducts annual breeding population surveys to measure the status of the breeding population of waterfowl, primarily duck species, on the major continental breeding grounds. Currently, the surveys monitor waterfowl population and habitat changes over approximately 1.3 million mi^2 of breeding habitat within Alaska, Canada, and the northcentral states.

   The survey period in Alaska is approximately from mid May to mid September, depending upon the date of the spring ice breakup.

   Alaska is divided into 11 survey strata (map 1). A stratum is a specific geographic unit encompassing areas of similar habitat type and waterfowl densities. Based on these descriptions, strata in Arctic Alaska are placed into the 8 and 11 group (Coastal Alaska Tundra). Transects within the stratum are a continuous series of segments usually parallel to each other, from 14 to 60 mi apart and equally spaced over the stratum. Alaska survey segments comprising the transects are 8 or 16 mi long and 1/4 mi wide, giving a sampling area of 2 or 4 mi^2 each (Conant and Hodges 1984a).

The species population index is computed by using the formula P = A·T/S·V, where A = the square miles in the stratum, T = the total observed birds, S = the square miles in the sample flown, and V = the species visibility factor.

Waterfowl populations can be adequately censused by these techniques designed for large land areas (i.e., continents). Comparisons at the smaller stratum level should be viewed as only part of a total index population (Conant, pers. comm.). Therefore, changes and/or comparisons in waterfowl population should be over a longer period and at the statewide level.

Table 1 shows the 10-year trend in Alaska-Yukon waterfowl breeding population estimates by species. These data present the waterfowl population estimates on a statewide basis over a longer period and are a better basis from which to make comparisons. The 1984 waterfowl population was slightly above the 10-year trend and compares favorably with previous years. The total population appears to be continuing its slightly increasing trend (table 1).

A variety of estimation techniques were used by the numerous authors cited herein. Because of the diversity and complexity of the methods used, the interested reader is directed to the citations accompanying the population estimates.

F. Regional Abundance

The 1974-1983 average estimated Alaskan breeding population is 6,012,900 birds (table 1). The 1984 population estimate shows a 2% increase over the 1983 population and a 1% increase over the 10-year average.

All dabbler species increased, mallards most noticeably, and are 15% above their 10-year average, with the exception of pintail. Pintails continue their slow increase but are still 16% below the 10-year average (Conant and Hodges 1984a).

Canvasback and scaup both increased and are 26% and 12%, respectively, above the 10-average. Bufflehead continues to decline for no apparent reason and is 34% below the 10-year average. Oldsquaws apparently declined by 40% from 1983 and 38% from the average. This apparent decline is related to their absence from the Yukon Flats in 1984, where they are sometimes recorded during migration. Scoter population estimates were also down from 1983. This was probably due to an average migration period compared to an early one in 1983 (ibid.).

II. ARCTIC SLOPE AREA

A. Present Abundance

1. Canada goose. Canada geese have been reported nesting in few locations on the arctic coastal plain. Although nearly 27,000 have been counted in the Teshepuk Lake area (King, pers. comm.), where they spend the molt period, none have been reported as nesting on the coastal plain in the National Petroleum Reserve - Alaska (NPR-A) (Derksen et al. 1977).

Table 1. Alaska-Yukon, Status of Adjusted Waterfowl Breeding Population Estimates by Species and Strata, Comparing 1984 with 1983 and the 1974-83 Average (Estimates in Thousands)

Ducks	*Strata			Total 1984	Total 1983	1974-1983 Average	% Change from 1983	% Change from Avg.
	1-7	8-11	12					
Dabblers:								
Mallard	233.3	170.0	29.1	432.4	270.5	263.5	+60	+64
Black duck	0.0	0.0	0.0	0.0	0.0	0.0	---	---
Gadwall	5.2	1.0	0.0	6.2	2.3	2.6	+170	+138
Am. widgeon	456.1	344.3	91.3	891.7	765.7	727.8	+16	+23
G.W. teal	160.3	175.6	8.3	344.2	283.7	300.4	+21	+15
B.W. teal	2.8	2.1	0.0	4.9	1.5	1.6	+227	+206
N. shoveler	165.5	88.1	4.2	257.8	204.2	235.1	+26	+10
Pintail	600.3	663.3	21.0	1,284.6	1,277.5	1,534.0	+1	-16
Subtotal	1,623.5	1,444.4	153.9	3,221.8	2,805.4	3,065.0	+15	+5
Divers:								
Redhead	0.3	0.0	0.0	0.3	1.5	4.2	-80	-93
Canvasback	96.1	17.9	3.7	117.7	108.1	93.4	+9	+26
Scaups	847.4	592.7	111.8	1,551.9	1,398.6	+11	+12	
Ringneck	15.7	11.7	0.9	28.3	3.0	1.7	+840	+1,559
Goldeneyes	80.3	41.3	9.0	130.6	112.0	130.9	+17	no change
Bufflehead	50.1	4.5	0.3	54.9	64.0	83.7	-14	-34
Subtotal	1,089.9	668.1	125.7	1,883.7	1,687.8	1,703.5	+12	+11
Miscellaneous:								
Oldsquaw	51.7	357.2	56.2	465.1	771.8	748.2	-40	-38
Eiders	0.0	15.5	0.0	15.5	19.5	20.1	-21	-23
Scoters	96.6	296.4	59.4	452.4	678.6	466.7	-33	-3
Ruddy duck	0.4	1.8	0.0	2.2	0.0	0.0	---	---
Mergansers	21.5	9.5	0.7	31.7	10.7	9.4	+197	+238
Subtotal	170.2	680.4	116.3	966.9	1,480.6	1,244.4	-35	-22
Total ducks	2,883.4	2,792.7	395.9	6,072.0	5,973.8	6,012.9	+2	+1

Source: Conant and Hodges 1984a.

--- means no data were available.

* 1-7 Interior Alaska Taiga; 8-11 Coastal Alaska Tundra; 12 Old Crow Flats, Yukon Territory, Canada.

In the Canning River delta, they are considered to be rare visitants (Martin and Moitoret 1981). Bergman et al. (1977) observed them in three of five years at Storkenson Point, with a maximum of 65 seen. Three birds were observed in two years at the Simpson Lagoon area (Johnson and Richardson 1980). At Icy Cape, 100 birds were observed during spring migration.

King (1970) has estimated 15,000 Canada geese molting along the Beaufort Sea coast from Smith Bay to the Canning River and suggested most were nonbreeders from interior Alaska south of the Brooks Range.

Kessel and Cade (1958) found 200-300 pairs of Canada geese breeding along the Colville River. A few pairs nest on islands (e.g., Howe Island, Duck Islands, Tigvariak Island) near Prudhoe Bay (Gavin 1976), and a nest was found at Storkersen Point in 1978 (Derksen et al. 1981). In the Arctic National Wildlife Range (ANWR), Spindler (1978a) reported "two pairs probably nested in the study area" at the Okpilak River delta. In the Canning River drainage, the Canada goose is a fairly common breeder and common migrant (Martin and Moitoret 1981).

2. Black brant. Brants breed sparingly on the Alaska Beaufort Sea coast, apparently more commonly to the west than to the east. Gavin (1972) reported a total of 293 nests in the Colville River delta. Derksen et al. (1981) reported nesting at four outer coastal plain sites, with a colony of 98 nests found at Island Lake (Derksen et al. 1979). Gavin (1972, 1975) reported that brants nest in river deltas and on some offshore islands in the Prudhoe Bay area. In ANWR, Spindler (1978a) found a colony of 15 pairs at the Okpilak River delta. Spindler et al. (1984) considers them to be an uncommon spring and fall migrant and a breeder in the Okpilak River delta.

Brants are found in large numbers in the Teshepuk Lake area, where they congregate while they undergo molt. Up to 32,000 have been counted there in mid July (Derksen et al. 1979).

Brants are commonly seen on the Alaskan arctic coastal plain in migration. Spring migrants have been recorded from Anaktuvuk Pass (Irving 1960) and well inland on the arctic coastal plain in migration (Kessel and Cade 1958). In fall, they appear to be confined to a narrow corridor along the Beaufort Sea coast, and a fall passage of from 3,000 to 15,000 has been recorded in various studies from the Yukon River to Point Barrow (Johnson et al. 1975). In the Canning River drainage, the black brant is an uncommon breeder and common-to-abundant migrant (Martin and Moitoret 1981). An estimated 24,000+ passed the Canning River in early June (Martin and Moitoret, pers. comm., cited in Lehnhausen and Quinlan 1981).

3. White-fronted goose. King (1970) estimated the breeding population of white-fronted geese on the Arctic slope at 50,000. White-fronted geese are a fairly common breeder from the central arctic slope to the west. In 1974, Sage reported white-fronts nesting between Franklin Bluffs and White Hills (in the Sagavanirktok River drainage) and Derksen et al. (1981) reported nesting at Storkersen Point and from all their study sites in the NPR-A. White-fronted geese molt in small flocks throughout much of the arctic coastal plain, although they are most concentrated at a few lakes near Teshepuk Lake, where up to 4,900 geese have been counted during the molt period (Derksen et al. 1979, Derksen et al. 1981). Of the four species of geese occurring in the NPR-A, white-fronted geese were the most numerous and widely distributed (King 1978a). East of the Sagavanirktok River drainage, this species seems to be much less common. In the ANWR, Spindler (1978a) at the Okpilak River delta, Schmidt (1973) at the Beaufort Lagoon, Lenhausen and Quinlan (1981) at Demarcation Point, and Spindler (1984) at Katakturak and Jago rivers all recorded this species in spring but found them absent in mid summer. In the Canning River drainage, the white-fronted goose is an uncommon-to-fairly common spring migrant and common fall migrant (Martin and Moitoret 1981).
4. Snow goose. The only known breeding colony of snow geese in the United States is located on Howe and Duck islands in the outer Sagavanirktok River delta in the Prudhoe Bay area (Johnson et al. 1975), where approximately 60 pairs nest (Welling et al. 1980). Scattered pairs are found nesting in other locations, such as the Meade River, Colville River, and Sagavanirktok River (Johnson et al. 1975), at East Long Lake (Derksen et al. 1981), and at Flaxman Island (Gavin 1976). In the Teshepuk Lake area, an important goose molting area, two broods of two and four were noted in 1979; 3 young were observed in 1982 and 10 young in 1983; young were not noted in 1976, 1977, 1978, or 1984 (King, pers. comm.). Molting snow goose populations in these years ranged from about 85 to over 700 birds, with a most recent population of 256 in 1984 (Derksen et al. 1979; King, pers. comm.).
In the ANWR, there are typically small flocks of snow geese (five to 75 birds) noted in June, with the net direction of movement often uncertain (Schdmidt 1973, Spindler 1978, Lehnhausen and Quinlan 1981). In fall, there is a massive influx of snow geese into the coastal plain of the ANWR from the Anderson River delta in the Northwest Territories (Spindler 1978b). A total of 12,828 birds were estimated in ANWR during fall staging in 1983 (Garner and Reynolds 1984). In 1979, Spindler (1979) recorded 80,000 snow geese in the ANWR during fall staging. The most consistently used areas in ANWR are east of Barter Island. In the Canning River

drainage, the snow goose is an uncommon spring migrant, rare summer visitant, and common fall migrant (Martin and Moitoret 1981).

5. Pintail. Derksen et al. (1981) considered pintails to be the most numerous duck on the arctic coastal plain, although in the ANWR it is not as common as the oldsquaw (Schmidt 1973, Anderson 1973), at least in some years. In the NPR-A, 90% of the dabbling ducks observed were pintails. At Icy Cape, 2,000 birds were recorded passing through during spring migration (Lehnhausen and Quinlan 1981). King and Lensink (1971) estimated a breeding population of 120,500 birds on the arctic slope. On the arctic coastal plain, pintail drakes generally outnumber hens by a wide margin, and most birds appear to be nonbreeders. In years of drought in the southern prairies, pintails occur in greater numbers in the arctic (Derksen and Eldridge 1980). Nesting seems to be more frequent in the western portions of the arctic coastal plain than in the eastern portions (Pitelka 1974). Schmidt (1973), however, did see broods in the Beaufort Lagoon area in the ANWR, and Spindler (1984) also found pintails to be fairly common breeders and fall migrants in the Okpilik River area of the ANWR. Spindler (1984) also found them to be a common summer resident and a fairly common breeder on the Jago River and an uncommon breeder and spring migrant on the Katakurak River in the ANWR. In the Canning River drainage, pintails are considered a very common migrant, a common summer resident, and a rare breeder (Martin and Moitoret 1981). In the eastern arctic coastal plain, pintails are more abundant as a migrant than as a summer resident, although their secretive behavior during molt probably gives a false impression of scarcity during mid summer (Martin and Moitoret 1981).

6. Green-winged teal. Green-winged teals are relatively rare on the North Slope but occur throughout the area in small numbers (Bailey 1948, Gabrielson and Lincoln 1959, Pitelka 1974). King and Lensink (1971) estimated a breeding population of 4,200 birds on the arctic slope. Green-winged teals breed in the interior arctic coastal plain to the west: at Umiat (West and White 1964) and at Anaktuvak Pass (Irving 1960). To the east it has been recorded as breeding in the interior arctic coastal plain in the Sagavanirktok River drainage (Sage 1974). In the ANWR, it has been recorded frequently in spring in many locations. Small numbers of green-winged teals were seen at the Beaufort Lagoon on the Aichilik River delta on June 24, 1970 (Schmidt 1973, Anderson 1973). They were also seen on the Okpilak River delta in June 1978 and in 1983 (Spindler 1978) and on the Sadlerochit River on May 22, 1979 (Spindler 1984). At Demarcation Point, to the east, green-winged teals were fairly common in both 1978 and 1979 (Lehnhausen and Quinlan 1981) and were breeding

there in 1979 (ibid.). At Katakturak River, Spindler (1978a) considers them to be uncommon breeders in the foothills.

In the Canning River delta, they are considered to be rare visitants (Martin and Moitoret 1981). Bergman et al. (1977) observed them in three of five years at Storkenson Point, with a maximum of 65 seen. Three birds were observed in two years at the Simpson Lagoon area (Johnson and Richardson 1980). At Icy Cape, 100 birds were observed during spring migration.

7. American widgeon. American widgeons are a "casual visitor" at the NPR-A study sites (Derksen et al. 1981). West and White (1964) described this species as "fairly numerous" in the Umiat area in 1964 and recorded several brood observations. Broods have also been observed in the Brooks Range (Irving 1960). Gavin (1972) described this species as having a "widely scattered light population," with most of his sightings in the Colville River area. Bergman et al. (1977) indicated irregular occurrence at Storkersen Point; a maximum count of 145 was recorded there in four years of study. In the ANWR, widgeons appear to be frequent migrants. Schmidt (1973) recorded three flocks in June 1970 in the Beaufort Lagoon area, with a maximum of 50 seen just east of the Kongakut River delta 24 June 1970. Up to 13 were seen on nine dates during 25 May-10 June 1979 at Demarcation Point (Lehnhausen and Quinlan 1981), and two pairs were seen at Sadlerochit Springs, 22 May 1979 (ibid.). At Simpson Lagoon eight birds were observed in 1977 and none in 1978 (Johnson and Richardson 1980).

8. Oldsquaw. Oldsquaws are the most numerous breeding ducks across the outer arctic coastal plain from the NPR-A to the Yukon (Derksen et al. 1981). In the ANWR and to the east, it is the most numerous duck (Schmidt 1973, Anderson 1973, Salter et al. 1980, Bartels and Doyle 1984), but to the west it is outnumbered by pintails in some sites. Widespread breeding is recorded across the arctic coastal plain and into the Brooks Range (Irving 1960).

Oldsquaws are abundant during the molt period on the coastal lagoons (Spindler 1979) and on large lakes of the arctic coastal plain (Lehnhausen and Quinlan 1981). Bartels (1973) estimated 337,000 postbreeding birds within 18 km of the coast between Point Barrow and the Sagavanirktok River. During fall migrations, 241,000 were estimated to have passed Barrow from 27 August to 16 September. If movement continues through October, at least 800,000 may pass Barrow (Timson 1976). Over 100,000 oldsquaws were in Simpson Lagoon as late as Sept. 22 in 1977 (Johnson and Richardson 1980).

Largest concentrations of oldsquaws occurred between Point Lay and Point Barrow, where 2,000 + birds were recorded in 1977 and 3,000+ in 1978 (King 1983). King and Lensink (1971) estimated a breeding population of 125,500 individuals on the arctic slope.

9. Common eider. Common eiders are an abundant spring and fall migrant past Point Barrow (Thompson and Person 1963, Johnson 1971) but are rare or absent in the interior arctic coastal plain (Sage 1974, Derksen et al. 1981). Common eiders are found nesting on spits and beaches along the entire Alaska Beaufort Sea coast (Johnson et al. 1975), and they nest colonially on barrier islands (Sowls et al. 1978). Although breeding is widespread coastally, it is more concentrated on the barrier islands east of the Colville River (Schamel 1974, Gavin 1979) and near Icy Cape on the Chukchi Sea (Divoky 1978, cited in Derksen et al. 1981). Small numbers are sometimes seen on the tundra in spring (Spindler 1978), and small flocks have been seen flying west in mid-to-late June in the ANWR (Schmidt 1973, Anderson 1973). In the Canning River drainage eiders are considered to be an uncommon breeder but a fairly common migrant (Martin and Moitoret 1981). In mid September 1977, 530 birds were recorded between Point Lay and Barrow; and in mid September 1978, 70 birds were recorded between Cape Thompson and Point Barrow. In 1981, Lehnhausen and Quinlan estimated 10,000 common and king eiders between Barrow and Wainwright (mostly in Peard Bay) on 20 May; at Icy Cape between 27 May and 12 June, they observed about 15,000 mixed common and king eiders passing through. Of those identified, 88% were common eiders. Only a small part of spring eider movement was visible at Icy Cape because most eiders migrate along the lead edge of the pack ice (Johnson 1971), and the ice lead was over 8 km offshore. Migration continued past Icy Cape until 10 July.

10. Mallard. Mallards have been regularly recorded in small numbers over various parts of the North Slope (Gabrielson and Lincoln 1959). They appear to be an occasional breeder on the arctic coastal plain during 1970-1972, and there is a breeding record from Umiat for 20 June 1950 (ibid.). Mallards occur as casual visitors in the NPR-A (Derksen et al. 1981) and are uncommon spring migrants to the east in the ANWR. Two to three were seen on three dates in 1970 at Nuvagapak Point (Anderson 1973) and in the Beaufort Lagoon area (Schmidt 1973). At Demarcation Point, Lehnhausen and Quinlan (1981) reported a drake mallard at Sadlerochit Springs, 22 May 1979. At Jago River in the ANWR, Spindler (1984) found them to be a rare summer visitant and breeder; four pairs were seen on 2 July and eight adults with 10 ducklings on 25 July. At Icy Cape, four were observed on May 29 by Lehnhausen and Quinlan (1981). Five were observed in the spring of 1977 at Simpson Lagoon (Johnson and Richardson 1980). King and Lensink (1971) estimate a breeding population of 500 birds on the arctic slope.

11. Northern shoveler. The northern shovelers is irregularly distributed and uncommon on the arctic coastal plain (Martin and Moitoret 1981).

In 1964, West and White (1966) documented breeding in the Umiat area. The shoveler has been reported on the Colville River delta, where it may also have bred (Kessel and Gibson 1978), and Derksen et al. (1981) termed this duck a casual visitant at the East Long Lake, Meade River, and Signiluk study sites in the NPR-A. Gavin (1972) called this species "scarce," its presence not recorded every year. In the ANWR, Schmidt (1973) reported a male shoveler at the Aichilik River delta on 24 June 1970. One-to-three individuals were seen on four occasions during 1-22 June 1979 at Demarcation Point (Burgess, pers. comm. cited in Lehnhausen and Quinlan). A pair was observed 22 May 1979 at Sadlerochit Springs (Robus, pers. comm. cited in Lehnhausen and Quinlan). In the Canning River drainage it is considered a rare visitant (Martin and Moitoret 1981).

At Icy Cape 14 birds were observed on June 4-18 (Lehnhausen and Quinlan 1981). Childs (1969) observed 30 shovelers in the spring at Pitmega River.

King and Lensink (1971) estimated a breeding population of zero individuals on the actic slope.

B. Historical Abundance

1. Snow goose. Along portions of the Alaskan arctic Slope, snow geese once occurred as common nesting birds (Anderson 1913, Bailey 1948, Gabrielson and Lincoln 1959). Since that time there has been a major reduction in their numbers on the North Slope; Bailey et al. (1933) hypothesized that when reindeer were introduced early in this century their herders may have been responsible for this reduction. According to King (1970), the number of snow geese using the Alaskan arctic slope during 1966 was less than 1,000. More recently, Pitelka (1974) has listed the snow goose as an occasional-to-regular breeder along the central portion of Alaska's Beaufort Sea coast. The nesting colony that once existed on Foggy Island (Bartonek, pers. comm. cited in Welling et al. 1981) in the Sagavanirktok River delta no longer exits (Gavin, pers. comm. cited in Welling et al. 1981). However, the same group of nesting snow geese has been known to move between Duck and Howe Island (Rothe, pers. comm.).

III. SEWARD PENINSULA/KOTZEBUE SOUND

A. Present Abundance

1. Canada goose. Scattered (100+) concentrations of breeding Canadian geese occur in the western arctic on the Pish River, near Deering, Kiwalik Bay, near Elephant Point and on the upper Kauk River (King 1983).

2. Black brant. In the Seward Peninsula/Kotzebue Sound area, significant numbers of blank brant (300+) were noted north of

Wales, Arctic Lagoon, and a breeding colony with 40 + nests were observed in the mouth of the Nugnugaluktuk River (King 1983). Large flocks have been observed in the spring around the Seward Peninsula (Bailey 1948; Flock 1972; Jones, pers. comm., cited in Lehnhausen and Quinlan 1981). It is possible that these are some of the 14,000+ birds nesting in the Soviet Union (King 1970).

3. White-fronted goose. In the western arctic, significant populations of breeding and molting white-fronted geese (800) occur in the lakes of upper Kauk River (King 1983).
4. Snow goose. In the Seward Peninsula/Kotzebue Sound area, snow geese are found in low numbers from the Seward Peninsula to Point Barrow in late June and in fall (King 1983).
5. Pintail. In the Seward Peninsula/Kotzebue Sound area, concentrations have been found from Ungalik to Cape Thompson, with total populations of 1,000 in June to roughly 12,000 in mid September (King 1983). King and Lensink 1971 estimated 87,000 pintails on the Seward Peninsula and 67,800 in the Kotzebue Sound area.
6. Green-winged teal. King and Lensink (1971) estimated 4,300 green-winged teal on the Seward Peninsula and 7,900 in the Kotzebue Sound area.
7. American wigeon. In the Seward Peninsula/western arctic area, during a late June 1982 population survey between Koyuk and Point Hope, King (1983) found 63 birds; surveys in mid September 1977 and 1978 found 8,000 and 500 birds, respectively, between Ungalik and Cape Thompson. King and Lensink (1971) estimated a breeding population of 12,700 birds on the arctic slope, 6,900 on the Seward Peninsula, and 23,000 in the Kotzebue Sound area.
8. Oldsquaw. In the Seward Peninsula/western arctic area, a late June (1982) population survey between Koyuk and Point Hope recorded 102 birds; surveys in mid September 1977 and 1978 between Ungalik and Point Barrow recorded roughly 3,350 birds. King (1983) found 49,200 oldsquaws on the Seward Peninsula and 25,600 in the Kotzebue Sound area.
9. Common eider. In a late June 1982 survey, King (1983) recorded 800+ king eiders from the southern Seward Peninsula to Point Hope.
10. Mallard. Fall mallard concentrations have been noted in the Kotzebue-to-Cape-Thompson area (King 1982). King and Lensink (1971) estimated a breeding population of 2,600 on the Seward Peninsula and 4,700 in the Kotzebue Sound area.
11. Northern shoveler. In 1977, a fall concentration of 200 birds was noted in the Kotzebue area, and 29 birds were observed between Lengalik and Nome.
    King and Lensink (1971) estimated 4,300 birds in the Seward Peninsula area and 7,900 birds in the Kotzebue Sound area.

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Freshwater/Anadromous Fish

Arctic Char/Dolly Varden Distribution and Abundance

I. REGIONWIDE INFORMATION

In this report, distribution and relative abundance information for char will be presented by sport fish postal survey areas, shown on map 1. Information on the level of char sport harvest is contained in the arctic char/Dolly Varden Sport Use narrative found elsewhere in this volume.

A. Regional Distribution

Char are found in every major watershed in the northwest Alaska area, including the Selawik, Kobuk, Noatak, Wulik, and Kivalina rivers (ADF&G 1978, 1984). The majority of char in northwest Alaska are of the anadromous form (ADF&G 1978). On the North Slope from Cape Lisburne to Demarcation Point, char are found in most rivers and many lakes. The eastern arctic, from the Colville River to the Canadian border has many rivers with groundwater springs which provide the most suitable char habitat (ibid.). Char are generally not found in rivers or lakes on the arctic coastal plain west of Teshekpuk Lake (Hablett 1979, Bendock and Burr 1984a); however, an isolated population was found in Lake 139, adjacent to the Chipp River (Bendock and Burr 1985). Anadromous and nonanadromous populations of char are found on the North Slope, with anadromous char most numerous (ADF&G 1978). Nonanadromous fish include lake residents, spring residents, and stream residents, which are generally dwarf males.

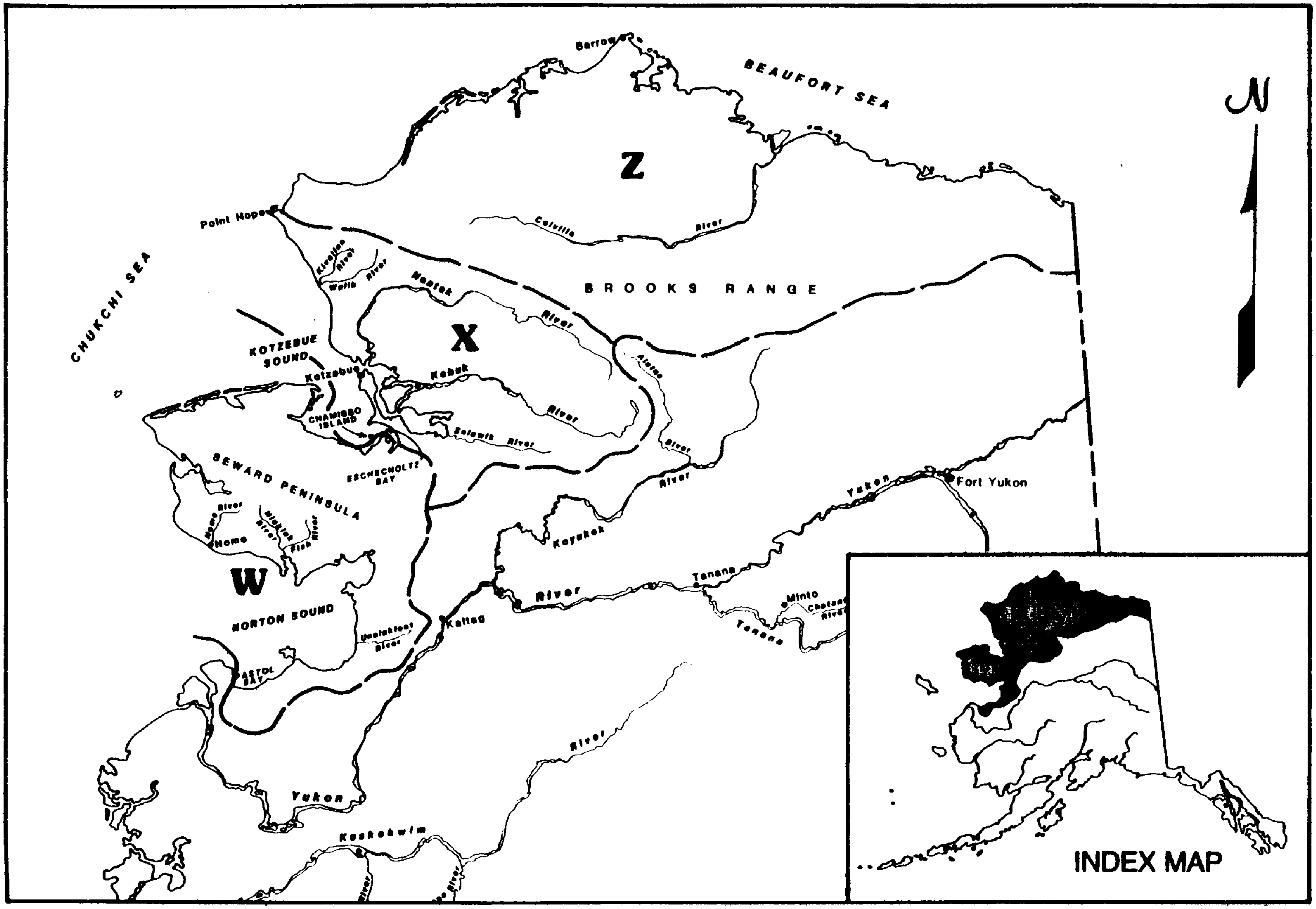
B. Areas Used Seasonally and for Life Functions

A series of freshwater fish distribution maps at 1:250,000 scale have been produced with this report. The categories of mapped information are as follows:

- General distribution
- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas
- Documented rearing areas

C. Factors Affecting Distribution

Water quality parameters, such as dissolved oxygen levels and temperature, and physical characteristics of streams and lakes, such as depth, velocity, and substrate type, all influence char distribution. In the Arctic Region, char are dependent on spring-fed habitats, which they use as spawning grounds, summer rearing areas of fry and juveniles, and as overwintering areas. Perennial sources of water are neccessary to assure overwinter survival of eggs, which are spawned in the fall and do not hatch until early spring.



Map 1. Arctic Region sport fish survey areas.

D. Movements Between Areas

The general pattern of char movement is discussed in the Life History and Habitat Requirements portion of this account found in volume 1.

In the Sagavanirktok and neighboring North Slope drainages, it is likely that seaward migration of andadromous char occurs during the spring flood in late May and June (McCart et al. 1972). In the Canning River, char begin to leave overwintering areas in May, with a large scale emigration observed in late June and early July (Craig 1977a). In the Anaktuvuk River, char out-migrate in mid June (Bendock 1982). Departure from North Slope overwintering habitats may more closely coincide with breakup along the Beaufort Sea coast than with breakup near the overwintering site (ibid.).

Char from the Wulik, Kivalina, Noatak, and Nome rivers in Northwest Alaska also out-migrate in late May or early June (Alt 1978, DeCicco 1983, Alt 1979). If the ice in the Chuckchi Sea has moved far offshore, the migration will be of short duration, and most char will have left the rivers by late June (Alt 1978). In the Noatak, Wulik, and Kivalina rivers, some fish that will spawn in the current year do not migrate seaward in the spring, but rather go directly to spawning grounds. Some of these summer spawners that spawn in early to mid August probably do migrate to sea for a month or two after spawning (DeCicco 1982, Alt 1978).

Once char leave fresh water, they disperse along the coastline, in some cases covering large distances (Craig and McCart 1976, Alt 1978). In the Beaufort Sea, arctic char may be found as far from shore as the seaward side of barrier islands (Craig 1984). Char in the Beaufort Sea have been reported to travel as much as 300 km along the coastline during the summer months (Craig and McCart 1976). Char from the Wulik and Kivalina rivers move at least as far north as Point Hope and south to Kotzebue Sound during the summer (Alt 1978).

Anadromous char return to streams to spawn in late summer. Mature anadromous char in the Sagavanirktok River have been taken in the vicinity of spawning tributaries as early as June 26 (McCart et al. 1972); however, they generally return to North Slope rivers by mid August (Craig and McCart 1976). Char move to spring or groundwater areas on the North Slope to spawn, with the peak of spawning activity probably occuring in late September or early October (McCart et al. 1972, Craig 1977a). In the Anaktuvuk River, spawning has been observed from early September through early November (Bendock 1981).

In the Canning River, mature anadromous char begin moving into the river in the last part of July (USFWS 1982). Mature spawners apparently enter the river first, followed by mature nonspawners and then by immatures. In-migration continues through the end of August (ibid.). In 1972, char were observed in the vicinity of a spawning area on the Canning River in September. Appproximately half of these fish had completed spawning by November 5 and moved downstream (Craig 1977a).

In the Noatak, Wulik, and Kivalina rivers in northwest Alaska, summer spawners which do not go to sea prior to spawning enter tributary streams sometime between late June and the end of July (DeCicco 1982, Alt 1978). After spawning, summer spawners move out of the tributaries and may migrate to sea for a month or two after spawning (DeCicco 1982). Fall spawners enter the Noatak, Wulik, and Kivalina rivers in mid August (ibid.). The fall in-migration is prolonged, extending into late September (ibid.). Although it appears that char return to their natal stream to spawn, nonspawners from Beaufort Sea drainages and from the Wulik and Kivalina drainages have been observed to overwinter elsewhere in the same drainage and in non-natal drainages (Craig 1977a, Craig and McCart 1976, DeCicco 1984).

On the North Slope, char spawn and overwinter in spring-fed areas, which do not freeze solid during the winter months (Craig 1978). In the Noatak River system, some spawning takes place in and around springs; however, most spawning occurs downstream of springs in the main channels of streams (DeCicco 1982). Many spawning areas in the Kivalina River are near spring areas, however in the Wulik River most spawning grounds are not directly influenced by ground water (Alt 1978). In the Noatak River, char move from tributary streams used for summer spawning to the main Noatak in late fall. Movements as far as 115 mi (185 km) to overwintering areas have been observed (DeCicco 1983).

North slope tagging studies indicate that little movement of char takes place during winter months (Bendock 1982).

E. Population Size Estimation

Aerial surveys of char in the Sagavanirktok drainage on the North Slope have been attempted annually since 1971 and on the Anaktuvuk River since 1979. These aerial counts are not considered to be estimates of the char population size but rather are a means of annually indexing the distribution and general abundace of the char (Bendock and Burr 1984b).

Aerial surveys of char at overwintering sites on the Noatak, Wulik, and Kivalina rivers have also been conducted periodically since 1968 (DeCicco 1983). Weather conditions in the fall may prevent an adequate aerial survey from being flown. The accuracy of aerial surveys is also affected by turbid water, the timing of the observation, weather and light conditions, the experience of the surveyor, channel and water level fluctuations, and by the presence of other fish species mixed with the char in the stream (DeCicco 1982, Bendock and Burr 1984b, Pearse 1977).

F. Regional Abundance

Char abundance information that has been collected applies only to specific lakes and streams. As a result, estimates of abundance cannot be appropriately made at the regional level. Abundance information is contained in the management area discussions that follow.

II. SEWARD PENINSULA-NORTON SOUND AREA

The boundaries of the Seward Peninsula-Norton Sound Sport Fish Postal Survey Area are described in the Sport Use of Freshwater Fish narrative found elsewhere in this volume.

A. Distribution

Char are found in nearly every stream on the Seward Peninsula (Alt 1978). Most populations are anadromous, but some dwarf resident populations exist. Char spend the summer feeding in the rich estuarine environment off Nome and return to fresh water in late summer (end of July to late August). Rivers containing char in the Nome area include Nome, Fox, Sinuk, Bluestone, Solomon and Penny rivers, and Boston Creek (ibid.). Char are also found in the Pilgrim River, though they are not abundant (Alt 1980). Subsistence fishermen harvest char in the Nome, Snake, Niukluk-Fish, Agiapuk, and Kuzitrin rivers and the Imuruk Basin area (Alt 1978).

B. Abundance

No abundance estimates are available for char in the Seward Peninsula-Norton Sound Area. Alt (1979, 1980) noted that the char population in the Nome River is not high and that char are also not abundant in the Pilgrim River.

III. NORTHWEST ALASKA AREA

The boundaries of the Northwest Alaska Sport Fish Postal Survey Area are described in the Sport Use of Freshwater Fish narrative found elsewhere in this volume.

A. Distribution

Char are present in every major watershed in the Northwest Alaska Area (ADF&G 1978). Char spawn in Noatak River tributaries as far east as the Kugrak River (DeCicco 1983). Char are known to overwinter in the Noatak from above the Agashashok River to Kivivik Creek (ibid.).

Large numbers of char also spawn in the Wulik and Kivalina rivers. In the Wulik River, char spawning is known to occur in Ikalurkrok Creek, the west fork of the Wulik to below the falls, the main Wulik above the forks, Sheep Creek, and the main stem of the Wulik below the forks (ibid.). The middle section of the Wulik from the forks downstream serves as important overwintering habitat for char (ibid.). Char rear throughout the Wulik and its tributaries (ibid.). In the Kivalina River char spawning occurs in Grayling Creek, the main fork of the Kivalina, and in the main stem below the forks (ibid.). Spawning has also been reported in Kisimilot Creek (Houghton 1983).

B. Abundance

Aerial surveys have been conducted of the Noatak, Wulik, and Kivalina river spawning grounds in the summer and of overwintering areas of the Wulik and Kivalina rivers in the fall. The earliest of these surveys was in 1968; however, counts were not consistently attempted until 1979. These counts should not be interpreted as complete censuses of the population but rather as annual indexes of char abundance.

Counts from 1980, 1981, and 1982 in the Wulik and Kivalina rivers were done by the same surveyor using the same methods under good-to-excellent light and wind conditions and so are considered to be directly comparable (DeCicco 1983). Larger numbers of char overwinter in the Wulik River than in the Kivalina. Substantially fewer overwintering char were seen in the Wulik and Kivalina rivers in 1982 than in the two previous years (table 1). This may be due to a large part of the char population overwintering in a different system that year (ibid.).

Table 1. Numbers of Overwintering Char Observed During Aerial Surveys in the Northwest Alaska Area, 1968-82[a]

Year	Noatak River	Wulik River	Kivalina River
1968	---	90,236[c]	27,640[e]
1969	21,000[b]	297,257	---
1976	---	68,300	12,600
1979	---	55,030[d]	15,744[d]
1980	45,185[b]	113,553	39,692
1981	---	101,826	45,355
1982	---	65,581	10,932

Sources: ADF&G 1983, DeCicco 1983.

--- means no data were available.

a Surveys were not flown in 1970-1975, 1977, 1978, and 1983.

b Incomplete survey.

c Survey is estimated to have counted 40 to 50% of the population (Winslow 1969).

d Survey conditions were poor this year. It is estimated that only 40% of the population was counted in 1979, compared to 90% in 1980 (Alt 1981).

e Survey is estimated to have counted 60% of the population (Winslow 1969).

Data on char overwintering in the Noatak are from surveys by the Division of Commerical Fisheries. In 1969, though only 21,000 char were counted, it was noted that they were as abundant in the Noatak as they were in the Wulik (ibid.). In 1980, in a partial survey, 45,185 overwintering char were counted in the Noatak (ibid.).

Early surveys indicated that a larger number of char spawned in the Kivalina River than in the Wulik River (table 2). More recent surveys, however, have indicated that the Wulik may be the more important spawning stream (table 2). Spawning area surveys of the Noatak River drainage have shown that the Noatak drainage is also a major spawning area for char. The Kelly River, Kugururok River, and Nimiuktuk River are major spawning areas in the Noatak drainage, with nearly 3,000 char observed in the Kelly River, 1,400 in the Kugururok River, and 2,200 in the Nimiuktuk River in 1983 (table 3).

Char also spawn in the Omikviorok River, which enters the Chuckchi Sea south of the Wulik River. In 1981, 114 char were observed spawning in the Omikviorok; 138 were seen in 1983 (DeCicco 1982, 1984). Rabbit Creek and Jade Creek, south of the Omikviorok River were surveyed in 1981. Three spawning char were observed in Rabbit Creek, 12 in Jade Creek (DeCicco 1982).

Char are also found in the Kobuk River, but aerial and float surveys in 1980 demonstrated that the Kobuk River char population is relatively small compared to the other rivers in the area. An aerial survey of the Squirrel River, tributary to the Kobuk, in late August 1980 counted only 54 char. A float survey of the Omar River, another Kobuk tributary, counted only 29 char (DeCicco 1982).

IV. NORTH SLOPE BROOKS RANGE

The boundaries of the North Slope Brooks Range Sport Fish Postal Survey Area are described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Char are found in all major drainages east of Teshekpuk Lake on the North Slope. Major char-producing streams include the Colville, Sagavanirktok, Canning, Hulahula, Aichilik, and Kongakut rivers (Craig and McCart 1976). Char have been found in marine waters as far west as Elson Lagoon (ibid.) but are generally not found in rivers or lakes west of Teshekpuk Lake (Hablett 1979, Bendock and Burr 1984, 1985). The apparent absence of char in this area may be because the coastal plain streams lack the perennial springs, associated with this species' spawning and overwintering areas (Craig 1984, Craig and Haldorson 1980).

In the Colville River drainage, char are found throughout the lower Colville, Anaktuvuk, and Chandler rivers (Bendock 1979). Few char, however, are found in the Colville River above its confluence with the Chandler River (ibid.). Char are also found within the Colville drainage in large glacial lakes of the Brooks Range in the Kurupa, Chandler, and Anaktuvuk river drainages.

Table 2. Numbers of Spawning Char Observed During Aerial Surveys of the Wulik and Kivalina River Drainages, 1980-83

River	1980		1981		1982		1983
	8-15, 8/16	9/12 Late Sept.[a]	8/20	9/25	8/06, 8/08	9/30	8/24, 8/25
Kivalina River drainage:							
Grayling Cr.	57[b]	244	106	---	146	---	183
Kivalina R. Braided Fork	---	---	331	---	---	---	412
Little R. (Kivalina North Fork)	---	200	---	---	7	0	---
Baqhalik Cr.	---	---	51	245	---	---	---
Kivalina R. Slow Fork	---	---	---	---	---	---	10
Kivalina R. main stem	---	---	40	---	299	40	90
Kivalina total	57	444	528	245	452	40	695
Wulik River drainage:							
Sheep Cr.	---	44	44	---	28	59	123
Wulik R. Main (East) Fork	---	87	---	---	73	2	223
Wulik R. West Fork	---	30	---	---	133	30	196
Ikalukrok Cr.	---	---	89	---	60	---	201
Tutak Cr.	---	---	---	---	---	---	43
Wulik R. main stem	200	---	129	---	184	20	394
Wulik total	200[c]	161[c]	262[c,d]	---	478	111	1,180

Sources: Alt 1981; DeCicco 1982, 1983, 1984; EPA 1984.

--- means no data were available.

a Survey was conducted on 9/12 on the Kivalina River, and in late September on the Wulik River.

b Foot survey.

c Incomplete survey.

d Large numbers of chum salmon present made it difficult to differentiate char (DeCicco 1982).

Table 3. Numbers of Spawning Char Observed During Aerial Surveys of the Noatak Drainage, 1980-83

	1980	1981		1982		1983
River	Late August	7/25-7/26	8/16-8/19	8/03-8/08	9/29	8/24-8/25
Eli R. tributaries:						
Ahaliknak Cr.	---	---	---	57	---	102
Eli main fork	---	---	---	180	---	199
Eli R. total	---	---	---	237	---	301
Kelly R. tributaries:						
Avan R.	300	---	346	341	---	254
Wrench Cr.	1,200	---	1,005	748	---	1,066
No Name Cr.	99	---	356	158	---	661
Kelly R. main stem	1,100	---	882	1,079	---	943
Kelly R. total	2,669	---	2,589	2,326	---	2,924
Kugururok R. tributaries:						
Cairn Cr.	---	---	---	10	---	---
Nunaviksak Cr.	---	38	317	257	---	---
Kagvik Cr.	---	317	792	620	0	463
Okatak Cr.	---	---	---	115	---	---
Trail Cr.	---	---	419	485	52	---
Kugururok R. main stem	---	553	1,756	2,499	557	923
Kugururok R. total	---	908	3,284	3,986	609	1,386[a]
Nimiuktuk R. tributaries:						
Seagull Cr.	1,100	---	606	474	0	---
Kukukpilak Cr.	---	---	361	56	---	---
Tumit Cr.	800	---	853	783	0	---
Nimiuktuk R. main stem	---	---	202	857	0	---
Niniuktuk R. total	1,900	---	2,022	2,170	0	---

(continued)

Table 3 (continued).

River	1980	1981		1982		1983
	Late August	7/25-7/26	8/16-8/19	8/03-8/08	9/29	8/24-8/25
Other Noatak R. tributaries:						
Anisak R.	18	---	---	---	---	---
Kaluktavik R.	---	---	---	549	199	---
Kivivik Cr.	---	---	---	15	---	---
Akikukchiak Cr.	---	---	---	25	---	---
Nikolik R.	---	---	---	47	---	---
Spring Cr.	---	---	---	10	---	---
Kavachurak Cr.	---	---	---	30	---	---
Igning R.	---	---	---	101	---	---
Kugrak R.	---	---	---	29	---	---
Unnamed Cr.	---	---	193	331	---	---

Sources: Alt 1981; Decicco 1982, 1983, 1984.

--- means no data were available.

a Incomplete survey.

Three life history patterns are followed by char within the Colville drainage. The char may be anadromous, nonanadromous stream residents, or nonanadromous residents of lakes with impassible barriers at their outlets (ibid.). Stream resident char in the Colville River drainage are found in the Etivluk, Killik, and Anaktuvuk rivers (Morrow 1973). Large numbers of char are found in the Sagavanirktok River, with major char-spawning areas located adjacent to springs at Echooka River, Ivishak River, Saviukviayak River, Flood Creek, Lupine River, Ribdon River, and Accomplishment Creek (Furniss 1975). Char distribution in the Sagavanirktok extends to near the headwaters above the Atigun River (ADF&G 1984). With the exception of the Atigun River above Atigun Canyon, mature anadromous char have been found in all the large mountain streams that originate in the Brooks Range in the Sagavanirktok drainage (McCart et al. 1972). The Atigun River is the only large mountain stream in the Sagavanirktok drainage without a spawning population of char (ibid.). Overwintering immature migrants are concentrated in mountain streams nearest the sea. Immature migrants are abundant in the Ivishak River and occur in smaller numbers in the Lupine River (ibid.). Lake resident char in the Sagavanirktok River drainage are found in Campsite Lake and in other lakes in the Oksrukuvic Creek drainage, in Galbraith Lake, in the Atigun Lakes south of Galbraith Lake, and in Elusive Lake (McCart et al. 1972, Bendock and Burr 1984a). Char are found throughout the Shaviovik River drainage (Craig 1977b). The Shaviovik drainage contains populations of both anadromous and nonanadromous freshwater resident char. Char are known to spawn and overwinter in a spring-fed area on the Shaviovik main stem, and in a spring area of the Kavik River approximately 80 km upstream of the confluence with the Shaviovik River (ibid.).

In the Canning River drainage, there are populations of anadromous char, nonanadromous residual males, nonadromous spring residents, and nonanadromous lake residents (Craig 1977a). Anadromous char are found throughout the Canning drainage, with spawning and overwintering areas located in main channels of the Canning or in springs originating within or near the Canning floodplain (ibid.). The largest concentration of anadromous spawners in the drainage occurs on the Marsh Fork of the Canning River (ibid.) and in the main Canning River above the Marsh Fork confluence (USFWS 1983). Fry have been reported to remain in the Marsh Fork during their first summer and winter; however, age two and older juveniles leave the spring and disperse throughout the drainage (ibid.).

Lake-resident char are found in Big Lake and Canning Fork Lake in the headwaters of the Canning drainage (Craig 1977a). Spring-resident char are found in Shublik Springs, an unnamed spring upstream of Shublik Springs, another unnamed spring in a nearby Canning tributary, and possibly in a fourth spring on Nanook Creek (ibid.).

In 1983 surveys of the Hulahula River, char were found to be widely distributed throughout the drainage. Char were collected in almost all of the areas sampled, as far upstream as East Patuk Creek (USFWS 1984). Fall concentrations of char were observed at three holes on the Hulahula that have historically been used as harvest areas by villagers from Kaktovik (ibid.). The most upstream of these holes (Fish Hole 3) is at the confluence of the Hulahula and East and West Patuk creeks. The second (Fish Hole 2) is located 1 mi above Old Man Creek, and the first (Fish Hole 1) is about 25 mi (40 km) downstream from the second. Spawning has been observed at the second hole, and char probably also spawn around Fish Hole 3 in a 5 km reach between Katak and East and West Patuk creeks (ibid.). It is not known whether char spawn in the area of Fish Hole 1 (ibid.).

In the Aichilik River, char have been found as far upstream as a spring south of Leffingwell Fork (USFWS 1983). A large concentration of char was observed in the area immediately downstream of this spring in late September (ibid.). The Aichilik char population consists of both anadromous fish and nonanadromous stream resident fish which are predominantly males (ibid.).

Char are also found in the Kongakut River and are known to overwinter in a large segment of the Kongakut as far upstream as the Pagiluk River (ADF&G 1978). Char also overwinter in the Egaksrak River drainage (ibid.). Other smaller coastal streams on the arctic coastal plain probably do not support year-round populations of char. Many of the small streams dry up by August and lack suitable overwintering habitat (USFWS 1984).

B. Abundance

Aerial index counts of char in the Sagavanirktok drainage have been conducted annually since 1971 (tables 4 and 5). All of the major tributaries to the Sagavanirktok that were determined to be char spawning areas were counted from 1971 through 1975. In 1976 through 1979, only the Ivishak and Echooka rivers were counted, and since 1980 only the Ivishak has been counted. The Ivishak contains the largest aggregation of char in the system, and counts from the Ivishak are considered to be indexes to overall population levels (Bendock and Burr 1984b).

Prior to 1977, counts were conducted by helicopter; however, counts are now made using fixed-wing aircraft (ibid.). All estimates have been made during mid September (ibid.). The number of char observed in the Ivishak River increased in 1979. Based on a limited sampling effort and observations from the air, it appears that the higher 1979 count was the result of a large increase in the number of small (1 to 3 lb) char (Bendock 1980).

Aerial counts have also been made of char in the Anaktuvuk River since 1979 (table 6). In 1979 and 1981, both the "Tuluga" spawning area adjacent to Rooftop Ridge and a concentration in Nanushuk Creek were counted; however, since 1979 only the "Tuluga" concentration, which is larger, has been counted. Aerial counts should not be interpreted as estimates of char population size but rather as a means of annually indexing both the distribution and general abundance of char (Bendock 1982). Not all fish present are counted, and estimates of the numbers accounted for range from 50 to 90% of the total (Pearse 1977).

Table 4. Aerial Survey Counts of Char in Major Tributaries of the Sagavanirktok River, 1971-75

River	1971		1972		1973		1974[a,c]	1975[d]
	No.	Date	No.	Date	No.	Date	No.	No.
Accomplishment Cr.	178	8/26	322	9/21	512	9/10	505	270
Ribdon R. main stem	400	8/26	467	9/25	123	9/10	240	153
Ribdon R. South Fork	49[b]	8/26	276	9/30	1,183	9/10	1,330	395
Lupine R.	"few"	9/9	---		318	9/10	260	195
Saviukviayak R.	321	8/30	378	9/15	264	9/10	650	584
Tributary between Saviukviayak R. and Flood Cr.	0	8/30	---		---		---	---
Flood Cr.	350	8/30	508	9/15	512	9/11	370	300
Gilead Cr.	0	8/30	0		---		---	---
Echooka R.	1,137	9/3	1,688	9/22	1,883	9/12	2,160	473[e]
Ivishak R. from Echooka R. to Flood Cr.	12,470	9/3	11,937	9/7	8,992	9/11	11,000	2,485[e]
Ivishak R. upstream of Flood Cr.	---		---		1,017	9/11	2,140	710[e]
Ivishak R. total	12,470[f]	9/3	11,937[g]	9/7	10,009	9/11	13,140	3,195[e]
Section Cr.	11	9/24	---		---		---	---
Sagavanirktok R. East Branch to headwaters	13	9/12	---		---		---	---
Sagavanirktok R. Main Branch to headwaters	0	9/12	---		---		---	---

Sources: Yoshihara 1972, 1973; Furniss 1975, 1976.

--- means no data were available.

a These counts are average figures for counts by two observers (Furniss 1975).

b Incomplete survey.

c All 1974 surveys flown from September 10 through 23.

d All 1975 surveys flown from September 7 through 10.

e A survey flown September 21-22 counted 851 char in the Echooka River, 8,306 in the Ivishak R. from Echooka R. to Flood Cr., and 337 in the Ivishak R. upstream of Flood Cr. in 1975 (Alt 1976).

f A survey flown under poor conditions on September 30 counted 20,994 char in the Ivishak R. in 1971; however, concentrated grouping of the char probably resulted in an overestimate of numbers present (Yoshihara 1972, 1973).

g A survey flown on September 24 counted 12,292 char in the Ivishak R. in 1972.

Table 5. Numbers of Char Observed During Aerial Surveys of the Echooka and Ivishak Rivers, 1971-83

	Echooka River		Ivishak River	
Year	No.	Date	No.	Date
1971	1,137	9/13	12,470[a]	9/3
1972	1,688	9/22	11,937[b]	9/7
1973	1,883	9/12	10,009	9/11
1974	2,160[c]	d	13,140[c]	d
1975	473[e]	f	3,195[e]	f
1976	2,254	9/22	8,570	9/22
1979	814	9/22	24,403	9/22
1981	316[g]	9/14	24,873	9/14
1982	---	---	36,432	9/19
1983	---	---	27,820	9/18

Sources: Yoshihara 1972, 1973; Furniss 1975, 1976; Pearse 1977; Bendock 1982; Bendock and Burr 1984.

--- means no data were available.

a A survey flown under poor conditions on September 30 counted 20,994 char in the Ivishak River in 1971; however, concentrated grouping of the char probably resulted in an overestimate of numbers present (Yoshihara 1972, 1973).

b A survey flown on September 24 counted 12,292 char in the Ivishak in 1972.

c These counts are average figures for counts by two observers (Furniss 1975).

d All Sagavanirktok drainage char surveys were flown on September 10 through September 23 in 1974; however, the exact dates for Echooka and Ivishak surveys were not reported.

e A survey flown on September 21-22 counted 851 char in the Echooka River and 8,643 in the Ivishak River in 1975 (Alt 1976).

f Sagavanirktok drainage char surveys were flown on September 7 through September 10 in 1975; however, exact dates for Echooka and Ivishak river surveys were not reported.

g Low count is the result of the count period preceding the peak of spawning activity (Bendock 1982).

Table 6. Numbers of Char Observed During Aerial Surveys of the Anaktuvuk River, 1979-83[a]

Year	Tuluga		Nanushuk Creek	
	No.	Date	No.	Date
1979	15,717	9/23	934	9/23
1981	10,563	9/14	1,005	9/14
1982	6,222[b]	b	---	---
1983	8,743	c	---	---

Sources: Bendock 1980, 1982, 1983; Bendock and Burr 1984b.

--- means no data were available.

a Weather conditions prevented surveys from being flown in 1980.

b Count was conducted during the third week of September. The Anaktuvuk River was high and turbid during the count period, and the char had not aggregated into dense schools as in past surveys. Both of these factors contributed to a low count for this year.

c Count was conducted during the third week of September under excellent counting conditions, with clear skies and ice-free water.

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Arctic Grayling Distribution and Abundance

I. REGIONWIDE INFORMATION

In this report, distribution and relative abundance information for grayling will be presented by sport fish postal survey areas, shown on map 1. Information on the level of grayling sport harvest is contained in the arctic grayling Sport Use narrative found elsewhere in this volume.

A. Regional Distribution

Grayling are widely distributed throughout the Arctic Region. On the arctic coast most of the freshwater drainages that have been surveyed contain grayling (USFWS 1982); they are the principal species inhabiting foothill lakes and streams on the Seward Peninsula; and they are found in lakes and streams draining into the Chukchi Sea between Kotzebue and Barrow (ADF&G 1978).

B. Areas Used Seasonally and for Life Functions

A series of freshwater fish distribution maps at 1:250,000 scale have been produced with this report. The categories of mapped information are as follows:

- General distribution
- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas
- Documented rearing areas

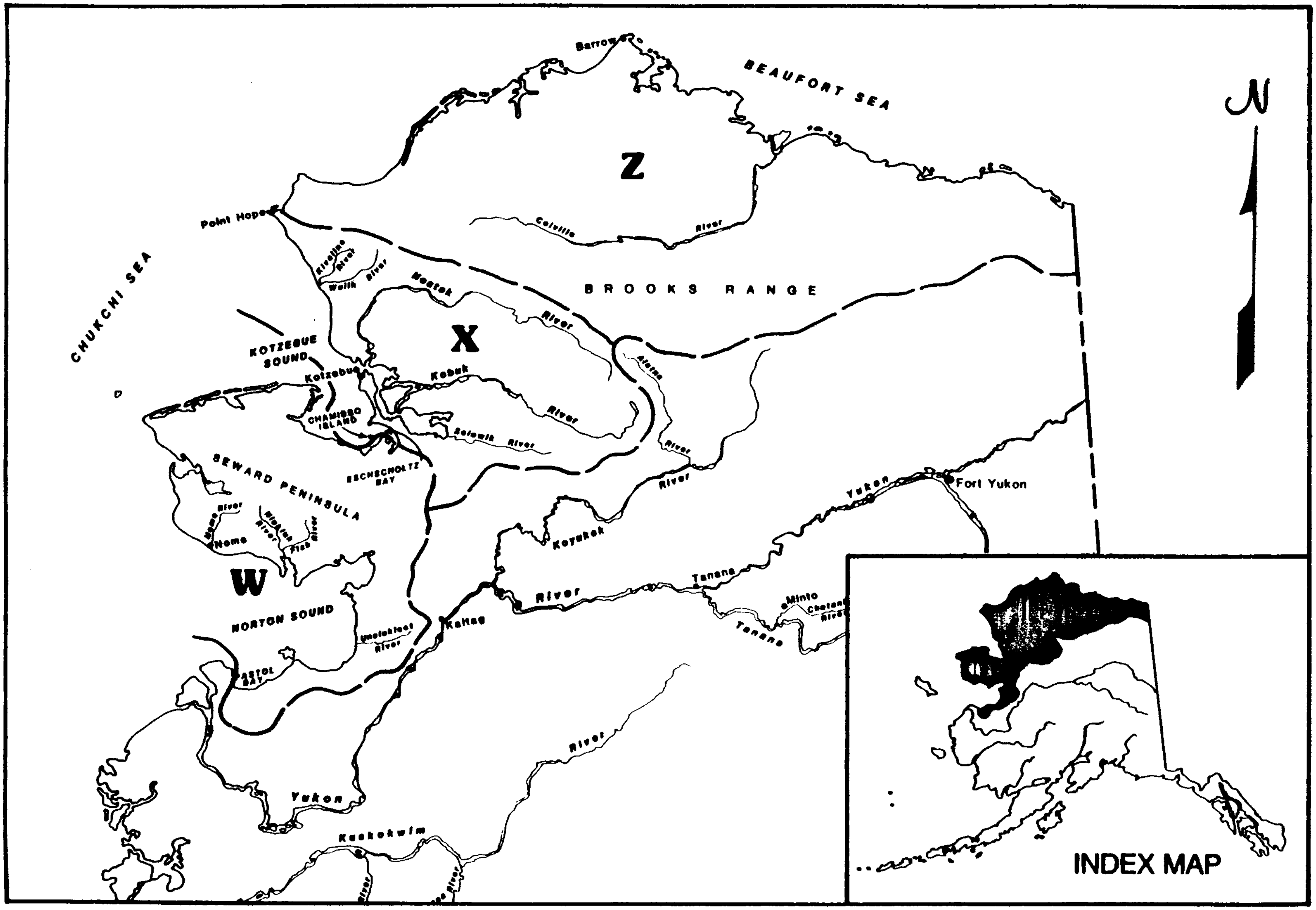
C. Factors Affecting Distribution

Water quality parameters, such as dissolved oxygen levels and temperature, and physical characteristics of streams and lakes, such as depth, velocity, and substrate type, all influence grayling distribution. In the Arctic Region, deep lakes or deep pools and spring areas in rivers are required for overwintering. Details of habitat requirements for grayling can be found in the Life History and Habitat Requirements narrative in volume 1 of this publication.

D. Movements Between Areas

The migrational patterns of grayling are often complex and vary considerably among drainages. The general pattern of grayling movement is discussed in the Life History and Habitat Requirements narrative in volume 1 of this publication.

McCart et al. (1972) described movements of grayling in their study area of the Sagavanirktok River drainage from Franklin Bluffs to Atigun Pass. In this area, grayling spawn in May or June in foothill streams that drain the tundra-covered slopes of the arctic foothills. Adults leave the foothill streams shortly after spawning and spend the summer feeding in the main stem of the Sagavanirktok or in large mountain streams that originate in the Brooks Range. Juveniles less than 200 mm fork length remain in the foothill streams throughout the summer.



Map 1. Arctic Region sport fish survey areas.

In September, the juveniles and young-of-the-year (YOY) fry leave the foothill streams. A similar pattern was observed in Weir Creek and the Kavik River, tributary to the Shaviovik River. Adults enter Weir Creek, a tundra stream, to spawn in late May and early June during the spring flood. Adults leave Weir Creek shortly after spawning, with out-migration complete by early July. Many juveniles apparently follow the movement of adults into Weir Creek and then leave the stream two to three weeks after the adults. Fry spend the entire summer in Weir Creek, out-migrating before freeze-up in September.

Grayling populations associated with deep lakes presumably overwinter in them. Stream populations must travel to overwintering sites in deep pools or spring areas in rivers.

In the upper reaches of the Chandalar River, the principal spawning habitats for grayling are the tributaries that meander across the wide valley floor between Arctic Village and Vettetrin Lake (Craig and Wells 1975). The spawning streams tend to be small, clearwater tributaries with low stream gradients. Grayling enter these tributaries to spawn during the latter half of May. Grayling leave spawning streams and disperse throughout the drainage in June. Grayling may overwinter in the Chandalar drainage downstream of the Arctic Village area (ibid.).

In the Colville River drainage, grayling spawn in small tributaries that by mid summer may become discontinuous, such as Seabee, Rainy, and Fossil creeks, and in major tributaries and the main stem of the Colville (most notably above the Etivluk River) (Bendock 1979). Most overwintering takes place in the main stem of the Colville (ibid.).

In the Nome-Seward Peninsula area, grayling are distributed in the summer throughout sections of rivers having gravel bottoms, with heaviest concentrations in locations with abundant pool-riffle areas (Alt 1978a). As salmon begin reaching spawning grounds in mid to late July, grayling concentrate in spawning areas and feed on salmon eggs (Alt 1978a, 1980). After the completion of salmon spawning, grayling are found in slower-water areas, feeding on insects (Alt 1980). No information on overwintering areas of grayling in the Nome-Seward Peninsula area is available, but they are probably located in deep holes in the lower reaches of the rivers or in delta areas (Alt 1978a). Grayling generally cannot tolerate the high salinities of the ocean, but there is some movement into tidal areas of the Nome River (ibid.). Grayling have also been taken off the mouths of the Sagavanirktok, Canning, and Kongakut rivers, which drain into the Beaufort Sea (Craig and McCart 1976).

E. Population Size Estimation

The relative abundance of grayling in Arctic Region lakes and streams has not been systematically assessed. Estimates of population size are based on rough measures of catch-per-unit-effort gathered during lake and stream gill net and hook and line surveys.

F. Regional Abundance

Very little grayling abundance information is available. Information that has been collected applies only to specific lakes and streams. As a result, abundance cannot be appropriately addressed at the regional level. Abundance information is contained in the postal survey area discussions that follow.

II. SEWARD PENINSULA-NORTON SOUND AREA

The Seward Peninsula-Norton Sound Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Few surveys have been conducted for freshwater fish on the Seward Peninsula; however, grayling are probably found in most major drainages in the area (ADF&G 1978). After arctic char and chum and pink salmon, grayling are the most important sport fish in the Nome area (Alt 1978a). Some of the rivers in the Nome-Seward Peninsula area are the only major rivers in the state other than the Ugashik system where trophy-size grayling are present (ibid.). Some of these rivers are the Sinuk, Grand Central, Pilgrim, American, and Niukluk-Fish (ibid.). In the Pilgrim River, rearing grayling have been found in Crater and Iron creeks, in sloughs and backwaters below the Kougarok Road bridge, and in greatest abundance in the main Pilgrim River near Pilgrim Hot Springs (Alt 1980).

B. Abundance

1. Summary of data. No systematic abundance surveys for grayling have been conducted in the Nome-Seward Peninsula area. Alt (1978a) noted that seemingly large populations of grayling are found in the Pilgrim and Niukluk-Fish systems. He roughly estimated that 30 to 40 grayling would be observed per river mile in the Pilgrim River from the Kougarok Road Bridge to 1 mi above Pilgrim Hot Springs (Alt 1980). Alt (1979) also surveyed the Nome River and concluded that its grayling population is not large.
2. Habitat enhancement efforts. No record of any habitat-enhancement efforts directed towards grayling in the Nome-Seward Peninsula area was found in the literature.

III. NORTHWEST ALASKA AREA

The Northwest Alaska Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Grayling are found in the Noatak and Kobuk river drainages and in the Wulik and Kivalina drainages (Alt 1969, 1978a, 1978b). In the Noatak drainage, they have been recorded as far upstream as Midas Creek and the Cutler River (O'Brian and Huggins 1974). Alt (1978a) sampled several Noatak drainage lakes and found grayling in Kavachurak Creek Lake, Kaluich Creek Lake, Kiingyak Lake, Kikitaliorak Lake, Feniak Lake, Aniralik Lake, and Kelly River Lake.

B. Abundance

1. Summary of data. No systematic abundance surveys for grayling have been conducted in the Northwest Alaska Area. In his Noatak drainage lake surveys, Alt set gill nets overnight and recorded the number of grayling caught (Alt 1978a). He found that grayling were most abundant in Kaluich Creek Lake, Kelly River Lake, Aniralik Lake, and Feniak Lake (ibid.). The highest grayling catch was in Kaluich Creek Lake, with 43 taken in two overnight gill net sets (ibid.). Feniak Lake and Kelly River Lake each had catches of 16 grayling in one gill net set, and Aniralik Lake yielded 14 grayling in one gill net set (ibid.).

   Alt (1978b) noted that grayling are very abundant in Grayling Creek, tributary to the Kivalina River, with an estimated 4,000 enumerated in a late August float of that river.
2. Habitat enhancement efforts. No record of any habitat-enhancement efforts directed toward grayling in the Northwest Alaska Area was found in the literature.

IV. NORTH SLOPE BROOKS RANGE AREA

The North Slope Brooks Range Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Grayling are found in lakes and streams across the North Slope. Craig and Wells (1975) and McCart et al. (1972) stated that grayling are the most widely distributed fish species in the Chandalar River region and the Sagavanirktok River and neighboring drainages on the North Slope. Within the Arctic National Wildlife Refuge, grayling have been reported from Canning, Tamayariak, Sadlerochit, Hulahula, Okpilak, and Aichilik rivers (Ward and Craig 1974, USFWS 1984). Bendock (1979) also found grayling to be the most widespread and abundant species in the Colville River drainage and reported that they are found in the Colville River upstream to its headwaters. Moderate numbers of grayling are found throughout the lakes and streams of the coastal plain west of the Colville River delta (Hablett 1979), including the Ikpikpuk, Tagagoruk, Meade, Utukok, and Kikolik river drainages (ibid.). Grayling are abundant in Teshekpuk Lake; however, they are found in few other coastal plain lakes (Bendock 1982, Hablett 1979).

B. Abundance

1. Summary of data. No systematic abundance surveys for grayling have been conducted in the North Slope Brooks Range Area. The USFWS has sampled fish populations in some lakes and streams of the Arctic NWR (USFWS 1984). Catch-per-unit-effort in streams varied widely with time and location. The catch-per-gill-net-hour in Okpilak Lake in the Okpilak River drainage was 0.42 grayling per hour (ibid.).

Bendock (1980) surveyed 18 lakes along the central North Slope and reported excellent angling for grayling in Toolik Access Lake north of Pump Station 4 on the Dalton Highway. A gill net set overnight in Toolik Access Lake yielded 18 grayling. Round Lake, Small Double Lake, and VABM 1507 Lake also yielded large gill net catches of grayling, with 13, 7, and 6 grayling per net night, respectively (ibid.). Bendock (1982) reported the results of surveys of four mountain lakes near the Anaktuvuk River. The highest catch per net night was five grayling from Tulugak Lake. Several lakes in the Colville River drainage have been surveyed and found to provide excellent angling for grayling. Colville River drainage lakes with abundant grayling populations inculde Shainin Lake, Stichiak Lake, Betty Lake, and Etivlik Lake (Bendock 1979). Bendock (1979) also reported good grayling sportfishing in the Colville River from the mouth of the Killik River to the confluence with the Etivluk River, and in the Etivluk River (ibid.).

2. Habitat enhancement efforts. Grayling were stocked in Upper Isatkoak Lagoon at Pt. Barrow in 1981 to enhance recreational fishing activities for the local residents (Bendock 1982). Gill-net sampling in 1983, however, did not yield any grayling, and it is probable that the experimental stocking did not succeed (Bendock and Burr 1984).

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Broad Whitefish Distribution and Abundance

I. REGIONWIDE INFORMATION

In this report, distribution and abundance information of broad whitefish will be presented by ADF&G, Division of Sport Fish, postal survey areas (map 1). Information on the level of whitefish harvest as a group is contained in the Sport Fish Harvest narrative found elsewhere in this volume.

A. Regional Distribution

Broad whitefish are found in most of the major drainages entering the Bering, Chukchi, and Beaufort seas (Baxter 1973, Morrow 1980). The majority of broad whitefish in the arctic coastal plain occur in the Colville, Sagavanirktok, Topagoruk, Ikpikpuk, and Canning rivers (Kogl 1971, Bendock 1977, Bendock and Burr 1985, USFWS 1982). They are found in most major drainages from the Kuskokwim River, where they are common, to the Canadian border (ibid.). They occur in the Yukon River system from the mouth to the headwaters in British Columbia (Morrow 1980), including the Koyukuk, Porcupine, and Tanana river drainages in Alaska (Alt 1971).

B. Areas Used Seasonally and for Life Functions

A series of freshwater fish distribution maps at 1:250,000 scale have been produced for this report. The categories of mapped information include the following:

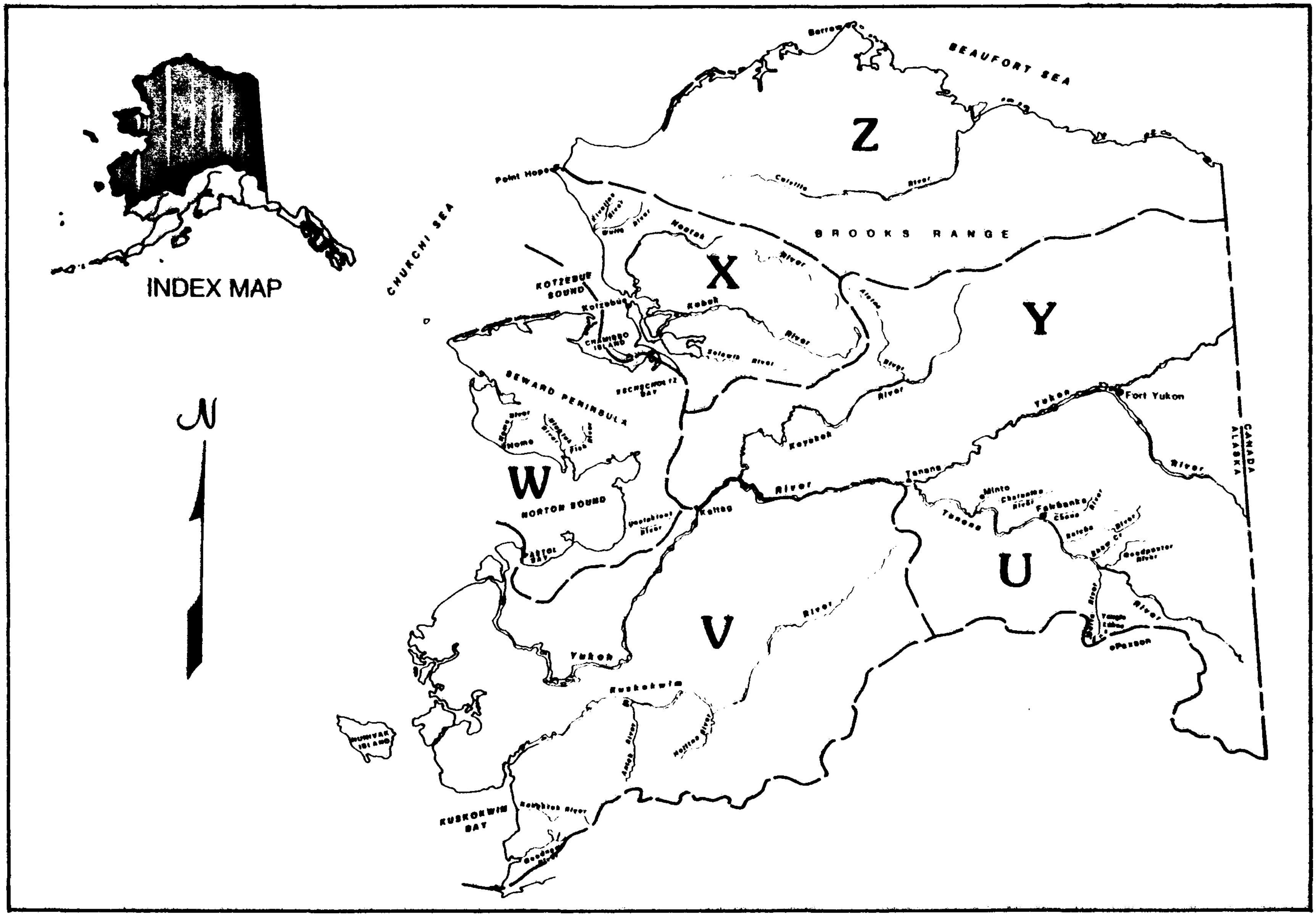
- General distribution
- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas
- Documented rearing areas

C. Factors Affecting Distribution

Water quality parameters, such as salinity, temperature, and dissolved oxygen levels, and physical characteristics of lakes, such as depth, velocity, and substrate type, all influence the distribution of broad whitefish. For detailed information, see the broad whitefish Life History and Habitat Requirements narrative in volume 1 of this series.

D. Movements Between Areas

1. Anadromous. On the North Slope, broad whitefish have been observed migrating out of larger rivers such as the Colville and Sagavanirktok during spring breakup in early June and into shallow bays and lagoons of the Beaufort Sea for summer feeding (Bendock 1977). Fish that had been feeding in coastal areas enter the Sagavanirktok River in late August to migrate to the spawning areas (ibid.). A sizeable spawning run moves up the Colville River in August (Bendock 1979). Alt and Kogl (1973) found that the Colville run is spread over several months and peaks in late July.



Map 1. Arctic, Western, and Interior Regions sport fish harvest postal survey areas.

After spawning, broad whitefish move downstream during freeze-up to overwinter under the ice in deeper freshwater pools, which are fed by springs or the interstitial flow of the major rivers.

2. Nonanadromous:
   a. Stream residents. In the lower Kuskokwim River, the population, which overwinters in the main stem of the river, migrates upstream during spring breakup in late May or early June to the summer feeding areas of the tundra lakes, ponds, and sloughs (Baxter 1973). A similar migration occurs in the Minto Flats area. Broad whitefish move in June from the Tanana, Tolovana, and Chatanika rivers to feed in the lakes and sloughs of the flats (Kepler 1973).
      Baxter (1973) noted that, in the Kuskokwim River area, the ripening females move downstream out of the tundra lakes, ponds, and streams in August and September and begin a slow migration up the Kuskokwim River. They are followed by the sexually developing males in September and October (ibid.). Apparently, in several stocks, there is a postspawning downstream migration of adults to overwintering areas in deep sections of rivers or in brackish water areas or lakes (ibid.).
   b. Lake residents. Little is known about the life history of lake-resident broad whitefish. Bendock and Burr (1985) reported finding broad whitefish in several thaw and deflation lakes located within the central arctic coastal plain. Baxter (1973) reported that broad whitefish occur in lakes throughout the Yukon-Kuskokwim delta. An isolated population of broad whitefish occurs in Lake Minchumina, northwest of Denali National Monument (ibid.).

E. Population Size Estimation
   Populations of broad whitefish have not been well studied in Alaska, and population size has not been estimated.

F. Regional Abundance
   Only limited information on broad whitefish is available. Except for a few isolated cases, which only compare the abundance of broad whitefish relative to the abundance of other fish species, abundance has not been estimated.

II. WESTERN AND INTERIOR REGIONS

A. Fairbanks Area
   The boundaries of the Fairbanks Area (Sport Fish Postal Survey Area U) are described in the Sportfishing Harvest narrative in this volume.
   1. Distribution. Broad whitefish are widespread in the Minto Flats region of the Tanana River drainage (Alt 1972). They have been documented in the Tanana River 14 km upstream from the mouth of the Chena River (ibid.). (For additional information on distribution, see table 1).

Table 1. Collection Locations of Broad Whitefish (<u>Coregonus</u> <u>Nasus</u>) Within Sport Fish Postal Survey Area U

Drainage/Waterbody	Lat. N	Long. W
<u>Yukon River</u>		
Tanana River	65°10'	151°58'
Minto flats	64°43'	148°49'
Tolovana River	64°51'	149°50'
Chatanika River	65°06'	147°26'
Tatalina River	65°04'	149°17'
Lake Minchumina	63°53'	152°19'

Source: Alt 1972, pers. comm.; Baxter 1973.

B. Lower Yukon-Kuskokwim Area

The boundaries of the lower Yukon-Kuskokwim Area (Sport Fish Postal Survey Area V) are described in the Sportfishing Harvest narrative in this volume.

1. <u>Distribution</u>. Broad whitefish are distributed throughout the <u>lower Yukon</u> and Kuskokwim rivers (Baxter 1973). Within the lower Yukon River, Alt (1983) reported that broad whitefish are very abundant in the Innoko River system. They are taken up the North Fork of the Innoko and below Dikeman (124 mi up the Iditarod River) (ibid.).

   Alt (1972) reported that broad whitefish are distributed throughout the Kuskokwim River drainage. They were taken in the Big River, the South and East forks of the Kuskokwim River, and on spawning grounds in Highpower Creek (1,350 km up the Kuskokwim River) (ibid.). (For additional information on distribution, see table 2.)

C. South Slope Brooks Range Area

The boundaries of the South Slope Brooks Range Area (Sport Fish Postal Survey Area Y) are described in the Sportfishing Harvest narrative in this volume.

1. <u>Distribution</u>. Broad whitefish are widely distributed in the <u>Yukon River</u> and its tributaries, including the Porcupine and Koyukuk rivers (Alt 1972). (For additional information on distribution, see table 3.)

Table 2. Collection Locations of Broad Whitefish (<u>Coregonus</u> <u>Nasus</u>) Within Sport Fish Postal Survey Area V

Drainage/Waterbody	Lat. N	Long. W
<u>Yukon River</u>		
Alakanuk	62°40'	164°36'
Kotlik	63°02'	163°33'
Nanvaranak Lake	62°39'	163°37'
Fish Village area	62°20'	163°50'
Andreafsky	62°03'	163°10'
Marshall	61°53'	162°05'
Ohogamiut	61°34'	161°52'
Kakamut	61°38'	161°40'
Innoko River	62°00'	159°38'
Hather Creek	63°35'	158°18'
Yentna River	63°10'	158°16'
Iditarod River	63°02'	158°46'
Dishna River	63°36'	157°17'
North Fork of Innoko R.	63°49'	156°37
<u>Kuskokwim River</u>		
Kuskokwim Bay off Quinhagak	59°45'	162°00'
Kwegooyuk, mile 30 Kusko. R.	60°24'	162°16'
Kialik River, mile 42 Kusko. R.	60°25'	162°25'
Kutukhun Slough	60°36'	162°35'
Kinak River, mile 38 Kusko. R.	60°24'	162°50'
Eenayarak River	60°19'	161°25'
Johnson River, mile 66 Kusko. R.	60°38'	162°06'
Kasigluk, mile 33	60°52'	162°32'
Nunapitchuk, mile 32	60°53'	162°29'
Atmauthluk, mile 29		
Bethel, mile 86 Kusko. R.	60°48'	161°45'
Kwethluk, mile 104 Kusko. R.	60°49'	161°26'
Akiachuk, mile 112 Kusko. R.	60°54'	161°26'
Lower Kalskag, mile 184 Kusko. R.	61°31'	160°22'
Aniak, mile 224 Kusko. R.	61°35'	159°32'
Chuathpaluk, mile 236 Kusko. R.	61°34'	159°34'
Crooked Creek, mile 295 Kusko. R.	61°52'	158°06'
Holitna River, mile 341 Kusko. R.	61°41'	157°51'
Stony River Village, mile 369	61°47'	156°35'
McGrath, mile 511 Kusko. R.	62°58'	155°38'
Medfra, mile 582 Kusko. R.	63°06'	154°43'
Nikolai, Mile 626 Kusko. R.	62°58'	154°10'
Telida, Fish Creek Lake, mile 741 Kusko. R.	63°23'	153°16'
North Fork of Kusko. R.	63°07'	154°34'
South Fork of Kusko. R.	63°05'	154°39'

(continued)

Table 2 (continued).

Drainage/Waterbody	Lat. N	Long. W
East Fork of Kusko. R.	63°07'	154°35'
Highpower Creek	63°25'	153°07'
Big River	62°58'	154°53'
Yukon - Kuskokwim Delta		
Manokinak River	61°32'	164°00'
Kgun Lake	61°34'	163°45'
Tungaluk Slough	61°14'	165°20'
Kashunuk River	61°24'	165°11'
Chakaktolik	62°47'	163°38'
Black River		
Nunavakanuk Lake	62°02'	164°37'

Source: Alt 1972, 1982; Baxter 1973.

Table 3. Collection Locations of Broad Whitefish (*Coregonus Nasus*) Within Sport Fish Postal Survey Area Y

Drainage/Waterbody	Lat. N	Long. W
Yukon River		
Porcupine River	66°52'	143°42'
Dall River	66°00'	149°15'
Nulato	64°34'	158°06'
Koyukuk River	65°41'	156°24'

Source: Alt 1972, Baxter 1973.

III. ARCTIC REGION

A. Seward Peninsula-Norton Sound Area

The boundaries of the Seward Peninsula-Norton Sound Area (Sport Fish Postal Survey Area W) are described in the Sportfishing Harvest narrative in this volume.

1. Distribution. Broad whitefish are known to be present in Imuruk Basin proper as well as in the lower reaches of the three major rivers flowing into the basin: the Agiapuk, Kuzitrin, and Pilgrim rivers (Alt 1972). (For additional information on distribution, see table 4.)

Table 4. Collection Location of Broad Whitefish (*Coregonus Nasus*) Within Sport Fish Postal Survey Area W

Drainage/Waterbody	Lat. N	Long. W
Norton Sound		
Saint Michael	63°29'	162°02'
Koyuk River, mile 5	64°55'	161°08'
Port Clarence		
Imuruk Basin	65°07'	165°45'
Agiapuk River, mile 3,7	65°10'	165°41'
Kuzitrin River	65°10'	165°25'
Pilgrim River	65°09'	165°13'

Source: Alt, 1972, Baxter 1973.

B. Northwest Alaska Area

The boundaries of the Northwest Alaska Area (Sport Fish Postal Survey Area X) are described in the Sportfishing Harvest narrative in this volume.

1. Distribution. Webb (1980) collected broad whitefish in Aliktongnak Lake and other unnamed lakes in the Noatak River drainage. They have also been observed in the Kobuk River drainage (Alt 1979). (For additional information on distribution, see table 5.)

C. North Slope Brooks Range Area

The boundaries of the North Slope Brooks Range Area (Sport Fish Postal Survey Area Z) are described in the Sportfishing Harvest narrative in this volume.

1. Distribution. Broad whitefish were captured along the arctic coast between the Topagoruk River and the eastern margin of Foggy Bay (Bendock 1977, Bendock and Burr 1985). They were

Table 5. Collection Location of Broad Whitefish (_Coregonus_ _Nasus_) Within Sport Fish Postal Survey Area X

Drainage/Waterbody	Lat. N	Long. W
Kotzebue Sound		
Kobuk River	66°54'	160°38'
Noatak River drainage		
Aliktongnak Lake	67°24'	162°41'
Unnamed Lake	67°29'	162°42'
Unnamed Lake	67°27'	162°33'

Source: Baxter 1973, Webb 1980.

found at stream and lake sites on the arctic coastal plain near Teshekpuk Lake (Hablett 1979, Bendock and Burr 1985). They were also captured throughout the summer in the main reaches of the Sagavanirktok and Colville rivers, and a large spawning run has been observed in the Colville at Umiat (Alt and Kogl 1973). Broad whitefish have been reported in the lower Canning River and may possibly use other systems to the east, although none were taken during a wide-scale sampling program in 1970 off the coast of the Arctic National Wildlife Refuge (USFWS 1972). (For additional information on distribution, see table 6.)

Table 6. Collection Locations of Broad Whitefish (Coregonus Nasus) Within Sport Fish Postal Survey Area Z

Drainage/Waterbody	Lat. N	Long. W
Arctic Coast		
Alaktak River	70°27'	154°54'
Teshekpuk Lake	70°35'	153°35'
Colville River,	70°10'	150°55'
Kalubik Creek	70°26'	150°06'
Kupigruak Channel	70°30'	153°23'
Itkillik River	70°09'	150°56'
Nechelik Channel	70°27'	151°04'
Tamayayak Channel	70°27'	151°02'
Nanuk Lake	70°19'	151°01'
Chandler River	69°27'	151°30'
Kachemach River	70°21'	150°40'
Umiat	69°22'	152°03'
Fossil Creek	69°18'	155°22'
Seabee Creek	69°22'	152°06'
Canning	70°04'	145°30'
Killik	69°01'	153°55'
Miluveach	70°23'	150°03'
Awuna River	69°03'	155°28'
Kikiakrovak River	69°59'	151°36'
Kogosukruk River	69°56'	151°35'
Anaktuvuk River	69°34'	151°28'
Sagavanirktok River	70°18'	147°52'
Barter Island	70°07'	143°40'
Inaru River	70°54'	155°59'
Topagoruk River	70°11'	155°57'
Ikpikpuk River	70°49'	154°19'
Oumalik Creek	70°04'	155°25'
Chipp River	70°44'	155°25'
Interlake Creek	70°20'	155°16'
Lake Betty	68°29'	156°30'
Sungovoak Lake	71°05'	156°30'
Pittalukruak Lake	70°50'	155°23'
Meade River	70°52'	155°55'
Okpiksak River	70°41'	156°37'
Fish Creek	70°22'	151°13'
Inigok Creek	70°10'	152°35'
Judy Creek	70°15'	151°45'
Kuparuk River	70°25'	148°52'
Migualiak River	70°39'	154°06'
Price River	69°53'	154°42'
Kalikpik River	70°27'	151°56'
Akmalik Lake	68°25'	154°04'
Imiaknikpak Lake	68°29'	154°03'

(continued)

Table 6 (continued).

Drainage/Waterbody	Lat. N	Long. W
Unnamed lake	70°32'	155°15'
Unnamed lake	70°07'	153°02'
Unnamed lake	70°02'	153°03'
Unnamed lake	70°01'	153°39'
Unnamed lake	70°09'	153°55'
Unnamed lake	70°03'	153°30'
Unnamed lake	70°34'	154°18'
Unnamed lake	70°18'	153°04'
Unnamed lake	70°01'	153°08'
Unnamed lake	70°22'	154°40'
Unnamed lake	70°04'	155°37'
Unnamed lake	70°39'	155°12'
Unnamed lake	70°32'	155°25'
Unnamed lake	70°26'	155°43'
Unnamed lake	70°20'	155°25'
Unnamed lake	70°09'	155°47'
Unnamed lake	70°06'	155°00'
Unnamed lake	69°51'	152°24'
Unnamed lake	70°03'	145°43'
Unnamed lake	70°01'	145°37'
Unnamed lake	70°18'	150°30'
Unnamed lake	70°12'	150°41'
Unnamed lake	70°17'	150°52'
Unnamed lake	70°24'	150°47'
Unnamed lake	70°26'	150°45'
Unnamed lake	70°18'	151°27'
Unnamed lake	70°24'	151°30'
Unnamed lake	70°25'	151°41'
Unnamed lake	70°06'	152°37'
Unnamed lake	70°18'	152°56'
Unnamed lake	70°25'	152°40'
Unnamed lake	70°26'	152°22'
Unnamed lake	70°40'	152°40'
Unnamed lake	70°19'	151°01'
Unnamed lake	69°57'	153°15'
Unnamed lake	69°53'	154°20'
Unnamed lake	69°58'	154°16'
Unnamed lake	70°18'	156°18'
Unnamed lake	70°49'	155°21'
Unnamed lake	70°42'	154°58'

Source: Alt 1972; Alt and Kogl 1973; Baxter 1973; Bendock 1977, 1979; Bendock and Burr 1985a,b; Hablett 1979.

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Lake Trout Distribution and Abundance

I. REGIONWIDE INFORMATION

In this report, distribution and relative abundance information for lake trout will be presented by sport fish postal survey areas, shown on map 1. Information on the level of lake trout sport harvest is contained in the lake trout Sport Use narrative found elsewhere in this volume.

A. Regional Distribution

Lake trout are widely distributed across the North Slope, primarily inhabiting lakes but also occurring in streams within the Colville, Sagavanirktok, and Canning river drainages (Bendock 1982). They have been found in most of the glacial lakes within the Brooks Range and in the southern foothills adjacent to the mountain front (McCart et al. 1972). Waters within the northern foothills region and the western margin of the coastal plain have few lake trout, but the species is well represented in the central coastal plain, which marks the northernmost distribution of this species in Alaska (Bendock 1982). Lake trout are present in the Kobuk drainage as far west as Selby and Narvak lakes (ADF&G 1978).

B. Areas Used Seasonally and for Life Functions

A series of freshwater fish distribution maps at 1:250,000 scale have been produced with this report. The categories of mapped information are as follows:

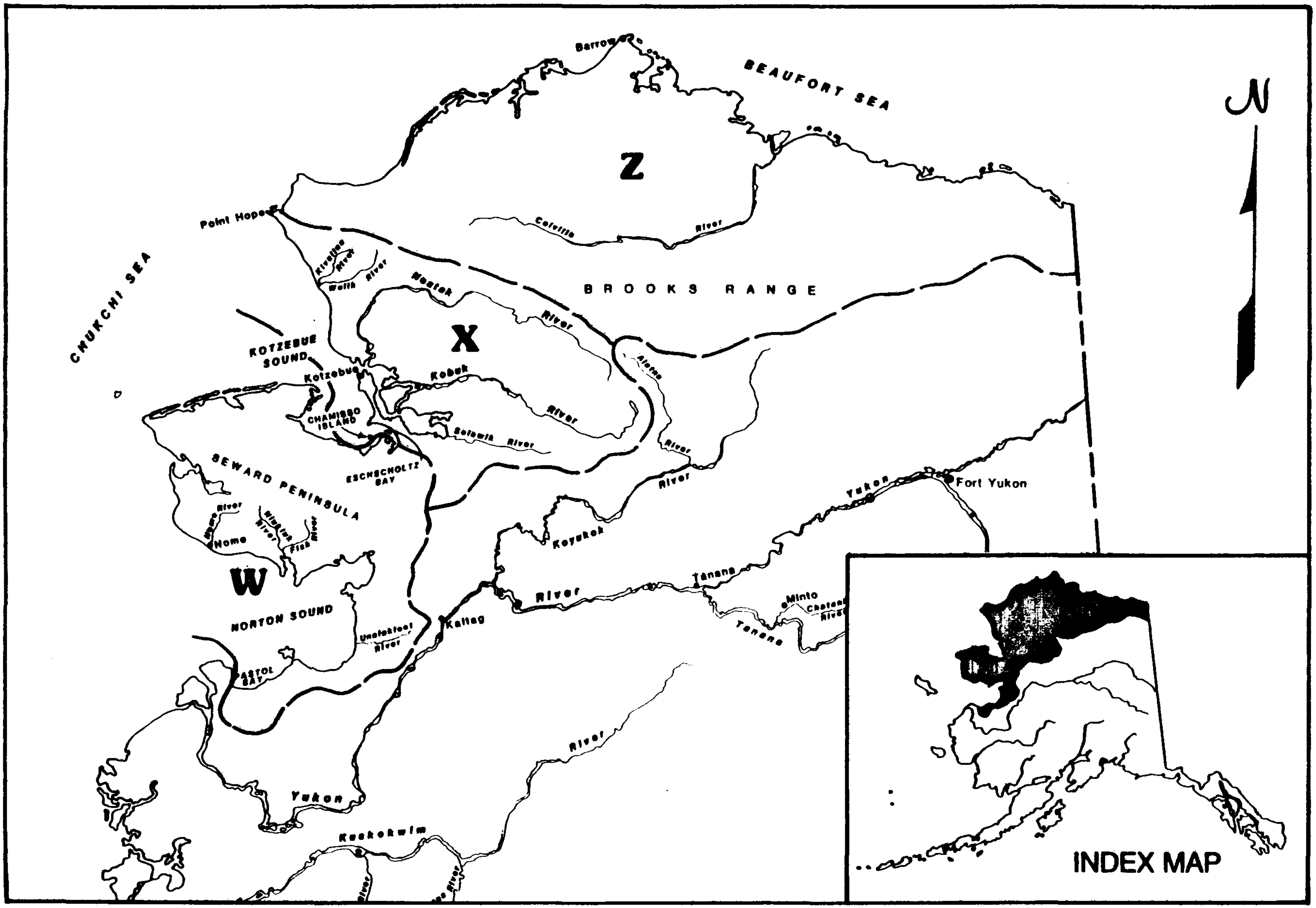
- General distribution
- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas
- Documented rearing areas

C. Factors Affecting Distribution

In the Arctic Region, lake trout are found in lakes deep enough to provide overwintering areas. The presence of clean rubble or gravel for spawning is also an important determinant for lake trout distribution. Lake trout are also found in some Arctic Region rivers. More details of lake trout habitat requirements can be found in the lake trout Life History and Habitat Requirements narrative in volume 1 of this publication.

D. Movements Between Areas

Whole populations of lake trout do not undertake movements in definite directions; however, individual lake trout travel extensively in their lake or stream environment. Lake trout generally feed near the water surface in the spring and then move into deeper areas as water temperatures rise in the summer. In the fall, lake trout move to shallow, rocky areas to spawn, and they then disperse throughout the lake during the winter months. In the Arctic Region, lake trout must move to deep areas of lakes



Map 1. Arctic Region sport fish survey areas.

or rivers or to spring areas during the winter months because other habitat will become frozen solid.

E. Population Size Estimation

The relative abundance of lake trout in Arctic Region lakes and streams has generally not been systematically assessed. Estimates of population size are based on rough measures of catch-per-unit-effort gathered during lake and stream gill net and hook and line surveys.

F. Regional Abundance

Very little lake trout abundance information is available. The information that has been collected applies only to specific lakes and streams. As a result, abundance cannot be appropriately addressed at the regional level. Abundance information is contained in the postal survey area discussions that follow.

II. SEWARD PENINSULA-NORTON SOUND AREA

The Seward Peninsula-Norton Sound Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report. No record of any lake trout populations in this area was found in the literature.

III. NORTHWEST ALASKA AREA

The Northwest Alaska Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Lake trout are found in Walker, Nutuvukti, Minakokosa, Selby, and Narak lakes in the Kobuk River drainage, with Selby and Narak lakes being the site of the westernmost recorded distribution in the Kobuk drainage (ADF&G 1978). In the Noatak drainage, lake trout are found in several lakes, with Lake Narvakruk being the westernmost recorded distribution. Other lakes in the Noatak drainage known to contain lake trout are Lake Isiak, Lake Matcharak, Lake Kipmik, two of the Kikitaliorak lakes, Kiingyak Lake, Feniak Lake, and Desperation Lake (ADF&G 1978, Alt 1978). Lake trout have also been found in the Noatak River at the mouth of the Nimiuktuk River (Alt 1978).

B. Abundance

1. Summary of data. No systematic abundance surveys for lake trout have been conducted in the Northwest Alaska Area. Alt (1978) sampled Isiak, Matcharak, Kimpik, Kiingyak, Kikitaliarak, and Feniak lakes with gill nets to determine species composition. He concluded that lake trout were present in these lakes but not in great abundance. The highest catch-per-unit-effort was four fish per net night in Matcharak, Kikitaliorak, and Feniak lakes. Desperation Lake, which was not sampled with gill nets because of the large number of fish present, has a large population of small lake trout (Alt 1978).
2. Habitat enhancement efforts. No record of any habitat-enhancement efforts directed toward lake trout in the Northwest Alaska Area was found in the literature.

IV. NORTH SLOPE BROOKS RANGE AREA

The North Slope Brooks Range Sport Fish Postal Survey Area is described in the Sport Use of Freshwater Fish portion of this report.

A. Distribution

Lake trout are widely distributed across the North Slope. In the eastern North Slope, they are found in a few coastal plain lakes near the Canning River drainage (Craig 1977) and in Peters and Schrader lakes in the Sadlerochit drainage (ADF&G 1978). Lake trout are found in foothill and mountain lakes across the North Slope and have been recorded as far west as Tukuto Lake in the Etivluk River drainage. North Slope lakes containing lake trout include Wahoo, Elusive, Campsite, Galbraith, Itikillik, Stichiak, Shainin, Tulugak, Natvakruak, Chandler, Imiaknikpak, Kurupa, Etivlik, Betty, and Tukuto (AEIDC 1977, ADF&G 1978, Bendock 1979, Bendock 1982). Lake trout are also found in Teshekpuk Lake and in many smaller, unnamed coastal plain lakes in the area of the Colville and Ikpikpuk rivers (ADF&G 1978, Bendock 1982).

Lake trout are also found in streams within the Colville, Sagavanirktok, and Canning river drainages (Bendock 1982). In the Colville River, they are found from the delta area upstream as far as the Etivluk River (Bendock 1979, Kogl 1971) and in many Colville River tributaries, including the Itkillik, Anaktuvuk, Chandler, Killik, and Etivluk rivers (Kogl 1971, Bendock 1979, ADF&G 1978).

Lake trout overwinter in deep lakes and in rivers. Bendock recorded lake trout overwintering in the Colville River near the mouth of the Lower Ninuluk River (Bendock 1981) and in the Anaktuvuk River near Rooftop Ridge (Bendock 1982).

B. Abundance

1. Summary of data. No systematic abundance surveys for lake trout have been conducted in the North Slope Brooks Range Area. Several lakes have been sampled with gill nets or by hook and line, and some qualitative abundance information may be derived from these studies.

   Bendock reported excellent lake trout sportfishing catches from Shainin, Karupa, and Etivlik lakes and from an unnamed lake near the Nigu River (Bendock 1979). Large gill net catches of lake trout have been reported from Irgnyivik Lake, a mountain lake 24 mi northeast of Anaktuvuk Pass (19 lake trout per net night); Lower Anayak Lake in the lower Anayaknaurak Creek drainage (9 lake trout per net night), Elusive Lake (7.8 lake trout per net night), and Campsite Lake (6 lake trout per net night) (Bendock 1980, 1982; Furniss 1974). Good numbers of lake trout have also been taken from Chandler, Tulugak, Natvakruak, and Itkillik lakes, all with catches of 5 lake trout per net night (Furniss 1974, Bendock 1982).
2. Habitat enhancement efforts. No record of any habitat-enhancement efforts directed towards lake trout in the North Slope Brooks Range Area was found in the literature.

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Least Cisco Distribution and Abundance

I. REGIONAL DISTRIBUTION

Both anadromous and freshwater forms of the least cisco are present and generally abundant throughout the inland areas of the Western and Interior regions and in the nearshore coastal marine zone of the Western Region. The species is present in most streams and lakes north of the Alaska Range (Morrow 1980). They ascend the Yukon River upstream at least as far as Circle (McPhail and Lindsey 1970). Alt (pers. comm.) found them within 20 mi of the Canadian border.

II. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

Anadromous forms of least cisco generally spend the summer months feeding in the nearshore coastal marine zone and migrate into the lower reaches of coastal rivers and river deltas in the fall to spawn and overwinter. It is presumed that they cannot withstand the subzero temperatures and increased salinities present in this nearshore environment in winter. However, high productivity and abundance of food in the nearshore marine environment during summer allows greater growth rates and fosters the greater maximum age attained by the anadromous forms of least cisco (McPhail and Lindsey 1970, Scott and Crossman 1973).

A migratory freshwater form of least cisco also exists. In the Innoko River, a major tributary to the lower Yukon River, mature least cisco begin an upstream migration in late spring, or soon after ice-out. They move into lakes and sloughs to feed all along the migration route (Alt 1983). In late summer (August), they continue the upstream migration towards spawning areas. In the Innoko River, primary least cisco spawning areas are upstream of the junction of the North Fork Innoko River and the main Innoko River. The 80-mi section of river from Cripple to Ophir is very important spawning habitat for least cisco, as well as for other fish species (ibid.). Similar movements of least cisco were observed in the upper Chatanika River near Fairbanks (Kepler 1973). Least cisco spawning is confined to a stretch of river from 16 km below to 12 km above the Elliott Highway bridge. Individual spawning areas vary in size from 100 to 800 m in length and 15 to 22 m in width (ibid.). After spawning occurs, the adults apparently move downstream again (Alt 1983).

The demersal eggs incubate in gravel during the winter and hatch in late May or early June (McPhail and Lindsey 1970). Young-of-the-year least cisco migrate downstream to rearing areas in slower, deeper waters of the lower Yukon River (Alt 1983).

A series of least cisco distribution and abundance maps have been produced for this report. The categories mapped are as follows:

- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas

- Documented rearing areas
- Documented spawning and/or rearing in an unspecified portion of stream or lake
- Species known to be in the system

III. FACTORS AFFECTING DISTRIBUTION

Various forms of least cisco are present and abundant throughout the Western and Interior regions. The species, as is typical of Coregonids, shows a high degree of both morphological and behavioral differences between local populations. Some populations became landlocked and have evolved separately, whereas other populations of least cisco have recently invaded previously glaciated watersheds (Lindsey 1981). Interspecific competition, predation, migration patterns, and the physical and chemical characteristics of a system are some factors affecting least cisco distribution. (For more details, see the least cisco Life History and Habitat Requirements narrative in volume 1 of this report.)

IV. MOVEMENTS BETWEEN AREAS

In the Western and Interior regions, migratory and nonmigratory populations of least cisco are generally abundant. Nonmigratory populations are typically found in the numerous lakes of both regions. Migratory and/or anadromous forms of least cisco occupy the Yukon and Kuskokwim rivers and many of their tributary lakes and streams. Mature least cisco begin migrating upstream in the Yukon, Innoko, and Chatanika rivers in late spring, or soon after ice-out (Alt 1983, Kepler 1973). They move into numerous lakes and sloughs to feed during summer. In late summer (August), they continue their upstream migration to spawning areas (Alt 1983, Kepler 1973). At some time after spawning, they move downstream again (Alt 1983). Anadromous least cisco have a similar pattern of movement, but they spend the summer months feeding and migrating along the brackish, nearshore coastal zone (Barton 1979). In August and September, they begin a return migration to the river deltas and coastal streams to spawn. Spawning occurs in late September and October, after which the adults remain in freshwater deltas and river channels over winter.

Larval least cisco hatch in late May or early June. In the Innoko River, young-of-the-year soon after hatching begin a downstream migration to deeper, slower waters in the lower Yukon River, where they rear (Alt 1983). Kepler (1973) reported a similar downstream movement of young-of-the-year from the upper Chatanika River.

V. POPULATION SIZE ESTIMATION

In the upper Chatanika River, near Fairbanks, Kepler (1973) estimated that 16,500 least cisco spawned in the area between 12 km above and 16 km below the Elliott Highway bridge. This estimate of spawning abundance was derived from visual counts in the 1972 season (Kepler 1973). In 1983, placer mining in the headwaters of the Chatanika River caused excessive turbidity in the defined spawning area. Attempts to determine the abundance of spawning least cisco were precluded because of turbidity (Hallberg 1984).

Barton (1979) sampled nearshore coastal areas (0 to 6 m depth) of Norton Sound, Port Clarence, and the Yukon River delta from June through October in 1976 and 1977. Least cisco were present at all sample locations and were among the 10 most frequently encountered species in all areas. Abundance was indicated by catch-per-unit-effort (CPUE) data collected with beach seines and gill nets. Beach seine CPUE of least cisco was highest in the Imuruk Basin and in the Golovin Bay area. The Imuruk Basin was sampled only during two periods in 1977 (7-21 July and 22 August-6 September), and CPUE of least cisco was very high at both times. In the Golovin Bay area, CPUE of least cisco was highest between late July and early September. Beach seines tended to capture smaller and/or younger least cisco, whereas gill nets captured larger and/or older fish (Barton 1979). Gill net CPUE data indicated that high abundances of least cisco were present in Golovin Bay and inner Norton Sound (Cape Denbigh to Cape Stebbins) and in the Imuruk Basin and Port Clarence areas (ibid.). In Golovin Bay, gill net CPUE indicated relatively high least cisco abundance from early July through early October. In inner Norton Sound, least cisco were abundant, as indicated by gill net CPUE data, between late July and mid August. In Port Clarence, least cisco were abundant in gill net CPUE samples in July and early August but were significantly less abundant from August to October. Catches in the Imuruk Basin indicated very high relative abundance when sampled in late August and late September. Gill net sampling was not conducted during other periods in Imuruk Basin (Barton 1979).

No population or abundance estimates are available for other areas in the Western and Interior regions.

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Sheefish Distribution and Abundance

I. REGIONAL DISTRIBUTION

In the Arctic Region, sheefish are found only in the Kobuk and Selawik rivers and brackish water areas of Selawik Lake, Hotham Inlet, and Kotzebue Sound. A small population of sheefish is also found in the Koyuk River, which drains into Norton Bay (ADF&G 1978). These fish are found up the Koyuk River to its confluence with the Peace River (ibid.).

II. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

A series of freshwater fish distribution maps at 1:250,000 scale have been produced for this report. The following are the categories of mapped information:

- General distribution
- Documented presence in stream or lake
- Documented spawning areas
- Documented overwintering areas
- Documented rearing areas

III. FACTORS AFFECTING DISTRIBUTION

Alt (1973) contains an excellent discussion of factors that may be responsible for the very limited distribution of sheefish in Alaska. Sheefish have such stringent spawning ground requirements that only a few spawning bars are available in all of Alaska's rivers (ibid.). Another limiting factor may be the presence of delta areas for rearing. Interconnected lakes and sloughs and slow-moving deep-water areas of lower rivers are biologically rich and apparently quite important for the growth and survival of young sheefish (ibid.). Velocity barriers may also limit the distribution of sheefish, which will not ascend streams with a rapid current or even the slightest falls (ibid.). Sheefish are not generally found in salt water, and saltwater barriers may limit their range expansion into the Seward Peninsula area and from Kotzebue Sound into northwestern Alaska and northern Alaska (ibid.).

IV. MOVEMENTS BETWEEN AREAS

Sheefish from the Selawik-Kobuk drainages overwinter in Selawik Lake, Hotham Inlet, and Kotzebue Sound.

The spawning migration up the Kobuk River begins immediately after ice-out (late May), and sheefish reach Noorovik by early June (Alt 1967). The upstream migration of spawning fish is protracted, and fish may remain in deep pools and eddies for some time before moving upstream (Alt 1967). Sheefish do not enter the tributaries of the Kobuk River (Alt 1977).

In the Kobuk River, sheefish have been reported as far upstream as lower Kobuk Canyon (Alt 1967). Sheefish arrive in the vicinity of the Kobuk River spawning grounds 38 km above Kobuk Village in late August and early September (ibid.). After spawning, there is a rapid downstream migration to Kiana and Noorvik and then a slower migration to the wintering areas (Alt 1977).

Sheefish that spawn in the Selawik River follow a similar migrational pattern. Main concentrations of sheefish in Selawik Lake during the spring were located off the mouths of the Tuklomarak and Selawik rivers (Alt 1969). Sheefish enter the Tuklomarak River as soon as the ice goes out. Prespawning fish apparently enter Selawik River via the Tuklomarak River, Tuklomarak Lake, Fox River, Inland Lake route (ibid.). Spawning areas of Selawik sheefish are located approximately 200 km up the Selawik River (ibid.). Nonspawning and immature fish return to Selawik Lake in August and September. Fish that have completed spawning migrate down the Selawik River to Selawik Lake under the ice in late October through December (Alt 1977).

Rearing immature sheefish of ages 4 to 10 are found during the summer months in Hotham Inlet, Selawik Lake, and the lower Kobuk, lower Selawik, and Tuklomarak rivers (Alt 1980). The estuarine environment of Kotzebue Sound is also very important for rearing sheefish, especially those of ages 2 to 8 (ibid.). Rearing sheefish are not found in the small lakes of the lower Kobuk and Selawik rivers, probably because of the presence of large numbers of pike (ibid.).

V. POPULATION SIZE ESTIMATION

In 1970, a tag and recapture study was carried out on the population of sheefish in the Kobuk River. The population size was estimated, using the Petersen formula, to be 7,130 (Alt 1971). Sheefish in this study, however, were tagged on the spawning grounds, and immature and nonspawning sheefish therefore had little or no chance of being tagged. Recaptures were made by subsistence fishermen in villages downstream from the spawning area; however, the total harvest by these fishermen, which was used to calculate the percentage of recaptures, included many immature and nonspawning fish (ibid.). As a result, the population estimate from this study was too large. Attempts were made to correct this bias, and these led to the 7,130 fish estimate. This estimate, however, is based on an unconfirmed approximation of the total subsistence harvest of spawning fish (ibid.) and so is itself only an approximation of population size.

With the exception of this tagging study, the status of sheefish populations in the Arctic Region is monitored by reports of commercial and subsistence fishermen, estimates of the volume of subsistence harvest, and by aerial surveys of spawning grounds (Alt 1972, ADF&G 1983). Spawning ground aerial surveys are primarily conducted along the upper Kobuk River in September (ADF&G 1983). In recent years, however, poor weather, inexperienced observers, and a survey date that targets for spawning chum salmon instead of sheefish have resulted in unreliable counts of spawning sheefish (ibid.).

VI. REGIONAL ABUNDANCE

Incomplete escapement and catch data provide little basis for assessing the current population status of sheefish in the Kobuk and Selawik area (ADF&G 1983). When Alt began his sheefish investigations in this area in the mid 1960's the annual sheefish harvest in northwest Alaska was around 36,000 fish, and many local residents felt that there had been a decline in the number of sheefish (Alt 1969). This could indicate that the northwest Alaska sheefish population is not large enough to sustain a harvest of 36,000 fish. Aerial surveys of the Kobuk River spawning grounds in 1968 to 1971 resulted in estimates ranging from 3,220 spawners in 1970 to 8,166 in 1971 (Alt 1971, 1972). Aerial surveys in recent years have suffered from several inaccuracies. However, in 1979 the Kobuk River spawning area count was 2,824 sheefish, and in 1980 the count was 1,772 (ADF&G 1983).

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Salmon Distribution and Abundance

I. REGIONWIDE INFORMATION

The Arctic Region contains all waters within the Norton Sound-Port Clarence and the Kotzebue-Northern commercial fisheries management areas. Within the marine and fresh waters of the Arctic Region lie the northernmost ranges of all five species of Pacific salmon indigenous to North America.

The distribution and abundance of each salmon species will be presented in sections II., III., IV., and V. of this narrative. These sections correspond to the ADF&G commercial fishing districts within the region and include the Norton Sound, Port Clarence, Kotzebue, and Northern districts. Maps found in the Atlas to the Arctic Region that accompanies this publication show the boundary lines of the management areas. Further, detailed descriptions of the boundaries and maps depicting the districts can be found in the salmon commercial harvest narrative located in the Human Use portion of this volume.

A. Regional Distribution

Pink and chum salmon have the widest range, each extending north to the Arctic Ocean and east as far as the MacKenzie River in Canada (Morrow 1980). The fish are relatively scarce, however, north of Point Hope. The northernmost large concentrations of chum and pink salmon are found within the Kotzebue Sound drainages (ADF&G 1983a; Bigler 1983; Bigler, pers. comm.). Chinook, sockeye, and coho salmon all range north to Point Hope but are uncommon north of Norton Sound (Morrow 1980). The region's sockeye salmon stocks are largely limited to small populations within Seward Peninsula drainages and in Kelly Lake on the Noatak River near Kotzebue (ADF&G 1983a).

B. Areas Used Seasonally and for Life Functions

To supplement the distribution information presented in the narrative, a series of 1:250,000-scale reference maps have been produced that depict documented anadromous fish streams and anadromous fish stream watersheds within the Arctic Region.

The anadromous stream maps show the following:

- ° Species present and documented upstream migration points
- ° Unsurveyed areas where it is not known if anadromous fish are found in the system
- ° Documented nonpresence of anadromous fish (e.g., in glacier fields or in areas above barriers to migration, such as waterfalls or rapids)

The reference maps have been reduced and combined and are included in the 1:1,000,000-scale index maps contained in the Arctic Region Atlas that accompanies this publication.

C. Factors Affecting Distribution

1. Fresh water. Water quality, quantity, and the waterbodies' substrate affect salmon as the adults migrate to spawning areas, as spawning occurs, as the eggs incubate, as the fry emerge from the gravel, as the juveniles rear, and as the smolt migrate to the sea. Major components of water quality include temperature, pH, dissolved oxygen, turbidity, and chemical composition. Water quantity includes the factors of velocity and depth. Substrate is important in that it must be composed of the proper size material to allow adult salmon to construct redds. It must also allow intragravel water movement so that dissolved oxygen may be transported to eggs and alevin and, in turn, metabolic wastes may be removed. (For more details of the factors that affect salmon distribution in the freshwater environment, see the Life History and Habitat Requirements narratives for each of the salmon species in volume 1 of this publication.)
2. Salt water. Little is known of the factors that contribute to salmon distribution in the marine environment. Water temperature and the depth of the thermocline, salinity, currents, and the availability or location of food organisms probably all influence where salmon move while in estuaries and the high seas. Species-specific information concerning these factors may be found in the Life History and Habitat Requirements narratives found in volume 1 of this publication.

D. Movements Between Areas

Very little information has been documented that addresses juvenile salmon movements, and only general data of smolt migration routes and patterns in marine waters appear in the literature. These data are included in each species life history found in volume 1 of this publication.

Some information has been documented that indicates the routes and timing of the adult salmon return to fresh water. Where appropriate, these data are presented in the management area narratives (section II., III., IV., and V. below). Additional migration information is also included in each species life history found in volume 1 of this publication.

E. Population Size Enumeration

Salmon abundance, or run-strength, is derived where possible by combining catch numbers (commercial, subsistence, and sport harvest) and escapement figures (number of fish entering fresh water). Escapement estimates are derived by using one or a combination of several measurement techniques. Aerial and ground survey counts, weir counts, and hydroacoustic (sonar) equipment counts are among the methods used to enumerate escapement.

The resultant population estimates, however, should be treated as an approximation or estimate of run-size because many factors can influence the harvesting and escapement enumeration of fish. Such factors as weather, current, and type or size of gear can affect the catch. Turbidity and/or glacial silt, weather, light conditions, stream flow, and the experience of the persons counting the fish can affect ground and weir counts as well as aerial surveys.

Salmon abundance estimates (total run-strength) for an individual stream system are derived, where possible, by combining catch numbers (commercial, subsistence, and sport harvests) and escapement numbers. In some cases, run-strength calculations for an individual stream system are difficult to achieve because the fisheries are harvesting mixed stocks of fish. It is therefore difficult to define what proportion of the catch should be allocated to which stream system unless stock identification techniques are implemented in the fishery (e.g., tagging, scale pattern analysis). Therefore, most of the abundance information presented in this narrative is estimated escapement in numbers of fish that have passed through the commercial fishery and have been enumerated in freshwater systems.

In the narratives and tables that follow, care has been taken to document locations, if known, and methods used to gather escapement data, so that the approximate level of detail may be deduced (e.g., aerial surveys are generally less precise than weir counts). The data are taken in large part from the annual finfish reports prepared by ADF&G area commercial fishery biologists, who stress that in most cases run-strength assessments are estimates that should not be treated as absolute figures.

II. NORTON SOUND DISTRICT

The Norton Sound District includes all waters from Canal Point Light north to Cape Douglas and includes over 500 mi of coastline. The area consists largely of plateaus, highlands, low mountains, and small areas of coastal plain. The topography in the highland ranges from gently sloping uplands to rolling and steep sloping mountains. The lowland is limited to a few relatively small valleys along the coast of Norton Sound. The area is bordered to the north by the Kigluaik, Bendeleben, and Darby mountains and to the east by the Nulato Hills. For management and regulatory purposes, the Norton Sound District is divided into six subdistricts. These include the Nome, Golovin, Moses Point, Norton Bay, Shaktoolik, and Unalakleet subdistricts. Each subdistrict contains at least one major salmon-spawning stream (ADF&G 1984b). A map delineating the boundaries of the subdistricts may be found in the commercial salmon harvest narrative in the Human Use portion of this volume.

A. Distribution

Within Norton Sound district waters are found all five species of Pacific salmon native to North America. The presence of adult salmon has thus far been documented in 32 first-order streams (i.e., those whose mouths are located at salt water) emptying into Norton Sound within the district boundaries (ADF&G 1984a). Major salmon-producing systems in the district include the Unalakleet and Fish river drainages, the Shaktoolik, Egavik, Inglutalik, Ungalik, Koyuk, Tubutulik, Kwiniuk, Kachavik, Bonanza, Eldorado, Flambeau, Nome, Snake, Sinuk, Solomon, Golsovia, and Kwik rivers (Schwarz, pers. comm.; Lean, pers. comm.).

In terms of general run-timing, adult salmon are present in Norton Sound bays and estuaries from mid June through late August and are found spawning in fresh waters from early July through late September (ADF&G 1977a). Table 1 provides general run-timing information for individual salmon species in the Norton Sound District.

Table 1. Norton Sound and Port Clarence Districts General Salmon Run-Timing

Species	Present in Bays and Estuaries[a]	Peak Spawning[a]	Peak Outmigration[b]
Pink	Late June-mid July	Mid July-early Aug.	Early June-mid June
Chum	Late June-late July	Early July-mid Aug.	Early June-mid June
Coho	Early August-mid Aug.	Late Aug.-late Sept.	---
Chinook	Mid June-mid July	Early July-early Aug.	---
Sockeye	Late June-late July	Mid July-early Sept.	---

Source: a ADF&G 1977a; b Schwarz, ADF&G, pers. comm.

--- means no data were available.

Note: Early = 1st to 10th of month, mid = 11th to 20th of month, late = 21st to 30th/31st of month.

B. Abundance

Pink salmon are the most abundant salmon species in the Norton Sound District, followed in descending order of abundance by chum, coho, and chinook salmon (ADF&G 1984b). Sockeye salmon occur only rarely in the district (ibid.).

Fisheries biologists compare effort, catch, and escapement data with that of previous seasons in order to judge relative salmon run magnitude from season to season. Taken alone, none of these factors is a very reliable indicator of abundance. To further complicate matters, salmon caught in a particular Norton Sound subdistrict may be destined for a spawning stream in a different subdistrict. Further, there is a distinct possibility that Yukon River stocks contribute greatly to the Norton Sound District fishery in some years (ADF&G 1977a). Thus, at this time it is not possible to combine catch and escapement numbers to produce total system-specific or even district-specific run estimates for the

Norton Sound District. Because of this, the abundance figures presented below reflect primarily escapement estimates.

Escapement estimates in the Norton Sound District are obtained primarily from aerial surveys flown or area streams and to a lesser extent from counting tower and sonar counts. A counting tower has been used consistently on the Kwiniuk River since 1965 and periodically on the Kachavik, Niukluk, Tubutulik, North, and Chirosky rivers. The use of sonar has been attempted on the Unalakleet River in 1982, 1983, and 1984 (Lean, pers. comm.). Significant problems, however, including a limited counting range, multiple counting of individuals that mill in the sonar beam, and identification of species counted bring the accuracy of sonar estimates into question (ADF&G 1983a). The remainder and majority of escapement estimates made on Norton Sound District streams were derived from aerial surveys. Escapement estimates derived from these surveys for the years 1973 through 1983 are presented in tables 2 through 5. Again, it should be emphasized that these estimates are only rough indices of abundance and because of limitations inherent to the surveying techniques are not necessarily indicative of total numbers of spawners (see section I. E., above). Care has been taken to document both the survey conditions and methods used to obtain escapement data. Discussions of individual species distribution and abundance are organized in sections 1. through 5. below according to abundance, with the most abundant species, pink salmon, presented first.

1. Pink salmon. The presence of pink salmon has been documented in 30 first-order streams (i.e., those whose mouths are located at salt water) within the Norton Sound District (ADF&G 1984a). It is suspected that more such streams exist but are as yet undocumented. In terms of general run-timing, pink salmon are normally present in Norton Sound bays and estuaries from late June to mid July, with spawning in fresh waters typically occurring from mid July to early August (table 1) (ADF&G 1977a). Peak out-migration of the fry normally occurs from early to mid June (Schwarz, pers. comm.).

   Norton Sound pink salmon do not exhibit strong even-odd year fluctuations in abundance, as do other pink salmon in more southerly latitudes (ADF&G 1977a). Norton Sound pink salmon, however, do exhibit large annual fluctuations, apparently in response to climatic conditions (ibid.). There has, however, been a general trend beginning in 1979 toward significantly larger pink salmon runs in the Norton Sound District (ADF&G 1983a).

   Major pink salmon-producing systems in the Norton Sound District include the Unalakleet and Fish river drainages and the Shaktoolik, Egavik, Inglutalik, Ungalik, Koyuk, Tubutulik, Kwiniuk, Kachavik, Bonanza, Eldorado, Flambeau, Nome, Snake, Sinuk, Solomon, Golsovia, and Kwik rivers (Schwarz, pers. comm.; Lean, pers. comm.). With the exception of the Kwik and the Golsovia rivers, pink salmon escapement estimates exist for all these systems and additional streams as well. Available pink salmon escapement data for the years 1973 through 1983 appear in table 2, with streams grouped by subdistrict.

2. Chum salmon. The presence of chum salmon has been documented in 26 first-order streams (i.e., those whose mouths are located at salt water) within the Norton Sound District (ADF&G 1984a). It is suspected that more such streams exist but are as yet undocumented.

   Chum salmon run-timing overlaps to a large degree with that of pink salmon, with chum salmon normally present in Norton Sound bays and estuaries from mid June to late July and with fish typically occurring on the spawning grounds from mid July to mid August (table 1) (ADF&G 1977a). Peak out-migration of the fry typically occurs from early to mid June (Schwarz, pers. comm.).

   Although pink salmon are more abundant, chum salmon is the target species of the commercial fishery in all Norton Sound subdistricts for most of the season. With the exception of the 1983 record harvest, chum salmon commercial catches have been fairly stable over the past 10 years, with the average commercial harvest approximating 170,000 fish (ADF&G 1984b).

   Major chum salmon-producing systems in the Norton Sound District include the Unalakleet and Fish river drainages and the Shaktoolik, Egavik, Inglutalik, Ungalik, Koyuk, Tubutulik, Kwiniuk, Kachavik, Bonanza, Eldorado, Flambeau, Nome, Snake, and Sinuk rivers (Schwarz, pers. comm.). Chum salmon escapement estimates exist for all these systems and additional streams as well. Available chum salmon escapement data for the years 1973 through 1983 are presented in table 3, with streams grouped by subdistrict.

3. Coho salmon. The presence of coho salmon has been documented in 19 first-order streams (i.e., those whose mouths are located at salt water) within the Norton Sound District (ADF&G 1984a). It is suspected that more such streams exist but are as yet undocumented.

   In terms of general run-timing, coho salmon are typically not present in Norton Sound bays and estuaries until early-to-late August, with spawning not normally occurring until late August to late September (table 1) (ADF&G 1977a). This is the latest run-timing exhibited by any salmon species in Norton Sound. This fact has contributed to the relative scarcity of historical coho salmon escapement data for the Norton Sound District. Field projects concerned with escapement monitoring have in the past normally been terminated prior to coho salmon-spawning activity. What little Norton Sound coho salmon escapement data are available are presented in table 4, with streams grouped by subdistrict. Although not the only significant coho salmon-producing systems, the

Table 2. Escapement Estimates of Pink Salmon in Norton Sound District Streams by Subdistrict, 1973-83[a]

	Nome Subdistrict								
	Eldorado River	Flambeau River	Nome River	Sinuk River	Solomon River	Bonanza River	Penny River	Snake River	Cripple Creek
1973	---	---	14,940[e]	---	---	---	---	---	---
1974	6,185[d]	---	17,832[e]	7,766	770	17,900[f,i]	---	---	---
1975	1,340[d]	1,505	3,405[f]	5,390	---	441[a]	335	---	---
1976	1,382	1,994	6,700[f]	---	---	2,085	---	---	---
1977	125	10	1,726	1,302	1,250	722	---	50	---
1978	12,800	---	34,900	22,435	1,988	23,936	1,500	1,100	9,960
1979	652	291	---	100	---	156[d]	150	---	---
1980	55,520	16,000	171,350	199,000	28,700	12,808[d]	---	---	---
1981	495[f]	2,710[f]	12,565[f]	350[f]	6,950[f]	14,935[f]	---	5[d]	---
1982	163,300[f]	25,001[f]	327,570[f]	148,800[f]	54,100[f]	67,800[f]	350[d,i]	---	1,575[d,i]
1983	270	200	9,170	10,770	8,180	10,576	---	---	600[i]

	Golovin Subdistrict					Moses Point Subdistrict		Norton Bay Subdistrict		
	Boston Creek	Fish River	Kachavik Creek	Niukluk River	Paragon River	Kwiniuk[b] River	Tubutulik River	Unagalik River	Inglutalik River	Koyuk[i] River
1973	3,213	15,564	22,275[d]	14,790[d]	2,150[d,i]	38,420	15,665[f]	---	---	---
1974	749	15,690[d]	2,723[d]	8,915	---	40,816	17,940[d]	---	---	---
1975	2,556	15,840[d]	23,360	16,258	---	57,317	38,003[d]	7,494[e]	---	---
1976	---	15,850[d]	---[b]	7,190	---	29,471	6,095[d]	5,753	---	247[d]
1977	385	2,430[d]	30,432[b]	4,150	66	46,234[e]	4,685[d]	---	---	---
1978	74,221	140,640[d]	26,533[b]	208,300[b]	7,225	72,270[e]	1,364[d]	51,894	6,800	---
1979	271	9,132[d]	23,850	30,147[b]	---	167,492	1,624[h]	14,920	14,960	---
1980	1,510	33,500[d]	---	75,770	---	320,389	663,937[h]	66,025	4,898	---
1981	---	450[f,j]	---	---	---[i]	566,417	480[e]	---	---	---
1982	22,020[f]	241,700[f,j]	72,235[f]	227,540[f]	30,300[i]	469,674	53,605[e]	37,650[f]	---	---
1983	---	300[e]	---	50[e]	---	251,965	40,790[d]	23,380	---	---

(continued)

Table 2 (continued).

	Shaktoolik Subdistrict	Unalakleet Subdistrict						
	Shaktoolik River	North River	Unalakleet River	Chirosky River	Egavik River	North Fork Unalakleet River	Old Woman River	Unalakleet System
1973	19,547[d]	26,542[b]	12,450[d]	---	---	---	---	38,992[d]
1974	---	154,285[b]	56,431[e]	600	48,795	---	---	200,820[e]
1975	37,971	17,885[e]	16,750[d]	13,081[b]	9,268	---	---	47,716[d]
1976	12,175	10,606[e]	39,074[d]	25,064[b]	2,895[e]	2,324[d,i]	---	74,081[d]
1977	7,602	4,565[f]	18,170[f]	3,470[f]	---	---	---	26,205[f]
1978	203,303	21,813	491,706	---	240,000	---	3,861	517,380
1979	40,450	9,500[e]	1,700[d]	---	---	---	---	11,200[e]
1980	69,915	127,900	166,390[d]	---	---	37,335	83,385	415,010[d]
1981	---	575	---	---	1,465[e,i]	---	---	575[e]
1982	36,550[e]	173,352[e]	6,227[e]	---	8,890[d,i]	---	7,712[e]	5,744,000[c,g]
1983	18,705	4,980[d]	---	---	---	---	---	89,324[c]

Sources: ADF&G 1973, 1974, 1975, 1976, 1977b, 1978, 1979, 1980, 1981, 1982, and 1983a, unless otherwise noted.

Note: Survey conditions rated as good by surveyor unless otherwise noted.

--- means no data were available.

a Escapements represent peak counts from aerial surveys unless otherwise noted.

b Tower counts.

c Sonar counts.

d Survey conditions rated as fair by surveyor.

e Survey conditions rated as poor by surveyor.

f Survey rating unlisted.

g Preliminary.

h Tower count plus aerial count below tower.

i Source: ADF&G 1984d.

j This count also includes chum salmon. Surveyor could not distinguish between pink and chum salmon.

Table 3. Escapement Estimates of Chum Salmon in Norton Sound District Streams by Subdistrict, 1973-83[a]

	Nome Subdistricts							
	Eldorado River	Flambeau River	Nome River	Sinuk River	Solomon River	Bonanza River	Penny River	Snake River
1973	---	---[j]	1,760[e]	---	---	---	---	---
1974	2,143[d]	190[j]	854[e]	463	160	820[d]	---	---
1975	328[d]	197	2,161[f]	4,662	---	124[d]	249	---
1976	411	375	1,200[f]	---	---	681	---	---
1977	1,835	1,275	3,046	5,207	275	990	---	366
1978	10,125	7,110	5,242	8,756	497	5,984	---	255
1979	326	283	---	---	131	102[d]	---	---
1980	9,900	13,190	7,745	2,022	2,600	748[d]	---	---
1981	15,605[f]	12,031[f]	1,195[f]	5,579[f]	133[f]	1,864[f]	---	140[d]
1982	1,095[f]	5,097[f]	700[f]	638[f]	487[f]	380[f]	8[d,j]	---
1983	994	1,195	198	2,150	310	723	35[j]	---

	Golovin Subdistrict						Moses Point Subdistrict		Norton Bay Subdistrict		
	Boston Creek	Fish River	Kachavik Creek	Niukluk River	Casadepaga River	Paragon River	Kwiniuk[b] River	Tubutulik River	Ungalik River	Inglutalik River	Koyuk[j] River
1973	3,014	6,887	10,325[d]	14,365[d]	---	---	28,617	5,383[f]	---	---	---
1974	2,426	10,945[d]	1,645[d]	8,720	---	---	35,899	9,560[d]	---	---	---
1975	1,885	20,114[d]	1,735	10,089	---	---	14,344	17,141[d]	3,720[e]	---[j]	---
1976	---	8,390[d]	---[b]	4,130	---	---	6,977	1,095[d]	982	1,242[j]	115[d]
1977	1,325	9,664[d]	9,564[b]	10,456	100	135	22,757	8,540[d]	---	---	---
1978	2,655	26,797[d]	3,481[b]	14,365[b]	---[j]	---	14,408	5,865[d]	12,564	12,569	---
1979	882	6,893[d]	2,650	10,127[b]	241[j]	200	12,355	812[h]	1,720	8,394	---
1980	2,450	19,100[d]	---	8,915	---	---[j]	19,374	21,616[h]	640	412	---
1981	1,985	24,095	---[f]	7,249[f]	---	1,802[j]	34,561	2,105[e]	---[f]	---	---
1982	1,730	---	1,111[f]	2,557[f]	---	375[j]	44,036	2,044[e]	290[f]	---[j]	---
1983	704	20,037	---	8,886	---	---	56,907	16,345[d]	8,357	935[j]	---

(continued)

Table 3 (continued).

	Shaktoolik Subdistrict	Unalakleet Subdistrict						
	Shaktoolik River	North River	Unalakleet River	Chirosky River	Egavik River	North Folk Unalakleet River	Old Woman River	Unalakleet System
1973	3,424[d]	4,332[b]	7,852[d]	---	---	---	---	12,186[d]
1974	---	861[b]	1,986[e]	3,814	5,105	---	---	6,626[e]
1975	16,601	5,237[e]	10,501[d]	3,138[b]	5,627	---	---	18,876[d]
1976	1,736	1,963[e]	2,976[d]	858[b]	310[e]	349[d,j]	---	5,788[d]
1977	20,899	8,139[f]	16,038[f]	2,568[f]	---	1,816[f]	---	28,561[f]
1978	19,972	9,349	28,600	---	24,500[j]	---	2,574	40,523
1979	4,350	1,130[e]	570[d]	---	---	---	---	1,700[e]
1980	3,019	2,300	11,105[d]	---	---	1,547	2,595	17,547[d]
1981	165[e]	405	55[e]	---	1,040[e,j]	380[e]	810[e]	1,650[e]
1982	48[e]	599[e]	563[e]	---	---	---	78[e]	195,000[c,g,i]
1983	12,414	4,135[d]	---	---	2,500[d,j]	---	---	58,540[c]

Source: ADF&G 1973, 1974, 1975, 1976, 1977b, 1978, 1979, 1980, 1981, 1982, and 1983a, unless otherwise noted.

--- means no data were available.

Note: Survey conditions rated as good by survey or unless otherwise noted.

a Escapements represent peak counts from aerial surveys unless otherwise noted.

b Tower counts.

c Sonar counts.

d Survey conditions rated as fair by surveyor.

e Survey conditions rated as poor by surveyor.

f Survey rating unlisted.

g Preliminary.

h Tower count plus aerial count below tower.

i Count is probably too high due to the overlap in timing of the pink and chum runs.

j Source: ADF&G 1984d.

Table 4. Escapement Estimates of Coho Salmon in Norton Sound District Streams by Subdistrict[a]

	Nome Subdistrict			Unalakleet Subdistricts				
	Eldorado River	Nome River	Sinuk River	North River	Unalakleet River	North Fork Unalakleet River	Old Woman River	Unalakleet System
1973	---	---	---	---	---	---	---	---
1974	---	---	---	---	---	---	---	---
1975	---	---	---	---	---	---	---	---
1976	---	---	---	---	---	---	---	---
1977	---	---	---	---	---	---	---	---
1978	---	---	---	---	---	---	---	---
1979	---	---	---	---	---	---	---	---
1980	56[c,e]	920	1,002	204	1,184[e]	331[c,e]	---	204
1981	---	---	---	263	1,001[c]	18[c]	574[c]	1,856[c]
1982	---	---	---	4,145[c]	3,648[e]	30[c,e]	628[c]	65,000[b,d]
1983	100	365	96	---	---	---	---	14,656[b]

Source: ADF&G 1980, 1981, 1982, and 1983a, unless otherwise noted.

--- means no data were available.

Note: Survey conditions rated as good or fair unless otherwise noted.

a Aerial survey counts unless otherwise noted.

b Sonar counts.

c Survey conditions rated as poor by surveyor.

d Preliminary.

e Source: ADF&G 1984d.

Unalakleet drainage and Shaktoolik River are considered to be the most important coho salmon-producing systems in the Norton Sound District (Schwarz, pers. comm.).

Though escapement data are limited, comparative catch statistics have indicated a recent trend toward significantly increasing coho salmon returns in the Norton Sound District (ADF&G 1984b). Similarly to pink salmon, coho salmon returns have greatly increased since 1979 (ibid.). Prior to 1979, the coho salmon harvest averaged only 6,000 salmon; since that time, however, the annual average coho harvest has been approximately 47,000 fish (ibid.).

4. Chinook salmon. The presence of chinook salmon has been documented in 13 first-order streams (i.e., those whose mouths are located at salt water) within the Norton Sound District (ADF&G 1984a). It is suspected that more such streams exist but are as yet undocumented.

   Chinook salmon exhibit the earliest run-timing of any salmon species found in the Norton Sound District. Chinook salmon are typically present in Norton Sound bays and esturaries from mid June to mid July and are present on the spawning grounds from early July to early August (table 1) (ADF&G 1977a).

   Although other important chinook salmon-producing systems exist in the area, the Unalakleet drainage and Shaktoolik River are considered the major chinook-producing systems in the Norton Sound District (Schwarz, pers. comm.). Available chinook salmon escapement data for the years 1973 through 1983 on these systems and additional chinook salmon-producing streams are presented in table 5, with streams grouped by subdistrict.

   There is a directed chinook salmon fishery early in the season in the Unalakleet and Shaktoolik subdistricts. Chinook salmon runs have been strong during the last six years as a result of the increased abundance of local stocks and Yukon River stocks that are intercepted in these fisheries (ADF&G 1984b). Chinook salmon catches nearly doubled during 1979-1983 compared to 1974-1978 (ibid.).

5. Sockeye salmon. Sockeye salmon are rare in the Norton Sound District (ibid.). The presence of sockeye salmon has been documented in only one first-order stream (i.e., one whose mouth is located at salt water), the Sinuk (Sinrock) River (Lean, pers. comm.). The fish are suspected to occur in other such streams in the district, but as yet their presence is undocumented.

   No escapement data exist for sockeye salmon within the Norton Sound District. Commercial and subsistence harvest averaged only 24 fish over the last 10 years (ADF&G 1983a).

Table 5. Escapement Estimates of Chinook Salmon in Norton Sound Streams by Subdistrict, 1973-83[a]

	Nome Subdistrict				
	Eldorado River	Flambeau River	Nome River	Sinuk River	Solomon River
1973	---	---	6	---	---
1974	13	---	---	---	2
1975	---	---	1	---	---
1976	---	---	---	---	---
1977	---	---	5	---	---
1978	---	---	2	---	---
1979	---	---	---	---	---
1980	6	---	5	3	---
1981	---	1	15	---	---
1982	2[f]	1[f]	---	---	---
1983	11	2	2	48	---

	Golovin Subdistrict				Moses Point Subdistrict		Norton Bay Subdistrict	
	Boston Creek	Fish River	Niukluk River	Paragon River	Kwiniuk[b] River	Tubutulik River	Ungalik River	Inglutalik River
1973	153	31	---	---	57	131[f]	---	---
1974	231	7	1	---	62	136[d]	---	---
1975	147	26[d]	---	---	44	7	---	---
1976	---	1[d]	---	---	12	---	25[i]	117[i]
1977	76	9	19	---	84	---	---	---
1978	136	29[d]	2	---	74[e]	2[d]	42	486
1979	58	11[d]	8[b]	15	107	69	44	973
1980	16	---	---	---	177	405[h]	---	65
1981	---	90	---	---	136	30[e]	---	---
1982	10[f]	---	20[f]	1[i]	138	49[e]	---	---
1983	154	87	54	---	267	135[d]	21	34[i]

(continued)

Table 5 (continued).

	Shaktoolik Subdistrict	Unalakleet Subdistrict						
	Shaktoolik River	North River	Unalakleet River	Chirosky River	Egavik River	North Fork Unalakleet River	Old Woman River	Unalakleet System
1973	374[d]	298[b]	243[d]	---	---	---	---	541[d]
1974	---	220[b]	266[e]	2	7	---	---	464[e]
1975	139	60[e]	173[d]	29[b]	---	---	---	262[d]
1976	69	66[e]	297[d]	17[b]	---	50[d,i]	---	362[d]
1977	1,875	1,275[f]	1,477[f]	8[f]	---	242[f]	---	3,002[f]
1978	519	321	823	---	8[i]	---	78	1,222
1979	167	735[e]	54[d]	---	---	---	---	789[e]
1980	47	61	29[d]	---	---	13	25	128[d]
1981	3[d]	68	3[e]	---	20[e,i]	2[e]	26[e]	99[e]
1982	---	8[e]	---	---	---	---	---	7,500[c,g]
1983	1,080	347[d]	---	---	15[d,i]	---	---	3,025[c]

Source: ADF&G 1973, 1974, 1975, 1976, 1977b, 1978, 1979, 1980, 1981, 1982, and 1983a, unless otherwise noted.

--- means no data were available.

Note: Survey conditions rated as good by surveyor unless otherwise noted.

a Escapements represent peak counts from aerial surveys unless otherwise noted.

b Tower counts.

c Sonar counts.

d Survey conditions rated as fair by surveyor.

e Survey conditions rated as poor by surveyor.

f Survey rating unlisted.

g Preliminary.

h Tower count plus aerial count below tower.

i Source: ADF&G 1984d.

III. PORT CLARENCE DISTRICT

The Port Clarence District includes all waters from Cape Douglas north to Cape Prince of Wales. The district is bordered to the north by the Brooks Range and Kougarok Mountains and to the south by the Kigluaik Mountains. A map delineating the boundaries of the district may be found in the commercial salmon harvest narrative in the Human Use portion of this volume.

A. Distribution

All five species of Pacific salmon native to North America are found within the waters of the Port Clarence District. The presence of adult salmon has thus far been documented in four of the district's first-order streams (i.e., those whose mouths are located at salt water) (ADF&G 1984a). Important salmon-producing systems in the Port Clarence District include the Pilgrim River-Salmon Lake-Grand Central River complex, the Kuzitrin River, and the Agiapuk River (ADF&G 1977a). Adult salmon are present in Port Clarence bays and estuaries from mid June to late August and are found spawning in fresh waters from early July through late September (ibid.). Table 1 provides general run-timing information for individual salmon species in the Port Clarence District.

B. Abundance

The only bona fide commercial fishery in the Port Clarence District took place in 1966, when 1,216 salmon consisting of 93 sockeye, 131 pink, and 992 chum salmon were taken in the Grantley Harbor/Tuksuk Channel area (ADF&G 1983a). Because of the relatively small salmon runs in this area and the existence of an important subsistence fishery, commercial fishing in the district has not been reopened.

Because of the lower priority assigned to districts that do not support commercial fisheries, escapement data for the Port Clarence District are limited. The only consistently made surveys have been for sockeye salmon within Salmon Lake and the Grand Central River. This sockeye salmon run is unique in that it is one of the northernmost occurrences of this species on the North American continent. Escapement estimates for the years 1973 through 1983 are presented in table 6. Over this period, escapement estimates for Salmon Lake range from a low count of 132 sockeye salmon in 1976 to a high of 1,250 in 1979; the Grand Central River estimates ranges from 0 in 1974 to a high of 607 in 1973 (ibid.).

Escapement estimates on other salmon streams in the district have been made only rarely. An aerial survey made by the ADF&G in 1966 on the Agiapuk River yielded a peak count of 4,840 chum salmon (ADF&G 1984d). Pilgrim River surveys have been flown in 1977 and 1980, both times under survey conditions rated as good. The 1977 survey yielded peak counts of 25 king, 150 chum, 375 pink, and 21 sockeye salmon, and the 1980 survey yielded counts of 904 chum, 1,790 pink, and 74 sockeye salmon (ibid.). Finally, a 1963 aerial

Table 6. Escapement Estimates of Sockeye Salmon in Numbers of Fish for Port Clarence District, 1973-83[a]

	Salmon Lake	Grand Central River	Total
1973	1,747	607	2,354
1974	820	0	820
1975	537	123	660
1976	132	22	154
1977	317	235	552
1978	822	280	1,102
1979	1,250	261	1,511
1980	512[b]	175	687
1981	---	---	---
1982	---	---	---
1983[c]	---	---	970

Source: ADF&G 1983a

--- means no data were available.

a Escapement counts represent peak counts from aerial surveys.

b Survey conditions rated as poor by the surveyor.

c Surveyor did not keep Salmon Lake and Grand Central River counts separate.

survey flown on the Kuzitrin River under fair conditions yielded a combined count of 15,996 pink and chum salmon (ibid.).

IV. KOTZEBUE DISTRICT

The Kotzebue District includes all waters from Cape Prince of Wales north to Point Hope. A map delineating the boundaries of the district may be found in the commercial salmon harvest narrative in the Human Use portion of this volume.

A. Distribution

All five species of Pacific salmon native to North America are found within the waters of the Kotzebue District. The presence of adult salmon has thus far been documented in 12 first-order streams (i.e., those whose mouths are located at salt water) of the district (ADF&G 1984a). Although small numbers of sockeye, chinook, coho, and pink salmon are present, the vast majority of salmon entering this district are chum salmon bound for the Noatak and Kobuk river systems (ADF&G 1983a).

The only detailed Kotzebue District run-timing information available is for chum salmon. The information is summarized in table 7. Tagging studies indicate that the majority of Kobuk River chum salmon migrate into the Kotzebue fishing district by traveling along the Baldwin Peninsula and reach peak abundance in the fishery prior to August 1 (Bigler and Burwen 1984). Noatak River chum salmon typically reach peak abundance in the fishery after August 1 and do not exhibit preferred migration corridors (ibid.). Further, there is some evidence that early migrating Kobuk River chum salmon are mostly destined for the spawning grounds of the lower Kobuk River, whereas later migrating Kobuk River stocks typically spawn above Ambler and are present in Kotzebue Sound during the peak of the Noatak River migration (ibid.).

A study conducted by Merritt and Raymond (1983) on the Noatak River sheds light on the developmental and out-migrational timing of chum salmon young in the Kotzebue District. They found that peak eyeing of the eggs occurred in early November and that peak hatching took place from late December through January. This was followed by peak emergence of the fry in early May and peak out-migration from the Noatak River into Kotzebue Sound in mid June. Further, their study revealed that the juvenile chum salmon remained in nearshore Kotzebue Sound waters until early July (Merritt and Raymond 1983). Chum salmon run-timing information for other river systems in the Kotzebue District is limited. Kneupfer (1984) conducted several foot and aerial escapement surveys of the Inmachuk River (located on the northern Seward Peninsula near Deering) and concluded that peak chum salmon entry into that river occurs in the fourth week in September. The highest estimated chum salmon escapement for the Inmachuk River is 13,297 (Kneupfer 1984).

Limited run-timing information is available for pink salmon in the Wulik River, located in the northern portion of the Kotzebue

Table 7. General Chum Salmon Run-Timing in the Kotzebue District

Major Drainage	Peak Abundance of Adults Arriving in Kotzebue Sound[a]	Spawning Stream	Peak Spawning Period[b]	Peak Period of Fry Emergence[c]	Peak Period of Outmigration[c]
Kobuk	Mid July - late July[d]	Squirrel River	Early Aug. - mid Aug.	---	---
		Salmon River	Early Aug. - mid Aug.	---	---
		Tutuksuk River	Early Aug. - mid Aug.	---	---
		Main Kobuk (Headwaters area)	Late Aug. - mid. Sept.	---	---
Noatak	Early Aug. - late Aug.	Eli River	Mid Aug. - mid Sept.	---	---
		Kelly River	Mid Aug. - mid Sept.	---	---
		Kelly Lake	Mid Aug. - mid Sept.	---	---
		Main Noatak River	Mid Aug. - mid Sept.	Early May	Mid June

Source: a ADF&G 1977a; b ADF&G 1983b; c Merritt and Raymond 1983.

--- means no data were available.

Note: Early = 1st to 10th of month, mid = 11th to 20th of month, late = 21st to 30th/31st of month.

d Later migrating Kobuk River stocks typically spawn above Ambler and are present in Kotzebue Sound during the peak of the Noatak River migration (Bigler and Burwen 1984).

District. Aerial surveys of the Wulik River have yielded a rough escapement estimate of "1,000 or more pink salmon, but not more than a few hundred chums" (Smith et al. 1966). Pink salmon were observed to enter the Wulik River in July and spawn during the first two weeks of August, largely within 5 mi of the coast (ibid.).

B. Abundance

The vast majority of salmon entering the Kotzebue District are chum salmon bound for the Noatak and Kobuk river systems (ADF&G 1983a). Chum salmon are the only salmon species for which detailed abundance estimates exist in the Kotzebue District. Bigler (1985) has derived a current Kotzebue District chum salmon abundance estimate. From 1980 through 1984, total returns of chum salmon to the Kotzebue District have averaged 556,000 fish: 392,000 distributed among approximately 190 commercial fisherman, a regional subsistence harvest of 14,500, and an average annual escapement of 150,000 fish (Bigler 1985).

Chum salmon abundance has fluctuated markedly from year to year in the Kotzebue District. Estimated chum salmon escapements for the years 1973 through 1984 are presented in table 8 for the Noatak and Kobuk river systems. Escapement estimates presented have been derived from aerial survey counts. In addition to aerial surveys, the use of sonar has been attempted to estimate escapement in the lower Noatak River since 1979. These counts have been judged unreliable because of the presence of other fish species that cannot be distinguished from salmon and significant numbers of salmon migrating beyond the operating range of the bank-deployed sonar units (ADF&G 1984c).

Poor survey conditions encountered in some years resulted in escapement estimates that have been judged unreliable (Bigler 1985). Using catch-per-unit-effort data and regression analysis, Bigler (1985) has calculated adjusted escapements in these years. These adjusted figures are also presented in table 8. From 1973 through 1984, the Kotzebue District chum salmon estimated escapement has ranged from a low of 29,213 fish in 1979 to a high of 234,611 in 1974 (ibid.).

As stated earlier, only relatively small numbers of sockeye, chinook, coho, and pink salmon are present in the Kotzebue District. Adult pink, chinook, coho, and sockeye salmon have thus far been documented in 10, 5, 4, and 3 Kotzebue District first-order streams (i.e., those whose mouths are located at salt water), respectively (ADF&G 1984a). It is suspected that each species is present in additional first-order streams of the district, although their presence is as yet undocumented. Kotzebue District first-order streams in which pink salmon have thus far been documented include the Pinguk, Inmachuk, Kugruk, Buckland, Kobuk, Noatak, Tasaychek, Wulik, and Kivalina rivers and Fish Creek. Chinook salmon have thus far been documented in the Buckland, Kobuk, Noatak, Wulik, and Kivalina rivers (ibid.). First-order streams in which coho salmon have thus far been

Table 8. Escapement Estimates of Chum Salmon in Numbers of Fish for Kotzebue District, 1973-84[a]

	Noatak River System				Kobuk River System						
	Noatak River (below Kelly River)	Eli River	Kelly River and Lake	Noatak River System Total	Main Kobuk River	Squirrel River	Salmon River	Tutuksuk River	Kobuk River System Total	Kotzebue District Totals	Adjusted[c] Kotzebue District Totals
1973[c]	32,144	---	2,590	34,734	2,470[b]	12,345	6,891	---	21,706	56,440	177,859
1974	112,836	22,249	1,381	136,466	28,120	32,523	29,190	8,312	98,145	234,611	
1975	96,509	1,302	3,937	101,748	10,642	34,236	9,721	1,344	55,943	157,691	
1976	44,574[b]	1,205	217	45,996	2,522[b]	7,229	1,161	758	11,670	57,666	
1977[c]	11,221	742	290	12,253	---	1,964[b]	---	---	1,964	14,217	91,401
1978[c]	37,817[b]	5,525	168	43,510	1,981	1,863	814	368	5,026	48,536	48,774
1979	19,655	1,794	3,200	24,649	2,008	1,500[b]	674	382	4,564	29,213	
1980	164,474	10,277	7,416	182,167	11,472	13,536	8,456	1,165	34,629	216,796	
1981	116,352	---	13,770	130,122	8,648	9,854	4,709	1,114	24,325	154,447	
1982[c]	20,682[b]	295	11,604	32,581	14,674	7,690	5,392	1,727	29,483	62,064	142,457
1983	79,773	3,044	12,137[b]	94,954	33,746	6,075	1,677	2,637	44,135	139,089	
1984	67,873	5,027	3,499	76,399	10,621	5,473	1,471	1,132	18,697	95,096	

Source: Bigler 1984.

--- means no data were available.

Note: Survey conditions rated as good or fair unless otherwise noted.

a Escapements represent peak counts from aerial surveys

b Survey conditions rated as poor by the surveyor.

c Escapement estimates in these years were obtained under such poor conditions that Bigler (1984) used regression analysis to derive the following formula to obtain a more representative estimate of escapement: Escapement = CPUE (24,083) + 7,833; r = 0.7476; P (0.001); n = 14. This formula yields the adjusted Kotzebue District escapement estimates for the years 1973, 1977, 1978, and 1982.

documented include the Buckland, Noatak, Wulik, and Kivalina rivers (ibid.). Finally, sockeye salmon have thus far been documented only in the Noatak and Kivalina rivers and Rabbit Creek (ibid.).

V. NORTHERN DISTRICT

The Northern District of the Arctic Region lies entirely north of the Arctic Circle and encompasses all of the drainages north of the Brooks Range from Point Hope eastward around the northern Alaska coast to the Canadian border at Demarcation Point. Topographically, the area ranges from flat arctic plains with a myriad of slow-moving rivers and shallow tundra ponds to the mountainous foothills of the northern Brooks Range. Rivers within the Northern District are generally not well suited for salmon production. Streamflow typically begins in early June, and freeze-up occurs in September. Peak discharge occurs in June shortly after breakup and is greatly reduced by mid summer. Streams in the area exhibit rapid changes in water level and turbidity in response to precipitation on the watershed, and many tributaries become discontinuous in mid summer because of low precipitation. Beaded streams (small streams containing a series of deep pools interconnected by very small channels) are common throughout the area and provide migration avenues for fish during run-off and periods of high water; however, most contain standing water during summer months and are of limited significance to fisheries (Bendock 1979).

While conducting inventories on Northern District coastal plain streams, Hablett (1979) found the physical characteristics of three of the larger rivers (the Kuk, Meade, and Ikpikpuk) to be very similar. Typically, the headwaters occupy the upper one-third of the rivers and are shallow (less than 2 ft), narrow (approximately 50 ft in width), and contain rock rubble substrates. Water color varies from tea-colored to clear. The middle third of the rivers contain larger pools and substrate consisting largely of sand and small gravel. Some of the larger pools could be more aptly called "lakes" because they may be a mile or more long and 100 yards wide, with water depths exceeding 9 ft in some of the pool areas. These pools eventually give way to wide (approximately 80 yd), shallow (less than 5 ft) areas with shifting sand bottoms. Finally, the lower one-third of the rivers typically exhibit meanders, with sandbars and dunes common. Water flows are greater than upriver, and the river bottom is largely shifting sand.

The Northern District of the Arctic Region represents the most northern range of North American pink and chum salmon. Stray chinook and sockeye salmon have, on rare occasions, also been documented in Northern District waters (Morrow 1980). Pink and chum salmon populations in the area are existing at the outer limits of their environmental tolerances, and their population numbers are extremely limited. The extreme environmental parameters and the lack of suitable spawning areas that are not subject to winter freeze-up are considered overriding restrictions against major salmon production (ADF&G 1977a). Even the Colville River, the largest arctic river in Alaska, draining approximately 24,000 mi^2 and over 420 mi long, freezes to the river bed in shallow areas and ceases to discharge during late winter (Bendock 1979). No commercial salmon fishing occurs in the Northern District of the Arctic Region.

Pink salmon appear to be more widely distributed than chum salmon within the waters of the Northern District. Pink salmon have been documented in 12 first-order area streams, and chum salmon have been observed in 9 first-order streams (i.e., those whose mouths are located at salt water) (ADF&G 1984a). It is suspected that pink and chum salmon occur in other Northern District first-order streams, although their presence is yet undocumented. A summary of streams in which salmon have thus far been documented appears in table 9 of this paper. Undoubtedly, salmon occur in additional Northern District streams not listed in this table.

1. Pink salmon. Specific pink salmon abundance estimates and run-timing information in waters of the Northern District are extremely limited.

   In a 1978 study on the Colville River, Hablett (1979) captured 64 adult pink salmon, all of which were in spawning condition. Pink salmon were observed spawning in the river near the Itkillik River on August 11 and at Umiat on August 19 (ibid.). Bendock (1979) states that pink salmon enter the Colville River in mid August and that spawning takes place in the main stem of the river as well as in the lower reaches of the Itkillik and possibly the Chandler and Anaktuvuk rivers.

   Aerial surveys of the Kukpuk River, located in the western portion of the Northern District, yielded a rough peak escapement estimate of 5,000 pink salmon over three years of surveys, while only "a few" chums were observed (Smith et al. 1966). Peak pink salmon spawning in the Kukpuk River was observed to occur around August 12 (ibid.).

2. Chum salmon. Little is known concerning abundance and run-timing of the relatively small numbers of chum salmon in Northern District waters.

   In 1978, Hablett (1979) observed chum salmon in the Colville River moving upstream past Umiat on August 19. The fish were not yet ripe. Bendock (1979) reported that chum salmon spawning takes place in the main stem of the Colville River from mid August to mid September. Bendock found adult chum salmon distributed from the river's mouth up to the confluence with the Etivluk River.

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Table 9. Salmon Species Documented in Northern Area Streams[a]

Stream	Pink Salmon	Chum Salmon	Chinook Salmon[b]
Kukpuk	x		
Pitmegea	x	x	
Kukpowruk	x	x	
Kokolik	x	x	
Utukok	x	x	
Kuk	x[c]	x	x[c]
Meade	x[c]	x	
Chipp	x		
Ikpikpuk	x		
Fish	x	x	
Colville	x	x	x[d]
Sagavanirktok	x	x	
Staines	x		
Canning	x	x	
Kugrua	x[c]	x[c]	
Inaru		x[c]	
Kungok	x[c]	x[c]	
Ketik	x[c]		
Itkillik	x[c]	x[d]	
Kikiakrorak	x[c]	x[c]	
Kogosukruk	x[c]		
Lupine		x[d]	

a Source: ADF&G 1984a unless otherwise noted.

b All chinooks documented considered strays.

c Source: Hablett 1979.

d Source: Bendock and Burr 1984.

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Marine Fish

Arctic Cod Distribution and Abundance

I. REGIONAL DISTRIBUTION

The range of arctic cod extends from the northern Bering Sea northward throughout the Arctic Region (Morrow 1980, NWAFC 1985). Craig (1984a) notes that arctic cod is the only major marine fish species present both in the nearshore and offshore waters of the southeastern Chukchi, northeastern Chukchi, and Beaufort seas. In the Beaufort Sea, arctic cod is widespread and abundant in both brackish nearshore and marine offshore habitats (Craig 1984b). In the southeastern Chukchi Sea and Norton Sound, arctic cod was the fish species most frequently captured in NMFS trawl surveys, and small concentrations were found throughout the survey region (Wolotira et al. 1977). Catches were lower in the inshore areas of Norton and Kotzebue sounds, where only trace amounts of arctic cod were sampled (ibid.).

Lowry and Frost (1981) found that arctic cod were more widespread and abundant in the northeastern Chukchi and western Beaufort seas and less abundant in the northern Bering and central Beaufort seas. Craig (1984a) explains that the northeastern Chukchi Sea is a transition zone between the fish communities of the Pacific and Arctic oceans. The contribution of the warmer, productive waters of the Bering Sea and the northward transport of nutrients accounts for high standing stocks of forage fish such as arctic cod in the northeastern Chukchi Sea.

II. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

A series of marine distribution maps at 1:1,000,000 scale have been produced for this report. The following is the category of mapped information for arctic cod:

° General distribution

III. FACTORS AFFECTING DISTRIBUTION

Arctic cod can tolerate widely ranging salinity and turbidity conditions (Morrow 1980, Craig et al. 1982). The maximum depths they can inhabit and their preferred depth range is unknown (Lowry and Frost 1981). More detailed information is presented in the arctic cod Life History and Habitat Requirements narrative in volume 1 of this publication.

IV. MOVEMENTS BETWEEN AREAS

Arctic cod make onshore-offshore migrations, which are associated both with spawning and the movements of ice (Morrow 1980). Lowry and Frost (1981) present evidence that arctic cod from the northern Bering and southern Chukchi seas move north with the receding ice edge, forming concentrations in the northeastern Chukchi and western Beaufort seas. Arctic cod have been observed to migrate from offshore to coastal areas in the fall. Craig and Haldorson (1980) observed large numbers of arctic cod moving through Simpson Lagoon in the Beaufort Sea in August. In the Beaufort Sea, cod vacate shallow nearshore waters in winter and have been sampled in deeper water 175 km offshore (Craig et al. 1982). Nearby deeper coastal waters between the Colville and Canning rivers were inhabited by cod through the winter, but the catch per unit effort was highest offshore (ibid.). General information on arctic cod migrations is presented in the Life History and Habitat Requirements narrative in volume 1 of this publication.

V. POPULATION SIZE ESTIMATION

Populations of arctic cod have been sampled in various studies in the Arctic Region by otter trawl, gill net, seine, and fyke net (Wolotira et al. 1977, Craig et al. 1982, Lowry and Frost 1981). Catch rates and biomass estimates have been reported, but because different methods were used in different areas, it is difficult to provide reliable estimations of population size for arctic cod.

VI. REGIONAL ABUNDANCE

Abundance estimates are not available for arctic cod in the Arctic Region.

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Capelin Distribution and Abundance

I. REGIONAL DISTRIBUTION

Capelin are distributed throughout the Arctic Region (Hart 1973). In the Beaufort Sea, capelin are found in both brackish nearshore and marine offshore waters (Craig 1984a). Capelin are one of the principal fish species present in nearshore habitats of the northeastern Chukchi Sea (Craig 1984b). Capelin are primarily observed as they move inshore to gravel beaches to spawn. Capelin are present in Kotzebue Sound, Norton Sound, and the southeastern Bering Sea (Wolotira et al. 1977, Barton 1978, Pahlke 1981a).

Spawning capelin have been observed north of Norton Sound, and the timing is generally later than in Norton Sound. In the Beaufort Sea, Craig and Haldorsen (1980) sampled capelin in spawning condition in Simpson Lagoon during August. Bendock (1977) captured capelin throughout the Prudhoe Bay area only during a two-week period in mid August when spawning took place within the surf along exposed gravel beaches. Pahlke (1981a) mentions less recent information documenting capelin spawning in Kotzebue Sound, Port Clarence, and Point Barrow.

Large populations of capelin spawn in Norton Sound and in the Togiak area, with several smaller populations spawning between these areas (Pahlke 1981b). Spawning is mostly along the northern coast of Norton Sound, inasmuch as the southern coast is predominately rocky, with little capelin spawning habitat. Spawning capelin were seen on Nome area beaches in late May (Whitmore 1983). Spawning capelin in Norton Sound consist of at least two age classes, ages 2 and 3, which spawn over a four-week period (Pahlke 1981b). The length and age of spawners decreases over the spawning period, and the capelin spawning in Norton Sound are smaller than those spawning in Togiak (ibid.).

II. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

A series of capelin distribution maps has been produced for this report. The categories mapped are 1) general distribution at 1:1,000,000 scale and 2) known spawning areas at 1:250,000 scale.

III. FACTORS AFFECTING DISTRIBUTION

Physical factors, such as temperature, and the availability of spawning substrate affect the distribution of capelin. (For more details see the capelin Life History and Habitat Requirements narrative in volume 1 of this report.)

IV. MOVEMENTS BETWEEN AREAS

Capelin may migrate into shallow coastal waters of the Beaufort Sea to spawn in mid-to-late summer. Their numbers are generally low, although large spawning runs occur occasionally (Craig and Haldorson 1980). In the Prudhoe Bay area, capelin move inshore to spawn over a two-week period (Bendock 1977), and large populations of capelin spawn in Norton

Sound over a four-week period (Pahlke 1981b). (For more details on movements of capelin see the Life History and Habitat Requirements narrative in volume 1 of this report.)

V. POPULATION SIZE ESTIMATION

Trawl surveys have been used to estimate the abundance of capelin populations. Demersal trawl surveys are not designed for sampling pelagic fish, however, and the time of year a survey is conducted is critical for a migratory species.

Aerial surveys have been used extensively in the Bering Sea to estimate the biomass of herring, and the same methods have been occasionally used for capelin. Pelagic species, however, are difficult to differentiate through aerial surveys. In an aerial survey, the surface area of a capelin school is calculated and then multiplied by a tonnage conversion factor to estimate total biomass. The ADF&G uses a relative abundance index (RAI) as the standardized unit of surface area of fish schools (ADF&G 1983). One RAI unit is the equivalent of a fish school with a surface area of 50 m^2. Daily RAI estimates are related to herring biomass by applying tonnage conversion factors obtained from changes in school surface area before and after removal of a known weight of fish by purse seine. No information on surface-area-to-volume conversions is available for capelin (Whitmore, pers. comm.).

VI. REGIONAL ABUNDANCE

Little information is available on the abundance of capelin in the Arctic Region. Wolotira et al. (1977) conducted trawl surveys in Norton Sound and the southeast Chukchi Sea in 1976 and encountered only trace amounts of capelin in offshore and deeper waters. These surveys were conducted in the fall, when capelin may be least abundant and the biomass estimate of 190 metric tons of capelin for the area is considered low (Pahlke 1981a).

Aerial surveys have been used to estimate the biomass of spawning capelin in northern Norton Sound (Whitmore 1983). In 1983, for the area from Cape Rodney to Rocky Point, the peak biomass estimate was 2,680 metric tons of pelagic fish, occurring in late May. Because of the school configuration and the season, most of the fish sighted were probably capelin (Whitmore, pers. comm.). This estimate was based on a conversion factor of 3.0 metric tons/RAI, which current data indicated was appropriate for herring, to convert the surface area estimate of the capelin school to metric tons (Whitmore 1983).

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Pacific Herring Distribution and Abundance

I. REGIONWIDE INFORMATION

Herring are found throughout the Arctic Region; however, they are sparsely distributed as far north as the Beaufort Sea (Craig 1984a). Commercial fisheries for herring occur annually in the Bering Sea. Commercial herring fisheries have been attempted in the Chukchi Sea; however, no fishery has developed in this area (Whitmore, pers. comm.). Three commercial fishing districts are included in the Arctic Region. The boundaries of these districts are mapped in the herring Human Use narrative in this volume. Area-specific distribution and abundance information in this report follows the regionwide information and will be presented for these areas: the Norton Sound District and the combined Port Clarence and Kotzebue districts.

A. Regional Distribution

Herring are distributed throughout the Arctic Region and are present in the brackish nearshore waters of the Beaufort Sea (Craig 1984a). In the northeastern Chukchi Sea, herring is one of the principal fish species in both nearshore and offshore waters (Craig 1984b). They are also present in the southeastern Chukchi Sea and the Bering Sea, including Kotzebue Sound and Norton Sound (Wolotira et al. 1977). Existing evidence indicates that herring remain within the Chukchi Sea throughout the year and form a separate stock from those in the Bering Sea (Whitmore and Bergstrom 1983).

B. Areas Used Seasonally and For Life Functions

A series of herring distribution maps has been produced for the Arctic Regional guide. The following categories are mapped:

° Known spawning areas
° General distribution
° Known overwintering areas
° Known summer concentration areas
° Known fall concentration areas

C. Factors Affecting Distribution

In the Bering Sea, temperature may have the greatest influence on the seasonal distribution of herring (Wespestad and Barton 1981). Herring are found in a wide range of depths and salinities. (More detailed information appears in the herring Life History and Habitat Requirements narrative in volume 1 of this report.)

D. Movements Between Areas

Herring move into estuarine habitats to spawn, and spawning coincides with ice breakup, progressing in a northerly direction along the coast (Whitmore and Bergstrom 1983). Herring spawn throughout most of Norton Sound from late May through June, in the Port Clarence area from late June through early July, and from mid to late July along the northern Seward Peninsula. Herring spawning in Kotzebue Sound began with ice breakup in late May during 1980 and 1981 and continued into July (ibid.). Because Chukchi Sea spawning areas may retain their ice cover into July, spawning may occur as late as August in Kotzebue Sound (Barton 1978). Both pre- and postspawning herring remain in nearshore waters throughout spring and summer (Barton 1978). In September and October, herring are widely distributed throughout the coastal and offshore waters of Norton and Kotzebue sounds (Barton 1978, Wolotira et al. 1977).

The major wintering ground of eastern Bering Sea herring is northwest of the Pribilof Islands, in deep water along the continental shelf break (Wespestad and Barton 1981). However, it has yet to be determined whether Norton Sound herring stocks migrate to this Pribilof Island area. Small stocks overwinter in Kotzebue and Norton sounds, but it is unlikely that all the herring stocks do this (Whitmore, pers. comm.). Norton Sound stocks winter inshore under the sea ice near spawning grounds, and Chukchi Sea herring winter under ice cover in brackish lagoons and estuaries (ibid.). Subsistence catches of herring taken under the ice and the presence of herring in sheefish and seal stomachs provide evidence of nearshore overwintering (Barton 1978).

E. Population Size Estimation

Herring biomass is determined through aerial survey observations performed while herring school and move inshore to spawn. Surface areas of herring schools are calculated and then are multiplied by a tonnage conversion factor to estimate the total biomass (ADF&G 1983). The ADF&G uses a relative abundance index (RAI) as the standardized unit of surface area of herring schools. One RAI unit is the equivalent of a fish school with a surface area of 50 m^2. Daily RAI estimates are related to biomass by applying tonnage conversion factors obtained from changes in school surface area before and after removal of a known weight of fish by purse seine. The results of estimates from aerial surveys can be biased by visibility and the presence of other species of schooling fish such as capelin, smelt, and sand lance. The conversion from RAI to biomass is subject to error from different water depths in areas where the RAI and the conversion factor were determined.

F. Regional Abundance

Abundance estimates of herring are not available for most of the Arctic Region. Estimates where available are presented in the following sections for the Norton Sound District and the Port Clarence-Kotzebue districts.

II. NORTON SOUND DISTRICT

A map of this area and a description of boundaries are provided in the Herring Human Use narrative.

A. Distribution

Trawl surveys conducted by the NMFS in September and October found low concentrations of nonspawning herring in outer Norton Sound, with very low catch rates in the inner area of the sound (Wolotira et al. 1977). The demersal trawl gear, however, may have sampled waters deeper than those occupied by the herring. Barton (1978) found the greatest abundance of spawning herring from aerial surveys in the southern and eastern portions of Norton Sound.

Major spawning areas in Norton Sound include Stuart Island to Tolstoi Point along the southern coast and the Cape Denbigh-Norton Bay area in the northeast (ADF&G 1983). Herring generally arrive and spawn first along the southern coastline from Stuart Island to Tolstoi Point. Spawning occurs several days later in the Cape Denbigh area as the herring migrate in a northerly direction along the coast from Unalakleet to Shaktoolik (Barton and Steinhoff 1980).

Most spawning occurs subtidally because of the relatively small tide changes. Spawning in Norton Sound was observed to occur on rocky headlands where the rockweed kelp (*Fucus*) was common (Barton 1978). Herring spawn on bare rock under conditions of dense spawning (ibid.). The availability of suitable spawning substrates may be a major limiting factor on the biomass of spring herring runs in Norton Sound (Barton and Steinhoff 1980).

Differences in size and behavioral characteristics indicate that herring populations from Golovin Bay in northern Norton Sound and northward may comprise a separate stock from the populations occurring from southern Norton Sound and southward (Barton 1978). The southern populations consist of larger fish that spawn on *Fucus* on rocky headlands and overwinter in deep water. Fall runs have not been documented for these southern fish. The northern populations are comprised of smaller fish that spawn in shallow bays on *Zostera* and overwinter in shallow bays. Nonspawning fall runs have been documented for northern populations (ibid.). The environmental conditions to which the populations have adapted may explain the size difference. Water temperatures and feeding conditions in deeper water are probably more favorable to growth than the shallow wintering habitats used by the more northern populations (ibid.).

Current information suggests that the spring spawning stock comes primarily from offshore wintering areas. However, smaller local stocks are masked by the nonlocal stocks in the spring. Local stocks in Norton Sound probably exist near St. Michaels and Golovin Bay (Whitmore, pers. comm.).

In 1984, 68% of the spawning herring biomass in Norton Sound was comprised of ages 5 and 7 herring. In areas south of Norton Sound, ages 6 and 7 dominated the spawning population (Lebida et al. 1984).

B. Abundance

The greatest abundance of Bering Sea herring is south of the Yukon River. In 1984, 14% of the herring biomass in the eastern Bering Sea, from Togiak through Norton Sound, came from Norton Sound (Lebida et al. 1984). North of the Yukon River, the relative abundance of spawning herring is greatest in the southern and eastern portions of Norton Sound (Barton 1978). Herring biomass in the Norton Sound District has been estimated through aerial survey observations. In 1983, the biomass estimate for the entire district was 25,500 metric tons (ADF&G 1983). Approximately 80% of this biomass was located in subdistricts 1, 2, and 3, which are the southern and eastern portions of the sound. Biomass estimates of herring in Norton Sound are available from 1978 through 1984, and the highest biomasses were observed in 1981, 1983, and 1984, when estimates were more than 20,000 metric tons (table 1).

Table 1. Biomass Estimates of Herring in Norton Sound

Year	Biomass[a] (Metric Tons)
1978	4,800
1979	7,000
1980	7,600
1981	20,800
1982	15,800
1983	25,500
1984	21,000

Source: Lebida et al. 1984.

a Biomass estimates were calculated from aerial surveys and analysis of data from test fishing and adjusted for the presence of nonherring pelagic species.

III. PORT CLARENCE-KOTZEBUE DISTRICTS

A map of this area and a description of the boundaries are provided in the herring Human Use narrative.

A. Distribution

Summer sampling in Kotzebue Sound found that both juvenile and adult herring were abundant along the northern coast throughout the summer (Raymond et al. 1984). Demersal trawl samples conducted in September and October found the main concentrations of herring in outer Kotzebue Sound, with very low catch rates in the inner sound (Wolotira et al. 1977). Demersal trawls are not designed for sampling pelagic fish, and herring may have been underrepresented in the samples. Summer test fishing by the ADF&G found herring throughout the sound, with the largest concentrations in the northern areas (Whitmore and Bergstrom 1983). Herring samples collected near Shishmaref indicate that this area may be a feeding area for juvenile and postspawning herring (Barton and Steinhoff 1980).

Major spawning areas include Imuruk Basin in the Port Clarence area, Shishmaref, and the Deering-Kiwalik area in Kotzebue Sound (ADF&G 1983). Most spawning habitats in the area consist of shallow bays, lagoons, or inlets. Spawning usually occurs subtidally on eelgrass (Zostera) (Barton 1978).

B. Abundance

Very little abundance information is available for herring stocks in the northern Seward Peninsula and Kotzebue Sound areas. Gill net sampling conducted by the ADF&G from June through September indicated that herring were most abundant in northern Kotzebue Sound, less abundant in southern Kotzebue Sound, and least abundant in the Shishmaref area (Whitmore and Bergstrom 1983). Year-class trends for southeastern Chukchi Sea herring paralleled those of eastern Bering Sea populations, suggesting that similar factors may affect year-class strength for both areas. However, Chukchi Sea herring were much smaller than Bering Sea herring of the same age (ibid.).

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Saffron Cod Distribution and Abundance

I. REGIONWIDE INFORMATION

Saffron cod (*Eleginus gracilis* Tilesius) occur throughout the Arctic and Western regions and are known to be locally abundant in Norton and Kotzebue sounds and adjacent sections of the northern Bering and southeastern Chukchi seas (Wolotira et al. 1979). In these areas, saffron cod are utilized for subsistence needs by local residents of the nearby coastal villages. There is basically no commercial harvest of saffron cod; thus management areas and plans are nonexistent for this species. In 1983, one local fisherman from Nome caught and sold 2,548 lb (4,348 fish) of saffron cod. During 1980, one fisherman harvested 89 lb (98 fish) of saffron cod and sold them to residents in Nome. These fish, along with other subsistence harvests, are typically used for dog food, crab bait, and human consumption (ADF&G 1983). The potential for a saffron cod commercial fishery exists in the Norton Sound area, but present marketing conditions are undetermined, and interest by local residents appears low (ibid.). Wolotira (1985) reviewed and analyzed resource information from trawl surveys conducted in 1976, 1979, and 1982 and discussed the commercial potential of the resource.

II. REGIONAL DISTRIBUTION

Saffron cod are distributed throughout the nearshore coastal zone of the Arctic and Western regions (Andriyashev 1954, Craig and Haldorson 1981, Morrow 1980). The northern Bering Sea is the center of distribution for the saffron cod; specifically, Norton and Kotzebue sounds are the primary areas of abundance (Wolotira et al. 1979).

III. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

A saffron cod distribution map has been produced for this report. The category mapped is general distribution at 1:1,000,000 scale.

IV. FACTORS AFFECTING DISTRIBUTION

Physical factors such as temperature, salinity, and the availability of habitat probably affect distribution of saffron cod. Ecological factors such as competition for food and space may also affect distribution. (For more details, see the saffron cod Life History and Habitat Requirements narrative in volume 1 of this publication.)

V. MOVEMENTS BETWEEN AREAS

Saffron cod are thought to make seasonal movements in relation to depth and distance offshore. Information that is presently available, however, indicates varying degrees of this movement, by sample location and time of sampling. Generally, saffron cod reside in the coastal zone, coming close to shore to spawn under the ice in fall and winter in river mouths, bays, and inlets; then adults move into deeper water (30-60 m) in spring and summer to feed (Morrow 1980, Svetovidov 1948, Andriyashev 1954). In the Bering and Chukchi seas, bottom trawl samples detected large concentrations of saffron cod in the nearshore zone (0-30 m) from September through October and failed to find significant numbers of saffron cod in the deeper waters (greater than 30 m) at that time (Wolotira et al. 1979, Lowry et al. 1983). (For more details on movements of saffron cod, see the Life History and Habitat Requirements narrative in volume 1 of this report.)

VI. POPULATION SIZE ESTIMATION

Demersal trawl studies have been conducted in the eastern Bering Sea, Norton Sound, and the southeastern Chukchi Sea by the National Marine Fisheries Service (NMFS) in 1976, 1979, and 1982 to determine the distribution, abundance, and population characteristics of saffron cod (Wolotira 1985). To date, these are the only studies known to have accomplished an intensive evaluation of the saffron cod resource in Western and Arctic Alaska.

The assumptions made for demersal trawl surveys point to the limitations of data interpretation. It is assumed that trawl samples are representative of the density and composition of the animals in the sample area and that the trawl equipment performs consistently between stations. Also, it is assumed that populations remain static: i.e., that no shifts in abundance occur within the survey area and that no animals move in and out of the survey area (Wolotira et al. 1979). However, it is known that trawls, like most fishing gear, are selective in relation to mesh size and dimensions of the net. Also trawling is limited to sampling of smooth substrates, and animals encountered over rough and/or rocky bottoms are not adequately sampled (ibid.). Thus trawl samples represent an "apparent" distribution and relative abundance that are a function of the vulnerability and accessibility of a species to the gear. In most cases, the vulnerability and accessibility are unknown (ibid.).

VII. REGIONAL ABUNDANCE

Large concentrations of saffron cod were documented from trawl survey data collected in 1976 and 1979 by the NMFS in the northeastern Bering Sea from Norton Sound to Cape Newenham and west to the 50 m depth contour. From the 1976 survey results, the Norton Sound resource was estimated at 750 million fish, with an associated biomass of 16,500 metric tons (table 1) (Wolotira 1985). From 1979 survey data, the Norton Sound population appeared to have decreased to 630 million fish, although the apparent biomass had increased to 50,000 metric tons (ibid.). The Bering Sea, from Norton Sound south to Cape Newenham, was also surveyed in 1979, and an estimate of 1.5 billion fish, with an associated biomass of 60,000 metric tons, was made (table 1) (Wolotira 1985).

The difference in population size and biomass in Norton Sound observed in the 1976 and 1979 data are apparently related to the size and age composition of the stock. In 1976, approximately 66% of all saffron cod collected in Norton Sound were less than 12 cm in length. In 1979, less than 5% of the estimated population in Norton Sound was smaller

Table 1. Estimated Biomass and Population Size of the Saffron Cod Resource In Norton Sound and the Northeastern Bering Sea[a]

Year of Survey(s)	Region Surveyed	Area Surveyed (Km^2)	Estimated Biomass (95% Confidence Interval (Metric Tons)	Estimated Population Size (95% Confidence Interval x 10^6)
1976	Norton Sound	41,444	16,570 (12,393-20,747)	757.71 (578.91-936.51)
1979	Norton Sound	57,471	50,621 (35,825-65,417)	632.99 (507.94-758.03)
1979	Nearshore from Kuskokwim Delta to Norton Sound	168,575	58,291 (38,378-78,204)	1,460.30 (753.58-2,167.08)

Source: Wolotira 1985.

a Information derived from 1976 and 1979 trawl surveys of the NMFS.

than 13 cm (ibid.). Wolotira (1985) interpreted that data from the two surveys indicate a strong variation in year-class strengths. He noted that the 1976 year class was numerically dominant, and by 1979 it still comprised a large portion of the population (five times more abundant than three-year-olds in the 1976 population).

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Starry Flounder Distribution and Abundance

I. REGIONAL DISTRIBUTION

Starry flounders are distributed along the coast of the Arctic Region in nearshore areas and brackish water (Morrow 1980). In the central parts of its range, from northern California to the Bering Sea, it may be the most abundant of the flounders in nearshore areas (ibid.). In trawl samples of Norton Sound and the southeastern Chukchi Sea, starry flounder was the second most abundant fish species throughout the area (Wolotira et al. 1977). Largest concentrations were located in outer Norton Sound, the northeastern Bering Sea, and the southern Chukchi Sea. Catch rates were lower in outer Kotzebue Sound and inner Norton Sound, and no catches occurred offshore in the southeastern Chukchi Sea and the northwestern Bering Sea (ibid.). Samples in nearshore waters of Kotzebue Sound, Hotham Inlet, and the Kobuk River delta found starry flounder to be locally abundant during the summer (Alt 1979, Raymond et al. 1984). Starry flounders were found throughout the area and did not appear to change in abundance during the summer (Raymond et al. 1984). Starry flounders are found along the Beaufort Sea coastline; however, they occur sporadically and in low numbers (USDI 1984, Craig 1984)

II. AREAS USED SEASONALLY AND FOR LIFE FUNCTIONS

A series of marine distribution maps at 1:1,000,000 scale have been produced for this report. The categories of mapped information for starry flounder are as follow:

- General distribution
- Known concentrations

III. FACTORS AFFECTING DISTRIBUTION

Substrate, temperature, depth, and salinity affect the distribution of starry flounder. In the Chukchi and Bering seas, the starry flounder does not move far from shore or into water of high salinity (Morrow 1980). More detailed information is presented in the starry flounder Life History and Habitat Requirements narrative in volume 1 of this publication.

IV. MOVEMENTS BETWEEN AREAS

The starry flounder makes inshore-offshore migrations with the seasons. During summer, the fish are inshore, in shallow water and estuaries, and in winter they move into deeper water (ibid.). More information is presented in the starry flounder Life History and Habitat Requirements narrative in volume 1 of this publication.

V. POPULATION SIZE ESTIMATION

Populations of starry flounder have been sampled in various studies in the Arctic Region by otter trawl, gill net, and beach seine (Wolotira et al. 1977, Raymond et al. 1984, Alt 1979). Catch rates and biomass estimates have been reported, but because different methods were used in different areas, it is difficult to provide reliable estimates of population size for starry flounder.

VI. REGIONAL ABUNDANCE
No abundance estimates are available for starry flounder in the Arctic Region.

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Shellfish

King Crab Distribution and Abundance

I. REGIONWIDE INFORMATION

King crabs are found throughout the Western Region and in the Arctic Region as far north as Kotzebue Sound. The Northern District of the Bering Sea Statistical Area (Area Q) includes waters of both the Arctic and Western regions for management of the species. In 1984, the Northern District was divided into three sections: Norton Sound Section, St. Matthew Island Section, and St. Lawrence Island Section. Prior to 1984, the St. Matthew Island and St. Lawrence Island sections were combined in the General Section. The boundaries of these management areas are mapped in the king crab Human Use narrative in this volume. Distribution and abundance information in this report will be presented for two areas: the Norton Sound Section, and the combined St. Matthew-St. Lawrence Island sections.

A. Regional Distribution

Two species of king crab are commonly found in the Western and Arctic regions, with red king crab (Paralithodes camtschatica) being the most common. The distribution of red king crab covers much of the eastern Bering Sea and is generally associated with the continental land mass. A concentration of red king crabs occurs in Norton Sound (Otto 1981). Blue king crab (P. platypus) tends to be associated with the offshore areas near St. Lawrence and St. Matthew islands (ibid.). The Norton Sound red king crabs are considered to be a separate stock from those in the southeastern Bering Sea, and the blue king crabs of the Pribilof and St. Matthew islands are also separate stocks (ibid.).

Brown king crabs (Lithodes aequispina) are found in the eastern Bering Sea along the continental shelf break in deeper waters (ibid.). National Marine Fisheries Service (NMFS) trawl surveys have not sampled this species in waters shallower than 128 m. No estimates of brown king crab abundance are available; therefore, brown king crab will not be discussed in this report.

B. Areas Used Seasonally and for Life Functions

A series of marine distribution maps at 1:1,000,000 scale have been produced for this report. The categories of mapped information for king crab are as follows:

- General distribution
- Known concentrations of females
- Known concentrations of males

C. Factors Affecting Distribution

Many factors affect the distribution of king crabs, including temperature, salinity, and substrate. In NMFS surveys, red king crabs were not found in the Bering and Chukchi seas, where deeper and colder waters occurred. The distribution of blue king crabs in the same area was associated with depths over 25 m and bottom temperatures less than 4°C (Wolotira et al. 1977). (See the king crab Life History and Habitat Requirements narrative for more details.)

D. Movements Between Areas

General information on king crab migration is discussed in the Life History and Habitat Requirements narrative. The ADF&G has conducted tagging studies of male red king crabs in Norton Sound during the summer commercial fishing season. Tagged crabs released south of Nome were found to move southwesterly as the season progressed (Powell et al. 1983). Sublegal males free for one year were recaptured 19 to 37 km south or west from their point of release. Legal size males free for one year showed more random movement, and most were recaptured within 28 km. Winter tagging studies conducted in nearshore waters south of Nome indicate that crabs found in nearshore waters during the winter and spring migrate offshore during the summer (ADF&G 1983a).

E. Population Size Estimation

The NMFS has conducted otter trawl surveys to estimate the population size and biomass of king crabs in the Western and Arctic regions. Catches from standardized trawls are used to calculate population size, using the area-swept technique, which assumes that the trawl obtained samples that represented the density and diversity of species in the sampled area and that the trawl's performance was constant from station to station (Wolotira et al. 1977). The ADF&G has also conducted research pot fishing in this area. Catches from pot fishing have been analyzed in conjunction with tag and recovery data utilizing the Peterson mark-recapture formula to obtain estimates of population size (Powell et al. 1983).

F. Regional Abundance

Detailed abundance information for king crab follows in the Norton Sound and St. Matthew-St. Lawrence Island sections.

II. NORTON SOUND SECTION

A map of this area and a description of boundaries are provided in the king crab Human Use narrative.

A. Distribution

Blue king crabs are only rarely found in Norton Sound or Kotzebue Sound, and trace amounts have been sampled in the southeastern Chukchi Sea (Wolotira et al. 1977; Schwarz, pers. comm.). Red king crabs are concentrated in Norton Sound, with the highest catch rates in trawl surveys occurring in outer Norton Sound and low catches in inner Norton Sound. Only trace amounts of red king crab were sampled farther north in Kotzebue Sound (ibid.). The Norton Sound red king crabs are the northernmost stocks fished commercially. Exploratory commercial fishing north of Norton Sound, near the Diomede Islands, Kotzebue Sound, and off Point Hope found few red king crabs (Powell et al. 1983).

Within Norton Sound, postrecruit male crabs were distributed over a large area southeast of Sledge Island, whereas smaller males were found northeast of this area, with intermingling occurring along the borders (ibid.). Female crabs were usually found northeast of the schools of males. Concentrations of females in Norton Sound have been found south of Cape Nome, off the northern coast east of Nome, in the mouth of Norton Bay, west of Stuart Island, and in the shallow 18 m Egavik trench (ibid.).

Knowledge of king crab distribution in Norton Sound has come from research and commercial fishing, which usually occurs from late June through early October. The distribution of crabs during the rest of the year is poorly understood.

B. Abundance

Six different research surveys, conducted in Norton Sound in 1976, 1979, 1980, 1981, and 1982, provided data from which estimates of the population of legal-size male red king crabs were made. Sampling was done by the NMFS with trawls in 1976, 1979, and 1982 and by the ADF&G with pots in 1980, 1981, and 1982. Estimates of population in 1977 and 1978 were made using the 1976 and 1979 trawl data, the size of crabs in the 1977 and 1978 commercial catches, and assumptions about molting, growth, recruitment, and mortality (Powell et al. 1983). The initial trawl estimate for 1979 was increased by the amount of the commercial harvest, because the survey occurred after the commercial harvest (ibid.). The initial 1980 estimate was also changed when it was discovered that inaccurate catch statistics had been reported (ibid.). The current best estimates of the legal male red king crab population for Norton Sound during the period 1976 through 1982 have ranged from 3.7 million crabs in 1977 and 1978 to .4 million in 1982 (table 1).

In 1976, when monitoring of the Norton Sound king crab population first began, the population was mainly composed of sublegal and recruit crabs (ADF&G 1983b). The legal male population peaked in 1978. Recruitment was low after 1978, and the population declined to a record low in 1982. Beginning in 1981, the numbers of sublegal crabs began to increase, and by 1983 recruitment into the legal male population also began to increase (ibid.). Winter pot surveys conducted near Nome in 1983 found that nearshore abundance of crabs was greater than in the past several years (ADF&G 1983a).

III. SAINT MATTHEW-SAINT LAWRENCE ISLANDS SECTIONS

Prior to 1984, the St. Matthew Island and the St. Lawrence Island sections were combined and called the General Section. A map of this area and a description of boundaries are provided in the king crab Human Use narrative.

A. Distribution

Red king crab stocks outside the Norton Sound section are widely and sparsely distributed (ADF&G 1983c). Small red king crab commercial catches have been reported south of Cape Romanzof, around Nunivak Island, and west of Cape Newenham (ADF&G 1980).

Blue king crabs have localized distributions, occurring in concentrations around the St. Matthew and St. Lawrence islands areas. The St. Lawrence Island crabs occur in concentrations southwest of Port Clarence and south of the Bering Strait (Wolotira et al.

Table 1. Population Estimates of the Legal Size Male Red King Crab Population in Norton Sound

Year	Number of Crabs (Millions)	Pounds of Crab[a] (Millions)
1976	3.1	8.1
1977	3.7	10.0
1978	3.7	11.0
1979	3.0 (1.8)[b]	9.0 (5.4)[b]
1980	1.9 (3.9)[c]	6.6 (13.4)[c]
1981	1.3	4.7
1982	.4[d]	1.3[d]
1983		1.6[e] (2.6)[f]

Source: Powell et al. 1983.

a Prior to commercial harvest.

b Initial trawl survey estimate made after commercial harvest.

c Initial estimates based on inaccurate catch statistics.

d Postseason estimate (ADF&G 1983a).

e ADF&G pot survey estimate (ADF&G 1983b).

f NMFS trawl survey estimate (ADF&G 1983b).

1977). Small research and commercial catches of blue king crabs have been reported around St. Lawrence Island and all the way to the USA-USSR convention line toward the Chukotsk Peninsula (Wolotira et al. 1977, ADF&G 1980). It is likely that the stocks extend westward across the convention line, but the extent of this westward distribution is unknown (Wolotira et al. 1977).

Concentrations of blue king crabs occur around the St. Matthew Island area (Otto et al. 1984a). Overall distributions within this area do not vary much from year to year. Most crabs were sampled at depths of 35 to 110 m at bottom temperatures from -1.0 to 3.0°C (ibid.). Legal-size males and prerecruits have been sampled south and west of the island, mainly at depths from 55 to 75 m (Otto et al. 1984b).

B. Abundance

Reliable estimates of the St. Lawrence Island blue king crab stocks are not available. Information from NMFS trawl surveys and commercial fishing indicates that the stocks are stable, with a wide distribution in sparse concentrations (ADF&G 1981). Population estimates of blue king crab in the St. Matthew Island area have been made from NMFS trawl surveys. The total number of crabs during the period 1978 through 1984 has ranged from 13.7 million in 1982 to 4.3 million in 1984 (table 2). The populations were highest in 1982 and have been declining since then. From 1983 to 1984 the populations declined by over 50%, and continued declines in recruitment are expected in 1985 (Otto et al. 1984a).

Table 2. Annual Abundance Estimates in Millions of Crabs for St. Matthew Island Blue King Crabs from NMFS Surveys

	Males		Females		Total Number of Males and Females
	Less Than 119 mm[a]	Greater Than 119 mm[a]	Less Than 80 mm[a]	Greater Than 80 mm[a]	
1978	8.0	1.8	0.8	0.4	11.0
1979	7.2	2.2	1.7	0.9	12.0
1980	5.6	2.5	0.8	2.2	11.1
1981	3.0	3.1	0.0	0.5	6.8
1982	5.8	6.8	0.4	0.7	13.7
1983	3.4	3.5	0.2	2.4	9.6
1984	2.0	1.6	0.2	0.5	4.3

Source: Otto et al. 1984a.

a Carapace length; categories reflect small average size of blue king crabs in the area; 80 mm is the median size at maturity for females.

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Tanner Crab Regional Overview

I. INTRODUCTION

Statistical Area J, or the Westward Registration area, includes all Pacific Ocean waters south of the latitude of Cape Douglas (58°52'N), west of the longitude of Cape Fairfield (148°50'W), east of 172° east longitude, and shoreward of the 400 fathom (732 m) depth contour, and all Bering Sea waters east of 172° east longitude. Area J is divided into the Kodiak, South Peninsula, Eastern Aleutians, Western Aleutians, Bering Sea, and Chignik districts (ADF&G 1984). With the exception of the Northern Subdistrict of the Bering Sea District, information regarding Tanner crab fisheries in Statistical Area J has been presented in volume 2 of the Alaska Habitat Management Guide for the Southwest Region.

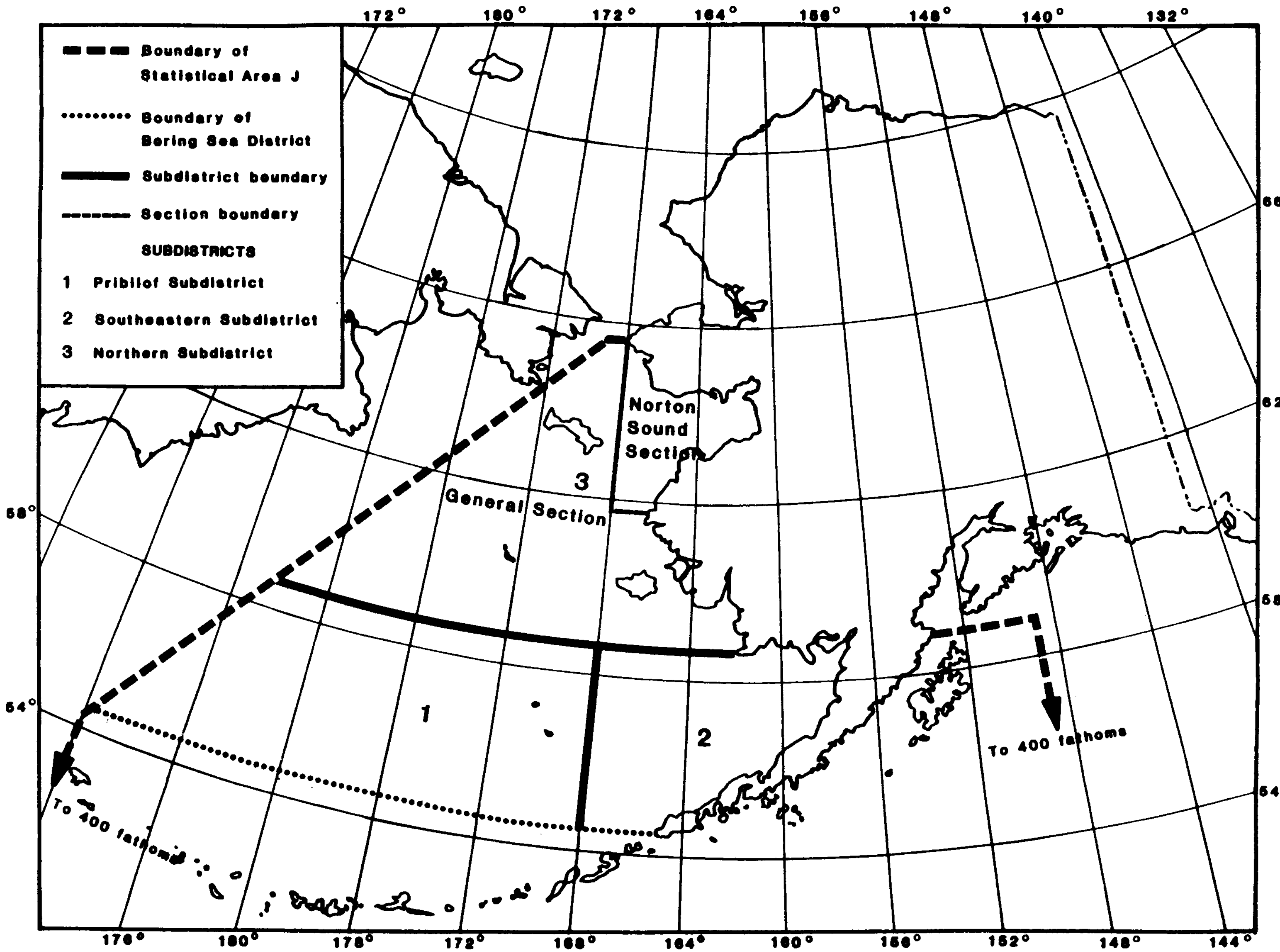
The Bering Sea District consists of all Bering Sea waters of Statistical Area J north of 54°36' north latitude. The Southeastern, Pribilof, and Northern subdistricts are contained within the Bering Sea District (map 1). Only the Northern Subdistrict occurs within the boundaries of the Arctic and Western resource management regions addressed in this volume.

The Norton Sound Section of the Northern Subdistrict includes all waters of the Bering Sea east of 168° west longitude and north of the latitude of Cape Romanzof. The General Section consists of all waters of the Northern Subdistrict not included in the Norton Sound Section (ibid.). Information presented in the following narrative will encompass the marine area covered by the Northern Subdistrict, which corresponds to that area represented by the combined Arctic and Western regions.

II. DISTRIBUTION AND ABUNDANCE

Two species of Tanner crab are commercially harvested in the Bering Sea. Distribution of *Chionoecetes bairdi*, the larger of the two species, is strongly associated with the coast of the Alaska Peninsula, continental slope areas, and the Pribilof Islands (Otto 1981). Recent trawl surveys have located *C. bairdi* in a broad band extending from inner Bristol Bay westward along the outer continental shelf edge to 178° west longitude (Otto et al. 1984b). The second Tanner crab species, *C. opilio*, occurs from the Bering Strait south to Unimak Island, with the exception of the northern or eastern shores of Bristol Bay and immediately south of Nunivak Island (Otto 1981, Otto et al. 1984b). A hybrid of these two species is also present, occurring within the zone of *C. bairdi* and *C. opilio* (Otto et al. 1984b).

Trawl surveys for Tanner crab in the Bering Sea are performed by the NMFS to obtain abundance estimates and information regarding reproductive condition, size, and distribution of male and female crabs.



Map 1. Tanner crab fishing subdistricts and sections of the Bering Sea District in Statistical Area J (ADF&G 1984).

Not only is the distribution of *C. opilio* in the Bering Sea extensive, but population size is immense, exceeding that of *C. bairdi*. Within this area, there are geographic clines in average size and in reproductive parameters. Clines are gradual and continuous and therefore are not indicative of separate stocks. The entire Bering Sea population of *C. opilio* is managed as one stock (Otto et al. 1984b, Otto 1981). Specifically, in the Northern Subdistrict total population estimates (male and female combined) peaked in 1979 at 22,832.4 million crabs and dropped gradually to 1,910.7 million crabs (table 1) during the 1984 survey (Otto et al. 1984b). The total population estimate for *C. bairdi* in the Northern Subdistrict has ranged from a high abundance of 358.3 million crabs in 1982 to a low of 29.0 million crabs (table 1) in 1984 (ibid.).

III. MANAGEMENT HISTORY AND REPORTED USE

Foreign and domestic crab fleets were originally attracted to the southeastern Bering Sea by the availability of the larger and more valuable red king crab (*Paralithodes camtschatica*). With development of markets and processing techniques, Tanner crab became a targeted species (Somerton 1981).

Between 1953 and 1964, Japanese and Soviet fleets caught Tanner crabs usually as an incidental catch of the king crab and groundfish trawl fisheries. Available data, though limited, indicate that annual production, at least by the Japanese mothership fleet, during this time was probably fewer than 1,000,000 Tanner crabs per year (Otto 1981).

In 1964, when the Soviet and Japanese king crab fisheries were at their peak, negotiations began between the United States, Japan, and the USSR. These negotiations restricted foreign harvest quotas of king crab and encouraged exploitation of Tanner crab as a substitute species. The initial fishery targeted exclusively on *C. bairdi* because of its larger size.

In 1965, approximately 1.7 million Tanner crabs were taken by Soviet and Japanese fleets. The fishery expanded rapidly during the following years, and in 1968 the United States entered the Tanner crab fishery, although fishing remained incidental to king crabbing until 1974 (Otto 1981).

By 1969, the direct harvest of *C. bairdi* increased to the level where foreign fishing quotas appeared necessary. As a result of restrictions imposed by the United States, foreign vessels began directing their effort toward *C. opilio* (Armstrong et al. n.d.).

As total landings of Tanner crab from the eastern Bering Sea increased (from 12 to 24 million crabs from 1967 to 1970), so did American interest in the fishery. Consequently, through a series of bilateral agreements and United States harvest quotas, foreign participation in the eastern Bering Sea Tanner crab fishery was gradually reduced and forced to fish areas to the north and west (ibid.). Foreign catches declined in 1971 and again in 1972, when the USSR left the fishery (Otto 1981).

In 1974, a directed United States Tanner crab fishery began, with the target species *C. bairdi* (ADF&G 1982). The fishery was, and continues

Table 1. Annual Abundance Estimates (Millions of Crabs) for Tanner Crabs in the Northern District from NMFS Surveys

C. bairdi

Size[a]	Males: Less Than 85	Males: 85-129	Males: Greater Than 129	Males: Total	Females: Less Than 85	Females: Greater Than 84	Females: Total	Grand Total
1978	66.0	7.5	0.6	74.1	121.2	7.8	129.0	203.1
1979	26.7	3.8	0.1	30.6	48.0	3.5	51.5	82.1
1980	44.0	0.3	0.1	54.4	100.3	9.3	109.6	164.1
1981	23.3	24.4	0.4	48.1	51.1	3.9	55.0	103.1
1982	12.6	39.4	2.6	54.5	288.4	15.4	303.8	358.3
1983	17.3	15.7	0.8	33.8	53.0	2.2	55.1	89.0
1984	6.7	8.0	0.3	15.0	13.0	1.0	14.0	29.0

C. opilio

Size[a]	Males: Less Than 110	Males: Greater Than 109	Males: Total	Females: Less Than 65	Females: Greater Than 64	Females: Total	Grand Total
1978	1,344.6	10.6	1,355.2	1,464.4	29.7	1,494.2	2,849.3
1979[b]	10,213.0	6.5	10,219.5	12,563.0	49.9	12,612.9	22,832.4
1980	1,989.4	4.2	1,993.6	2,966.5	46.0	3,012.5	5,006.0
1981	934.4	6.5	940.9	1,137.4	46.9	1,184.4	2,125.3
1982	1,292.2	10.9	1,303.1	1,036.2	96.9	1,133.1	2,436.2
1983	1,274.0	9.2	1,283.2	1,161.6	15.3	1,176.9	2,460.0
1984	1,030.1	20.0	1,050.0	854.8	5.9	860.7	1,910.7

C. bairdi - *C. opilio*

Size[a]	Males: Less Than 110	Males: Greater Than 109	Males: Total	Females: Less Than 65	Females: Greater Than 64	Females: Total	Grand Total
1978	0.6	0.1	0.7	0.3	0.7	1.0	1.7
1979	1.1	0.4	1.5	2.0	1.6	3.6	5.1
1980	1.3	0.7	2.0	4.6	10.9	15.6	17.6
1981[c]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	1.3	0.1	1.4	12.0	50.1	62.1	63.6
1983	0.4	0.0	0.4	0.8	3.7	4.5	4.9
1984	4.3	0.0	4.3	7.4	0.4	7.8	12.1

Source: Otto et al. 1984.

a Carapace width (mm).

b Survey estimates of the smallest size groups in 1979 are not comparable to other years because of large differences in area coverage.

c All estimates less than 0.05 in 1981.

to be, conducted north of the Alaska Peninsula and near the Pribilof Islands (Otto 1981). After the directed United States fishery began, C. bairdi catches grew from 2,300 metric tons in 1974 to 10,100 metric tons in 1976 and peaked at 30,030 metric tons in 1978 (ibid.). With a decline in C. bairdi abundance, United States vessels moved north and began catching C. opilio (Somerton 1981). Landings of C. opilio exceeded those of C. bairdi by almost three million pounds during the period 1980 through 1982, although C. opilio continues to command a considerably lower ex-vessel price (Armstrong et al. n.d.). In 1981, because of increased United States participation in the C. opilio fishery, foreign fishing was eliminated (Somerton 1981). Today, all Tanner crab fishing in the southeastern Bering Sea (except for incidental catch) is conducted aboard American vessels and is directed at both C. bairdi and C. opilio (Armstrong et al. n.d.).

Prior to the 1982-1983 fishery, commercial exploitation of Tanner crab occurred primarily in the Southeastern and Pribilof subdistricts of the Bering Sea. The fishery harvested about 26.1 million pounds of C. opilio during the 1982-1983 fishery, increasing to 26.8 million pounds during the 1983-1984 fishery. During the 1982-1983 fishery, 1.4 million pounds of the total C opilio harvest was taken in the Northern District. The Northern District catch increased to 3.1 million pounds during the 1983-1984 fishery (Griffin, pers. comm.). The harvest of C. bairdi in the Northern District was incidental to that of C. opilio, reaching .048 million pounds during the 1982-1983 season (ADF&G 1985). Declining catches of C. bairdi in the Southeastern and Pribilof subdistricts of the Bering Sea has resulted in effort directed toward C. opilio (Otto et al. 1984a). The total harvest of Tanner crab (C. bairdi and C. opilio) in the Bering Sea for the 1982-1983 and 1983-1984 seasons averaged 4.0 million pounds per year. Of this average, about 89% of the harvest was C. opilio (Griffin, pers. comm.). C. opilio from the Northern subdistrict accounted for about 8.5% of the total Bering Sea C. opilio harvest during the 1982-1983 and 1983-1984 seasons (ADF&G 1985).

IV. MANAGEMENT OBJECTIVES AND CONSIDERATIONS

The Tanner crab fishery within 3 mi of the shoreline is managed by the State of Alaska and the 3 to 200-mi area by the NMFS. Management is directed by a policy jointly developed by the Alaska Board of Fisheries and the North Pacific Management Council. Because Tanner crab distribution is not restricted by state/federal jurisdictional boundaries, problems can arise when state and federal policies conflict. Regulations, though nonexistent during the first two years of the Tanner crab fishery, have since evolved to accomplish the following objectives:

1. To maximize yield from harvestable surpluses. This is to be accomplished by season and gear restrictions to increase meat yield per individual crab and reduce mortality on sublegal crabs.
2. To maximize the reproductive potential of the Tanner crab stocks. This is to be accomplished by a) imposing seasons, gear restriction, size, and sex limits, and harvest levels to protect

crabs during the reproductive period; b) minimizing mortality on female crabs due to handling or harvest; and c) assuring full female fertilization by providing adequate numbers of mature males for breeding.

3. To seek economic stability in the Tanner crab industry. This is to be accomplished by avoiding overcapitalization based on levels of population abundance that may not be sustained over time by a) regulating annual harvest to discourage too rapid expansion of harvesting and processing capability until resource potential can be better evaluated and b) by stabilizing harvest levels within the range of natural recruitment fluctuation, if not precluded by excessive natural mortality beyond the first year of maturity (NPFMC 1981).

Currently, forecasting long-term abundance and harvest levels for different fisheries is difficult. Better knowledge of the biology, age classification, and refinement of population assessment are needed to forecast abundance and harvest levels for the fishery and to ensure compatible management policies.

To prevent overexploitation of given Tanner crab populations, superexclusive and nonexclusive registration areas have been established. Vessels or gear registered for fishing in a superexclusive area may not be used to take Tanner crab in any other registration area during that registration year. A vessel or gear may register for one or more of the nonexclusive registration areas; however, a vessel or gear so registered may not be used to take Tanner crab in a superexclusive registration area during that registration year. The registration year extends from August 1 through July 31. The Bering Sea District is one of four nonexclusive registration areas (ADF&G 1984).

Bering Sea Tanner crab stocks are managed by two agencies. The domestic fishery is managed by the State of Alaska. The NMFS is responsible for regulating the foreign fishery (NPFMC 1981). Management is under the joint policy established by the Alaska Board of Fisheries and the NPFMC. As with other Tanner crab fisheries, regulations governing the fishery involve sex, gear type, season, and size. Guideline harvest levels are determined annually by the state. The harvest levels are based on population estimates and biological data provided from trawl surveys performed by the NMFS (ADF&G 1983). Identification of hybrid _C. opilio_ and _C. bairdi_ crabs is difficult, which may provide loopholes in closure dates of the season on _C. bairdi_. The large area and remoteness of the fishery and movement of processing facilities to offshore/on-the-grounds locations makes acquiring in-season biological and harvest data difficult for in-season management decisions.

V. PERIOD OF USE AND HARVEST METHODS

Harvest seasons for Tanner crab have been designed to prevent fishing during soft-shelled and reproductive stages of the species' life cycles. In the Bering Sea District, which includes the Northern Subdistrict, male Tanner crabs could be harvested from 12:00 noon January 15 through 12:00 noon June 15, except male Tanner crabs other

than *C. bairdi* may be taken or possessed from 12:00 noon January 15 through 12:00 noon August 1. The Norton Sound section of the Northern Subdistrict is closed to the taking of Tanner crab (ADF&G 1984). Tanner crab may be harvested with pots and ring nets (ibid.).
Regulations stipulate that only male crabs may be possessed. Sex and size stipulations ensure that male Tanner crabs remain in the breeding population at least one season before they are harvested. Until June 1982, a size limit had not been imposed on *C. opilio*, as most of the catch was greater than 4.3 inches. A minimum size limit as measured by shell width was established for the 1983 season at 3.1 inches (78 mm) in carapace width. For *C. bairdi*, the minimum size limit is 5.5 inches (140 mm) in carapace width.

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Brown Bear Human Use

I. POPULATION MANAGEMENT HISTORY

A. Introduction

Human use data in the following sections are presented by game management units (GMU) and subunits (GMS) (see map 1). Data are presented for the years 1979 through 1984 and include resident and nonresident harvest, reported nonsport harvest, such as defense of life and property kills, total known harvest, and, where available, estimated harvest. Reported harvest data are obtained from sealing certificates. All people who harvest a brown bear are required to have the hide and skull sealed by an authorized representative from the ADF&G. The data obtained from these certificates represent successful hunters only. No information is available concerning those hunters who hunted brown bear but were not successful. It is hoped that by 1986 the information from sealing certificates will be coded to the Game Division Uniform Coding System. Until then it is difficult to obtain harvest information below the GMS level.

B. Regional Summary of Hunting

1. Regional summary of human use information. Within the Arctic Region, which is composed of GMUs 22, 23, and 26, brown bear harvest has ranged from 7 in 1962 to 126 in 1984. The average annual harvest from 1961 to 1984 has been about 49 brown bears (ADF&G 1985).
2. Managerial authority. Wildlife management in Alaska was formally established in 1925 when Congress created the Alaska Game Commission. Prior to 1925, protection of wildlife had been undertaken by the Departments of Treasury, Commerce, and Agriculture and by the territorial governor. After statehood in 1959, the State of Alaska assumed administration of its wildlife and established the Department of Fish and Game.

II. GMU 22

A. Boundaries

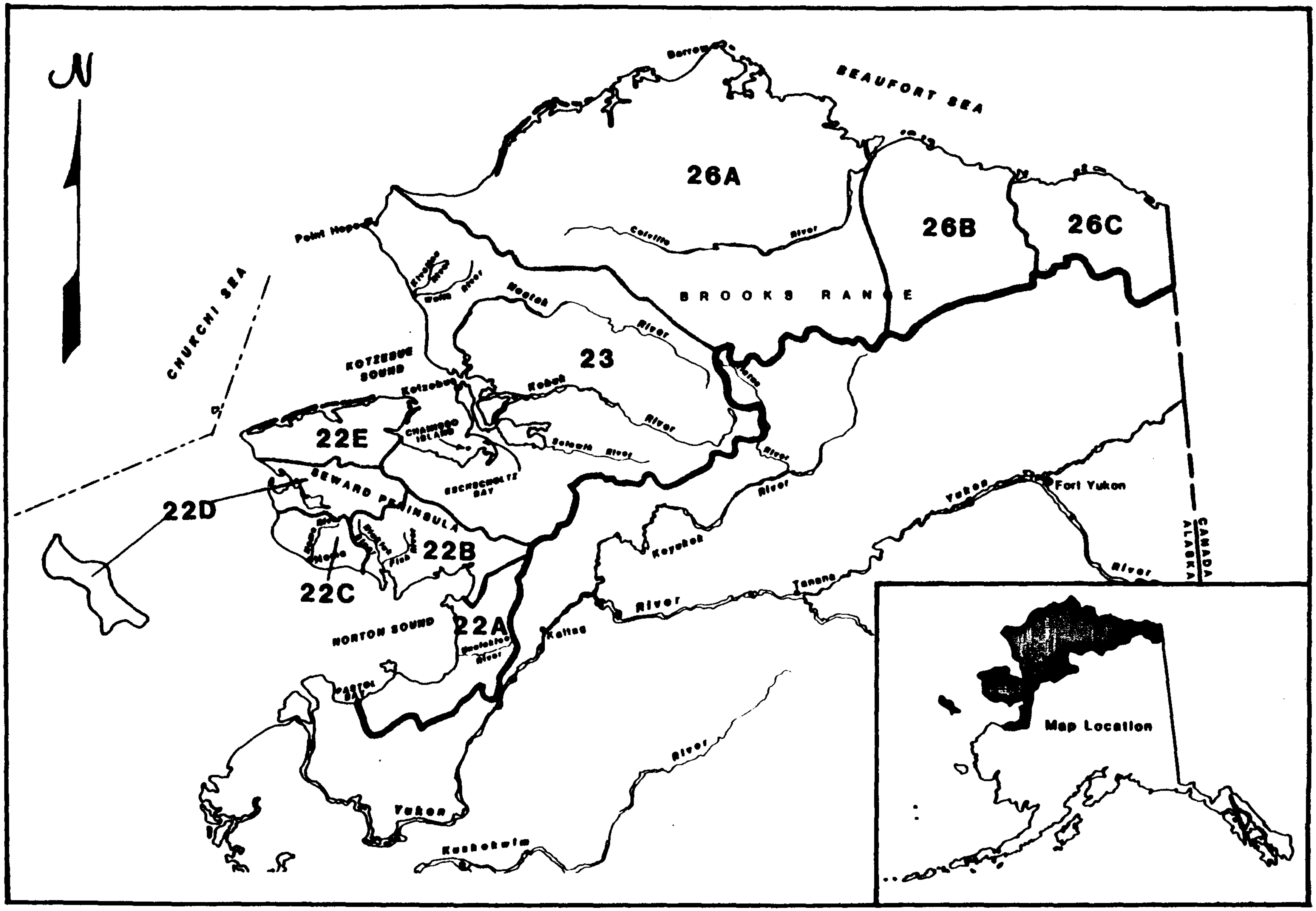
GMU 22 includes most of the Seward Peninsula and lands bordering Norton Sound. See map 1 and the latest GMU boundary descriptions.

B. Management Objectives

The Northwestern Alaska Brown Bear Management Plan pertains to GMU 22. The primary management objective is to provide the greatest sustained opportunity to participate in hunting brown bears, and the secondary objective is to provide sustained opportunities for subsistence use of brown bears (ADF&G 1976a, Bos 1980).

C. Management Considerations

Accurate estimates of the number of brown bears in GMU 22 are currently not available. Based on research conducted elsewhere in



Map 1. Game management units in the Arctic Region.

Alaska and the quality and quantity of bear habitat available in GMU 22, extrapolated population estimates range from 300 to 1,100 brown bears in the unit (Grauvogel 1982, 1985a, 1985b). Research conducted throughout the state indicates that a harvest of 5% of the population is a safe sustainable harvest and that 10% is probably a maximum level (Grauvogel 1982, 1985a). Based on the minimum and maximum population estimates, a safe sustainable harvest is between 15 and 55 bears, and an upper limit is between 30 and 100 bears (Grauvogel 1985a).

Because population and harvest estimates are not precise and bear densities are not uniform throughout GMU 22, it is not possible to accurately assess the impact of the current harvest on the bear population. It is believed, however, that the harvest is within sustainable limits in some areas and that overharvest may be occurring in others (ibid.).

Although harvest in GMS 22A was relatively high (15) in 1984, it is still probably below sustainable levels. In GMS 22B, reported harvest has been increasing and may be approaching sustainable limits. GMS 22C receives the heaviest hunting pressure because of its proximity to Nome and relatively good road access. Harvest in this subunit has probably exceeded sustained yield, and bear numbers may have been significantly reduced in recent years. Harvest in GMSs 22D and E have probably been below sustained yield levels (ibid.).

Public opinion concerning brown bears in GMU 22 is quite diverse. Local guides and hunters want liberal seasons and bag limits and a continuing annual harvestable surplus of bears. The reindeer industry and some local residents consider bears a nuisance and would like to see their numbers reduced (Nelson 1984a; Grauvogel 1985a and b). Local nonhunters and nonlocal residents generally want brown bear numbers preserved or increased (Grauvogel 1985b).

The lack of accurate brown bear population data and precise harvest data, coupled with diverse public opinion, make sound management decisions difficult (Nelson 1984b, Grauvogel 1985b).

D. Period of Use

The hunting season dates have fluctuated considerably over the past 24 years. During the 1960's, the spring and fall seasons ran for a total of 154 days; the seasons dropped, however, to a total of 61 days by 1972. Since then, they have gradually increased until the 1983 and 1984 seasons, when season dates ran from 15 April through 25 May and from 1 September through 31 October, for a total of 102 days. (See the latest Alaska game regulations for current seasons and limits.)

E. Human Use Data

Table 1 presents reported harvest data for the years 1979 through 1984. These data represent only successful hunters. Unsuccessful hunters of brown bears are not required to report.

Table 1. Reported Brown Bear Harvest Data for GMU 22, 1979-84

Year	Harvest by Residents*	Harvest by Nonresidents	Non Sport** Harvest	Total Harvest	Estimated Harvest
1979	12	38	0	50	53-56
1980	12	19	0	31	34-37
1981	21	7	0	28	---
1982	12	3	0	15	25-35
1983	8	20	4	32	35-40
1984	32	22	0	54	---

Source: Grauvogel 1980, 1981, 1982; Nelson 1984a, 1984b; ADF&G 1985.

--- means no data were available.

* Residents are hunters whose legal residence is Alaska.

** Nonsport harvest are bears reported taken in defense of life or property or other known kills.

From 1961 through 1978, the average annual brown bear harvest in GMU 22 was between four and five bears (Grauvogel 1980). The spring season in 1979 was opened two weeks earlier than in adjacent units; this early season, coupled with increased guiding effort, resulted in a dramatic increase in reported harvest to 50 bears. As a result of this increased harvest and concern about possible overharvest, a nonresident drawing permit system was implemented for the 1980 hunting season. Also, by 1981 most of GMU 22 had been assigned to one-to-five guides for their exclusive use. Prior to 1980, any guide registered in the Arctic Region could guide in GMU 22 (Grauvogel 1982). The drawing permit system and guide restrictions succeeded in reducing annual harvest from 1980 through 1983 to 31 or fewer bears (Nelson 1984a, Grauvogel 1985b). The 1984 reported harvest increased to 54 bears, largely as a result of three factors: 1) lengthening of the spring season by 10 days, 2) elimination of the resident $25.00 brown bear tag fee in the unit, and 3) increased guiding effort in GMS 22A (Grauvogel 1985b).

Based on reports received from USFWS protection officers and comments from the public, the estimated annual unreported harvest is between 10 and 30 bears (ibid.).

F. Significance of Particular Use Areas

Most bears harvested by residents from Nome are taken in GMS 22C during the spring hunting season. In 1983, however, poor snow conditions for hunting and reduced numbers of bears in GMS 22C changed the spatial distribution of the 1983 harvest. Most bears taken by residents of Nome during 1983 were taken during the fall season in GMS 22B (Nelson 1984a).

III. GMU 23

A. Boundaries

GMU 23 includes the northeast portion of the Seward Peninsula, the Noatak and Kobuk valleys, and lands bordering Kotzebue Sound. (See map 1 and the latest GMU boundary descriptions.)

B. Management Objections

There are two brown bear management plans pertaining to portions of GMU 23, the Northwestern Alaska Brown Bear Management Plan, which includes most of GMU 23, and the Brooks Range Brown Bear Management Plan, which pertains to that part of GMU 23 draining into the Noatak River above Maiyumerak Creek (ADF&G 1976a, Bos 1980). The primary management objective for the northwestern plan is to provide the greatest sustained opportunity to participate in hunting brown bears. The secondary objective is to provide sustained opportunities for subsistence use of brown bears. In the Brooks Range plan, the primary management objective is to provide sustained opportunities to hunt brown bears under aesthetically pleasing conditions (Bos 1980).

C. Management Considerations

The GMU 23 brown bear harvest has steadily increased since 1980, largely as a result of increased harvest by residents. This trend is likely to continue because the brown bear tag fee was eliminated in the unit, and hunting seasons are relatively long. Brown bear population estimates range from 570 to 2,300 in GMU 23 (Grauvogel 1985b). Based on harvest levels of 5 and 10% (see GMU 22 Management Considerations discussion), a safe sustainable level of harvest would be between 38 and 115 and an upper limit of between 57 and 230 bears. On a unitwide basis, harvest currently appears to be at acceptable levels. At least 25 bears were taken from the Noatak drainage in 1984, however, and there may be a potential for overharvest in this area (ibid.).

As in GMU 22, few specific population data are available for GMU 23 brown bears (ADF&G 1976a, Craighead 1982, Grauvogel 1985a). In 1983, surveys were conducted in the unit that may have the potential for determining minimum densities and estimating actual densities (Quimby 1984a). Until managers are better able to collect such information, sound management decisions will be difficult to make.

Resource exploitation and industrial development will most likely escalate in GMU 23. Such activities may alter habitat important to brown bears and increase human/bear interaction, leading to adverse impacts upon the bear population (ADF&G 1976, Craighead 1982). Because of federal actions designating about 30% of GMU 23 a national park monument or park, sport hunters are forced to confine their hunting effort to a smaller portion of GMU 23 than prior to 1980. With reduced area available to sport hunters, the department will need to carefully monitor hunting pressure.

Perennial hunting areas found within the national parks and monuments have been abandoned by sport hunters, who have shifted to other areas of the unit. Close monitoring will be required in order to guard against overharvest in the areas remaining open to sport hunting (Johnson 1980).

D. Period of Use

Brown bear spring and fall hunting seasons have run for a combined total of up to 166 days in 1963, down to a 31-day fall season only in 1974. Since 1974 the season, lengths have increased to a total of 81 days, from 15 April to 25 May and from 1 September to 10 October. (See the latest Alaska Game Regulations for current seasons and limits.)

E. Human Use Data

Table 2 presents reported harvest data for the years 1979 through 1984. These data represent only successful hunters. Unsuccessful brown bear hunters are not required to report.

Table 2. Reported Brown Bear Harvest Data for GMU 23, 1979-84

Year	Harvest by Residents*	Harvest by Nonresidents	Nonsport** Harvest	Total Harvest	Estimated Harvest
1979	21	37	0	58	---
1980	9	14	1	24	---
1981	14	7	1	22	---
1982	24	6	1	31	50
1983	30	9	0	39	45
1984	33	13	1	47	50-100

Source: Johnson 1980; Craighead 1982; Quimby 1984a, b; ADF&G 1985.

--- means no data were available.

* Residents are hunters whose legal residence is Alaska.

** Nonsport harvest are bears reported taken in defense of life or property or other known kills.

The reported harvest of brown bears peaked in 1979 in GMU 23. Since then, a unitwide drawing permit system for nonresidents has been implemented, limiting the number of nonresident hunters and reducing the harvest. The harvest again began to increase after 1980, possibly because of increased interest and season lengths in the GMU. Part of the increase from the 1983 to the 1984 season may be the result of Board of Game action eliminating the requirement for a brown bear tag in the unit. This action, however, may have also increased compliance with the sealing requirements of brown bears harvested in Alaska. The unreported kill is believed to range between 10 and 30 bears annually (Grauvogel 1985b).

IV. GMU 26

A. Boundaries

GMU 26 includes the North Slope from the crest of the Brooks Range north. (See map 1 and the latest GMU boundary descriptions.)

B. Management Objectives

The Brooks Range Brown Bear Management Plan pertains to GMU 26 (ADF&G 1976b). The primary management objective is to provide sustained opportunities to hunt brown bear under aesthetically pleasing conditions (Bos 1980).

C. Management Considerations

Research conducted in portions of GMU 26 (Reynold 1976, 1980; Reynolds and Hechtel 1984) indicates that the reproductive capacity and densities of brown bears varies from one portion of the GMU to another (Reynolds 1984). Because of this, regulations need to be tailored to various portions of the GMU.

As Reynolds (1976) explains:

> The potential for adverse impact of development on grizzly bear populations in Alaska is probably greatest from the Brooks Range north to the Arctic Ocean. Here the grizzly is at the northern extent of its range; the period of food availability during the summer season is short, reproductive potential is low, the area required for individual home ranges is large, and the stunted vegetation of the region provides little cover.

D. Period of Use

Spring and fall brown bear hunting seasons have run for a combined total of as much as 180 days in 1963 to no open season in 1972. Currently, the seasons run from 10 May through 31 May and from 1 September through 31 October, for a total of 83 days. (See the latest Alaska game regulations for current seasons and limits.)

E. Human Use Data

Table 3 presents reported harvest data for the years 1979 through 1984. These data represent successful hunters only. Hunters who are not successful hunting brown bears are not required to report. Since the fall 1977 brown bear season, all of GMU 26 has been under a drawing permit system. In 1984, however, portions of GMS 26A and all of GMS 26C have been opened to hunting by residents without permits. Nonresidents are still required to obtain a drawing permit. This permit system has effectively limited harvest in GMU 26. Research has indicated portions of the GMU 26 may sustain higher harvest; thus the seasons were liberalized was implemented in 1984 (Reynolds 1984).

Table 3. Reported Brown Bear Harvest Data for GMU 26, 1979-84

Year	Harvest by Residents*	Harvest by Nonresidents	Nonsport** Harvest	Total Harvest	Estimated Harvest
1979	7	4	1	12	---
1980	10	12	0	22	---
1981	9	3	3	15	---
1982	8	11	2	21	---
1983	8	16	3	27	---
1984	11	15	1	27	---

Source: ADF&G 1985.

--- means no data were available.

* Residents are hunters whose legal residence is Alaska.

** Nonsport harvest are bears reported taken in defense of life or property or other known kills.

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Caribou Human Use

I. POPULATION MANAGEMENT HISTORY

A. Introduction

Human use information for caribou in the Arctic Region will be organized by the three major herds: Porcupine (PH), Central Arctic (CAH), and Western Arctic (WAH). These herds are associated with the following game management units (GMU) or subunits:

- ° Porcupine Herd: GMUs 25 and 26
- ° Central Arctic Herd: GMU 26B
- ° Western Arctic Herd: GMUs 22A, 22B, 23, 24, and 26A

II. CENTRAL ARCTIC HERD (GMU 26B)

A. Boundaries

See map 1 and the current Alaska Game Management Unit map, which provides a geographical description and delineates the boundaries of the areas listed in Alaska's hunting regulations.

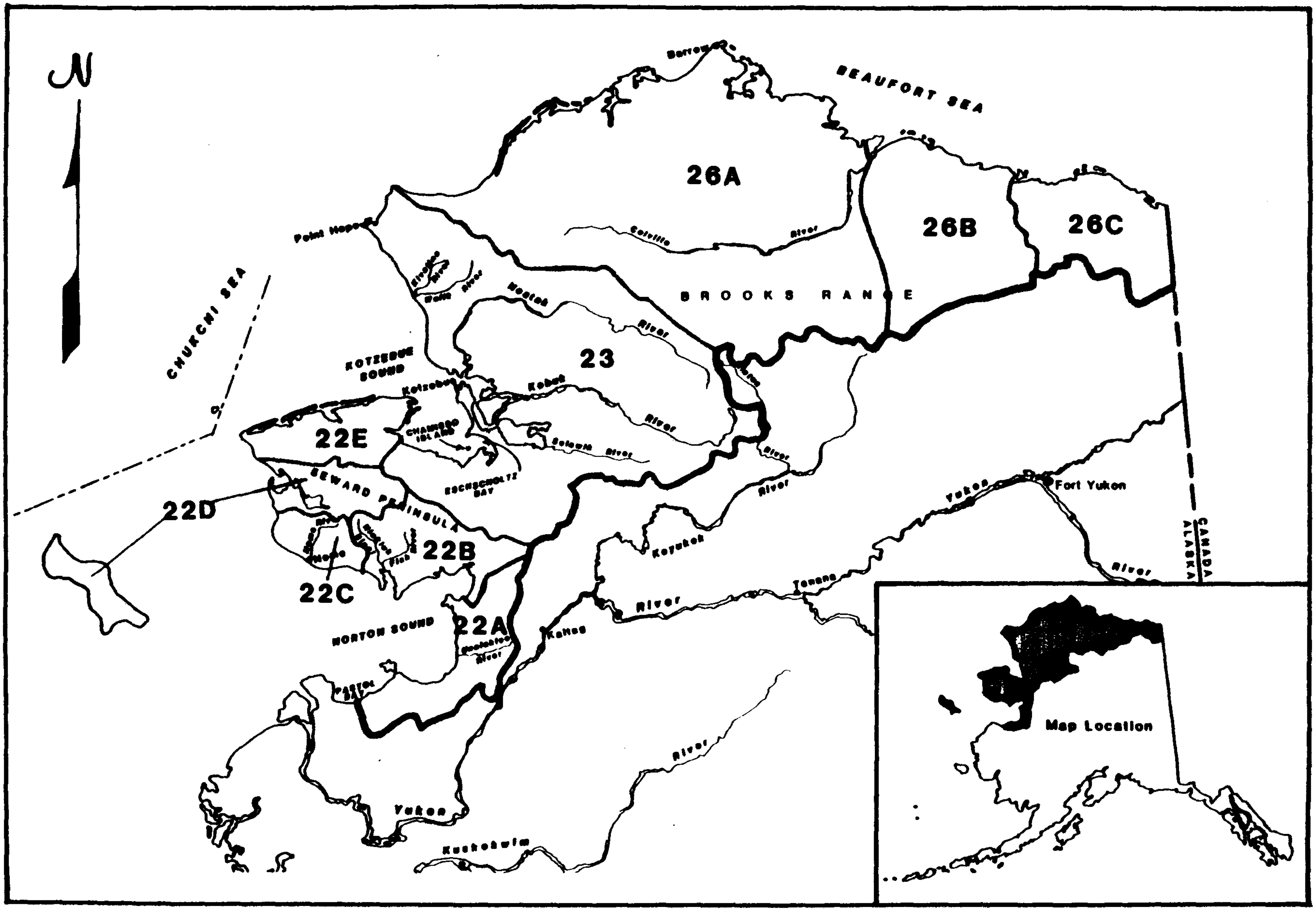
B. Management Objectives

Most of the present range of the Central Arctic Herd (the area between the Colville and Sagavanirktok rivers) is included within the geographical jurisdiction of the Dietrich Caribou Management Plan (ADF&G 1977). This plan covers the upper Koyukok drainage and the central Brooks Range as well as the North Slope. The primary management goal is to provide an opportunity to hunt caribou under aesthetically pleasing conditions. This goal would make available a hunting experience composed of one or a combination of the following characteristics: an area of undisturbed wilderness, with low hunter densities, with controlled methods of transport, and with regulation of conflicting resource uses.

A secondary management goal is to provide an opportunity to observe, photograph, and enjoy caribou.

C. Management Considerations

1. Illegal hunting along the Dalton Highway. In recent years, hunting pressure has increased during August and September with the removal of the traffic check station and the relaxation of enforcement of traffic restrictions to commercial vehicles only (Smith 1985). Whitten (1984) noted instances of illegal hunting and/or unreported hunting within the 5-mi area closed to firearms hunting. For example, in three different locations, snowmobile trails led to caribou gut piles, but only one hunter reported using a snowmachine.
2. Compliance with state game regulations. In most years, the local subsistence harvest of caribou by Kaktovik, Anaktuvuk, and Nuigsut village residents has not been reported. Presently, subsistence and sport hunting mortality do not effect the productivity of the Central Arctic Herd. This situation could change in the future, however. An aggressive



Map 1. Game management units in the Arctic Region.

program of education and information explaining the necessity for compliance with the harvest report system and enforcement could significantly increase the level of harvest reporting by local residents.

3. Petroleum development. Increased petroleum-related development in the range of the Central Arctic Herd appears imminent. Two very important management concerns are the displacement of caribou from previously occupied habitat and restriction of their movements, especially during the summer, as animals seek relief from insect harassment. This issue has been summarized by Cameron (1983), Cameron et al. (1983), and ADF&G (1985).

D. Period of Use

From statehood through 1975, there was no bag limit or closed season for caribou in GMU 26B. From 1976 to early 1980, the harvest of Central Arctic Herd caribou was by registration permit only. During the 1980-1981 regulatory year, a new harvest ticket program was instituted to replace the arctic caribou harvest ticket program, which focused mainly on nonlocal (sport) hunting activity. The new program intended to provide data on both the sport and subsistence take. The season lasted from August 10 through October 15 and from February 15 through April 15, with a bag limit of three bulls during the 1981 and 1981-1982 regulatory years. Since 1982, a 10-month season lasting from July 1 through April 30, with a bag limit of five caribou, has been in effect. However, female caribou can be taken only from October 1 through April 30.

Most hunting activity occurs during the traditional August-through-September season (Smith 1985), with very little hunting occurring during the winter months (Whitten 1984).

E. Human Use Data

Table 1 summarizes available human use data from 1980 to 1984. Because females are not as available to hunters utilizing the Dalton Highway for access, bulls make up most of the harvest (almost 97%) (ADF&G 1984b). In most years, most of the hunting activity occurs from mid August to the end of September and during April. Eighty-four percent of all hunters were successful, and 71% of the successful hunters were residents. About 36% of all hunters used a highway vehicle for access, with 31% flying into an area to hunt. Airplane hunters were more successful than highway hunters. Successful hunters and all hunters as a group spent slightly less than six days in the field. More than 72% of all reporting hunters were Alaskan residents. More than half of all resident hunters were from the Fairbanks area. Although most of the statistics mentioned pertain to the 1983-1984 regulatory year, the conclusions are applicable to most recent years.

F. Significance of Particular Use Areas

1. Dalton Highway (Haul Road). The northern section of the Dalton Highway (DH) north of Disaster Creek is restricted to commercial traffic. Removal of the traffic check station and

Table 1. Human Use of the Central Arctic Caribou Herd, 1980-84

Regulatory Year	Reported Harvest	Estimated Harvest	Reported Hunters	Success. Hunters
1980-81	65	115-165*	54	47
1981-82	95	195-210*	98	65
1982-83	81	---	78	55
1983-84	170	---	108	91

Source: Smith 1985; Whitten 1984; Whitten and Cameron 1982, 1983.

--- means no data were available.

* Author's minimum estimate.

minimal enforcement of the restriction to commercial traffic only have led to an increase in the number of hunters gaining access to the herd via the DH. In the 1983-1984 hunting season, approximately two-thirds of all hunters used the DH as an access point. In the past, access to the Central Arctic Herd usually was split between road and airplane. Discharge of firearms is not allowed within 8 km (5 mi) of the DH. Because most females and calves generally avoid the road because of its close association with the riparian habitat zone, mostly bulls are found and taken in this area.

2. Canning River delta. Kaktovik residents reportedly take 25 to 50 caribou from this area during July (Whitten and Cameron 1983).
3. Sadlerochit Mountains. Although the hunting occurs during closed season, Kaktovik residents reportedly take caribou from this area during May (ibid.).

III. WESTERN ARCTIC HERD (GMUS 22A, 22B, 23, 24, 26A)

A. Boundaries

See the current Alaska Game Management Unit map, which provides a geographical description and delineates the boundaries of the areas listed in Alaska's hunting regulations.

B. Management Objectives

The Western Arctic Herd is currently managed according to objectives set forth in the Western Arctic Caribou Herd Strategic Management Plan (ADF&G 1984a):

The objectives of this plan are: 1) to protect and maintain the Western Arctic Caribou Herd (WAH) and other components of the natural ecosystem upon which caribou depend; 2) to provide opportunity for subsistence and recreational hunting on a sustained yield basis; 3) to provide opportunity for viewing and scientific study of caribou; and 4) to perpetuate associated wild carnivore populations.

C. Management Considerations

As discussed in the Western Arctic Caribou Herd Strategic Management Plan (ibid.), management considerations are as follows:

1. Maintain a postcalving population of at least 200,000 caribou. The highest priority in WAH management is to prevent the herd from declining to low numbers. When survey data and other biological evidence indicate a substantial reduction in the population, the harvest should be reduced to help reverse the decline and regain a postcalving herd of at least 200,000 animals. Reduction of the harvest should not be undertaken until a census reveals fewer than 170,000 animals or unless indices such as recruitment rates, estimates of natural mortality, and harvests clearly indicate a downward trend. Harvests will be allocated on the basis of the state subsistence priority law; the primary role of the Division of Game will be to report to the board what harvest levels are consistent with the sustained yield management of the herd. Department predator control programs may also be considered, where no conflict with federal policy exists. No such programs are now under consideration.

   The WAH may increase beyond 200,000 animals during particularly favorable periods when the number of young caribou recruited into the herd considerably exceeds losses due to hunting and natural causes. During such periods, seasons and bag limits will be liberalized if restrictive regulations are in effect. Additional uses of caribou (e.g., for animal food, bait, or for commercial purchase and sale) will be discouraged.

   If the herd grows beyond 200,000, the probability of conflict with reindeer husbandry and other land uses will increase. Changes in herd distribution resulting from high densities may reduce the availability of caribou to some villages and increase the availability of caribou to others. However, because no evidence indicates that mainland caribou are ever limited by food shortages, preventing herd growth beyond 200,000 caribou should be a low priority.

2. Minimize conflict between caribou management goals and the reindeer industry. The reindeer industry has always been troubled by the loss of deer to migratory caribou. The decline of reindeer herds in the 1930's and 1940's was caused by a combination of factors, including reindeer joining moving caribou herds. Caribou have been largely absent from the Seward Peninsula during the

twentieth century. However, during its recent growth phase, the WAH has occupied the eastern peninsula in increasing numbers and has expanded westward. In the winters of 1981-1982 and 1982-1983, 5,000 to 10,000 caribou inhabited the area south of Candle. In the winter of 1983-1984, as many as 20,000 caribou inhabited the eastern Seward Peninsula from the Koyuk River to Candle and as far west as the Unit 22(D) boundary. This has caused increasing concern among reindeer herd owners. Because reindeer and caribou have identical habitat requirements, the occupation of reindeer ranges by caribou, together with the tendency of reindeer to join moving caribou bands, will probably lead to increasing conflict. The WAH is the most important terrestrial wildlife resource in northwestern Alaska, and any major threat to the security of the herd will compromise the objectives of this plan. For these reasons, the department will

a) recommend against issuing additional reindeer permits on ranges currently occupied by caribou or with a high probability of being occupied by caribou in the future (specifically, the area east of the West Fork of the Buckland River and east of the East Fork of the Koyuk River);
b) conduct periodic reconnaissance flights on the Seward Peninsula during winter to determine the proximity of caribou to reindeer herds and to inform herd owners of impending conflict;
c) generally discourage expansion of reindeer herds already occurring on caribou range until suitable methods are developed to reduce interaction between caribou and reindeer;
d) not oppose expansion of the reindeer industry when it minimally impacts caribou or other wildlife resources;
e) continue to gather basic biological information on caribou and reindeer habitat requirements to achieve the objectives of this plan and to apply this information when compromise and mitigation are necessary; and
f) develop an issue paper to more specifically address problems arising from reindeer/wildlife interactions.

3. <u>Monitor the size and composition of the population, and use this information to predict population trends.</u> The decline of the WAH in the early 1970's was partially due to inadequate population monitoring. In the future, the highest survey-inventory priority will be conducting a biennial photocensus to determine the size of the herd. Composition counts during spring and fall will be made

periodically to determine the sex and age structure of the herd. Calving-ground surveys will be conducted annually to identify any unusual circumstances attendant to calving. Data will be incorporated into a basic simulation model designed to predict population changes. This information will provide an additional tool for evaluating and recommending harvest quotas and predation levels consistent with these management objectives.

4. Develop an information and education program to improve harvest reporting and public understanding of management goals. Major tasks facing the department are to improve local understanding of WAH dynamics, the regulatory process, and harvest reporting. The reported harvest from the WAH has always been a small fraction of the actual harvest, and the failure of rural residents to report their take is in part due to a lack of understanding of hunting regulations and the reasons for the reporting requirement. An ongoing public information program using both the media and personal communication should be undertaken in northwestern Alaska, with the general goal of increasing public awareness of the value of and need to conserve caribou, and with the specific goal of increasing the accuracy of WAH harvest estimates. The department will continue to evaluate harvest-reporting systems in an effort to simplify and streamline reporting requirements. Several different methods of assessing harvest levels, such as statistical surveys and voluntary reporting, will be considered and discussed with user groups.

   Wasteful hunting practices were evident during the decline of the WAH in the mid 1970's and have been less apparent since 1977. However, wasteful practices are still occasionally observed, and efforts should be continued to inform people about the necessity of wisely using this valuable resource. The success of these efforts will, to a large extent, depend upon the department's ability to develop and improve communications with rural residents and leaders in northern and western Alaska.

5. Encourage public involvement in the regulatory process and in the formulation of management guidelines. The department will continue to encourage local advisory committees and the regional councils to participate directly in the formulation and review of regulatory proposals, the development of harvest-reporting systems, the formulation of general management goals, and future revisions of this plan. In addition, the department should involve the public directly through village meetings and individual contacts with community representatives. In this context, efforts will be made

to improve public understanding of the goals of this management plan. It is particularly important to develop a liaison with the public during this period of caribou abundance so that user groups, the department, and the Board of Game can effectively work together to initiate corrective action during periods of caribou decline. Dialog between the department and user groups should focus on the problem of allocation to assist the board in developing a general strategy for restricting harvests in times of shortage, with minimal disruption of traditional use patterns.

6. Advocate measures to minimize the impacts of industrial development on caribou habitat and movement patterns.

Habitat loss and alteration due to industrial development and other land uses are major concerns with respect to conservation of the WAH. Northwestern Alaska is entering a period of unprecedented industrial growth. The highly migratory WAH may be particularly vulnerable to loss of migration routes and key calving and wintering areas through oil and mineral development. Associated with such developments are transportation corridors that may present barriers to migrating caribou and create increased hunter access to the herd. These corridors and the access they create may present a greater threat to the well-being of the WAH than do the development sites themselves. The department will work with landowners and managers to advocate low-impact alternatives to exploration and development, when such alternatives can be identified.

The department will participate in and encourage other agencies to undertake habitat assessment programs designed to identify key caribou use areas and to quantify habitat availability and quality. It will continue to explore new technologies in habitat inventory and habitat selection research. The department will continue to use radiotelemetry to document movement patterns and to identify areas heavily used by caribou.

D. Period of Use

The following description of harvest seasons, bag limits, and means used to monitor human use of the WAH is from the WAH Strategic Management Plan (ADF&G 1984a):

From 1952 to 1959, seasons and bag limits were established by territorial regulations. Seasons ranged from August 20 to December 31 in most years, with no closed season in 1957. Bag limits were 3-5 caribou of either sex in some years, with no limit in 1956-1957.

Under state management there were no closed season and no bag limits from 1959 to 1975. In 1975, the upper drainage of the Anaktuvuk River was closed to caribou hunting from August 10 to September 15 at the request of Anaktuvuk Pass residents. No closed seasons or bag limits were imposed on the remainder of the WAH range. In spring 1976, the Board of Game set the 1976-1977 season at July 15 through December 20 and January 6 through May 31 (except for the Anaktuvuk Pass area, which opened September 16). The bag limit was 15 caribou, with a daily limit of 5, and no more than 2 could be transported south of the Yukon River.

The season was closed by emergency order on August 13, 1976. At an emergency meeting held in Fairbanks on September 20 of the year, the Board set the season for Units 23, 24, 26A, and 26B at September 25 through March 31. Caribou were to be taken by permit and a quota of 3,000 bulls was established. Permits were allocated to 16 villages in the western Arctic, and were issued, in part, on the basis of need. At the same meeting, the Board adopted a resolution establishing a management goal of 100,000 breeding-age caribou and bull:cow ratio of 30:100. On April 6, 1977, the Alaska Superior Court overturned the Board's regulation of the previous September. (On September 8, 1978, the Alaska Superior Court overturned the lower court's injunction.)

At its spring 1977 meeting, the Board closed the range of the WAH to caribou hunting. On August 18, 1977, the Board adopted an emergency regulation, setting the season at September 1 through October 5 and March 15 through April 15, with a one-bull limit by permit. This time permits were available in the villages to anyone desiring to hunt caribou. The season was to be closed by emergency order if the harvest exceeded 3,000 bulls. Because the reported harvest did not exceed the quota, the season was not closed.

In spring 1978, the Board set the 1978-1979 season at August 10 through October 15 and February 15 through April 15, with a 2-bull bag limit. One bull could be taken in the fall, or both in the spring if a hunter took none in the fall. Permits were available through local license vendors and at interior or arctic department offices. The season was to be closed by emergency order if the harvest exceeded 5,000 bulls. Because the reported harvest did not exceed the quota, the season remained open until April 15.

In 1979-1980, the seasons and permit system of the previous year were retained, as was the 5,000 bull quota. However, the bag limit was increased to 3 bulls, with no more than 1 to be taken during the fall hunt.

In 1980-1981, the season remained essentially the same. However, a harvest ticket replaced the permit, no harvest ticket was required in Unit 26A, and the quota was eliminated. The bag limit remained at 3 bulls.

The 1981-1982 season was set at July 1 through April 15. The bag limit was increased to 4 caribou, females to be taken only from September 15 to April 15. The harvest ticket was retained and no more than 2 caribou were to be transported from the units involved. On May 6, 1982, the department issued an emergency order to open the season in Unit 23 from May 6 to May 15 at the request of local residents. Because the northward migration was delayed in 1982, this provided residents of the Kobuk River with an opportunity to legally harvest some animals not normally available after the close of the regular season.

At its spring 1982 meeting, the Board adopted a regulation setting the season at July 1 through April 30, and providing for the harvest of 5 either-sex caribou on a harvest report, and for additional caribou by registration permit in increments of 5, i.e., an unlimited bag.

The 1983-1984 caribou season length and bag limit remained the same. In 1984, the Board of Game maintained the same season length (July 1 though April 30) but eliminated the registration permit and allowed the taking of five caribou per day on an arctic caribou harvest report card, with mandatory registration and voluntary reporting. These regulations were not altered for the 1985-1986 regulatory year, except that same-day-airborne hunting was prohibited over the entire WAH range (Anderson, pers.comm).

E. Human Use Data

WAH management efforts have been chronically plagued by the absence of reliable harvest data. The acquisition of better harvest information is a high management priority, and the accuracy of the harvest estimates presented below is inadequate for rational management.

A number of independent estimates based on the reported kill in villages, hunter interviews, and personal observations are available for the period 1953-1972. The estimates range from 15,000 in 1953 to 29,000 in 1965 and average 24,000. These estimates are probably conservative and do not account for wounding loss and waste.

Estimates for 1976-1984 (table 2) are taken from Game Division data files and range from 1,687 in 1976-1977 to more than 25,000 in the early 1970's. In 1975-1976, the department undertook an intensive effort to quantify the harvest and hired village data collectors in Anaktuvuk Pass, Point Hope, Kivalina, Noatak, Selawik, Noorvik, Kiana, Shungnak, and Ambler. Game Division staff obtained estimates from Wainwright, Point Lay, Barrow, Nuigsut, Meade River, Bettles, Kobuk, Allakaket-Alatna, Hughes, and Huslia by direct observation and interviews and discussions with local village councils. This system functioned reasonably well until January, at which time local cooperation was impaired by widespread concern over impending emergency harvest reductions. For the remainder of the year, only rough estimates provided by

Table 2. Reported and Estimated Harvest of WAH Caribou, 1976 through 1985

Regulatory Year	Reported Harvest	Estimated Harvest
1976-77	1,100	1,687
1977-78	672	---
1978-79	1,166	3,635
1979-80	852*	3,000
1980-81	458	3,000
1981-82	906	3,000
1982-83	1,509	---
1983-84	1,249	5,000-12,000
1984-85	2,513	7,000-10,000

Sources: ADF&G 1984a; Johnson 1981; Johnson and James 1982; Anderson and James 1983, 1984; Anderson 1985; Anderson, pers. comm.

--- means no data were available.

* Bulls-only season.

department staff were available. Efforts through January revealed a harvest of about 15,000 animals; efforts for the remainder of the year increased the total to 21,900. This value does not include crippling loss from January through May or any summer harvest.

The harvest apparently declined greatly in 1976-1977 when the bull quota and permit system were established. Compliance with the reporting requirement has been very poor in recent years and certainly does not reflect the actual harvest. It is unclear whether the increased reporting rate from 1980-1981 to 1982-1983 is the result of better compliance, increased hunting efforts, growth of the WAH, or a combination of these. However, casual observations made by department personnel suggest that the harvest is increasing. The low rate of registration permit issuance and return in 1982-1983 suggested that the current harvest report/registration permit system should be simplified (ADF&G 1984a).

Since adoption of the WAH Strategic Management Plan, better harvest information has been obtained as a result of the implementation of the simplified caribou harvest recording system. As of mid July, 1985, 83% of all registrants had returned harvest report cards, as opposed to a 35% return rate under the previous harvest ticket registration system (Anderson, pers. comm.).

Based on the 1983-1984 reported harvest data, WAH hunters harvested 1,249 animals, of which 84% were males. Most reported hunting activity occurs in late August, September, and early October during the fall migration period of the WAH. However, a substantial amount of unreported hunting does occur in late fall and winter (James, pers. comm.). More than two-thirds of all reporting hunters used either aircraft or boats for their caribou hunts. Only a minor portion of the reported harvest of WAH caribou can be attributed to residents living outside the herd's range. More than 90% of all the hunters were Alaskan residents. Of the 507 hunters reporting in 1983-1984, 437 (86%) were successful; of the successful hunters, 81% were Alaskan residents. Most hunters came from Kotzebue, Fairbanks, Kiana, Anchorage, Nome, Noatak, Noorvik, Selawik, Ambler, and Shungnak. Of the successful hunters, 26% killed one caribou, 17% killed two, 12% killed three, 5% killed four, and 26% killed five animals.

F. Significant Use Areas

Table 3 describes locations of almost 84% of the total reported harvest of WAH caribou for the 1983-1984 regulatory year.

IV. PORCUPINE HERD (GMUS 25 AND 26C)

A. Boundaries

See the current Alaska Game Management Unit map, which provides a geographical description and delineates the boundaries of the areas listed in Alaska's hunting regulations.

B. Management Objectives

The primary management goal of the Porcupine Caribou Management Plan is to provide for an optimum harvest of caribou (ADF&G 1977). This goal attempts to accommodate the domestic needs of local, rural residents as well as recreational hunters primarily interested in meat. This management goal also allows managers to deal with situations involving the maintenance of the Porcupine caribou population at specified levels. The aesthetic value of the hunting experience and the availability of trophy animals may be compromised to accomplish this goal.

The secondary management goal is to provide the greatest opportunity to participate in hunting caribou.

C. Management Considerations

The same management considerations mentioned for the Western Arctic Herd and the Central Arctic Herd apply to the Porcupine Herd as well.

D. Period of Use

In response to the decline of the WAH, hunting regulations for the Porcupine Herd were changed in September 1976. The hunting season, previously open year round, was restricted then to

Table 3. Important Locations of Reported Human Use of the Western Arctic Caribou Herd, 1983-84

Location	Total Hunters	Total Days Hunted	Number Success. Hunters	Reported Harvest
Koyuk River	12	18*	8	22
Noatak River unknown	30	136*	25	51
Noatak River (below Kelly River	39	248	27	83
Kobuk River (Kiana-Ambler)	46	201*	44	158
Kobuk River (Ambler-Kobuk)	47	239	39	119
Kobuk River Delta	22	129*	21	67
Kobuk River unknown	14	41*	13	32
Buckland River	10	50	10	29
Lower Selawik River	28	67*	28	98
Hunt River	15	64	14	61
Agashashok River	11	74*	10	26
Kelly River	11	77	10	29
Meade River	12	42*	9	29
Anaktuvuk River	19	100*	18	50
Colville River (Killik-Anaktuvuk)	10	41*	5	11
Etivluk River	12	54	11	14

Source: ADF&G 1984b.

* Does not include total days hunted because some hunters did not report this figure.

August 1 through March 31 in GMU 25 and July 1 though March 21 in GMU 26C. Previously, the take had been unlimited but was restricted in 1976 to 10 caribou per season, as many as five per day, with no more than two transportable from these GMUs. The 1978-1979 season was shortened slightly for both management units and ran from July 1 through March 1, with the same bag limits. The season was extended to March 31 in the 1979-1980 regulatory year and to April 30 in the 1983-1984 regulatory year. In 1984, the bag limit was increased to 10 caribou, five of which could be transported from these units per regulatory year.

The time period of use is naturally influenced by the availability of Porcupine Herd caribou to villages within the range of the herd. The majority of Porcupine Herd caribou harvested in Alaska are taken by residents of Arctic Village, Venetie, and Kaktovik (Whitten 1985). The Kaktovik harvest generally occurs during the summer, and the Arctic Village-Venetie harvest generally takes place during fall and winter.

E. Human Use Data

Table 4 describes reported and estimated human use of the Porcupine Herd from 1976 to 1984. The relatively low reported harvest in 1976-1977 probably occurred because fewer Porcupine Herd caribou were in Alaska than any year since 1970 (Davis 1978). Alaskan harvest estimates have been based mainly on the following factors:

- Division of Subsistence recording of the harvest in Kaktovik
- Rough estimates of the harvest in Arctic Village by Division of Subsistence personnel
- Data collected by USFWS biologists
- Actual reported harvest data (i.e., success rate, number of hunters, etc.)
- Contacts with enforcement personnel, local residents
- Annual availability of caribou to village residents
- Personal observations by ADF&G biologists

Table 4. Reported and Estimated Human Use of the Porcupine Herd, 1976-84

Regulatory Year	Reported Harvest	Sport Hunt*	Estimated Alaska Harvest	No. Reported Alaska Hunters	Estimated Canada Harvest
1976-77	15	---	200-500	59	1,500-3,000
1977-78	76	---	450-550	92	1,519-1,619
1978-79	48*	48	375-690	63	300-500
1979-80	---	---	---	---	---
1980-81	110	78+	875-1,200	49	700
1981-82	141	---	1,680	123	3,300-5,600
1982-83	93	65	600-1,000	101	2,400
1983-84	81	---	---	83	---

Sources: LeBlond 1979; Davis 1978; Whitten 1982, 1984, 1985; Whitten and Cameron 1983; Reynolds 1978.

--- means no data were available.

* Represents reported harvest of "out-of-unit" hunters only.

Local residents harvest most caribou with snowmachines and boats, whereas most nonlocal hunters are dependent on aircraft, and, occasionally, when caribou are available along major rivers, boats may be used.

Martell and Russell (1983) calculated an average annual harvest of 3,352 caribou from 1972 to 1977. Basing their calculation on available census data, composition counts, and these harvest figures, they estimated the total mortality rate from 1972 to 1977 to be 7%, a hunting mortality rate of 3% and, thus, a natural mortality rate of 4%.

Any discussion referring to harvest data is fruitless because of the high incidence of unreported harvest.

F. Significance of Particular Use Areas

Some of the more important areas, based on the reported harvest by Porcupine Herd hunters, can be found in table 5.

Table 5. Reported Harvest Data for Significant Areas of the Porcupine Caribou Herd, 1983

Specific Area	Total No. Hunters	Success. Hunters	Harvest	Total Days Hunted
Skeenjek River drainage in GMU 25A	15	11	14	118
East fork of the Chandalar River	5	4	4	26
Junjik River drainage	5	2	2	24
Upper Koness River	5	3	5	18
Coleen River	9	5	14	63

Source: ADF&G 1984b.

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Dall Sheep Human Use

I. POPULATION MANAGEMENT HISTORY

A. Introduction

In Arctic Alaska, Dall sheep inhabit mountainous terrain in the Brooks Range, which includes Game Management Units (GMUs) 23, 24, 25A, and 26A, B, and C. GMU 24 and 25A are within the Interior Region; however, all sheep habitat within those units occurs in the Brooks Range. The ADF&G has attempted to present data and manage Dall sheep populations on the basis of the mountain range they inhabit. Therefore, for ease of discussion and data presentation, human use information presented here will include GMUs 23, 24, 25A, and 26A, B, and C.

Information on harvests by subunit or smaller area prior to 1983 is not consistently available; human use information will therefore be presented primarily on a GMU basis (map 1), and subunit information will be presented where available.

B. Regional Summary of Hunting

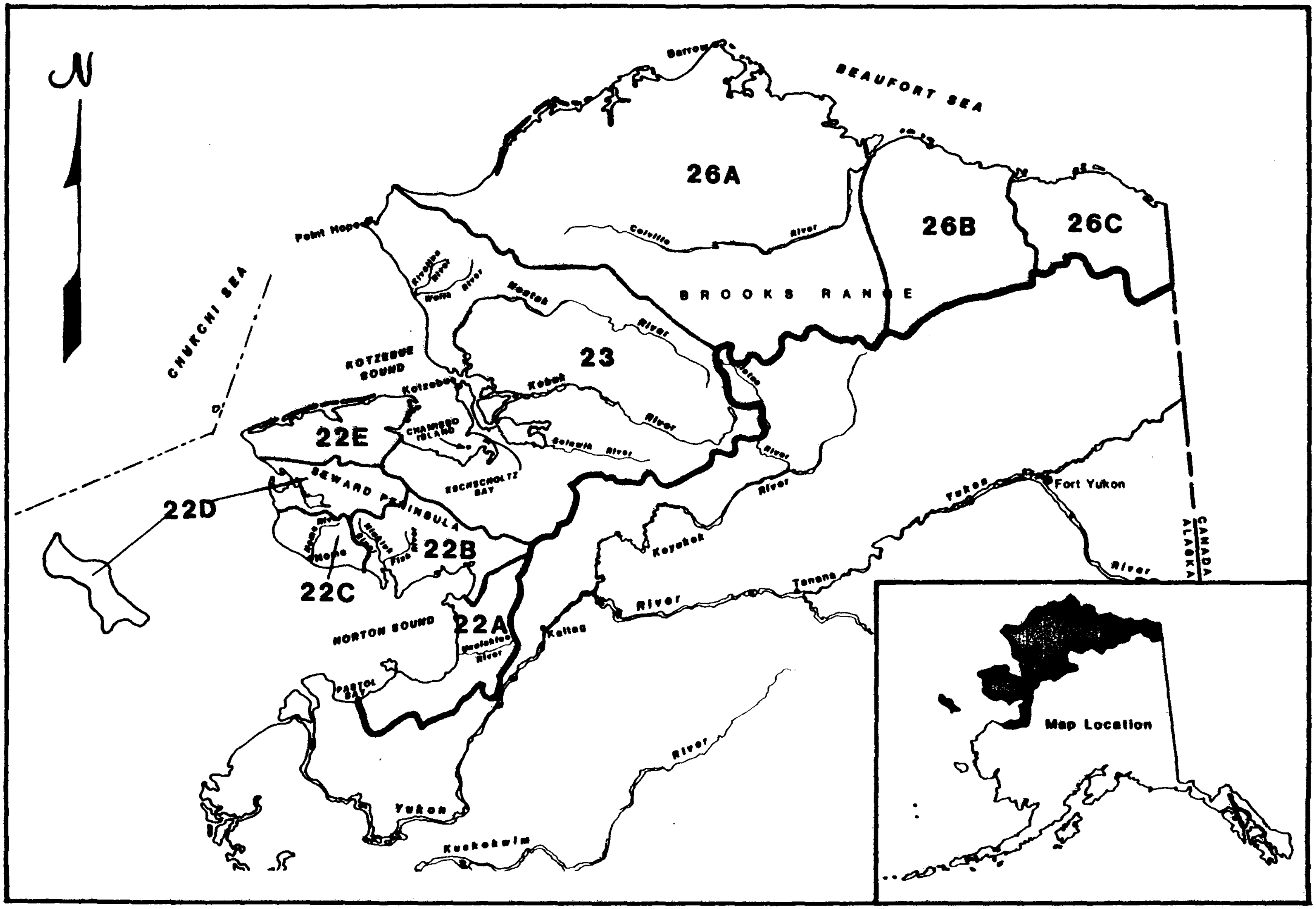
The Arctic Region provides excellent remote Dall sheep hunting opportunities. Access to sheep hunting areas in the Arctic is primarily by light aircraft, although late season subsistence hunters utilize snowmachines. The fall hunting season is sometimes limited by inclement weather conditions.

About 1,100 sheep are reported harvested annually in Alaska (Heimer 1984a). The Arctic Region contributes about 200 sheep annually to the statewide harvest, of which about 60% is taken by guided nonresident hunters (ibid.).

The harvest in the Arctic Region has ranged from 101 in 1980 to 269 in 1984, with effort (expressed in hunter-days) ranging from 1,086 in 1980 to 2,603 in 1984 (ADF&G 1980-1984).

C. Managerial Authority

Dall sheep in Alaska have been managed by the ADF&G as a big game animal since 1960. Most state or federal lands not designated as parks or closed areas have open hunting seasons, with harvest regulations established by the Alaska Board of Game. Some areas that receive especially heavy use or areas with specific management goals have been restricted to permit hunts. Other areas have been designated for specific harvest levels or time periods, consistent with specific management objectives. For specific information on open areas, seasons, and permit restrictions, see the most recent Alaska game regulations. In 1980, large areas of Alaska were placed in new or expanded national parks, park/preserves, or wildlife refuges. Specific lands within the Arctic Region included in these designations are the Noatak National Preserve, Kobuk Valley National Park, Gates of the Arctic National Park/Preserve, Arctic National Wildlife Refuge, and Cape Krusenstern National Monument. Management of game resources on



Map 1. Game management units in the Arctic Region.

national park lands is subject to congressional mandate and the National Park Service's (NPS) policy. Some national park lands are closed to hunting completely, and others remain open for subsistence hunting by local residents. National park/preserve lands are currently managed to allow consumptive use of game resources under regulations established by the Alaska Board of Game. Aircraft access and other human use activities are currently allowed on national park/preserve lands.

II. GMU 23

A. Boundaries

GMU 23 encompasses the drainage area of all streams flowing into the Arctic Ocean and Kotzebue Sound, from Cape Lisburne on the north to, and including, the Goodhope River on the south. This area includes the mountainous regions of the western extreme of the Brooks Range and the major drainages of the Noatak and Kobuk rivers. (See the most recent edition of the Alaska game regulations or the latest GMU map for the exact legal boundary description.)

B. Management Objectives

The ADF&G has developed two management plans for Dall sheep in the western Brooks Range: the Western Brooks Range Sheep Management Plan for the majority of GMU 23 and the Southern Brooks Range Sheep Management Plan, which pertains to that portion of GMU 23 including the drainages of the Noatak River above its confluence with Mayumerak Creek (ADF&G, 1977).

The Western Brooks Range Sheep Management Plan has a primary objective to provide the greatest sustained opportunity to participate in hunting sheep (Bos 1980).

The Southern Brooks Range Sheep Management Plan has a primary objective to provide the greatest sustained opportunity to hunt sheep under aesthetically pleasing conditions. A secondary objective is to provide an opportunity to be selective in hunting sheep (ibid.).

C. Management Considerations

Beginning in 1982, residents of GMU 23 permanently residing north and west of the Noatak River were allowed to participate in a special registration sheep hunting season. (See the most recent Alaska game regulations for hunting seasons and restrictions.)

The GMU 23 sheep population to which both the general and subsistence hunts apply consists of approximately 1,700 sheep (Heimer 1984b). That population is currently capable of sustaining existing harvest levels. The 40-sheep subsistence quota could be excessive, however, especially if the harvest is directed at a small, locally accessible sheep population such as in the Wulik Peaks-Kivalina area (Quimby 1984).

As demands on sheep in GMU 23 increase because of the subsistence and general harvest, unregulated use could become increasingly detrimental to the sheep population. Enforcement of existing regulations will be necessary to avoid excessive use of sheep.

The recent development of mineral deposits at the Red Dog mine site and the proposed development of the Ambler/Bornite mining district could dramatically impact sheep populations in the area. These impacts would result from increased mineral mining and processing activities and facilities and the development and use of transportation corridors in or near sheep habitat. Increased access to previously inaccessible areas and wildlife populations via new transportation corridors could result in localized overuse of animal populations.

D. Period of Use

The general hunting season since 1960 has been from 10 August through 20 September. Dall rams with 7/8 curl or larger horns have been legal since 1979. Prior to that, 3/4 curl or larger horns were legal. Beginning in 1982, a special subsistence sheep hunt was provided for by the Alaska Board of Game for residents living north and west of the Noatak River. This season is open from 1 August through 30 April, with a bag limit of one sheep and a total harvest of 40 sheep. (See the latest Alaska game regulations for current seasons and restrictions.)

E. Human Use Data

Beginning in 1962, hunters were required to return harvest reports specifying the GMU they hunted; in 1967, they were required to report the specific area within the GMU they hunted. Compliance with these regulations is notoriously low in many areas of the state, including GMU 23. ADF&G personnel are initiating a vigorous education and information program in this region in an attempt to increase compliance with harvest reporting.

Additional problems with harvest reporting have resulted from confusion and resistance to land status changes in the area. In 1980, for example, the majority of the Noatak drainage was under federal monument status, in which only subsistence hunting by local hunters was allowed. It is doubtful that all nonsubsistence hunters moved out of familiar hunting areas in the western portion of the Noatak drainage, even though they were in violation of monument regulations. It is assumed that some sheep taken in the monument were reported as being harvested outside of the monument (Johnson 1982).

With some land status changes completed and with the general acceptance by user groups of land ownership and accompanying restrictions, the problems of accurate reporting should lessen.

Table 1 presents Dall sheep harvest data for GMU 23 from 1980 through 1984. Data are presented by year and indicate the total reported harvest, number of hunters, and number of hunter-days.

The largest reported general harvest occurred in 1982 and 1983, with 21 animals taken each year. The largest effort, however, occurred in 1983, with 37 hunters spending 218 hunter-days in the field. Effort remained high in 1984, with 45 hunters spending 213 days in the field. The sustained high effort reflects the growing importance of this area to hunters not only from Alaska but from outside Alaska as well.

Hunter success has ranged from 40% in 1981 to 64% in 1982, with an average of 52% from 1980 through 1984.

Access to sheep hunting areas in GMU 23 is almost exclusively by light aircraft. In 1983, for example, all hunters except one gained access to sheep hunting via aircraft. Local residents utilize the major drainages of the Kobuk and Noatak rivers as access corridors during all seasons of the year. Sheep are occasionally harvested by boat hunters traveling the Noatak River searching for other game - moose and caribou, e.g. (James, pers. comm.).

Table 1. Reported Dall Sheep Harvest Information in GMU 23, 1980-1984

Year	GMU	Harvest	No. of Hunters	No. of Hunter-Days
1980	23	16	29	29
1981	23	13	32	180
1982	23	21	33	113
1983	23	21	37	218
1984	23	19	45	213

Source: ADF&G 1980-84.

F. Significance of Particular Use Areas

Beginning in 1983, the ADF&G introduced a new system for coding the hunter's harvest, the Uniform Coding System (UCS), designed to identify specific areas where harvest occurs. The system is hierarchical and identifies blocks of land in a progressively smaller subdrainage format. Hunters record the specific hunting locations on their harvest report, which is changed into a 12-character identifying code and entered into the computer. Information from the computer can be compared to permanent 1:250,000-scale maps identifying each UCS minor tributary.

Data presented in table 2 indicate that six areas in GMU 23 received most of the hunting pressure. One area in particular, (36) the Kugururok River drainage, however, sustained the majority of hunter use during 1983 (ADF&G 1980-1984).

Table 2. Reported Dall Sheep Harvest and Permit Harvest and Hunter Data in GMU 23, 1983-84

Unit	Subunit	Minor Trib	No. of Hunter-Days	No. of Hunters	Harvest
23	Z	36	57*	6	4
23	Z	34	30*	5	1
23	Z	31	26*	4	1
23	Z	32	26*	5	4
23	Z	35	23*	4	2
23	Z	38	23*	4	3
23	Z	33	12	3	2
23	Z	50	11	2	0
23	Z	51	9	3	3
23	Z	13	9	9	21
Unit total			218	37	21

Source: ADF&G 1984.

* Areas of particular significance.

The Kugururok River drainage had 4 of 21 successful hunters and 6 of 37 total hunters who spent 57 of 218 total days in the field. This represents 19% of the total harvest, 16% of the hunters, and 26% of the total effort in GMU 23. (See the sheep human use maps in the 1:250,000-scale Reference Maps volume, available in ADF&G offices.)

III. GMU 26A

A. Boundaries

Game Management Subunit 26A covers the western north slope of the Brooks Range from the Colville River drainage to Cape Lisburne on the Arctic Coast. (See the latest Alaska game regulations and the GMU subunit map for the legal boundary description.)

B. Management Objectives

In 1980, a portion of the southwestern corner of GMU 26A was included within the Gates of the Arctic National Park and Preserve (GAAR). The NPS is mandated by federal law to manage game resources with GAAR, utilizing plans developed by the ADF&G unless those plans are incompatible with NPS policy. The management plan for GAAR is in preparation by the NPS, and final decisions regarding management policy will be determined at a future date.

The ADF&G has developed the North Slope Brooks Range Sheep Management Plan, which applies to all portions of GMU 26. The primary objective of this plan is to provide an opportunity to hunt sheep under aesthetically pleasing conditions. Management guidelines for the North Slope plan can be found in the Arctic Alaska Wildlife Management Plans (ADF&G 1977).

C. Management Considerations

Beginning in 1982, the Alaska Board of Game established that Alaska residents whose permanent residence is within Gates of the Arctic National Park and Preserve were allowed a special registration hunt to take sheep. In 1983, the Game Board complied with provisions of ANILCA and expanded subsistence hunting opportunities to all residents of the subsistence zone associated with GAAR. This zone, as defined by ANILCA, includes residents of Alatna, Allakaket, Ambler, Anaktuvuk, Bettles, Hughes, Kobuk, Nuiqsut, Shungnak, and Wiseman.

The limit for this hunt is three sheep of either sex, with a 50-sheep quota. The season is from 1 August to 30 April, with most of the harvest occurring in late winter. Airplanes are not allowed for transportation of hunters or meat.

Sheep population fluctuations could occur as a result of increased localized hunting from residents of Anaktuvuk. The late season hunt that allows hunters to take three sheep of either sex is considered a higher risk to sheep populations than the general early season harvest of mature rams (Heimer 1984). Areas of localized harvest during the late season should be identified, therefore, and populations in these areas surveyed annually (ibid.).

Access within the GAAR park is limited by NPS regulations. Interest in hunting sheep within the preserve portion of the GAAR has increased (Watson 1985). Access to these areas should be maintained for all user groups.

D. Period of Use

Since statehood, the general hunting season for 7/8 curl rams has been from 10 August through 20 September. As mentioned previously, in 1982 a special extended season for residents living within GAAR was provided for by the Alaska Board of Game. This season runs from 1 August through 30 April.

E. Human Use Data

Human use information reported here is obtained from ADF&G statistical reports derived from returned hunter reports. Table 3 presents Dall sheep harvest information for GMU 26A from 1980 through 1984. Data are presented by year and indicate total harvest, number of hunters, and number of hunter-days. Harvest information for 1980 is not available by subunit. Harvest figures for the entire GMU 26 for 1980 are as follows: harvest, 54; total hunters, 102; number of hunter-days, 615.

As can be seen in table 3, harvest in GMU 26A has remained relatively similar during 1980-1984; however, the effort in hunter-days doubled between 1981 and 1983 and increased again for 1984. The reason for this increased use is not clear at this time.

Table 3. Reported Dall Sheep Harvest Information in GMU 26A, 1981-84

Year	GMU	Harvest	No. of Hunters	No. of Hunter-Days
1981	26A	11	20	---
1982	26A	9	12	48
1983	26A	9	17	108
1984	26A	15	23	149

Source: ADF&G 1981-84.

--- means no data were available.

F. Significance of Particular Use Areas

See section II.F. for a brief discussion of the Uniform Coding System (UCS).

Table 4 presents the 1983-1984 sheep harvest information from GMU 26A. The Anaktuvuk River drainage (07) received the most use although no harvest was reported from that area. The Killik River drainage (10) had the largest reported harvest. (See the sheep human use maps in the 1:250,000-scale Reference Maps volume, available in ADF&G offices.)

Table 4. Reported Dall Sheep Harvest and Permit Harvest and Hunter Data in GMU 26A, 1983-84

Unit	Subunit	Minor	No. Days	No. Hunt	No. Succ.
26	A	07*	51	6	0
26	A	10*	20	5	4
26	A	08	17	3	2
26	A	02	13	2	2
26	A	01	7	1	1
Unit total			108	17	9

Source: ADF&G 1984.

* Areas of particular significane.

IV. GMU 26B

A. Boundaries

GMU 26B is that portion of the north slope of the Brooks Range east of the Colville River watershed and west of the Canning River watershed. (See the latest Alaska game regulations or the latest GMU map for the legal boundary description.)

B. Management Objectives

The ADF&G has developed two management plans that apply to sheep populations within GMU 26B: the North Slope Brooks Range Sheep Management Plan and the Atigun Sheep Management Plan.

The North Slope Brooks Range Plan applies to the entire north slope of the Brooks Range as well as to GMU 26B, its primary objective being to provide an opportunity to hunt sheep under aesthetically pleasing conditions. The Atigun Sheep Management Plan has as its primary objective to provide opportunities to view, photograph, and enjoy sheep (ADF&G 1977). Management guidelines for these plans are available in the Arctic Alaska Wildlife Management Plans (ibid.).

The extreme southwest corner of GMU 26B is located within the preserve portion of the GAAR. A management plan for this park/preserve is in preparation and will provide guidelines for use and management of populations in this area.

C. Management Considerations

The Atigun Canyon area contains important sheep winter range, lambing areas, and mineral licks. The service road for the Trans-Alaska Pipeline now traverses the length of the Atigun River, except for Atigun Canyon, and allows access by highway vehicle to the upstream end of Atigun Canyon. In addition, a permanent airstrip now exists near the north end of Galbraith Lake. Increased human activities in the Atigun Canyon area can be expected due to these facilities (ADF&G 1977). Disturbance of sheep on lambing grounds and mineral licks, interference with traditional sheep seasonal movements, and habitat destruction could result from this increased activity (ibid.). Cooperative action with the appropriate land management agency would enhance nonconsumptive use opportunities of this accessible sheep population.

D. Period of Use

The general hunting season since 1960 has been from 10 August through 20 September. Dall sheep rams with 7/8 curl or larger horns have been legal since 1979. Prior to that, 3/4 curl or larger horns were legal. (See the latest Alaska game regulations for current seasons and restrictions.) The extended subsistence hunt for residents who live within the subsistence zone of the GAAR boundaries also applies to portions of GMU 26B. Hunting is allowed from 1 August through 30 April, with a limit of three sheep by registration permit and a total harvest of 50 sheep. For further information on hunting eligibility on park lands, contact the NPS.

E. Human Use Data

Human use information reported here is obtained from ADF&G statistical reports derived from returned hunter reports. Table 5 presents Dall sheep harvest information for GMU 26B from 1980 through 1984. Data are presented by year, total harvest, number of hunters, and number of hunter-days.

Sheep harvest in GMU 26B has ranged from 29 in 1983 to 47 in 1982. The largest number of hunters also occurred in 1982, with 73 hunters spending 420 hunter days in the field. The low harvest of 29 sheep in 1983 may be attributable to poor weather conditions during the hunting season.

Table 5. Reported Dall Sheep Harvest Information in GMU26B, 1981-84

Year	GMU	Harvest	No. of Hunters	No. of Hunter-Days
1981	26B	31	60	---
1982	26B	47	73	420
1983	26B	29	57	356
1984	26B	42	63	430

Source: ADF&G 1981-84.

--- means no data were available.

F. Significance of Particular Use Areas

See section II.F. for a brief discussion of the Uniform Coding System (UCS).

Table 6 demonstrates that the majority of all general harvest and use occurred in one area within GMU 26B. Area 03, the Sagavanirktok River drainage, had 239 of 356 hunter-days (67%), 40 of 57 hunters (70%), and 20 of 29 harvested sheep (69%) (ADF&G 1984). This represents a heavy concentration of human use in one area and may result in the depletion of mature rams in local areas. (See the sheep human use maps in the 1:250,000-scale Reference Maps volume, available in ADF&G offices.)

Table 6. Reported Dall Sheep Harvest and Permit Harvest and Hunter Data in GMU 26B, 1983-84

Unit	Subunit	Minor	No. Days	No. Hunt	No. Succ.
26	B	03	239	40	20
26	B	01	87	12	9
26	B	00	15	3	
26	B	05	9	1	
26	B	04	6	1	
Unit total			356	57	29

Source: ADF&G, 1984.

* Area of particular significance.

V. GMU 26C

A. Boundaries

GMU 26C is that portion of the north slope of the Brooks Range lying east of the Canning River and extending to the Canadian border. (See the latest Alaska game regulations or the latest GMU map for the legal boundary description.)

B. Management Objectives

The ADF&G has developed the North Slope Brooks Range Sheep Management Plan, which applies to sheep populations within GMU 26C.

The North Slope Brooks Range Plan applies to the entire north slope of the Brooks Range as well as to 26C, its primary objective being to provide an opportunity to hunt sheep under aesthetically pleasing conditions (ADF&G 1977).

Almost all of GMU 26C is now located within the Arctic National Wildlife Range. A management plan for this range is scheduled for preparation and will provide guidelines for use and management of populations in the area.

C. Management Considerations

Local overharvest of sheep by residents of Kaktovik may prove to be a problem in the future. As yet, sheep populations appear to be able to withstand current harvest levels, however. Additional information is needed.

D. Period of Use

The general hunting season has been from 10 August through 20 September. Dall sheep rams with 7/8 curl or larger horns have been legal since 1979. A registration permit hunting season is allowed from 10 October through 30 April. The limit is three sheep, with a total allowed harvest of 50.

E. Human Use Data

Human use information reported here is obtained from ADF&G statistical reports derived from returned hunter reports. Table 7 presents Dall sheep general harvest information for GMU 26C from 1981 through 1984. Data on total harvest, number of hunters, and number of hunter-days are presented by year.

Table 7. Dall Sheep Harvest Information, GMU 26C, 1981-84

Year	Harvest	No. of Hunters	No. of Hunter-Days
1981	61	122	---
1982	46	70	---
1983	62	92	612
1984	85	116	614

Source: ADF&G 1980-84.

--- means no data were available.

The general sheep harvest in GMU 26C during this period changed from 46 in 1982 to 85 in 1984. The lowest number of hunters also accurred in 1982, with only 70 hunters reporting. The low hearvest and low effort during 1982 may be attributable to poor weather conditions.

Harvest data from the registration permit hunt is incomplete. Poor compliance with reporting requirements has prevented accurate data gathering. The limited information available indicates that approximately 30-40 sheep are killed each year, with ewes comprising about 70% of the harvest. No information is available on total number of hunters or effort (Heimer, pers. comm.).

F. Significance of Particular Use Areas

See section II.F. for a brief discussion of the Uniform Coding System (UCS).

Table 8 demonstrates that most of the general harvest and use occurred in three areas of GMU 26C: 04, the Hulahula River; 01, the Canning River east side; 08, the Kongakut River.

The Hulahula River had the greatest harvest (19), the largest number of hunters (29), and the most effort in hunter-days (192). The three areas together (Hulahula, Canning, and Kongakut) accounted for 48 of 62 rams harvested (77%), 71 of 92 successful hunters (77%), and 465 of 612 total days of effort (76%) (ADF&G 1984).

Table 8. Sheep Harvest and Hunter Data for GMU 26C, 1983-84

Unit	Sub-unit	Minor Trib.	No. of Hunter-Days	No. of Hunters	Harvest
26	C	04*	192	29	19
26	C	01*	164	28	18
26	C	08*	109	14	11
26	C	05	75	11	10
26	C	03	36	4	1
26	C	06	24	5	2
26	C	07	12	1	1
Unit total			612	92	62

Source: ADF&G 1984.

* Areas receiving most use by hunters.

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Moose Human Use

I. POPULATION MANAGEMENT HISTORY

A. Introduction

The following information will be presented by game management unit (GMU) (see map 1).

It is becoming increasingly important for wildlife managers to accurately assess the number and location of moose being harvested. Managers rely heavily upon harvest and permit ticket reports for this information. The increasing number of hunters afield necessitates more accurate and detailed information, such as the means of transport used and the number of days hunted in specific areas. Such specifics are useful to both managers and economists, but the greater detail included may, however, lead to misinterpretation or to reports containing outlandish data. In table 1, e.g., Game Management Subunit 22A, Minor Tributary Unit 04, two hunters reported hunting 102 days, and one of these hunters reported hunting unsuccessfully for 99 days. When applied to large geographic areas, odd or erroneous data are somewhat buffered and may not significantly affect the data summaries. When applied to smaller geographic areas, however, unusual information can drastically influence data summaries. The information presented in the Significance of Particular Use Areas section of this report can be very useful; however, it should be interpreted cautiously.

II. GMU 22

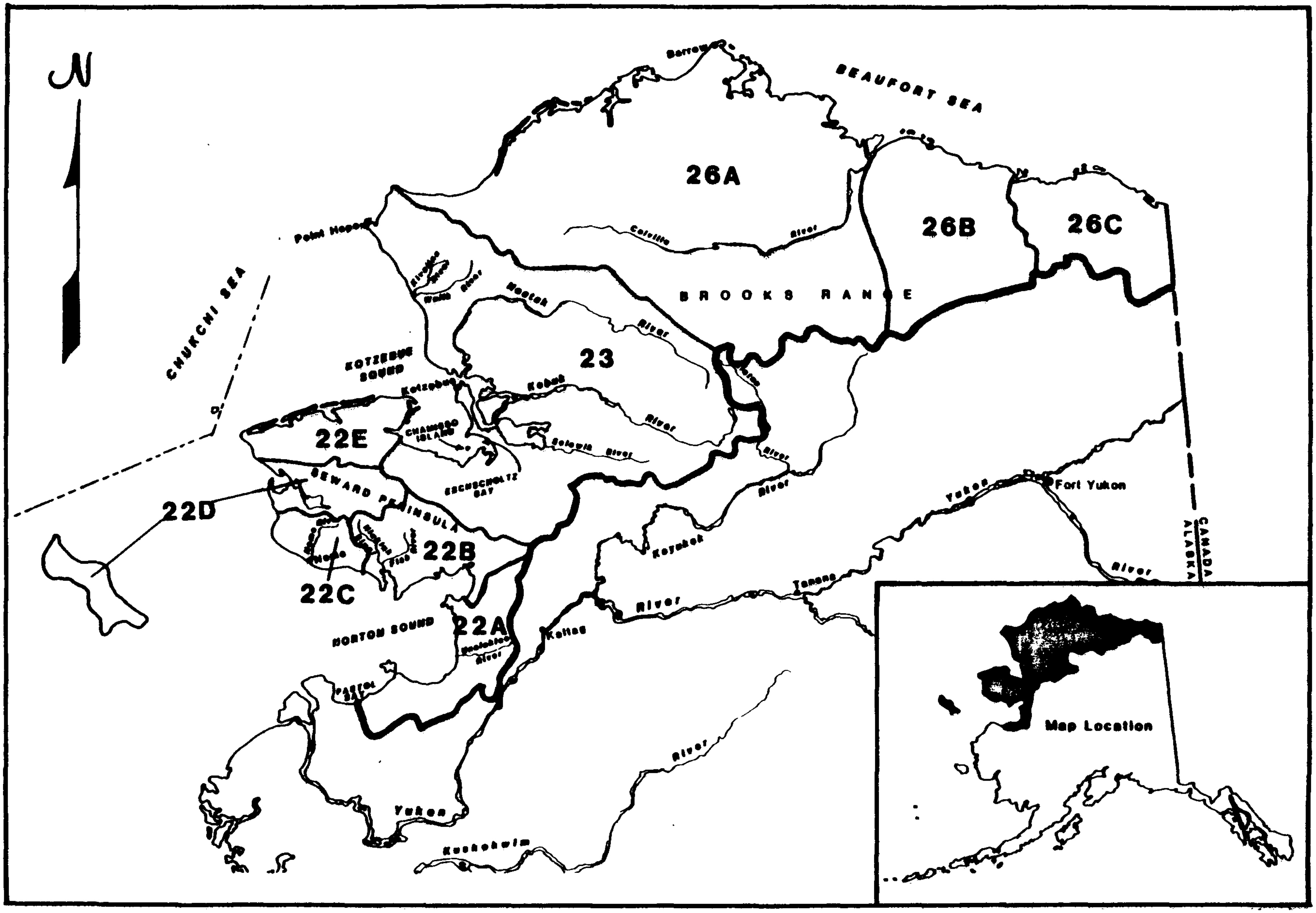
A. Boundaries

See the latest GMU maps and boundary descriptions.

B. Management Objectives

Three moose management plans pertain to portions of GMU 22: the Seward-Kobuk-Noatak, Nome Area, and Granite Mountain plans. In all three plans, the primary management objective is to provide sustained opportunities for subsistence use of moose. The secondary objective in the Seward-Kobuk-Noatak Plan is to provide the greatest sustained opportunity to participate in hunting moose. In the Nome Area Plan, the secondary objectives are to provide sustained opportunities to view and photograph moose and to provide sustained opportunities for scientific and educational studies of moose. The Granite Mountain Plan has a secondary objective to provide sustained opportunities to be selective in hunting moose (ADF&G 1976a, Bos 1980).

Moose were virtually absent from the Seward Peninsula prior to the 1930's. A few immigrants from the east probably established the initial colonizing stock in the 1940's and 1950's. Since the early 1970's, aerial surveys have shown a substantial increase in the moose population (Grauvogel 1983). Recently, liberal hunting



Map 1. Game management units in the Arctic Region.

Table 1. Reported GMU 22 General and Permit Moose Harvest and Hunter Data by Minor Tributary for 1983-84

Subunit	Minor Trib.	No. Days	No. Hunters	No. Success
A	03	843	85	20
A	04	102	2	1
A	02	20	5	2
A	05	19	7	4
A	00	13	2	---
A	06	10	1	---
A	01	6	1	---
Subunit total		1,013	103	27
B	04	1,273	265	104
B	00	535	89	1
B	02	115	16	10
B	03	3	2	1
Subunit total		1,926	372	116
C	03	244	22	13
C	04	198	33	14
C	01	62	8	4
C	00	33	6	---
C	05	28	5	2
C	02	16	4	4
Subunit total		581	78	37
D	03	3,054	428	143
D	00	1,260	156	3
D	01	331	54	23
D	02	57	15	9
Subunit total		4,708	654	178
E	02	253	61	39
E	01	65	9	9
E	00	17	13	1
Subunit total		335	83	49
Z	---	299	23	---
Subunit total		299	23	---
Unit total		8,862	1,313	407

Source: ADF&G 1984.

--- means no data were available.

seasons have been maintained in much of GMU 22 in order to slow and/or curtail "excessive" population growth (Grauvogel 1984).

C. Management Considerations

Winter browse is generally restricted to a narrow riparian belt along the major rivers; in some areas, moose density may exceed the long-term carrying capacity of the winter range. More information is needed, however, to determine the desired density of moose on the winter range (ibid.).

Moose composition surveys have revealed a gradual decline in the bull:cow ratios in heavily hunted areas but relatively stable ratios in unhunted or lightly hunted populations. Surveys conducted in 1982 showed a marked decline in calf survival and/or production compared to previous years. The causes of lower productivity are not known but in part may be attributed to cows being in poorer physical condition. This condition may be only temporary, or it may be a long-term trend. Bull:cow ratios and annual recruitment are being monitored closely, especially in Subunit 22D, where hunting pressure and harvest are highest. In portions of Subunits 22D and 22B, the harvest may be approaching the annual recruitment to the population (Grauvogel 1983, 1984).

Moose on the Seward Peninsula are extremely vulnerable to overhunting because of its open terrain and accessibility by aircraft and snowmachine. As harvest continues to escalate and as habitat conditions change, precise harvest information will become increasingly more important. Unreported harvest contributes to management problems in GMU 22. Every year a number of hunters fail to return harvest reports even though it is a requirement under the game regulations established by the Board of Game. Of at least 1,400 moose harvest tickets issued in GMU 22, only 664 were returned during the 1981-1982 hunting season. Hunters from rural villages probably account for an additional source of unreported moose mortality. In a few villages, less than 10% of the adult population acquired harvest tickets (Grauvogel 1983).

At the present time, predation does not appear to be a major source of mortality but may be increasing. As the moose population increased in the 1970's, the major trend was for hunters to take an increasing number of moose. If predators become more abundant, this trend may change (ibid.) because there would be fewer moose available to hunters.

D. Period of Use

Recent hunting seasons in GMU 22 have been the longest in the state, ranging from five to eight months, beginning as early as August 1 and continuing through March 31 in some portions of the unit. (See the latest Alaska game regulations for current hunting seasons and bag limits.)

E. Human Use Data

Table 2 presents moose harvest and hunter data in GMU 22 for regulatory years 1979-1980 through 1983-1984.

Table 2. GMU 22 Reported Moose Harvest and Hunter Data for Regulatory Years 1979-80 through 1983-84

Regulatory Year	Reported Harvest	Estimated Harvest*
1978-79	297	325-350
1979-80	270	325-340
1980-81	228	275-300
1981-82	298	325-350
1982-83	344	344-400
1983-84	407	420-435

Source: Grauvogel 1980, 1981, 1983, 1984, 1985; ADF&G 1984.

* Estimated harvest figures are based upon the success rate (5%) reported by harvest ticket holders who were sent reminder letters and subsequently returned their harvest tickets. This success rate was then multiplied by the number of harvest tickets issued within GMU 22 but not returned. Other factors contributing to these estimates include information from conversations with village residents, case histories filed by enforcement officials, and other sources of harvest information (Grauvogel 1983).

Increased hunting pressure has resulted in increased annual harvests (Grauvogel 1984).

The decline in reported harvest from the 1979-1980 hunting season to the 1980-1981 season was the result of weather. Unusually dry conditions persisted during the summer and fall of 1980. Moose remained at higher elevations and therefore were less accessible to hunters (Grauvogel 1980).

Despite the limited road system in GMU 22, road hunters using highway vehicles and off-road vehicles account for the largest percentage of the reported harvest. Boats and snowmachines are the next most frequently reported means of transport used by successful hunters, followed by hunters using aircraft (Grauvogel 1983).

Access plays a dominant role in the chronology of the harvest. Most moose are killed during the first 10 weeks of the regular hunting season, when lack of snow makes it feasible to use ORVs and highway vehicles and/or boats (ibid.).

During the last six years, nearly 90% of the hunters who reported hunting in GMU 22 were residents of the unit. Other Alaskan residents accounted for most of the balance. Nonresidents composed less than 2%.

As mentioned earlier, the number of hunters who fail to return harvest reports remains high.

F. Significance of Particular Use Areas

Based on reported harvest information, a majority of the total kill occurs in Subunit 22D, principally in the drainages of the Kuzitrin, Kougarok, and Pilgrim rivers. A well-maintained gravel road traverses most of this area in a north-south direction, providing ready access for residents of Nome. A high percentage of GMU 22 residents are avid hunters, and the area immediately adjacent to the road system receives heavy hunting pressure (ibid.).

During the 1983-1984 hunting season, a total of 1,313 hunters reported hunting in GMU 22 for a total of 8,862 days (ADF&G 1984). Table 1 lists the number of hunters and hunter-days by subunit and minor tributary. Note that subunit designation "z" represents hunters who hunted in GMU 22 but did not supply sufficient information on their harvest reports to be coded to a particular subunit. Minor tributary designation "00" represents hunters who reported hunting in a particular subunit but did not supply sufficient information on their harvest report to be coded to a minor tributary unit (MTU). (See the moose human use maps in the 1:250,000-scale Reference Maps, available in ADF&G offices.)

III. GMU 23

A. Boundaries

See the latest game management unit maps and boundary descriptions.

B. Management Objectives

Three moose management plans pertain to portions of GMU 23: the Seward-Kobuk-Noatak, Upper Noatak-Kobuk, and Granite Mountain plans. In the Seward-Kobuk-Noatak and Granite Mountain management plans, the primary management objective is to provide sustained opportunities for subsistence use of moose. The secondary objective in the Seward-Kobuk-Noatak Plan is to provide the greatest sustained opportunity to participate in hunting moose. The upper Noatak-Kobuk Plan has a primary objective to provide sustained opportunities to hunt moose under aesthetically pleasing conditions (ADF&G 1976a, Bos 1980).

C. Management Considerations

In GMU 23, as in most areas in northwestern Alaska, a number of hunters fail to return moose harvest reports even though it is a requirement under the game regulations. During the 1982-1983 hunting season, a total of 735 harvest reports were issued in this unit, and only 141 (19%) were returned (James 1984).

Future moose management in the Selawik area of GMU 23 will be influenced by fire management on refuge lands. To maintain the subpopulation of moose in this area at its current state, sizeable acreages must be burned at a 10-to-15-year interval. Fire suppression to protect caribou winter range could reduce moose numbers (Quimby and James 1985).

Water collection ditches for gold-mining operations and mining activities themselves on Candle Creek and the Inmachuk River have created significant amounts of good moose browse (ibid.).

D. Period of Use

Recent hunting seasons in GMU 23 have been the longest in the state, ranging from five to eight months. Seasons begin August 1 throughout the unit and continue through December 31 in most of the unit and through March 31 in a portion of the unit. (See the latest Alaska game regulations for current hunting seasons and bag limits.)

E. Human Use Data

Table 3 presents moose harvest data and the number of hunters reporting for GMU 23.

Table 3. GMU 23 Reported Moose Harvest and Hunter Data for Regulatory Years 1979-80 through 1983-84

Regulatory Year	Reported Harvest	Number of Hunters	Estimated Harvest
1979-80*	139	239	300-370
1980-81	112	211	---
1981-82	176	239	---
1982-83	128	267	---
1983-84	141	306	360-530

Source: Johnson 1980, Quimby and Moser 1981, Quimby 1983, James 1984, ADF&G 1984, Quimby and James 1985.

--- means no data were available.

* Reminder letters were not sent during regulatory year 1979-80. Statewide, only 37.2% of the hunters returned harvest reports, compared to the previous year's total of 67.9%, when reminder letters were sent (Johnson 1980).

The decline in harvest and number of hunters reporting from the 1979-1980 hunting season to the 1980-1981 season may have been greater than the data indicate. Reminder letters were not sent out after the 1979-1980 season, and statewide only 37.2% of the hunters returned harvest tickets (Johnson 1980). Reminder letters were sent out after the 1980-1981 hunting season, and statewide

Table 4. Reported GMU 23 1983-84 Moose Harvest and Permit Harvest and Hunter Data by Minor Tributary

Minor Trib.	No. Days	No. Hunters	No. Success.
31	422	74	31
00	271	46	17
12	241	25	9
20	208	28	9
34	175	22	17
11	116	16	4
35	53	6	4
36	48	11	5
05	39	3	3
32	39	4	1
04	35	4	3
40	33	5	5
07	32	12	5
13	25	8	1
06	21	6	1
43	19	4	4
26	18	6	6
10	13	3	2
19	12	2	1
41	12	1	1
25	10	1	1
21	8	2	2
33	6	2	2
50	6	4	3
51	5	1	1
53	5	1	---
15	4	2	1
08	3	1	---
27	3	1	1
23	2	1	---
28	2	1	1
30	2	3	---
Subunit total	1,888	306	141
Unit total	1,888	306	141

Source: ADF&G 1984.

--- means no data were available.

67.9% of the hunters returned their harvest reports (Quimby and Moser 1981). Several factors appear to have contributed to the decline: The high cost of gasoline limited extended boat trips for unit residents and discouraged airplane trips by residents of Anchorage or Fairbanks. A contributing factor was the increased limit and availability of caribou, the preferred meat animal for many local residents. The general decline in economic activity associated with the oil pipeline and increased availability of moose near Fairbanks may have contributed to the decline in the GMU 23 moose harvest (ibid.).

The increase from the 1980-1981 season to the 1981-1982 season may have been because caribou were not as available as in past years along the Noatak and Kobuk rivers during September (Quimby 1983). Reasons for the decline in harvest from the 1981-1982 season to the 1982-1983 season and the subsequent increase during the 1983-1984 season are not apparent.

Boat and aircraft are the most frequently reported means of access by hunters. Of those who use these two transport means, aircraft hunters are the most successful. Snowmachines are used to a much lesser extent (Quimby and James 1985).

Between 80 and 90% of the hunters reporting are Alaska residents. During the 1983-1984 hunting season, 306 moose hunters reported hunting for a total of 1,888 days for an average of about 6.2 days/reporting hunter (ADF&G 1984).

E. Significance of Particular Use Areas

Based on reported harvest information, the Kobuk and Noatak drainages sustain most of the hunting pressure and harvest (Quimby 1983). Table 4 lists the number of hunters, hunter-days, and harvest by minor tributary. Note that minor tributary designation "00" represents hunters who reported in GMU 23 but did not supply sufficient information on their harvest reports to be coded to a minor tributary. (See the moose human use maps in the 1:250,000-scale Reference Maps, available in ADF&G offices.)

IV. GMU 26

A. Boundaries

See the latest GMU maps and boundary descriptions.

B. Management Objectives

Three moose management plans pertain to portions of GMU 26: the Northeast Arctic, Dietrich, and Colville plans. In the Northeast Arctic Management Plan, the primary objective is to provide for the greatest sustained opportunity to participate in hunting moose. The secondary objective is to provide sustained opportunities for subsistence use of moose. The Dietrich Moose Management Plan has a primary management objective to provide sustained opportunities to hunt moose under aesthetically pleasing conditions. The secondary objective is to provide sustained opportunity to view and photograph moose. The primary objective of the Colville Moose Management Plan is to provide sustained opportunities for subsistence use of moose. The secondary objective is to provide sustained opportunities to participate in hunting moose (ADF&G 1976b, Bos 1980).

C. Management Considerations

Browse surveys conducted in GMU 26 have indicated a high degree of use of the available annual plant growth on preferred species. Moose population trends between 1975 and 1980 indicated an inverse relationship between the total number of adults and the percentage of calves, possibly suggesting that browse may be limiting the population (Coady 1981).

It is evident that some local residents fail to report hunting moose; however, the extent of this bias and the reasons for it are not presently clear (Trent 1984). Moose distribution is centralized along rivers, where moose are highly visible and access by aircraft or riverboat is excellent. Because of this, moose are vulnerable to hunters, and the potential for overharvest is high (ADF&G 1976b).

Access to GMU 26 has been increasing. The area within 2 mi of the Dalton Highway, however, has been closed to the hunting of moose.

D. Period of Use

Recent hunting seasons in GMU 26 opened on the first of September and extended through the end of December, for a total of four months. In the lower Colville River portion of GMS 26A, an early opening (Aug.) has been held since the 1983 hunting season. Hunting seasons are more restrictive within Gates of the Arctic National Park. (See the latest Alaska game regulations for current hunting seasons and bag limits.)

E. Human Use Data

Table 5 presents moose harvest data and the number of hunters reporting.

Until the 1982-1983 hunting season, reported moose harvest and the number of hunters had generally been increasing since 1977. The decline during the 1982-1983 season is not completely understood, although several factors may have contributed to the decline. Poor flying weather during September south of the Brooks Range limited access to the Colville River system from Fairbanks. Also, closure of the Dalton Highway to all moose hunting contributed to the decline in harvest and the number of hunters (Trent 1984).

Hunter access for moose hunting in GMU 26 is principally by aircraft, boats, and highway vehicles; snowmachines are also used but to a much lesser extent.

The majority of reporting hunters are Alaska residents; however, the majority of this group are composed of nonlocal residents (Melchior 1980, Coady 1981, Anderson 1983, Trent 1984 and 1985, Boertje 1985). During the 1983 hunting season, hunters from Nuiqsut took an estimated 20-25 moose, compared to an estimated 6 moose in 1982. This apparently occurred because Nuiqsut hunters requested an early (1 August) opening for the lower Colville

Table 5. GMU 26 Reported Moose Harvest and Hunter Data for Regulatory Years 1979-80 through 1983-84

Regulatory Year	Reported Harvest	Number of Hunters	Estimated Harvest
1979-80	90	108	100
1980-81	84	132	---
1981-82	99	145	---
1982-83	60	102	---
1983-84	51	76	---

Sources: Melchior 1980, Coady 1981, Anderson 1983, Trent 1984 and 1985, ADF&G 1984, Boertje 1985.

--- means no data were available.

River, which the Board of Game established for the 1983 hunting season (Trent 1985).

F. Significance of Particular Use Areas

Typically, most of the GMU 26 harvest comes from GMS 26A. The Colville River between the mouths of the Killik and Anaktuvuk rivers and along the Anaktuvuk and Chandler river drainages are the most popular hunting areas. Table 6 lists the number of hunters, hunter-days, and harvest by MTU. Note that subunit designation "Z" and MTU designation "00" represent those hunters who did not supply sufficient information on their harvest reports to be coded to either subunit or MTU. (See the moose human use maps in the 1:250,000-scale Reference Maps, available in ADF&G offices.)

Table 6. GMU 26 General and Permit Moose Harvest and Hunter Data by Minor Tributary, 1983-84

Subunit	Minor Trib.	No. Days	No. Hunters	No. Success.
A	09	103	19	13
A	07	34	6	5
A	11	30	3	3
A	13	22	3	1
A	10	20	6	5
A	08	14	4	4
A	00	10	3	1
A	06	10	3	3
A	14	9	2	1
A	12	8	1	1
Subunit total		260	50	37
B	03	66	8	6
B	04	35	2	2
B	02	13	5	3
B	00	4	1	
Subunit total		118	16	11
C	01	21	3	1
C	05	1	1	1
Subunit total		22	4	2
Z	00	34	6	1
Subunit total		34	6	1
Unit total		434	76	51

Source: ADF&A 1984.

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Commercial Harvest of Capelin

I. BOUNDARIES

The geographic area covered in this narrative encompasses the Norton Sound, Kotzebue Sound, and Chukchi Sea areas of the Bering Sea Herring Statistical Area Q. Three districts constitute this area: the Norton Sound District, the Port Clarence District, and the Kotzebue District (ADF&G 1984). The Norton Sound District consists of all waters between the latitude of the westernmost tip of Cape Douglas and the latitude of Canal Point Light (ibid.). The Port Clarence District consists of all waters of Alaska between the latitude of Cape Douglas and the latitude of Cape Prince of Wales (ibid.). The Kotzebue District consists of all waters of Alaska between the latitude of Cape Prince of Wales and the latitude of Point Hope (ibid.). Though the occurrence of capelin has been documented in these waters, this resource has yet to be commercially exploited.

II. REGIONAL SUMMARY

Capelin are sought by commercial markets for reduction (meal or oil), roe, bait, or for a whole frozen food product. Capelin are usually harvested as they move into coastal areas to spawn.

Distribution of capelin in the Bering Sea has been documented from the Aleutian Chain to Point Barrow (Pahlke 1981a). Commercially significant quantities are believed to occur in Bristol Bay and Norton Sound (Hale 1983). Commercial fishing effort targeting on capelin in the Bering Sea has been small and restricted to Bristol Bay. The first recorded harvest of 26 tons was taken in 1974. Subsequent catches of 52 and 80 tons were taken during the 1977 and 1979 herring seasons for test-marketing purposes. The first directed commercial fishery upon capelin occurred during the spring of 1984, when 1,178 tons were caught in Bristol Bay. These fish were frozen and sold primarily for the roe product (Pahlke 1984).

To date, there has been no commercial exploitation of capelin in the Arctic Region. Very few capelin were found during test-fishing efforts for herring in Kotzebue Sound during the spring of 1980 (Whitmore, pers. comm.). Trawl surveys performed from September through October of 1976 noted trace amounts of capelin, caught only in offshore waters between the Seward Peninsula and St. Lawrence Island and in the southeastern Chukchi Sea (Wolotira et al. 1976).

Large populations of capelin in spawning condition have been documented in Norton Sound (Pahlke 1981b), and the feasibility of harvesting capelin for commercial purposes in this area has been examined (Hale 1983). The fishery would probably complement spring herring fisheries. Pahlke (1981b) noted, however, that capelin caught in Norton Sound could be too small for marketing.

A. Period of Use
Currently, capelin are not harvested commercially in the Arctic Region. However, capelin schools appear in coastal areas of Alaska and spawn between the months of April and July (Pahlke 1981a). Timing may be concurrent or subsequent to the spring migration of spawning herring along the Bering Sea coast (Pahlke 1981b, ADF&G 1980).

B. Management Considerations
Currently, commercial fishing regulations do not provide for any restrictions on the taking of smelt or capelin. The seasonal occurrence of capelin, other species of smelt, and herring overlap in many areas. It is possible that high incidental catches and potential overharvest of herring would occur in a directed fishery for capelin or that herring regulations might be violated by fishermen claiming to fish for smelt or capelin. The Alaska Board of Fisheries therefore adopted the policy that time-area closures should be utilized to contain smelt-capelin fisheries in areas of low herring abundance. The policy also states that, after closure of the commercial herring fishery, should catches of herring in the directed fishery for smelt-capelin species approach or exceed 10% of the total commercial catch or should individual landings be composed consistently of 20% or greater of herring, the smelt-capelin fishery will be closed (ADF&G 1980).

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Commercial Harvest of Pacific Herring

I. POPULATION MANAGEMENT HISTORY

A. Introduction

The Bering Sea, Kotzebue Area, or Statistical Area Q, consists of the area extending from a line west from Dall Point north to a line extending west from Point Hope, and its western boundary is the International Date Line in the Bering and Chukchi seas. Four districts for herring management are located within Statistical Area Q. These districts are Cape Romanzov, Norton Sound, Port Clarence, and Kotzebue Sound (ADF&G 1985a). Only the Norton Sound, Port Clarence, and Kotzebue districts are within the Arctic Region. Information presented in sections II. and III. following is organized by district.

B. Summary of the Regional Fishery

1. Harvest summary. The Arctic Region, once supporting one of the earliest Alaskan fisheries, currently supports one of the five sac roe herring fisheries and one of two spawn-on-seaweed harvests along the eastern Bering Sea coast. Since 1979, when interest in the fishery increased, the Arctic Region harvest has accounted for about 13% of the entire herring harvest (food bait and sac roe combined) and about 13% of the spawn-on-seaweed harvest for the entire eastern Bering Sea. Both the sac roe and spawn-on-seaweed harvests occur in the Norton Sound District. Although active subsistence fisheries exist, the Kotzebue Sound and Port Clarence districts have yet to be commercially exploited.
2. Managerial authority. Pacific herring in the Arctic Region are managed by the Alaska Department of Fish and Game under joint policy of the Alaska Board of Fisheries and the North Pacific Fisheries Management Council.
3. Gear types. Purse seines, gill nets, and beach seines are legal gear by which herring may be harvested in the Arctic Region. Legal gear, however, is specific to each district (ibid.).
4. Period of use. Seasons by which herring may be taken in the Arctic Region depend upon the district and product desired. Herring in spawning condition that move into bays and estuaries to spawn during spring months, are harvested in the sac roe fishery. Though unripe herring may be processed as food or bait during the sac roe season, the food-bait fishery generally targets on herring in nonspawning condition during fall and winter months. Spawn-on-seaweed harvest occurs during spring months concurrently with the sac roe fishery.

II. NORTON SOUND DISTRICT

A. Boundaries

The Norton Sound District is comprised of all waters of Statistical Area Q (Bering Sea) between the latitude of the westernmost tip of Cape Douglas and the latitude of Canal Point Light and 62° N. The Norton Sound District in turn is divided into seven subdistricts (map 1) (ibid.).

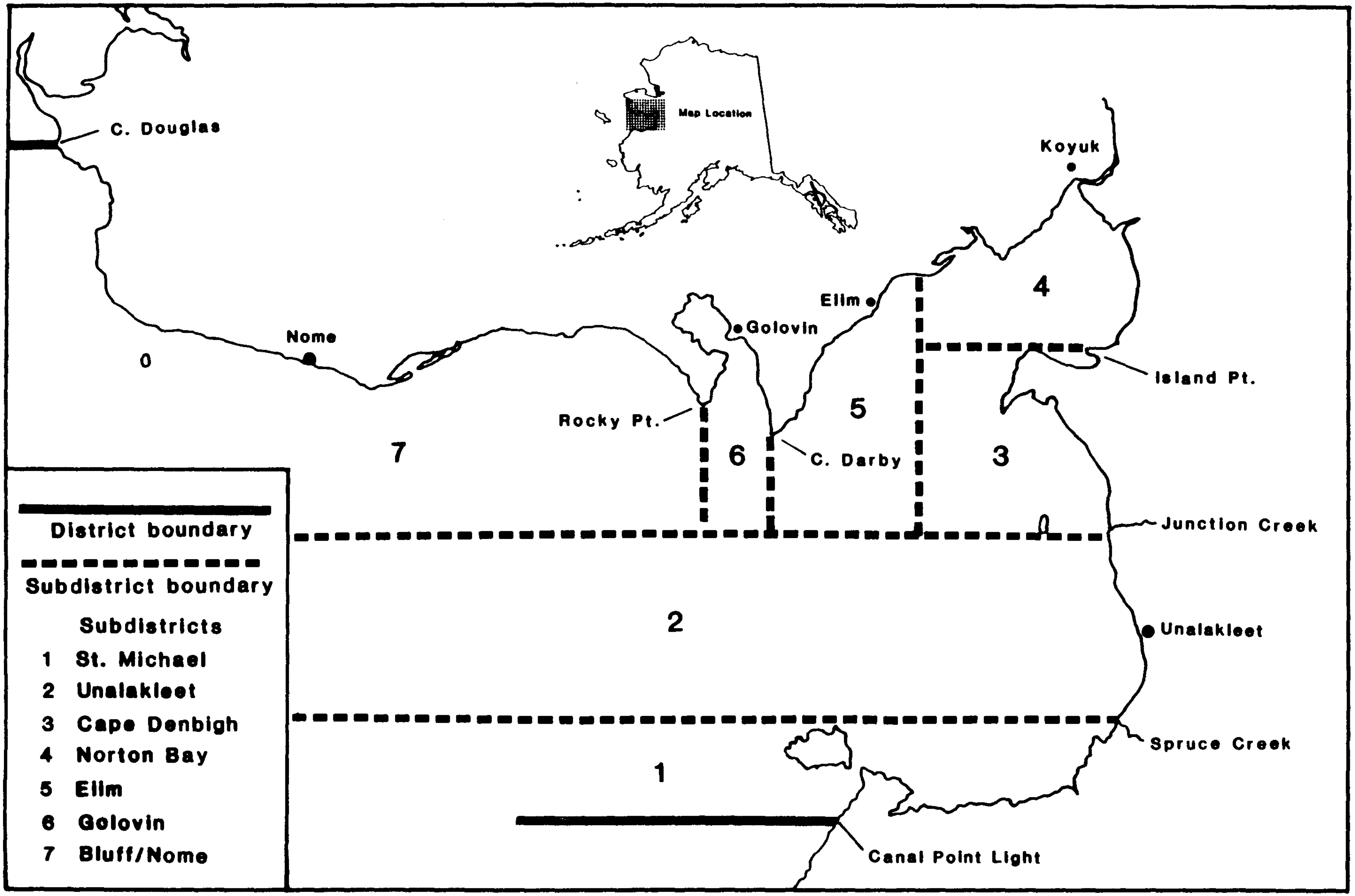
B. Fishery Description and Reported Harvest

1. Harvest summary. Documented harvest of Pacific herring in the Norton Sound area dates back to the 1800's, when herring were caught by coastal residents and used for subsistence purposes. About 1909, commercial exploitation of herring began in the Golovin Bay area by domestic fishermen marketing a salt-cured or pickled food product. Records indicate harvest levels between 1916 and 1941 averaged about 137.9 metric tons annually. As foreign competition increased, marketability of these herring declined, and interest in this fishery ceased completely by 1942 (ADF&G 1982).

   The domestic fishery did not resume until 1964, when fishermen sought herring in spawning condition for the oriental sac roe market. Domestic effort was intermittent, with catch levels remaining below 33 metric tons through the 1974 season (ADF&G 1984). Shortly thereafter, the Japanese gill net fleet also began to fish in the Norton Sound area. Catches averaged about 405 metric tons annually during the short seven-year duration of the fishery. Most of the harvest was taken offshore near the center of Norton Sound, particularly near Stewart Island. Foreign harvest was prohibited beginning with the 1977 season, with implementation of the Fisheries Conservation Management Act.

   The domestic harvest, however, continued and increased dramatically from 14 metric tons taken during the 1978 season to a harvest of 1,173 metric tons caught in 1979. The expansion of the fishery was in response to the increased demand for sac roe on the Japanese market (ADF&G 1984b). Catches increased thereafter, peaking during the 1983 season with a harvest of 4,156 metric tons taken by 272 fishermen. Effort has ranged from 11 participants during the 1978 season to 332 fishermen in 1981. The location of the fishery depends primarily upon distribution of the fish, based on ice and weather conditions. Although herring have been caught in all seven subdistricts, catches are primarily taken in the Unalakleet, St. Michael, and Cape Denbigh subdistricts. (The 1984 harvest of 3,240 metric tons by 199 fishermen was taken exclusively in the Cape Denbigh Subdistrict (table 1).

   A fall food fishery on nonspawning herring has been authorized in the Bluff/Nome Subdistrict. However, only one fishermen has participated to date, taking less than 1% of the guideline harvest level of 10 metric tons (ADF&G 1983).



Map 1. Herring commercial fishing subdistricts of the Norton Sound District (ADF&G 1983).

Table 1. Commercial Harvest of Pacific Herring in Metric Tons and Effort in Number of Vessels by Subdistrict and Year for the Norton Sound District, 1976-84[a]

Subdistrict	Year								
	1976	1977	1978	1979	1980	1981	1982	1983	1984
1 (St. Michael)	---	---	0	289.4	1,066.4	2,782.5	1,870.0	394.0	0
2 (Unalakleet)	---	---	14.0	367.2	573.6	754.2	858.0	1,147.0	0
3 (Cape Denbigh)	---	---	0	503.8	573.6	427.8	839.0	2,479.0	3,240.0
4 (Norton Bay)	---	---	0	0	4.6	0.6	0	0	0
5 (Elim)	---	---	0	0	0	0	0	59.0	0
6 (Golovin)	---	---	0	0	6.4	0	0	77.0	0
7 (Bluff/Nome)	---	---	0	12.6	0	0	0	0	0
Management area total	7.7	9.5	14.0	1,173.0	2,224.6	3,956.1	3,567.0	4,156.0	3,240.0
Management area effort	---	---	11	67	294	332	237	272	199

Source: ADF&G 1984a, Lebida et al. 1984.

--- means no data were available.

a Includes herring harvested for both sac roe and bait product.

Norton Sound also supports one of three spawn-on-seaweed fisheries in Alaska. The fishery, targeting upon herring spawn deposited on rockweed (Fucus spp.), increased from about 4.0 metric tons taken during the 1978 season to 42.0 metric tons harvested by 22 pickers during the 1981 season (table 2). Peak participation in the fishery occurred during the 1982 fishery, with an effort of 44 pickers. The fishery occurs in the St. Michael Subdistrict, where the greatest concentration of Fucus (spp.) occurs in Norton Sound (ADF&G 1984a).

For the first time in the history of the spawn-on-seaweed fishery, Macrocystis (spp.), a broad-leafed kelp, was imported into Norton Sound. This vegetation was strung between Elim and Cape Darby (map 1.). Once spawn had been deposited upon this substrate, the Nome, Elim, and Norton Bay subdistricts were open to commercial harvesting of kelp. A total of 3 metric tons were taken (ibid.).

2. Harvest methods:
   a. Herring. Herring harvested in the Norton Sound Management Area may be harvested only by gill net and beach seine (ADF&G 1985a). Prior to the 1980 fishing season, there were no gear restrictions in the Norton Sound District. Local fishermen could afford investment only in gill net gear, and prohibition of purse seine gear would decrease competition with the highly efficient gear type. During the 1980 season, gill net fishermen demonstrated their ability to harvest the available catch. As a result, in an attempt to encourage involvement of local fishermen in what was at that time a relatively new fishery, the regulation preventing use of purse seine gear to harvest herring in the Norton Sound Area was implemented the following year and is still in effect (ADF&G 1982).
   b. Spawn-on-seaweed. Gear restrictions are not specified for the harvest of herring spawn-on-seaweed. However, most of the harvest has been picked by hand or raked.
3. Period of use:
   a. Herring. Prior to 1941, herring were taken in nonspawning condition during fall months (ibid.). Currently, there is provision for a fall food/bait fishery in the Nome Subdistrict from September 1 through November 15. However, the Norton Sound herring fishery is primarily directed toward herring in spawning condition during spring months. The fishery opens by regulation April 15 and closes by June 30. Though the fishery has consistently opened by regulation April 15, closure is usually by emergency order (Lebida et al. 1984). First deliveries have ranged from May 18 to June 6, occurring about two weeks after initiation of the Togiak herring fishery in Bristol Bay. In past years, the fishery has closed as late as June (ADF&G 1985b).

Table 2. Commercial Harvest of Spawn on Seaweed in Metric Tons in the Norton Sound Management Area

	1977	1978	1979	1980	1981	1982	1983	1984
Harvest	Trace	4.0	12.0	22.0	47.0[a]	35.0	26.5[b]	20.5[c]
Effort	---	9	19	20	22	44	35	32

Source: ADF&G 1984a, Lebida et al. 1984.

--- means no data were available.

a Includes about five metric tons of wastage.

b Includes about 1.5 metric tons of wastage.

c Includes about 3.0 metric tons of spawn on Macrocystis (spp.).

b. Spawn-on-seaweed. The herring spawn-on-seaweed fishery in past years has opened and closed by emergency order, occurring about the same time as the sac roe fishery. However, a new regulation adapted by the Alaska Board of Fisheries during the winter of 1984 closed the Norton Sound District to the commercial harvesting of spawn-on-kelp (ADF&G 1985b).

C. Management Objectives and Considerations

1. Herring fishery. The management objective of the herring fishery is to maintain the resource at levels that will retain maximum sustainable yield. The statewide management strategy is to harvest 0 to 20% of the herring biomass, with the upper end of the exploitation range applied to stocks in good condition. The lower end of the exploitation rate is applied to stocks exhibiting a trend in decreasing abundance and poor recruitment (ADF&G 1985b). Difficulty arises in determining harvest levels when poor visibility, inclement weather, and a high incidence of other pelagic species inhibit aerial surveys, increasing the error in assessing abundance or biomass levels.

Both beach seines and gill nets are legal in the Norton Sound District. Beach seines, however, were not used extensively until the 1984 season, when 10 beach seines took about 9% of the harvest. The Alaska Board of Fisheries adapted a regulation for the 1985 fishery that will limit the beach seine harvest to not more than 10% of the preseason projected harvest (ibid.).

2. Spawn-on-kelp fishery. Norton Sound supports one of three spawn-on-seaweed fisheries in the state. Though subtidal vegetation has been documented, the harvest upon wild vegetation occurs in the intertidal area and is primarily comprised of rockweed (*Fucus* spp.). Spawn-on-kelp management strategies utilized include estimating linear miles of herring smelt by aerial surveys, conducting preseason ground surveys to ensure a marketable product of spawn-on-kelp, and establishing fishing periods by emergency order to maintain the established guideline harvest level (Whitmore 1985).

Of major concern in establishing harvest levels of aquatic vegetation is the rate of regeneration. Findings by the University of Alaska indicate that two or three growing seasons may be required in areas not severely cleared for regrowth of the beds in Bristol Bay to harvestable levels (Stekoll 1983b). Norton Sound, however, has a more severe winter, steeper intertidal area, less species diversity, and a smaller tidal range than Bristol Bay. It is possible that growth of *Fucus* spp. in Norton Sound may be slow compared to growth rates of *Fucus* spp. in Bristol Bay, resulting in longer time periods for harvested areas to be repopulated (Stekoll 1983a). The low species diversity indicates that, unless properly managed, the species could be easily eliminated (ibid.). A new regulation adopted by the Board of Fisheries during the winter of 1984 closed the Norton Sound District to the commercial harvesting of spawn-on-kelp to help conserve the limited kelp resource and to help increase future recruitments into the herring population (ADF&G 1985b).

D. Significance of Particular Use Ares

Most of the Norton Sound herring and spawn-on-seaweed harvest occurs in the St. Michael's, Unalakleet, and Cape Denbigh subdistricts. A series of reference maps have been prepared for use with this report. The categories of mapped information include the following:

° Commercial herring harvest areas

III. KOTZEBUE AND PORT CLARENCE DISTRICTS

A. Boundaries

The Port Clarence District consists of all waters of Alaska between the latitude of Cape Douglas and the latitude of Cape Prince of Wales (ADF&G 1985a).

The Kotzebue District consists of all waters of Alaska between the latitude of Cape Prince of Wales and the latitude of Point Hope (ibid.).

B. Fishery Description and Reported Harvest

1. Harvest summary. There has yet to be a commercial fishery in the Port Clarence or Kotzebue districts. Processors and fishermen have attempted landings of marketable sac roe herring in both these districts but have never been successful (ADF&G 1985b). Two major obstacles to development of a commercial fishery are high transportation costs for products and large incidental catches of unmarketable fishes (Whitmore and Bergstrom 1983).
2. Harvest methods. Beach seines, purse seines, and gill nets may be used to harvet herring in the Port Clarence and Kotzebue Sound districts (ADF&G 1985a).
3. Period of use. In both the Port Clarence and Kotzebue Sound districts, herring may be taken from 15 April through 15 November, with the exception of the open commercial salmon fishing season (ibid.).

C. Management Objectives and Considerations

Should a commercial fishery develop in the Kotzebue Sound-Port Clarence area, assessment work must be performed to better examine available biomass so that management would be on a 10 to 20% exploitation rate, as with other herring fisheries in Alaska. Gear mesh size regulations should also be examined because Kotzebue herring are smaller than more southerly stocks (Whitmore and Bergstrom 1983).

D. Significance of Particular Use Areas

Currently no commercial herring fishery exists in Kotzebue Sound or Port Clarence areas.

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Commercial and Subsistence Harvest of Salmon

I. POPULATION MANAGEMENT HISTORY

A. Introduction

Within the Arctic Region are found two commercial fisheries management areas: the Norton Sound-Port Clarence Area and the Kotzebue-Northern Area. The Norton Sound-Port Clarence Area includes all waters of Alaska between the latitude of the westernmost tip of Cape Prince of Wales and the latitude of Canal Point Light, including the waters of Alaska surrounding St. Lawrence Island and those waters draining into the Bering Sea. The Kotzebue-Northern Area includes all waters of Alaska north of the latitude of the westernmost tip of Cape Prince of Wales and west of 141° west longitude, including those waters draining into the Chukchi Sea and Arctic Ocean (map 1) (ADF&G 1985b).

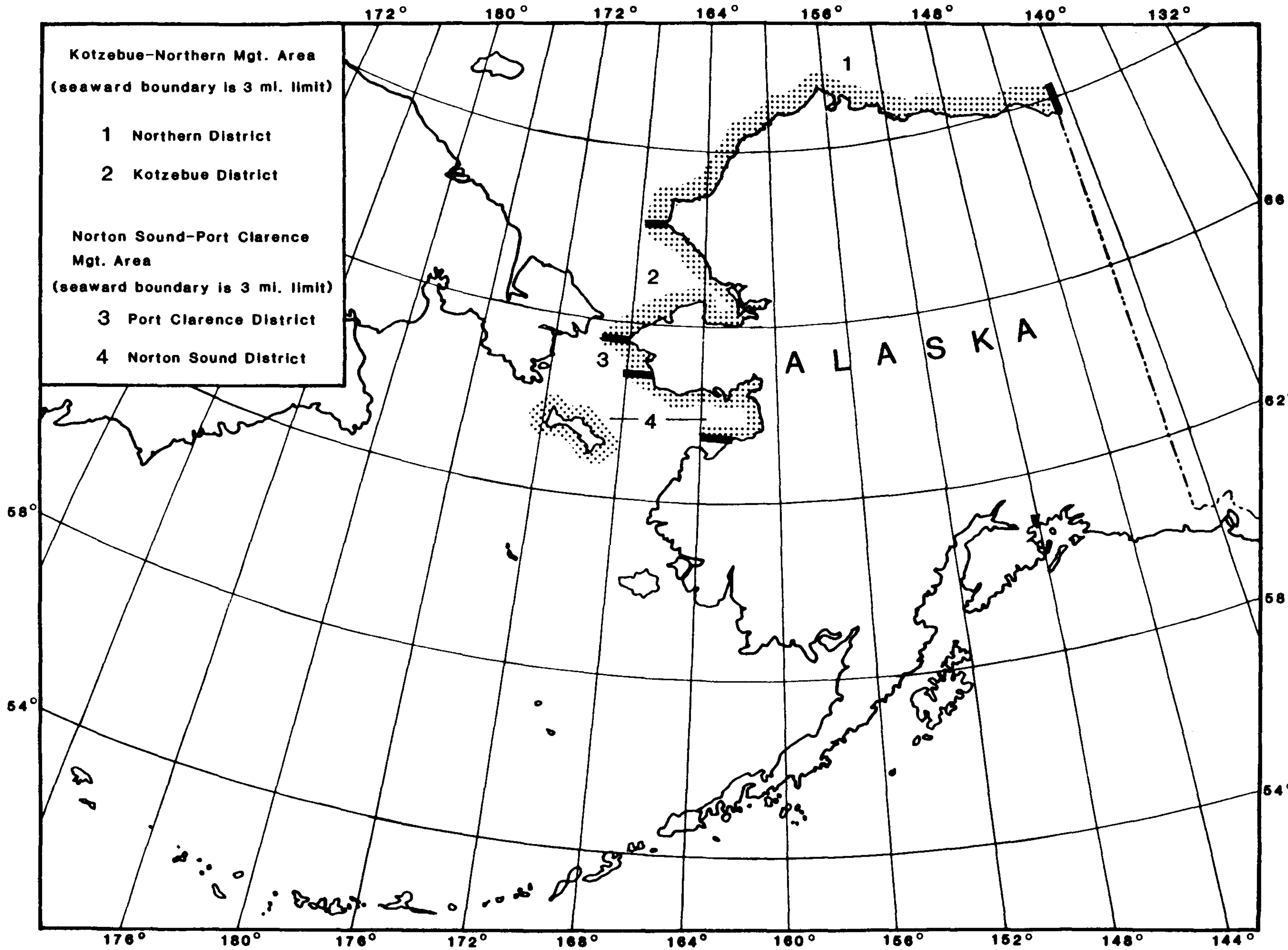
Commercial fishing for salmon, however, is restricted to the area between the latitude of the westernmost tip of Point Hope on the north and the latitude of Canal Point Light on the south. This area is divided into three sections for salmon management and includes the Norton Sound, Kotzebue, and Port Clarence districts (ibid.). These districts are depicted on map 1.

Information presented in sections II., III., and IV. of this narrative is organized by fishing district. Because no commercial salmon harvest occurs north of Point Hope in the Northern District of the Kotzebue-Northern Area it will not be addressed in this publication.

B. Summary of Regional Fisheries

1. Harvest summary. Five species of Pacific salmon occur within the Arctic Region. Although all species may be present in the subsistence and commercial harvests, the more abundant species, chum salmon (*Oncorhynchus keta*) and pink salmon (*O. gorbuscha*), dominate both the subsistence and commercial fisheries. Subsistence use of salmon in the Arctic Region is important to local residents. Catches determined from surveys and interviews in the past 10 years reached a peak of 127,738 fish in 1982 (see tables 2, 13, and 14).

   Commercial harvest of salmon in the Arctic Region has occurred periodically since about 1914. Participation has been steady since the 1960's, although harvest levels are heavily dependent upon market demand and the processing capacity in the area. Commercial catches of salmon region-wide since 1974 have ranged from 352,766 salmon in 1976 to 1.1 million salmon in 1981 and averaged about 640,606 per year (see tables 1 and 12). As of 1983, a total of 420 commercial fisheries entry permits have been issued for the salmon fisheries.



Map 1. Commercial salmon fisheries management areas and districts of the Arctic Region (ADF&G 1985).

Table 1. Commercial Salmon Harvest (All Species) in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	10,848	8,989	16,129	31,670	11,289	23,937	22,380	33,162	12,283	4,571
Golovin Bay	52,754	55,593	62,292	113,611	77,879	63,783	108,139	95,844	66,054	145,234
Moses Point	51,122	16,218	57,000	84,977	79,146	16,692	55,945	50,450	83,057	43,471
Norton Bay	18,679	11,814	16,217	31,058	25,203	8,242	3,351	12,091	21,511	4,604
Shaktoolik	51,963	32,622	46,277	84,086	46,694	38,487	53,471	67,172	94,964	46,248
Unalakleet	65,682	67,824	59,410	186,546	110,150	293,194	198,468	252,489	178,551	98,031
District total	251,048	193,060	257,325	531,948	350,361	444,335	441,734	511,208	456,420	342,159

Source: ADF&C 1984a.

2. Managerial authority. The U.S. Fish and Wildlife Service (USFWS) regulated Alaska's fisheries from the late 1800's through 1959. After statehood was granted in 1959, the Alaska Department of Fish and Game (ADF&G) managed the salmon fishery. The Alaska salmon fishery became a limited entry fishery in 1974 after the Commercial Fisheries Entry Commission was established.

   Management of fisheries in waters within three nautical miles of the shore is the responsibility of the State of Alaska. The Magnuson Fishery Conservation and Management Act, implemented in 1977 and amended in 1980, provided for conservation and exclusive United States management of all fisheries within 200 nautical miles of the shore, creating the Fishery Conservation Zone (FCZ) from 3 to 200 nautical miles from shore. The North Pacific Fishery Management Council is responsible for managing fisheries in the FCZ and prepares management plans, which become federal law. The International North Pacific Fisheries Commission, comprised of Canada, Japan, and the United States, recommends management procedures and prepares conservation measures outside the United States and Canadian 200 nautical mile zones. The ADF&G manages the salmon fishery in the Norton Sound, Kotzebue, and Port Clarence districts.
3. Gear types. Set gill nets are primarily used in the Arctic Region to commercially harvest salmon. Beach seines and set gill nets are used for the taking of salmon for subsistence purposes (ADF&G 1985b).
4. Period of use. Timing of the commercial fishery depends upon timing of the salmon runs into the management area. Fishing seasons and fishing periods are established by regulation for each district.
5. Economic value. Information concerning the value of salmon within the Arctic Region is presented in the Economic Overviews of Fish and Wildlife volume.

II. NORTON SOUND DISTRICT

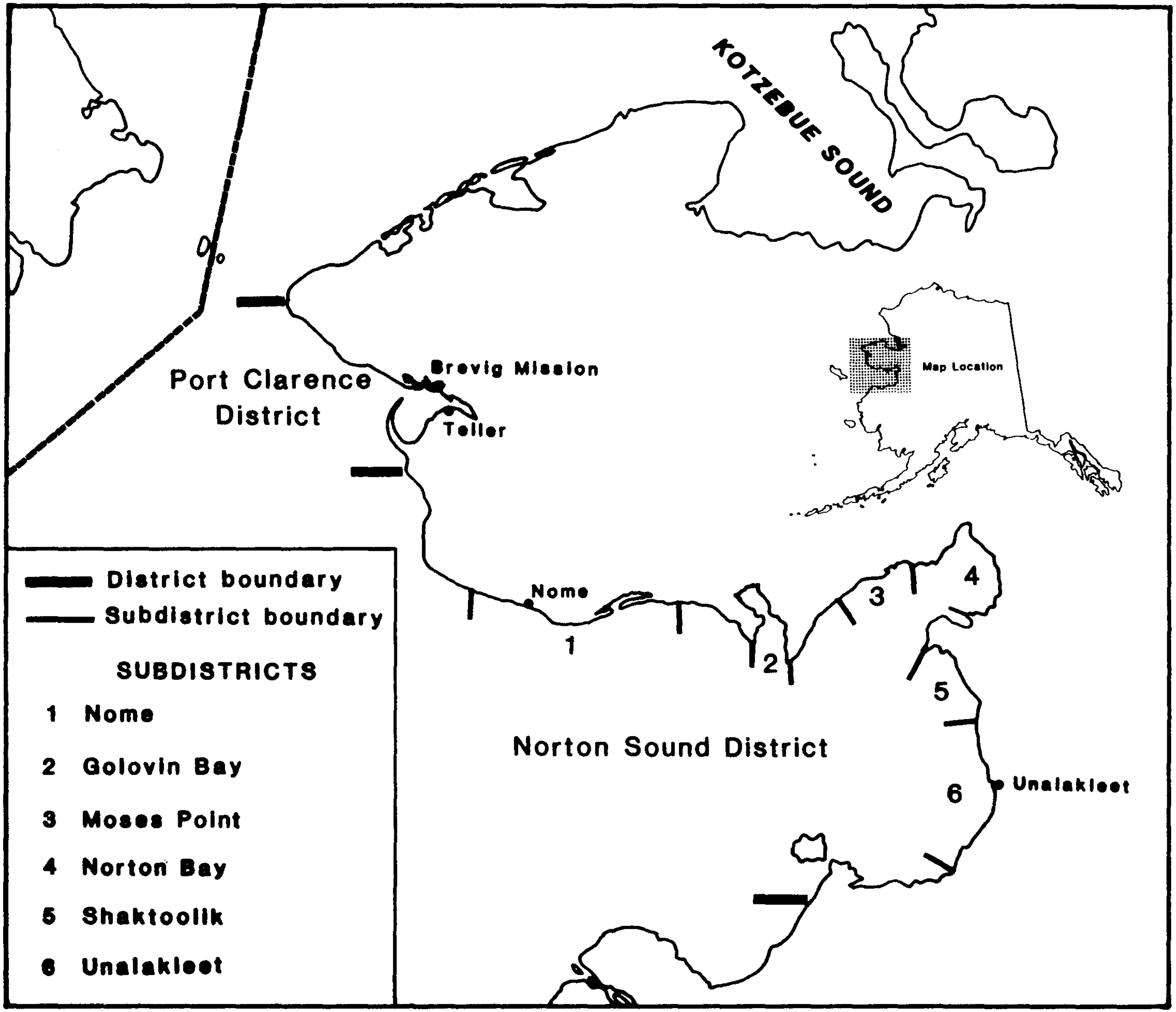
A. Boundaries

The Norton Sound District (see map 2) consists of all waters between the latitude of the westernmost tip of Cape Douglas and the latitude of Canal Point Light. The following are the six regulatory subdistricts that comprise the Norton Sound District:

1) Subdistrict 1 (Nome) - all waters from the terminus of Penny River to the tip of Topkok Head

2) Subdistrict 2 (Golovin Bay) - all waters from the tip of Rocky Point to the southernmost tip of Cape Douglas

3) Subdistrict 3 (Moses Point) - waters from an ADF&G regulatory marker located three-fourths of a mile east of Elim Village on Elim Point to the terminus of Kwik River



Map 2. Commercial salmon fishing districts and subdistricts of the Norton Sound-Port Clarence Management Area (ADF&G 1984a).

4) Subdistrict 4 (Norton Bay) - waters from the terminus of the Kuiuktulik River located 8 mi southwest of Koyuk to the tip of Island Point

5) Subdistrict 5 (Shaktoolik) - waters from the westernmost tip of Cape Denburgh to the terminus of Junction Creek located 7 mi north of Egavik

6) Subdistrict 6 (Unalakleet) - waters from the terminus of Junction Creek located 7 mi north of Egavik to the tip of Beach Point (ADF&G 1985b).

Information in the following narratives will be presented by species within the Norton Sound District.

B. Fishery Description and Reported Use

Salmon in the Norton Sound District are harvested for both subsistence and commercial use. Combined catches have ranged from 95,813 salmon in 1965 to 609,898 salmon taken in 1982 (ADF&G 1984b).

1. All species harvest:

a. Commercial harvest summary. Five species of salmon are harvested in the Norton Sound commercial fishery. Commercial exploitation began in 1961, centering in the Shaktoolik and Unalakleet subdistricts. Interest during the early years of the fishery focused upon the harvest of chinook and coho salmon. These fish were frozen and flown to Anchorage for additional processing (ibid.). The concurrent pink and chum salmon harvest was purchased and processed by an American freezer ship. Operation of two floating canneries in the district the following year caused expansion of the fishery into the Norton Bay, Moses Point, and Golovin Bay subdistricts. Canned production of salmon diminished after the 1963 season. Commercial harvest levels were a reflection of the available tendering and processing facilities, which until recently were limited. Better availability of processing facilities in recent years has resulted in a more consistent and intensive fishery in most of the Norton Sound District (ibid.). Currently, most process ing operations freeze or ice the catch for later shipment (ibid.). During the 1984 season, six domestic processors bought fish on the grounds, and Nome District fishermen sold salmon locally to individuals, restaurants, and grocery stores. In addition, there was a joint venture between 3NC, a fishermen group, and the North Pacific Longline Gill Net Association under a permit issued by the governor's office. Two Japanese freezer ships were allowed to buy Norton Sound pink and chum salmon taken from the Golovin, Moses Point, and Norton Bay subdistricts (Eggers 1985).

Since 1974 the commercial harvest of salmon has ranged from 193,060 fish taken in 1976 to a peak harvest of 531,948 fish taken in 1978. About 40% of the harvest occurs in the Unalakleet Subdistrict, followed by the Golovin Bay Subdistrict at 22%, and the Shaktoolik and Moses Point subdistricts at approximately 15% of the total catch (table 1).

Approximately 13,000 people reside in more than 26 small villages in the Norton Sound area. Most of the residents are Eskimos dependent to varying degrees upon fish and game resources for their livelihood (ADF&G 1984a).

b. Commercial fishing effort. By 1983, 201 limited entry permits had been issued to salmon fishermen in the Kotzebue District (CFEC 1983). A total of 194 permits were renewed for the 1984 season, with only 141 permits fished. During the past five years, fishing effort in Norton Sound has been stable, with an average seasonal participation of 168 fishermen during the past five years (Schwarz and Lean 1984).

c. Subsistence harvest summary. Subsistence harvest of salmon in the Norton Sound District prior to the 1983 and 1984 seasons was grouped by reported catches in permit returns. Harvest figures in 1983 and 1984 were obtained by harvest survey but were partial because the surveys were not performed throughout the district. The subsistence harvest of salmon has been significant, with reported catches reaching 92,422 fish during the 1980 season (table 2). Most of the reported subsistence harvest came from the Unalakleet and Nome subdistricts. Primary species harvested, in order of magnitude, are pink, chum, and coho salmon. Catches of chinook salmon are very small, and sockeye salmon are few.

2. Chum salmon:

a. Commercial harvest summary. The timings of pink and chum salmon runs overlap considerably (ADF&G 1984b). Though pink salmon are believed to be more abundant in the Norton Sound District, the commercial fishery targets upon chum salmon. Catches during the past 10 years have ranged from 95,956 fish harvested during the 1976 season to 319,437 chum salmon caught in 1983; the catch has averaged about 183,868 fish annually (table 3).

Although the timing of the run differs for each subdistrict, about 89% of the districtwide harvest was taken between June 5 and July 23 (Lean et al. 1984). The Unalakleet, Golovin Bay, and Moses Point subdistricts account for the greatest proportion of the catch, accounting for about 89% of the harvest from 1975 through 1984 (table 3). During the same decade, the chum salmon harvest represented about 49% of the Norton Sound District's total salmon catch (tables 1 and 3).

Table 2. Subsistence Salmon Harvest (All Species) in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	9,224	7,399	15,498	17,618	10,757	30,515	15,938	25,889	17,215	23,619
Golovin Bay	4,037	3,123	3,701	3,532	6,231	15,488	12,229	7,916	---	---
Moses Point	1,796	6,586	2,562	3,669	8,179	5,985	11,726	9,158	---	---
Norton Bay	455	279	2,489	2,303	2,844	5,462	5,918	9,158	---	---
Shaktoolik	1,760	1,602	2,994	4,541	5,912	5,867	6,248	7,236	---	---
Unalakleet	7,033	7,984	17,235	20,292	12,527	30,105	16,686	32,691	26,998	29,092
District total	24,305[a]	26,973	44,479	51,955	46,450	93,422	68,745[b]	92,048	44,213	52,711

Source: ADF&G 1984a.

--- means no data were available.

a Includes 11 recorded sockeye salmon in all subdistricts.

b Includes 38 recorded sockeye salmon in all subdistricts.

Table 3. Commercial Chum Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	8,364	7,620	15,998	8,782	5,391	13,922	18,666	13,447	11,691	3,744
Golovin Bay	41,761	30,219	53,912	41,462	30,201	52,609	58,323	51,970	48,283	54,153
Moses Point	46,699	10,890	47,455	44,595	37,123	14,755	29,325	40,030	65,776	9,477
Norton Bay	17,385	7,161	13,563	21,973	15,599	7,855	3,111	7,128	17,157	3,442
Shaktoolik	49,536	15,798	36,591	35,388	22,030	27,453	21,097	26,240	67,310	32,309
Unalakleet	48,740	24,268	32,936	37,079	30,445	64,198	39,186	44,520	109,220	43,317
District total	212,485	95,956	200,455	189,279	140,789	180,792	169,708	183,335	319,437	146,442

Source: ADF&G 1984a.

b. Subsistence harvest summary. Harvest of chum salmon is second in magnitude to that of pink salmon in the subsistence fishery. Catches during the past 10 years have ranged from 7,718 fish in 1976 to about 28,181 fish in 1981. About 8,191 chum salmon were harvested in the 1984 fishery (table 4).

3. Pink salmon:

a. Commercial harvest summary. Pink salmon returning to the Norton Sound District appear to be the most abundant species in the district (ADF&G 1984a). Although pink salmon are caught throughout the Norton Sound District, the Unalakleet, Golovin Bay, and Moses Point subdistricts have accounted for about 84% of the harvest from 1975 through 1984. During the same time period, catches ranged from 32,388 fish taken in 1975 to 325,503 salmon harvested during the 1978 season, averaging 154,832 fish annually (table 5).

b. Subsistence harvest summary. About 55% of the subsistence salmon harvest since 1975 has been comprised of pink salmon (tables 2 and 6). Catches have ranged from about 14,496 fish in 1977 to 63,778 fish in 1980 (table 6).

4. Coho salmon:

a. Commercial harvest summary. The commercial harvest of coho salmon has comprised about 9% of the total Norton Sound commercial salmon catch. The Shaktoolik and Unalakleet subdistricts account for about 19% and 73% of the total catch, respectively (table 7). Coho salmon show later run-timing into Norton Sound District than the other salmon species, appearing in August (ADF&G 1984b). Catches during the 1983 season were first reported the week of July 10-16, extending through August (Lean et al. 1984). Catches of coho salmon for the Norton Sound District have increased gradually from a low of 3,690 fish taken in 1977 to 91,690 coho salmon harvested in 1982. About 67,875 coho salmon were taken during the 1984 season (table 7).

b. Subsistence harvest summary. Coho salmon subsistence catches have ranged from 192 fish harvested during the 1975 fishery to a peak of about 15,963 salmon taken during the 1982 season. The harvest has averaged about 6,9112 fish per year (table 8). The Unalakleet, Nome, Moses Point, and Shaktoolik subdistricts produce most of the catch.

5. Chinook salmon:

a. Commercial harvest summary. In the Shaktoolik and Unalakleet subdistricts, a directed commercial fishery for chinook salmon occurs early in the season (ADF&G 1984b). Chinook salmon catches have been strong since 1978 because of the increased abundance of local and

Table 4. Subsistence Chum Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

	Year									
Subdistrict	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	2,858	1,705	12,192	4,295	3,273	5,983	8,579	4,831	7,091	4,843
Golovin Bay	2,025	1,128	2,915	1,061	2,840	4,057	5,543	1,868	---	---
Moses Point	508	1,548	1,170	1,229	1,195	1,393	2,819	3,537	---	---
Norton Bay	361	236	2,055	1,060	1,400	1,132	3,515	3,537	---	---
Shaktoolik	334	269	2,190	1,170	1,670	1,827	3,490	1,165	---	---
Unalakleet	2,038	2,832	6,085	3,442	1,597	5,230	4,235	4,694	4,401	3,348
District total	8,124	7,718	26,607	12,257	11,975	19,622	28,181	16,095	11,492	8,191

Source: ADF&G 1984a.

--- means no data were available.

Table 5. Commercial Pink Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

	Year									
Subdistrict	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	2,163	1,331	65	22,869	5,860	10,007	3,202	18,512	308	0
Golovin Bay	10,770	24,051	7,928	72,033	45,948	10,774	49,775	39,510	17,414	88,588
Moses Point	4,407	5,072	9,443	39,694	40,811	1,435	26,417	9,849	17,027	28,035
Norton Bay	1,737	4,456	2,495	8,471	6,201	47	177	2,535	3,935	1,162
Shaktoolik	1,774	15,803	7,743	46,236	18,944	1,947	29,695	17,019	12,031	1,596
Unalakleet	12,137	37,203	21,001	136,200	49,647	203,142	123,233	142,856	26,198	0
District total	32,388	87,916	48,675	325,503	167,411	227,352	232,499	230,281	76,913	119,381

Source: ADF&G 1984a.

Table 6. Subsistence Pink Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

	Year									
Subdistrict	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	6,267	5,492	2,773	13,063	6,353	22,246	5,584	19,202	8,086	17,052
Golovin Bay	2,011	1,995	703	2,470	2,546	10,727	5,158	4,742	---	---
Moses Point	1,280	5,016	1,145	1,995	6,078	4,232	6,530	3,785	---	---
Norton Bay	93	41	420	1,210	735	4,275	2,314	3,785	---	---
Shaktoolik	1,394	1,188	585	3,275	2,575	3,227	2,225	3,865	---	---
Unalakleet	4,758	4,316	8,870	13,268	6,960	19,071	5,750	20,045	13,808	17,418
District total	15,803	18,047	14,496	35,281	25,247	63,778	28,741	55,424	21,894	34,470

Source: ADF&G 1984a.

--- means no data were available.

Table 7. Commercial Coho Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	319	26	58	0	29	0	508	1,183	261	820
Golovin Bay	206	1,311	426	94	1,606	328	13	4,281	295	2,462
Moses Point	0	232	6	244	177	0	5	318	0	5,959
Norton Bay	89	95	1	144	2,547	0	0	2,332	204	0
Shaktoolik	812	129	418	1,116	3,383	8,001	1,191	22,233	12,877	10,730
Unalakleet	3,167	5,141	2,781	5,737	23,696	21,512	29,845	61,343	36,098	47,904
District total	4,593	6,934	3,690	7,335	31,438	29,841	31,562	91,690	49,735	67,875

Source: ADF&G 1984a.

Table 8. Subsistence Coho Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	97	189	498	225	1,120	2,157	1,726	1,829	1,911	1,625
Golovin Bay	1	---	80	---	845	692	1,520	1,289	---	---
Moses Point	6	---	225	407	890	229	2,345	1,835	---	---
Norton Bay	---	---	---	21	697	33	82	1,835	---	---
Shaktoolik	14	121	170	15	1,605	756	525	2,138	---	---
Unalakleet	74	694	1,557	2,538	3,330	4,758	5,808	7,037	6,888	6,675
District total	192	1,004	2,530	3,206	8,487	8,625	12,006	15,963	8,799	8,300

Source: ADF&G 1984a.

--- means no data were available.

Yukon River stocks, which are intercepted in the Norton Sound District fisheries (ibid.). During the 1983 fishery, about 86% of the harvest occurred in the Norton Sound District between June 12 and July 2 (Lean et al. 1984). Since 1974, chinook salmon catches have ranged from 2,243 fish taken in 1976 to a peak harvest of 10,666 salmon harvested in the 1979 fishery. About 8,455 salmon were harvested during the 1984 fishery. The Shaktoolik and Unalakleet subdistricts consistently produced the largest chinook salmon catches accounting for about 22% and 69% respectively of the harvest during the past ten years (table 9).

b. Subsistence harvest summary. Subsistence catches of chinook salmon primarily occur within the Nome, Shaktoolik, Unalakleet, Moses Point, and Nome subdistricts. Catches have averaged 1,023 fish per year, ranging from 186 fish harvested during the 1975 season to a peak catch of 1,942 fish in 1983 (table 10).

6. Sockeye salmon:

a. Commercial harvest summary. Sockeye salmon production in the Norton Sound District is minimal. Catches have remained below 60 fish annually and have occurred incidentally to fisheries for other salmon species in the Golovin Bay, Shaktoolik, and Golovin Bay fisheries (table 11).

b. Subsistence harvest summary. Harvest of sockeye salmon in the subsistence fishery has yet to be documented.

C. Harvest Methods

1. Commercial. Commercial fishing gear is restricted to set gill nets, with a maximum aggregate length of 100 fathoms allowed for each fisherman. There are no mesh or depth restrictions during the normally scheduled periods. The majority of the gill nets fished are approximately 5 1/2-inches stretched measure. In the Unalakleet and Shaktoolik subdistricts, 8 1/2-inch stretched-mesh gill nets are commonly used during the chinook salmon run in June through early July. During years when large pink salmon runs occur, the department provides fishing periods when nets of only 4 1/2-inch mesh or less may be set or drifted. These special pink salmon periods are an attempt to target pink salmon without overharvesting the other, larger-sized species.

2. Subsistence. Salmon for subsistence use may be taken by gill net, beach seine, or fish wheel (ADF&G 1985b).

D. Period of Use

1. Commercial. Commercial fishing seasons are specific to each subdistrict. The commercial harvest of salmon may occur in Subdistrict 1 from July 1 through August 31. In Subdistricts 2 and 3, the season opens by emergency order between June 8 and June 20, depending upon the timing of the salmon returns

Table 9. Commercial Chinook Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

	Year									
Subdistrict	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	2	2	8	19	9	8	4	20	23	7
Golovin Bay	17	12	26	22	75	36	23	78	52	31
Moses Point	16	24	96	444	1,035	502	198	253	254	0
Norton Bay	68	102	158	470	856	340	63	96	215	0
Shaktoolik	651	892	1,521	1,339	2,337	1,086	1,484	1,677	2,742	1,613
Unalakleet	1,638	1,211	2,691	7,525	6,354	4,339	6,152	3,768	7,022	6,804
District total	2,392	2,243	4,500	9,819	10,666	6,311	7,929	5,892	10,308	8,455

Source: ADF&G 1984a.

Table 10. Subsistence Chinook Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

Subdistrict	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	2	13	35	35	11	129	35	21	74	83
Golovin Bay	0	0	3	1	0	12	8	7	---	---
Moses Point	2	22	22	38	16	131	32	1	---	---
Norton Bay	1	2	14	12	12	22	7	1	---	---
Shaktoolik	18	24	49	81	62	57	8	68	---	---
Unalakleet	163	142	723	1,044	640	1,046	869	913	1,868	1,650
District total	186	203	846	1,211	741	1,397	959	1,011	1,942	1,733

Source: ADF&G 1984a.

--- means no data were available.

Table 11. Commercial Sockeye Salmon Harvest in Numbers of Fish in the Norton Sound District, 1975-84

	Year									
Subdistrict	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Nome	0	10	0	0	0	0	0	0	0	0
Golovin Bay	0	0	0	0	49	36	5	5	10	0
Moses Point	0	0	0	0	0	0	0	0	0	0
Norton Bay	0	0	0	0	0	0	0	0	0	0
Shaktoolik	2	0	4	7	0	0	4	3	4	0
Unalakleet	0	1	1	5	8	3	47	2	13	6
District total	2	11	5	12	57	39	56	10	27	6

Source: ADF&G 1984a.

Table 12. Commercial Salmon (All Species) Harvest in Numbers of Fish in the Kotzebue Sound District, 1975-84

Species	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984[a]
Chinook	---	3	10	146	227	223	79	67	121	107
Sockeye	0	0	0	0	0	0	0	0	0	0
Coho	0	0	0	0	0	0	0	0	0	0
Pink	---	47	11	6,980	693	1,537	156	2	114	0
Chum	553,000	159,656	192,506	111,533	141,539	366,453	677,428	415,741	175,648	320,206
District total	553,000	159,706	192,527	118,590	142,459	368,213	677,663	415,810	175,883	320,313

Source: ADF&G 1985a; Bigler, pers. comm.

--- means no data were available.

a Preliminary data.

into the area. Though the closing date for Subdistricts 2 and 3 is August 31, by regulation, processors have usually terminated their operation earlier in August. The commercial fishing season in Subdistricts 4, 5, and 6 opens between June 8 and June 20, extending through September 7 (ADF&G 1984b, 1985b).

In Subdistrict 1, salmon may be taken from 6:00 p.m. Monday to 6:00 p.m. Tuesday and from 6:00 p.m. Thursday to 6:00 p.m. Friday. In Subdistricts 2, 3, 4, 5, and 7, salmon may be taken only from 6:00 p.m. Monday until 6:00 p.m. Wednesday and from 6:00 p.m. Thursday until 6:00 p.m. Saturday (ADF&G 1985b).

2. Subsistence. In the Norton Sound District, fish may be taken for subsistence purposes, except as follows:

   In subdistrict 1 from June 15 through August 31, salmon may be taken only from 6:00 p.m. Monday until 6:00 p.m. Wednesday and from 6:00 p.m. Thursday until 6:00 p.m. Saturday (ibid.).

   In subdistricts 2 through 6, commercial fishermen may not fish for subsistence purposes during the weekly closures of the commercial salmon fishing season, except that from July 15 through August 1, commercial fishermen may take salmon for subsistence purposes seven days per week in the Unalakleet and Shaktoolok river drainages with gill nets having a mesh size that does not exceed 4 1/2 inches, and with beach seines (ibid.).

E. Management Objectives and Considerations

The main objective of the ADF&G program is to manage the commercial salmon fishery on a sustained yield basis. The Norton Sound District is managed on the basis of comparative commercial catch data, escapements, and weather conditions. A single factor or combination of factors may result in issuance of emergency orders affecting seasons, fishing periods, mesh size, and areas (ADF&G 1984a).

Management of the salmon fishery is complicated by the difficulty in obtaining valid escapement data in this large area and by insuffiicent comparative catch-and-return information. Management problems are compounded by the need to provide not only for adequate escapements but for the needs of several different user groups. Past ADF&G policy has been to provide for subsistence as the primary beneficial use of the fishery resource. This policy is now state law. If the subsistence harvest or demand increases, commercial fishing may be restricted. It should be pointed out that increases in the efficiency of commercial fishing techniques are expected, which may balance any immediate decline in subsistence utilization or increase in run size, with the result that present regulations will be maintained or made even more restrictive (ibid.).

The basic regulation that governs the commercial salmon harvest in all districts is the scheduled weekly fishing period. Commercial fishing is provided by regulation for a total of two to four days a week during the open season, depending on area and season. The department attempts to spread fishing effort throughout the entire run to avoid harvesting only particular segments of the run. Occasionally, fishing time is increased or decreased by emergency order, depending upon fishing conditions and the strength of the runs or spawning escapements, as determined by special studies conducted by the ADF&G (ibid.).

Management considerations and objectives differ by season and subdistrict. One of the largest and confining problems of the Norton Sound District, however, exists within the Nome Subdistrict. Salmon passing through the Nome Subdistrict are faced with fishing pressure from commercial, subsistence, and sport users. Unlike other subdistricts, nearly all spawning streams of the Nome Subdistrict are accessible by road to subsistence and sport fishermen. The commercial fishery, which also targets upon chum salmon most years, must be managed conservatively because of the importance of subsistence fishing, the limited abundance of local chum salmon stocks, and the interception of other stocks bound for Kotzebue Sound, Port Clarence, and eastern Norton Sound fisheries (ADF&G 1984c). Restrictions upon commercial fishing time and area and upon harvest limits of the subsistence harvest were imposed in 1984 to help conserve local chum and coho salmon population (ibid.).

F. Significance of Particular Use Areas

A series of 1:250,000-scale reference maps have been prepared that depict areas used for commercial salmon harvest. Categories of mapped information include the following:

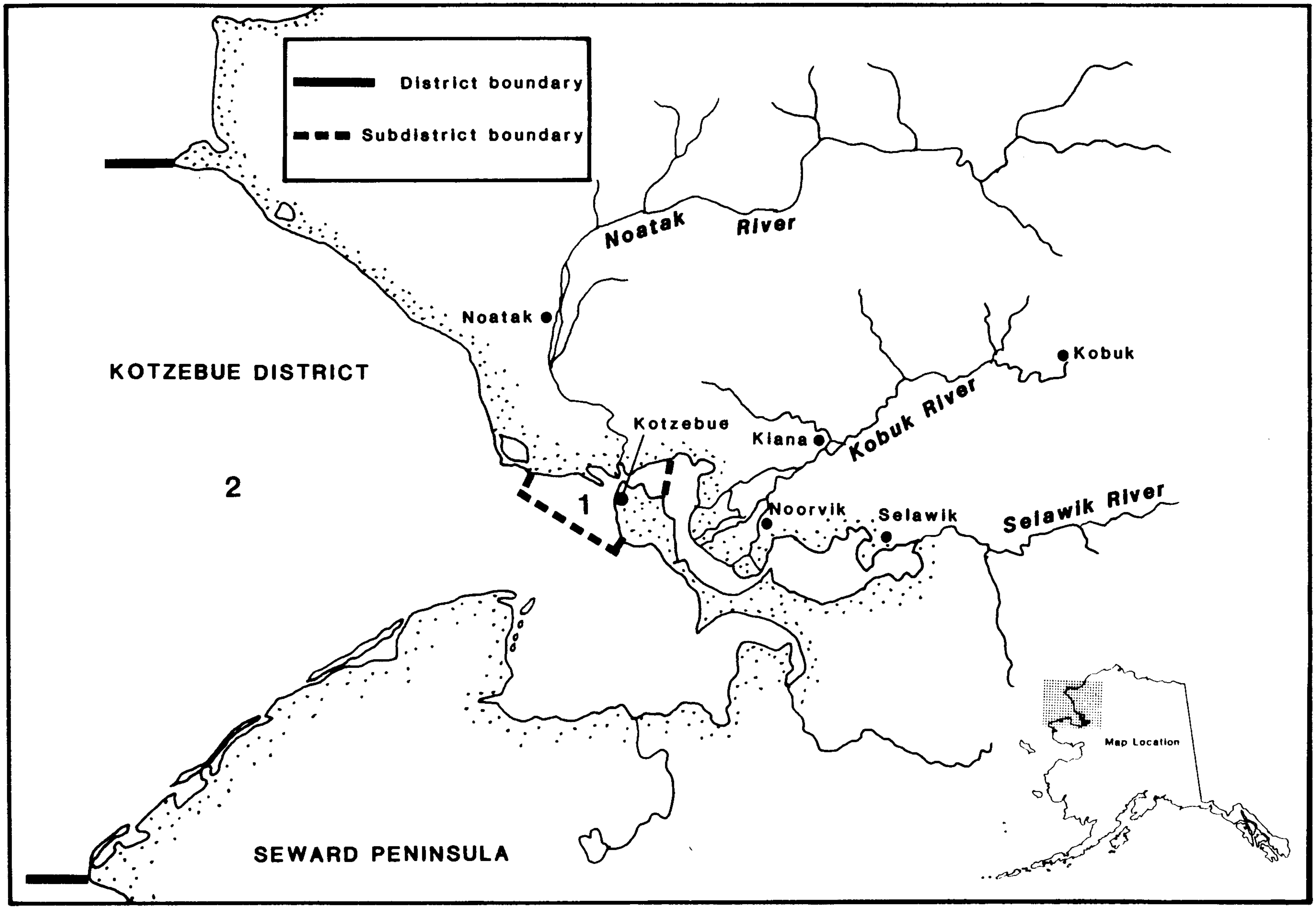
- Gear type
- Target species

II. KOTZEBUE DISTRICT

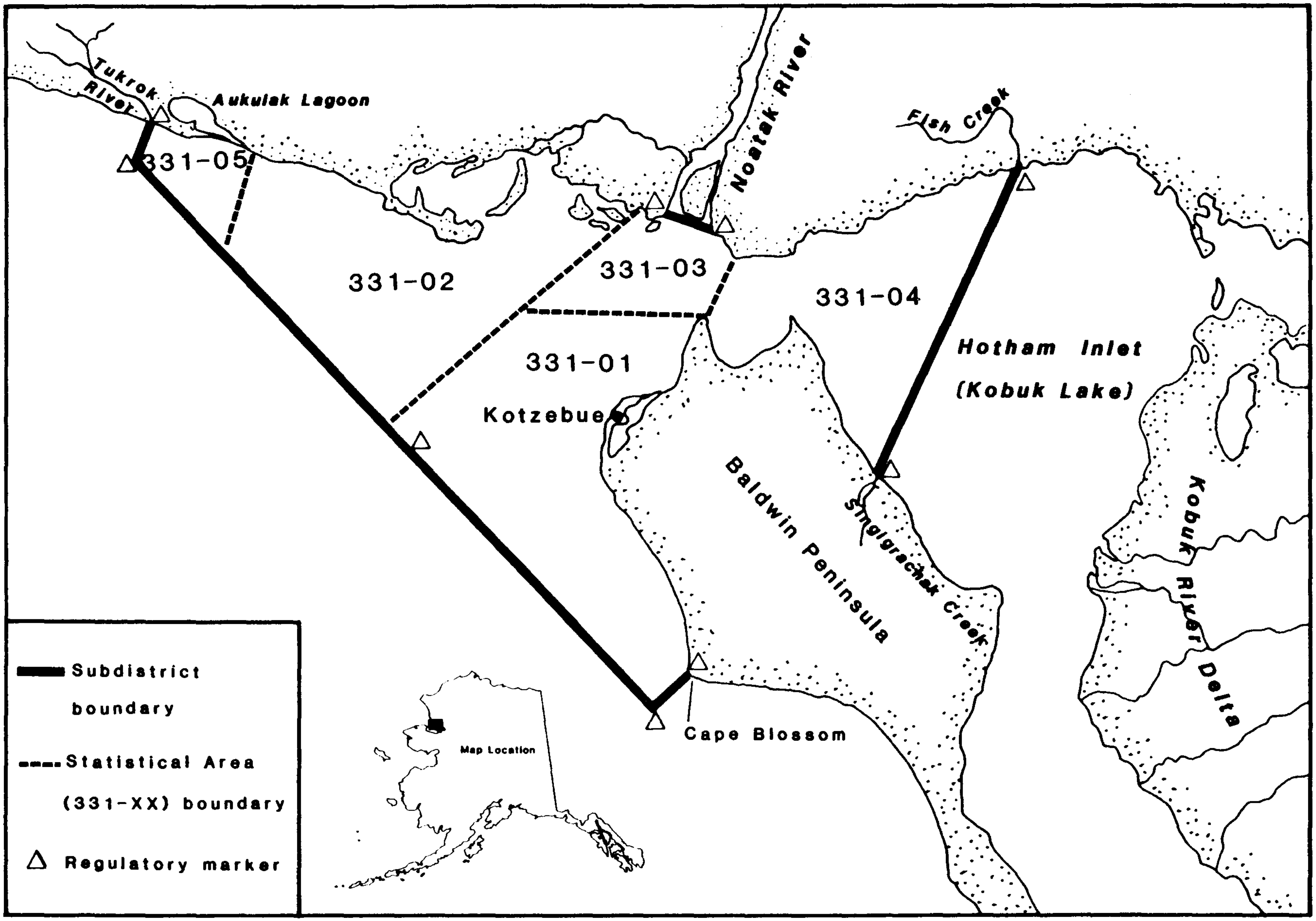
A. Boundaries

The Kotzebue District consists of all waters of Alaska between the latitude of the westernmost tip of Point Hope and the latitude of the westernmost tip of Cape Prince of Wales, including those waters draining into the Chukchi Sea (ADF&G 1985b). The Kotzebue District is comprised of two subdistricts for regulatory purposes (ibid.).

Subdistrict 1 of the Kotzebue District consists of all waters east of a line 1 mi offshore from the terminus of the Tukrok River to an ADF&G regulatory marker located approximately 1 mi offshore from Cape Blossom to the westernmost tip of Cape Blossom and west of a line from an ADF&G regulatory marker placed near the Noatak River at 67° 02'north latitude, 161°59'west longitude to an ADF&G regulatory marker on the northern shore of the Baldwin Peninsula near the terminus of Singigrachak Creek (66°9'N,162°11'W). Subdistrict 2 consists of all remaining waters of the Kotzebue District (maps 3 and 4) (ibid.).



Map 3. Commercial salmon fishing subdistricts of the Kotzebue District (ADF&G 1985a, 1985b).



Map 4. Statistical areas of commercial salmon fishing subdistrict 1 of the Kotzebue District (ADF&G 1985b; Bigler pers. comm.).

B. Fishery Description and Reported Use

River systems within Kotzebue Sound support five species of Pacific salmon, of which chum salmon are most abundant (Bigler and Burwen 1984). The salmon resource has proved important to both commercial and subsistence users in this district.

1. Commercial harvest:

a. All-species summary. The first commercial fishing effort in the Kotzebue District occurred between 1914 and 1918. During this period, the Midnight Sun Packing Company processed a total of 10,130 cases (48 one-pound cans per case) and 300 barrels of hard-salt salmon in the Kotzebue area. It is believed that the entire catch was chum salmon. Commercial interest did not develop again until 1962 and has since continued. Chum, chinook, and pink salmon are commercially harvested in the Kotzebue District. Chum salmon, however, dominate the fishery.

Although fish were harvested in the 1983 fishery between July 11 and August 19, about 93% of the catch was taken between July 18 and August 12. The fishery peaked the week of July 28 (Lean et al. 1984).

b. Commercial fishing effort. The commercial harvest occurs primarily in Kotzebue Sound by fishermen gill-netting from outboard powered skiffs (ADF&G 1983). Fishing activity usually begins on July 10, when the fishery opens by regulation, continuing through August 31. Historically, the peak harvest occurs between August 4 and 10 (Bigler and Burwen 1984). During the 1983 fishery, about 90% of the harvest had been taken by August 10 (Lean et al. 1984). By 1983, 219 limited entry permits had been issued to fishermen for the Kotzebue salmon fishery (CFEC 1983).

c. Chum salmon. The commercial chum salmon fishery has increased in economic importance since 1962. Catches have fluctuated from a low of 29,400 chum salmon taken during the 1967 season to a record catch of 677,428 fish in 1981 (Bigler and Burwen 1984, table 12). The average harvest between 1962 and 1972 of 84,000 fish increased to an average harvest of about 347,000 chum salmon between 1973 and 1984 (ADF&G 1984c). Fluctuation in population size has been attributed to the vulnerability of a fish population to conditions inasmuch as it inhabits the northern extreme of the species range (ADF&G 1983, Bird 1982). About 320,206 chum salmon were taken during the 1984 season (table 12). About 99% of the salmon harvest in the Kotzebue Sound District are chum salmon (table 12). Fishing activity begins about July 10 and continues through August 31 with peak harvest occurring between August 4 and 10 (Bigler and Burwen 1984).

d. Pink salmon. Pink salmon are harvested incidentally to chum salmon in the commercial fishery. Catches are very small, averaging about 1,000 fish per year, and ranging from no catch at all to 6,983 fish (table 12). A substantial run of pink salmon returns to the Noatak River, with escapement counts reaching 92,280 fish (Bigler 1983). Pink salmon are not sought in the commercial fishery, however, because of their poor quality upon reaching the fishing grounds (Bigler, pers. comm.).

e. Chinook salmon. Chinook salmon are also harvested incidentally to chum salmon in the commercial fishery. Catches have averaged 109 fish annually and ranged from 3 fish in 1976 to 227 fish during the 1979 fishery (table 12).

f. Sockeye and coho salmon. No commercial harvest of sockeye and coho salmon in the Kotzebue District has been reported.

2. Subsistence harvest:

a. All species summary. Subsistence fishing for salmon has historically been an important activity for the Eskimo population in the Kotzebue District. Relics of spears and fishing nets dating to 1250 A.D. have been found in old village sites on the Kobuk River (ADF&G 1983). Currently, subsistence fishermen use set gill nets and beach seines (ibid.). Residents of the Kobuk River villages most commonly use set gill nets, although some beach seining is done in salmon-spawning areas late in the season. Beach seines are used almost exclusively by residents of the Noatak village on the Noatak River. Some chum salmon are harvested at fish camps on the Lower Noatak River by gill net as well. Subsistence fishing also occurs near Kotzebue, Sheshalik, and within Hotham Inlet (Bigler and Burwen 1984).

Subsistence catches, recorded since 1962, peaked during the 1982 fishing season at 30,133 fish. About 15,673 salmon (all species) were taken during the 1984 fishery. Between 1974 and 1984, subsistence catches averaged about 16,614 fish annually (table 13).

Chum salmon catches also dominate the subsistence fishery, with catches ranging from 9,752 fish in 1977 to about 30,133 fish harvested during the 1982 season (table 13). The documented harvest of all species shows catches of pink, sockeye, coho, and chinook salmon comprising less than 2% of the total subsistence take.

C. Harvest Methods

1. Commercial. Only set gill nets are legal for the commercial harvest of salmon in the Kotzebue District (ADF&G 1985b).

2. Subsistence. Salmon for subsistence use may be taken only by gill net on beach seines.

Table 13. Subsistence Salmon (All Species) Harvest in Numbers of Fish in the Kotzebue Sound District, 1975-84

Species	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Chinook	---	---	---	---	---	---	---	---	2	21
Sockeye	---	---	---	---	---	---	---	---	1	1
Coho	---	---	---	---	---	---	---	---	121[a]	18
Pink	---	---	---	---	---	---	---	---	213	125
Chum	27,605	15,765	9,752	12,864	14,605	10,635	17,766	30,133	10,287	15,508
District total	27,605	15,765	9,752	12,864	14,605	10,635	17,706	30,133	10,624	15,673

Source: ADF&G 1984a; Bigler, pers. comm.

--- means no data were available.

a Species identification not confirmed.

D. Period of Use

1. Commercial. Salmon may be commercially harvested in the Kotzebue Sound District from July 10 through August 31. Fishing periods are restricted to two 24-hour openings per week prior to August. Following August 1, the length of commercial openings is regulated by emergency order (ibid.).
2. Subsistence. Statewide provisions allow commercial fishermen to retain fish for their personal use from their legally harvested commercial catch. Commercial fishermen may not harvest salmon for subsistence purposes during weekly fishing closures. Persons not holding a valid commercial fishing period may taken salmon for subsistence purposes at any time (ADF&G 1985b).

E. Management Objectives and Considerations

The main objective of the department's program is to manage the commercial salmon fishery on a maximum sustained yield basis (ADF&G 1984c). Fisheries management is dependent upon catch, fishing effort, and spawning escapement data (ADF&G 1984b).

Kotzebue District chum salmon runs are primarily composed of stocks that spawn in the Noatak and Kobuk river drainages (Bigler and Burwen 1984). Commercial fishing effort is limited to an area near Kotzebue to prevent a cape fishery, which would intercept salmon from other streams (ADF&G 1982). The Kobuk River chum salmon run arrives in this district first, peaking between July 17 and 28 (ibid.). A segment of this run, however, destined for the upper part of the Kobuk River, passes through the commercial fishing district from middle to late August and is intermixed with Noatak River chum salmon. Timing of the larger Noatak run follows the Kobuk River run, peaking during August 1 through 14 (ibid.). The main challenge for management in this fishery is to separately manage and protect the weaker Kobuk River component of the run yet allow harvest of the more abundant Noatak River stocks (ADF&G 1983).

F. Significance of Particular Use Areas

A series of 1:250,000-scale reference maps have been prepared that depict areas used for commercial salmon harvest. Categories of mapped information include the following:

° Gear type
° Target species

IV. PORT CLARENCE DISTRICT

A. Boundaries

The Port Clarence District consists of all waters between the latitude of the westernmost tip of Cape Prince of Wales and the latitude of the westernmost tip of Cape Douglas (map 2) (ADF&G 1985b).

B. Fishery Description and Reported Use

1. All species harvest:
   a. Commercial harvest summary. The only commercial fishery

Table 14. Subsistence Salmon (All Species) Harvest in Numbers of Fish in the Port Clarence District, 1975-84

Species	Year									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984[a]
Chinook	0	7	---	1	0	7	8	23	17	---
Sockeye	244	291	---	392	320	3,195	255	405	261	---
Coho	5	20	---	0	35	5	110	100	---	---
Pink	743	436	---	7,783	741	3,170	765	4,345	615	---
Chum	1,589	6,026	---	705	1,658	1,715	5,845	684	299	---
District total	2,581	6,780	5,910	8,881	2,720	8,092	6,983	5,557	1,192	---

Source: ADF&G 1984a.

--- means no data were available.

a No surveys conducted.

for salmon held in the Port Clarence District occurred in July of 1966 (ADF&G 1966, ADF&G 1984a). A favorable market for fresh salmon in Japan and an attractive price per pound prompted fishermen from Teller to commercially fish for salmon in this area. Regulations were established in June, and the fishery opened the first week of July. A total of 1,216 salmon were harvested. The catch consisted of 93 sockeye salmon, 131 pink salmon, and 992 chum salmon (ADF&G 1966).

Though a few salmon are sold or traded each year in Teller or Nome, the small runs of salmon returning to this area are not of sufficient size to support both the important subsistence fishery and a commercial salmon fishery. Therefore, the commercial fishery for salmon has remained closed since the 1966 season (ADF&G 1984a).

b. Subsistence harvest summary. Salmon in the Port Clarence District have been used for subsistence purposes for centuries. Data collected by ADF&G personnel show fishermen from the Brevig Mission fishery in the northern and northeastern areas of the Port Clarence District. Fishermen from Teller harvest salmon primarily in Grantley Harbor, Tuksuk channel, and the Agiapuk River. Fishing within Salmon Lake and the Pilgrim River drainage is by residents of Nome (ADF&G 1984b). Since 1974, catches have ranged from a low of 1,192 fish taken during the 1983 season to a peak harvest of 8,881 salmon taken during the 1978 season (table 14). In the past decade, the subsistence harvest has averaged about 5,146 fish annually.

2. Chinook salmon harvest. The harvest of chinook salmon was nonexistent in the commercial fishery held in 1966. Catches are minor in the subsistence fishery, having ranged from no catch at all to a harvest of 23 chinook salmon taken during the 1982 season. The chinook harvest has accounted for less than .1% of the subsistence catch (table 14).

3. Coho salmon harvest. Coho salmon were not caught in the commercial fishery in 1966. The presence of coho salmon in the subsistence fishery has been consistent, although the harvest levels have fluctuated considerably. Since 1974, the coho subsistence harvest has averaged 37 fish annually, ranging from 0 to 110 fish taken during 1981. Catches of coho salmon in the subsistence fishery have decreased since 1974 (table 14). Between 1963 and 1973, catches averaged 444 fish per year, reaching a peak harvest of 1,074 fish during the 1970 fishery (ADF&G 1984a).

4. Pink salmon harvest. Approximately 10% of the commercial harvest in 1966 was pink salmon. Pink salmon have been a major component of the subsistence harvest, comprising about 37% of the total catch of the past 10 years. Within the same 10-year time frame, the harvest of pink salmon has ranged

from a low of 436 fish taken in 1976 to 7,783 salmon caught during the 1978 fishery (table 14).

5. Chum salmon harvest. Historically, chum salmon have dominated the subsistence harvest. Chum salmon also comprised over 82% of the commercial harvest during the 1966 fishery. In the subsistence fishery, catches have ranged from 299 fish taken in 1983 to 6,026 fish harvested during the 1976 season. Chum salmon have comprised about 42% of the total subsistence harvest and averaged about 2,562 fish per year (table 14).
6. Sockeye salmon harvest. Most of the sockeye salmon caught in the Port Clarence District are destined for spawning grounds in the Pilgrim River system, primarily Salmon Lake and the Grand Central River. The run into the Pilgrim River is believed to be the largest known northernmost population of sockeye salmon in Alaska (ADF&G 1966). Subsistence fishing in the area increased substantially since 1957, with road construction providing easier access for Nome residents (ibid.). In 1964, a permit system was authorized to limit subsistence catches of sockeye salmon. Another regulation prohibiting subsistence fishing in the Grand Central River was adopted the same year. These and additional restrictions resulted in declining subsistence catches of sockeye salmon in this district. In 1966, sockeye salmon comprised 7.6% of the commercial harvest. In the subsistence fishery, sockeye salmon have comprised about 12% of the total subsistence harvest between 1975 and 1983. Catches have ranged from 244 fish taken in 1975 to 3,195 fish harvested in 1980 (table 14). These figures show a marked decrease from catches taken between 1963 to 1973, during which time the sockeye salmon component comprised about 27% of the subsistence harvest. Catches during that time ranged from 46 fish harvested in 1973 to 4,866 sockeye salmon taken during the 1963 season and they averaged about 1,239 fish annually (ADF&G 1984a).

C. Harvest Methods

For subsistence purposes, harvest of salmon may be by gill net, beach seine, or fish wheel (ADF&G 1985b).

D. Period of Use

Currently, fish in the Port Clarence District may be harvested for subsistence purposes at any time, with the exception of the period July 1 through August 15, when salmon may be harvested from 6:00 p.m. Thursday until 6:00 p.m. Tuesday (ibid.).

E. Management Objectives and Considerations

Proper management of the salmon fishery is inhibited by little knowledge of run-timing, run magnitude, subsistence utilization, distribution of spawners, and the basic life history of salmon stocks in the area. The Salmon Lake sockeye salmon return has been depressed for many years and may be below threshold population levels because of heavy subsistence use. The difficulty, however, in managing the subsistence fishery to give further protection to the sockeye run is that the pink, chum, and sockeye salmon enter this district and migrate in the Pilgrim River as a mixed-stock run. Placing further restrictions upon the fishery without the information necessary to formulate stock-specific management strategy would result in the inability of subsistence fishermen to harvest sufficient numbers of the healthy chum and salmon stocks (Pope 1981).

F. Significance of Particular Use Areas

Because no commercial harvest of salmon has occurred in the Port Clarence District since 1966 no maps of commercial harvest areas have been prepared.

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Commercial Harvest of King Crab

I. POPULATION MANAGEMENT HISTORY

A. Introduction

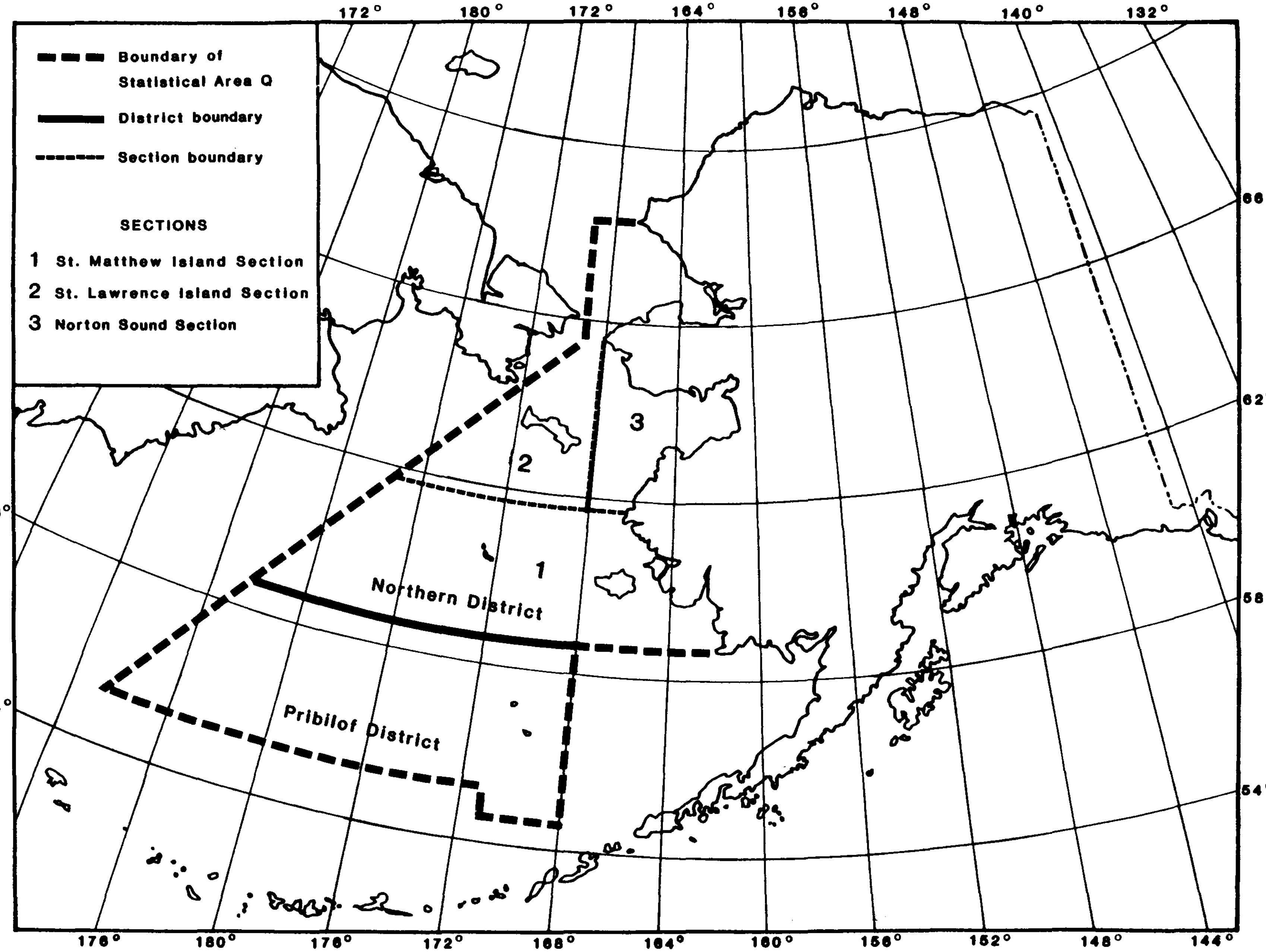
The Bering Sea Statistical Area (Statistical Area Q) for king crab includes waters of the Bering and Chukchi seas north of Cape Sarichef (54°36'N) and east of the United States-Russian convention line of 1867 (see map 1). Its northern boundary is the latitude of Point Hope (68°21'N). The area is separated into two fishing districts: the Pribilof and Northern districts. The Northern District contains the waters of Statistical Area Q north of the latitude of Cape Newenham (38°39'N) and is divided into the St. Matthew Island, St. Lawrence Island, and Norton Sound sections (ADF&G 1984a). The Norton Sound and St. Lawrence Island sections are located within the Arctic Region. The St. Matthew Island Section occurs in the Western Region. In this narrative, information will be presented for the Norton Sound Section and combined for the St. Matthew and St. Lawrence islands sections.

B. Summary of Fishery

1. Harvest summary. Currently, three species of king crabs are of commercial interest. Red king crab (*Paralithodes camtshatica*) has been the more abundant and most widely distributed species in the Bristol Bay Registration area. Blue king crab has been the most abundant and widely distributed species in the Pribilof and Northern districts (Griffin, pers. comm.). Red king crab has been targeted by the commercial fishery. With declines in red king crab populations, interest and harvest effort for blue king crab (*P. platypus*) and brown king crab (*Lithodes aequispina*) have intensified.

   The commercial harvest of king crab in the eastern Bering Sea was initiated by the Japanese in 1930. During the first year, approximately one million red king crabs were caught with tangle nets in the area north of the Alaska Peninsula by a fleet of 12 small catcher boats (Bakkala et al. 1976). Fishing did not occur in 1931, but each year from 1932 through 1939 one or two Japanese factory ships operated in the area. During this eight-year period, some 7.6 million crabs were taken from the Bering Sea (Miyahara 1954). The Japanese discontinued fishing after the 1939 season.

   The United States conducted exploratory fishing and processing studies on the king crab resource in 1940 and 1941. Ignorance of Japanese canning techniques, an import-dominated market, and a healthy salmon fishery that left little incentive for winter fishing (Gray et al. 1965) were factors partly responsible for the late entry of American fishermen and processors into the king crab fishery.



Map 1. King crab fishing districts and sections of Statistical Area Q (ADF&G 1984).

In March of 1948, the factory ship Pacific Explorer left Seattle with a fleet of 10 fishing vessels to fish for both groundfish and king crab; king crab was the target species. This fleet used otter trawls and tangle nets to catch a total of 387,250 crabs. The success of these exploratory fishing ventures resulted in development of a small United States trawl fishery for king crab in the Bering Sea (NPFMC 1980).

Between 1949 and 1952, commercial operations by United States fishermen in the eastern Bering Sea yielded 4,250 metric tons of crab (Otto 1981). Domestic trawlers continued to fish for crabs until after the 1957 season, when development of a successful pot fishery for king crab south of the Alaska Peninsula attracted domestic crab fishermen from the eastern Bering Sea. In 1959, no domestic catch was reported from the Bering Sea (NPFMC 1980).

Japan reentered the eastern Bering Sea king crab fishery in 1953 with a catch of 1.3 million crabs weighing approximately 5,100 metric tons. Japanese landings, however, were less than 4,500 metric tons through the remainder of the 1950's (Otto 1981).

The USSR entered the fishery in 1959 with a catch of 620,000 crabs weighing about 1,000 metric tons (ibid.). The combined catch of these two countries peaked in 1964 when about 9 million crabs were harvested (Bakkala et al. 1976).

Domestic fishermen increased their effort for king crab in the Bering Sea in 1970 as stocks in the Gulf of Alaska became heavily exploited. In the late 1960's and early 1970's, the domestic harvest of red king crab increased, but the total catch by all countries declined to less than one-half the peak years of 1962-1964. The reduced foreign catch was partly a result of declining stocks and partly a result of agreements that limited harvest size and fishing gear (ibid.). In 1971, the Soviets ceased fishing for king crab in the area, and by 1975, after four years of very low catches, the Japanese ceased operation. The king crab fishery of the eastern Bering Sea has been a domestic effort since the mid 1970's.

The Bering Sea fishery for king crab has traditionally taken the harvest from Bering Sea and Bristol Bay waters along the Alaska Peninsula from Cape Sarichef to Port Heiden. In 1973, however, fishing for blue king crab began in the Pribilof District. By 1977, exploratory fisheries developed for red king crab in the Norton Sound District and for blue king crab near the St. Lawrence and St. Matthew islands (ADF&G 1981).

Currently, all three species of king crabs are harvested in the Northern District. Combined catches since 1977 have ranged from about 2.3 million pounds harvested the first year of the fishery to 10.1 million pounds taken during the 1983 season. About 4.2 million pounds were harvested in 1984 (tables 1 and 3). During the 1984 season, about 48% of the

Table 1. Commercial Harvest in Thousands of Pounds and Effort for King Crab Fisheries in the Norton Sound Section of the Northern District of the Bering Sea, 1977-84

Fishing Section	Fishery and Species	Year							
		1977	1978	1979	1980	1981	1982	1983	1984
Norton Sound	Summer red catch	520	2,100	2,900	1,200	1,400	230	370	390
	Effort[a]	7	8	34	9	36	11	23	8
	Winter red catch[c]	0	27	[d]	0.66[d]	0	[e]	1.51[e]	2.4
	Effort[b]		37	1	1	0	1	5	8
	Management area total catch	520	2,127	2,900	1,200.66	1,400	230	371.51	392.4

Source: Schwarz and Lean 1985.

a Number of vessels.

b Number of fishermen.

c Winter catch, reported as number of crabs; therefore numbers multiplied by 2.8 lb per crab, the average crab weight during the 1984 summer fishery.

d Harvest combined for 1979 and 1980 to protect confidentiality.

e Harvest combined for 1982 and 1983 to protect confidentiality.

entire king crab harvest in Bering Sea waters (Statistical Area Q) was taken in the Northern District (see map 1) (ADF&G 1985).

2. Managerial authority. Prior to statehood, Alaskan king crab fisheries were managed by the United States Bureau of Fisheries. In 1959, management was transferred to the State of Alaska. By 1960, the king crab fleet had expanded into offshore areas beyond the state's 3-mi jurisdictional boundary. With enactment of the Fishery Conservation Zone (FCZ) from 3 to 200 nautical miles from shore and by pending memorandum of agreement between the State of Alaska and the federal government, the management of the Bristol Bay, Adak, Dutch Harbor, Bering Sea, and Aleutian Islands king crab statistical areas is by a joint statement of principles between the Alaska Board of Fisheries and the National Marine Fisheries Service.

3. Harvest methods and period of use. Harvest seasons for king crab have historically been used in the king crab fishery to protect crabs during the mating, molting, and growing period of their life cycle, which usually occurs from mid January through mid July in most areas of the State of Alaska. By law, the fishing season may therefore occur from August through mid January. Seasons differ by management area as environmental and biological concerns may be considered (e.g., recovery rate, migrational patterns, weather conditions, etc.).

   To maximize the reproductive potential of the crab resource, harvest is restricted to male crabs. Size limits are established to ensure that sufficient numbers of male crabs are available to meet reproductive needs and to maximize total yield from each year class. Fishing gear is restricted to pots and ring nets to protect nonlegal crabs because high mortality rates can occur with other gear types (e.g., tangle nets, trawls).

C. Management Objectives and Considerations

The resource is managed to achieve optimum yield of king crab stocks in the FCZ and to promote full utilization of the resource by the domestic fishery (NPFMC 1980). The current management framework has evolved through a complex system of regulatory measures involving size, sex, season, area, gear restriction, area registration, and a flexible quota system. These regulatory measures 1) relate to maximizing the reproductive potential of the resource, 2) consider the competitive advantages among vessels of different sizes, 3) attempt to prevent conflicts with other fisheries, 4) promote even distribution of the fishing fleet, and 5) monitor catch and catch rate in particular areas (ibid.). Management objectives are similar in all king crab statistical areas, and guideline harvest levels are set at a specified percentage dependent upon the estimated abundance of recruit and postrecruit overall population levels. Size limits in these northern areas are smaller because of slower growth rates and smaller crabs (ADF&G 1983a; Otto, pers. comm.). Regulations used to address these objectives in state waters differ by area (NPFMC 1980).

A major problem in determining harvestable population levels of king crab is the length of time (7-9 years) between egg hatching and recruitment of crabs on the fishing grounds. This problem, coupled with the inability to age crabs, has resulted in poor understanding of the causes and rates of mortality during this growth period. Therefore long-term projections of stock status based on fishery performance alone is not possible.

To prevent overexploitation of given crab populations, superexclusive, exclusive, and nonexclusive registration areas have been established. A vessel or gear registered for a superexclusive registration area may not be used to take king crab in any other registration area during that registration year. A vessel or gear registered for an exclusive registration area may not be used to take king crab in any superexclusive registration area or any other exclusive registration area during that registration year. A vessel or gear registered for one or both of the nonexclusive areas may also be registered for one exclusive registration area but may not be used to take king crab in more than one exclusive registration area or in any superexclusive registration area during that registration year (ADF&G 1983b). Statistical Area Q is a nonexclusive registration area.

II. NORTON SOUND SECTION

A. Boundaries

The Norton Sound Section is comprised of waters east of 168° west longitude and north of the latitude of Cape Romanzof (61°49'N) and south of the latitude of Cape Prince of Wales (65°36'N) (see map 1) (ADF&G 1984a).

B. Fishery Description and Reported Harvest

1. Harvest summary. The only shellfish fishery in Norton Sound is for red king crab (*Paralithodes camtshatica*). Blue king crab (*P. platypus*) and Tanner crab (*Chionoecetes opilio*) also occur in the region but are seldom caught by commercial or subsistence fishermen (ADF&G 1983a). The commercial harvest of king crab in Norton Sound is relatively new.

   Two separate fisheries actually occur in the area. The summer fishery was first conducted as an exploratory fishery, as designated by the Alaska Board of Fisheries in 1977 (Powell et al. 1983). Catches have ranged from 230,000 lb taken by 11 vessels during the 1982 season to a peak harvest of 2.9 million pounds taken in 1979 by 34 vessels. Peak participation of 36 vessels was evident during the 1981 fishery (table 1). Though catches have fluctuated, the crab catch per pot has declined from a high of 64 in 1978 to 6 in 1982 as a result of declining crab abundance (ADF&G 1983a). However, by 1983 recruitment into the legal male population began to increase. The 1984 harvest of about 390,000 lb of crabs was below the season's guideline harvest level of 400,000 lb (Schwarz and Lean 1985).

The second fishery for king crab in Norton Sound occurs during the winter months. This fishery is small and is conducted primarily by residents of Nome using pots, ring nets, and hand lines set through holes or leads in the ice (Otto 1981). Peak effort of 37 fishermen and harvest of 27,000 lb occurred during 1978, the first year of the fishery. Catches dramatically decreased thereafter. About 2,400 lb were taken by eight fishermen during the 1984 fishery (table 1).

The subsistence fishery for king crab in Norton Sound has also traditionally occurred during the winter, with the nearshore ice packs serving as a convenient platform for gaining access to the fishing grounds and operating fishing gear. Most of the effort has occurred in the Nome area from Sledge Island to Cape Nome, concentrating within 2 to 3 mi of shore. Access to the grounds in this area is by foot or snowmachine. Participants are both Native and non-Native fishermen of varying incomes and lifestyles (Regnart 1978). The fishery occurs from December to May. Harvest levels recorded since the 1977-1978 season show catches, based on permits issued and returned, that exceed those of the winter commercial harvest, producing up to 35,000 lb (during the 1977-1978 fishery) and averaging 14,500 lb per year (5,200 crabs) (table 2).

1. Commercial gear type and size limits. In the Norton Sound Section of the Northern District, legal gear for harvesting king crab is pots. The minimum size limit is the smallest in the state for red king crab. The size limit is 4 3/4 inches carapace width (CW), and for blue king crabs it is 5 1/2 inches CW (ADF&G 1984a).
2. Period of use. Harvest in the Norton Sound summer commercial fishery must occur in the summer prior to sea ice formation. As a result, most of the commercial harvest has occurred in July and August (Powell et al. 1983). By regulation, male red king crab and blue king crab may be taken or possessed from 12:00 noon, August 1, through 12:00 noon, September 3 (summer season), and from January 1 through April 30 (winter season) (ADF&G 1984a).

C. Management Objectives and Considerations

Norton Sound crab production is relatively small compared to the rest of the eastern Bering Sea. The smaller crabs of Norton Sound frequently may be more costly to harvest than in other Bering Sea areas and bring a lower price per pound to fishermen (Powell et al. 1983). The fishery is the newest and northernmost Alaskan red king crab fishery. The nearest onshore processing facilities are located in Dutch Harbor and Akutan in the Aleutian Islands. The catch (from the summer fishery) is currently processed entirely by

Table 2. Subsistence Harvest in Number of Pounds of Red King Crab in Norton Sound and Effort in Number of Fishermen from 1978 through 1984

	Year						
	1978	1979	1980	1981	1982	1983	1984[a]
Harvest[b]	35,016	627	596	1,008	3,606	29,209	31,416
Effort	149	38	9	23	54	85	143

Source: ADF&G 1984b, Schwarz and Lean 1985.

a Figures reflect the number of crabs removed and kept.

b Figures are number of crabs as reported, multiplied by 2.8 lb, the average weight per crab harvested in the 1984 summer fishery.

floating processor ships and catcher/processor vessels operating during the season in the Norton Sound area (ibid.). The significance of the Norton Sound fishery is the necessity to ensure the development of a "new" commercial fishery that will not impact the long-established subsistence fishery. The emotional impact of the local populace upon seeing commercial utilization of crab stocks off their shores by modern crab vessels with home ports from as far away as Seattle has been considerable (ibid.).

The size or abundance of the legal male population is derived from pot and trawl surveys performed periodically in the Norton Sound area. A harvest strategy was adopted by the Board of Fisheries in 1983 (5AAC 34.915) that set the optimum yield in Norton Sound at 50% of the normal exploitation rate as determined in 5AAC 34.080, to provide protection to a long-established subsistence fishery. Under harvest strategy guidelines specified in 5AAC 34.080, the status of the male king crab population in Norton Sound is depressed, with a stable abundance of prerecruits and a moderate level of postrecruitment. The appropriate level of exploitation is 30% under these conditions but is reduced to 15% for the summer fishery, translating to a guideline harvest level of about 400,000 lb for the 1984 season (Schwarz and Lean 1985). As with other areas in the State of Alaska, information regarding king crab is limited to male king crabs. Information regarding female crabs is scarce. The reason for low recruitment, which has caused the decline in population levels, though currently under investigation, is equally obscure.

III. ST. MATTHEWS AND ST. LAWRENCE ISLAND SECTIONS

A. Boundaries

The St. Matthew Island section of the Northern District consists of all waters north of the latitude of Cape Newenham (58°39'N) and south of the latitude of Cape Romanzof (61°49'N) (map 1). The St. Lawrence Island Section consists of all remaining waters of the Northern District, excluding the Norton Sound Section (ADF&G 1985). Because most of the fishing activity occurring in this portion of the Bering Sea is within the Norton Sound District, information for these two fishing sections is combined in the following narrative.

B. Fishery Description and Reported Harvest

Blue, brown, and red king crabs have been harvested in the Northern District. Small subsistence fisheries for blue king crab occur around St. Lawrence, Little Diomede, and Nunivak islands. The commercial fishery in this offshore area of the Bering Sea began in 1977, concentrating upon blue king crab near St. Matthew Island. The fishery produced 1.2 million pounds during the first season, increasing to about 2.0 million pounds during the 1978 fishery. Catches decreased the following two years to less than 220,000 lb because of low participation in the fishery (ADF&G 1983a). Both catch and effort increased steadily beginning in 1981 and reached a peak harvest of almost 9.5 million pounds during the 1983 season taken by the peak effort of about 164 vessels (table 2). Both catch and effort decreased during the 1984 fishery, with about 3.8 million pounds harvested by 90 vessels. The decreased harvest resulted from an apparent decline in stock abundance and the resultant decreased guideline harvest level from 9.5 million pounds during the 1983 season to 2.0 to 4.0 million pounds for the 1984 fishery (ADF&G 1985).

Although the blue king crab fishery has primarily taken place near St. Matthew Island, about 13 fishermen also reported harvest of about 52,000 lb in the St. Lawrence Island Section during the 1983 season (table 3). It is believed, however, that 16,000 lb of this harvest were taken from the St. Matthew Section (Griffin, pers. comm.). Although the St. Lawrence Island Section was open during the 1984 season and two or three vessels were present, no landings were reported (ADF&G 1985).

Red king crab stocks outside the Norton Sound Section are widely and sparsely distributed. As a result, the red king crab fishery outside the Norton Sound Section has historically been incidental to the blue king crab fishery at St. Matthew Island (ibid.). Catches have remained below 130,000 lb (tables 1 and 3). No red king crab harvest was reported during the 1984 fishery (table 3).

The only reported harvest of brown king crab in the Northern District occurred during the 1983 season, when 22 vessels took 193,500 lb. Although the fishery was also opened the following year and is presently open year-round by permit, no effort nor landings have since been reported (ADF&G 1985; Griffin, pers. comm.). This species has not been encountered in trawl surveys performed by NMFS in the Bering Sea at depths less than 128 mm. Although apparently not consistently sought by domestic fishermen, brown king crabs are the most frequently occurring king crab incidentally caught in eastern Bering Sea Japanese and Soviet trawl fisheries (Otto 1981).

1. Gear type. King crab in the St. Lawrence and St. Matthew islands areas may be taken only by pots for commercial purposes. King crabs taken by means other than pots must be immediately returned to the fishery (ibid.).
2. Period of use and size limits. In the St. Matthew Island Section, male king crabs 4 3/4 inches and male blue king crabs 5 1/2 inches or greater in shell width may be taken or possessed from 12:00 noon September 1 through September 22 (ADF&G 1984a). Male brown king crabs 5 1/2 inches or greater in width of shell may be taken or possessed from January 1 through December 31 under conditions of a permit issued by the commissioner (ibid.).

   In the St. Lawrence Island Section, male king crabs 4 3/4 inches and male blue king crabs 5 1/2 inches or greater in width of shell may be taken or possessed from 12:00 noon August 1 through September 3 (ibid.). Male brown king crabs 5 1/2 inches or greater in width of shell may be taken or

Table 3. Commercial Harvest in Thousands of Pounds and Effort in Number of Vessels for King Crab Fisheries of the St. Matthew and St. Lawrence Islands Sections of the Northern District, 1977-84

King Crab Species		Fishing Section	Fishing Season 1977	1978	1979	1980	1981	1982	1983	1984
Blue	Catch	St. Matthew Is.	1,202.1	1,984.3	210.9	219.8	4,627.8	8,844.8	9,454.3	3,764.6
		St. Lawrence Is.	0	0	0	0	0	0	52.6	0
	Total		1,202.1	1,984.3	210.9	219.8	4,627.8	8,844.8	9,506.9	3,764.6
	Effort	St. Matthew Is.	10[b]	22[b]	18[b]	2[b]	31[b]	96[b]	164[b]	90[b]
		St. Lawrence Is.	0	0	0	0	0	0	13	0
Brown	Catch		0	0	0	0	0	0	193.5[c]	0
	Effort		0	0	0	0	0	0	22	0
Red	Catch[a]		543.0	2,007.9	3,024.2	353.7	64.0	3.7	1.6	0
	Effort[b]		-	-	-	-	-	-	-	-
Combined section and species catch			1,745.1	3,992.2	3,235.1	573.5	4,691.8	8,848.5	9,702.0	3,764.6

Source: ADF&G 1983a, 1985.

a Harvest is incidental to the targeted blue king crab. Catches from 1977 through 1979 include the Norton Sound Section. Data from 1980 through 1984 is for the St. Matthew Section only.

b Because harvest is incidental, effort is by the same vessels reporting blue king crab catches in St. Matthew Section.

c Catch reported from southern portion of St. Matthew Section.

possessed from January 1 through December 31 under conditions of a permit issued by the commissioner (ibid.).

C. Management Objectives and Considerations

Three stocks of blue king crab have been identified in the Bering Sea: Herendeen Bay, the Pribilof Island, and the northern Bering Sea blue king crab. The northern Bering Sea blue king crab refers primarily to the population in the St. Matthew Island area. Each stock is managed independently of the other. Trawl surveys performed by the NMFS occur annually to obtain population estimates and other biological data for king crab stocks in the Bering Sea. Guideline harvest levels are developed from this information. The ADF&G recommends regulatory changes, monitors the fishery, and issues closure announcements commensurate with the overall objectives for managing king crab.

The occurrence of red king crab in the St. Matthew/St. Lawrence islands sections is comparatively sparse. Although seasons and size limits have been established, the harvest is incidental to the blue king crab harvest. Abundance estimates and guideline harvest levels have not been set, as the harvest is totally dependent on the parameters established for the blue king crab fishery.

Catches for the brown king crab fishery have been reported for only one year. Season and size limits have been established for this fishery. Research surveys are not performed on this species in this area. Therefore, distribution, abundance, and basic biological information is not available.

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Sport Use of Selected Freshwater Resident and Anadromous Fish Species

I. MANAGEMENT HISTORY

A. Management Agency Jurisdiction

The territory of Alaska established a sport fish management program in 1951. Program activities were concentrated on inventory studies, lake rehabilitation, and trout stocking on lakes and streams near population centers and bordering the highway system (ADF&G 1957). With the granting of statehood in 1959, the ADF&G, Division of Sport Fish, assumed full control of the sport fish resources. Primary regulatory authority is vested in the Alaska Board of Fisheries. Following statehood, the Division of Sport Fish began receiving federal funds from the Dingell-Johnson (D-J) Bill and was able to initiate several research projects in addition to extending its management program (ADF&G 1959).

B. Management Objectives

During the early years of resource management, sportfishing was viewed as a minor factor in context of the management of commercially harvested species. The sport fisheries of the state were not intense enough to damage stocks. The management objective was simply to accumulate basic survey information on the fishery resources. With rapid population expansion and industrial development came many more user groups, including an ever-increasing recreationally oriented population. Gradually, management objectives began to focus on stocks and areas having potential for overharvest. As natural fish stocks around cities and towns began to decrease and easily accessible sport fisheries began to get crowded, new fisheries were developed. In response to public demand for quality recreational fishing opportunities, standard fishery management practices that had been aimed primarily at maximizing numbers of fish available for harvest (yield) were refined to meet the aesthetic, social, and psychological needs of people. A multi-user group philosophy and a quality fishing concept were incorporated into Alaska sport fish management in the 1960's.

Recreational fisheries have grown tremendously since statehood and now play a significant role in total fisheries management (Mills 1983). Alaska statewide sportfishing regulations now address access to and development near recreational fisheries. Bag limits and/or gear have become restrictive to prevent overharvest and distribute the available larger fish among more anglers, thus affording the optimum possible opportunity per angler for taking large, or trophy-size, fish (Andrews n.d.).

Artificial (stocked) urban fisheries also continue to be created adjacent to population centers and are enthusiastically used.

II. ALASKA STATEWIDE SPORT FISH HARVEST PROGRAM

A. Program History

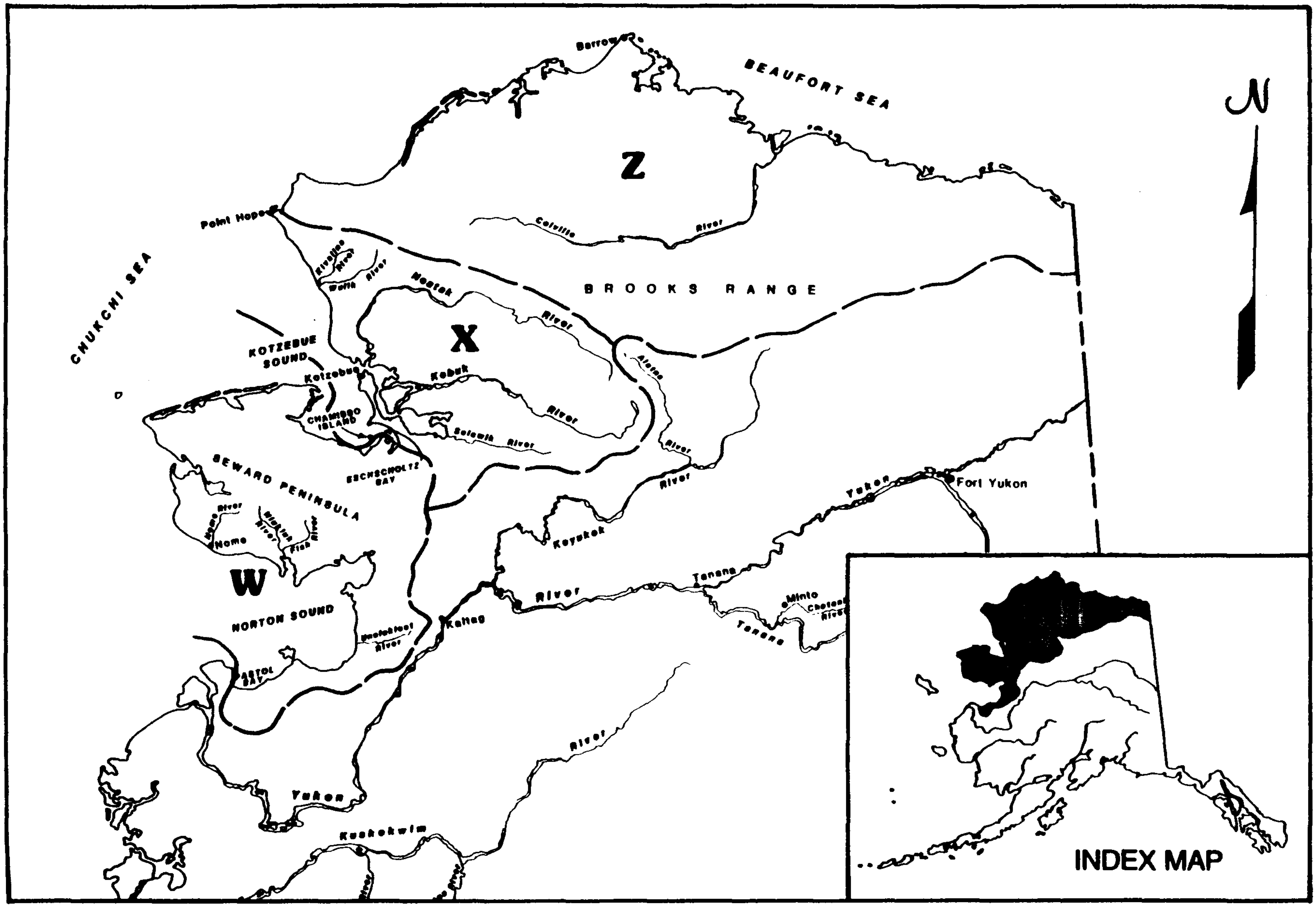
In the early years of statehood, when quality, uncrowded sportfishing was readily available, large sport fisheries were few and easily monitored. On-site creel census surveys of the more intensively fished waters, rather than the compulsory statewide reporting as required of the commercial fishing industry, provided the information needed for proper management of the sport fish populations.

Detailed statistics were not kept on the sport harvest of fish in Alaska prior to 1977, except where a knowledge of the effort and catch was required for protective in-season management or to ensure compliance with regulatory and management policies, quotas, and guidelines (Mills 1983). Annual sport harvest estimates for ADF&G management areas were based on area sport fish biologists' own knowledge and observations, in addition to creel census data. These "historical" annual management area harvest estimates are therefore subjective, limited in total scope, and should be considered minimum harvest estimates. The annual sport harvest estimates of salmon caught in Alaska as reported to the Technical Committee of the INPFC and published in their annual Statistical Yearbook are examples of such historical data (Mills, pers. comm.).

Essential for regulation and management of Alaska's sport fisheries and for total regulation, management, and allocation of multiple-use fisheries is a statewide database of information on where sportfishing occurs, the extent of participation, the preferences of participants, and the species and numbers of major sport fishes being harvested. Statewide on-site creel censuses were considered prohibitively costly. To meet this data need in 1977, the ADF&G, Division of Sport Fish, combined a postal survey with creel censuses to obtain annual estimates of effort and harvest for major Alaskan sport-caught species by area and fishery (Mills 1983). Arctic Regional harvest survey areas and boundaries are delineated on map 1. This program is in its eighth year of operation.

B. Application of Data

Detailed tabulations of annual effort and harvest by region, area, fishery, and species for 1977 through 1983 may be found in Mills (1979-1984). Summary tables of annual (1977-1983) Arctic Region sportfishing effort and harvest data have been prepared and are included in this narrative for easy reference. When using these tables, it is important to remember that effort is reported by lake or river system, not by species. Thus data in tables 1 through 8 include effort directed toward species, such as whitefish, not addressed in detail in these narratives. It is also important to remember that harvest data include only those fish caught and kept, not those caught and released. In this way, harvest totals that are of most direct importance for management are readily available. However, the importance of recreational



Map 1. Arctic Region sport fish survey areas.

fisheries where catch and release is a common practice may be underestimated if evaluated on the basis of these tables alone.

It is also important to understand that sport harvest estimates from the statewide postal survey for fisheries that attract relatively few anglers when compared to total statewide effort may not be accurate. This is true for many fisheries within the Arctic Region that may be important within the region but attract only a small percentage of total statewide sportfishing effort. In 1983, for instance, no fishing location in the arctic had more than 50 respondents in the statewide harvest survey, and many had less than 10 (Mills 1984).

III. REGIONAL HARVEST SUMMARY

A. Harvest Methods

Sportfishing for salmon, char, sheefish, and lake trout in streams and lakes in the Arctic Region is permitted by hook and line only. Northern pike may be taken by spears. In lakes, northern pike, burbot, and whitefish may be taken by spear by persons who are completely submerged (ADF&G 1985). Readers should see the latest sportfishing regulations summary or 5AAC 70.001-050 for details of gear restrictions.

B. Angler Effort

It is estimated that sport anglers in 1983 spent approximately 30,500 angler-days fishing in the Arctic Region. From 1977 through 1983, an annual average of less than 3% of the total angler-days fished in Alaska were expended in the Arctic Region (Mills 1984). It should be remembered, however, that while the total number of sportfishing angler-days in the Arctic Region is relatively low, sportfishing in the arctic is a unique and valuable experience for those who do participate. Local sportfishing opportunities are also very important for people living in villages and cities in the arctic.

C. Harvest Data

Pink salmon, char, and arctic grayling provide the largest sport fish harvests in the Arctic Region. Pink salmon runs are larger in even-numbered years, and this is reflected in the magnitude of the sport harvest. The Arctic Region pink salmon sport harvest in even-numbered years from 1978 through 1982 has averaged 9,624 fish. In odd-numbered years from 1977 through 1983 the harvest averaged 3,324 fish. The Arctic Region char sport harvest has increased from approximately 2,300 fish in 1977 to 15,000 fish in 1983, with an annual average over that period of 7,000 char. Grayling harvest has also increased in the Arctic Region from approximately 4,300 fish in 1977 to 15,500 in 1983. The average annual grayling harvest from 1977 through 1983 was 8,409 fish. Substantial sport harvests of coho salmon, northern pike, sheefish, and whitefish are also taken from the Arctic Region.

Once again, it is important to remember that harvest statistics in this report, unless otherwise stated, are from the Statewide Harvest Survey, which is not very accurate for the relatively small fisheries of the Arctic Region. On-site creel censuses would provide more accurate harvest information for these fisheries; however, they are usually prohibitively expensive. The Statewide Harvest Survey is therefore, the only available measure of harvest and effort, but its numbers should be used with caution.

In the following sections, sport harvest information for all species will be presented for each sport fish postal survey area.

D. Harvest Survey Areas

1. Seward Peninsula-Norton Sound Area:

a. Boundaries. The Seward Peninsula-Norton Sound Area (Sport Fish Postal Survey Area W, illustrated on map 1) includes all waters north of the Yukon River drainage south of the Selawik River-Kotzebue Sound area and west of the Yukon-Koyukuk river drainages. This area includes Pastol Bay and all salt water north and west of it in Norton Sound as well as salt water adjacent to the Seward Peninsula, including Spafarief Bay in Kotzebue Sound and the southern half of Eschscholtz Bay (ADF&G 1984).

b. Major watersheds and significant fisheries. Sportfishing effort in the Seward Peninsula-Norton Sound Area is heaviest on streams that are accessible via the Nome road system and on the Unalakleet River (table 1).

Most fishing pressure in the Nome vicinity occurs on the Nome River (table 1) (Alt 1979). During 1977 and 1978 angler utilization surveys, it was noted that fishing effort on the Nome River is greatest in July, when chum and pink salmon are available (Alt 1978, 1979); however, sportfishing is also heavy in some years during May and June, when char are outmigrating (ibid.), and in early September, when char and coho salmon are available (Alt 1978). In years with strong pink salmon runs, Magdanz and Olanna (1984) note that the predominant group of Nome River fishermen are school-age boys who may fish from dawn to dusk. Grayling and a few chinook salmon and pike are also taken from the Nome River (tables 2, 3, and 4).

Most of angling observed during the 1977 and 1978 surveys on the Nome River occurred in the 0.8 km distance from the Nome River Bridge to the mouth (Alt 1978, 1979). The two most popular locations are on or around the Nome River bridge and along the channel at the mouth (Magdanz and Olanna 1984). Some anglers fish from boats in deep holes along the lower reaches of the river, but boat fishing is limited by shallow waters further upstream (ibid.). Other important sportfishing areas on the Nome River are between miles 8 and 13 on the Kougarok Road, where char and grayling are harvested in the fall (ibid.).

Sportfishing pressure on the Nome River is affected by weather conditions. Sportfishing is less enjoyable and less successful during periods of rainy weather and high, turbid stream flow (Alt 1979). Movements and availability of fish are also affected by weather conditions. Spring char fishing is especially successful in years such as 1977 when the sea ice remains packed against the shore during May and June, delaying the movement of char into the ocean (ibid.). The timing of char inmigration also affects fishing pressure in the fall. In years when the char return as early as late July, they are available to sport anglers for a longer period, and the harvest is greater (ibid.). Other important sportfishing areas around Nome are the Snake, Sinuk, Penny, Cripple, Feather, and Bluestone rivers on the Kougarok Road; and the Eldorado, Solomon, and Niukluk-Fish rivers on the Nome-Council Highway (Alt 1978). Of these, the Niukluk-Fish and Pilgrim rivers receive the heaviest fishing pressure, mainly because of excellent fishing for trophy-size grayling, but also for chum, pink, and coho salmon, char, and northern pike (ibid.). Other waters fished by Nome area residents include the Agiapuk and American rivers, which drain into Imuruk Basin (ibid.). In 1983, the grayling harvest from the Niukluk-Fish system was estimated by the Statewide Harvest Survey to have been approximately 5,200 fish (table 2). Approximately 2,100 char and 1,400 coho salmon were also taken from the Fish-Niukluk system in 1983, along with smaller harvests of pink salmon, chum salmon, and northern pike (tables 5, 6, 7, 8, and 9). Boats can be used in both the Fish and Niukluk rivers, resulting in increased sportfishing access (ibid.). An airstrip is located at Council, which allows many anglers to fly from Nome and then use boats that are kept at the river (ibid.). Peak fishing periods on the Fish-Niukluk system are during June and July, when anglers target on chum and pink salmon and grayling, and August and September, when anglers target on coho salmon and char (Alt 1984).

The Pilgrim River can be accessed by road at the Salmon Lake outlet, by unimproved road at points along the upper part of the river, and at the Kougarok Road bridge (Alt 1980). Anglers also fish in the area below the bridge, using jet-equipped boats (ibid.). Grayling, pike, char, chum salmon, and a few coho salmon were reported harvested from the Pilgrim River in 1983, along with a few pink salmon. Alt (1980) also noted that a few round whitefish are captured by hook and line in the Pilgrim River.

The lower Pilgrim River is an important pike harvest area for Nome anglers. Anglers generally travel by jet-equipped boat from the Kougarok Road bridge to reach the numerous lakes and sloughs on the lower river where pike are found (ibid.).

The most intensely used area of the Pilgrim River is the portion of the river downstream from the bridge to 1 mi above Pilgrim Hot Springs (ibid.). Anglers in this area fish for large grayling, along with char, chum, pink, and coho salmon.

The Unalakleet River was estimated by the 1983 Statewide Harvest Survey to have received approximately 4,000 angler-days of effort, which is essentially the same amount as received by the Nome River. Fishing effort on the Unalakleet is directed toward grayling, char, chum salmon, and pink salmon (Alt 1978). The char harvest from the Unalakleet in 1983 is estimated to have been approximately 2,200 fish, along with approximately 1,600 coho salmon, 909 pink salmon, 800 grayling, 700 chum salmon, and 100 whitefish (tables 5, 6, 7, 2, 8, and 9). Chinook salmon are also harvested on the North River, a Unalakleet tributary, with an estimated harvest of about 90 chinook in 1983 (Alt 1978, Mills 1984).

c. Management considerations. Trophy-sized grayling are found in some of the rivers in the Nome-Seward Peninsula area, particularly the Pilgrim, and there has been some concern that these stocks may be depleted as angler effort increases (Alt 1980). The potential for overexploitation does exist, given the low abundance, late age at maturity, and ease of harvest of grayling. No evidence of overharvest was detected during a three-year study from 1978 through 1980 (ibid.). Results of the study, however, were inconclusive, and continued monitoring of this fishery is important.

Subsistence fishermen in the Nome area frequently use hook and line to harvest salmon for food (Magdanz and Olanna 1984, Alt 1979). While hook and line is not technically defined as a subsistence harvest method, it is obvious that the distinction between sport and subsistence harvest is hazy in this area. Many, perhaps most, of the people who have subsistence permits also fish with hook and line (Magdanz and Olanna 1984), because under some circumstances it is the more efficient method. Many hook-and-line fishermen snag fish, a technique that is illegal under sport fish regulations. It is difficult for anglers who are fishing for food and who may have a subsistence permit to understand why fishing with nets (under subsistence regulations) is legal but snagging is not (ibid.).

Commercial harvests of chum salmon from the Nome subdistrict have increased greatly since a fish buyer began flying fresh salmon on ice to distant markets in 1974 (ibid.). Subsistence effort on the Nome River has increased, as effort that used to be directed on other systems has moved to this stream (ibid.). Sportfishing on Nome River stocks is also increasing, possibly because coho runs into the rivers are becoming larger. Thus, Nome River salmon stocks are subject to harvest from three different (but overlapping) groups, and the allocation of the resource between these groups is an increasing problem. Monitoring of sport harvests has been made more complicated since many people in the area evidently do not correctly identify what salmon species they are harvesting. Coho salmon may be misidentified as sockeye salmon, and bright chum salmon may be called coho. As a result, it is difficult to know how many of the approximately 2,500 chum, pink, and coho salmon taken from the Nome River in 1983 were actually coho salmon and how many were chum salmon.

2. Northwest Alaska Area:
   a. Boundaries. The Northwest Alaska Area (Sport Fish Postal Survey Area X, illustrated on map 1) includes all waters and drainages of the Kotzebue area, including drainages of the Selawik, Kobuk, Noatak, Wulik, and Kivalina rivers. The Northwest Alaska Area also includes all salt water in the northern half of Eschscholtz Bay, including the Chamisso Island area and the northern half of Kotzebue Sound to and including Point Hope (ADF&G 1984).
   b. Major watersheds and significant fisheries. Sportfishing effort in the Northwest Alaska Area is heaviest on the Kobuk, Noatak, and Wulik rivers (table 10). Returns from the Statewide Postal Survey indicate that in 1983 approximately 1,400 grayling, 1,400 sheefish, 400 char, and 300 whitefish were harvested from the Kobuk River (tables 11, 12, 13, and 14). Many visitors to Gates of the Arctic National Park and Kobuk Valley National Park participate in float trips on the Kobuk River from Walker Lake to Kobuk Village (USDI 1985, 1984; Alt 1984). There is also a lodge at Walker Lake that promotes fishing for char and lake trout in that lake (USDI 1985). Recreational use of the Kobuk River is most intense from late June to mid September (USDI 1984). Kobuk and Selawik river sheefish populations are also subjected to harvest in the open-water recreational fishery off Kotzebue during the early summer (Alt 1984). In this fishery, anglers cast for sheefish and char from beaches around Kotzebue (Bigler, pers. comm.).

There are three groups of recreational anglers on the Noatak, Wulik, and Kivalina rivers. These are guided anglers, Kotzebue residents, and persons participating in float trips on the Noatak River (DeCicco 1983). In 1983, approximately 1,400 grayling, 550 char, 500 northern pike, and 300 chum salmon were harvested from the Noatak River by sport fishermen (tables 11, 13, 15, and 16). Kotzebue residents fly in or boat up to Noatak River tributary streams throughout the summer to fish (Alt 1978, 1981). The Kelly River receives the heaviest fishing pressure; however, there is also light fishing pressure on the lower Kugururok and Nimiuktuk rivers (ibid.). The most popular use of the Noatak is floating the river in rafts, kayaks, or canoes. Most groups put in at Matcharak Lake and portage to the river, or land on gravel bars farther up the Noatak (Alt 1978, USDI 1985). Most parties who float the Noatak and other Northwest Alaska streams also sport fish (USDI 1985, DeCicco 1983). In the upper Noatak, only grayling are available, but below the Nimiuktuk River some char, chum salmon, and possibly pike are also taken (Alt 1978). Lake trout can be taken from Matcharak Lake (ibid.) and possibly from other lakes in the middle and upper Noatak area. Most lakes in this area, however, can be reached only by float-equipped aircraft, so fishing pressure is light. The lake trout harvest from the Northwest Alaska area in 1983 was estimated by the sport fish postal survey to be only about 200 fish (table 17).

In the fall, Kotzebue residents fly into the Wulik River to sport fish for char (Alt 1981). The char harvest from the Wulik River was estimated from the sport fish postal survey to have been approximately 700 fish in 1983 (table 13). Approximately 300 grayling were also taken (table 11). There is one guide camp located on the Wulik River and small groups of anglers from this camp fish in the Wulik and Kivalina rivers and some Noatak tributaries throughout the summer (ibid.).

c. Management considerations. The magnitude of sport fish harvest from the Northwest Alaska Area is not very large. Many sport fishermen in the area practice catch and release, which further reduces the impact of sportfishing on the fish populations.

There has been some concern, however, by Kobuk River residents and organizations that the sheefish sport harvest may be impacting the subsistence fishery (Alt 1984). The Kobuk River sheefish spawning population, however, appears to be in good condition, with no evidence of a decline (ibid.).

3. North Slope Brooks Range Area:

a. <u>Boundaries</u>. The North Slope Brooks Range Area (Sport Fish Postal Survey Area Z, illustrated on map 1) includes all drainages north of the Brooks Range flowing into the Beaufort and Chukchi seas east of Point Hope and west of the Canadian border, including adjacent saltwater areas.

b. <u>Major watersheds and significant fisheries</u>. In 1983, Statewide Postal Survey returns indicated that approximately 5,600 angler-days of effort were expended by sport fishermen in the North Slope Brooks Range Area (table 18). Char and grayling were by far the most frequently harvested species, with harvest estimates of approximately 3,000 char and 2,500 grayling in 1983 (tables 19 and 20). Lake trout, pink salmon, whitefish, and burbot were also harvested in 1983, though in lesser numbers (tables 21, 22, 23, and 24).

Access to the North Slope area is either via the Dalton Highway (Haul Road) or by small plane. The Dalton Highway was built in 1974 by the Alyeska Pipeline Service Company to serve construction of the Trans-Alaska Pipeline. In May of 1974, the ADF&G closed to sportfishing a strip within 5 mi on each side of the Trans-Alaska Pipeline alignment. This closure was enacted because of the unknown impacts of construction camps and the lack of biological information on affected fish populations (Bendock 1980). In 1979, this closure was rescinded by the Alaska Board of Fisheries, opening the Dalton Highway corridor to sportfishing for all species except sheefish and salmon (ibid.). Until 1981, access to the Dalton Highway was limited to permitted commercial users, which limited sportfishing opportunities primarily to truckers and employees of the Alyeska Pipeline Service Company and the Alaska Department of Transportation. In June of 1981, the highway was opened to the general public from the Yukon River to Disaster Creek, approximately 150 mi north of the Yukon River (Bendock 1982).

The Dalton Highway crosses tributaries of the Sagavanirktok, Toolik, and Kuparuk rivers and parallels the Sagavanirktok itself from pump station 3 to Prudhoe Bay, providing sportfishing opportunities for grayling, lake trout, and char (Bendock 1980). Lakes along the highway contain lake trout, char, grayling, and, in some cases, burbot and whitefish (ibid.). Between pump stations 3 and 4 there are numerous small lakes that provide excellent sportfishing opportunities for the above fish (ibid.). Lakes in the vicinity of Toolik lake and the upper Kuparuk and Sagavanirktok rivers are the most frequently fished areas north of Atigun Pass (Bendock and Burr 1984). Other popular lakes between pump stations 3 and 4 include Galbraith, Island, and Tea lakes (Bendock 1980). A limited creel census in 1979 based on 73 angler interviews obtained along the Dalton Highway from June through August found a catch per unit effort of 2.7 fish per hour in North Slope streams and 2.1 fish per hour in North Slope lakes (ibid.). These data, however, are biased because many unsuccessful trips were not reported (ibid.). Despite excellent sportfishing opportunities, effort along the Dalton Highway remains light. Some of the factors contributing to low fishing activity on the Dalton Highway may be 1) poor weather conditions, 2) rough road conditions, 3) poorly situated and infrequent camping facilities, and 4) the long distance and travel time required from the nearest towns and villages (Bendock 1982).

Outside the Dalton Highway corridor, access is either by hiking or floating rivers accessible from the highway or by small plane. Lakes outside the Dalton Highway corridor that are accessible by hiking or by air and that receive some sportfishing effort include Elusive, Shainin, Itkillik, and Chandler lakes (Furniss 1974, USDI 1985). Within the Colville River drainage, lakes that receive occasional sportfishing effort include Cascade and Kurupa lakes (Bendock 1979). Sportfishing also takes place on the Colville, Kongakut, Canning, Ivishak, Echooka, Killik, and Anaktuvuk rivers (Bendock 1979; Bendock, pers. comm.), and some fishing may be done by persons participating in recreational float trips on the Nigu and Etivluk rivers (Bendock 1983; Bendock, pers. comm.).

In an effort to enhance sportfishing opportunities in the vicinity of Point Barrow, grayling were stocked in Isatkoak Lagoon in 1981. Gill-net sampling in 1983, however, did not yield any grayling, and it is probable that the experimental stocking did not succeed. There are no plans for restocking the lagoon at this time (Bendock and Burr 1984).

c. Management considerations. Access to the North Slope area is limited, and sportfishing effort in the area is light. Access is probably the most important factor affecting sportfishing in the Arctic Region. Few people have the means necessary to reach sportfishing areas in the arctic. Sportfishing effort is, therefore, probably not heavy enough at this time to seriously impact fish populations. More serious threats to fish stem from industrial developments, which may affect the quality and quantity of limited overwintering and spawning habitats (Bendock pers. comm.). Impacts of development activities are discussed in more detail in the Impacts of Land and Water use volume of this series.

Table 1. Seward Peninsula-Norton Sound Area Sportfishing Effort Expressed as Angler-Days[a] and as a Percentage of the Total Sportfishing Effort in the Seward Peninsula-Norton Sound Area Each Year

	Angler-Days													
	1977		1978		1979		1980		1981		1982		1983	
Location	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Salt water:														
Boat	---		---		---		---		---		---		2,178	12.8
Shoreline	---		---		---		---		---		---		2,088	12.3
Saltwater total	---		---		---		---		---		---		4,266	25.2
Fresh water:														
Unalakleet River	---		---		---		---		---		---		4,057	23.9
Nome River	---		---		---		---		---		---		3,908	23.1
Fish-Niukluk River	---		---		---		---		---		---		1,939	11.4
Pilgrim River	---		---		---		---		---		---		597	3.5
Other streams	---		---		---		---		---		---		2,058	12.1
Lakes	---		---		---		---		---		---		119	0.7
Freshwater total	---		---		---		---		---		---		12,678	74.8
Grand total	7,828	100.0	8,379	100.0	8,725	100.0	7,968	100.0	10,879	100.0	13,198	100.0	16,944	100.0

Source: Mills 1979-84.

--- means no data were available.

a Effort is the number of days spent fishing, where any portion of a day spent fishing is counted as one whole angler-day.

Table 2. Seward Peninsula-Norton Sound Area Arctic Grayling Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	0
Shoreline	---	---	---	---	---	---	0
Saltwater total	---	---	---	---	---	---	0
Fresh water:							
Unalakleet River	---	---	---	---	---	---	835
Nome River	---	---	---	---	---	---	464
Fish-Niukluk River	---	---	---	---	---	---	5,160
Pilgrim River	---	---	---	---	---	---	761
Other streams	---	---	---	---	---	---	1,021
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	8,241
Grand total	1,607	1,455	2,173	1,635	2,104	6,225	8,241

Source: Mills 1979-84.

--- means no data were available.

Table 3. Seward Peninsula-Norton Sound Area King Salmon Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	56
Shoreline	---	---	---	---	---	---	204
Saltwater total	---	---	---	---	---	---	260
Fresh water:							
Unalakleet River	---	---	---	---	---	---	93
Nome River	---	---	---	---	---	---	93
Fish-Niukluk River	---	---	---	---	---	---	0
Pilgrim River	---	---	---	---	---	---	0
Other streams	---	---	---	---	---	---	241
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	427
Grand total	197	303	234	52	70	409	687

Source: Mills 1979-84.

--- means no data were available.

Table 4. Seward Peninsula-Norton Sound Area Northern Pike Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	0
Shoreline	---	---	---	---	---	---	0
Saltwater total	---	---	---	---	---	---	0
Fresh water:							
Unalakleet River	---	---	---	---	---	---	0
Nome River	---	---	---	---	---	---	56
Fish-Niukluk River	---	---	---	---	---	---	557
Pilgrim River	---	---	---	---	---	---	148
Other streams	---	---	---	---	---	---	37
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	798
Grand total	302	389	450	284	303	210	798

Source: Mills 1979-84.

--- means no data were available.

Table 5. Seward Peninsula-Norton Sound Area Dolly Varden-Arctic Char Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	0
Shoreline	---	---	---	---	---	---	74
Saltwater total	---	---	---	---	---	---	74
Fresh water:							
Unalakleet River	---	---	---	---	---	---	2,190
Nome River	---	---	---	---	---	---	2,468
Fish-Niukluk River	---	---	---	---	---	---	2,097
Pilgrim River	---	---	---	---	---	---	445
Other streams	---	---	---	---	---	---	2,579
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	9,779
Grand total	1,621	1,690	4,109	5,811	3,981	6,498	9,853

Source: Mills 1979-84.

--- means no data were available.

Table 6. Seward Peninsula-Norton Sound Area Coho Salmon Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	297
Shoreline	---	---	---	---	---	---	111
Saltwater total	---	---	---	---	---	---	408
Fresh water:							
Unalakleet River	---	---	---	---	---	---	1,596
Nome River	---	---	---	---	---	---	204
Fish-Niukluk River	---	---	---	---	---	---	1,355
Pilgrim River	---	---	---	---	---	---	37
Other streams	---	---	---	---	---	---	223
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	3,415
Grand total	449	742	2,421	1,455	1,504	2,986	3,823

Source: Mills 1979-84.

--- means no data were available.

Table 7. Seward Peninsula-Norton Sound Area Pink Salmon Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	37
Shoreline	---	---	---	---	---	---	241
Saltwater total	---	---	---	---	---	---	278
Fresh water:							
Unalakleet River	---	---	---	---	---	---	909
Nome River	---	---	---	---	---	---	1,782
Fish-Niukluk River	---	---	---	---	---	---	631
Pilgrim River	---	---	---	---	---	---	37
Other streams	---	---	---	---	---	---	575
Lakes	---	---	---	---	---	---	371
Freshwater total	---	---	---	---	---	---	4,305
Grand total	2,402	7,399	2,918	7,732	3,101	13,742	4,583

Source: Mills 1979-84.

--- means no data were available.

Table 8. Seward Peninsula-Norton Sound Area Chum Salmon Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	0
Shoreline	---	---	---	---	---	---	0
Saltwater total	---	---	---	---	---	---	0
Fresh water:							
Unalakleet River	---	---	---	---	---	---	687
Nome River	---	---	---	---	---	---	538
Fish-Niukluk River	---	---	---	---	---	---	371
Pilgrim River	---	---	---	---	---	---	111
Other streams	---	---	---	---	---	---	335
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	2,042
Grand total	670	546	973	1,601	1,889	2,620	2,042

Source: Mills 1979-84.

--- means no data were available.

Table 9. Seward Peninsula-Norton Sound Area Whitefish Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water:							
Boat	---	---	---	---	---	---	0
Shoreline	---	---	---	---	---	---	0
Saltwater total	---	---	---	---	---	---	0
Fresh water:							
Unalakleet River	---	---	---	---	---	---	111
Nome River	---	---	---	---	---	---	0
Fish-Niukluk River	---	---	---	---	---	---	0
Pilgrim River	---	---	---	---	---	---	0
Other streams	---	---	---	---	---	---	37
Lakes	---	---	---	---	---	---	0
Freshwater total	---	---	---	---	---	---	148
Grand total	170	87	282	353	123	597	148

Source: Mills 1979-84.

--- means no data were available.

Table 10. Northwest Alaska Area Sportfishing Effort Expressed as Angler-Days[a] and as a Percentage of the Total Sportfishing Effort in the Northwest Alaska Area, 1977-83

	Angler-Days													
	1977		1978		1979		1980		1981		1982		1983	
Location	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Noatak River	935	26.8	948	19.0	597	23.0	1,228	32.0	1,505	28.8	1,518	22.2	1,372	17.2
Kobuk River	950	27.2	1,249	25.0	1,226	47.3	1,314	34.2	2,389	45.7	2,405	35.2	2,148	27.0
Wulik River	648	18.6	---		314	12.1	---		---		580	8.5	805	10.1
Others (general)	954	27.3	2,800	56.0	456	17.6	1,299	33.8	1,325	25.4	2,337	34.1	---	
Other streams	---		---		---		---		---		---		2,206	27.7
Lakes	---		---		---		---		---		---		1,432	18.0
Total	3,487	100.0	4,997	100.0	2,593	100.0	3,841	100.0	5,219	100.0	6,840	100.0	7,963	100.0

Source: Mills 1979-84.

--- means no data were available.

a Effort is the number of days spent fishing, where any portion of a day spent fishing is counted as one whole angler-day.

Table 11. Northwest Alaska Area Arctic Grayling Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Noatak River	413	642	218	585	1,166	922	1,429
Kobuk River	297	289	827	809	2,808	1,535	1,410
Wulik River	118	---	545	---	---	262	297
Others (general)	579	1,066	555	396	1,372	702	---
Other streams	---	---	---	---	---	---	391
Lakes	---	---	---	---	---	---	1,188
Total	1,407	1,997	2,145	1,790	5,346	3,421	4,715

Source: Mills 1979-84.

--- means no data were available.

Table 12. Northwest Alaska Area Sheefish Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Noatak River	0	0	0	0	0	0	0
Kobuk River	625	307	682	1,248	1,015	1,886	1,448
Wulik River	0	---	0	---	---	0	0
Others (general)	31	199	27	465	248	336	
Other streams	---	---	---	---	---	---	557
Lakes	---	---	---	---	---	---	74
Total	656	506	709	1,713	1,263	2,222	2,079

Source: Mills 1979-84.

--- means no data were available.

Table 13. Northwest Alaska Area Dolly Varden-Arctic Char Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Noatak River	133	163	145	189	583	860	557
Kobuk River	14	36	64	0	108	0	372
Wulik River	184	---	718	---	---	545	705
Others (general)	138	0	845	112	486	126	---
Other streams	---	---	---	---	---	---	502
Lakes	---	---	---	---	---	---	56
Total	469	199	1,772	301	1,177	1,531	2,192

Source: Mills 1979-84.

--- means no data were available.

Table 14. Northwest Alaska Area Whitefish Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Noatak River	17	0	0	9	0	0	0
Kobuk River	85	0	0	1,025	32	21	334
Wulik River	0	---	0	---	---	0	0
Others (general)	283	50	154	34	54	1,696	---
Other streams	---	---	---	---	---	---	909
Lakes	---	---	---	---	---	---	0
Total	385	50	154	1,068	86	1,717	1,243

Source: Mills 1979-84.

--- means no data were available.

Table 15. Northwest Alaska Area Northern Pike Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Noatak River	11	172	218	0	76	14	520
Kobuk River	65	36	136	456	65	21	0
Wulik River	0	---	0	---	---	0	0
Others (general)	71	181	173	396	324	419	---
Other streams	---	---	---	---	---	---	612
Lakes	---	---	---	---	---	---	130
Total	147	389	527	852	465	454	1,262

Source: Mills 1979-84.

--- means no data were available.

Table 16. Northwest Alaska Area Chum Salmon Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Noatak River	0	0	0	0	0	263	278
Kobuk River	9	254	27	86	32	83	74
Wulik River	0	---	0	---	---	0	0
Others (general)	19	0	0	0	0	0	---
Other streams	---	---	---	---	---	---	111
Lakes	---	---	---	---	---	---	0
Total	28	254	27	86	32	346	463

Source: Mills 1979-84.

--- means no data were available.

Table 17. Northwest Alaska Area Lake Trout Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Noatak River	0	0	0	0	0	0	0
Kobuk River	0	0	0	0	0	0	0
Wulik River	0	---	0	---	---	0	0
Others (general)	90	9	0	17	216	168	---
Other streams	---	---	---	---	---	---	19
Lakes	---	---	---	---	---	---	204
Total	90	9	0	17	216	168	223

Source: Mills 1979-84.

--- means no data were available.

Table 18. North Slope-Brooks Range Area Sporfishing Effort Expressed as Angler-Days[a] and as a Percentage of the Total Sporfishing Effort in the North Slope Brooks Range Area, 1977-83

	Angler-Days													
	1977		1978		1979		1980		1981		1982		1983	
Location	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Salt water	---		---		---		---		---		---		1,282	22.8
Fresh water:														
Streams	---		---		---		---		---		---		3,949	70.2
Lakes	---		---		---		---		---		---		388	6.9
Freshwater total	---		---		---		---		---		---		4,337	77.2
Grand total	2,434	100.0	1,422	100.0	1,526	100.0	2,142	100.0	2,601	100.0	4,879	100.0	5,619	100.0

Source: Mills 1979-84.

--- means no data were available.

a Effort is the number of days spent fishing, where any portion of a day spent fishing is counted as one whole angler-day.

Table 19. North Slope-Brooks Range Area Dolly Varden-Arctic Char Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Salt water	---	---	---	---	---	---	911
Fresh water:							
Streams	---	---	---	---	---	---	2,013
Lakes	---	---	---	---	---	---	42
Freshwater total	---	---	---	---	---	---	2,055
Grand total	241	181	364	801	1,188	2,065	2,966

Source: Mills 1979-84.

--- means no data were available.

Table 20. North Slope-Brooks Range Area Arctic Grayling Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Salt water	---	---	---	---	---	---	0
Fresh water:							
Streams	---	---	---	---	---	---	2,390
Lakes	---	---	---	---	---	---	178
Freshwater total	---	---	---	---	---	---	2,568
Grand total	1,239	678	1,373	1,765	2,904	4,077	2,568

Source: Mills 1979-84.

--- means no data were available.

Table 21. North Slope-Brooks Range Area Lake Trout Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water	---	---	---	---	---	---	0
Fresh water:							
Streams	---	---	---	---	---	---	231
Lakes	---	---	---	---	---	---	136
Freshwater total	---	---	---	---	---	---	367
Grand total	88	9	264	379	454	629	367

Source: Mills 1979-84.

--- means no data were available.

Table 22. North Slope-Brooks Range Area Pink Salmon Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water	0	0	0	0	0	0	0
Fresh water:							
Streams	0	0	0	0	0	0	283
Lakes	0	0	0	0	0	0	0
Freshwater total	0	0	0	0	0	0	283
Grand total	0	0	0	0	0	0	283

Source: Mills 1979-84.

--- means no data were available.

Table 23. North Slope-Brooks Range Area Whitefish Sport Harvest, 1977-83

	Angler-Days						
Location	1977	1978	1979	1980	1981	1982	1983
Salt water	0	0	0	0	0	0	0
Fresh water:							
Streams	0	0	0	0	0	0	125
Lakes	0	0	0	0	0	0	0
Freshwater total	0	0	0	0	0	0	125
Grand total	0	0	0	0	0	0	125

Source: Mills 1979-84.

--- means no data were available.

Table 24. North Slope-Brooks Range Area Burbot Sport Harvest, 1977-83

Location	Angler-Days						
	1977	1978	1979	1980	1981	1982	1983
Salt water	0	0	0	0	0	0	0
Fresh water:							
Streams	0	0	0	0	0	0	83
Lakes	0	0	0	0	0	0	0
Freshwater total	0	0	0	0	0	0	83
Grand total	0	0	0	0	0	0	83

Source: Mills 1979-84.

--- means no data were available.

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Bering Strait/Norton Sound Subregion

I. LOCATION AND ENVIRONMENT

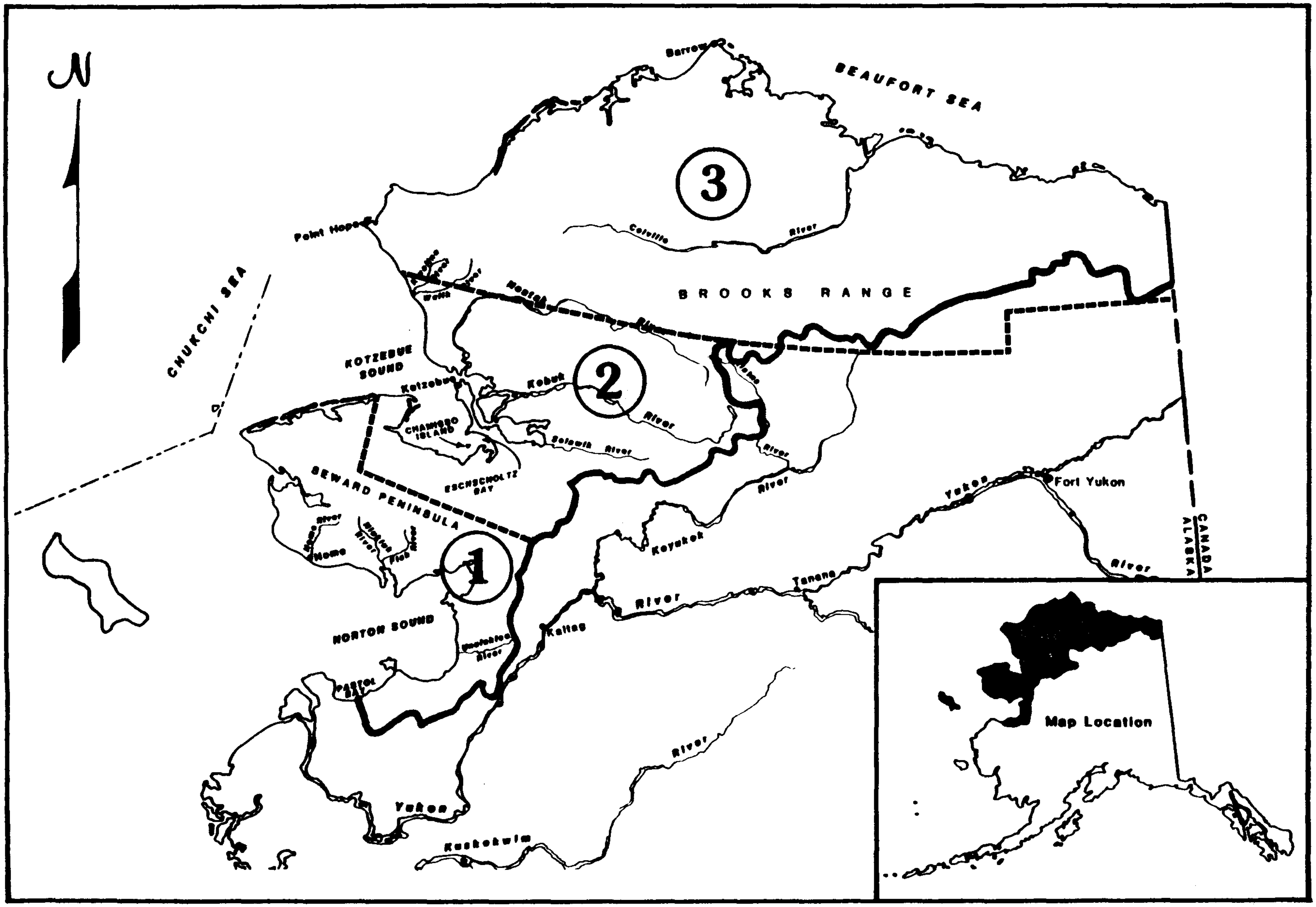
The Bering Strait/Norton Sound subregion has a land area of approximately 26,000 mi^2, encompassing all watersheds draining into Norton Sound and Bering Strait from Shishmaref in the north to Stebbins in the south and including St. Lawrence Island. The subregion lies entirely within Game Management Unit 22. Maps 1 and 2 outline this subregion.

The western half of the Seward Peninsula is generally treeless, with terrestrial habitats ranging from wet coastal tundra to alpine tundra with elevations of over 4,000 ft. The eastern half of the Seward Peninsula and eastern rim of Norton Sound have these habitat types and include some forested areas, especially along inland river drainages (Viereck and Little 1972). Major river systems in the subregion include the Unalakleet, Koyuk, Fish, Kuzitrin, Agiapuk, and Serpentine drainages.

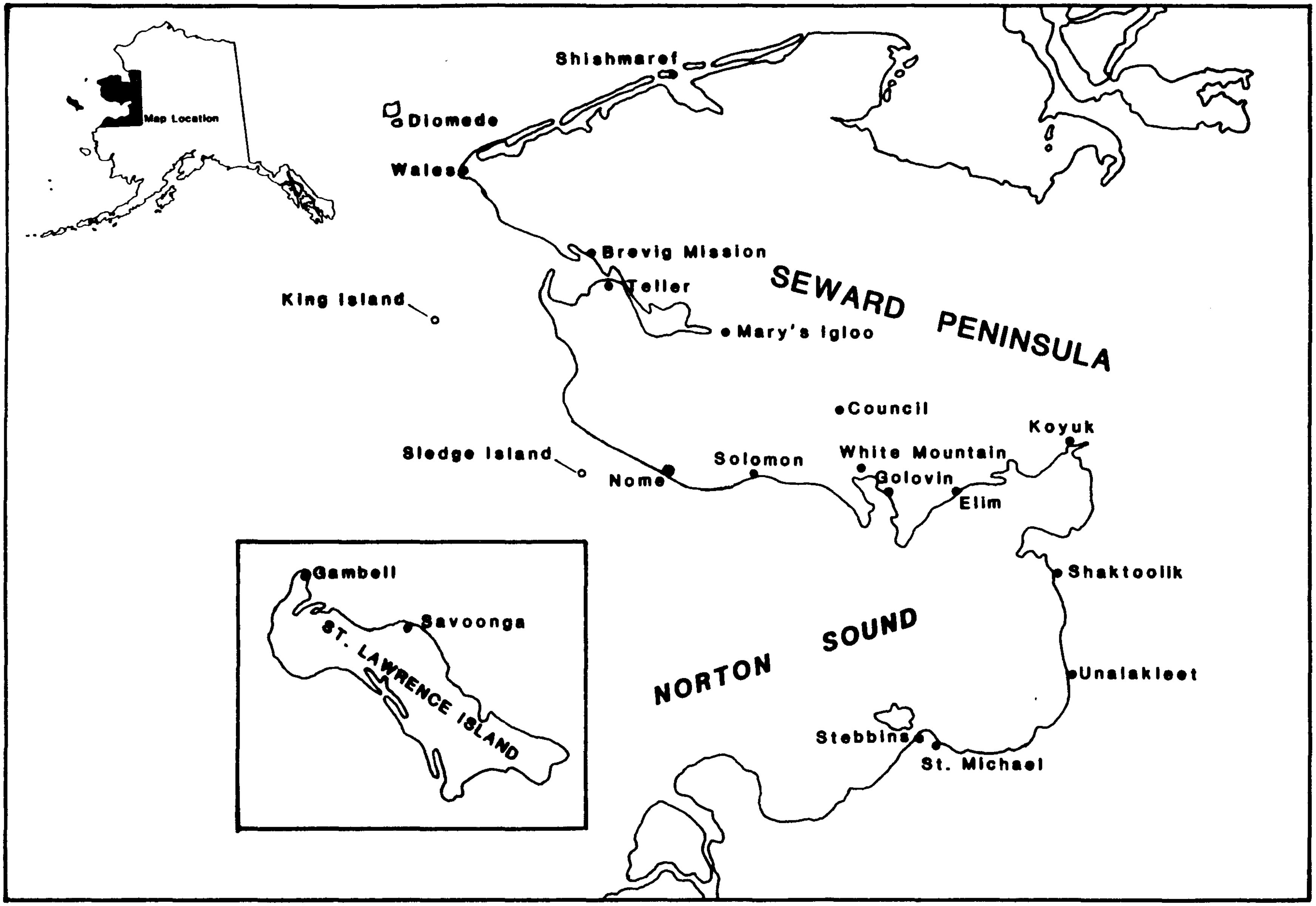
The entire subregion lies south of the Arctic Circle and falls generally within the transitional climatic zone (Selkregg 1976). Average summer temperatures are from 30 to 50°F and include 77 frost-free days. Winter temperatures average between 5 and 10°F (ibid.). Sea ice dominates the area marine environment for much of the year. Latitude, currents, wind, local weather, and tidal action make the dates of sea ice formation and retreat highly variable within the subregion and from year to year. Bering Strait is generally ice-free by late June and usually ice-covered by early November (ibid.). Fractured leads are present throughout much of the winter in Norton Sound.

Fish and wildlife inhabiting the marine, tundra, and riparian habitats are varied and seasonally abundant. Many species commonly utilized for subsistence are not evenly distributed throughout the subregion but occur as residents or seasonal migrants in preferred habitats. Readers are directed to individual species accounts found elsewhere in this guide for the Arctic Region for more detailed life history and distribution information on selected arctic species.

From a subsistence standpoint, marine resources are particularly important. Marine mammals of this subregion include bearded, spotted, ringed, and ribbon seals, walrus, and bowhead, belukha, and gray whales. Polar bears are commonly associated with sea ice along the western Seward Peninsula and St. Lawrence Island but are less frequently found in Norton Sound. Common fish species include chinook,



Map 1. The Arctic Region and its three subregions: 1 - Bering Strait/Norton Sound; 2 - Kotzebue Sound; and 3 - North Slope.



Map 2. The Bering Strait/Norton Sound subregion and the communities discussed in this narrative.

chum, coho, pink, and sockeye salmon, Pacific herring, arctic and saffron cod, rainbow smelt, arctic char, Dolly Varden, burbot, arctic grayling, and broad and round whitefish. The anadromous nature of many of these species allows them to be harvested in both marine and freshwater habitats. King crab, Tanner crab, mussels, cockles, and clams also occur within the subregion. Migratory waterfowl, seabirds, gulls, and cranes are seasonally abundant, nesting in coastal tundra areas and rookeries.

Terrestrial resources include caribou and black bear, which are both generally restricted in distribution to the Nulato Hills and eastern Seward Peninsula, as well as brown bear and moose. Although caribou were formerly common throughout most of the Seward Peninsula, that portion of their range was largely abandoned during the last decades of the nineteenth century. Introduced commercial reindeer herds now range over much of the western and central Seward Peninsula. Arctic fox, beaver, land otter, lynx, marten, mink, muskrat, red fox, wolf, and wolverine are found within the subregion. Important small game species include arctic hare, arctic ground squirrel, ptarmigan, and snowshoe hare.

St. Lawrence Island has few land mammals. Arctic fox is the only resident, indigenous game species (Rausch 1953). Residents rely largely on the abundant marine resources for subsistence. Reindeer were transplanted to St. Lawrence Island in 1900. The important role of the reindeer industry in the history and economy of the subregion is discussed elsewhere in this narrative.

II. HISTORY AND PATTERNS OF HUMAN ACTIVITY

A. Original Habitation

As part of the Bering land bridge, the Seward Peninsula has played an important role in the peopling of North America. Archaeological sites at Cape Prince of Wales, Cape Denbigh, and on St. Lawrence Island have added significantly to the chronology of human occupation in the north. Ancient hunters crossing the land bridge some 30,000 years ago came to settle the North and South American continents. It is thought that the last migration of hunters, already adapted to life in a northern environment, crossed into Alaska prior to the submergence of the land bridge about 10,000 years ago and populated the North American arctic, becoming the ancestors of Alaska Eskimos (Selkregg 1976).

On the basis of language, it appears that three cultural groups of Eskimos developed and converged around Norton Sound: Siberian Yup'ik speakers on St. Lawrence Island, Central Yup'ik speakers from Unalakleet south to Bristol Bay, and Inupiaq speakers from

Unalakleet north across Canada. A Central Yup'ik dialect known as Unalit was dominant along the coast of Norton Sound north of Unalakleet prior to an influx of Inupiat from the Kotzebue Sound area in the early 1800's. Along Norton Sound, the blend of Inupiaq and Yup'ik language and ancestry remains evident today. The indigenous population of the subregion are referred to collectively as Bering Strait Eskimos. St. Lawrence Island, culturally and geographically isolated from Alaska, has been inhabited for over 2,000 years (Braund 1981). Because of their proximity to Siberia, St. Lawrence Islanders have historically had a closer association, through trade and visits, with Siberian Eskimos than with the Natives of the Alaskan mainland (ibid.).

B. Early Contact Period

Vitus Bering's voyages of 1728 and 1729 led to the discovery of St. Lawrence Island, the Diomede Islands, and the confirmation that Asia and North America were separate continents. The next recorded voyage to this area was a brief visit by Captain Cook to Norton Sound and as far north as Icy Cape in 1778. Over the next 40 years, a mere handful of Russian, American, and European ships found reason to explore the Bering Strait region. Contacts with the Native peoples during this period were sporadic and brief. European trade goods at that time consisted primarily of tobacco, beads, and knives, which were exchanged for furs and occasionally for fresh provisions such as fish (Ray 1975b). Trade also flourished between Bering Strait Eskimos and Siberian Natives, as it had for centuries, providing the primary avenue for western goods into the subregion. During the 1820's, contact with the Bering Strait Eskimos became more frequent. Limited use of firearms by Eskimos in Kotzebue Sound was reported as early as 1820 (Ray 1975a). Between 1820 and 1822, Russian explorations in search of the northwest passage made repeated contacts with the Eskimos of Norton Sound, King Island, Seward Peninsula, and Kotzebue Sound. The logs of two voyages by Frederick Beechey to the Bering Strait region in 1826 and 1827 offer some of the first detailed ethnographic observations of the indigenous population (ibid.). The establishment of a Russian settlement at St. Michael in 1833 was the first permanent non-Native settlement in the subregion and provided increased opportunities for trade and contact and the accompanying cultural changes during the ensuing historic period.

C. Nineteenth-Century Settlement and Subsistence Patterns

During the nineteenth century, the Bering Strait region was divided into several local societies, each with distinct villages, territories, and subsistence patterns. The general settlement pattern of the Bering Strait Eskimos during that time consisted of a single large village with several smaller, linguistically related villages located within a 20- or 30-mi radius (Ray 1964). This village cluster formed a territory within which marriage, subsistence activities, trade, and ceremonies took place (ibid.). Large year-round villages were located at Stebbins, Shaktookik, Elim, Golovin Bay, Cape Nome, Sledge Island, King Island, Cape Rodney, Little Diomede, Grantley Harbor, Wales, and Shishmaref (Ray 1975b). The St. Lawrence Island population was divided among some 35 settlements prior to 1880, becoming concentrated at Northwest Cape after that time (Ellanna 1983a). Of these villages, Wales was notably large, with 50 houses reported there in 1791 (Ray 1975b). Semisubterranean wood and turf houses commonly had floors and benches of wood planks (ibid.). A prominent feature of a village, and one which usually distinguished permanent from seasonal settlements, was the kazgi, or ceremonial house. Each large village had one or more of these structures (Ray 1964). Smaller villages were usually occupied only during the winter, with residents relocating to traditional hunting or fishing camp locations during the summer. Summer dwellings were wood and turf structures or tents made of skins (ibid.).

Whereas the settlement pattern described above was similar throughout the subregion, subsistence patterns varied. Subsistence patterns during the nineteenth century are summarized below within two major areas: Bering Strait and Norton Sound (Ellanna 1980).

1. Bering Strait subsistence patterns. At least 10 societies existed in the Bering Strait region comprising the western half of the Seward Peninsula from Shishmaref to Cape Nome, as well as the insular areas of Diomede, King, Sledge, and St. Lawrence Island (table 1). These 10 societies demonstrated three general subsistence patterns (ibid.).

   The large-sea-mammal-hunting pattern focused on bowhead whales and walruses and was practiced by the mainland settlements at Wales and Cape Nome and by all of the island settlements (Diomede, King, Sledge, and St. Lawrence). The caribou-hunting pattern was practiced primarily by the inland settlement of Kawerak and the Fish River people. The small-sea-mammal-hunting pattern focused on seals and belukha whales and was practiced at coastal locations such as Shishmaref and Port Clarence, which were not favorably situated to intercept bowhead whales and walruses.

   This subsistence classification highlights only the major focus of subsistence activities. During the nineteenth century, all settlements, regardless of their location,

Table 1. Bering Strait Societies in the Nineteenth Century

Society	Contemporary Communities	Territorial Boundaries
Tapqaqaqmiut (Tapkakmiut)	Shishmaref	Cape Espenberg inland to Serpentine Hot Springs and southwest along the coast of Seward Peninsula to approximately Lopp Lagoon
Diomede Islands (Ingalik)	Little Diomede	Little Diomede (Ingalik) Island
Wales (Kingikmiut)	Wales	Tip of Seward Peninsula from Lopp Lagoon southwest and then southeast north of Port Clarence
Port Clarence	Teller Brevig Mission	Port Clarence, Point Spencer, Grantly Harbor, Tuksuk Channel, and surrounding areas
Kawerak (Kuzitrin River, Igloo)	Mary's Igloo	Interior Seward Peninsula along the drainage of the Kuzitrin River
King Island (Ukiuvungmiut)	King Island	King Island (Ukiuvok)
Nome	Nome Solomon	Along the southern coast of Seward Peninsula east of Cape Rodney and west of Bluff
Sledge Island	None	Sledge Island (Ayak)
Fish River	Council White Mountain	Fish River drainage
St. Lawrence Island (Sivokak or Sevoukak)	Gambell Savoonga	St. Lawrence Island

Source: Adapted from Ellanna 1980.

relied on a mixture of marine mammals, caribou, and fish for subsistence (Ray 1964). Inland settlements heavily dependent on caribou had access to marine mammals along the lower stretches of rivers and through annual trips to the coast. Island populations had access to caribou and other terrestrial resources through trade or annual trips to mainland areas for hunting and fishing (Ellanna 1980, Koutsky 1982). Seals were important to all Bering Strait communities. Gray whale, minke whale, and Steller sea lion were additional marine resources occasionally available to St. Lawrence Islanders. Important fish resources were chum, coho, pink salmon, arctic grayling, herring, arctic and saffron cod, sculpin, smelt, and whitefish. Crabs and clams were also used. Waterfowl, seabirds, bird eggs, ptarmigan, and arctic hare formed an important part of the diet at various times of the year (Ellanna 1980, Ray 1964).

2. <u>Norton Sound subsistence patterns</u>. Eleven societies existed along coastal Norton Sound from Cape Nome to the present-day community of Stebbins (table 2) (Ellanna 1980). The communities of the Norton Sound area typically lacked access to large marine mammal migrations (bowhead and grey whale and walrus). Their subsistence patterns therefore fell generally into two categories. The caribou-hunting pattern was practiced by the communities of Koyuk, Inglutalik, Egavik, and Shaktoolik (table 2); the small-sea-mammal hunting pattern was practiced by all the remaining communities (ibid.).

   The caribou-hunting communities of Norton Sound differed from their counterparts in the Bering Strait area in that they were located on the coast and hunters traveled inland to hunt caribou. Fish, specifically salmon and herring, were utilized to a greater extent by Norton Sound Eskimos than by those of the Bering Strait area. Because the availability of walruses and large whales in Norton Sound was unreliable, the large-sea-mammal-hunting pattern and some socialcultural elements connected with whaling (ceremony, crew structure, ritual distribution) did not exist in Norton Sound (Ellanna 1980). Belukha whale and seal were the major marine mammals of Norton Sound. Walrus was hunted in some years at specific locations.

   Traditional subsistence patterns incorporated seasonal mobility and flexibility into the annual cycle, making effective use of all available resources while avoiding overdependence on a single resource (Ray 1964). Boundaries between subsistence patterns were not clearly defined, and the subsistence patterns of individual families or entire communities were adjusted yearly. This flexibility allowed

Table 2. Norton Sound Societies in the Nineteenth Century

Society	Contemporary Communities	Territorial Boundaries
Chiukak (Golovin Bay area)	None	Uncertain (Ray 1964)
Ignituk (Rocky Point)	None	Rocky Point at the western mouth of Golovin Bay
Atnuk	Golovin Elim Moses Point[a]	Cape Darby and Golovin Bay
Koyuk	Koyuk	Koyuk River drainage and head of Norton Bay, west along the coast to Moses Point
Inglutalik	None	Northeastern Norton Bay
Shaktoolik	Shaktoolik	Shaktookik River drainage and eastern shore of Norton Sound coast, and Besboro Island
Egavik	None	Eastern shore of Norton Sound
Unalakleet	Unalakleet	Unalakleet River drainage and southeastern shore of Norton Sound
Kikiktauk	None	East of contemporary St. Michael
St. Michael (Tachik)	St. Michael	"St. Michael Island"[b] on south-western edge of Norton Sound and Stuart Island
Stebbins (Atuik)	Stebbins	"St. Michael Island"[b] west of St. Michael and Stuart Island

Source: Adapted from Ellanna 1980.

a Primarily occupied today seasonally as a subsistence and commercial fishing community mainly for Elim residents.

b "St. Michael Island" is today a cape separated by a stream from the mainland and is not recognizable as an "island" on most maps.

the Eskimos to survive natural, short-term fluctuations in resource abundance. Sustained declines in a major resource, such as the reductions in caribou that began around 1870, triggered population shifts. For example, the inland Seward Peninsula communities, heavily dependent on caribou, were abandoned during the last decades of the nineteenth century, their residents relocating to coastal areas (ibid.).

D. Historic Period

During the historic period encompassing the last half of the nineteenth century and the first half of the twentieth century, several events impacted the culture, settlement, and subsistence activities of the subregion. The effects of commercial whaling, the introduction of reindeer herding, and the Nome gold rush are briefly examined below.

1. Commercial whaling. Prior to 1848, commercial whaling activities in the North Pacific were largely confined to the Bering Sea and Siberian Gulf of Anadyr (Bockstoce 1977). A steady northward expansion of the whaling industry between 1848 and 1900 brought increased contact between whalers and Eskimos on St. Lawrence Island, the Diomedes, the Seward Peninsula, and all of northwest Alaska. Port Clarence, which between 1849 and 1854 had proved a safe harbor for several ships involved in the search for the lost Franklin expedition, provided an occasional harbor, watering, trading, and rendezvous location for whaling vessels awaiting favorable ice conditions in the Bering Strait (ibid.). By 1884, a coal stockpile had been established at Cape Spencer to service steam vessels operating in arctic waters, and Port Clarence became a popular anchorage during the last decades of the whaling industry (Ray 1975b).

   The commercial whalers brought disease and alcohol to Bering Strait during this period (Selkregg 1976). Large numbers of people died, and communities suffered extreme disruptions. It is thought that St. Lawrence Island lost two-thirds of its population through disease and starvation by 1880 (Ellanna 1983a).

   The commercial harvest of 18,000 bowhead whales between 1848 and 1914 (Bockstoce and Botkin 1980) had serious consequences for the Inupiat whalers of Point Hope and communities farther north. In a similar fashion, Bering Strait communities were severely impacted by the whaling fleet's harvest of walruses. When whales became relatively scarce after 1870, walruses were turned to by the commercial whalers as an alternate source of revenue. Large numbers of walruses were harvested for their oil and ivory. One ship in 1877 reported the harvest of 1,600 walruses, taking 750 in a two-day period (Ray 1975b). An estimated 140,000 walruses were harvested during the 65-year lifespan of the whaling industry in northwest Alaska (Bockstoce and Botkin 1982). Reductions in walrus populations had the greatest impact on St. Lawrence Island, King Island, and Diomede Island, which relied heavily on walruses for subsistence.

2. The reindeer industry. Responding to reports of desperate conditions among the Natives of northwest Alaska about 1889, presumably caused by declines in subsistence resources such as caribou, walrus, and whale, a joint American missionary and government effort established domestic reindeer herds in the Bering Strait region. In 1892, a small herd of Siberian reindeer was established in the Port Clarence area, with headquarters at Teller. After the importation of Lapps as herding instructors, herds were established throughout northwest Alaska, growing steadily in number and size. By 1908, the Reindeer Service was formally established to oversee the herding operations of some 20,000 animals throughout western Alaska (Stern 1980). Prior to 1914, herd ownership and industry involvement had been dominated by the U.S. Government, missionaries, and Lapp herders. In 1902, there were only 43 Eskimos who owned herds. In keeping with the original intent of establishing a largely Native-run enterprise, more Natives were encouraged to become involved. By 1916, there were over 1,200 Eskimo reindeer owners (ibid.).

   At the same time that the mission and government role in reindeer ownership was being diminished to allow greater Native participation, large-scale, non-Native commercial interest in the reindeer industry was developing by Lomen and Company. Throughout the 1920's, Lomen and Company diversified and aggressively pursued financial backing and markets for reindeer products outside Alaska in an apparent attempt to monopolize the industry. By 1933, the reindeer industry reached a peak, with an estimated 720,000 reindeer. Though Natives owned most of the animals, the average size of Native-owned herds was too small to be commercially viable. Small Native-owned herds catered to dwindling local markets or were managed on a subsistence basis. By the mid 1930's, depressed markets for reindeer products within and outside Alaska, combined with overgrazing, predation, and heavy winter losses, precipitated the rapid decline of the reindeer industry. By 1940, reindeer numbers had fallen to 240,000, further dropping to around 30,000 animals in 1950 (ibid.).

Although reindeer herding never became a regional economic base for northwest Alaska, it did become an important food source for many communities. Reindeer contributed to the health and survival of residents during a difficult period between 1890 and 1940 (Stern 1980). As caribou declined, reindeer provided a semidomesticated substitute for an important wild source of food and raw materials. As it bolstered the subsistence economy, herding also provided a relatively culturally compatible introduction into the developing cash economy. The industry was able to attract and hold the level of Native participants it eventually did because of the opportunities it afforded to combine traditional hunting, fishing, and trapping activities with herding operations.

3. The gold rush. The Klondike gold strikes in interior Alaska led to the emergence of St. Michael as a major port for ships serving the gold fields along the upper Yukon River at Circle City and Dawson. Miners began prospecting throughout Alaska, including the Seward Peninsula. Between 1897 and 1901, gold discoveries along the beach and rivers of the southern Seward Peninsula attracted a stampede of miners and established Nome, which had grown to a population of 20,000 by 1901, when it was incorporated, as the largest and most prosperous city in Alaska (Selkregg 1976). Between 1900 and 1905, annual production of gold in the Nome district averaged $4.75 million. Though focused at Nome, mineral exploration and mining activities encompassed much of the Seward Peninsula. Two railroads and a trail network were constructed to outlying mining areas north and east of Nome. Annual gold production from the Nome district peaked in 1909 at $11 million. After 1910, gold production and the population of Nome dropped dramatically. Some mining activity continued until World War I, when gold production virtually ceased. Nevertheless, Nome continued to serve as a regional supply point and population center for the Seward Peninsula.

4. Establishment of contemporary communities. Most contemporary Bering Strait and Norton Sound communities are located at or near traditional settlement sites. Contemporary communities have grown from villages or camps that became the locations of missions, schools, trading posts, mining activity, and reindeer herding stations between 1890 and 1920. Within the subregion in 1985 there were 19 communities, including 16 incorporated cities and three seasonally occupied sites (Council, Mary's Igloo, and Solomon), which are formally recognized as villages under the 1971 Alaskan Native Claims Settlement Act (ANCSA) (see map 2 for community locations). The historical events that led to the establishment of these contemporary communities are outlined below. Except as

noted, information on community histories was gathered from Koutsky (1982) and Environmental Services Limited (1980).

Southeastern Norton Sound was the area of early Russian trade activities. A Russian post of St. Michael was established in 1833, making that location the center for trade, exploration, and missionary activity throughout the nineteenth century. Several nearby villages diminished in size as St. Michael attracted people from surrounding settlements. St. Michael became a major port serving the Yukon gold fields. A United States military post and the first post office in Norton Sound were located there in 1897. The importance of St. Michael as a Yukon River shipping port declined with the completion of the Alaska Railroad in the 1920's. During the early decades of the twentieth century, a village site just south of St. Michael was resettled by Eskimos from Nelson Island south of the Yukon River, becoming the village of Stebbins. Stebbins and St. Michael were both incorporated as second class cities in 1969.

The site of Unalakleet was strategically located as the saltwater terminus of the Kaltag Portage, the shortest overland route between Norton Sound and the Yukon River. Unalakleet became the site of a small Russian post in the late 1830's and further developed as a Native trading center. A mission was established there in 1887 and, affiliated with it, the first Norton Sound area school in 1889. A reindeer station (Eaton Station) was established near Unalakleet in 1899, followed by a post office in 1901 and a public school in 1904. Unalakleet was incorporated as a second class city in 1974.

At the time of historic contact, Wales was the largest Eskimo village in Alaska (Ellanna 1983a). Wales was actually composed of two contiguous villages that functioned as a single population (ibid.). A mission was built in Wales in 1890, and a reindeer station was established there in 1894, followed by a post office in 1902. Wales was incorporated as a second class city in 1964.

The Port Clarence area communities of Teller and Brevig Mission began with the establishment of the first reindeer station and public school in the Norton Sound area at Teller in 1892. Teller became the site of a mission in 1900 but was renamed Brevig Mission in 1903 to distinguish it from the new town of Teller that had developed across Grantly Harbor in 1900 to service gold mining activities on the Bluestone River. The mission, schools, and services provided at Brevig Mission and Teller attracted Native settlers from Diomede Island and the large inland settlement of Kauwerak on the

Kuzitrin River. The dwindling caribou population added further incentive for Kauwerak residents to relocate, and by 1900 that traditional village had been abandoned. In that same year, mining activity on the Kuzitrin River established the settlement of Mary's Igloo. A post office was built there in 1901, followed by a mission and public school by 1907. The school was closed in 1952, and Mary's Igloo remains only a seasonally occupied site today. Teller was incorporated as a second class city in 1963. Brevig Mission was incorporated as a second class city in 1969.

Shishmaref was a traditional Eskimo village site at the time of historic contact. Shishmaref Inlet provided a safe harbor for ships supplying mining activities in the central Seward Peninsula. A post office was established there in 1901, a school in 1906, and a mission in 1929. Shishmaref was incorporated as a second class city in 1969.

Golovin, Council, White Mountain, Solomon, and Nome were all established as a result of gold mining activity in the Fish River and Cape Nome area around 1900. The history of Nome was outlined previously. The traditional Eskimo village of Chinik was located at the site now known as Golovin. In 1890, a trading post was built there to service prospecting activities for the entire Seward Peninsula. A mission was established at Golovin in 1894 and a post office in 1906. Council, on the Niukluk River, was the site of the original gold discovery on the Seward Peninsula in 1897. The boomtown that developed at Council between 1897 and 1899 included a railroad to outlying mines, a hotel, post office, and hospital. Council declined with the establishment of Nome and the depletion of gold. The post office was closed in 1953. White Mountain on the Fish River was the site of a traditional Eskimo village. In 1899, a warehouse was built there to serve area mining activities. White Mountain was the site of a government-operated orphanage and boarding school in 1926 and had a post office in 1932. Solomon was established as a mining camp in 1900 and was originally located on the delta of the Solomon River. Because of its susceptibility to flooding, Solomon was moved to its present location in 1939. A school was built there in 1940 but, with a declining population, was closed in 1956. In 1985, Solomon and Council were, for the most part, seasonal settlements. White Mountain was incorporated as a second class city in 1969, Golovin in 1971.

Because of a lack of significant mineral discoveries around Norton Bay, contemporary communities in that area were a bit slower to develop than elsewhere in the subregion. A trading post was established at Koyuk around 1900 to supply prospecting activities in the Koyuk River area. A school was built at Koyuk in 1928. Elim, the site of a traditional Malemiut Eskimo settlement, became the site of a mission in 1914 and had a post office in 1943. The Cape Denbigh and lower Shaktoolik River area has a history of occupation dating back thousands of years. Shaktoolik village was relocated to the mouth of the Shaktoolik River in 1933 from a previous location several miles upriver. The village moved again to its present location in 1967, having been incorporated as a second class city in 1964. Elim and Koyuk were incorporated as second class cities in 1970.

The insular communities of Diomede, Gambell, and Savoonga are all traditional Eskimo village sites. In 1900, residents of the village of Diomede (Inalik) were temporarily relocated to Teller, and the village was burned because of a diptheria epidemic (Ellanna 1983a). Diomede was quickly rebuilt and repopulated. Prior to World War II there was frequent contact between Eskimo populations on Little Diomede and Russian-owned Big Diomede islands. Since then, contact between Russian and American Diomede Islanders has become infrequent. Diomede was incorporated as a second class city in 1970.

On St. Lawrence Island, Gambell and Savoonga represent 2 of 35 sites that were occupied at historic contact (ibid.). Following devastation by famine and disease around 1880, most of the island population was concentrated at Gambell, a location that provided reliable hunting areas and proximity to mainland Siberia for trade (ibid.). Savoonga was resettled when a reindeer-herding camp was established there in 1916. Gambell was incorporated as a second class city in 1963, Savoonga in 1969.

A traditional settlement was located on King Island and occupied until 1968. Between the mid 1950's and the closure of the school in 1968, King Islanders gradually relocated to Nome, seeking better access to medical facilities, education, and wage employment opportunities. King Islanders continue to function as a discrete subpopulation of Nome (ibid.).

III. POPULATION

Just prior to the intensive historic contact circa 1850, the population of the Bering Strait region from Shishmaref to Stebbins was estimated to be about 2,000 persons, excluding St. Lawrence Island (Ray 1984). St. Lawrence Island was estimated to have had 2,500 inhabitants circa

1830 (Ellanna 1983a). Thus, during the early nineteenth century, the population of the subregion probably approached 4,500, more than half of which resided on St. Lawrence Island. The seemingly large population on St. Lawrence Island was supported by an abundance of marine mammals and through trade with the Siberian mainland. At certain periods in its prehistory, St. Lawrence Island may have supported as many as 4,000 inhabitants (ibid.).

During the historic period, a variety of introduced diseases ravaged the Native population. In 1838 a smallpox epidemic reduced the population of Unalakleet but apparently did not extend north of Norton Bay (Ray 1984). By 1880, the population of St. Lawrence Island had been reduced to around 500 from disease and starvation (Ellanna 1983a, Hughes 1984). In 1900, an epidemic of measles and influenza struck western Alaska, killing half the population in some villages (Ray 1984, Wolfe 1982). Outbreaks of pneumonia, diptheria, and tuberculosis were also reported (ibid). Another epidemic of influenza in 1918 claimed hundreds more lives and resulted in the abandonment of some traditional settlements, as survivors relocated to Nome and children were moved to orphanages such as the one built at White Mountain in 1926 (Ray 1984).

Several population shifts also occurred in the subregion during the nineteenth and twentieth centuries. During the first decades of the nineteenth century, there was an immigration of Eskimos from the Kotzebue Sound (Malemiut) to the southern Seward Peninsula (Ray 1964, 1984). In the 1910's, a group of Eskimos from the Kuskokwim River delta moved north to repopulate Stebbins (Ray 1984). The most dramatic influx of people into the subregion was associated with the discoveries of gold at Council and Cape Nome beginning in 1897 and the stampede to Nome discussed above.

Population figures for traditional settlements and villages in the subregion were not systematically collected prior to 1900. Population figures for Bering Strait and Norton Sound communities 1890 to 1980 are presented in table 3. Because of the rapid turn of events and inadequacies of the early censuses, these data do not accurately reflect the chaotic period of epidemic disease, abandonment of traditional settlements, and the goldrush, between 1890 and 1920. The 1900 population figure for Nome of 12,483, for example, was probably momentarily correct but was, in a matter of days or weeks, outdated as thousands continued to pour into Nome. The populations of St. Michael, Teller, Council, and Solomon all peaked and declined between 1900 and 1910, events not reflected in the census data. With the establishment of contemporary communities and the slowed pace of mining activity, the census data from 1930 on probably present a more accurate portrayal of the population of the subregion.

Alaskan Natives comprise the majority of the population in all communities of the subregion, making up 59% of the population in Nome,

Table 3. Population Data for Bering Strait/Norton Sound Communities, 1890-1980

Village	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980*
Brevig Mission	---	---	---	---	---	---	---	---	123	138
Council	---	---	289	109	---	48	41	---	---	---
Diomede	---	---	90	---	139	129	103	88	84	139
Elim	---	---	162	162	97	100	154	145	174	211
Gambell	---	---	221	48	250	296	309	358	372	445
Golovin	25	185	---	---	135	116	94	59	117	87
King Island	---	---	119	---	170	208	---	49	---	---
Koyuk	---	---	---	---	110	100	134	129	122	188
Mary's Igloo	---	---	141	115	113	114	64	---	---	---
Nome	41	12,483	2,600	852	1,213	1,559	1,876	2,316	2,357	2,301
Savoonga	---	---	---	---	139	209	249	---	364	491
Shaktoolik	---	---	---	73	104	128	127	187	151	164
Shishmaref	---	---	---	131	223	257	194	217	267	394
Sledge Island	64	---	---	---	---	---	---	---	---	---
Solomon	---	---	---	---	---	106	93	---	---	---
Stebbins	---	---	---	---	---	98	115	158	231	331
St. Michael	101	857	415	371	147	142	157	205	207	239
Teller	---	---	125	80	76	118	160	217	220	212
Unalakleet	175	241	247	285	261	329	469	574	434	623
Wales	---	---	337	136	170	193	141	128	131	133
White Mountain	---	---	---	198	205	199	129	151	87	125

Source: Rollins 1978, * USDC 1981.

--- means no data were available.

88% in Unalakleet, and more than 90% in all the remaining communities in 1980 (USDC 1981).

IV. SUBREGIONAL ECONOMIC OVERVIEW

In general, the economy of the Bering Strait/Norton Sound subregion is a mixed subsistence-cash economy whereby contemporary communities are supported by a mix of subsistence activities and commercial-wage activities (Wolfe 1983, Thomas 1982). Most communities have a limited number of state or federally funded positions available, such as postmaster, airport maintenance personnel, health aide, schools, and power plant operator. Local government offices, Native corporations, and seasonal construction work also provide some employment in most communities (Ellanna 1983b, Sobelman 1985). Self-employment through commercial fishing, reindeer herding, trapping, and the production of Eskimo arts and crafts is also common (Ellanna 1980).

Nome has the most wage employment opportunities within the subregion by virtue of its role as a regional center for government services, transportation, and private support sectors. Many jobs are seasonal or part-time, and persons filling higher-paying, professional positions are commonly recruited from outside the subregion. For these reasons, wage employment opportunities for local residents are relatively limited. Ellanna (1983b) states that "a majority of Nome's population participates in a complex economic system which combines some level of cash derived from wage employment and reliance on a wide spectrum of locally available fish, game, and plant resources."

Household incomes, especially in communities outside of Nome, are relatively low. In 1982, average taxable incomes ranged from $6,830 in Brevig Mission to $19,745 in Nome (table 4). By comparison, the average taxable income for Anchorage in 1982 was $23,590 (ADR 1985). Incomes for this subregion are particularly low when one considers the substantially higher costs of fuel and other imported items in remote communities. As a result of these low incomes, many households qualify for and receive transfer payments from state or federal aid programs (Ellanna 1980, 1983b; Sobelman 1985; Thomas 1982).

Contemporary household diets typically include a mix of store-bought and subsistence foods (Thomas 1982). Because of limited wage-earning opportunities, cash is regarded as the least reliable component of the mixed economy in most communities and cannot be counted upon to support most households. Hunting and fishing combined with limited wage employment provide the most stable means for obtaining economic security (Sobelman 1985). Toward that end, cash is typically invested into subsistence endeavors through the purchase of guns, nets, boats, outboard motors, and snowmachines. Hunters and fishers adjust

Table 4. Average Taxable Income for Bering Strait/Norton Sound Communities* 1978, 1981, 1982

Community	Average Taxable Income 1978	1981	1982
Brevig Mission	5,368	6,820	6,830
Diomede	5,310	5,680	8,816
Elim	4,150	6,511	8,175
Gambell	5,764	8,231	9,448
Golovin	5,936	6,150	7,822
Koyuk	5,416	7,284	7,696
Nome	14,654	18,856	19,745
Savoonga	5,346	8,850	8,693
Shaktoolek	5,573	7,965	10,150
Shishmaref	8,235	9,420	9,855
Stebbins	4,654	7,394	9,183
St. Michael	5,058	9,988	10,709
Teller	5,446	7,221	9,087
Unalakleet	7,745	11,797	14,511
Wales	4,153	6,670	7,257
White Mountain	7,327	8,622	9,942

Source: ADR 1985.

* Based on federal tax return sorted by zip code.

employment schedules when possible to accommodate participation in subsistence activities. Working household members sometimes sponsor the subsistence activities of other family members. Through economic strategies like these, subsistence foods and products are made available to the household (ibid.). Subsistence harvests are frequently widely distributed through established networks within and between communities. In this way, the cash and subsistence components of the economy interact to form the mixed, subsistence-based economic system that characterizes the subregion.

Commercial fishing, reindeer herding, trapping, and the production of Eskimo arts and crafts are components of the subregional economic system that are tied to renewable fish and game resources. The role of these enterprises in providing household income is briefly examined below.

A. Commercial Fishing

Commercial salmon fishing is an important source of income for many households in Norton Sound communities. Participation in commercial salmon fishing is restricted to those who possess a limited entry permit. Table 5 shows levels of participation and incomes derived from Norton Sound commercial salmon fishing in 1979, by location. Participation in the commercial salmon fishery has remained relatively constant since 1970. In 1984, a total of 141 fishermen participated in the Norton Sound commercial salmon harvest, which was valued at $721,055 (ADF&G 1985). This resulted in an average gross earning of $5,113 per fisherman. In the Nome subdistrict in 1983 a total of 19 commercial fishermen earned an average of $1,300 (Magdanz and Olanna 1984). Shore-based salmon processing plants employ some local residents at Golovin, Moses Point, and Unalakleet during the fishing season. The commercial salmon fishery is examined in more detail in the Commercial and Subsistence Harvest of Salmon narrative found elsewhere in this volume.

A commercial fishery for herring sac roe, roe-on-kelp, and herring carcasses exists in eastern Norton Sound. The commercial herring fishing effort is concentrated near Shaktoolik, Unalakleet, and St. Michael. Thomas (1982) reported that 19 Shaktoolik residents participated in the 1980 commercial herring fishery at Shaktoolik and that the average catch per fisherman was valued at $2,770. Out of 272 fishermen participating in the 1983 commercial herring fishery in Norton Sound, 133 were local residents, and the average catch per fisherman was valued at about $5,000 (ADF&G 1984).

A commercial king crab fishery has operated in Norton Sound since 1977. This fishery has been dominated by large boats from outside

Table 5. Participation in and Value of Commercial Salmon Fishing in Norton Sound Subdistricts, 1979

Subdistrict	Number of Fishermen	Total Harvest Value ($)	August Harvest Value Per Fisherman ($)
Nome	15	19,203	1,280
Golovin	21	122,003	5,810
Moses Point	41	150,131	3,662
Norton Bay (Koyuk)	22	75,755	3,351
Shaktoolik	29	119,291	3,941
Unalakleet	53	397,184	7,494
Totals	181	876,548	4,843

Source: Ellanna 1980.

the subregion and therefore does not represent a significant source of local income. In 1983, 23 boats harvested 368,032 lb of king crab in Norton Sound, valued at $552,048 (ibid.).
A commercial fishery for herring sac roe, roe-on-kelp, and herring carcasses exists in eastern Norton Sound. The commercial herring fishing effort is concentrated near Shaktoolik, Unalakleet, and St. Michael. Thomas (1982) reported that 19 Shaktoolik residents participated in the 1980 commercial herring fishery at Shaktoolik and that the average catch per fisherman was valued at $2,770. Out of 272 fishermen participating in the 1983 commercial herring fishery in Norton Sound, 133 were local residents, and the average catch per fisherman was valued at about $5,000 (ADF&G 1984).

A commercial king crab fishery has operated in Norton Sound since 1977. This fishery has been dominated by large boats from outside the subregion and therefore does not represent a significant source of local income. In 1983, 23 boats harvested 368,032 lb of king crab in Norton Sound, valued at $552,048 (ibid.).

B. Reindeer Herding

In 1984, there were 14 Seward Peninsula area reindeer herds, totaling about 20,000 animals (Sobelman 1985). The history of the reindeer industry in Northwest Alaska was outlined in section II.D. Herds are managed for the export of antlers overseas as a medicinal ingredient and for the sale of meat to a predominantly local market (ibid.). Corrallings for cutting antlers, marking calves, castrating bulls, and butchering occur at scheduled intervals throughout the year and may employ local residents, who are paid wages in cash or meat (Sobelman 1985, Stern et al. 1980).

Reindeer herding is more important in terms of employment and income on the community level than to the subregion as a whole. The role of reindeer herding in the village economy is illustrated by one herding operation in the mid 1970's, based out of a Seward Peninsula village with a population of 87 (Stern et al. 1980). The reindeer herd of 1,000-2,000 animals was managed by a local family. Herding provided the major share of the annual income for three individuals: the herd owner, his son, and a winter herder. In addition, herding activities provided seasonal employment for up to 15 villagers during corrallings. Aside from cash wages paid, 64 reindeer carcasses were used as payment for labor or home consumption in 1976, and 100 reindeer carcasses were sold through the village store. In this example, reindeer herding provided a seasonal source of local employment for a few individuals, as well as contributing to the food requirements of the community.

C. Trapping

Little quantitative data have been published to assess commercial trapping participation and earnings in the subregion. Ellanna (1980) suggested that participation in trapping for commercial sale of pelts in the Bering Strait/Norton Sound region is generally low, except on St. Lawrence Island, where fox trapping continues to make a significant contribution to some household incomes. Sobelman (1985) noted that furbearers with the highest commercial value, such as wolverine, lynx, mink, and wolf, are rare around Shishmaref and when harvested are commonly utilized locally. In his survey of Shaktoolik, Thomas (1982) stated that 60% of surveyed households were involved in trapping in 1980 and that participation in trapping was increasing. Jorgensen et al. (1983) reported active trapping for beaver, fox, lynx, marten, mink, muskrat, wolf, and wolverine in Unalakleet. Trapping may play a more important economic role along the eastern mainland portion of the subregion, where a more diverse assortment of furbearers is available and generally more abundant.

D. Eskimo Arts and Crafts Production

The production of Eskimo arts and crafts is an important source of income for many households, especially in Gambell, Savoonga, Diomede, Teller, Wales, Shishmaref, and for King Islanders in Nome

(Ellanna 1980). Ivory carving is perhaps the most lucrative of these, but dolls and skin clothing are also sold. Ellanna (1980) reported that a moderately skilled ivory carver who works consistently may gross from $10,000 to $12,000 annually. Among the insular Eskimo communities, 70 to 90% of the households probably participate in the production of arts and crafts to some degree (ibid.).

V. LAND STATUS

Current land status in the subregion has been shaped by the passage of the Alaska Native Claims Settlement Act (ANCSA) in 1981 and the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. Land ownership within the subregion is generally divided among federal, state, and Native corporation lands.

The federal government is the subregion's largest land holder. About half of the almost 2.5 million-acre Bering Land Bridge National Preserve lies within the subregion and is managed by the National Park Service out of Nome. This preserve lies in the northwest and northcentral Seward Peninsula and was created to protect and preserve the unique arctic habitats, archaeological potentials, and geologic processes found in that area. A small portion of the Yukon Delta National Wildlife Refuge is included in the subregion south of St. Michael and managed by the U.S. Fish and Wildlife Service out of Bethel. The Bureau of Land Management (BLM) owns large land areas that are not classified under a specific designation. Since hunting, fishing, and gathering continue to be the predominant land use activity within the subregion, provisions have been made for reindeer-grazing permits and continued access for subsistence activities on most federal lands within the subregion (Bering Straits Coastal Resource Service Area Board 1984).

The State of Alaska owns tidelands, the submerged lands beneath navigable waterways, and several large tracts on the inland Seward Peninsula area and along the coast near Nome. Some state land selections have not yet been conveyed to the state by the BLM. Management plans for state-owned lands are still being considered, but reindeer grazing and wildlife habitat have been tentatively identified as the primary use for most of these lands (ibid.).

Private land ownership in the subregion is dominated by Native regional and village corporation holdings. Under ANCSA, 17 villages within the subregion have selected and are eligible to receive about 1.8 million acres of land. Selected lands are predominantly coastal lands surrounding the villages. Three village corporations, Elim, Gambell, and Savoonga, chose to take title to the federal reserve lands that previously surrounded those villages. As a result, all of St. Lawrence

Island is jointly owned by the village corporations of Gambell and Savoonga, with the exception of about 10 acres of state land (ibid.).

Aside from the major landowners mentioned above, other private land holdings include mining claims and Native allotments located throughout the subregion. These holdings are concentrated along the coast and inland waterways.

VI. CONTEMPORARY PATTERNS OF RESOURCE USE

The use of wildlife resoruces will be discussed in detail below. All known resource harvest is decribed in this section; however, discussion of harvest that is currently not permitted by regulation does not constitute endorsement of such harvest by the Department of Fish and Game. Subsistence activities continue today as integral parts of the local economy of the Bering Strait/Norton Sound subregion. Three general subsistence patterns are functioning within the Bering Strait/Norton Sound subregion (Ellanna 1980):

- The small-sea-mammal-hunting, inland-hunting, and fishing pattern, practiced by the contemporary communities of Brevig Mission, Shishmaref, Teller, Mary's Igloo, and Nome
- The large-sea-mammal-hunting pattern, as practiced in the contemporary communities of Diomede, Gambell, King Island, Savoonga, and Wales
- The Norton Sound fishing and coastal-and inland-hunting pattern, practiced by the contemporary Norton Sound communities of Council, Elim, Golovin, Koyuk, Shaktoolik, Solomon, Stebbins, and St. Michael

These patterns reflect general subsistence strategies and represent convenient categories in which to discuss groups of communities. There are not well-defined boundaries separating these patterns but rather a gradual shift in the emphasis of some species over others across the subregion (ibid.). Table 6 lists subsistence resources utilized by communities of the Bering Strait/Norton Sound subregion. Each general subsistence pattern is discussed below and illustrated with community-specific data where available.

A. The Pattern of Small Sea Mammal Hunting, Inland Hunting, and Fishing

As mentioned above, the resource uses of the contemporary communities of Brevig Mission, Mary's Igloo, Nome, Teller, and Shishmaref fall within this general pattern.

Table 6. Biotic Resources Utilized by Residents of the Bering Strait/Norton Sound Subregion**

Common Name	Scientific Name
Marine Mammals	
Whale, bowhead	Balaena mysticetus
Whale, belukha	Delphinapterus leucas
Walrus, Pacific	Odobenus rosmarus
Seal, bearded (ugruk or mukluk)	Erignathus barbatus
Seal, harbor or spotted	Phoca vitulina
Seal, ringed	Phoca hispida
Seal, ribbon	Phoca fasciata
Whale, gray	Eschrichtius gibbosus
Bear, polar	Ursus maritimus
Terrestrial Mammals	
Moose	Alces alces
Caribou or reindeer	Rangifer tarandus
Bear, black	Ursus americanus
Bear, brown	Ursus arctos
Beaver	Castor canadensis
Squirrel, arctic ground	Citellus parryi
Porcupine	Erethizon dorsatum
Hare, arctic	Lepus arcticus
Hare, snowshoe	Lepus americana
Fox, arctic*	Alopex lagopus
Fox, red*	Vulpes fulva
Lynx*	Felis lynx
Marmot, hoary*	Marmota caligata
Marten*	Martes americana
Mink/weasel*	mustela sp.
Muskrat*	Ondatra zibethicus
Wolf*	Canis lupus
Wolverine*	Gulo gulo

(continued)

Table 6 (continued).

Common Name	Scientific Name
Wildfowl	
Auklet, least	Aethia pusilla
Auklet, crested	Aethia cristatella
Auklet, parakeet	Cyclorhyncus psittaculus
Eider, common	Somateria mollissima
Eider, king	Somateria spectabilis
Eider, spectacled	Lampronetta fisheri
Eider, Stellar's	Polysticta stelleri
Oldsquaw	Clangula hyemalis
Pintail	Anas acuta
Black grant	Branta nigricans
Snow goose	Chen hyperborea
White fronted goose	Anser albifrons
Crane	Grus canadensis
Murre, common (particularly eggs)	Uria aalge
Murre, thick billed (particularly eggs)	Uria lomvia
Ptarmigan, willow	Lagopus lagopus
Ptarmigan, rock	Lagopus mutus
Fish	
Blackfish, Alaska	Dallia pectoralis
Char, arctic	Salvelinus alpinus
Cod, saffron	Eleginus gracilis
Tom cod, Pacific	Microgadus proximus
Cod, arctic	Boreogadus saida
Grayling, arctic	Thymallus arcticus
Pike, northern	Esox lucius
Herring, Pacific	Clupea harengus
Halibut, Pacific	Hippoglossus stenolepis
Smelt, rainbow	Osmerus mordax
Mussels (several species)	unknown
Sculpin, slimy	Cottus cognatus
Burbot	Lota lota
Whitefish, least cisco	Coregonus sardinella
Whitefish, arctic cisco	Coregonus autumnalis
Salmon, chinook	Oncorhyncus tshawytscha
Salmon, coho	Oncorhyncus kisutch
Salmon, chum	Oncorhyncus keta
Salmon, pink	Oncorhyncus gorbuscha
Salmon, sockeye	Oncorhyncus nerka
Whitefish, broad	Coregonus nasus
Whitefish, humpback	Coregonus pidschian
Sheefish	Stenodus leucichthys

(continued)

Table 6 (continued).

Common Name	Scientific Name
Marine Invertebrates	
Crab, king	Chinoecetes opilio
Crab, Tanner	Paralithodes platypus
Clams	Macoma calcerea
Plants and Berries	
Seaweed	Unknown
Greens	Phodiola rosea
Potato	Claytonia tuberosa
Willow leaves	Salix
Sourdock	Rumex articus
Salmonberry (cloudberry)	Rubus chamaemorus
Crowberry	Empetrum nigrum
Blueberry	Vaccinium uliginosum
Cranberry	Vaccinium vitis-idaea

Sources: Ellanna 1980, Sobelman 1985.

* Most of these furbearers were not used for food except in times of food shortage -- at most not a preferred food source.

** Not all the biotic resources are utilized by all communities within the study area, because of the ecological and cultural diversity of the region.

The subsistence pattern can be illustrated using data from Shishmaref and Nome. Shishmaref's resource uses illustrate the subsistence strategies of most small western Seward Peninsula villages outside of Nome. Nome represents contemporary subsistence activities within a relatively large regional center in which the subsistence use pattern is integrated with a large and relatively more secure commercial wage sector.

1. Sea mammal hunting. Ellanna (1980) states that the small-sea-mammal-hunting, inland-hunting, and fishing patterns are characterized by a seasonal diversity and use of resources, with a particular focus on seals. The seasonal round of subsistence activities in Shishmaref is depicted in figure 1 and exemplifies this subsistence pattern. Four species of seal, bearded, spotted, ringed, and occasionally ribbon seal, are found in Bering Strait at various times throughout the

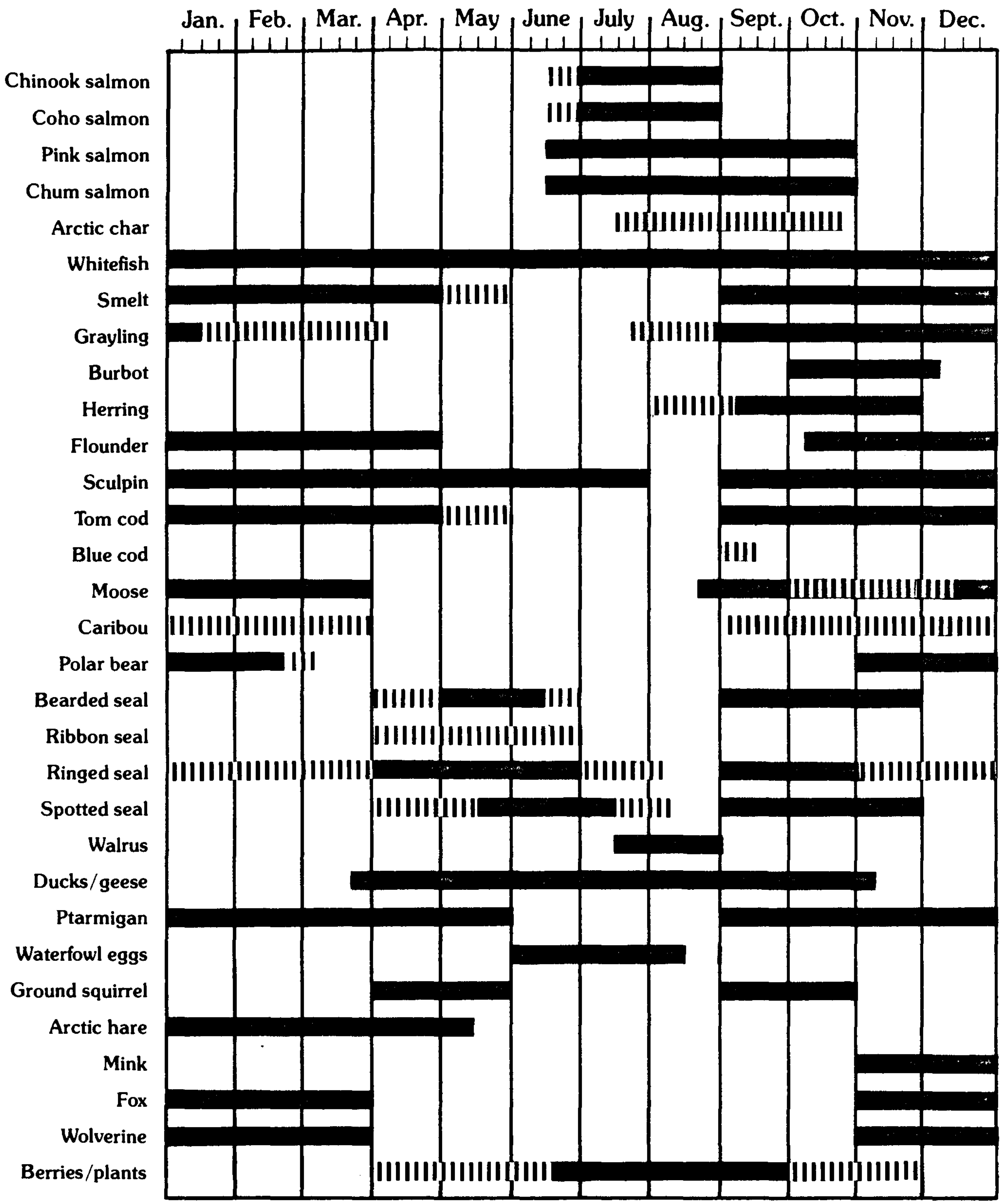


Figure 1. Contemporary annual round of harvest activities by Shishmaref residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Sobelman 1985).

year. Ringed seals are commonly available during the winter months and are hunted at breathing holes and leads in the sea ice. Other seal species are more commonly associated with broken ice or the pack ice edge, conditions which occur during spring (April-June) and fall (September-November). The harvest of seals is usually greatest during the fall and spring seal migrations.

In the winter, seal hunters use snowmachines to travel as far as 50 mi along the coast in search of seals (ibid.). As spring progresses, open-water areas allow travel by boat. Intensive seal-hunting activities are frequently based out of traditional seal camp locations along the coast. The large bearded seals, or ugruk, weighing up to 750 lb, are the preferred species for human consumption. Ugruk meat and some internal organs are eaten fresh or hung on racks to dry. Ugruk blubber is rendered in containers into oil. Hides are cleaned and processed for use in clothing, footwear, and crafts (Sobelman 1985). Ringed seal meat, blubber, and hides are similarly utilized. Spotted seals may be eaten but are less desirable for human consumption and are harvested primarily for their hides and as a source of dog food. In Shishmaref, an estimated 150-175 ugruk and 800 to 1,000 small seals are harvested annually (Ellanna 1980). The cultural and economic importance of ugruk hunting is evident in the reported level of hunting activity. Sobelman (1985) reports that 81% of all Shishmaref households surveyed hunted ugruk (table 7). Ugruk is also the most frequently shared resource among Shishmaref households (ibid.).

Other economically important marine mammals include polar bear and walrus. Historically, migrating herds of walruses passed too far offshore to be reliably available to residents of Brevig Mission, Shishmaref, and Teller. Walrus migration patterns have changed recently, making them more commonly available (Sobelman 1985), and the use of large (25-30 ft) wooden boats and outboard motors has allowed residents of these communities to greatly expand their participation in walrus hunting. Hunters now range up to 40 mi offshore in the early summer months to hunt walrus (Ellanna 1980). Walrus hunting by these communities is, however, less ritualized and socially important than the organized crew hunts among the insular Eskimo communities (ibid.). Polar bears are actively pursued during the winter and spring months along the coast and out on the pack ice. Polar bear hunting is recognized as a specialized and prestigious skill (Sobelman 1985). The meat and hide of the polar bear are utilized.

Table 7. Participation in Resource Harvest by Shishmaref Households*, 1982

Resource Category	Household Harvest Participation Harvested (%)	Did Not Harvest (%)	Tried No Success (%)
Seals			
Bearded seal	79	19	2
Ringed seal	51	49	---
Spotted seal	60	35	5
Ribbon seal	5	90	5
Walrus	30	51	19
Polar bear	5	84	11
Fish			
Herring	47	53	---
Blue cod	28	72	---
Tom cod	67	33	---
Smelt	58	40	2
Sculpin	54	39	7
Flounder	14	86	---
Burbot	26	72	2
Whitefish	72	28	---
Arctic grayling	44	54	2
Chum salmon	40	60	---
Pink salmon	42	58	---
Chinook salmon	7	93	---
Coho salmon	7	93	---
Char	5	95	---
Moose	63	35	2
Furbearers			
Fox	26	72	2
Wolverine	5	91	4
Arctic hare	54	42	4
Ground squirrel	28	70	2
Mink	5	95	---
Caribou	12	88	---
Wildfowl			
Ducks/geese	11	89	1
Ptarmigan	67	30	2
Wildfowl eggs	35	63	2
Berries/greens	91	9	---

Source: Adapted from Sobelman 1985. * N = 43 households surveyed.

--- means no data were available.

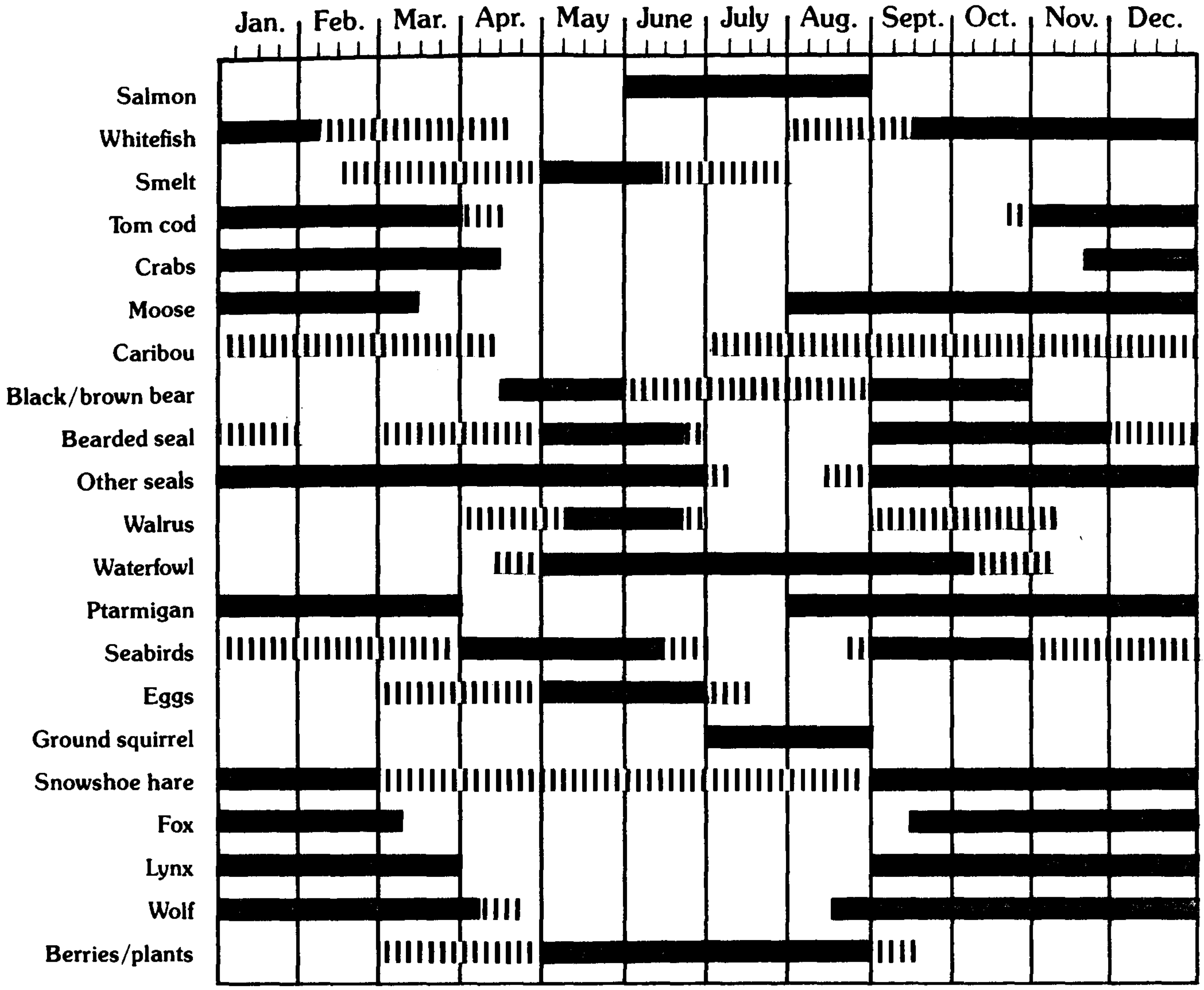


Figure 2. Contemporary annual round of harvest activities by Nome residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Ellanna 1983b).

for the subsistence king crab fishery. Permit returns show that 80 permit holders fished in 1983, harvesting an average of 127 crabs each (Magdanz and Olanna 1984b).

Humpback and broad whitefish are abundant and caught year-round by jigging through holes in the ice or with nets. Herring, ling cod, blue cod, arctic cod, saffron cod, arctic grayling, arctic char, sculpin, smelt, and flounder are caught at various times throughout the year (fig. 1). In the summer, nets are set both near the villages and at traditional fish camp locations along the coast, coastal lagoons, and anadromous fish streams (Ellanna 1980). Winter fishing activities occur near the villages or on outings in conjunction with other land use activities. No commercial fisheries currently exist in the subregion north and west of Cape Nome.

4. Nome. Nome, the largest community in the subregion, also manifests a pattern of subsistence resource use combined with commercial wage activities. The seasonal round of harvest activities in Nome is shown in figure 2. Salmon, berries, trout, ptarmigan, and moose, in that order, are the resource categories used by the greatest number of Nome households. Certain marine mammals, herring, brown bear, black bear, clams, and halibut, in that order, were used by the least number of households in Nome (Ellanna 1983b). Ellanna (1983b) found that among Nome residents, participation in fishing and hunting activities varied according to a household's length of residency and place of origin. Within Nome, identifiable subgroups existed, such as the relocated King Island Eskimo population, which has a separate and distinct historic and contemporary pattern of resource use (ibid.).

B. Large-Sea-Mammal-Hunting Pattern

The large-sea-mammal-hunting pattern characterizes the resource uses by the communities of Gambell, Savoonga, King Island, and Diomede and the mainland Seward Peninsula community of Wales. Pacific walrus and, to a lesser degree, the bowhead whale, provide the major subsistence resources for these communities. For large sea mammal hunters, Ellanna (1980) noted, "unquestionably the open skinboat (umiak) hunting of the Pacific walrus is economically and culturally the most important subsistence activity of the populations within this subregional grouping."

Bowhead whaling activities also are important, especially on St. Lawrence Island. But walrus hunting remains a primary economic activity, and the institution of crew hunting for walrus today, as in the past, provides the basis for social organization within the communities (Ellanna 1980). Despite the singular

2. Other hunting. Waterfowl and a variety of terrestrial game resources complement the large marine mammal component of the diet. Sea bird rookeries and waterfowl nesting areas are important sources of eggs in the late spring and summer. Waterfowl are harvested throughout the spring, summer, and especially in the fall when the birds are fat. Waterfowl hunts are often combined with other subsistence activities, such as berry picking or moose hunting (Sobelman 1985). Moose have been common on the Seward Peninsula since about 1960 and currently are a primary subsistence resource. Sixty-five percent of Shishmaref households surveyed participated in moose hunting activities in 1982 (table 7) (ibid.). Hunting success for moose is high, and moose meat is extensively shared within communities. Residents of the western Seward Peninsula now travel long distances to hunt caribou, and participation in caribou hunting is sometimes determined by the degree of success in fall moose hunting (ibid.). In addition, reindeer meat and hides from local commercial herds play an important role in the subsistence economy of many Seward Peninsula communities.

   Furbearer hunting and trapping are important activities to many households. About one-fourth of Shishmaref households surveyed actively harvested furbearers (ibid.). Pelts from red fox, arctic fox, wolverine, and occasionally lynx, wolf, or mink, are sold or used locally as trim on garments. In conjunction with winter trapping, hunting, and other travel, arctic hare and ptarmigan are harvested when encountered.

3. Fishing. Fishing is a highly valued activity participated in by most western Seward Peninsula households to some extent (Ellanna 1980). In general, salmon play a less vital economic role on the outer Seward Peninsula than among inner Norton Sound communities. Species availability is a function of geographic location (chum, pink, and sockeye salmon in Port Clarence; chum, pink, and coho salmon in Shishmaref) (Ellanna 1980, Sobelman 1985). The Nome River is a source of salmon for some Nome residents. Subsistence fishing there, using seine and gill nets, has required a permit since 1968. Between 1972 and 1983, an average of 49 subsistence permit holders fished for salmon in the Nome River (Magdanz and Olanna 1984a). The average subsistence catch during that period consisted of 112 pink, 21 chum, and 10 coho salmon (ibid.). Rod-and-reel fishing in the Nome River for salmon, arctic car, and arctic grayling is also popular.

   A subsistence king crab fishery in Norton Sound is heavily participated in by Nome residents during the winter. Fishers use baited handlines or pots, which are fished through the sea ice, to harvest crab. In 1983, 172 permits were issued importance of large marine mammals to the economy, a variety of marine and terrestrial resources are pursued throughout the annual subsistence cycle. Contemporary seasonal rounds of subsistence activities for Diomede, Gambell, King Island, Savoonga, and Wales are presented in figures 3-7. Readers are reminded that the King Island population has, since 1975, relocated to Nome, where it continues to exist as a discrete subpopulation. Traditional subsistence activities are carried out by King Islanders both on the mainland and during annual trips to King Island (Ellanna 1983a).

1. Walrus hunting. The bulk of walrus hunting occurs in conjunction with the spring breakup of sea ice. Walruses are commonly available to St. Lawrence Islanders during most of the year, but the spring hunt still accounts for the vast majority of the annual harvest (ibid.). Walrus hunting is a cooperative activity involving crews of usually two or three men directed by a captain. Aluminum or plywood skiffs powered by outboard motors are usually used for walrus hunting today. In 1982, only two walrus crews out of 77 St. Lawrence Island crews used skin boats (Little and Robins 1984). Rifles are used in combination with harpoons for killing and retrieving walruses.

   Walrus meat provides a preferred subsistence food, as well as raw materials for skin boat construction, rawhide line, ceremonial drums, and ivory for carving. As mentioned previously, ivory carving is a major source of cash income for many households in some communities. Walrus products are ritually distributed among crew members and kinship based distribution networks provide nutritional and economic support for the entire community (Ellanna 1980). Walrus harvest data for Gambell, Savoonga, and Wales 1962-1982 are presented in table 8.

2. Subsistence whale hunting. Among the Eskimos south of Point Hope, bowhead whales are pursued most successfully by the residents of Gambell and Savoonga. Whaling is an important economic and cultural activity on St. Lawrence Island. The residents of Wales and Diomede also consider themselves whalers and have organized whaling crews and technology. However, whaling has been markedly less successful in recent history than on St. Lawrence Island. Wales, for example, harvested only four bowhead whales during the 20-year period from 1962 to 1982 (Alaska Consultants, Inc. 1984). For Diomede, the last documented harvest of a bowhead whale was in 1916 (Ellanna 1980). Gray whales were landed by Diomede hunters in 1978 and 1982 (ibid.). In general, King Islanders (now residing in Nome) do not participate in hunting large whales.

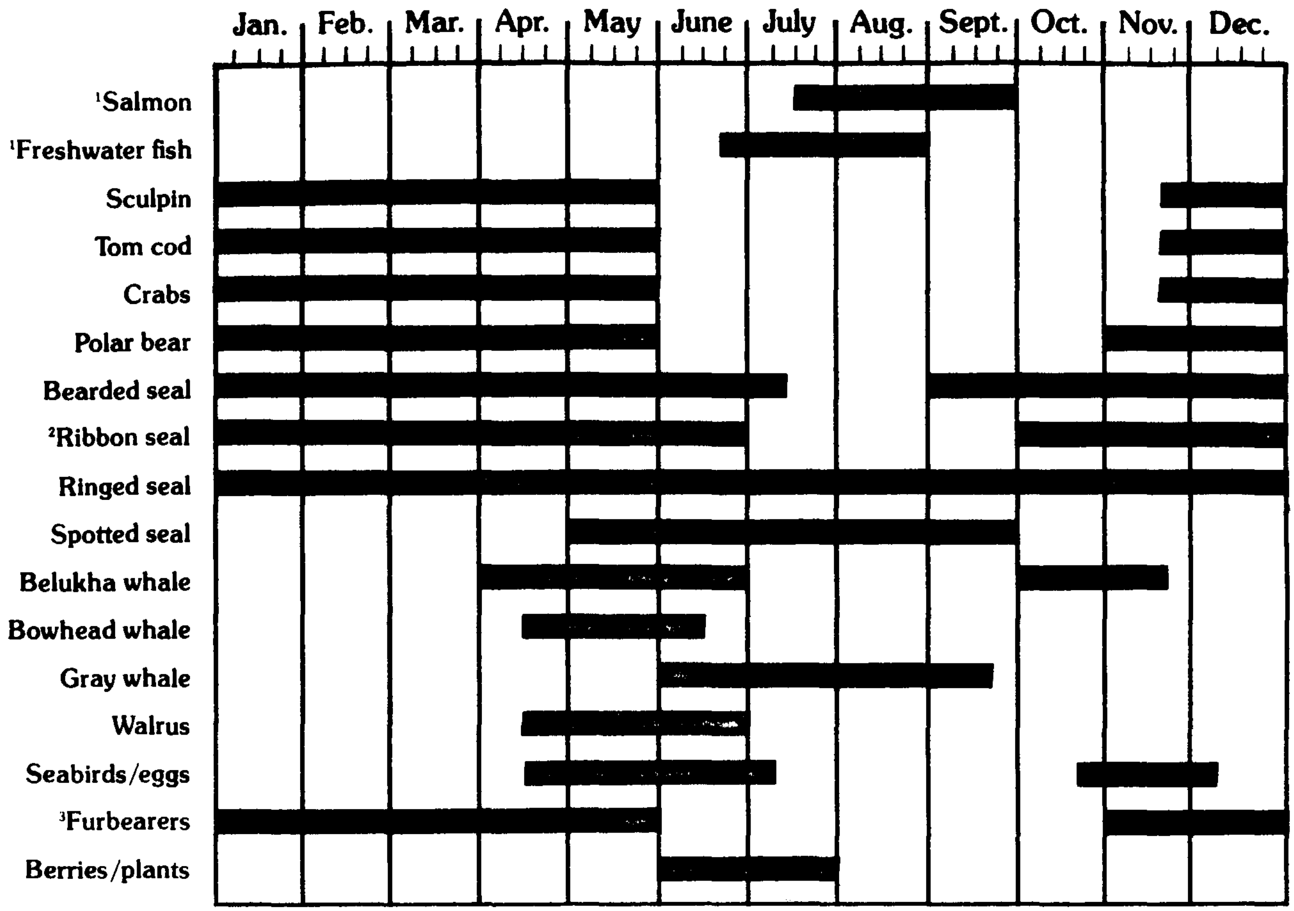


Figure 3. Contemporary annual round of harvest activities by Diomede residents (Ellanna 1983a).

1 Salmon and freshwater fishing is carried out at mainland locations.

2 Ribbon seals are rare but taken opportunistically.

3 Arctic fox are taken on Diomede, other furbearers are harvested at mainland locations.

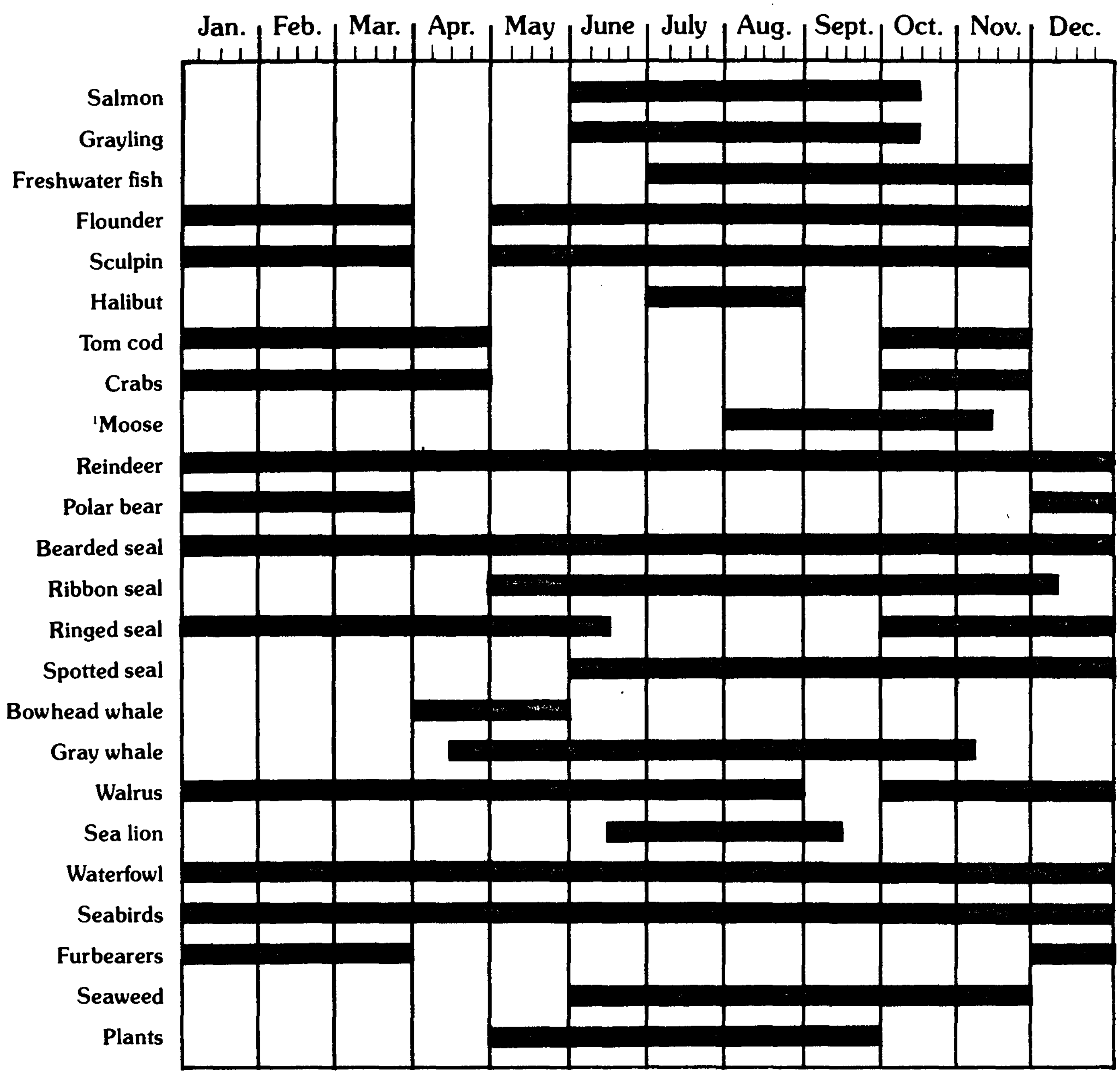


Figure 4. Contemporary annual round of harvest activities by Gambell residents (Ellanna 1983a).

1 Moose do not occur on St. Lawrence Island but are hunted by some residents at mainland locations.

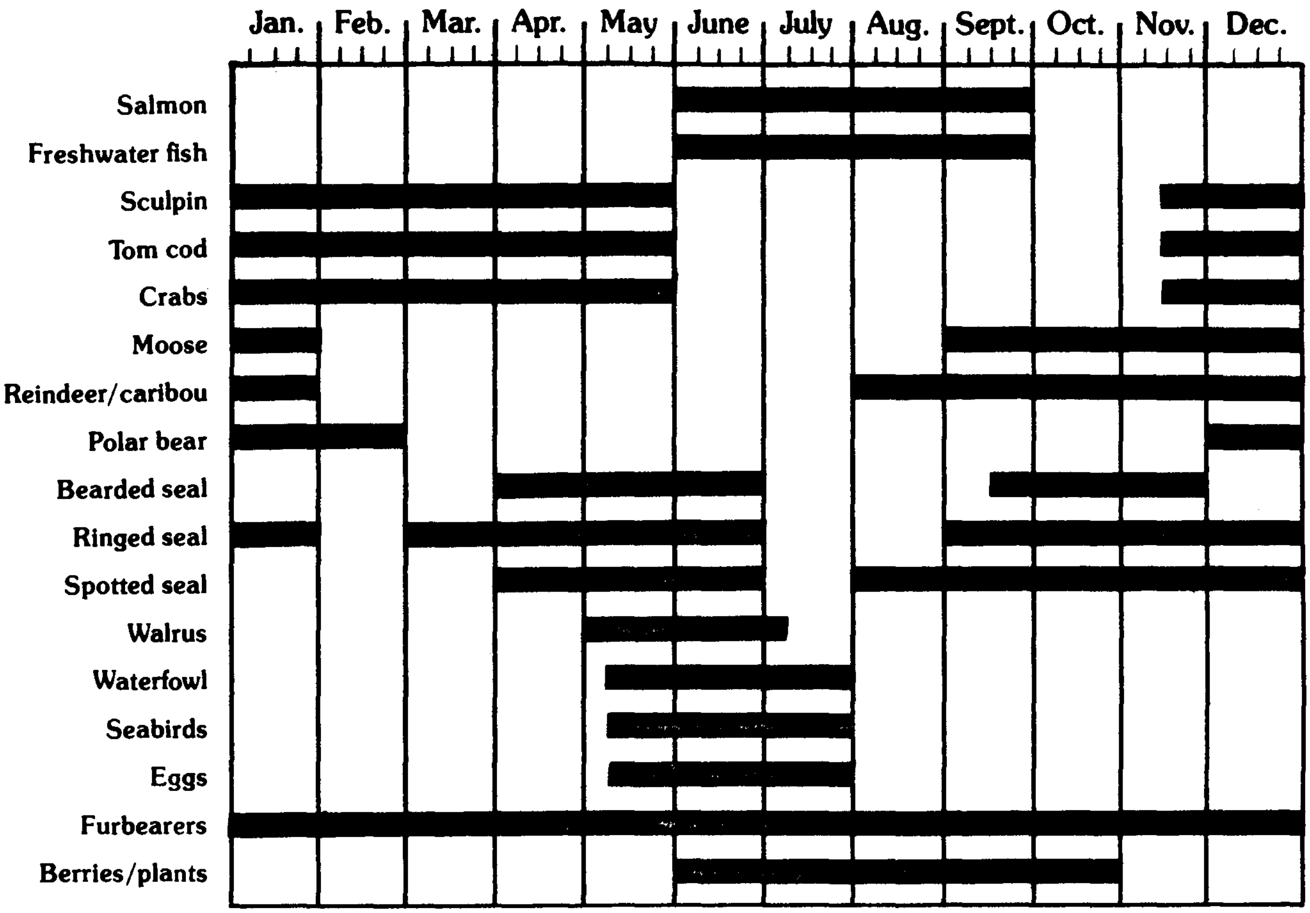


Figure 5. Contemporary annual round of harvest activities by King Islanders (Ellanna 1983a).

Note: King Islanders reside in Nome and return seasonally to King Island for some of the subsistence activities depicted above.

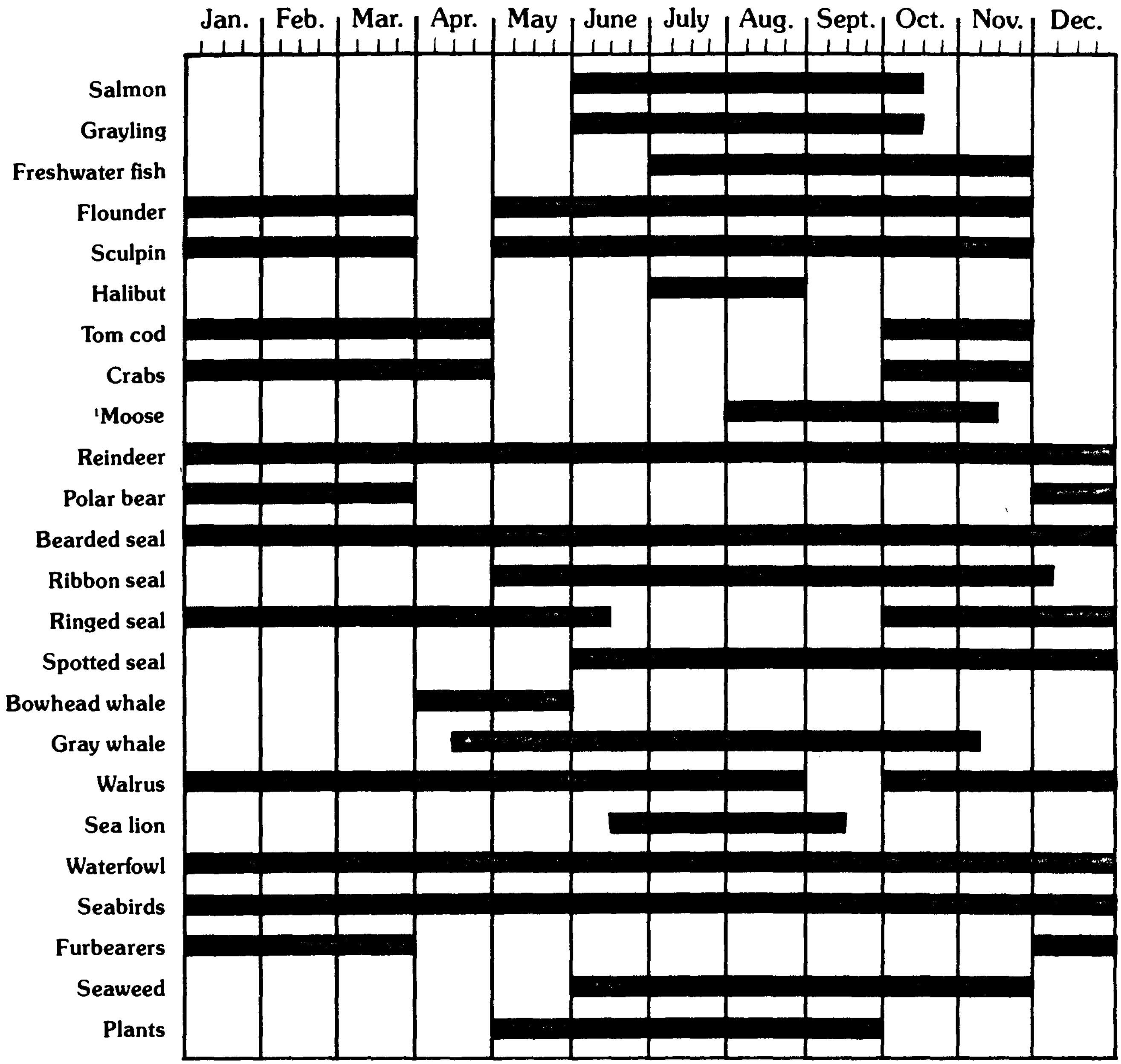


Figure 6. Contemporary annual round of harvest activities by Savoonga residents (Ellanna 1983a).

1 Moose do not occur on St. Lawrence Island but are harvested by some Savoonga residents at mainland locations.

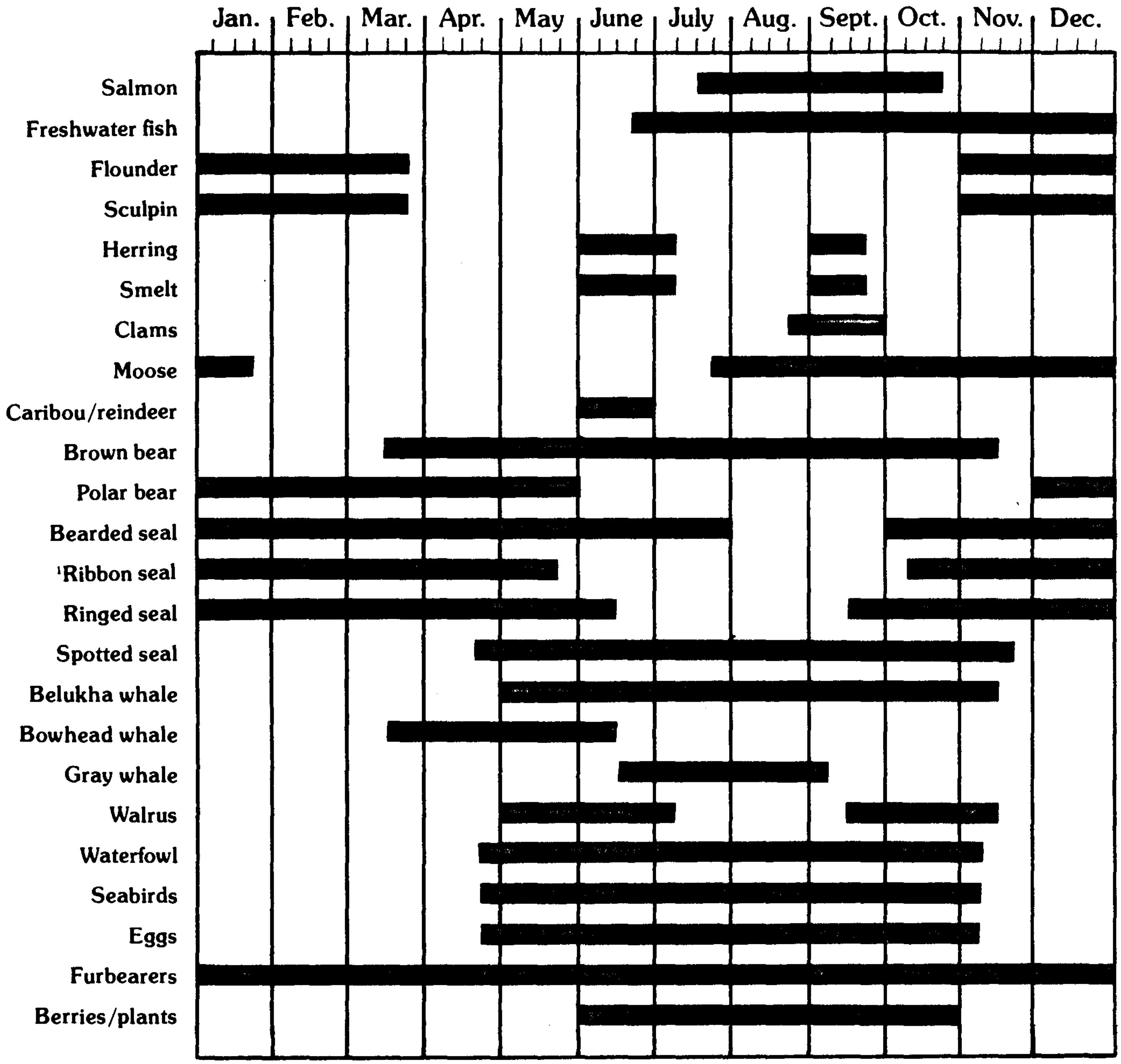


Figure 7. Contemporary annual round of harvest activities by Wales residents (Ellanna 1983a).

1 Ribbon seals are rare but are harvested opportunistically.

Table 8. Number of Walruses Harvested in Gambell, Savoonga, and Wales, 1962-82

	Gambell	Savoonga	Wales
1962	380	293	---
1963	314	452	8
1964	118	238	7
1965	447	389	9
1966	488	511	140
1967	84	299	4
1968	466	117	66
1969	226	179	6
1970	243	180	77
1971	175	543	146
1972	250	236	15
1973	255	515	35
1974	261	214	16
1975	641	466	116
1976	742	656	109
1977	1,059	640	39
1978	471	567	174
1979	479	467	257
1980	556	456	100
1981	963	658	128
1982	920	167	106

Source: Stoker 1983.

--- means no data were available.

Like walrus hunting, whaling is a crew based cooperative effort combining traditional and modern technology. For whaling, traditional skin boats are commonly used, although wood or aluminum boats are becoming more accepted (Little and Robbins 1984). Whaling guns (bomb guns) are universally used. Whale products are ritually distributed among whaling crews, along kinship lines and between villages (Ellanna 1980). Characteristics of whaling crews in Gambell and Savoonga are compared in table 9. Bowhead harvests for St. Lawrence Island 1962-1982 are presented in table 10.

3. Other subsistence activities. Aside from walrus and large whales, other marine resources also are important to communities in the large-sea-mammal-hunting pattern. For

Table 9. Characteristics of Gambell and Savoonga Whaling Crews, 1982

	Gambell	Savoonga
Number of crews	22	10
Total members	153	59
Range of size	4-11	4-8
Average size	7.0	5.9
Households represented	107	46
Average number of households per crew	4.9	4.6
Range of households per crew	2-8	2-8
Percent of village households involved	96	47

Source: Little and Robbins 1984.

Table 10. Number of Bowhead Whales Harvested by St. Lawrence Island Communities, *1962-82

Year	No. Bowhead Harvested
1962	0
1963	0
1964	0
1965	0
1966	0
1967	0
1968	1
1969	0
1970	0
1971	1
1972	2
1973	6
1974	2
1975	1
1976	8
1977	2
1978	2
1979	0
1980	3
1981	3
1982	3

Source: Stokes, 1983.

* Gambell and Savoonga whale harvests are combined.

St. Lawrence Island communities, it is estimated that as much as 98% of all subsistence resources are marine resources (ibid.). Bearded seals, ringed seals, and spotted seals are hunted at various times throughout the year, in conjunction with walrus hunts and whaling activities. Seals are hunted on the sea ice at leads and from boats during open-water periods. Ribbon seal are less common but are hunted opportunistically. Summer sealing activities are most pronounced on St. Lawrence Island. Residents of Wales, Diomede, and King Island (at Nome) tend to participate more in mainland fishing and gathering activities during the summer (ibid.).

Nearly all parts of the seal are utilized. Seal meat is eaten raw, boiled with greens, fried, roasted, or dried and frozen. Seal livers, intestines, and brains are also eaten. Blubber is rendered into oil, and hides are used for garments, boot soles, ropes, gun cases, and packs (Little and Robbins 1984).

Fish also are important components of the overall food supply. Summer fishing activities take place at traditional coastal and river locations for chum, pink, and coho salmon, Dolly Varden, arctic grayling, sculpin, and whitefish. Winter fishing activities focus on tomcod jigged through the ice near the villages (ibid.). Harvest data for fish species taken by Gambell and Savoonga are presented in table 11.

Bird resources, specifically murres and their eggs, auklets, ducks, geese, gulls, kittiwakes, and cormorants are harvested in large numbers from May to December 1981. Bird harvest figures for Gambell and Savoonga are presented in table 12.

Table 13 gives harvest averages and the percentage of the contribution to the total village harvest for all major subsistence resources in Wales, Gambell, and Savoonga for the period 1962-1982. Although annual harvest averages tend to mask annual variations in harvest, these figures do illustrate the relative importance of marine resources, especially walrus, to the economy of these large-sea-mammal-hunting communities.

C. Norton Sound Fishing and Coastal-and Inland-Hunting Pattern

In contrast to the two previous subsistence patterns, this subsistence pattern is characterized by less species specialization (Ellanna 1980). Subsistence activities are more diverse and adapted to local variations in resource availability but generally focus on the abundant marine and marine associated resources of

Norton Sound and Norton Bay. This subsistence pattern is illustrated by the communities of Shaktoolik, Unalakleet, and Stebbins. The seasonal round of subsistence activities in Shaktoolik, Unalakleet, and Stebbins are presented in figures 8, 9, and 10. Specific elements of the seasonal round are discussed below.

1. <u>Fishing</u>. Among Norton Sound fishing activities, salmon fishing is of particular importance. Historically, large quantities of dried salmon were required for both human consumption and as dog food. Salmon continues to be a

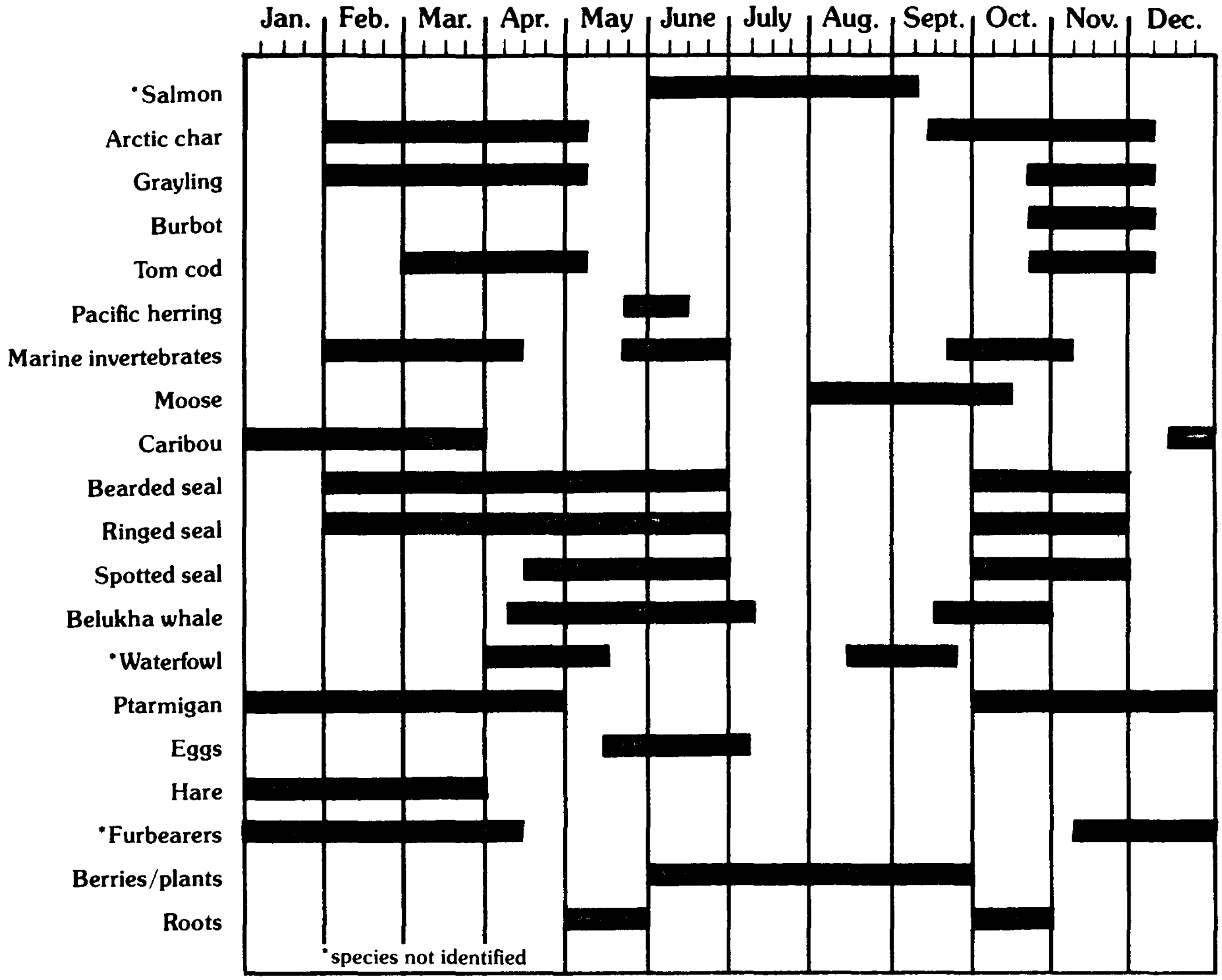


Figure 8. Contemporary annual round of harvest activities by Shaktoolik residents (Thomas 1982).

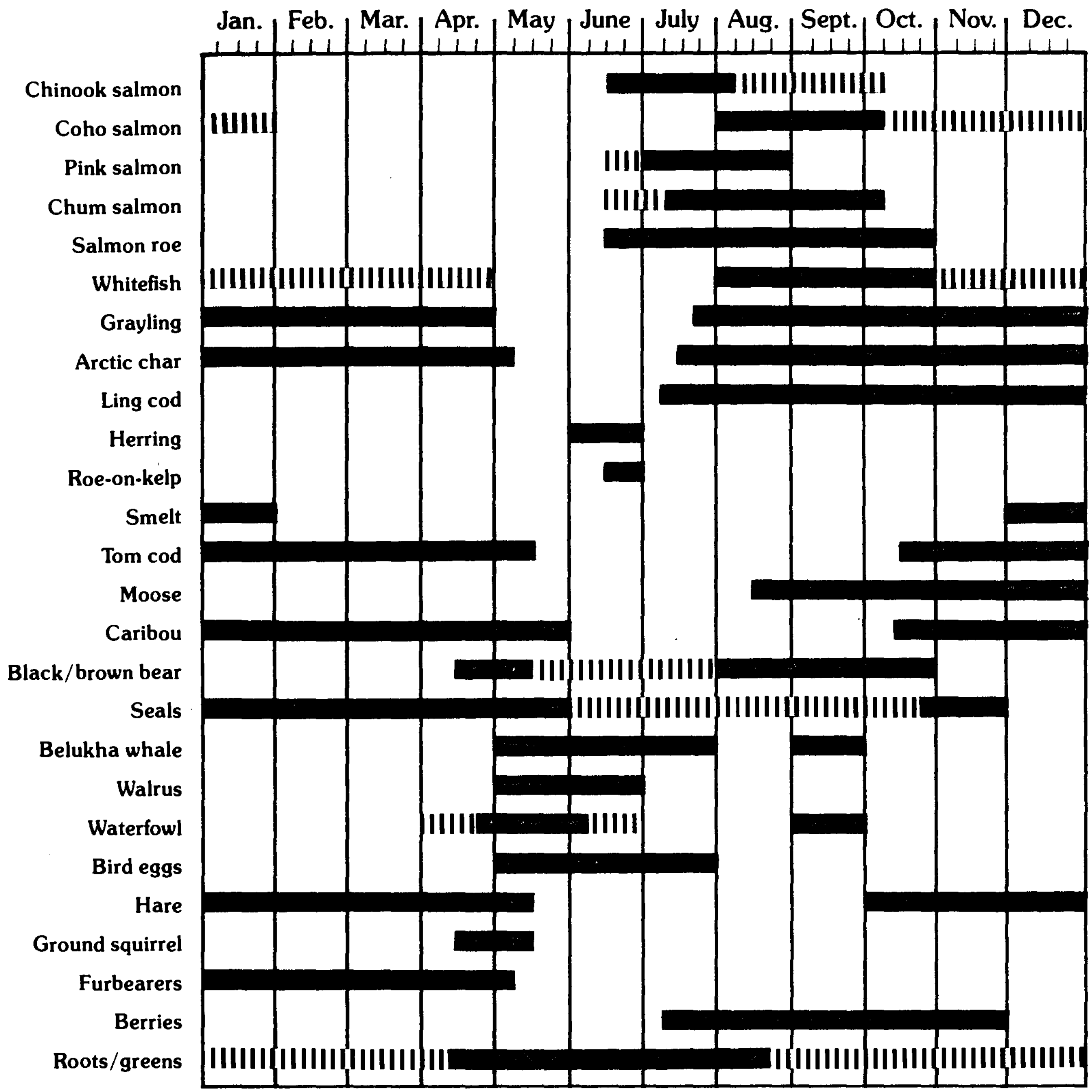


Figure 9. Contemporary annual round of harvest activities by Unalakleet residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Jorgensen et al. 1983).

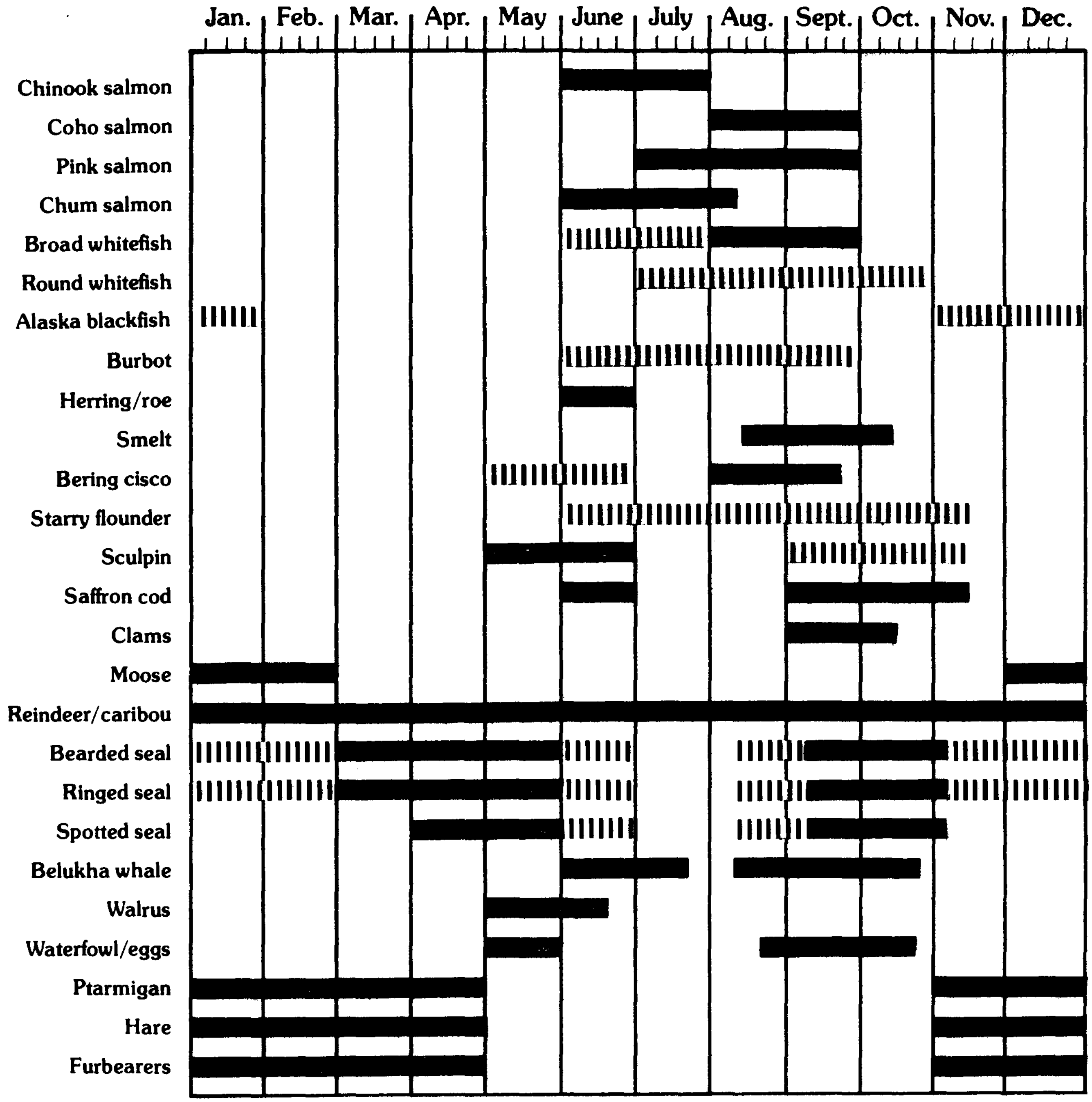


Figure 10. Contemporary annual round of harvest activities by Stebbins residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Wolfe 1982).

Table 11. Harvests of Major Fish Species Reported by Gambell and Savoonga Fishermen, 1981

Gambell

Species	No. Taken	No. of Recorded	Individual or Avg. Crew Catch
Sculpin[a]	3,579	19	188
Tomcod and blue cod	2,750	16	172
Coho salmon	1,134	11	103
Chum salmon	916	7	131
Dolly Varden[b]	750	5	150
Pink salmon	600	10	60
Arctic grayling	370	2	185
Salmon	351	16	22
Whitefish	(Unknown)		

Savoonga

Species	No. Taken	No. of Recorded	Individual or Avg. Crew Catch
Dolly Varden[b]	2,760	9	307
Tomcod and blue cod	1,965	10	197
Sculpins	1,022	10	102
Arctic grayling	700	6	117
Coho salmon	296	4	74
Whitefish	285	4	71
Chinook salmon	199	5	40
Pink salmon	160	5	32
Chum salmon	50	2	25

Source: Little and Robbins 1984.

[a] Species not identified.

[b] Probably includes arctic char.

Table 12. Species and Numbers of Birds Harvested by Gambell and Savoonga Households, 1981

	Gambell			Savoonga		
	No. Households	Total Harvest	Avg. Household Harvest	No. Households	Total Harvest	Avg. Household Harvest
Murres	24	6,186	258	15	1,950	130
Auklets	20	5,485	274	12	645	54
Ducks (all)	21	1,940	92	12	463	39
Geese (all)	17	984	58	8	219	27
Gulls and kittiwakes	16	2,770	173	8	473	59
Cormorants	10	700	70	---	---	---
Murre eggs	---	---	33+	---	---	33+

Source: Little and Robbins 1984.

--- means no data were available.

Table 13. Average Annual Subsistence Resource Harvests for the period 1962-1982 in Gambell, Savoonga, and Wales

No. Harvested/Useable Weight (kg.)/Contribution to Total Community Harvest (%)

Resource	Gambell	Savoonga	Wales
Bowhead whale	.75 6,675 3.2%	.75 6,675 3.5%	.20 1,780 3.2%
Walrus	443 155,050 74.1%	383 134,050 71.2%	77 26,950 49.0%
Bearded seal	200 16,000 7.6%	250 20,000 10.6%	150 12,000 21.8%
Hair seal*	720 13,680 6.5%	806 15,314 8.1%	372 7,068 12.9%
Belukha whale	1 400 0.2%	1 400 0.2%	3 12,000 2.2%
Polar bear	6 1,350 0.6%	20 4,500 2.4%	3 675 1.2%
Moose	0	0	---
Reindeer	0	0	---
Small game	---	---	---
Birds	a 4,545 2.2%	a 1,818 1.0%	a 364 0.7%
Fish	a 10,910 5.2%	a 1,136 0.6%	a 1,727 3.1%
Vegetation	a 682 0.3%	a 1,000 0.5%	a 3,227 5.9%

(continued)

Table 13 (continued).

Resource	Gambell	Savoonga	Wales
	No. Harvested/Useable Weight (kg.)/Contribution to Total Community Harvest (%)		
Total harvest (kilograms)	202,292	188,393	54,991
Per capita harvest (kilograms)	492	407	451

Source: Stoker 1983.

--- means no data were available.

* includes ringed, spotted, and ribbon seal.

a Data expressed as useable weight (kg) rather than as number of animals harvested.

critically important subsistence food constituting 35 to 40% of the total diet for most residents of inner Norton Sound (Ellanna 1980). The decline in dog teams with the introduction of the snowmachine in the 1960's generally coincided with the development of the commercial salmon fishery in Norton Sound. Currently, much of the fishing effort that was previously expended to provide dog food has shifted to commercial fishing (Thomas 1982). Commercial salmon fishing is also a major source of income for many Norton Sound families.

In Norton Sound, salmon fishing is conducted from fishing camps and sites along the coast and major streams. Some families adhere to the traditional practice of relocating to fish camps for the summer fishing season, but most prefer to make frequent round trips between their village homes and nearby fishing sites during open fishing periods (ibid.). Chinook salmon fishing begins in June, followed in July and

August by runs of pink, chum, and coho salmon. Limited runs of sockeye salmon are also harvested at some Norton Sound locations such as Unalakleet in early August (Jorgensen et al. 1983). Fishing locations for the various species may shift throughout the summer. Fall fishing for chum and coho, for example, often takes place from upriver locations, as fishing is frequently combined with other hunting and gathering activities (Thomas 1982, Jorgensen et al. 1983). Set gill nets, beach seines, and rod and reel are used to catch salmon.

As in the past, air drying is the most common method of processing and preserving salmon. Salmon are also eaten fresh or preserved by smoking, salting, or freezing (Thomas 1982, Jorgensen et al. 1983). Drying technique and preservation methods depend on the weather, the species of fish, the location of the catch, and the season. Salmon are very thoroughly utilized. Heads, fins, entrails, and eggs are commonly eaten. Those portions not used for human consumption are used for dog food, trapping bait, or garden fertilizer (Jorgensen et al. 1983). Dried salmon is widely shared and distributed among households within the communities (Thomas 1982).

Salmon harvests in Norton Sound vary from household to household and from year to year. In 1980, Shaktoolik households harvested an average of 3 chinook, 44 coho, 190 pink, and 107 chum salmon (ibid.).

Herring is another important fish resource in Norton Sound. Herring are available in large numbers in late May and early June and are taken with gill nets from boats or by beach seines. Herring are salted, pickled, and dried and stored in barrels in seal oil, or they are frozen (Thomas 1982, Jorgensen et al. 1983). Roe from spawning herring is commonly deposited in kelp beds and gathered at low tide or harvested from boats by pulling egg-laden kelp strands loose from the bottom. Herring roe is eaten raw or boiled or preserved by salting, freezing, or drying. Commercial fishing for herring and herring roe occurs simultaneously with subsistence herring fishing. It is common for fishermen to simply retain a portion of their commercial catch for their own use (Thomas 1982).

Saffron cod is a winter staple in many communities and is commonly jigged through holes in sea or river ice throughout the late fall and winter months. Burbot, pond smelt, and rainbow smelt are also jigged through the ice. Net, rod and reel, and fishing through the ice produce a variety of incidental fish species, providing year-round supplement and variety to the subsistence diet. Other fish resources utilized include arctic char and Dolly Varden, blackfish, whitefish, sheefish, capelin, arctic grayling, lamprey, stickleback, sculpin, halibut, and northern pike. Clams, mussels, and shrimp are occasionally harvested but more often obtained from the stomachs of bearded seals or walruses. King and Tanner crabs are caught at specific localities throughout Norton Sound (Thomas 1982, Ellanna 1980, Jorgensen et al. 1983). Subsistence catches of king crabs, which are an important winter food item in many communities, have declined following the opening of a commercial crab fishery in Norton Sound in 1977 (Magdanz and Olanna 1984b). Average household harvest of king crab in Golovin, for example, have dropped from 30 crabs in 1978 to 3 crabs in 1983 (ibid.). Similar harvest levels and harvest declines have been recorded in White Mountain, Elim, and Shaktoolik (ibid.).

2. Hunting. Small marine mammals, including belukha whale, bearded seal, spotted seal, and ringed seal, make up a significant part of the subsistence diet in Norton Sound. Belukha whales are hunted in the spring and fall with rifles and harpoons from boats. Belukha hunts are generally planned crew hunts, but the formal umiak crew organization found in northwest Alaska communities is absent. Belukhas are occasionally taken in nets with 18-inch mesh set offshore. Belukha are pursued over much of inner Norton Sound and Norton Bay. Belukha muktuk is a favored food, eaten raw or boiled. Belukha meat is eaten or used as dog food (Thomas 1982, Jorgensen et al. 1983).

   Bearded seals (ugruk) are hunted in association with the ice edge, primarily in the spring. Swimming or basking ugruk are shot from boats and then harpooned. Ringed and spotted seals are hunted primarily in the late fall but are also encountered in the spring and summer months and are occasionally taken in the lower reaches of rivers. Seals provide oil, meat, and hides. Ugruk meat is a preferred subsistence food eaten fresh, boiled, fried, or dried. The meat of ringed and spotted seals is eaten and used as dog food (Thomas 1982, Jorgensen et al. 1983). The harvest of seals has declined from traditional times because of a decrease in the use of hides for skin sewing and seal meat to feed dog teams. Thomas (1982) reports that in Shaktoolik the number of seals now required per household for a winter supply of seal oil ranges from one to four seals.

   Walruses area only sporadically available in inner Norton Sound but are hunted in the spring and summer during years of availability. Large whales are also occasionally encountered and taken by Norton Sound residents. In 1980, a small bowhead whale was taken by Shaktoolik hunters pursuing belukha (Thomas 1982). In 1982, an unidentified large whale was entangled in a small net and harvested by residents of Unalakleet (Jorgensen et al. 1983).

A variety of ducks, geese, cranes, and sea birds and their eggs are harvested in the spring and fall. It is important to note that although birds may form a small overall percentage of the annual diet, they are among the first available sources of fresh meat in the spring and as such fill an important niche in the seasonal round. Thomas (1982) reports households gathering 100-200 murre eggs during spring "egging" trips.

Among terrestrial resources, caribou, furbearers, and moose are actively pursued. Caribou hunting occurs primarily in inland locations in the late fall and winter when river ice and snow allow snowmachine travel and when caribou appear on the Seward Peninsula at the end of their fall migration (Thomas 1982; Jorgensen et al. 1983; Anderson, pers. comm.). The availability of a limited quantity of domestic reindeer from a small herd in Shaktoolik somewhat lessens the need for caribou meat and hides in that community. From the herd of about 380 animals, 30 reindeer were butchered and made locally available in 1980 (Thomas 1982). Furbearer trapping is practiced by some households. Species harvested primarily for fur include beaver, land otter, lynx, marten, mink, red fox, wolf, and wolverine (Thomas 1982, Jorgensen et al. 1983). Moose is not a major subsistence resource but is important during years when caribou are less plentiful. Thomas (1982) reports an average annual harvest of five or six moose in Shaktoolik. Less than 10% of surveyed households in Stebbins reported harvesting a moose between June 1980 and May 1981 (Wolfe 1981).

Black bear and brown bear fall into the category of large terrestrial mammals that are not actively pursued by most Norton Sound hunters but are harvested opportunistically, usually in conjunction with other spring, summer, and fall land use activities. In conjunction with winter hunting, fishing, and trapping activities, ptarmigan and snowshoe hare are often harvested when encountered.

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Kotzebue Sound Subregion

This narrative presents data on the human use of fish and game by residents of the Kotzebue Sound subregion (maps 1 and 2). Most of the subregion population is located in 11 incorporated communities, with a small number of people living at camps, mines, and other locations throughout the general use area. Data are drawn primarily from the rich ethnographic literature available for northwestern Alaska, from planning documents and reports, from ADF&G records, and from interviews with area ADF&G staff and other experts.

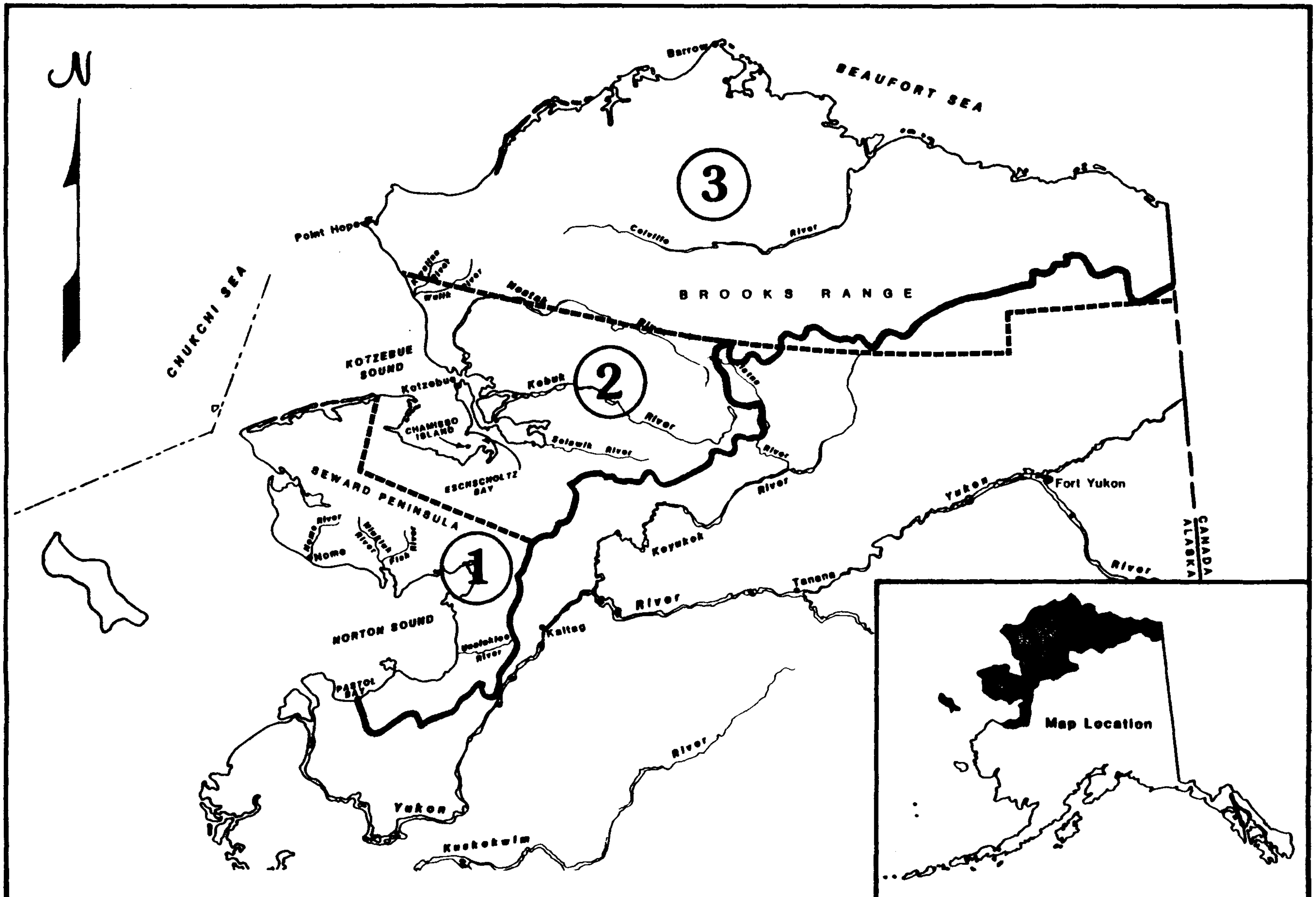
Because contemporary research on some aspects of subsistence harvest and use has yet to be completed, this narrative should be regularly updated to include the most current information. Particular data gaps exist for longitudinal estimates of the quantities of fish and game used for subsistence, comprehensive mapping of the areas used for subsistence harvest, distribution and exchange of fish and game products, and change in subsistence economy.

I. LOCATION AND ENVIRONMENT

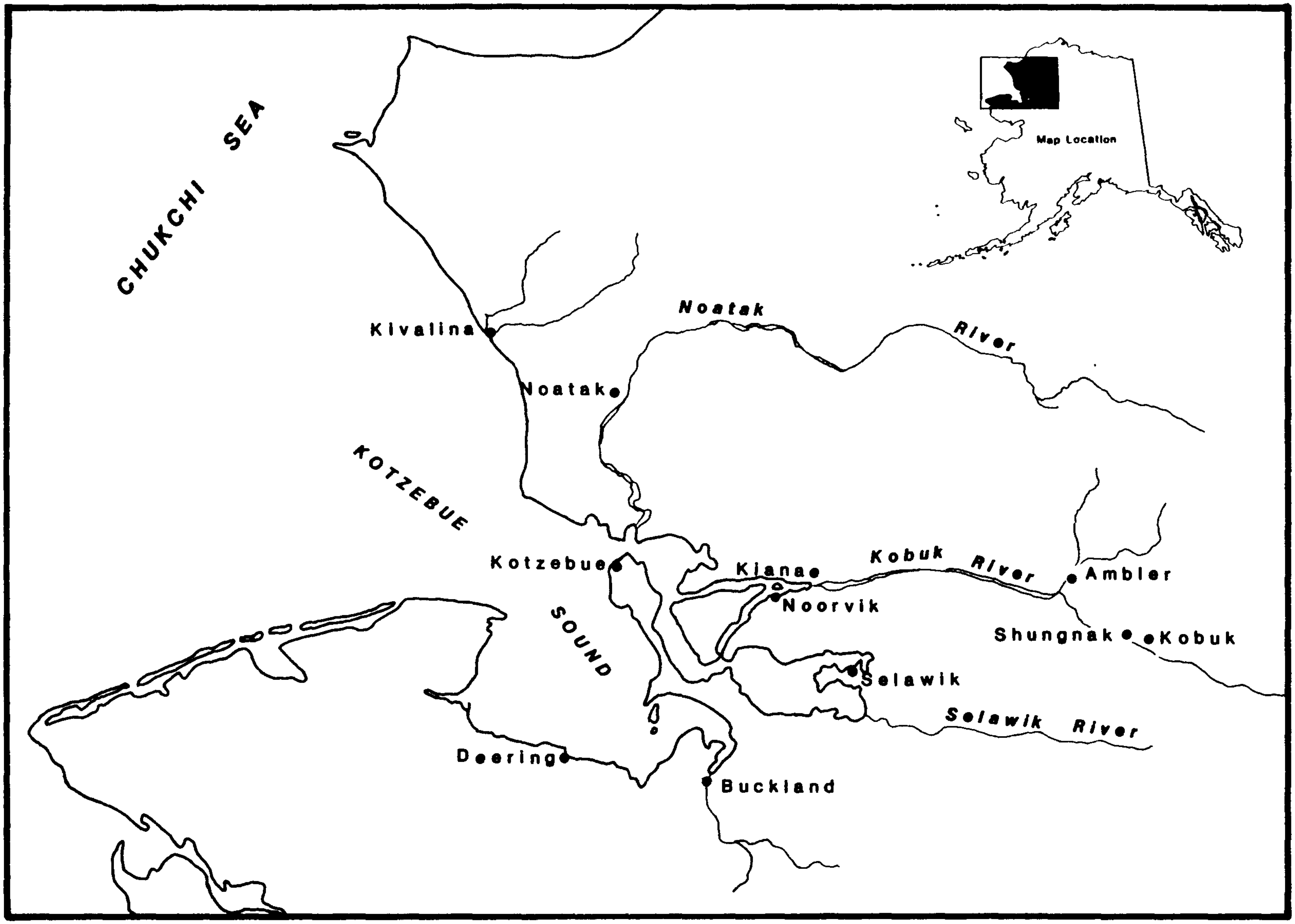
A. Major Geographical Features

The subregion includes the land and water area defined by the Northwest Alaska Native Association (NANA) Corporation regional boundaries and other areas beyond these boundaries regularly used by the residents of Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Kotzebue, Noatak, Norvik, Selawik, and Shungnak, and by residents living in unincorporated areas within the Kotzebue Sound Corporation boundaries (map 2). The subregion includes marine waters and sea ice of all of Kotzebue Sound, Eschscholtz Bay, and Hotham Inlet and areas of the Bering Sea within about 100 mi of land from Cape Espenberg at the north tip of the Seward Peninsula to Cape Thompson in the north. Hunting for sea mammals on the ice itself, from the edge of shore fast ice, in leads that open in pack ice, and in open water are known to take place a great distance from shore.

The Kobuk, Noatak, Selawik, and Buckland rivers form the largest river systems in the subregion and, along with their tributaries and the Kivalina, Wulik, Inmachuk, and Kugrik rivers, and other smaller rivers, provide riparian and estuarian environments that have been heavily used for traditional subsistence harvests and for transportation by boat, snowmachine, and dog sled. Selawik, Inland, and Imuruk lakes are the largest bodies of fresh or brackish water in the subregion, although there are countless small lakes in open tundra country near the communities of Noatak,



Map 1. The Arctic Region and its three subregions: 1 - Bering Strait/Norton Sound; 2 - Kotzebue Sound; and 3 - North Slope.



Map 2. The Kotzebue Sound subregion and the communities discussed in this narrative.

Noorvik, and Selawik, as well as small lakes at lower elevations along all major drainages in the subregion and in low-lying areas of the Seward Peninsula.

Imkruk Lagoon and other lagoons near Kivalina, and Krusenstern Lagoon and other lagoons in the Cape Krusenstern and Sisualik Spit area have been important traditional sites for subsistence harvest. The Baird, Purcell, and Waring mountains, the Selawik Hills, and parts of the Delong and Endicott mountains are areas regularly hunted or traversed for subsistence harvesting by residents of the subregion (see Henning et al. 1981, for geographic overview; and see NPS 1983, 1984a, 1984b, 1985a, 1985b, 1985c, for descriptions of parks, preserves, and monuments).

B. Management Units

Most of the land area intensively used for subsistence harvest of fish and game lies within Game Management Unit (GMU) 23. Subregion residents' customary and traditional use is also known to occur in portions of GMUs 26A, 24, 21D, and 22A,B,C,D, and E (Carter 1985, Magdanz 1985, Norbert 1985, Stern 1985).

A number of sets of maps showing subsistence use areas have been done over the last 25 years for different purposes and at varying definition (Andersen et al. 1977; Braund and Burnham 1983; Eisler 1978; Foote 1966; Foote and Williamson 1961, 1966; Hale 1979; Patterson 1974; Saario and Kessel 1966; Uhl and Uhl 1979). Subsistence resource use areas for Ambler, Buckland, Deering, Kobuk, and Shungnak are being mapped through a joint project by Maniilaq and the Division of Subsistence, ADF&G. This mapping, using standard mapping methodologies, is scheduled to be completed in the fall of 1985. (See accompanying subsistence use area maps.)

C. Climate and Vegetation

1. Climate. The subregion lies entirely within an arctic climatic zone characterized by long cold winters, short cool summers, and little precipitation. Kotzebue averages 252 days of frost per year (Burch 1975). Table 1 presents temperature and precipitation data for representative communities and locations.

   Since subsistence harvest activities usually depend on some form of transport, freeze-up and breakup mark the most important seasonal transitions that occur within the subregion. Rivers, lakes, and lagoons are ice-free for from four to six months of the year (table 2). Major surface

Table 1. Kotzebue Sound Region Temperature and Precipitation

Community	Summer Average (F)	Winter Average (F)	Temp. Range (F)	Precipitation Total/Snow (inches)
Kotzebue	37 to 59	-13 to 4	-52 to 85	8.9"/47"
Candle	36 to 63	-20 to 2	-60 to 85	8.6"/36"
Noatak	35 to 65	-21 to 3	-60 to 75	11"/48"
Kobuk	42 to 69	-24 to 1	-68 to 90	17.3"/56"
Noorvik	42 to 68	-16 to 1	-54 to 87	16.2"/60"

Source: Lewis and Barloon 1984.

Table 2. Average Breakup and Freeze-up Dates for Kotzebue Sound Region

Location	Range of Breakup (B) Freeze-up Dates (F)	Average Date	Number of Observations
Candle/ Kiwalik R.	5/5 to 5/27 (B) 10/10 to 10/23 (F)	5/18 10/17	8
Deering	5/13 to 6/11 (B) 10/3 to 10/29 (F)	5/27 10/16	3
Kivalina	5/15 to 5-26 (B) 10/15 to 11/1 (F)	5/19 10/22	5
Kotzebue	5/17 to 6/8 (B) 10/2 to 11/5 (F)	5/31 10/23	14
Noorvik	5/18 to 6/11 (B) 9/26 to 10/25 (F)	5/29 10/11	17
Kiana	5/7 to 5/29 (B) 10/10 to 11/4 (F)	5/18 10/17	6
Selawik	5/13 to 6/7 (B) 10/3 to 10/30 (F)	5/28 10/17	12

Source: Lewis and Barloon 1984.

travel does not take place during breakup and freeze-up, because of unsafe ice and water conditions. Depending on currents, latitude, and other factors, some sea ice may be present during summer months. Climatic variability exerts a strong influence on subsistence activities. Timing of breakup and freeze-up, presence or absence of leads in sea ice accessible from shore, variable snow conditions, as well as periods of extreme cold and severe weather constrain what subsistence activities can be undertaken. Because these climatic conditions are not the same from year to year, the seasonal round of subsistence harvest activities (figures 1, 2, 3, 4, 5, 6, 7) may reflect this variability.

2. Vegetation. Most of the subregion is covered with tundra vegetation, including lichens, mosses, short grasses and sedges, and dwarf shrubs. A number of berries are harvested from this vegetative zone as well as Eskimo spinach (Rumex arcticus) and Eskimo potato (Hedysarum alpinium) (see table 19 for listing of plant species known to be used).

   The northern boreal forest of mainly spruce and birch species reaches into many of the valleys of the subregion. Birch and spruce are found in the Selawik, Kobuk, and lower Noatak valleys. In these valleys, trees grow on higher, better-drained areas close to the banks of the rivers and on hillsides at some distance from the rivers. Poorly drained valley floors are usually in tundra vegetation.

   A vegetative zone of shrub willows, cottonwoods, and alders is found along rivers and creeks far beyond the limits of spruce. Shrub growth is often quite thick and has been an important source of fuel and shelter for people living inland in the subregion (see Burch 1975).

II. HISTORY AND PATTERNS OF HUMAN ACTIVITY

A. Original Habitation of the Subregion

According to the archeological record, the earliest documented occupation of the area took place about 10,000 years ago by people of the American Paleo-Arctic Tradition. This tradition represented an adaptation to open tundra habitat. The lower Noatak basin is known to have been occupied by people of the Northern Archaic Tradition beginning about 6,000 years ago. The archeological record shows that the Noatak basin was subsequently occupied by people of the Arctic Small Tool Tradition, with most heavy utilization of the lower Noatak River valley occurring between 400 B.C. and 400 A.D.

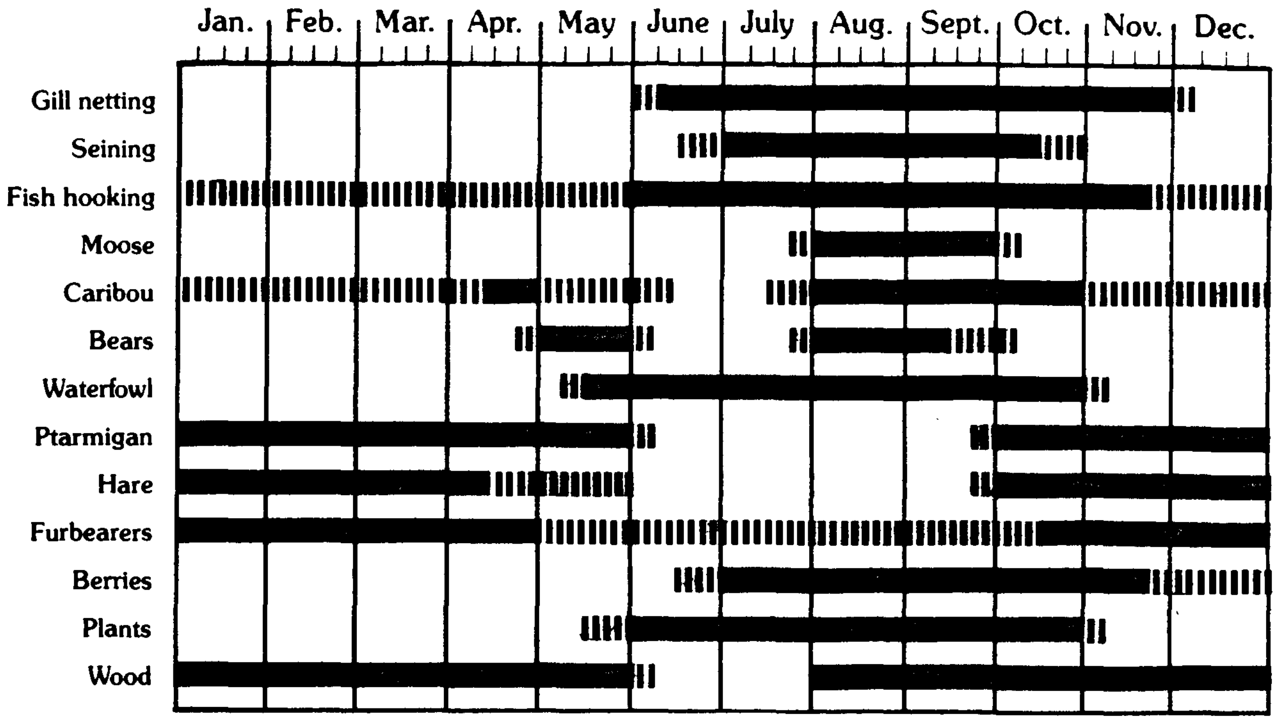


Figure 1. Annual round of harvest activities by Ambler residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Anderson et al. 1977, James pers. comm. 1985).

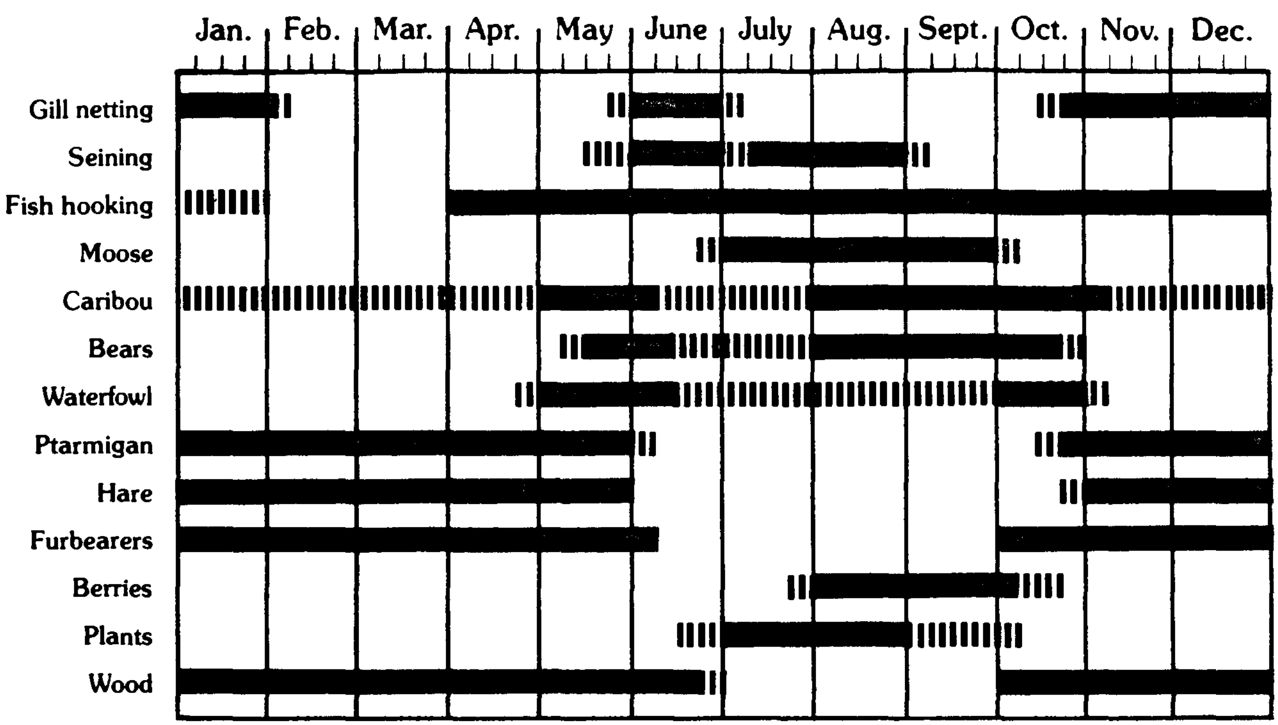


Figure 2. Annual round of harvest activities by Kiana residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Anderson et al. 1977).

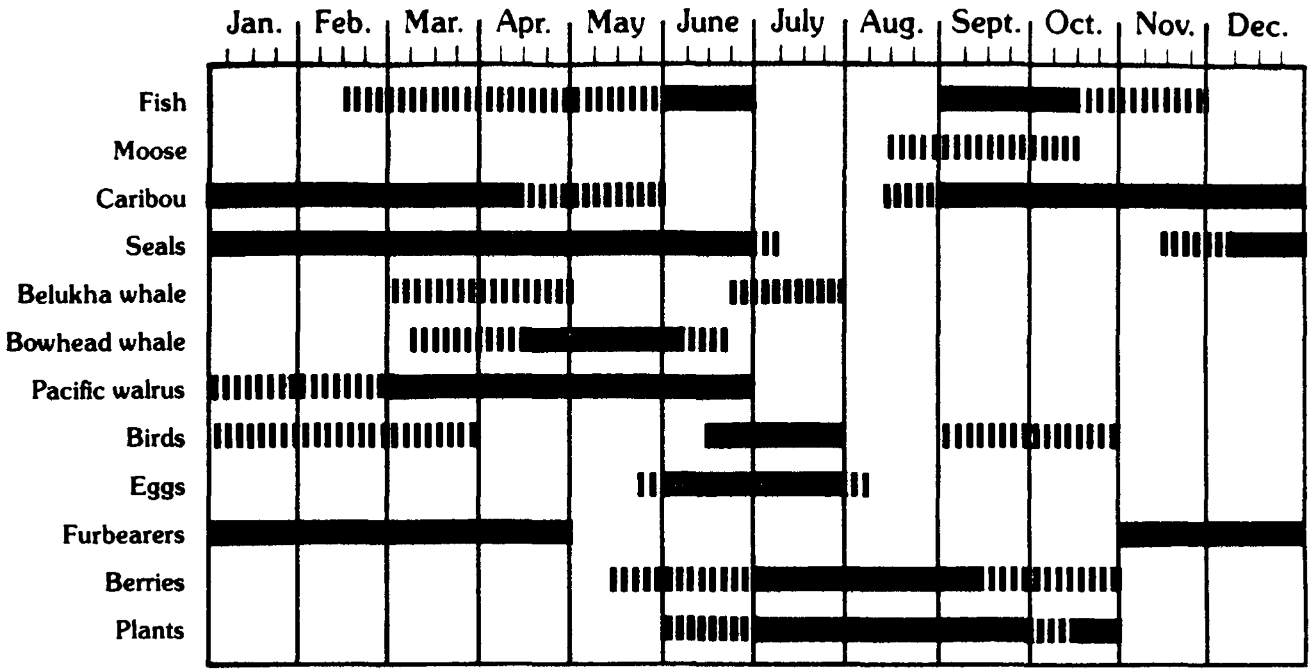


Figure 3. Annual round of harvest activities by Kivalina residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Braund and Burnham 1984).

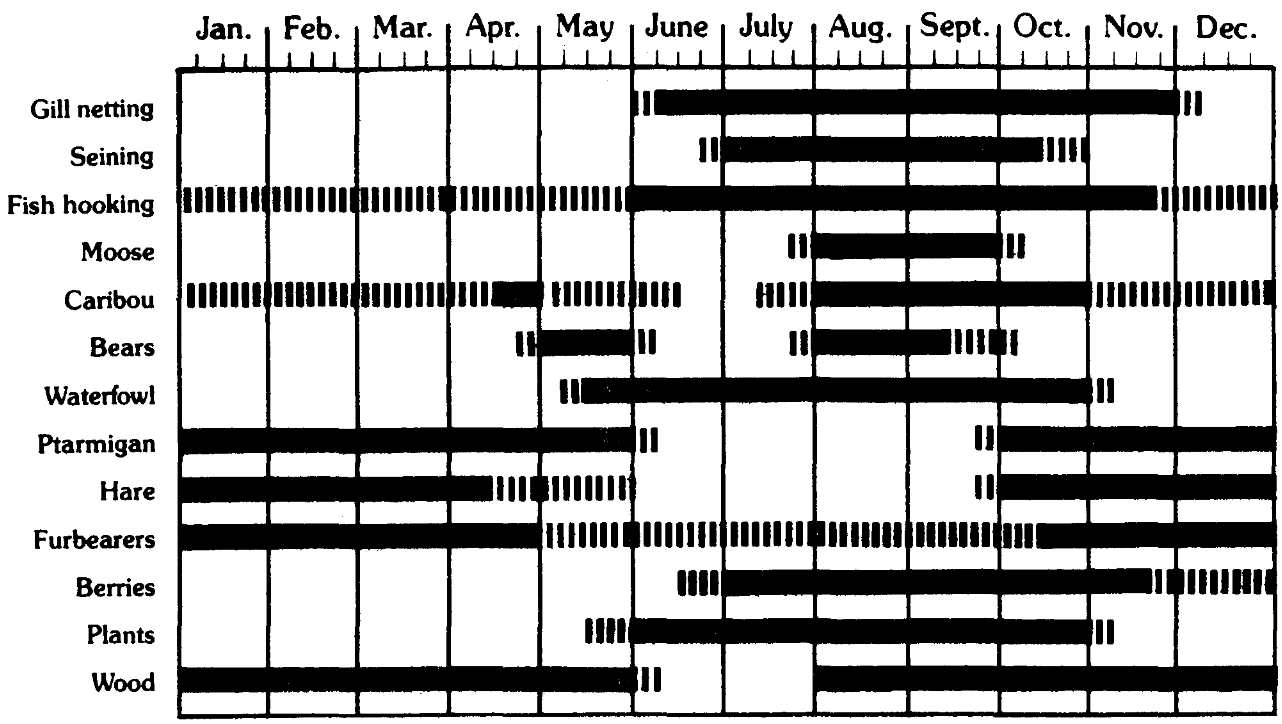


Figure 4. Annual round of harvest activities by Kobuk residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Anderson et al. 1977, James pers. comm. 1985).

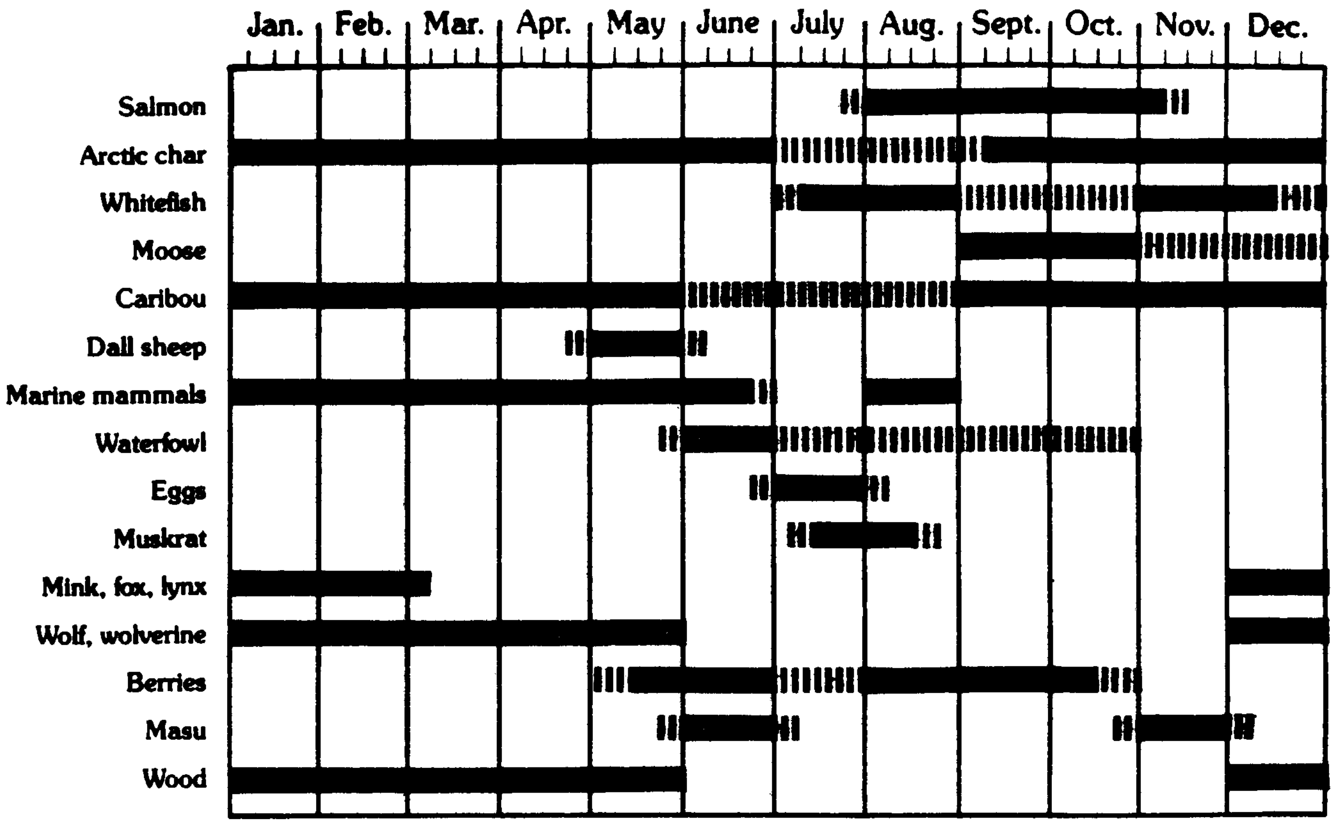


Figure 5. Annual round of harvest activities by Noatak residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Uhl and Uhl 1979).

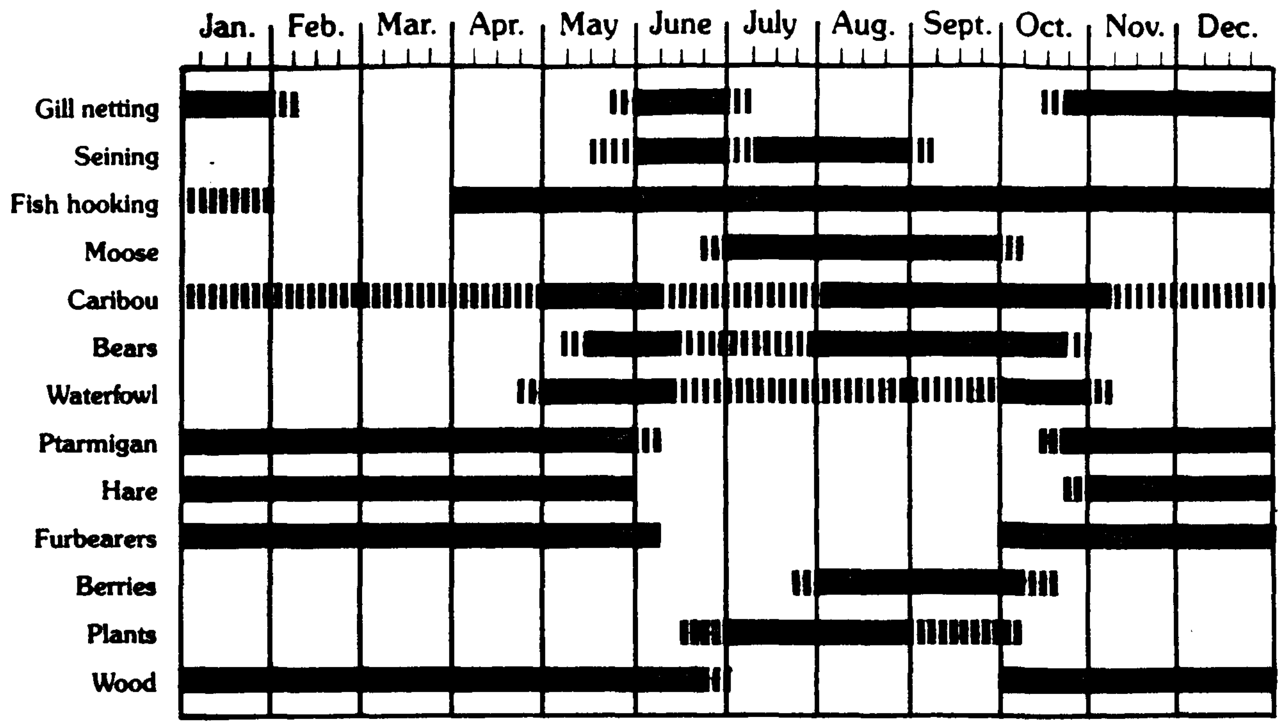


Figure 6. Annual round of harvest activities by Noorvik residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Anderson et al. 1977).

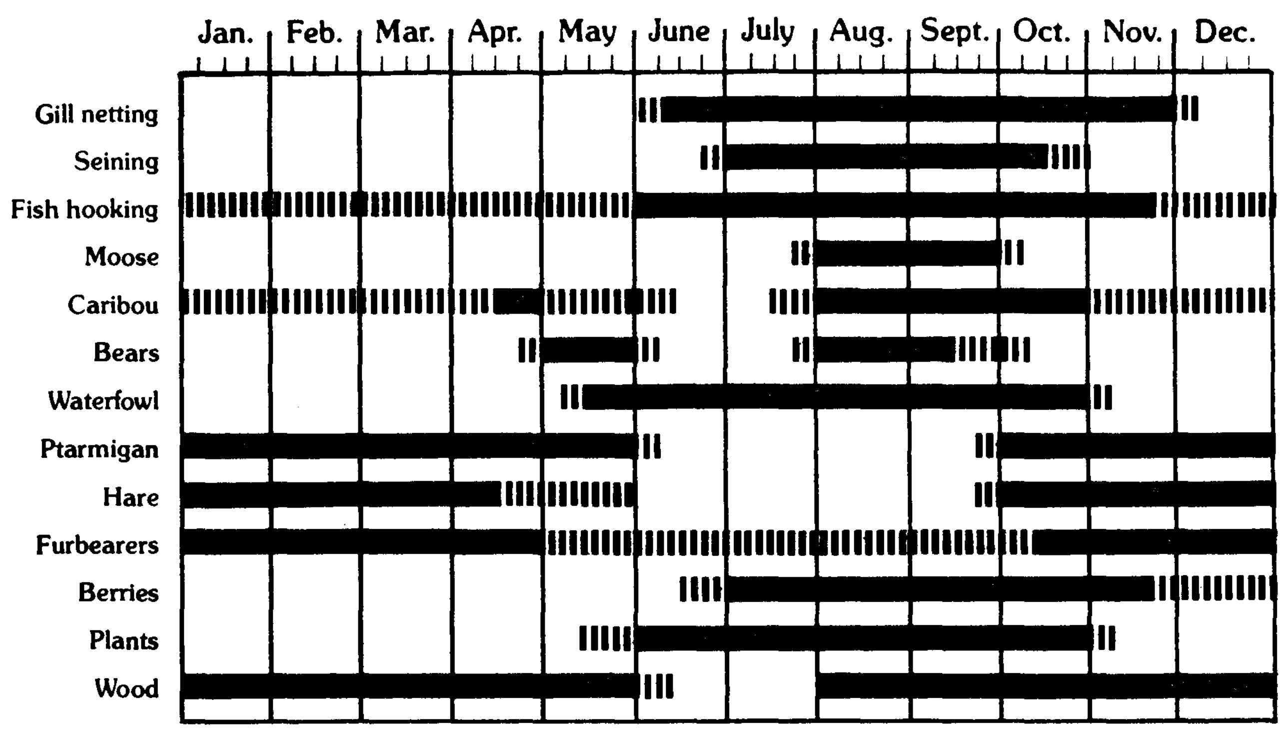


Figure 7. Annual round of harvest activities by Shungnak residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Anderson et al. 1977, James pers. comm. 1985).

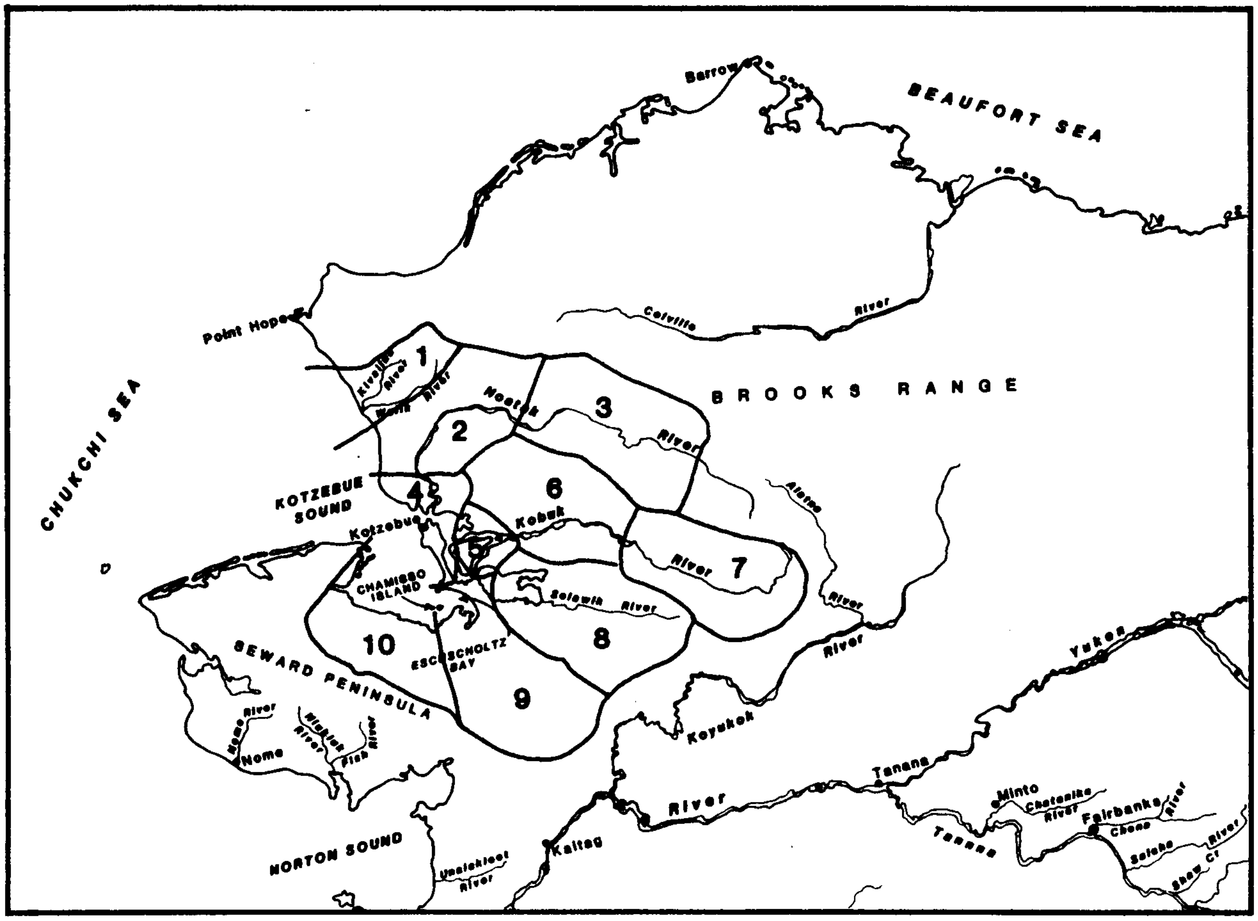
Apparently, from about 400 A.D. to 1200 A.D., much of the Brooks Range and inland valleys of the Kotzebue Sound subregion did not support regular human habitation, although habitation of coastal areas seems to have been continuous. Eskimos moved back into upper river valleys during the late prehistoric period, from 1200 A.D. to 1400 A.D. Both coastal and inland areas of the subregion were continuously inhabited from that time to the time of contact with Europeans and Americans. (See Davis and McNabb [1983] and Lewis and Barloon [1984] for a brief review of the subregion's prehistory and Anderson [1977], Burch [1984d], and Dumond [1977, 1984] for more complete treatment.)

Detailed information concerning subsistence harvest and use of fish and game, social and political order, family structure, and demography begins to be available for the post-1800 time period in the Kotzebue Sound subregion. For descriptions of conditions at the time of first contact (that is the time period 1800 to about 1850), historical reconstructions based on interviews with area residents and analyses of reports of early European and American explorers have provided the best sources of data (Burch 1975, 1978b; Foote 1965).

At the time of contact, people of the subregion were divided into 10 named groups (map 3, table 3). Burch (1978b) considers these groups to be "societies" that occupied territory, defended territorial boundaries, and had a great deal of inner cohesion. Marriage was primarily intrasocietal; most family and kinship relationships existed within the society; and whaling crews and hunting parties were made up of members of one society. Intersocietal trade through the institution of trading partners and feasting through messenger feasts regularly took place. However, relations between societies were often hostile, and bloodshed was not uncommon.

Yearly truce periods when hostilities were suspended permitted members of societies to harvest fish and game in other society's territory. Members of most of the societies traveled during these truce periods to the Cape Krusenstern and Sisualik area before breakup to harvest marine mammals and to attend regional fairs that brought members of coastal and interior societies together.

Although the subsistence patterns of different societies varied because of differential access to fish and game populations, the species used in this early period were probably the same as those currently used (see discussion below). Snares, traps, pits, deadfalls, and other noncontact harvest methods may have been more common methods of harvest for land mammals before the introduction of firearms.



Map 3. Location of Eskimo societies in the Kotzebue Sound subregion ca. 1816-1842 (adapted from Burch 1978b).

The estimated populations of each society are also presented in table 3. Based on these estimates, the subregion had a population of almost 4,000 in 1840.

A number of factors contributed to the radical restructuring of the societal organization that existed at the time of early contact, with epidemics, famines, and changes in species distribution and abundance standing out as having crucial effects. Famine in 1882-1884 virtually wiped out the Kobuk delta, Kivalina, and Kotzebue societies and severely affected the Lower Noatak society. The caribou decline during the 1870's and 1880's significantly disrupted the middle Kobuk, Selawik, upper Kobuk, and upper Noatak societies and induced population out-migration to coastal and lower river areas. After disruption of subsistence harvest activities and introduction of serious new diseases into the population, members of the Buckland and Goodhope Bay societies emigrated elsewhere, and these societies ceased to function in the 1840's and 1850's. The gold rush of 1898-1899 and commercial whaling and walrus harvesting contributed to further disintegration of the early nineteenth century societal boundaries (see Burch 1978b for details).

B. Early Contact Period

Foote (1965) provides a detailed summary of accounts of early Russian, American, and British travel in, and exploration of, the Kotzebue Sound subregion. Table 4 gives dates for the first known contact with Kotzebue Sound subregion societies. Colonization did not proceed rapidly in the subregion, in part because the area lacked sea otters or other natural resources that could be readily exploited in the early 1800's and in part because non-Natives had not yet learned how to survive in the arctic. Early expeditions to the arctic often did not know how to harvest and use local fish and wildlife resources and had trouble with food supplies and scurvy. This early contact differs from what took place in many other parts of Alaska in that first known contact or exploration took place relatively late. Contact in the Kotzebue Sound subregion occurred later than in the Aleutian Islands, Kodiak Islands, and in southeast Alaska, where first contact took place almost 100 years earlier, in the early or mid 1700's.

The subregion's Native population declined rapidly in the years following Euro-American penetration into the area. Population estimates are unavailable for the time period between the 1840 estimate of the society population (table 3) and the census done in 1880, 1910, and subsequently, as part of national decennial enumerations (table 5). The recorded population was 1,344 and 1,987 in 1880 and 1910, respectively (Lewis and Barloon 1984). Even allowing for problems with both of these early census, this

Table 3. Eskimo Societies of the Kotzebue Sound Subregion of the 1816-1842 Period, with Estimated Population ca. 1840

Society	Population
1. Kivalina (Kivalinirmuit)	300
2. Lower Noatak (Napaqturmiut)	225
3. Upper Noatak (Nautarmiut)	550
4. Kotzebue (Qiqiqtarzurmiut)	375
5. Kobuk Delta (Kuungmiut)	260
6. Middle Kobuk (Akunirmiut)	375
7. Upper Kobuk (Kuvaum Kangianirmiut)	500
8. Selawik (Siilvingmiut)	775
9. Buckland (Kangigmiut)	300
10. Goodhope Bay (Pitarmiut)	300
Total	3,960

Source: Burch 1978b.

represents a drastic decline from the 1840 estimated population of about 4,000 for the subregion. The introduction of smallpox, measles, and other European diseases into the subregion's virgin population (Wolfe 1982), shortages of subsistence food caused by the decline in the caribou population and by overharvesting of whales and walruses by commercial whalers, and attendant severe social disruptions are three related causes of this population decline.

The surviving subregion population became centralized in the period 1850 to 1900. The community sites that developed were at places that had good access to subsistence harvest of fish and game but also had good water transportation to Kotzebue or other areas where ships could put in.

Trading with whaling ships became more regularized as the whaling effort increased in the 1850 to 1880 time period. Steam whalers and trading schooners began visiting the subregion in about 1880. The first trading posts were established in the late 1800's. The establishment of missions followed this economic activity. Under agreement with other churches proselytizing in Native societies, the Kotzebue Sound subregion communities were open to Quaker missionaries. Robert and Carrie Samms and Anna Hunnicutt established the first church and mission at Kotzebue in 1897, and this formed the locus for the growth of that community. The first area school was built in Kotzebue in 1902 (Smith 1966).

As part of Sheldon Jackson's and the federal government's efforts to provide local industry and to compensate for the decline in the caribou population and poor subsistence harvests of other species in the late 1800's, reindeer herding was introduced to the subregion at Kotzebue in 1901. Herds were also established at Deering and Kivalina in 1905, at Selawik in 1909, at Noatak in 1910, and at Buckland in 1911 (Stern et al. 1977, 1980). Some herding continues to take place on the Seward Peninsula.

III. POPULATION

Table 5 presents available census data for communities in the Kotzebue Sound subregion. Based on these data the area population has shown a slow rate of growth over the 1880 through 1960 period and a fairly rapid rate of growth since 1960. Considering the subregion as a whole, it has only been since 1970 that the area population has equaled the 1840 estimated population. Recent area population has been estimated to be about 6,000 (Lewis and Barloon 1984).

In 1980, about 1,125 NANA Corporation shareholders, or about 25% of the shareholder population, lived outside the subregion (ibid.). Many of these shareholders and their families continue to use the natural resources of the subregion and may return to live in natal communities in the future.

Some of the increase in population in recent years has come from migration of non-Natives into the area. In 1970, about 12.7%, or 514 persons, and in 1980 about 14.8%, or 710 persons, were non-Natives (ibid.). Both the proportion and absolute size of the non-Native population are likely to have grown since the 1980 census. Most non-Natives in the subregion live in Kotzebue. There are also significant numbers of non-Natives in Ambler and a small number of non-Natives remote land disposal sites or homestead sites in the subregion.

In 1940, Kotzebue was more of a large village of the same scale as Selawik, Deering, Noorvik, or Noatak. In recent years, the Kotzebue population has grown faster than that of the smaller communities, and Kotzebue has clearly emerged as a regional center. Village population has fluctuated but generally has been increasing, albeit at a slower rate, over the last 20 years or so. Over the 1960 through 1980 time period the population of Ambler, Buckland, Deering, Kiana, Kivalina, Noorvik, and Shungnak increased significantly; Kobuk, Noatak, and Selawik remained about the same; and Candle ceased to exist as a census community.

The subregion's historic population trends have great relevance to the subsistence harvest and use of natural resources. Although very

Table 4. Time of First Known Contact with Kotzebue Sound Subregion Societies

Society	Expedition or Explorer (Year)
1. Kivalina (Kivalinirmuit)	Shishmaref (1821) or Kasheravov (1838)
2. Lower Noatak (Napaqturmiut)	Beechey (1826)
3. Upper Noatak (Nautarmiut)	Beechey ?(1826)
4. Kotzebue (Qiqiqtarzurmiut)	Beechey (1826)
5. Kobuk Delta (Kuungmiut)	John Simpson (1850)
6. Middle Kobuk (Akunirmiut)	?? at Sisualik 1860s
7. Upper Kobuk (Kuvaum Kangianirmiut)	?? at Sisualik 1860s
8. Selawik (Siilvingmiut)	John Simpson (1850)
9. Buckland (Kangigmiut)	Vasiliev and Shishmaref (1820)
10. Goodhope Bay (Pitarmiut)	Kotzebue (1816)

Source: Burch 1978b, Foote 1965.

Table 5. Population of Kotzebue Sound Subregion Communities, 1910 through 1980

Community	1910	1920	1930	1940	1950	1960	1970	1980
Ambler	---	---	---	---	---	70	169	192
Buckland	---	52	104	115	108	87	387	177
Candle	---	91	85	119	105	103	---	---
Deering	100	73	183	230	174	95	85	150
Kiana	---	98	115	167	181	253	278	345
Kivalina	---	87	99	98	117	142	188	241
Kobuk	---	---	---	31	38	54	---	62
Kotzebue	193	230	291	372	623	1,290	1,696	2,054
Noatak	121	164	212	336	326	275	293	273
Noorvik	---	281	198	211	248	384	462	492
Selawik	---	274	227	239	273	348	429	361
Shungnak	210	95	145	193	141	135	165	202
Total	---	1,445	1,659	2,111	2,334	3,236	4,152	4,549

Source: Rollins 1978.

--- means no data were available.

difficult to estimate, the overall quantities of fish and game resources used for subsistence and may continue to be less than that of the precontact period. In the precontact period, the subregion depended almost totally on harvesting fish, wildlife, and plant resources within the subregion for food, clothing, and other material items. Dog traction, first by simple sleds and later by large dog teams, also required the harvest of large quantities of fish and wildlife. Until 1970, the area population was less than the estimated 1840 population, so that the overall amount of yearly harvest needed to support the local human population over the 1850 to 1970 time period was probably less than that needed in 1840. In addition, since 1970, few area residents use dog teams for transportation, so that the quantities of fish and wildlife that were formerly needed to support working dog teams are no longer harvested.

The subregion population is young and has a large proportion of people who will soon be in their child-bearing years. This population structure underlies the forecast that the population will increase to about 7,500 by 1990 (ibid.).

The methods of take used today, however, may be putting more stress on the animals than did earlier harvest methods (James, pers. comm.).

IV. SUBREGIONAL ECONOMY

The communities of the subregion have been found to have mixed, subsistence-based economies. The economies of Kotzebue Sound communities include a "mix" of subsistence harvest and use of fish and game with cash-generating economic activities.

In rough order of importance, the cash-generating economic activities within the subregion include employment by local, state, and federal government agencies, related employment in social service occupations, commercial fishing for salmon in Kotzebue Sound, and employment in sales and services. Trapping provides income to some area residents, although fur prices are currently depressed. A small number of subregion residents are employed in placer and hard-rock mining or related activities, in prospecting and surveying, and in production of jade from NANA Corporation holdings.

Employment outside the region accounts for an important share of the subregion's earned income. Residents leave the area for work on the North Slope in NANA and other enterprises and to urban Alaska. Some of this labor migration is on a temporary or seasonal basis. Other area residents spend long periods of time away from the Kotzebue Sound subregion and return when they have achieved enough financial security to allow them to come back to home communities. Most typically, however, area residents living outside the subregion return periodically during the year to participate in local subsistence harvests.

Table 6 presents income data for subregion communities for 1978, 1981, and 1982 on federal tax returns. Cash-generating activities are very limited in the subregion, and cost of living is extremely high. Limited food basket data for Kotzebue indicate that costs of purchased food are about 200% that of Anchorage prices (Stetson 1981-1985). Prices of food in village stores are significantly higher than in Kotzebue. Gasoline cost $3.00 per gallon in 1985 in upper Kobuk River communities (Carter 1985). Some of the discrepancy between cash needs of subregion residents and earned income is made up by transfer payments administered from state and federal programs; often these are administered by Maniilaq, the subregion's nonprofit corporation.

The subregion's economy may change dramatically should the Red Dog mine, located near Kivalina, be developed and put into production. The mine could provide important employment opportunities within the subregion both during an extended construction phase and during production. (See Braund and Burnham [1983], Lewis and Barloon [1984], and the economics sections of this guide for more complete data on cash-generating activities.)

Table 6. Average Taxable Income for Kotzebue Sound Subregion Communities, 1978, 1981, and 1982

Community	1979 ($)	1981 ($)	1982 ($)
Ambler	8,165	11,599	13,486
Buckland	4,883	10,224	11,717
Deering	6,529	12,158	12,781
Kiana	8,612	13,141	12,302
Kivalina	6,166	8,821	11,839
Kobuk	6,173	15,839	10,347
Kotzebue	13,539	19,080	18,586
Noatak	5,845	9,843	10,920
Noorvik	6,980	9,043	11,682
Selawik	5,691	8,605	10,635
Shungnak	7,796	9,793	12,173
All Alaska	16,274	21,127	21,624

Source: ADR 1985.

The economies Kotzebue Sound communities continue to be subsistence based in that subsistence harvest and use of fish and wildlife are the most consistent economic activities that take place during the year and in that subregion residents continue to rely on local fish and wildlife resources for most of the protein and fat they consume (Durrenberger 1984). Division of Subsistence research throughout the state has distinguished eight characteristics of mixed, subsistence-based economies (Wolfe et al. 1984). These characteristics, which apply to Kotzebue Sound communities are as follows:

- Communitywide seasonal round of fishing and hunting activities for subsistence use: subsistence harvest and use varies seasonally with distribution and abundance of fish and game species (Mauss and Beuchat 1979) (see figures 1, 2, 3, 4, 5, 6, and 7)

- Large diet breadth relative to fish and wildlife species available: a large proportion of available food species are utilized (tables 15, 16, 17, 18, 19)

- High overall harvest and use level: resources harvested make a significant contribution to the support of individual households and of the community as a whole; fish and wildlife supply a majority of meat, fish, and fowl used on a household and community basis

- Noncommercial distribution and exchange networks: harvested fish and wildlife are distributed between households and between communities

- Traditional systems of land tenure and use rights: customary law defines access to resource harvest areas and sites such as traplines, fish camp sites, set net sites, and community hunting areas and regulates the resource harvest activities by members of the local social group

- Time allocation: a significant amount of time is used harvesting and processing subsistence fish and wildlife

- Complementary cash and subsistence activities: cash income is used to purchase supplies needed for subsistence hunting and fishing; commercial fishing boats and gear may be used for subsistence; subsistence harvest and use may compensate for uncertain cash income and difficult logistics for imported food

- Domestic mode of production: the organization of subsistence production differs markedly from that of market organized production (Sahlins 1972)

V. TRANSPORTATION

A. Transportation to and from the Region

For most of the year, the major means of personal travel to and from the region is by air. Kotzebue is connected by regularly scheduled jet flights to Nome and Anchorage and by limited scheduled small plane flights to Fairbanks. Occasionally, upper Kobuk River communities find it convenient to use air charters directly to Fairbanks; Seward Peninsula communities may charter directly to Nome.

A good deal of travel by snowmachine to neighboring villages outside the subregion takes place during months when there is adequate snow cover, particularly in March and April, when days are long and weather generally less severe. For example, Ambler, Kobuk, and Shungnak residents exchange visits with relatives and friends in Anaktuvuk and Allakaket; Buckland residents exchange visits with Huslia and other villages.

Most transport of fuel, building material, vehicles, food staples, and other items into the region takes place in summer months, when barge service to Kotzebue Sound is possible. Ice is generally present in the sound well into June and freeze-up can occur as early as mid September. This means that there is a relatively tight window when barge shipments can reach Kotzebue.

Because Kotzebue has no deep water harbor, most ships and sea-going barges have to unload to shallow draft barges that are able to dock at the city dock. This extra handling of shipments adds to the already high cost of freight going into the region.

During the rest of the year, any goods reaching Kotzebue must arrive by air freight. This would include all fresh foodstuffs and parts, equipment, and supplies that are not stocked in Kotzebue.

B. Transportation within the Subregion

Surface travel between communities in the subregion is by snow-machine from freeze-up to breakup when there is snow cover and by skiff or boat in months when there is open water. A minimally equipped household needs to have at least one snowmachine and sled for use during frozen months and at least one skiff or boat with an outboard motor for water travel. More adequately equipped or larger families usually have more than one operating snowmachine and more than one outboard motor. Because of the heavy use these pieces of equipment receive, frequent repair and replacement are necessary. Purchase and maintenance costs of these essential vehicles are major components in household budgets.

Dog teams continue to be maintained by some subregion residents who use them for racing and for local transportation. Prior to the introduction of snowmachines in the mid 1960's, virtually all households in the subregion maintained working dog teams for winter travel and transport.

Scheduled small plane flights and air taxi charters have become increasingly common means of intercommunity personal travel within the subregion. Given the high cost of fuel and maintenance of personal vehicles, air travel may be the most economical way of travel between many communities.

Transportation of large quantities of goods, fuel oil and gasoline, foodstuffs, and equipment within the region is by small barge during the open water months and by air during most of the year. Small barges or freighters are able to make summer deliveries at all of the subregion's communities. Air freight and the postal service are used during winter months.

Snowmachines, skiffs, and boats are used by subregion residents to transport personal goods from Kotzebue to home communities and to transport supplies to camps and other subsistence harvest or processing sites.

VI. USE OF FISH AND GAME AND OTHER NATURAL RESOURCES

A. Historic Patterns of Resource Use

The pre-1855 patterns of subsistence use by three Eskimo groups in the Kotzebue Sound subregion have been reconstructed by Foote (1965) based on historical reports and records and on estimates from his knowledge of contemporary groups. Foote choose three groups for this analysis: the Tigeragmiut living in the Point Hope area whose subsistence pattern is representative of a coastal adaptation in the subregion, the Napaqturmiut of the lower Noatak River, and the Nautarmiut of the upper Noatak River basin. (Note that, although Foote's breakdown of pre-1855 Eskimo population into groups is in basic accord with Burch's division into societies (1978b), there is not an exact correspondence.)

The reconstructed seasonal rounds for the three groups are presented in tables 7, 8, and 9. Tables 10 through 14 present estimates of composition of harvest and food dependencies for each group. As Foote recognized, composition of species harvested and used for subsistence varies significantly from year to year. The

Table 7. Seasonal Round of Tigeragmiut Subsistence Harvesting Activities, Ca. 1850

Season	General Hunting Area	Principal Species Harvested*
Summer (late June to early Sept.)	Coast: from Tolageak to Sisualik Inland: to headwaters of Kukpuk and Kukpowruk rivers	Belukha Caribou Ducks Grayling Marmot Murre Ptarmigan Salmon Seal, harbor Squirrel Trout Whitefish
Autumn (early Sept.) to early Nov.)	Coast: Cape Sabine to Kivalina Inland: lower and upper Kukpuk River	Caribou Cod, polar Ducks Grayling Owl, snowy Ptarmigan Salmon Seal, bearded Seal, harbor Squirrel Walrus
Winter (early Nov. to March)	Coast: Cape Lisburne to Cape Thompson Inland: lower and middle Kukpuk River	Bear, polar Caribou Cod, polar Fox, arctic Seal, ringed
Spring (April to late June)	Coast: Cape Lisburne to Cape Thompson Inland: lower and middle Kukpuk River	Belukha Caribou Cod, polar Ducks Murre Seal, bearded Seal, harbor Seal, ringed Whale, bowhead Walrus

Source: Foote 1965.

Note: Beginning and end of seasons are influenced by ice conditions and may not be the same in each year. Areas and species listed are representative; in all probability other areas and species were also used.

* Species harvested represent those harvested either inland or along coastal areas during each season.

Table 8. Seasonal Round of Napaqturmiut Subsistence Harvesting Activities, Ca. 1850.

Season	General Hunting Area	Principal Species Harvested*
(Summer July to Aug.)	Coast: Ohkaleeksout- Killeegmaek to Sisualik	Belukha Caribou Ducks Grayling Marmot Ptarmigan Salmon Seal, harbor Sheep, Dall Squirrel Trout Whitefish
Autumn Aug. to Oct.)	Coast: Sisualik	Bear, grizzly Caribou Grayling
	Inland: lower and middle Noatak River	Ptarmigan Salmon Trout Whitefish
Winter (Nov. to Feb.)	Coast: not utilized	Caribou Fox, arctic Hare
	Inland: lower Noatak River	Ptarmigan Trout
Spring (late June to July)	Coast: Ohkaleeksout to Killeegmaek	Caribou Cod, polar Ducks Hare
	Inland: lower and middle Noatak River	Seal, bearded Seal, ringed Trout Walrus Whale, bowhead

Source: Foote 1965.

Note: Beginning and end of seasons are influenced by ice conditions and may not be the same in each year. Areas and species listed are representative; in all probability other areas and species were also used.

* Species harvested represent those harvested either inland or along coastal areas during each season.

Table 9. Seasonal Round of Nautarmiut Subsistence Harvesting Activities, Ca. 1850.

Season	General Hunting Area	Principal Species Harvested*
Summer (June to Aug.)	Coast: Sisualik, Nirlik-Oliktok, Piknik-Pt. Barrow	Belukha Caribou Ducks Grayling
	Inland: upper Noatak River basin	Marmot Ptarmigan Salmon Seal, bearded Seal, harbor Seal, ringed Sheep, Dall Squirrel Trout
Autumn (Sept. to Oct.)	Coast: not utilized	Bear, grizzly Caribou Grayling
	Inland: Noatak River basin, middle Colville River	Ptarmigan Salmon Sheep, Dall Trout Whitefish
Winter (Nov. to April)	Coast: not utilized	Caribou Grayling Ptarmigan
	Inland: upper Noatak River basin	Sheep, Dall Trout Whitefish
Spring (May to June)	Coast: Sisualik	Caribou Grayling Ptarmigan Sheep, Dall
	Inland: Noatak, middle and lower Colville and Ikpikpuk rivers	Trout Whitefish

Source: Foote 1965.

Note: Beginning and end of seasons are influenced by ice conditions and may not be the same in each year. Areas and species listed are representative; in all probability other areas and species were also used.

* Species harvested represent those harvested either inland or along coastal areas during each season.

Table 10. Reconstructed Seasonal Diet of the Tigeragmiut Based on Caloric Need for Protein and Carbohydrates, Ca. 1850

Winter		Summer	
% Caloric Needs	Species	% Caloric Needs	Species
35	Whale, bowhead	40	Caribou
25	Seal, ringed	15	Whitefish, grayling
15	Seal, bearded	15	Belukha
10	Walrus	10	Salmon and trout
8	Caribou	5	Whale, bowhead
2	Belukha	5	Seal, harbor
2	Bear, polar	2	Murre
1	Whitefish, grayling	1	Bear, grizzly
1	Cod, polar	1	Cod, polar
1	Ducks	1	Ducks
		1	Marmot
		1	Murre eggs
		1	Ptarmigan
		1	Squirrel
		1	Berries

Source: Foote 1965.

Note: Estimates are based on historical reconstruction and authors research; measurements of actual quantities of subsistence foods used was not undertaken in 1850.

Table 11. Reconstructed Seasonal Diet of the Napaqturmiut Based on Caloric Need for Protein and Carbohydrates, Ca. 1850

Winter		Summer Coastal	
% Caloric Needs	Species	% Caloric Needs	Species
60.0	Salmon	25	Seal, bearded
30.0	Caribou	20	Whitefish, grayling
6.0	Trout	20	Salmon, trout
1.0	Berries	15	Seal, ringed
1.0	Sourdock	5	Seal, harbor
1.0	Ptarmigan	5	Belukha
0.5	Sheep, Dall	5	Caribou
0.5	Hare	2	Walrus
		2	Ducks
		1	Willow leaves

Summer Inland	
% Caloric Needs	Species
60.0	Caribou
20.0	Whitefish, grayling
10.0	Salmon, trout
5.0	Marmots
2.0	Bear, grizzly
1.0	Ducks
1.0	Willow leaves
1.0	Berries

Source: Foote 1965.

Note: Estimates are based on historical reconstruction and author's research; measurements of actual quantities of subsistence foods used was not undertaken in 1850.

Table 12. Reconstructed Seasonal Diet of the Nautarmiut Based on Caloric Need for Protein and Carbohydrates, Ca. 1850

Winter Inland		Summer Sisualik	
% Caloric Needs	Species	% Caloric Needs	Species
90	Caribou	50	Belukha
6	Whitefish, grayling	25	Salmon, trout
1	Sheep, Dall	15	Seal, bearded
1	Bear, grizzly	5	Seal, harbor
1	Ptarmigan	2	Ducks
1	Berries	2	Willow leaves

Summer Nirlik		Summer Inland	
% Caloric Needs	Species	% Caloric Needs	Species
50	Caribou	70.0	Caribou
25	Whitefish, grayling	20.0	Whitefish, grayling
10	Seal, harbor	5.0	Sheep, Dall
5	Seal, bearded	2.0	Bear, grizzly
5	Belukha	2.0	Marmot
2	Marmot	1.0	Sourdock
1	Willow leaves		

Source: Foote 1965.

Note: Estimates are based on historical reconstruction and author's research; measurements of actual quantities of subsistence foods used was not undertaken in 1850.

Table 13. Per Capita Food Consumption, People, and Dogs Combined, Kivalina, Alaska

Year	No. of People[a]	No. of Dogs[a]	Total Consumers	Total Lb Meat, Fish	Lb Per Consumer	Lb/ Consumer Per Day
1965-66	182	221	403	267,920	665	1.82
1982-83	261	87[b]	348	275,999	793	2.17
1983-84	254	92[b]	346	283,645	820	2,25

Source: Burch 1984e.

a All age groups.

b Small dogs kept as pets were counted as one-half a nonworking sled dog as far as consumption is concerned. In 1965-66, all adult dogs worked; in 1982-84, very few of them worked at all, and none did so on a regular basis.

Table 14. Total Harvest in Pounds of Major Food Subsistence Resources by Species,[a] Kivalina, Alaska

Species	1964-65[b]	1965-66[b]	1982-83[b]	1983-84[b]
Caribou	30,785 (12.5)	129,006 (48.1)	46,705 (16.9)	70,378 (24.8)
Fish	84,904 (34.5)	35,158 (13.1)	71,535 (25.9)	82,184 (29.0)
Moose	0	1,500 (.6)	3,000 (1.1)	3,500 (1.2)
Polar bear	0	0	0	2,100 (.7)
Seal, bearded	71,795 (29.2)	60,180 (22.5)	62,196 (22.5)	31,000 (10.9)
Seal, ringed	56,831 (23.1)	33,421 (12.5)	16,089 (5.8)	7,868 (2.8)
Walrus	0	6,370 (2.4)	60,300 (21.9)	3,200 (1.1)
Whale, belukha	1,785 (.7)	2,285 (.8)	16,174 (5.9)	17,415 (6.1)
Whale, bowhead	0	0	0	66,000 (23.4)
Totals	246,100 (100.0)	267,920 (100.0)	275,999(100.)	283,645 (100.0)

Source: Burch 1984c.

a Figures are for estimated pounds of usable meat, blubber, and fish.

b A subsistence year runs from June 1 through May 31.

tables present an idealized case and do not include probable variation over time or a total listing of all species harvested (see tables 15, 16, 17, 18, and 19).

Differences in seasonal movements underlie the inter-group differences shown in these tables. The Tigeragmiut stayed close to the coast most of the year and relied heavily on sea mammals for most of their subsistence use during winter. Their summer pattern included major use of caribou, fish found in fresh water, and belukha.

The Napaqturmiut spent late summer and winter on the lower Noatak and had access to both anadromous fish from the river and inland game species. In spring and summer, some family groups travelled to the coast, where they harvested sea mammals while other family groups stayed inland. Salmon and caribou probably accounted for most of the winter diet. The majority of the summer diet was made up of caribou and fish found in freshwater rivers and lakes for those families that stayed inland. The summer diet consisted primarily of seal, other marine mammals, and fish caught at stream mouths and in coastal lagoons for families that traveled to coastal areas.

The winter diet of Nautarmiut, who lived further inland than the other two groups, consisted mainly of caribou with some whitefish and grayling. The summer diet depended on whether summer was spent at Sisualik, Nirlik, or inland. For families who went to Sisualik, belukha, seal, salmon, and trout were most important summer species. Families who went to Nirlik harvested caribou, whitefish, and grayling, and some sea mammals. Families that stayed inland subsisted on a summer harvest primarily of caribou, whitefish, and grayling.

Members of all three groups regularly participated in sea mammal harvesting in the Sisualik-Cape Krusenstern area. Some transfer of subsistence products took place through trade and barter relationships that were institutionalized between members of inland and coastal societies. Institutionalized trading partners exchanged seal oil, muktuk, and other items from coastal areas for furs, dried meat, conk fungus, and other items from interior areas (see Riches 1982, for a general approach to arctic subsistence).

B. Contemporary Patterns of Resource Use

The use of fish and wildlife resources will be discussed in detail below. All known resource harvest is described in this section; however, discussion of harvest that is currently not permitted by regulation does not constitute endorsement of such harvest by the Department of Fish and Game.

Table 15. Land Mammals Harvested for Subsistence by Kotzebue Sound Subregion Residents, 1985

Species Known to be Harvested

Binomial	Common Name	Inupiaq Name
Ursus americanus	Bear, black	*Iyyagriq*
Ursus arctos	Bear, grizzly	*Aklaq*
Castor canadensis	Beaver	*Paluqtq*
Rangifer tarandus	Caribou	*Tuttu*
Alopex lagopus	Fox, arctic	*Qusrhqaaq*, *Tigiganniaq*
Vulpes fulva	Fox, red	*Kayuqtuq*
Vulpes fulva	Fox, red (cross phase)	*Qaingaq*
Vulpes fulva	Fox, red (red phase)	*Kavvaiq*
Vulpes fulva	Fox, red (silver phase)	*Qigniqtaq*
Lepus arcticus	Hare, arctic	*Ukalliuraq*
Lepus americana	Hare, snowshoe	*Ukalliq*
Lynx canadensis	Lynx	*Nuutuuyiq*
Marmota broweri	Marmot, hoary	*Siksrikpak*
Marmota caligata	Marmot, hoary	*Siksrikpak*
Martes americana	Marten	*Quapvaitchiaq*
Mustela vison	Mink	*Itigiaqpak*
Alces alces	Moose	*Tuttuvak*
Ovibos moschatus	Muskox	*Oomingmuk*
Ondatra zibethicus	Muskrat	*Kigvaluk*
Lutra canadensis	Otter, river	
Erethizon dorsatum	Porcupine	*Iluqutaq*
Ovis dalli	Sheep, Dall	*Imnaiq*
Spermophilus parri	Squirrel, arctic ground	*Siksrik*
Spermophilus undulatus	Squirrel, arctic ground	*Siksrik*
Mustela erminea	Weasel, ermine	*Itigiaq*
Canis lupus	Wolf	*Amaguq*
Gulo gulo	Wolverine	*Qapuik*, *qavvik*

Species Present and Probably Harvested

Binomial	Common Name	Inupiaq Name
Canis latrans	Coyote	
Lemmus sibiricus	Lemming, brown	
Dicrostonyx torquatus	Lemming, collared	
Synaptomys borealis	Lemming, northern bog	

(continued)

Table 15 (continued).

Species Present and Probably Harvested

Binomial	Common Name	Inupiaq Name
Marmota boweri	Marmot, Alaska	
Mus musculus	Mouse, house	
Zapus hudsonius	Mouse, meadow jumping	
Myotis lucifugus	Myotis, little brown	
Lutra canadensis	Otter, river	
Ochotona collaris	Pika, collared	
Phococena phococena	Porpoise, harbor	
Rattus norvegicus	Rat, Norway	
Sorex jacksoni	Shrew, St. Lawerance	
Sorex arcticus	Shrew, arctic	
Sorex obscurus	Shrew, dusky	
Sorex palustris	Shrew, masked	
Microsorex hoyi	Shrew, pygmy	
Glaucomys sabrinus	Squirrel, northern flying	
Tamiasciurus hudsonicus	Squirrel, red	
Microtus longicaudus	Vole, long-tailed	
Microtus pennsylvanicus	Vole, meadow	
Clethrionomys rutilus	Vole, northern red-backed	
Microtus miurus	Vole, singing	
Microtus oeconomus	Vole, tundra	
Microtus xanthognathus	Vole, yellow-cheeked	
Marmota monax	Woodchuck	

Source: Field research and Anderson 1985, Carter 1985, Schroeder 1985.

Note: Dialectic variation within the Kotzebue Sound Subregion precludes a single definitive listing of Inupiaq species names.

Table 16. Marine Mammals Harvested for Subsistence by Kotzebue Sound Subregion Residents, 1985

Binomial	Common Name	Inupiaq Name
Thalarctos maritimus	Bear, polar	Nanuq
Erignathus barbatus	Seal, bearded	Ugruk
Phoca vitulina	Seal, harbor	Qasigiaq
Phoca fasciata	Seal, ribbon	Çaigutliq
Phoca hispida	Seal, ringed	Netchiq, natchiq
Odobenus rosmarus	Walrus, Pacific	Aiviq
Delphinapterus leucas	Whale, belukha	Sisuaq, qilalugaq
Baleena mysticetus	Whale, bowhead	Agviq
Eschrichtius gibbosus	Whale, gray	Akvikluak

Species Present and Probably Harvested

Binomial	Common Name	Inupiaq Name
Orcinus orca	Whale, killer	
Balaenoptera musculus	Whale, littel piked or Minke	

Source: Field research and Anderson 1985, Carter 1985, Schroeder 1985.

Note: Dialectic variation within the Kotzebue Sound Subregion precludes a single definitive listing of Inupiaq species names.

Table 17. Fish and Invertebrates Harvested for Subsistence by Kotzebue Sound Subregion Residents, 1985

Species Known to be Harvested

Binomial	Common Name	Inupiaq Name
Dallia pectoralis	Blackfish, Alaska	Iluuqiniq
Lota lota	Burbot (lingcod, cusk, lush, eelpout)	Tittaaliq
Mallotus villosus	Capelin	Ilhaugniq
Salvelinus alpinus/ S. malma	Char, arctic or Dolly Varden (goldfin, dwarf char, old man fish, char)	Iqalukpik
Coregonus autumnalis	Cisco, arctic	Qaaktaq
Coregonus sardinella	Cisco, least	Iqalusaaq
Macoma calcerea (various)	Clams	Ivilluq
Boreogadus saida	Cod, arctic	Kanayuq
Gadus macrocephalus	Cod, Pacific (true cod, gray cod)	
Elginus gracilis	Cod, saffron (tomcod)	Uugaq
Paralithodes camtschatica	Crab, red king	Putyuvak
Chionoecetes opilio	Crab, Tanner	Putyuvak
Liopsetta glacialis	Flounder, arctic	Natagnaq, ipqaqnailqaq
Platichthys stellatus	Flounder, starry	Natagnaq
Thymallus arcticus	Grayling, arctic	Suluqpaugak
Hippoglossus stenolepis	Halibut	
Clupea harengus pallasi	Herring, Pacific	Ugsruqtuuq
Various	Mussles	Avvyak
Esox lucius	Pike, northern	Siilik
Oncorhynchus tshawytscha	Salmon, chinook (king)	
Oncorhynchus keta	Salmon, chum (dog)	Iqalugruaq
Oncorhynchus kisutch	Salmon, coho (silver)	
Oncorhynchus gorbuscha	Salmon, pink (humpy)	Amaktu, amaqtuq
Oncorhynchus nerka	Salmon, sockeye (red)	
Various species	Sculpin	Kanayuq
Stenodus leucichthys	Sheefish (cony, inconnu, shovelnose whitefish)	Sii
Osmerus mordax	Smelt (rainbow)	Ilhaugniq
Pungitius pungitius	Stickleback, nine-spined	Kakilisak
Catostomus catostomus	Sucker, longnose	Qauiqsuaq
Salvelinus namaycush	Trout, lake (lake char)	Iqalukpik
Coregonus nasus	Whitefish, broad	Qaaligiz, annaakliq
Coregonus clupeaformis	Whitefish, humpback	Amaktu
Prosopium cylindraceum	Whitefish, round	Quptiq

(continued)

Table 17 (continued).

Species Present and Probably Harvested		
Binomial	Common Name	Inupiaq Name
Couesius plumbeus	Chub, lake	
Coregonus laurettae	Cisco, Bering	
Entosphenus tridentatus	Lamprey, Pacific	
Lampetra japonica	Lamprey, arctic	
Myoxocephalus quadricornis	Sculpin, fourhorn	
Gasterosteus aculeatus	Stickleback, threespine	
Percopsis omiscomaycus	Trout-perch	
Coregonus nelsoni	Whitefish, Alaska	

Source: Field research and Anderson 1985, Carter 1985, Schroeder 1985.

Note: Dialectic variation within the Kotzebue Sound subregion precludes a single definitive listing of Inupiaq species names.

Table 18. Birds Harvested for Subsistence by Kotzebue Sound Subregion Residents, 1985

Species Known to be Harvested

Binomial	Common Name	Inupiaq Name
Aethia cristatella	Auklet, crested	
Aethia pusilla	Auklet, least	
Cyclorhyncus psittaculus	Auklet, parakeet	
Euphagus carolinus	Blackbird, rusty	Tulukkaan ittuq
Branta nigricans	Brant, black	Niglignaq
Bucephala albeola	Bufflehead	Nunuqsigiilaq
Grus canadensis	Crane, sandhill	Tatturagaq
Histrionicus histrionicus	Duck, harlequin	Saquak tinmiaq
Aquila chripaetos	Eagle, golden	Tigmiakpak
Various species	Eggs, bird	Mannich
Polysticta stelleri	Eider, Steller's	Eknikauk tuk
Somateria mollissima	Eider, common	Amauligruaq
Somateria spectabilis	Eider, king	Kingalik, winalik
Lampronetta fisheri	Eider, spectacled	Mitik, kavaasuk
Falco perigrinus	Falcon, peregrin	Kirgavaichak
Branta canadensis	Goose, Canada	Nigliq
Chen hyperborea	Goose, snow	Kanuq
Anser albifrons	Goose, white-fronted	Kigliyuk
Podiceps auritus	Grebe, horned	Sugliq
Podiceps grisegena	Grebe, red-necked	Suglitchauraq
Pinicola enucleator	Grosbeak, pine	Qayuttaaq
Bonasa umbellus	Grouse, ruffed	Ituqtuuq
Canachites canadensis	Grouse, spruce	Napaaqtuumaqargiq
Xema sabini	Gull, Sabine's	Aqargiyiaq
Larus glaucescens	Gull, glaucous	Nauyak
Larus canus	Gull, mew	Nauyatchaiq
Falco rusticolus	Gyrfalcon	Kirgavik
Circus cyaneus	Hawk, marsh	Papiktuuq
Anas platyrhynchos	Mallard	Ivugasrugruk
Stercorarius longicaudus	Jaeger, long-tailed	Isungnaq
Stercorarious parasiticus	Jaeger, parasitic	Isungnaq
Stecorarius pomarinus	Jaeger, pomarine	Isungnaq
Parisoreus canadensis	Jay, gray	Kiiriq
Gavia arctica	Loon, arctic	Malgi
Gavia immer	Loon, common	Taatchiniq
Gavia stelata	Loon, red-throated	Qaqsrauk
Gavia adamsii	Loon, yellow-billed	Tuutlik
Mergus serrator	Merganzer, red-brested	Paisugruk
Uria aalge	Murre, common	Akpa
Uria lomvia	Murre, thick-billed	Akpa

(continued)

Table 18 (continued).

Species Known to be Harvested

Binomial	Common Name	Inupiaq Name
Clangula hyemalis	Oldsquaw	Aaqhaaliq, ahaaliq
Pandion haliaetus	Osprey	Qaluksiigayuk
Strix nebulosa	Owl, great grey	Naataq
Bubo virginianus	Owl, great-horned	Nukisagaq
Nyctea scandiaca	Owl, snowy	Ukpik
Anas acuta	Pintail	Kurugaq, ivugak
Pluvialis dominica	Plover, American golden	Tullik
Charadrius semipalmatus	Plover, semipalmated	Gurra, guraq
Lagopus mutus	Ptarmigan, rock	Niksaaktuniq
Lagopus lagopus	Ptarmigan, willow	Aqargiq
Corvus corax	Raven	Tuluqaq
Ereunetes pusillus	Sand piper, semipalated	Livlivlii
Ereunetes mauri	Sand piper, western	Livlivlii
Aythya marila	Scaup, greater	Quqlukpalik
Aythya affinis	Scaup, lesser	Quqluktuuq
Oidemia nigra	Scoter, common	Uvinauyuk
Malanitta perspicillata	Scoter, surf	Tuungaagruk
Melanitta deglandi	Scoter, white-winged	Killalik
Spatula clypeata	Shoveler	Alluutaq
Iridoprochne bicolor	Swallow, tree	Tulugagnauraq
Cignus columbianus	Swan, whistling or tundra	Qugruk
Anas corolinensus	Teal, green-winged	Qainniq
Sterna aleutica	Tern, Aleutian	Mitqutaillaq
Sterna paradisaea	Tern, arctic	Mitqutaillaq
Numenius phaeopus	Whimbrel	Turraa, turqaq
Mareca americana	Widgeon, American	Ugiihiq
Totanus flavipes	Yellowlegs, lesser	Tinmiamqipmia

Species Present and Probably Harvested

Binomial	Common Name	Inupiaq Name
Agelaius phoeniceus	Blackbird, red-winged	
Sialia currucoides	Bluebird, mountain	
Luscinia svecica	Bluethroat	
Branta bernicla	Brant	
Plectrophenax hyperboreus	Bunting, snow	

(continued)

Table 18 (continued).

Binomial	Common Name	Inupiaq Name
Species Present and Probably Harvested		
Parus atricapillus	Chickadee, black-capped	
Parus hudsonicus	Chickadee, boreal	
Fulica americana	Coot, American	
Phalacrocorax pelagicus	Cormorant, pelagic	
Grus grus	Crane, common	
Certhia familiaris	Creeper, brown	
Loxia leucoptera	Crossbill, white-winged	
Dinclus mexicanus	Dipper	
Eudromias morinellus	Dotterel	
Zenaida macroura	Dove, mourning	
Columba livia	Dove, rock	
Alle alle	Dovekie	
Limnodromus scolopaceus	Dowitcher, long-billed	
Aythya collaris	Duck, ring-necked	
Calidris alpina	Dunlin	
Haliaeetus leucocephalus	eagle, bald	
Falco peregrinus anatum	Falcon, peregrine American	
Falco peregrinus tundrensis	Falcon, peregrine tundra	
Carpodacus erythrinus	Finch, common rose	
Leucosticte tephrocotis	Finch, gray-crowned rosy	
Colaptes auratus	Flicker, common	
Empidonax hammondii	Flycatcher, Hammond's	
Empidonax alnorum	Flycatcher, alder	
Nuttallornis borealis	Flycatcher, olive-sided	
Fulmarus glacialis	Fulmar, northern	
Limosa haemastica	Godwit, Hudsonian	
Limosa lapponica	Godwit, bar-tailed	
Bucephala islandica	Goldeneye, Barrow's	
Bucephala clangula	Goldeneye, common	
Branta canadensis taverneri	Goose, Canada Taverner's	
Branta canadensis parvipes	Goose, Canada lesser	
Philacte canagica	Goose, emperor	
Accipiter gentilis	Goshawk	
Pedioecetes phasianellus	Grouse, sharp-tailed	
Cepphus grylle	Guillemot, black	
Cepphus columba	Guillemot, pigeon	
Larus philadelphia	Gull, Bonaparte's	
Rhodostethis rosea	Gull, Ross'	
Xema sabini	Gull, Sabine's	
Larus thayeri	Gull, Thayer's	
Larus ridibundus	Gull, black-headed	

(continued)

Table 18 (continued).

Binomial	Common Names	Inupiaq Name
Species Present and Probably Harvested		
Larus hyperboreus	Gull, glaucous	
Larus glaucescens	Gull, glaucous-winged	
Larus argentatus	Gull, herring	
Pagophilia eburnea	Gull, ivory	
Buteo swainsoni	Hawk, Swainson's	
Buteo lagopus	Hawk, lagopus	
Biteo jamaicensis	Hawk, red-tailed	
Accipter striatus	Hawk, sharp-shinned	
Perisoreus canadensis	Jay, gray	
Junco hyemalis	Junco, dark-eyed	
Falco sparverius	Kestrel, American	
Megaceryla alcyon	Kingfisher, belted	
Regulus calendula	Kinglet, ruby-crowned	
Rissa tridactyla	Kittiwake, black-legged	
Rissa brevirostris	Kittiwake, red-legged	
Calidris canutus	Knot, red	
Eremophila alpestris	Lark, horned	
Calcarious pictus	Longspur, Smith's	
Calcarius lapponicus	Longspur, lapland	
Pica pica	Magpie, black-billed	
Anas platyrhynchos	Mallard	
Mergus merganser	Merganser, common	
Lophodytes cucullatus	Merganser, hooded	
Falco columbarius	Merlin	
Uria aalge	Murre, common	
Brachyramphus brevirostris	Murrelet, Kittlitz's	
Synthliboramphus antiquus	Murrelet, ancient	
Sitta canadensis	Nuthatch, red-brested	
Aegolius funereus	Owl, boreal	
Surnia ulula	Owl, hawk	
Asio flammeus	Owl, short-eared	
Contopus sordidulus	Pewee, western wood	
Lobipes lobatus	phalarope, northern	
Phalaropus fulicarius	Phalarope, red	
Sayornis saya	Phoebe, Say's	
Anthus cervinus	Pipit, red-throated	
Anthus spinoletta	Pipit, water	
Charadius mongolus	Plover, Mongolian	
Pluvialis squatarola	Plover, black-bellied	
Lagopus leucurus	Ptarmigan, white-tailed	

(continued)

Table 18 (continued).

Binomial	Common Name	Inupiaq Name
Fratercula corniculata	Puffin, horned	
Lunda cirrhata	Puffin, tufted	
Aythya americana	Redhead	
Carduelis flammea	Redpoll, common	
Carduelis hornemanni	Redpoll, hoary	
Turdus migratorius	Robin, American	
Philomachus pugnax	Ruff	
Calidris alba	Sanderling	
Calidris bairdii	Sandpiper, Baird's	
Tryngites subruficollis	Sandpiper, buff-brested	
Tringa hypoleucos	Sandpiper, common	
Calidris ferruginea	Sandpiper, curlew	
Calidris minutilla	Sandpiper, least	
Calidris melanotos	Sandpiper, pectoral	
Calidris ptilocnemis	Sandpiper, rock	
Calidris ruficollis	Sandpiper, rufous-necked	
Calidris acuminata	Sandpiper, sharp-tailed	
Tringa solitaria	Sandpiper, solitary	
Actitis macularia	Sandpiper, spotted	
Micropalama himantopus	Sandpiper, stilt	
Xenus cinereus	Sandpiper, terek	
Bartramia americana	Sandpiper, upland	
Calidris fuscicollis	Sandpiper, white-rumped	
Tringa glareola	Sandpiper, wood	
Melanitta nigra	Scoter, black	
Puffinus tenuirostris	Shearwater, short-tailed	
Anas clypeata	Shoveler, northern	
Lanius excubitor	Shrike, northern	
Carduelis pinus	Siskin, pine	
Gallinago gallinago	Snipe, common	
Myadestes townsendi	Solitaire, Townsend's	
Porzana carolina	Sora	
Melospiza lincolnii	Sparrow, Lincoln's	
Spizella passerina	Sparrow, chipping	
Passerella ilaica	Sparrow, fox	
Zonotrichia atricapilla	Sparrow, golden-crowned	
Passerculus sandwichensis	Sparrow, savannah	
Spizella arborea	Sparrow, tree	
Zonotrichia leucophys	Sparrow, white-crowned	
Sturnus vulgaris	Starling	

Species Present and Probably Harvested

(continued)

Table 18 (continued).

Binomial	Common Name	Inupiaq Name
Calidris temminckii	Stint, Temminck's	
Calidris subminuta	Stint, long-toed	
Aphriza virgata	Surfbird	
Riparia riparia	Swallow, bank	
Petrochelidon pyrrhonota	Swallow, cliff	
Tachycineta thalassina	Swallow, violet-green	
Olor buccinator	Swan, trumpeter	
Heteroscelus brevipes	Tattler, Polynesian	
Heteroscelus incanus	Tattler, wandering	
Catharus ustulatus	Thrush, Swainson's	
Catharus minimus	Thrush, gray-cheeked	
Catharus guttatus	Thrush, hermit	
Ixoreus naevious	Thrush, varied	
Arenaria melanocephala	Turnstone, black	
Arenaria interpres	Turnstone, ruddy	
Motacilla alba	Wagtail, white	
Motacilla flava	Wagtail, yellow	
Dendroica townsendi	Warbler, Townsend's	
Wilsonia pusilla	Warbler, Wilson's	
Phylloscopus borealis	Warbler, arctic	
Dendroica striata	Warbler, blackpoll	
Vermivora celata	Warbler, orange-crowned	
Dendroica petechia	Warbler, yellow	
Dendroica coronata	Warbler, yellow-rumped	
Seiurus noveboracensis	Waterthrush, northern	
Bombycilla garrulus	Waxwing, bohemian	
Oenanthe oenanthe	Wheatear	
Picoides arcticus	Woodpecker, black-backed three-toed	
Picoides pubescens	Woodpecker, downy	
Picoide villosus	Woodpecker, hairy	
Picoides tridactylus	Woodpecker, northern three-toed	
Tringa melanoleuca	Yellowlegs, greater	

Species Present and Probably Harvested

Source: Field research and Anderson 1985, Carter 1985, Schroeder 1985.

Note: Dialectic variation within the Kotzebue Sound subregion precludes a single definitive listing of Inupiaq species names.

1. Species harvested and used. In addition to the limited reports of early exploration of the Kotzebue Sound subregion and of early research that document subsistence uses of fish and wildlife (Cantwell 1885; Giddings 1956, 1961; Healy 1887; Kashevarov 1977 (1879); Nelson 1983 (1899); Smith 1966), numerous studies of contemporary subsistence use of fish and game have been conducted over the last 25 years. Most of these later studies have been directly concerned with proposed land use and other natural resource decisions that have the potential to seriously affect subsistence harvest and use.

Anderson et al. (1977) conducted research to provide data to inform NPS management policy in the Kobuk River drainage. Armstrong and Braund (1983) and Braund and Burnham (1983) conducted studies to provide background data for federal government policy on Eskimo whaling and to outline possible impacts from development of the Red Dog mine in the subsistence use area of Kivalina and Noatak. Davis and McNabb (1983) completed work as part of data gathering for the Outer Continental Shelf Management Plan for the Kotzebue Sound subregion. Much of the work of Foote (1960, 1961, 1966), Foote and Williamson (1961, 1966), and Sarrio and Kessel (1966) was commissioned to determine the likely effect on subsistence use of fish and wildlife of the U.S. Atomic Energy Commission's plan to use nuclear explosions to create a port in northwest Alaska. Grauman (1977) and Nelson et al. (1982) prepared reports to inform NPS management. Uhl and Uhl (1977) analyzed subsistence use patterns in the Cape Krusenstern National Monument area; in a subsequent document, they provide analysis of subsistence use in the Noatak National Preserve (1979).

Other studies conducted to improve anthropological knowledge of northwest Alaska Eskimos have often included extensive treatment of subsistence. Burch (1970, 1971, 1972, 1978a, 1978b), Clark and Clark (n.d.), Hall (1975), Jamison et al. (1978), papers in Kotani and Workman (1978), and Smith (1966) report research of this type. Burch's recent work (1982a, 1982b, 1983a, 1983b, 1983c, 1983d, 1983e, 1984a, 1984b, 1984c) concerns research conducted in Kivalina to improve baseline subsistence data for that community.

Tables 15, 16, 17, and 18 list species of land mammals, marine mammals, birds, fish and invertebrates, respectively, for which subsistence use in the Kotzebue Sound subregion has been documented in the literature or confirmed by unpublished field research. Anderson et al. (1977), Hildreth and Conover (1983), and Uhl and Uhl (1977, 1979) contain the most complete documentation, particularly for species harvested in small quantities. The most widely used species are documented in virtually all the sources listed above. Carter (1985) and Schroeder (1985) confirmed other species use based on field studies conducted in 1984 and 1985.

These tables also include listing of species from Taylor (1979) that are probably present in the Kotzebue Sound subregion and for which use is suspected. Although all species known to be used for subsistence or for which subsistence use is likely are listed in these tables, there are doubtlessly other species for which use exists but for which neither species presence nor use has been documented. These would include additional bird species, primarily of Asian and Pacific migratory birds that occasionally appear in northwest Alaska, and also additional fish and intertidal or littoral species.

Table 19 presents a listing of the plants and fungus most commonly used in the Kotzebue Sound subregion. This listing, drawn primarily from Anderson et al. (1977), Hildreth and Conover (1983), Jones (1983), and Uhl and Uhl (1977, 1979), is illustrative and does not attempt to be complete. Thorough research to exhaustively list plant and fungus species used in northwest Alaska has not been conducted, and undocumented uses of other plant species is likely.

2. Inupiaq taxonomy. Inupiaq species names and some variants have been included in tables 15, 16, 17, 18, and 19. In general, Inupiaq recognizes virtually all the fish and wildlife species maintained by Linnaean taxonomic classification and includes further distinctions as well. Although thorough research on Inupiaq taxonomy has yet to be done, incidental research has recorded numerous taxa that denote differences at the subspecies level, particularly with most important species or most commonly used species (Anderson et al. 1977; Uhl and Uhl 1977, 1979). Some Inupiaq terms are presented in table 20 for caribou, *Rangifer tarandus*, and Dall sheep, *Ovis dalli*. Many anthropologists maintain that the depth and breadth of a cultures knowledge of its biological environment is reflected in the richness of local language taxonomic classification (Brown 1985, Kronenfeld 1985). Others have noted that classification in hunting and gathering societies often goes beyond utilitarian needs (Levi-Strauss 1962). Other studies have examined systems of species and kinship classification as a means of understanding cognition (Tylor 1969). In any case, Inupiaq taxonomy demonstrates a developed understanding of area biology and the cultural and utiltiarian importance of fish and wildlife resources to Inupiaq Natives.

Table 19. Plants Used for Subsistence by Kotzebue Sound Subregion Residents, 1985

Binomial	Common Name	Inupiaq Name	Source
Edible leaves			
Angelica lucida	Celery, wild	Ikuusuk	1,2
Allium schoenoprasum	Chive, wild	Paatitaaq	1,2
Petasites frigida	Coltsfoot	Kipmimangaun, kipnimangauna, milukutakpak	2
Petasites hyperboreus	Coltsfoot	Kipmimangaun, kipmimangauna, milukutakpak	2
Epilobium angustifolium	Fireweed	Pamiuqtaq (pautnuq = young edible shoots	1,2
Epolobium latifolium	Fireweed, dwarf	Pamiuqtaq, pautnaq	2
Chenopodium album	Lamb's quarters	?	2
Pedicularis lanata (kanei)	Lousewort, wooly	Qutliutaq, qutliiraq	2
Ligusticum scoticum	Lovage, sea	Tukkaayuk	2
Polygonum alaskanum	Rhubard, wild	Qusrimmaq, qusimmaq	1,2
Sedum roseum	Roseroot	Likutaq, liviaqluk	2
Saxifraga punctata	Saxifrage, grook	Asriatchiaq, kaunalik (salad greens)	2
Rumex arcticus	Sourdock	Quagaq	1,2
Oxyria digyna	Sourgrass	Kitluq	2
Ledum palustre (decumbens)	Tea, Eskimo	Tilaaqiuq	1,2
Salix pulchra	Willow, sura	Kanunniq (sura or ikutautchiqq for young buds) (diamond leafed willow)	2
Salix alexensis	Willow, big (river willow)	Uqpik (uqpisugruk = big willow)	2
Edible berries			
Arctostaphlylos alpine	Bearberry	Kaviaq (black alpine bearberry)	1,2
Arctostaphylos rubra	Bearberry, red-fruited	Anutvak	1,2
Empetrum nigrum	Blackberry, (crowberry)	Paungaq	1
Vaccinium uliginosum	Blueberry, bog or alpine	Asriavik, asiavik	1,2
Vaccinium oxycoccus	Cranberry, bog	Qunmum sarmiruq, Qunmam asriaq	1,2
Viburnum edule	Cranberry, highbush	Uuqpinnaq	1,2
Vaccinium vitis-idaea	Cranberry, lowbush	Kikminnaq	1,2
Ribes triste	Current, northern red	Nivinnaqutaq	
Juniperus communis	Juniper, common mountain	Tulukkam asriaq	1,2 2
Arctostaphylos uva-ursi	Kinnickinnick (bearberry)	Tinnik	1.2

(continued)

Table 19 (continued).

Binomial	Common Name	Inupiaq Name	Source
Rubus arcticus	Nagoonberry (trailing) raspberry, wineberry	Aqpinnaq, ivgum asriaq, tuungaum	1,2
Rubus idaeus	Raspberry, American red	?	2
Rosa acicularis	Rosehips	Igrunnaq	1,2
Rubus chamaemorus	Salmonberry (cloud- aqpik		1,2
Shepherdia canadensis	Soapberry (buffaloberry)	? not often used	2
Edible roots			
Eriophorum angustifolium	Cottongrass, tall	Pikniq	1,2
Oxytropis maydelliana	Oxytrope yellow	Aigaq, masu aigaq	2
Hedysarum alpinum	Potato, Eskimo	Masruqutaq, masu (masu = the root)	1,2
Wood			
Alnus crispa	Alder, American green	Runaniaq	1
Populus tremuloides	Aspen, quaking	Pinuqraitchiaqmi ninnuq	1
Betula papyrifera	Birch, paper	Urgiilik	1
Juniperus communis	Juniper, common	Tulukkam asriaq	1
Populus balsamifera	Poplar, balsam (cottonwood)	Ninnuq	1
Picea mariana	Spruce, black	Napaaqtuq	1
Picea glauca	Spruce, white	Napaaqtuq	1
Salix sp.	Willow	Uapik	1
Salix planifolia	Willow, diamond-leafed	Qanuniaq	1
Fungus			
Fome ingniarius	Fungus, birch	Avaatsiqiq	1
(unknown)	Fungus, white bracket	Tunuuraq	1
Other			
Cassiope tetragona	Cassiope four-angled	Ikugutigiksut	1
(unknown)	Grass or sedge	Ivgiich, punaq	1
Cladonia rangiferiana	Lichen, reindeer	Niqaaq	1
(unknown)	Moss, peat	Tininniq	1
Sphagnum sp.	Moss, spagnum	Ivruiyaq	1
(unknown)	Moss, various	Manaq	1
	Moss, various	Ipagaksraq	1
	Moss, various	Tinauraq	1
Artemisia alaskana	Sagebrush, Alaska	Sargiich	1
Saxifranga punctata	Saxifrage, cordate-	Asriachiak	1
Parrya nudicaulis	Wallflower, Parry's	Masu aigiq	1

Source: Anderson et al. 1977, Jones 1983.

Table 20. Inupiaq Taxonomy for Caribou and Dall Sheep

English Gloss	Inupiaq Taxa
Caribou, _Rangifer_ _tarandus_	
One caribou, either sex	_Tuttu_
Two caribou, either sex	_Tuttuk_
Three or more caribou	_Tuttut_
Herd of caribou (10 to about 400)	_Tuttugaruitch_
Huge number of caribou (as in migration)	_Tuttupauragatat_
Caribou fetus	_Ivilauq_
Adult barren cow	_Aimaknak_
Adult cow	_Kulavak_
Bull	_Paknik_
Fawn or calf	_Nugak_
Calf, about 9-15 mo. old	_Shiokalaq_
Yearling	_Anayukliakruq_
Young bulls (general)	_Nukatagaq_
Young bull (stage after yearling)	_Nukatagauraq_
Young bull (older than _nukatagauraq_)	_Nukatagaluq_
Nukatagaruaq (almost mature bull)	_Nukatagaruaq_
Old bull	_Pagnigoichiaq_
Very old, skinny bull	_Pagnigoichauraq_
Young cow	_Kolavauraq_
Very old cow (over 20 years)	_Kolavagoichiaq_
Very old skinny cow	_Kolavagoichauraq_
Odd, shriveled up, or stunted caribou	_Tikitagauraq_
Reindeer	_Kuunzik_
Reindeer barren cow	_Nugitaitak_
Reindeer bull	_Nuliaktaurak_
Reindeer cow	_Kulavak_
Reindeer fawn	_Nugakruak_

(continued)

Table 20 (continued).

English Gloss	Inupiaq Taxa
Dall Sheep, *Ovis dalli*	
Dall sheep (general)	*Ipniaq*
Adult male sheep	*Anuttiisugruk*
Female sheep (also female moose,caribou)	*Nuvak*
Sheep less than one year old	*Iivutuk*
Yearling sheep	*Tumutalook*
Two-year-old sheep	*Avaliiyalook*
Large ram with broomed horns	*Navuyaqayak*
Half curl ram	*Qalutuksaarak*

Source: Anderson et al. 1977, Grubser 1965.

Note: Dialectic variation within the Kotzebue Sound subregion precludes a single definitive listing of Inupiaq species names.

3. Subsistence characteristics: composition of harvest. A common characteristic of subsistence use of fish and game throughout Alaska is that virtually all species present in an area are utilized to some degree for food, clothing, or craft purposes. What is particularly striking about the Kotzebue Sound subregion is the number of species seasonally present and available for subsistence harvest. In addition to resident populations of large and small land mammals, marine mammals, and fish, important migrations of caribou, whales, walruses, anadromous fish, and migratory waterfowl pass through the area and are harvested by subregion residents. Many traditional subsistence strategies in the area are directed at interception of these migrations.

   Use of at least 24 species of land mammals, 33 of fish and invertebrates, 9 of sea mammals, and 67 of birds has been documented (tables 15-18). These estimates include use for crafts, use of fur, and use of bird eggs. At least 35 species of plants and berries are used for food, with additional plants having traditional medicinal uses (table 19). Because research on species used has not been extensive, species lists presented are not complete;

undocumented subsistence use of other animal species present in the region (see additional species listed in tables 15, 16, 17, 18) and of plant and fungus species probably occurs.

A second striking characteristic of species use in the Kotzebue Sound subregion is the extreme variability in the availability and success of the harvest of many of the important food species. In addition to very large fluctuations in general species distribution and abundance (see the caribou, walrus, and other species accounts), changing migration patterns or difficult hunting conditions may mean that an abundant harvest of caribou in one year may be followed by the virtual absence of caribou harvest in a subsequent year. Diachronic harvest data for Kivalina have shown that while the general overall level of harvest, in terms of food weight per capita, has been maintained over a 25-year period, the species composition of harvest has varied dramatically (Burch 1982a, 1982b, 1983a, 1983b, 1983c, 1983d, 1983e, 1984a, 1984b, 1984c, 1984d).

4. Subsistence characteristics: harvest variability. Quite obviously the fish and wildlife species listed in tables 15, 16, 17, and 18 do not make equal contributions to subsistence harvest and diet. As a general observation of subsistence in Alaska based on areas where good harvest data are available (KANA 1983, Wolfe 1981), from 10 to 20 species usually make up 90% of subsistence harvest in terms of food weight. This observation is confirmed in Foote's reconstructed harvest figures for the early contact period (see tables 10, 11, and 12 above) and from limited data available for the Kotzebue Sound subregion (see below).
Dietary preference and the amount of work needed to harvest and process some available species means that they are not actively sought by subsistence users in most years. These same species may be heavily used in years of poor harvest for preferred species. Alaska blackfish and ringed seal may be species in this category. With many bird species populations, density does not permit harvesting in quantity.

Other variability in harvest in the subregion stems from the local distribution and abundance of species harvested (see species narratives). Coastal communities rely more heavily on marine mammals than inland communities, especially in the case of communities with poor access to large land mammals and anadromous fish (Sobelman 1984). Communities are typically situated where harvest opportunities for some species are particularly good, such as salmon at Noatak, belukha at Elephant Point near Buckland, seal at Cape Espenberg near Deering, sheefish near Selawik, Noorvik, and

Kiana, and belukha, whitefish, and salmon by Kivalina residents. Consequently, although all Kotzebue Sound subregion communities are located near favorable fishing and hunting areas, the species composition of that harvest varies from community to community.

The western arctic caribou herd, the main caribou population hunted by Kotzebue Sound subregion residents, has gone through a number of historical fluctuations (see species narratives for details). As noted above, the dramatic decline in caribou numbers after 1850 was an important factor in the demise of inland societies on the Kobuk and Noatak rivers and triggered major important human migrations to coastal areas. Most recently the size of the western arctic caribou herd has been increasing, and the herd has frequently been moving through parts of the Kotzebue Sound subregion where caribou had been scarce. Hunting for this species has generally been improving.

Moose were not present in the Kotzebue Sound subregion in any numbers until about 1940. They have become an important species for subsistence harvest for Seward Peninsula communities, and for Kobuk, Noatak, and Selawik River communities only recently (Anderson 1985, Coady 1980, Stern 1985).

Commercial walrus hunting drastically reduced the walrus population at the end of the whaling era and made subsistence harvesting of walrus difficult around the turn of the century. The population has been subject to many fluctuations in the last 75 years. Most recently, the walrus population has expanded, and subsistence hunting opportunities have improved (see Burns 1984 and species narratives for details).

Local species abundance has a more immediate effect on the success of subsistence harvest than area species abundance. For example, from June 1965 through May 1966, in Kivalina, many more caribou were harvested than in the previous years or in typical harvest years because large numbers of caribou passed near Kivalina and were available for hunting over a relatively long period of time (Burch 1982a, 1982b, 1983a, 1983b, 1983c, 1983d, 1983e, 1984a, 1984b, 1984c). For another example, in the winter of 1984-1985 most of the western arctic caribou herd had stayed north of the Brooks Range, adversely impacting hunter success in the same communities in the Kotzebue Sound subregion (Andersen 1985; James 1985). Although caribou may be the most extreme example of changing migration patterns and fluctuation abundance, other species regularly harvested by Kotzebue

Sound subregion residents also exhibit some degree of variability that influences hunter success.

Further variability occurs because of poor weather and travel conditions. This may limit access to fish and wildlife species normally harvested or create conditions that interfere with food preservation and storage. As an example, Uhl and Uhl (1977) report that ice and weather conditions off Cape Krusenstern and Sisualik can drastically affect both winter and spring seal-harvesting activities.

4. Subsistence characteristics: strategies to deal with uncertainty. Subsistence users have a number of strategies to cope with harvest uncertainty. Trade and exchange, storage and preservation, and species substitution are three strategies discussed below.

   a. Trade and exchange. Trade, exchange, and gifts of subsistence products are customary and traditional ways of distributing subsistence resources. Within communities, family groupings exchange harvested resources with one another. This permits some limited specialization in harvesting wherein families with specialized hunting or fishing equipment or particular expertise in harvesting a resource supply other families on a reciprocal basis. Other intracommunity distribution takes place when families with active hunters undertake to supply elder community residents and families unable to harvest enough fish and wildlife for their needs. In the Kotzebue Sound subregion, many important resources are distributed in this way. This distribution may involve cash payment, although transactions generally take place in a social, cultural, or kinship context rather than as part of a market economy.

   Intercommunity trade and exchange operate much like the intracommunity distribution, with the important difference that some communities have exceptionally good access to particular fish and wildlife resources. At the time of contact, formal trading relationships existed between members of different societies, and these relationships facilitated exchange of subsistence products, primarily exchange of coastal and inland resources (see above and Burch 1975, 1978; Foote 1965). Not surprisingly, this sort of trade and exchange continues, with many resources being involved. Muktuk from Kivalina bowhead whale harvests, for example, is distributed throughout the Kotzebue Sound subregion (Burch 1982a, 1982b, 1983a, 1983b, 1983c, 1983d, 1983e, 1984a, 1984b, 1984c); sheefish caught by residents of Kotzebue, Noorvik, and Selawik are widely distributed in the subregion; seal oil moves from coastal harvesters inland (Carter 1985, Schroeder 1985). As with intra-community trade and exchange, although some cash may be involved, this distribution is based more on social, cultural, and kinship relationships between people than on market economics.

Both intracommunity and intercommunity trade and exchange serve in times of resource scarcity to distribute fish and wildlife products from areas where they are locally abundant to areas where they are needed. They are an expression of the ties that join area residents together at both the community and the subregion level.

b. Storage and preservation. The ability to maintain an adequate stock of subsistence foods between harvest opportunities has been an important feature of subsistence systems in the subregion. Harvest opportunities for most species are both highly seasonal and variable from year to year; relatively short periods of harvest abundance are often followed by long periods of time when harvest of significant quantities of fish and game is impossible. Storage and preservation strategy aims at providing a supply of a subsistence food to carry over until the next harvest opportunity for that food. Seasonal round of resource use data presented below illustrate some of this harvest opportunity variability (figures 1, 2, 3, 4, 5, 6, and 7).

Traditional methods of storage and preservation of subsistence foods have been described at some length for Kotzebue Sound communities in Anderson et al. (1977), Hildreth and Conover (1983), Jones (1983), and Uhl and Uhl (1977, 1979). Drying, smoking, salting, freezing, preserving in oil, caching, burying, and fermenting are the main methods of storage and preservation used. All of these methods are used throughout the subregion, although the importance of particular storage and preservation methods varies across communities.

Parts of almost all fish and wildlife species harvested (tables 15, 16, 17, and 18) are preserved by drying. Fish are split and hung on racks, and meat from birds and sea and land mammals is butchered to uniform thickness and hung in open air. Most drying appears to take place around breakup and freeze-up, when low night temperatures limit insect populations. Because insects are not a problem at this time, simple air drying without use of salt or smoke can be employed. Whitefish, sheefish, salmon species, and other fresh-water fish are the species most often dried in late summer and at freeze-up to provide dried fish over winter months. Caribou and, to a lessor extent, moose are dried in late spring at breakup to provide a supply of red meat to last until harvest of these large mammals begins again late August. Seal and whale meat and meat of birds and small game species are similarly preserved. Smoking and light salting of meat and fish are done when insects are a problem and to improve flavor.

Fish and wildlife harvested for subsistence from about mid September through about the end of May have been customarily preserved by freezing by the simple expedient of leaving harvested animals outside in a cache or other sheltered place. The average temperature during these months is low enough to prevent spoilage; during most of these months subsistence foods are in a natural deep freeze. Often caribou are stored whole in this manner over the winter months and then butchered and dried in April and May when air drying becomes possible. Since electrification of the villages in the Kotzebue Sound subregion, many residents have purchased freezers, which allow the use of preservation by freezing over the warm months.

In some communities, pits are dug into the permafrost in areas not subject to spring flooding. These are covered and used as cold storage, particularly over the summer months. In Buckland, for example, these storage cellars in the permafrost were used for berry, belukha muktuk, and seal and belukha oil storage in the spring of 1985 (Schroeder 1985).

Seal, belukha, and whale blubber is processed into oil by keeping the blubber in a warm place and later removing rendered oil. Blubber is usually not cooked to render oil. Oil will not spoil if kept clean and cool and may be used to preserve other subsistence foods. Dried seal meat and cooked and dried muktuk are frequently preserved in oil. Sourdock, other green plants, and many species of berries are often preserved in oil.

Above-ground caches continue to be used for storage of subsistence foods in communities with access to building logs. Caches are also used at fish camps to store dried fish until they can be conveniently picked up by boat or, after freeze-up, by snowmachine. Some residents have caches in trapping or hunting camps, where subsistence products are stored until they are taken to home communities.

Sourdock and other green plants are gathered in quantity and fermented for storage. The fermented foods store well and add both diversity and important nutrients to the winter diet. Animal products are also fermented. For example, whitefish caught just before freeze-up on the upper Kobuk River are often buried and allowed to ripen for some days before they are frozen solid. Similar anaerobic fermentation, or ripening, is done with caribou meat in this area. These fermented foods are an area delicacy (Schroeder 1985).

c. Harvest levels and species substitution. Data documenting the magnitude of subsistence harvest of fish and wildlife in the Kotzebue Sound subregion are not collected on a regular basis. The best estimates of subsistence harvest are from a NANA survey conducted in 1972 (Patterson 1974) and from Burch's work in Kivalina over the 1964 to 1984 time period (summarized in Burch 1984c). Consult species accounts for harvest estimates on a species-by-species basis.

Table 21 presents summary data on food weight of subsistence harvests for communities of the Kotzebue Sound subregion; table 22, 23, and 24 presents a breakdown of these data by species for mammals, fish and birds, and plants and berries, respectively. Based on computations from these data, subregion residents harvested almost four million pounds of subsistence fish and wildlife for human consumption, or about 969 lb per capita per year in the period covered by the survey. Additional quantities of subsistence harvest were used to support the subregion dog population. These data should be taken as indicative but not definitive of subsistence harvest in subregion communities. Yearly recording of subsistence harvests needs to be done to determine actual harvest levels in Kotzebue Sound communities.

Although the yearly need for subsistence foods may be more or less constant from year to year in Kotzebue Sound communities, harvest opportunities and availability of particular species vary greatly from year to year. Best available data to illustrate this variability are from studies conducted in Kivalina. Tables 13 and 14 present per capita food consumption and

Table 21. Total Harvest in Pounds of Subsistence Foods Resources by Harvest Category, Kotzebue Sound Communities, 1972*

Species/Item	Human Food	Dog Food
Mammals	2,728,228	164,747
Fish	1,077,035	359,012
Fowl	47,017	
Berry/green/veg.	132,184	
Total (lb)	3,984,464	523,759

Community	Population	Mammals	Fish	Fowl	Berry/Green/Veg.	Total
Buckland	104	157,270	7,345	8,200	5,413	178,226
Deering	60	21,765	2,794	1,195	1,174	26,928
Kivalina	190	176,428	83,213	1,688	2,582	263,911
Noatak	293	214,620	100,288	1,010	4,420	320,338
Kotzebue	1,696	939,368	123,360	2,463	16,782	1,081,973
Selawik	450	344,001	380,367	3,170	16,926	744,464
Noorvik	462	282,551	283,091	1,947	24,259	591,848
Kiana	300	176,540	177,025	1,219	15,040	369,824
Ambler	195	411,313	91,200	3,885	23,065	529,463
Kobuk	60	33,620	44,251	9,550	7,656	95,077
Shungnak	165	135,499	143,115	12,690	14,867	306,171
Total population	3,975					
Total lb		2,892,975	1,436,047	47,017	132,184	4,508,223

Source: Patterson 1974.

* Includes food used for human and dog consumption, unless otherwise specified.

Table 22. Subsistence Harvest of Mammals in Numbers of Animals and Pounds, Kotzebue Sound Communities, 1972

	NANA Region		Buckland	Deering	Kivalina	Noatak	Kotzebue	Selawik	Noorvik	Kiana	Ambler	Kobuk	Shungkak
Resources	No.	Pounds	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Black bear	106	15,900						18	22	14	20	5	27
Brown & grizzly bear	80	18,000	5	2		4		12	16	10	10		21
Polar bear	1	450			1								
Beaver	1,084	16,260	10					600	35	22	400		17
Caribou	14,219	2,132,850	150	6	513	1,214	5,000	1,887	1,381	863	2,500	180	525
Coyote	---	---											
Deer (reindeer)	(608)	(76,000)	(450)	(36)					(75)	(47)			
Fox (arctic)	42	*	5	6	13		18						
Fox (red)	349	*	28	15	6	20	50	80	33	20	40	15	42
Goat	---	---											
Hare (arctic & snow)	5,079	15,237	205			150	350	485	1,272	795	500	200	1,122
Land otter	215	*				10	1	100	27	17	30		30
Lynx	95	*	2		6	6		5	28	18	10		20
Marmot	53	636						28	4	3	10		8
Marten	18	*									15	1	2
Mink	331	*	40				3	75	82	51	20		60
Moose	317	221,900	15	8		20	60	42	47	29	30	7	59
Muskrat	11,988	23,976	150	25	9	1,100	350	2,000	4,446	2,779	50	100	979
Porcupine	204	2,040	8	2		27	10		45	28	30	17	37
Sheep (Dall)	42	4,200				1	13		1	1	20		6
Squirrel (tree)	30	15							6	4	6		14
Squirrel (ground)	191	191		25	10		18		47	29	40		22
Weasel	105	*		2			3	25	32	20	10	3	10
Wolverine	256	*	15	9	9	9	12	100	26	16	20	8	32
Wolf	201	*	20	5	3	7	29	20	23	14	30	10	40
Seal (bearded)	533	213,200	80	20	125	12	260	15	13	8			
Seal (hair)	909	72,720	150	24	500	10	90	7	79	49			
Seal lion	---	---											
Walrus	9	9,000			3	3	3						
Whale (belukha)	244	146,400	130	8	10	10	50	8	17	11			
Whale (bowhead)	---	(2,744)					(2,144)	(200)	(400)				
Total (lb, dressed weight)		2,892,975	157,270	21,765	176,428	214,620	939,368	344,001	282,551	176,540	411,313	33,620	135,499

Source: Patterson 1974.

--- means no data were available.

* Furbearers: not used for human consumption.

() Reindeer/bowhead whale: generally purchased, some barter/trade.

Note: The inventory data were obtained in 1972 from a survey of individual households in each village by NANA representatives. The estimates are an annual average over a period of years.

Table 23. Subsistence Harvest of Fish and Birds in Numbers of Animals and Pounds, Kotzebue Sound Communities, 1972

Resources	NANA Region Pounds	Buckland Pounds	Deering Pounds	Kivalina Pounds	Noatak Pounds	Kotzebue Pounds	Selawik Pounds	Noovik Pounds	Kiana Pounds	Ambler Pounds	Kobuk Pounds	Shungnak Pounds
Arctic cod	1,200			1,200								
Blackfish	1,965							640	400	200		725
Burbot	---											
Char/pike	143,312	150	25			337	65,126	28,415	17,759	29,000	1,000	1,500
Flounder	38					30	8					
Grayling	4,544	10		1,200	100	250	700	975	609	300	100	300
Halibut	---											
Herring	2,550					2,500	50					
Ling cod	50		50									
Needlefish	---											
Coho/silver	1,550		1,500									
Chum/dog	209,090	400	1,000	600	52,698	1,146	700	90,475	56,547	2,000	1,399	2,125
Pink/humpy	10,069	180	200			50		5,670	3,544	200	50	175
Chinook/king	701					100		370	231			
Sockeye/red	---											
Shark (mud)	22,253	500			100	265	980	10,097	6,311	4,000		
Sheefish	447,092					138,300	85,079	75,085	46,928	30,500	9,200	62,000
Sucker	5,211							1,668	1,043	1,000	300	1,200
Smelt	39,375	7,000				840	63	17,655	11,034		783	2,000
Tomcod	8,200		200			8,000						
Trout	209,921	50	250	95,950	73,200	10,000	100	18,001	11,250	500	370	250
Whitefish (shortnose)	322,672	1,500	500	12,000	200	2,647	98,000	61,400	38,500	25,800	20,000	62,125
Whitefish (longnose)	276,155				7,320		76,350	59,794	37,371	25,100	20,000	50,220
Whitefish (small)	208,816				100		180,000	7,210	4,506	3,000	5,800	8,200
Clam/crab/shrimp	15					15						
Totals (lb, live weights)	1,914,729	9,790	3,725	110,950	133,718	164,480	507,156	377,455	236,033	121,600	59,002	190,820

	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Auk/Murre/Puffin	220	200		20	200								
Crane	37	555		10			2	4			5		16
Ducks	17,716	17,716	3,000	500	400	500	554	2,000	637	400	1,000	2,500	6,225
Geese	3,650	14,600	700	100		50		100			500	1,000	1,200
Swan	---	---											
Ptarmigan	11,726	11,726	2,400	120		300	1,819	600	1,023	639	700	3,000	1,125
Spruce hen/grouse	362	362		5		10	12	50	77	48	50	50	60
White (snowy) owl	223	1,338			98		8	10	35	22	10		40
Harvest eggs	(3,000)	500			(3,000)								
Totals (lb, dressed weights)		47,017	8,200	1,195	1,688	1,010	2,463	3,170	1,947	1,219	3,885	9,550	12,690

Source: Patterson 1974.

--- means no data were available.

Table 24. Subsistence Harvest of Plant Resources in Pounds, Kotzebue Sound Communities, 1972

Resources	NANA Region	Buckland	Deering	Kivalina	Noatak	Kotzebue	Selawik	Noorvik	Kiana	Ambler	Kobuk	Shungnak
Berries												
Blueberries	37,650	1,400	300	90	3,600	3,262	5,873	6,763	4,200	4,500	2,000	5,662
Blackberries	19,452		200	1,200	60	7,175	587	2,445	1,530	3,100	600	2,555
Cranberries	19,768		50	60		1,571	1,007	2,920	1,825	7,000	2,579	2,756
Crowberries	112	100						12				
Currants	310							190	120			
Gooseberries	50							50				
Salmonberries	20,765	2,550	500	130	200	2,857	6,348	4,506	2,820	30	374	450
Strawberries	684	35					256	168	105			120
Totals, berries	98,791	4,085	1,050	1,480	3,860	14,865	14,071	17,054	10,600	14,630	5,553	11,543
Greens/roots												
Fireweed	306	25				18		103	70			90
Grass roots	1,164		20			19	40	485	300			300
Rose hips	96					5	28	63				
Sourdock	7,818	350	50		360	1,625	890	2,725	1,700	50		68
Tundra/Alaska tea	95	5					28	20		10		32
Willow leaves	765	115	10	12		99	64	220	140	100		5
Wild roots	235					25		100	60	50		
Sudikroak	72					18	29			25		
Tinnik	1,270						70	370	230	100		500
Tree gum	38						15	17				6
Totals, greens/roots	11,859	495	80	12	360	1,809	1,164	4,103	2,500	335		1,001
Vegetables (wild)												
Celery	631	8	4	10		1	346	162	100			
Eskimo potato (musse)	6,768	10		300	200	88	85	1,405	880	1,500	1,100	1,200
Mushroom	61						60					1
Onions	821	15				6		115	70	600	3	12
Rhubarb	12,473	800	40			13	1,200	1,420	890	6,000	1,000	1,110
Spinach	780			780								
Totals, vegetables	21,534	833	44	1,090	200	108	1,692	3,102	1,940	8,100	2,103	2,323
Grand totals	132,184	5,413	1,174	2,582	4,420	16,782	16,926	24,259	15,040	23,065	7,656	14,867

Source: Patterson 1974.

The inventory data were obtained in 1972 from a survey of individual households in each village by NANA representatives. The estimates are an annual average over a period of years.

composition of harvest for Kivalina (Burch 1984c). Care should be taken in interpreting these tables inasmuch as conversion factors used to calculate food weight are provisional.

Overall harvest level of fish and game in Kivalina, based on usable food weight, is approximately the same in the 1982 to 1983 and 1983 to 1984 time periods as it was in 1965 to 1966 (table 13). A great deal of the harvest in the earlier time period, however, went to feed working dog teams. Although less subsistence food goes to dogs in the 1982 to 1984 time periods, more food is needed to support the increased population of Kivalina.

Per capita food consumed appears to have increased slightly from 665 lb per person, or 1.8 lb per person per day, in 1965 to 1966 to about 800 lb per person, or about 2.2 lb per person per day in the later time periods. These data suggest a remarkable consistence in use of subsistence foods over a 20-year time period. Overall harvest levels reported are consistent with those reported above and for other subsistence areas of Alaska (KANA 1983, Wolfe 1981). Differences in estimated harvest levels between Patterson (1974) and Burch (1984c) may reflect different methods of computing food weight from harvest number rather than any substantive change.

Composition of harvest, however, exhibits considerable variability over the four time periods for which estimates are available (table 14). Belukha accounted for less than 1% of harvest in the 1964 to 1966 time period; in the 1982 to 1984 time period, belukha accounted for about 6% of all subsistence fish and wildlife. Caribou harvest has fluctuated wildly from a low of 30,785 lb in 1964 to 1965 to a high of 129,006 lb in 1965 to 1966. Data for 1983 to 1984 are intermediate at 70,378 lb of caribou. The 1982 to 1983 time period was particularly good for walrus harvesting, with about 60,000 lb or about 22% of total subsistence harvest being taken. Kivalina was successful in bowhead hunting in 1983 to 1984 and harvested about 66,000 lb of meat, muktuk, and blubber, accounting for about 23% of the total year's subsistence harvest.

Often, some subsistence resources are harvested in quantity only when other resources are unavailable. These "starvation" resources provide some protection against severe food shortages. In Kotzebue Sound communities with access to tundra lakes, Alaska blackfish are a resource in this category and may be harvested in quantity when other fish and wildlife are scarce. Burbot (Lota lota) for riparian communities, ringed seals for coastal communities, and snowshoe and arctic hares, in years when they are abundant, are other resources in this category.

2. Seasonal round of resource use. Figures 1, 2, 3, 4, 5, 6, and 7 present the seasonal round of key subsistence harvesting activities for 7 of the 11 communities in the Kotzebue Sound subregion (from Anderson et al. 1977, Braund and Burnham 1983, Uhl and Uhl 1979). Although seasonal round data have not been systematically collected for Buckland, Deering, Kotzebue, and Selawik, seasonal rounds for these communities are believed to be similar to those of nearby communities. Seasonal rounds for Buckland would show greater emphasis on belukha, other sea mammals, caribou, and moose. Deering would probably show greater emphasis on moose, belukha, and other sea mammals. Depending on the size and migration pattern of the western arctic caribou herd, Buckland's and Deering's caribou hunting may be limited in some years, compared to other communities' harvest (Schroeder 1985, Stern 1985). The seasonal rounds for Kotzebue would resemble those of Noorvik and Kiana, with more emphasis on sea mammal harvesting. Seasonal round for Selawik would be similar to that of Noorvik, with greater harvest of sheefish (Schroeder 1985).

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North Slope Subregion

I. LOCATION AND ENVIRONMENT

The North Slope subregion is an area of approximately 81,000 mi^2 bounded by the Beaufort Sea to the north and the crest of the Brooks Range to the south. East to west, the subregion extends more than 600 mi from the Canadian border to Point Hope. Notable geographic features include the wide arctic coastal plain--a treeless, generally low, flat expanse of wet tundra dotted with thousands of lakes. Far inland, the coastal plain rises to form the northern foothills of the Brooks Range. The Brooks Range rises relatively abruptly in the eastern and central portions to peaks of 6,000-7,000 ft and more gradually in the west to elevations of 3,000-4,000 ft. Maps 1 and 2 depict the location and boundaries of the North Slope subregion.

This subregion includes all rivers draining the north face of the Brooks Range into the Beaufort and Chukchi seas. The Colville River and its many tributaries form the largest watershed on the North Slope. Rivers generally terminate in coastal deltas. A discontinuous chain of barrier islands and spits parallels the coastline, forming shallow coastal lagoons in many locations.

The subregion boundaries include all of Game Management Unit (GMU) 26 and a portion of GMU 23 in the vicinity of Point Hope. North Slope communities today include the villages of Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright, as well as the industrial settlement of Prudhoe Bay/Deadhorse and several pump stations and work camps along the North Slope portion of the Dalton Highway. Umiat and Colville village are small, permanently inhabited industrial and private sites located on the middle and lower Colville River, respectively (map 2).

The entire subregion lies well above the Arctic Circle, extending to 70°23' north latitude at Point Barrow. The majority of the area falls within the arctic climatic zone characterized by low monthly temperature averages, frequent winds, and low precipitation. A small portion of the subregion between Point Hope and Cape Lisburne lies outside the arctic climatic zone and is classified as having a more mild continental climate (Selkregg 1976). The Chukchi and Beaufort seas remain ice-covered for up to nine months, restricting ocean travel to an ice-free period generally between late July and early October. The nearly constantly frozen condition of the Beaufort Sea acts to cancel the moderate, wet coastal conditions that occur in lower latitudes. The high latitudes also create exaggerated periods of seasonal light and darkness. Barrow, for example, experiences a 118-day period of continuous daylight in the summer and a 67-day period without direct sunlight in the winter.

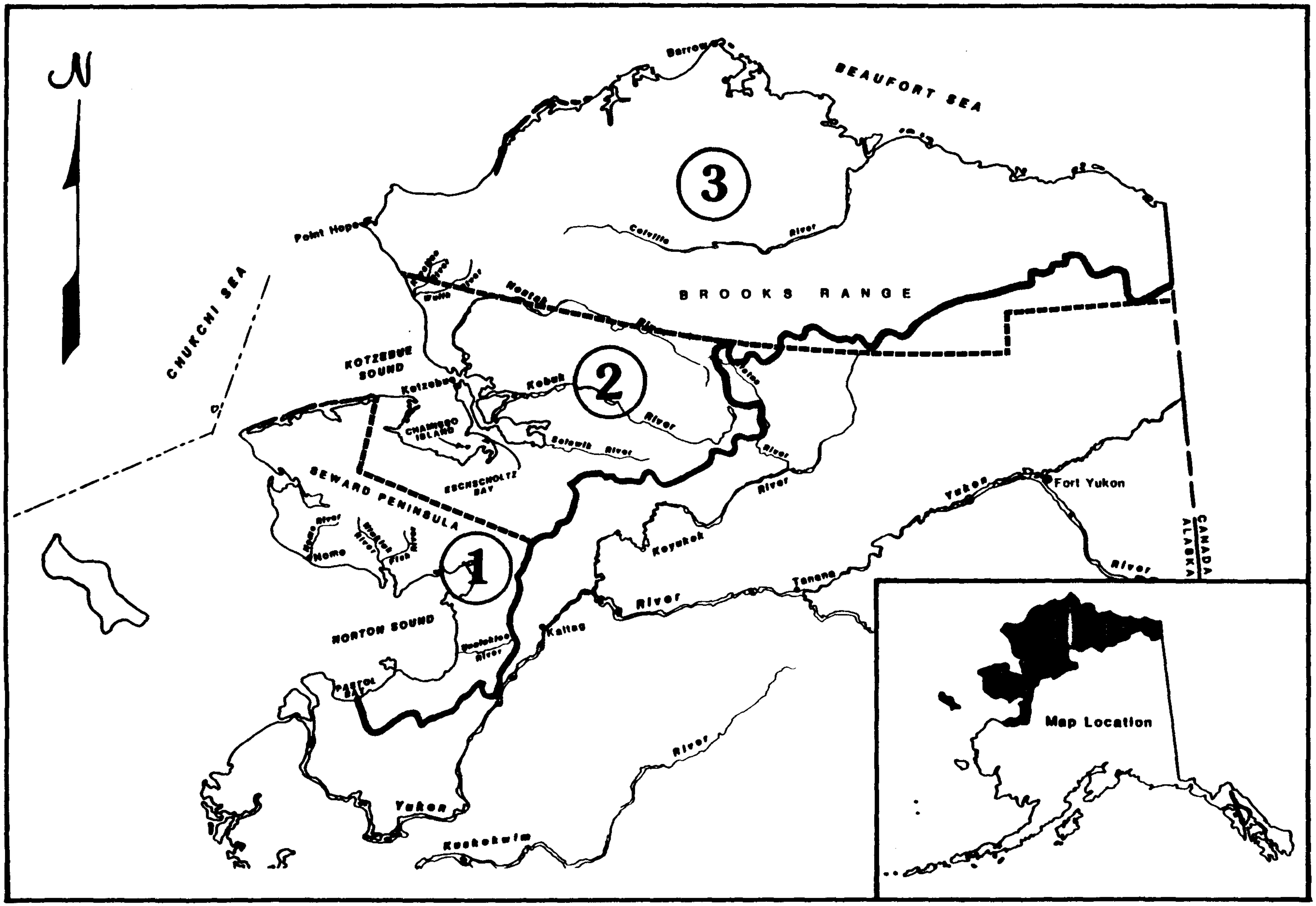
North Slope marine and terrestrial habitats support a variety of resident and seasonally migrant wildlife upon which past and present human inhabitants have relied for subsistence. Resources of particular importance from a subsistence standpoint are mentioned below. Readers are directed to life history accounts elsewhere in the guide for more information on selected North Slope species.

Among the terrestrial mamamls, caribou are perhaps the most important to North Slope subsistence users. Caribou in the Western Arctic and Porcupine herds typically calve on the North Slope. Elements of both herds make long seasonal migrations out of the subregion. The smaller Central Arctic and Teshekpuk Lake herds are more sedentary and remain much closer to their calving grounds. Moose are presently year-round residents near drainages with good willow growth. Moose have occurred in substantial numbers north of the Brooks Range only since the late 1800's, with resident breeding populations becoming established during the 1920's in the eastern North Slope and as recently as the 1960's in the western portion of the subregion (Coady 1980). Other large terrestrial mammals are the brown bear, Dall sheep, and muskox. Furbearers include river otter, arctic fox, red fox, wolf, wolverine, and lynx. Small mammals used for subsistence include arctic ground squirrel, hoary marmot, weasel, porcupine, and arctic hare. None of these terrestrial species is ubiquitous. They occur in regional or seasonal concentrations in favored tundra, foothill, riparian, or mountain habitats.

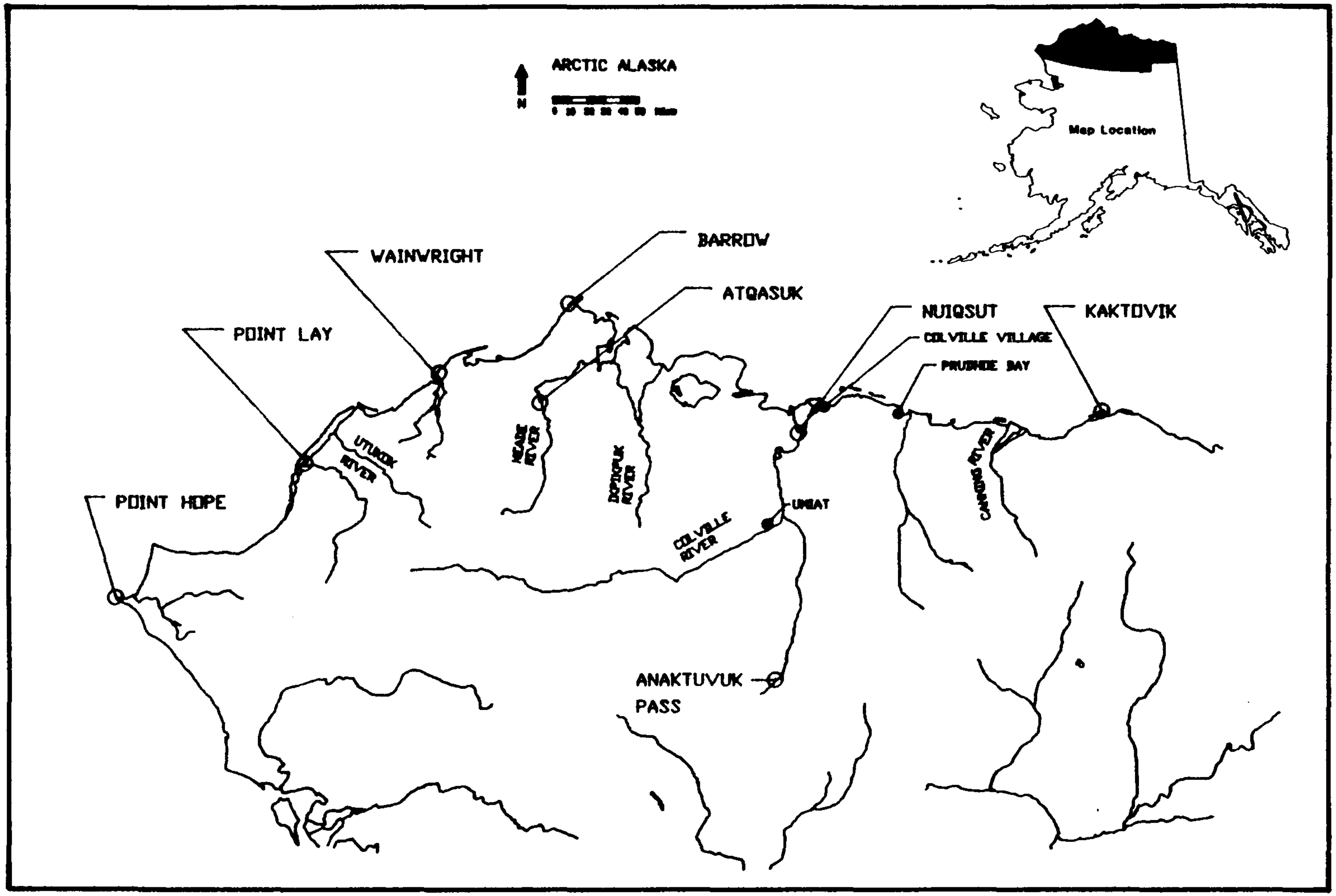
Marine mammals of the Beaufort and Chukchi seas include belukha, bowhead, and gray whales, polar bear, bearded seal, harbor seal, and ringed seal. Pacific walruses frequent the Chukchi coast as far north as Barrow and occasionally migrate into the Beaufort Sea.

Marine fish include arctic cod, chum salmon, pink salmon, and smelt. Arctic char, arctic grayling, burbot, lake trout, northern pike, and whitefish inhabit North Slope lakes and rivers.

Ptarmigan and raven are resident avian species. Vast areas of tundra marsh, coastal wetlands, and estuaries provide summer breeding habitat for millions of migratory birds. Gulls, sea birds, shorebirds, and waterfowl are seasonally abundant across the arctic coastal plain.



Map 1. The Arctic Region and its three subregions: 1 - Bering Strait/Norton Sound; 2 - Kotzebue Sound; and 3 - North Slope.



Map 2. The North Slope subregion and the communities discussed in this narrative.

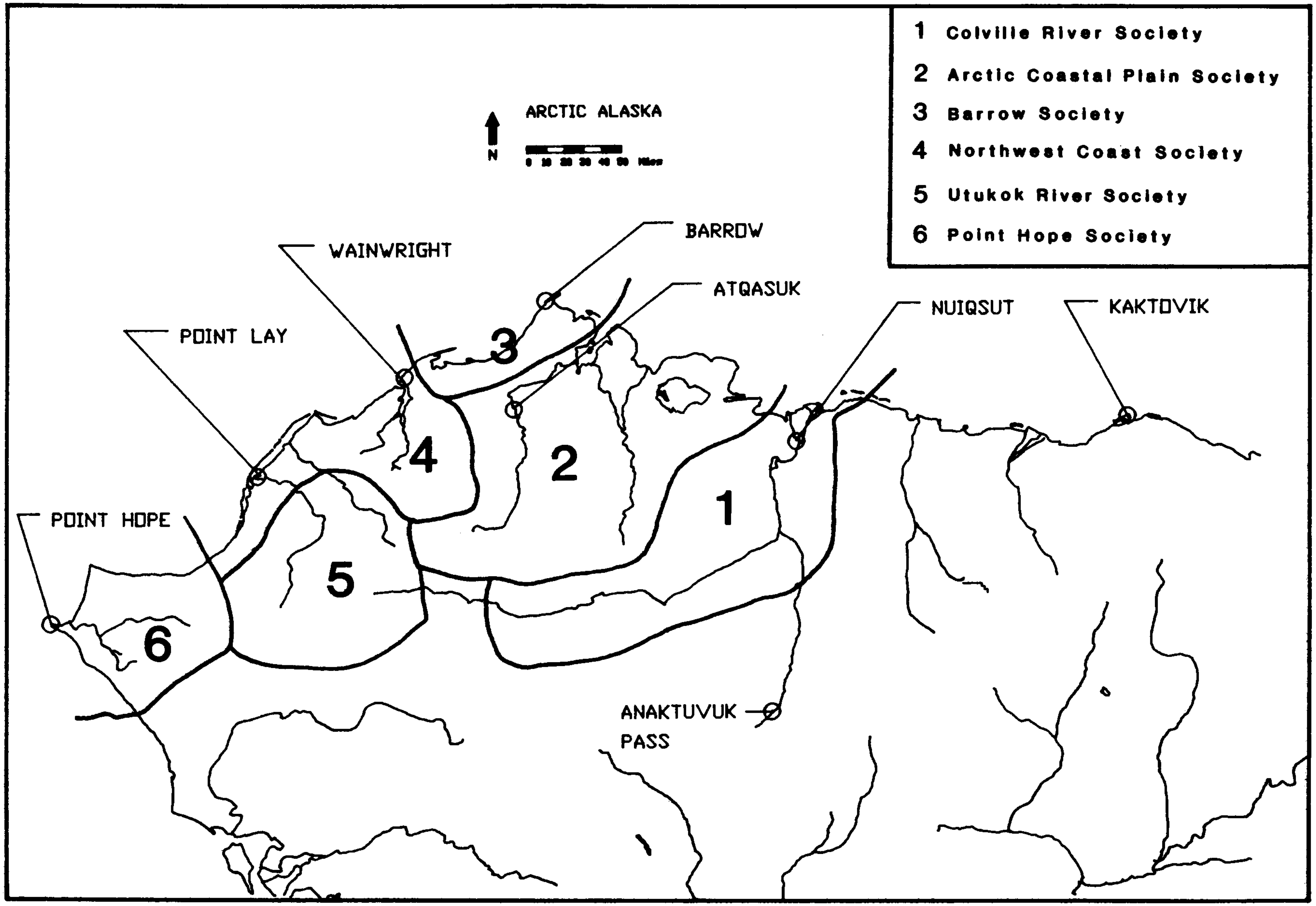
II. HISTORY AND PATTERNS OF HUMAN ACTIVITY

A. Original Habitation of the Subregion

Archaeological evidence suggests that ancestors of Alaska's present-day Eskimo population entered Alaska some 10,000 years ago via the Bering land bridge, the last of several human migrations into Alaska, dating back perhaps 40,000 years. These paleo-Eskimos were primarily caribou hunters living most of the year in inland forest areas, taking advantage of available marine mammal resources along the coast during the short summer months (Oswalt 1967). Between A.D. 600 and A.D. 900, specialization began to take place among the paleo-Eskimos. Some groups took up permanent residence along the coast, exploiting large and small marine mammals as well as terrestrial resources, while other groups continued an inland focus on caribou combined with annual expeditions to coastal areas. By A.D. 1400, modern Eskimo culture had taken form in Alaska (ibid.). Multiple Eskimo groups or societies evolved that were based on regionally specialized hunting activities within a cooperative social network. Immediately prior to the contact era around 1800, North Slope Eskimos were occupying and utilizing the coastal area between Point Hope and the Colville River as well as the inland area of the western and central Brooks Range (Burch 1980). Alaska's eastern North Slope, at that time had no winter settlements but was used seasonally for subsistence activities by Inupiat from west of the Colville River and by Kutchin Athabaskans from the eastern Brooks Range (Burch 1980, Hadleigh-west 1959, Hall 1975).

B. Settlement and Subsistence Patterns Prior to 1850

Prior to 1850, North Alaska Inupiat were organized into 25 territorial societies located between Norton Sound and the Colville River (Burch 1980). Six of these societies fall within the area defined here as the North Slope (map 3). These societies were autonomous, socioterritorial units. Extended local family units representing three or four generations form the basic units of each society (ibid.). Each local family occupied two or more dwellings, which constituted a settlement. Larger settlements were commonly composed of two or more local families occupying dwellings built in separate clusters. Settlement size was a function of the productivity of the territory exploited. A few favorable locations were capable of supporting large human concentrations on a permanent basis. Large whaling centers were established at Point Hope, Icy Cape, and Point Barrow to take advantage of ice and lead conditions favorable for whaling.



Map 3. North Slope Eskimo society territories, ca. 1840 (Burch 1980).

Food storage and seasonal mobility characterized the pre-1850's subsistence pattern:

> All of the major faunal resource species that occur in Northwest Alaska -- mammals, fish, birds -- are seasonally nomadic. This condition poses a critical problem for the humans who subsist on them: either they must move about too, or else they must overharvest during periods of abundance and store the surplus for leaner seasons, or both. The universal pattern in early nineteenth century Northwest Alaska was to do both (ibid.).

Some societies were oriented more toward marine or terrestrial resources relative to others (Burch 1976, Larsen 1973, Spencer 1959). In addition, no two societies shared exactly the same annual cycle of subsistence activities or dependence on specific resources. Subsistence strategies at the societal and local family level were aimed at effective use of virtually all local plant and animal resources (Burch 1980). Annual cycles had to be flexible enough to adjust to natural fluctuations in species abundance.

Trade took place between local family units on a more or less continuous basis. Between societies, trade occurred at annual trade fairs held at traditional locations such as Nirliq on the Colville River delta and Sisualik on Kotzebue Sound. Ventures across territorial boundaries for trade and subsistence activities were common (ibid.). The picture that emerges of subsistence prior to 1850 is one of a structured yet remarkably flexible pattern whereby local family units variously exploited portions of their societal territory across a coastal-inland continuum. Generalized seasonal rounds for the six traditional North Slope societies are presented in section VI. A.

C. The Historic Period After 1850

Arctic Alaska remained relatively isolated from the acculturative influences of Russian occupation felt along Alaska's southern coast during the eighteenth and nineteenth centuries. European explorers in search of the northwest passage made contact with Eskimos along Alaska's arctic coast in 1826. These early contacts were brief and sporadic and had little impact on the Eskimo culture. Burch (1975) regards 1850 as the end of this period of relative isolation. The disappearance of John Franklin's third arctic expedition in 1845 touched off a decade of intensive search and exploration during which western Eskimo contact with Euro-americans became more prolonged and commonplace. The British ship Plover, in search of Franklin, wintered over for two years near Barrow, from 1852 to 1854. About this same time, commercial whalers operating in arctic waters ushered in an era of great change to the Inupiat.

1. Commercial whaling. In 1848, the whaling ship Superior negotiated the Bering Strait, opening arctic waters to commercial whaling. Early whaling vessels were powered by sail and generally restricted to Chukchi Sea waters off northwest Alaska and Siberia. With the advent of steam-powered vessels and their inherent greater mobility, the whaling trade expanded into the Beaufort Sea. By 1889, ships began to winter over at Herschel Island and in the MacKenzie River delta area. During the winter of 1894-1895, 15 ships and more than 600 whalers wintered over in arctic waters. Between 1889 and 1909, more than 68 ships wintered at Herschel Island (Bockstoce 1977). By 1910, market prices collapsed for baleen and whale oil, bringing an abrupt end to commercial whaling in the western arctic.

   Sixty-five years of trade and contact between Euroamerican whalers and traders and Eskimos had left its mark on the Inupiat. Imported diseases such as measles, whooping cough, influenza, and tuberculosis took a steady toll of lives. Barrow's 1828 population of 1,000 was reduced to 152 by 1890, and the population of Point Hope during the same period declined from around 1,200 to 350 (Burch 1981, Selkregg 1976, USDC 1981). Inupiat who survived the epidemics found themselves in direct competition with a "resident" whaling fleet for food resources. As early as 1852, Point Hope Eskimos noted a reduction in the number of bowhead whales available to them, a trend which continued over the next several decades (Burch 1981). An estimated 18,000 bowhead whales were harvested by commercial whalers in the western arctic between 1848 and 1914 (Bockstoce and Botkin 1980). By 1870, whale populations were so low that whaling ships operating in the Chukchi Sea turned to the walrus as an alternate source of oil. An estimated 140,000 walruses were harvested during the 65-year life span of the whaling industry in northwest Alaska (Bockstoce and Botkin 1982). Thus, the commercial harvest of walrus contributed to the decline of another major Inupiat food source (Burch 1981).

   Toward the end of the nineteenth century, caribou were also in decline in northwest Alaska. Although their decline is not directly attributable to the whaling industry, it coincides with the depletion of other resources decribed above and compounded the problems of the North Slope Inupiat. By 1910, caribou populations on the arctic coast west of the Colville River were very low (Skoog 1968). Human harvest combined with natural fluctuations and a general eastward shift in the caribou population probably all contributed to this dramatic decrease in the availability of caribou (Skoog 1968, Amsden 1977, Burch 1975). This decline became the impetus behind the establishment of commercial reindeer herds throughout western Alaska.

2. The reindeer industry. Reindeer herding was introduced to northwest Alaska in the 1890's by missionary groups and federal agencies as a solution to hardships caused by declining wild resources. Although the Seward Peninsula was to become the focal point of the reindeer industry, herds were established throughout western Alaska. Herds were established at Barrow, Icy Cape, Wainwright, and Point Hope between 1890 and 1909 and remained until around 1950 (Stern et al. 1980). Although reindeer herds benefited a few local families, the industry was plagued by problems and did not prove to be the boon to the village economy it was intended to have been. A more thorough account of the reindeer industry is presented in the narrative on the Bering Strait/Norton Sound subregion found elsewhere in this volume.

3. Other postwhaling developments. By the end of the commercial whaling era around 1910, the Inupiat way of life on the North Slope had been severely disrupted by sudden and prolonged contact with western culture (Burch 1980). The introduction of disease and alcohol, together with the depletion of wild food resources, caused shifts in the population and disruptions of families, bands, and social relationships. These difficult times continued into the twentieth century. From 1900 through the 1930's, traditional territories, especially among the inland Eskimo, were depopulated. Settlements developed around coastal whaling stations, trading posts, missions, and schools (Selkregg 1976, Spearman et al. 1982). Firearms and other trade goods created an increased Inupiat need for cash for purchasing ammunition and other new necessities. During the 1920's, high fur prices briefly induced many Inupiat into commercial fox trapping along the arctic coast. Fur prices dropped during the 1930's, ending most trapping efforts on the North Slope.

   Geologic exploration began on the North Slope in the early 1900's. The promise of large oil reserves beneath the arctic coastal plain prompted the establishment of Naval Petroleum Reserve No. 4 by federal action in 1923. Continued oil exploration activities and a growing scientific interest in all aspects of the arctic environment led to construction of the Naval Arctic Research Laboratory (NARL) at Barrow in 1947. Besides representing a federal commitment to arctic research that was to span more than three decades, NARL represented local employment opportunities in construction and facility maintenance. During World War II and the Korean War, the strategic importance of Arctic Alaska was recognized. Petroleum exploration activities and the construction of numerous Distant Early Warning (DEW Line) stations by the military along the arctic coast during the late 1940's and 1950's provided additional wage labor opportunities to supplement the subsistence activities of the Inupiat.

Statehood in 1959 and the discovery of commercial oil deposits at Prudhoe Bay in 1968 brought to light new questions surrounding Native rights and land claims. Native rights organizations were bound to deal with the changing cultural, political, and economic issues surrounding land claims. In 1971, the Alaska Native Claims Settlement Act (ANCSA) was passed. In 1972, the North Slope Borough was established as the home rule governing body on the North Slope.
Petroleum exploration and development at Prudhoe Bay have brought significant changes to arctic Alaska and the North Slope Inupiat through road and pipeline construction activity and the establishment of a permanent settlement at Prudhoe Bay. Oil development activities have provided wage employment opportunities for North Slope residents as well as unprecedented Borough tax revenues to finance needed community improvements. The assessment of the environmental and socioeconomic consequences of arctic oil development is not yet complete.

D. Contemporary Communities

Today, eight predominantly Native communities make up the resident population of the North Slope: Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright. The locations of these contemporary communities were at least seasonally occupied in prehistoric times as communities, camps, or trading sites. Some of these communities, such as Barrow and Point Hope, have been more or less permanently occupied for thousands of years. Others, such as Kaktovik, represent historic sites that have been given a new permanence and community status by the establishment of some sort of facility that attracted settlers. Atqasuk and Nuiqsut are new communities recently reestablished at historic sites by Inupiat seeking to reestablish traditional ties to the land.

Point Hope is the westernmost extension of North America into the Chukchi Sea. Warm ocean currents flowing north from the Bering Sea mix with arctic waters at this location, resulting in an assortment of marine life that is unusually rich for the arctic

(Alaska Consultants, Inc. 1983). Archeological evidence suggests that Point Hope may be one of the longest continually occupied sites in the arctic (Selkregg 1976.) An estimated 1,000 Inupiat lived in the vicinity of Point Hope at the time of contact around 1820 (Burch 1981). A commercial whaling station was built at Point Hope in 1887, followed by a mission in 1890 and a government school in 1920. Point Hope was incorporated as a second class city in 1972.

Point Lay, 188 mi southwest of Barrow, was formed by the consolidation of numerous small Inupiat settlements between Cape Lisburne and Icy Cape following the establishment of a school there in 1930. A DEW Line facility was constructed at Point Lay in the late 1950's. Although DEW Line construction provided some employment opportunities, more jobs and better community facilities were available at Point Hope and Barrow, and Point Lay's population slowly declined. Following a period of population out-migration between 1950 and 1970, families began to move back to Point Lay in the early 1970's. The school was reopened in 1971. Threatened by tidal erosion, the village was relocated to its present location in 1981. Housing and public facilities have recently been expanded.

The community of Wainwright represents the consolidation of several Inupiat groups that traditionally occupied the coastal and inland areas between the Utukok and Kuk rivers (Ivie and Schneider 1978). A school and reindeer-herding station built near the mouth of the Kuk river in 1904 established the community of Wainwright at its present location approximately 90 mi southwest of Barrow. Reindeer herding remained an important economic activity throughout the 1930's. Wainwright-based reindeer herds totaled more than 22,000 animals in 1934 (ibid.). A DEW Line station was constructed in 1950 at a location 5 mi inland from Wainwright. Wainwright was incorporated as a second class city in 1971.

The present-day site of Barrow, known locally as Utigiagvik, probably has been continuously occupied for about 1,300 years and intermittently occupied by paleo-Eskimos for over 5,000 years (Schneider et al. 1980). Its unique geographic location provided subsistence hunters access to both the Beaufort and Chukchi seas. As a permanent settlement and northernmost landfall, it also attracted the attention of explorers and whaling ships. Barrow became a major port of call for ships operating in arctic waters. Forty houses and 250 people were counted at Barrow in 1852-1853 (Alaska Consultants, Inc. 1983). In 1881, a government meteorological station was built at Barrow, which later became a commercial whaling station. Another whaling station, mission, and school were established at Barrow just prior to 1900 (Brower 1960). The end of the whaling industry around 1910 brought a decline in population and commercial whaling activity at Barrow.

The next major change for Barrow occurred in the late 1940's as oil exploration activities, the construction of NARL, and a DEW Line installation created unprecedented wage employment opportunities. Barrow has grown steadily since 1950, adding local businesses, Native corporation, state, and federal offices, as well as improved community facilities during the 1960's and the 1970's. Barrow was incorporated in 1974 as the North Slope's only first class city.

Atqasuk, 60 mi south of Barrow, and Nuiqsut, 160 mi southeast of Barrow on the lower Colville River are relatively new communities established at traditional Inupiat land use sites. Atqasuk lies along the Meade River near the sites of old Atqasook and Tigaluk, traditional camp sites for Inupiat hunting, fishing, and trapping in the Meade River region. A commercial coal mine operated at Tigaluk from the mid 1940's to 1960 employing some local residents (Alaska Consultants, Inc. 1983). The present community of Atqasuk was established in the early 1970's by a handful of Barrow families wishing to renew family and cultural ties to the Meade River area. Resettlement was encouraged and sponsored by village and regional corporations established under the 1971 ANCSA and the North Slope Borough. Atqasuk was incorporated as a second class city in 1982.

In April of 1973, 27 Barrow families resettled near the traditional Inupiat trading site of Nirliq on the Colville River delta. The new settlement was called Nuiqsut. Like the resettlement of Atqasuk, the settlers wished to reestablish cultural ties with the land at Nuiqsut. The establishment of Nuiqsut was encouraged by the Arctic Slope Regional Corporation, which initially funded new housing for residents. Nuiqsut was incorporated as a second class city in 1975.

Anaktuvuk Pass is located in the central Brooks Range. The Anaktuvuk Pass area was part of a traditional inland Eskimo territory that was largely abandoned during the first decades of the twentieth century because of declines in the caribou population. As caribou numbers increased in the late 1930's and 1940's, people began to return to the Anaktuvuk Pass area to hunt. A trading post was established at Anaktuvuk Pass in 1949, followed by a post office in 1951, a church in 1958, and a school in 1961 (Alaska Consultants, Inc. 1983). Anaktuvuk Pass was incorporated as a fourth class city in 1959 and reclassified as a second class city in 1971.

Kaktovik, on Barter Island, is the easternmost settlement on the North Slope. Although this area lies outside the pre-1850 traditional territory of the Alaskan Inupiat outlined by Burch (1980), the Barter Island area was previously a place where Barrow and Colville River Eskimos met for trade with Canadian Eskimos from further east (Jacobson and Wentworth 1982). During the late nineteenth century, Barter Island became a frequent stop for commercial whalers operating in the Beaufort Sea. The decline in available subsistence resources throughout northwest Alaska discussed previously caused a general eastward drift of Northwest Eskimo groups into this area. A trading post was operated there from 1923 to 1938, providing a market for local trappers. Employment opportunities connected with the construction of a DEW Line facility at Barter Island in 1947 attracted Inupiat families from the surrounding area to settle at Kaktovik. A BIA school in 1951 attracted more people and firmly established the community. Kaktovik was incorporated as a second class city in 1971.

The largest oil field in North America was discovered at Prudhoe Bay in 1968. The size of the Prudhoe field and its distance from any major population center resulted in the development of the Prudhoe Bay/Deadhorse industrial settlement 8 mi inland from Prudhoe Bay near the Sagavanirktok River. At the height of field development and pipeline construction activities in 1976, the work force at Prudhoe Bay reached 5,500 workers, making it by far the largest settlement on the North Slope (CCC/HOK, Inc. 1978). As an industrial enclave managed and financed by private industry, the Prudhoe Bay settlement currently lacks the status, structure, and governing powers of a city. However, a small resident population and civic body have begun to develop there.

Umiat, on the middle Colville River, and Colville Village, on the Colville River delta, are small permanently inhabited sites with unofficial standing as organized North Slope communities. Umiat was established as an industrial service facility for oil, gas, and mineral exploration activities. Colville Village consists of several houses on privately owned land, occupied primarily by one extended family. This family is developing close economic and civic ties with the nearby industrial community at Prudhoe Bay.

III. POPULATION

The six traditional Eskimo societies on the North Slope numbered almost 3,000 ca. 1840 (Burch 1980) (table 1). United States census figures, 1890 to 1980, and recent North Slope Borough population estimates are presented in table 2. United States Census data for the North Slope prior to 1950 should be utilized cautiously. With the exception of population concentrations at Point Hope and Barrow, which were relatively well-documented, the North Slope Inupiat were seasonally and spatially dispersed along the coast and among nomadic inland bands. Observations of early census takers probably represent reasonable estimates of summer coastal concentrations of Inupiat but not of the total North Slope Inupiat population. Unknown numbers of Inupiat along the coast and especially inland undoubtedly were not counted.

Table 1. Population Estimates of Traditional North Slope Eskimo Societies, ca. 1840

Society	Estimated Population
Arctic coastal plain society	300
Barrow society	600
Colville River society	500
Northwest coast society	425
Point Hope society	900
Utukok River society	250
Total	2,975

Source: Burch 1980.

Given the questionable quality of census data for the North Slope at the turn of the century, the population devastation brought about by imported disease and starvation about that time is probably not accurately reflected. Large numbers of Inupiat and Yupik Eskimo throughout western Alaska died from measles and influenza around 1900 (Wolfe 1982). The movement of Eskimos out of the Brooks Range to coastal areas during the difficult years of the 1920's and 1930's was discussed previously. This movement is perhaps evidenced by the recording of populations at Cape Halkett and Beechey Point in 1930 and at Colville River in 1939 (table 2). By 1950, most contemporary North Slope communities had formed as Inupiat congregated at locations offering schools, trading posts, missions, medical facilities, and limited wage employment opportunities. Barrow grew from 391 in 1940 to 2,104 in 1970, becoming the largest Eskimo community in Alaska and the headquarters for Native corporations and borough, state, and federal offices on the North Slope.

The population of Barrow was 90% Alaska Native in 1970 and 78% in 1980. The populations of the seven remaining North Slope communities are all predominantly Inupiat, ranging from 87% Alaska Native in Nuiqsut to 94% Alaska Native in Anktuvuk Pass.

United States census figures do not include the Prudhoe Bay/Deadhorse work force. During peak oil field development and construction in 1976, the population numbered more than 5,000. The population dropped

Table 2. Population of North Slope Communities, 1890-1983

Community	1890	1900	1910	1920	1930	Year 1940	1950	1960	1970	1980	1983*
Anaktuvuk Pass	---	---	---	---	---	---	66	---	99	203	228
Atqasuk	---	---	---	---	---	---	---	---	---	107	231
Barrow	152	---	573	416	412	391	951	1,314	2,104	2,207	2,882
Kaktovik	---	---	---	---	---	---	46	---	123	165	203
Nuiqsut	---	---	---	---	---	---	---	---	---	208	324
Prudhoe Bay/Deadhorse	---	---	---	---	---	---	---	---	---	3,628*	7,016
Point Hope	301	623	243	141	139	257	264	324	386	464	570
Point Lay	77	---	---	---	---	117	75	---	---	68	126
Wainwright	72	---	---	99	197	341	227	253	315	405	483
Beechey Point	---	---	---	---	66	---	---	---	---	---	---
Cape Halkett	---	---	---	---	83	---	---	---	---	---	---
Colville River	---	---	---	---	---	86	---	---	---	---	---
Other-industrial	---	---	---	---	---	---	---	---	---	119*	---
Other-military	---	---	---	---	---	---	---	---	109*	222*	193

Source: *Maynard and Partch-Woodward Clyde Consultants 1984; Rollins 1978; USDC 1981.

--- means no data were available.

to around 1,800 with completion of the trans-Alaska pipeline in 1977 (USDC 1981). Subsequent expansion of oil field activities into offshore areas and the neighboring Kuparuk oil field have increased the resident work force over the last several years (table 2).

Some company policies prohibit Prudhoe Bay workers from participating in hunting and fishing activities on the North Slope. The use of firearms is prohibited by state law within the Dalton Highway corridor north of the Brooks Range and big game hunting is prohibited in the Prudhoe/Kuparuk industrial complex. Some fishing and hunting by industry employees does take place outside these restricted areas, but it is recreational in nature and will not be considered in this narrative.

IV. LAND STATUS

The North Slope land area consists of over 50 million acres. As elsewhere in the state, North Slope land status is a patchwork of land ownership. The federal government is the largest land owner in arctic Alaska, holding 23 million acres in the National Petroleum Reserve-Alaska alone (formerly Naval Petroleum Reserve No. 4), 7 million acres of the Arctic National Wildlife Refuge lying within the North Slope Borough, and 26,600 acres tied up in 16 separate military reserve sites along the arctic coast (Selkregg 1976). A portion of the Gates of the Arctic National Park also falls within the subregion. State lands consist of about 4.5 million acres concentrated in tracts surrounding Prudhoe Bay and along the Chukchi Sea coast and the Dalton Highway corridor. Native regional and village corporation land selections total over 12 million acres. A small remainder of North Slope land is divided among borough, private ownership, Native allotments, mining claims, and homesites.

V. THE MIXED SUBSISTENCE-CASH ECONOMY

By the twentieth century, North Slope Eskimos derived knowledge from two cultures that could be used to complement each other. The flexibility that had necessarily been built into their annual cycle to survive in the arctic also allowed them to weather the resource shortages, demographic changes, and changes in societal boundaries outlined above. New technology was used to improve upon traditional harvest methods. Participation in the cash economy was becoming necessary to obtain firearms, ammunition, steel traps, oil stoves, and western clothing. Until about 1940, forms of wage employment were usually commercial extensions of traditional activities such as reindeer herding, commercial whaling, market hunting, trapping, and expedition guiding (Sonnenfeld 1957). Wage labor in petroleum exploration and military base construction provided additional sources of income during the 1940's and 1950's. Employed Inupiat continued to be involved in subsistence activities as incomes were commonly reinvested into subsistence equipment. Subsistence whaling activity, for example, increased during the 1950's, as more people could afford to outfit boats and support whale crews (ibid.).

Inupiat involvement in wage employment in order to afford technological innovations that augment subsistence activities has continued into the contemporary period. This is illustrated by the introduction of the snowmachine in the 1960's. Acceptance of the snowmachine was swift. In Anaktuvuk Pass, for example, the number of snowmachines increased from one in 1964 to 16 in 1967 and to a complete replacement of dog teams by 1969 (Osburn 1974). Time spent at wage employment activities in order to afford snowmachines and gasoline was, for the most part, offset by the increased mobility a snowmachine offered and the liberation from year-round care and feeding of a dog team. The use of imported equipment has meant that a certain minimum level of income is now required to effectively participate, even part-time, in the occupation of hunting and fishing. Because of the increasing mechanization of subsistence equipment, this minimum level of cash involvement is rising (Francis 1969).

Oil development activities in the 1970's have, indirectly, greatly increased local employment opportunities on the North Slope. The North Slope Borough, which derives most of its income from taxing the oil industry, has become the largest employer of North Slope Inupiat. An estimated 80% of North Slope Inupiat employment is provided by borough government positions or capital improvement construction projects contracted by the borough (Kruse et al. 1983). Few Inupiat are directly employed by the oil industry at Prudhoe Bay.

Wages on the North Slope are among the highest in the state, and household incomes are correspondingly high (table 3). In 1980, personal income within the North Slope census district was 65% higher than the national average. This comparison, however, fails to consider the high cost of living on the North Slope, which is estimated at 213% of the national average (MMS 1983). Despite relatively high average household incomes, wage employment opportunities are not great enough to provide the sole economic base on the North Slope (Kruse 1982). Subsistence continues to play an important economic role, especially in the smaller communities where imported foods are prohibitively expensive and less available.

The relationship between wage employment and participation in subsistence activities among the Inupiat has been examined by Kruse (1982), using a household survey in North Slope communities. His data indicate that participation in wage employment has increased since 1970, especially among Inupiat women. Inupiat men prefer to follow a dual pattern of economic activity involving both subsistence and part-year

Table 3. Average Taxable Income for North Slope Communities* 1978, 1981, and 1982

Community	Average Taxable Income 1978	1980	1981
Anaktuvuk Pass	15,515	11,599	19,637
Atqasuk	11,588	18,417	24,871
Barrow	18,788	25,701	29,406
Kaktovik	20,876	24,842	23,442
Nuiqsut	13,092	22,734	19,866
Point Hope	15,551	18,891	25,904
Point Lay	12,812	25,900	20,893
Wainwright	17,337	18,027	21,719

Source: ADR 1985.

* Based on federal income tax returns sorted by zip code.

wage employment. Based on the experiences of Inupiat men who did pursue year-round work, it appears that Inupiat men would continue to find time to engage in subsistence activities even if a year-round pattern of employment became predominant. Wage earners carry out subsistence activities during time off, evenings, weekends, and vacations, and one of the major uses of increased incomes is to purchase subsistence equipment (Kruse et al. 1983). Many of the most active subsistence users also have relatively high incomes, indicating that the motivation for engaging in subsistence is not entirely economic. Social and cultural values are promoted through the serving of subsistence foods at home and at communal celebrations (Maynard and Partch-Woodward Clyde Consultants 1982). As in the past, kin-based groups form the basis for subsistence harvest activities and food-distribution networks. Subsistence foods are shared among families, throughout villages, and between villages (Wickersham and Flavin 1983). In this way, subsistence appears to play an important role in maintaining social ties and a sense of heritage during times of rapid social change (Kruse 1982).

Data presented in the next section suggest that per capita harvest of subsistence resources on the North Slope may be among the highest in the state. This, along with relatively high cash incomes, suggests that the mixed subsistence-cash economy of contemporary rural Alaska is perhaps epitemized by the North Slope example. Traditional Inupiat subsistence skills have undoubtedly been lost through reliance on imported and increasingly mechanized technology (Kruse 1982). Paradoxically, the extent to which the Inupiat will effectively participate in subsistence activities may depend on the continued availability of wage employment (ibid.).

VI. SUBSISTENCE USE OF FISH AND GAME RESOURCES

A. Historic Patterns of Resource Use, ca. 1840

1. Seasonal round of subsistence activities. Generalized annual cycles of the six traditional Eskimo societies on the North Slope were reconstructed (Burch 1980). The seasonal rounds pertain to the period ca. 1840, prior to the disruptive changes brought by commercial whaling and introduced diseases. The annual cycle of each society is summarized below.

   a. Arctic coastal plain society. These Eskimos wintered in settlements along the lower and middle Meade and Ikpikpuk rivers. Winter subsistence activities included caribou hunting and whitefish fishing. Preserved marine mammal products were consumed throughout the winter and spring. Spring was highlighted by participation in the Colville River trading fair at Nirliq. In late spring and summer, the population was dispersed along the Beaufort Sea Coast hunting seal and fishing at traditional locations. By fall, they traveled to the upper reaches of the Meade and Ikpikpuk rivers to hunt caribou and fish for whitefish prior to freeze-up, after which they returned to winter settlements.

   b. Barrow society. Primarily whalers, Barrow society Eskimos inhabited coastal settlements such as Nuvuk and Utqiagvik. Spring whaling was a main event, followed by participation in the trading fair at Nirliq and a gradual summer movement back to Point Barrow, fishing and seal hunting at traditional sites along the coast. A second whaling season occurred in the fall off Point Barrow as whales returned south. Winter subsistence activities included seal hunting and some caribou hunting. Stored whale meat and blubber were consumed throughout the winter.

c. Colville River society. Winter settlements were located at good fishing and caribou-hunting locations along the Colville River. A major event was the spring trading fair on the Colville delta, after which the population dispersed along the delta and Beaufort Sea coast to fish and hunt seal. A major caribou-hunting effort took place during the fall in the upper reaches of the Colville River. Following freeze-up, the population returned to winter settlements hunting caribou and small game and fishing throughout the winter.

d. Northwest coast society. Northwest coast Eskimos were distributed among several coastal settlements, including a large village at Icy Cape. In spring and summer, people dispersed along the Chukchi coast hunting seal and walrus. Inland hunting for caribou occurred in the fall, and fall fishing was important at some coastal locations such as Wainwright Inlet. Winter subsistence activities focused on seals.

e. Point Hope society. The Point Hope society was distributed among several coastal and Kukpuk River settlements. The largest village was Tigara at Point Hope, where spring whaling efforts were concentrated. As many as 20 whaling crews participated in whaling at Point Hope. Whaling also occurred at Cape Lisburne. After spring whaling, the population dispersed to attend the trade fair at Sisualik on Kotzebue Sound, for seal and walrus hunting along the coast, or for caribou hunting inland, returning to winter settlements by freeze-up. Inland settlements primarily fished and hunted caribou throughout the winter, whereas coastal settlements primarily hunted seal (see also Burch 1981).

f. Utukok River society. The Utukok River people were dispersed among several winter settlements located along the middle Utukok River. Winter subsistence activities concentrated on hunting caribou. Fishing and small game hunting were also important winter activities. Following breakup, they moved to the coast, spending the summer hunting marine mammals and waterfowl. In the fall, they moved back to inland settlements to resume caribou-hunting activities.

2. Species utilized. Though subsistence activities were focused on certain primary species, the Inupiat made use of virtually all local plant and animal resources for food and raw

materials. The wide diet breadth is illustrated by the subsistence resources used by Point Hope Eskimos (table 4). Resources used by the Barrow and Colville River Eskimos probably were similar but perhaps more restricted in species diversity. The relative importance of certain species varied from region to region and perhaps even from family to family. Settlements tended to specialize in particular subsistence activities or focus on particular locally abundant resources.

3. Historic harvest methods, ca. 1840:

a. Whaling. Spring whaling was a particularly important subsistence activity and cultural event along the Chukchi coast from Point Hope to Point Barrow. In April and May, bowhead whales migrating north would appear along offshore leads. At these times, Inupiat congregated to the major whaling settlements at Point Hope, Icy Cape, and Point Barrow to participate in whaling. The advent, participation in, and successful conclusion of whaling were marked by ceremonial enactment of traditional beliefs, and festivities (Larsen 1973). Whaling crews camped along the ice edge to spot whales consisted of 8 to 10 individuals, usually men, and formed important social units within the Eskimo society. Crews had a captain, a harpooner, and six to eight paddlers (Burch 1981). Boats were umiaks of seal (Ugruk) or walrus skin stretched over a driftwood frame.

When a whale was spotted, it was pursued by one or several crews in an attempt to harpoon it, with a set of sealskin floats attached to the harpoon. A whale thus harpooned eventually tired and was killed with large stone or iron lances. In the 1880's, Eskimos began using bombguns purchased or salvaged from commercial whaling vessels (Murdoch 1892). Crew composition and technique remained basically the same except for the addition of a gunner, who shot the whale before or after harpooning (ibid.).

A killed whale was towed to the ice edge by several crews and butchered. The landing of a large whale provided as much as 50 tons of food and raw materials, which were distributed among all participants and their respective villages. Blubber and meat were valued as food, fuel, and dog food; baleen was used for making fish nets and lashings; and bones were crafted into implements, sled runners, and sod-house supports.

Some whaling took place in the fall at Point Barrow as the bowhead migrated south. Fall whaling was generally

Table 4. Subsistence Resources Used at Point Hope, ca. 1840

Common Name	Inupiaq Name	Scientific Name
Land mammals:		
Caribou	Tuttu	Rangifer tarandus
Brown bear	Aglag	Ursus arctos
Arctic ground squirrel	Sugzik	Spermophilus undulatus
Arctic fox	Pisukkaaq	Alopexlagopus
Red fox	Qayuqtuq	Vulpes fulva
Hoary marmot	Sigzikpak	Marmota caligata
Wolf	Amaruq	Canislupus
Wolverine	Qavvik	Gulogulo
Dall sheep	Imnaiq	Ovis dalli
Weasel (ermine)	Itiriaq	Mustela erminea
Marine mammals:		
Bowhead whale	Arviq	Baleena mysticetus
Belukha whale	Sesuaq	Delphinapter usleucas
Pacific walrus	Aiviq	Odobenus rosmarus
Bearded seal	Ugzuk (ugruk)	Erignathus barbatus
Harbor seal	Kasigiaq	Phoca vitulina
Ringed seal	Patsiq (natchiq)	Phoca hispida
Polar bear	Nanuq	Thalarctos maritimus
Fish/marine invertebrates:		
Coho salmon (silver)	Sikaiyurlak	Oncorhynchus kisutch
Chum salmon (dog)	Aqalugzuaq	Oncorhynchus keta
Pink salmon (humpy)	Amaaqtuq	Oncorhynchus gorbushcha
Broad whitefish	Kausilik	Coregonus nasus
Humpback whitefish	Qaalriq	Coregonus laveretus
Round whitefish	Qupitiq	Prosopium cylindraceum
Arctic char	Iqalukpik	Salvalinus alpinus
Sculpin	Kanayuq	various
Arctic flounder	Natarnaq	Liopsetta glacialis
King crab	Putyuvak	Chionoecetes opilio
Tanner crab	Putyuvak	Paralithodes platypus
Clams	Ivilluq	Macoma calcerea

(continued)

Table 4 (continued).

Common Name	Inupiaq Name	Scientific Name
Birds		
Common murre	Aakpaliq	*Uria aalge*
Thick-billed murre	Aakpaluuzaq	*Uria lomvia*
Horned puffin	Qilanaq	*Fratercula corniculata*
Cormorant	Initqaq	*Phalacrocorax pelagicus*
Red-throated loon	Qagzuaq	*Gavia stellata*
Arctic loon	Tuullik	*Gavia arctica*
Black brant	Nigliq	*Branta nigricans*
Snow goose	Kanuq	*Chen hyperborea*
Whistling swan	Kugzuk	*Olor columbianus*
Oldsquaw	Aaraaliq	*Clangual hyemalis*
Eider ducks (female)	Arnaviaq	various
King eider (male)	Kinaligaaluk	*Somateria spetabilis*
Common eider (male)	Amauligaaluk	*Somateria mollissima*
Spectacled eider (male)	Qavaasuk	*Lampronette fisheri*
Pintail	Kugugaq	*Anas acuta*
Arctic tern	Mitqutailaq	*Sterna paradisaea*
Gulls	Qiritiraaq	
	Mauyaaluk	
	Nauyavak	
Sandhill crane	Tatilgaq	*Grus canadensis*
Snowy owl	Ukpik	*Nayctea scandica*
Rock ptarmigan	Aqazigiq	*Lagapus mutus*
Willow ptarmigan	Aqazigiq	*Lagopus lagopus*
Gyrfalcon	Killavak	*Falco rusticolus*
Golden eagle	Tinmiaqpak	*Acuila chrysaetos*
Raven	Tulugaq	*Corvus corax*

Source: Burch 1981.

Note: Dialectic variation within the North Slope subregion precludes a single definitive spelling of Inupiaq species names.

less productive than spring whaling and was largely abandoned because of competition with commercial whalers during the nineteenth and early twentieth centuries (ibid.).

b. Other marine mammal hunting. Walrus, belukha whale, and seal were often hunted opportunistically in conjunction with bowhead whale, and by the same methods. Later in the summer, belukha whales were occasionally caught in nets set close to shore. Walruses hauled out on land or ice were stalked and speared, clubbed, or shot. Seals were shot and/or harpooned from kayaks (Burch 1981, Murdoch 1892). Among coastal dwellers, seal was a major source of food and raw materials throughout the year. Murdoch (1892) noted that "the flesh of smaller seals forms such a staple of food, and their blubber and skin serve so many important purposes that their capture is one of the most necessary pursuits at Point Barrow, and is carried out at all seasons of the year and in many different methods."

In the fall, with the formation of new sea ice, seals were hunted along leads and pools or at breathing holes. During the dark winter months, a particularly effective method of seal hunting was by netting under the ice at night. Murdoch (1892) reported 100 seals taken by this method in one night. During the sunny spring months, basking seals were stalked and shot.

Firearms were in common use among the North Slope Inupiat by the 1880's (Burch 1981, Murdoch 1892). The introduction of firearms had little effect on the hunting of marine mammals except that the harpoon was gradually relegated from primary killing weapon to retrieving tool (Sonnenfeld 1957). Another change was in the active pursuit of polar bear, which became more commonplace with the increased killing power offered by rifles (ibid.).

b. Caribou hunting. Some inland Eskimo groups were highly dependent on caribou (Amsden 1977, Larsen 1969, Binford 1978). In addition, caribou were an important resource to coastal North Slope Eskimo groups prior to their decline in the last decades of the nineteenth century. Hunting methods and means were largely the same from region to region. Prior to the common use of firearms, bands of caribou were stalked and shot, using bow and arrow, or driven into a constricted compound, restricted pass, willow thicket, lake, or stream, where they were snared or speared (Larsen 1969). Caribou drives were frequently a communal effort. During the spring, in areas of deep snow, pitfall traps were constructed and baited with lichen (Murdoch 1892). With the common use of rifles, caribou hunting shifted to a fall pursuit and no longer relied upon the presence of deep snow (Murdoch 1892).

The declines in western arctic caribou populations caused aggregations of caribou to become especially rare along the Chukchi coast after the 1870's (Burch 1981). The use of caribou fences and corrals in those areas, which were geared towards capturing large groups of caribou and required time and effort to build and maintain, began to decline in favor of stalking the small bands and individuals that still passed through the area. As stated above, after 1900, the shortage of caribou along the coast was somewhat relieved by the establishment of reindeer herds at Barrow, Icy Cape, and Point Hope, and inland groups more heavily dependent upon caribou shifted to coastal locations and resources.

d. Fishing. The relative importance of the fish resource varied between regions and family groups. Murdoch (1892) states that at Barrow "fishing fills the voids between major (subsistence) activities . . . For those who retreat to fishing stations on the rivers during the summer however, fishing is the major subsistence activity, and may be indicative of the original inland orientation or origin of that family."

Fish resources were exploited throughout the year by means of lures, nets, and weirs. Saffron and arctic cod were jigged through the sea ice during the late winter and spring. During the summer, salmon, char, and whitefish were harvested by means of gill nets and seines of sinew or baleen at coastal locations, lagoons, and river mouths (Burch 1981, Murdoch 1892). In the fall, whitefish, grayling, and char were harvested at inland river locations in conjunction with caribou hunting (Murdoch 1892). Whitefish, grayling, and burbot were caught through the river ice in early winter by hook and line.

e. Trapping. Traditionally, ground squirrels and marmots were the main furbearers harvested for both food and fur. These were taken by snares and deadfalls during summer trips to inland areas (Burch 1981). Arctic and red fox, wolf, and wolverine were taken opportunistically. The introduction of steel traps and an increasing market for furs during the 1870's increased

Inupiat participation in trapping. For commercial trade, the primary species was arctic fox (Burch 1981). Fur harvest and the fur trade remained an important subsistence activity during the first half of the twentieth century.

B. Contemporary Patterns of Resources, ca. 1980's
The use of wildlife resources will be discussed in detail below. All known resource harvest is described in this section; however, discussion of harvest that is currently not permitted by regulation does not constitute endorsement of such harvest by the Department of Fish and Game.

1. Seasonal round of subsistence activities. The contemporary villages on the North Slope continue to follow annual cycles of subsistence fishing, hunting, gathering, and trapping activities tied to the seasonal availability of wild resources. The contemporary seasonal rounds of subsistence activities for each community are summarized below.

   a. Point Hope. Marine resources play a dominant role in the subsistence cycle at Point Hope (fig. 1). Spring subsistence activities focus on bowhead whaling. From April to June, almost the entire community is involved in the pursuit or processing of bowhead whales as they migrate north. Seal, belukha whale, polar bear, and an occasional walrus are taken in conjunction with whaling activities. Walrus, seal, and belukha hunting continues into the summer months, along with waterfowl and sea bird hunting and egg gathering. Fishing for char, salmon, and whitefish, using seines and gill nets, also occurs throughout the summer along the cost and in coastal lagoons. Small bands of caribou are hunted near the coast, and caribou hunting intensifies during the late summer and fall. The Kukpuk River is an important fall fishing area for salmon, grayling, char, and whitefish. As winter sets in, some Point Hope residents trap furbearers. Seal and caribou are the major resources taken during winter. Seal hunting intensifies when the sea ice is thick enough to allow travel. Saffron and arctic cod are jigged through the ice, and polar bear are actively pursued in late winter and early spring. With spring comes preparation for another whaling season and the beginning of another annual cycle of subsistence activities (Wickersham and Flavin 1983).

   b. Point Lay. Belukha whale, caribou, and fish are major subsistence resources in Point Lay (fig. 2). The location of Point Lay is not conducive to productive

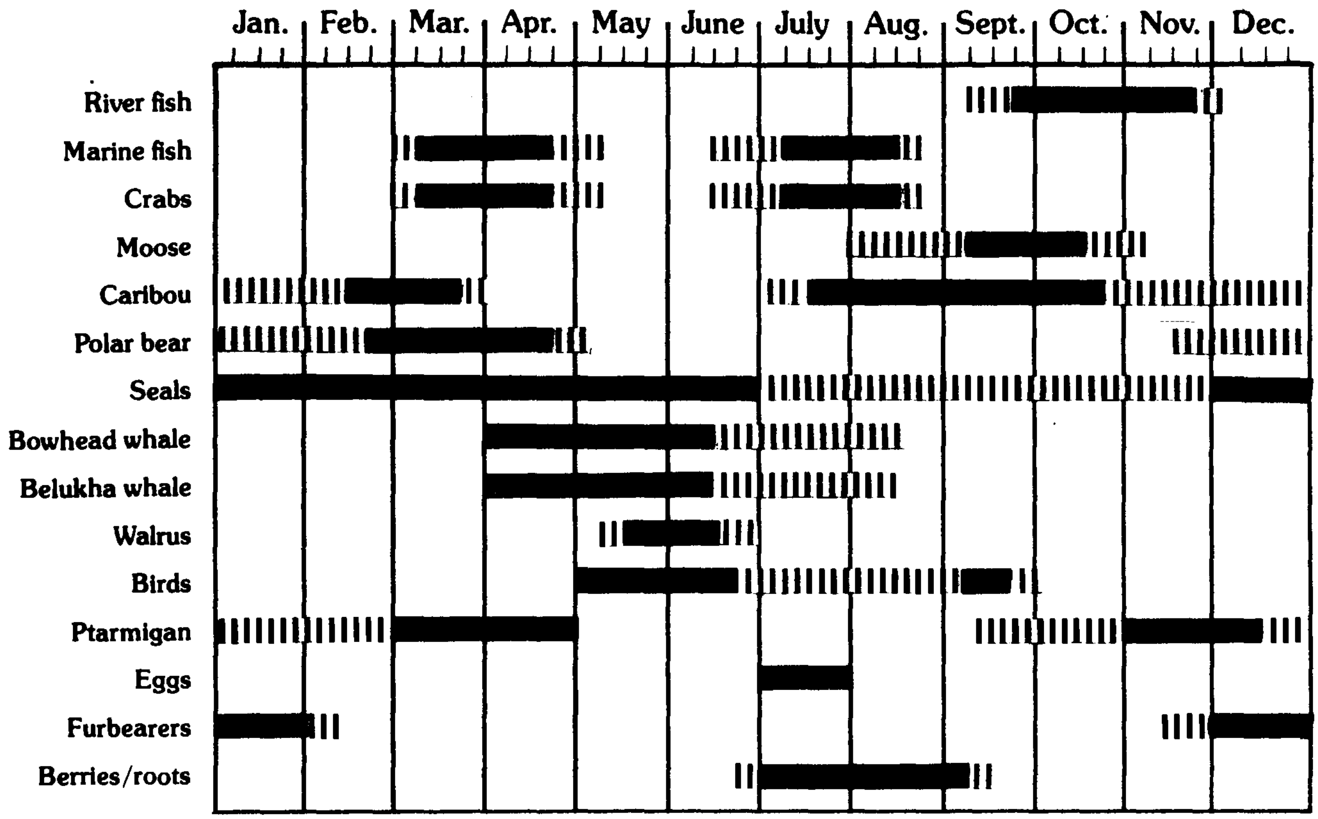


Figure 1. Annual round of harvest activities by Point Hope residents, ca. 1980's. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Pedersen 1977).

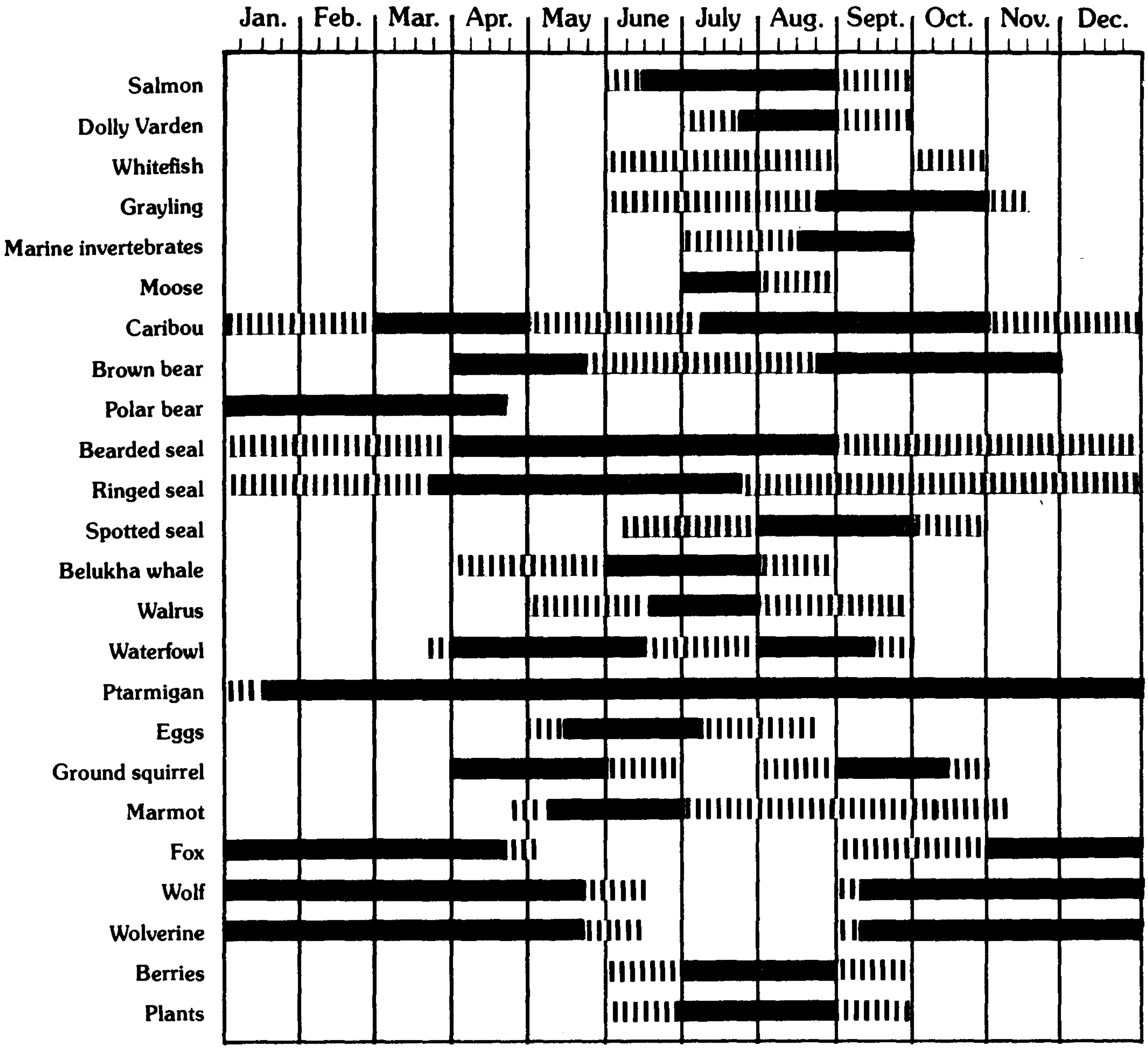


Figure 2. Annual round of harvest activities by Point Lay residents, ca. 1980's. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Schneider N.d.).

bowhead whaling, so some Point Lay residents travel to neighboring villages to participate in spring bowhead whaling activities. Other Point Lay residents trap furbearers during the spring. Late spring trapping trips into inland areas are combined with hunts for ground squirrel, marmot, ptarmigan, and waterfowl. Waterfowl, sea birds, and sea bird eggs are taken along the coast in conjunction with seal hunting activities. In addition, caribou are hunted in the spring by snow-machine.

Summer is an active subsistence season in Point Lay. Seals are hunted by boat, and caribou are taken when encountered in near-coastal locations. Fishing in coastal lagoons and at river mouths produces catches of salmon, whitefish, flounder, smelt, herring, and sculpin. Communal hunts for walrus and belukha whale are organized during June and July. Fall activities focus on caribou hunting and grayling fishing at inland locations such as the Kukpowruk River. Nets are used until freeze-up, after which fish are jigged through the ice. Winter is a time of relative calm, with some residents trapping or hunting furbearers. Inland trapping excursions are combined with hunts for caribou and ptarmigan. Trapping along the coast commonly is done in conjunction with hunts for seal and polar bear. The return of late spring caribou hunting marks the beginning of a new seasonal round in Point Lay (Wickersham and Flavin 1983).

c. Wainwright. Wainwright's location provides easy access to extensive coastal, estuary, and inland riparian habitats. Spring bowhead whaling is the major subsistence activity, beginning in April and peaking in May (fig. 3). Some ringed seals, belukha whales, and waterfowl are taken in conjunction with whaling activities. Ptarmigan, furbearers, and small mammals such as ground squirrel and marmot are hunted inland on spring trips up the Kuk River prior to breakup. As the summer thaw restricts overland travel, subsistence hunting activities for waterfowl, seal, belukha whale, and walrus are conducted from traditional coastal camp locations. Fishing and caribou hunting are the major late summer activities. Nets are used for trout, salmon, and whitefish in coastal and river locations near the village. Fall fishing activities shift inland to camps along the Avalik, Ivisaruk, and Kuk rivers. Caribou, brown bear, and moose are also hunted from these fall campsites. As shorefast ice forms, hunting for ringed seal and polar bear increases. Large

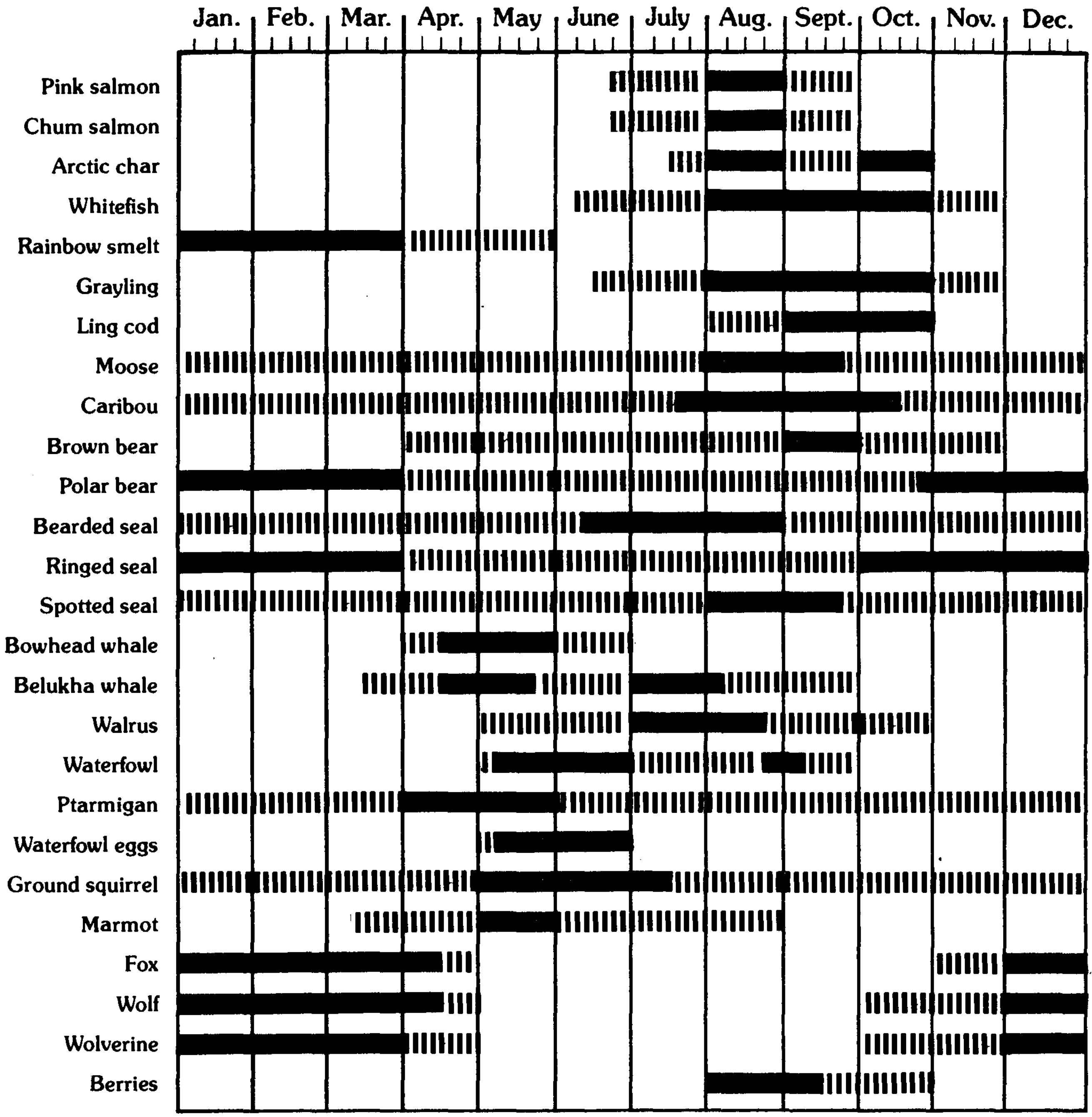


Figure 3. Annual round of harvest activities by Wainwright residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Ivie and Schneider 1978, Nelson 1981).

quantities of rainbow smelt are jigged through the ice of Kuk Lagoon throughout the winter and spring (Nelson 1981). Trapping and hunting for fox, wolf, and wolverine occur during the winter and intensify with the longer daylight hours of spring. Preparation for whaling brings the annual round of Wainwright full circle (Wickersham and Flavin 1983).

d. Barrow. Bowhead whaling overshadows all other subsistence activities in Barrow from April to mid June (fig. 4). As many as 33 crews are involved in spring whaling at Barrow. Waterfowl, walrus, and ringed seal are also taken in conjunction with spring whaling activities. Recent quotas imposed on the harvest of bowhead whales have led to increased harvests of walrus, seal, and belukha whale to satisfy the food needs in this relatively large community (ibid.). Waterfowl and their eggs are harvested in early summer from traditional camps along the coast to Peard Bay. Hunting for bearded and spotted seals increases as the sea ice retreats. Coastal fishing and duck hunts are often combined with communal hunts for walrus and beared seal. In late summer, caribou hunting intensifies, and inland fishing for whitefish and grayling with nets is productive. Fall whaling occurs in open water areas east of Barrow. The fall whaling effort is much reduced and generally less productive than the spring hunt. With the formation of new sea ice, ringed seals are hunted by some residents. The cold dark months of mid winter are a time for socializing and festivities in Barrow. Furbearer trapping is conducted by some. Polar bear, caribou, and seal are occasionally taken throughout the winter, especially in conjunction with trapping activities. Ptarmigan are hunted to provide variety to the winter diet. Furbearer and caribou harvests intensify with the longer days of spring, and preparation for whaling season marks the beginning of a new cycle in Barrow (ibid.).

e. Atqasuk. Because of its inland location, Atqasuk's primary subsistence resources are caribou, waterfowl, and fish. Caribou and waterfowl are intensively pursued in late spring prior to breakup (fig. 5). Difficulties associated with summer land travel restrict summer subsistence activities to areas near the village. Fishing dominates summer subsistence pursuits, with peak fishing activity taking place in August. Gill nets are used to harvest arctic grayling, arctic char, whitefish, and pink salmon. Fall activities combine fishing, caribou hunting, and berry picking from traditional camp

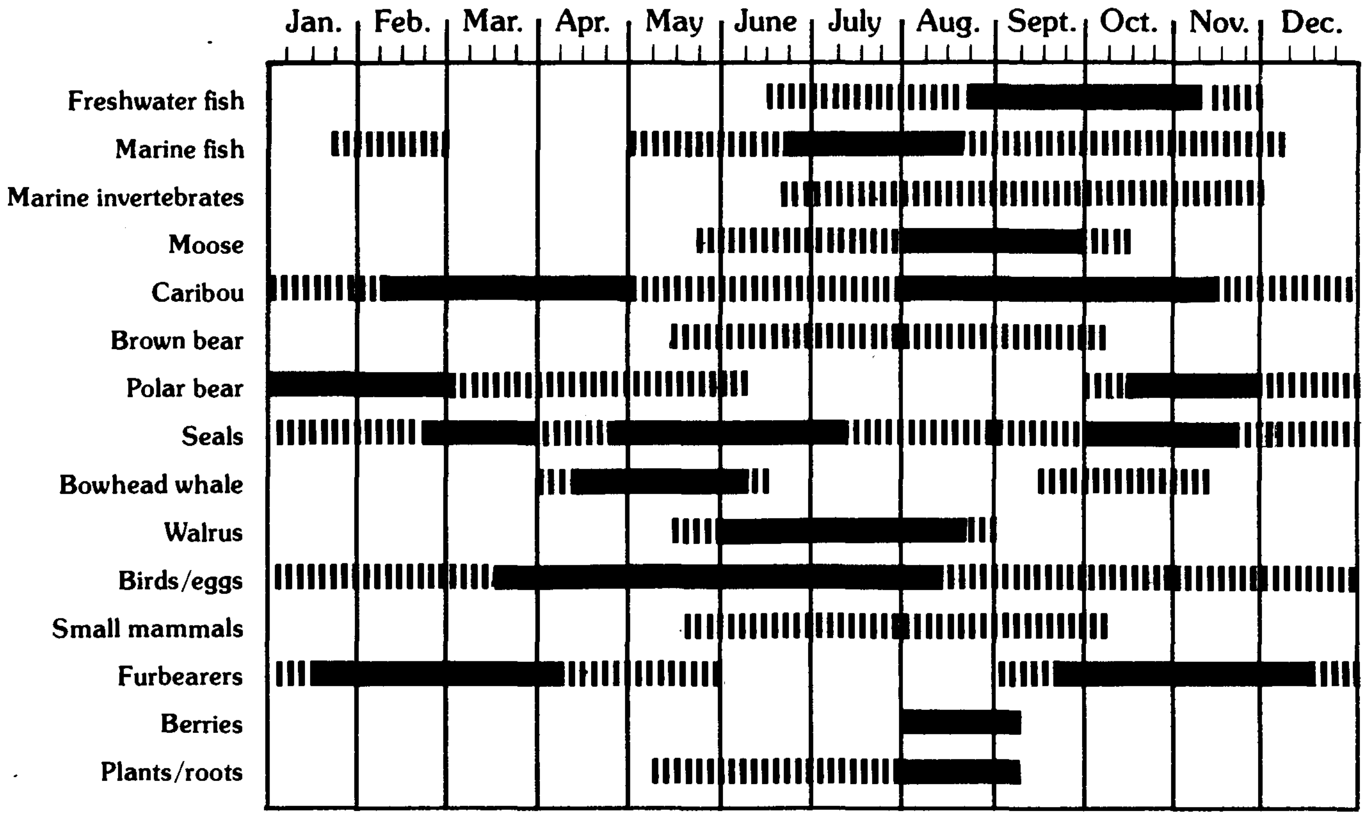


Figure 4. Annual round of harvest activities by Barrow residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Schneider et al. 1980).

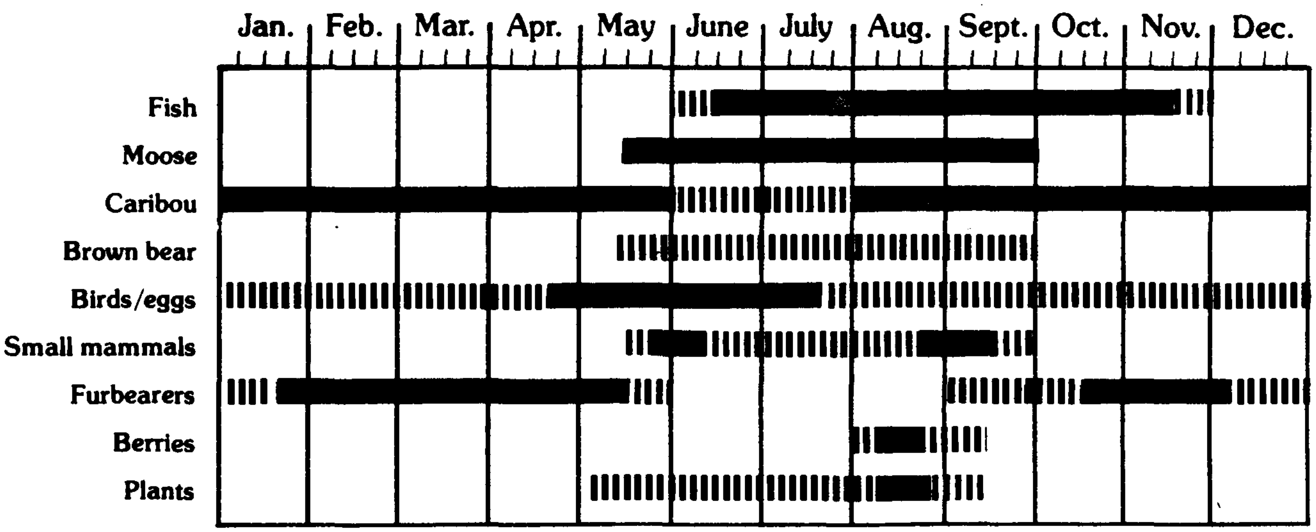


Figure 5. Annual round of harvest activities by Atqasuk residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Schneider et al. 1980).

locations along the Meade, lower Nigisaqtuvik, and Isuqtug rivers. Moose and grizzly bear are taken on these trips when encountered. Following freeze-up, caribou hunting intensifies, with increased access by snowmachine to outlying areas. River fishing continues by jigging or the use of nets under the ice. Trapping is a major winter activity. Caribou and ptarmigan hunting and fishing through the river ice take place in conjunction with trapping activities. Caribou hunting activities intensify with the longer daylight hours of spring. Some Atqasuk residents also travel to Barrow to participate in spring bowhead whaling activities (ibid.).

f. Nuiqsut. Spring subsistence activities in Nuiqsut include seal hunting on the sea ice and hunting and trapping inland for furbearers and caribou (fig. 6). No spring whaling is done in the vicinity of Nuiqsut. Some Nuiqsut residents travel to Barrow to participate in

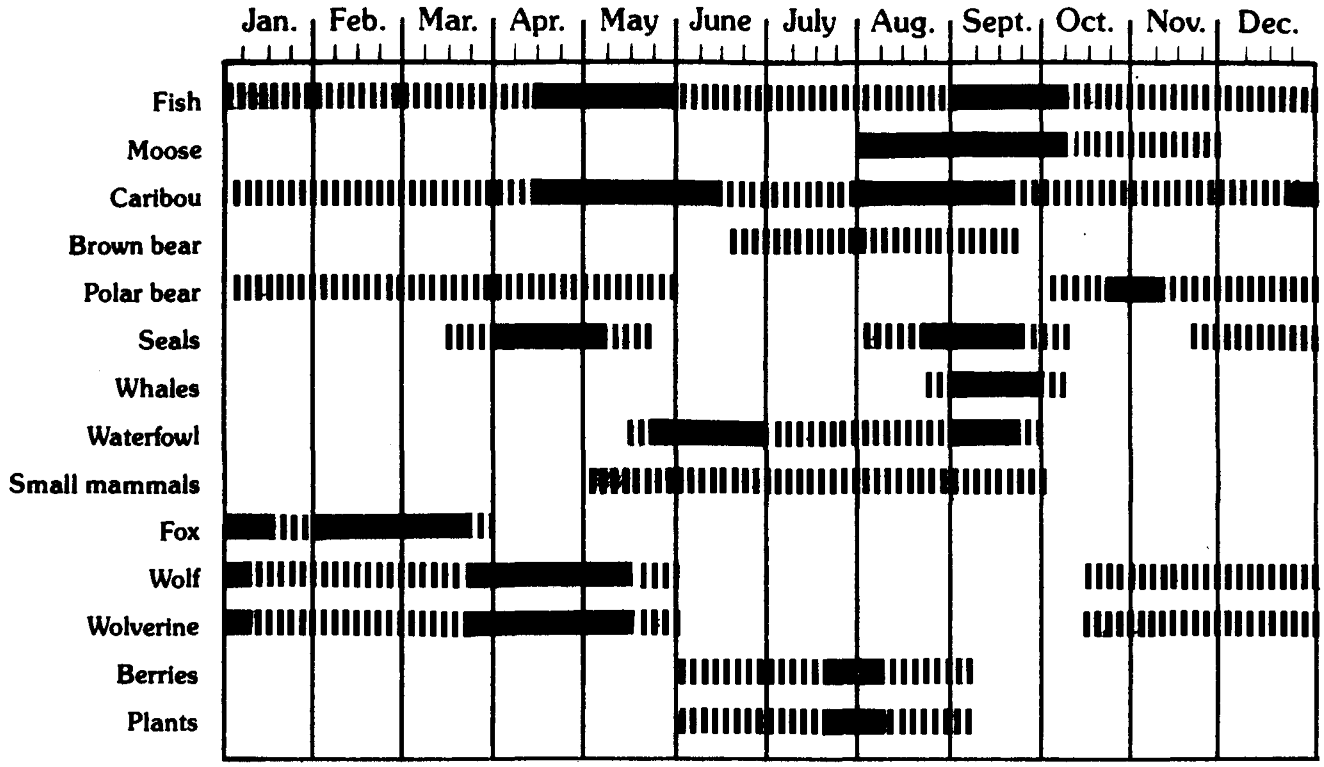


Figure 6. Annual round of harvest activities by Nuiqsut residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Hoffman et al. 1979; Galinaitis et al. 1983; Trent, pers. comm. for moose).

spring whaling there. As rivers and lakes become ice-free, grayling, cod, and lake trout are taken with hook and line, and whitefish are taken with nets from camps along Fish Creek and the Colville River. Waterfowl are taken during the spring and summer. Fall is an active season for harvest activities. Caribou and moose are hunted inland along the Colville River and its tributaries. Whitefish are caught in nets prior to freeze-up, and arctic grayling and burbot are jigged through the ice following freeze-up. Bowhead whaling begins in mid September. Nuiqsut whale crews travel as far east as the Canning River in pursuit of whales, taking seal, waterfowl, polar bear, and caribou out of coastal whale camps. Trapping occurs during the winter months, along with occasional hunts for caribou and moose. Polar bear is taken along the coast. During late winter and early spring, trapping, caribou hunting, and ice fishing activities increase. Bearded seal hunting begins in April (Wickersham and Flavin 1983). The ADF&G, Division of Subsistence, initiated subsistence research in Nuiqsit in 1985. Research findings were not available at the time of this writing. Readers should contact the Division of Subsistence for updated seasonal round information on this community.

g. Kaktovik. Kaktovik's geographic setting provides relatively easy access to inland mountain areas for sheep and caribou as well as access to coastal resources such as seal and bowhead whale. Spring subsistence activities in Kaktovik are highlighted by inland trips to mountain and foothill areas where sheep and caribou are hunted along with ptarmigan, ground squirrel, and marmot (fig. 7). Arctic char are caught through the ice by jigging at traditional inland river locations prior to breakup. As overland travel is difficult at breakup, summer subsistence activities are concentrated along the coast, where waterfowl and seal are hunted. Arctic char, whitefish, and pink salmon are caught with nets and rod and reel at coastal camps. Caribou are harvested throughout the summer and fall near the coast. The Canning River delta is an especially productive summer caribou hunting and fishing area for Kaktovik residents (Jacobsen and Wentworth 1982). Fall whaling takes place in August and September, with whalers traveling far out into open waters in search of bowhead whale. Seals are also harvested in conjunction with whaling expeditions. Following freeze-up, inland travel by snowmachine resumes. In October and November, trips are made to traditional mountain area camps for sheep and caribou hunting. The Hulahula River is a major corridor for fall and winter land use activities. Fishing through the ice occurs for arctic char, arctic grayling, whitefish, and burbot. Mid winter is a time of reduced land use activity. Trapping and furbearer hunting is engaged in by some. Polar bears are occasionally hunted near the village. In late winter, inland harvest of fish, caribou, and sheep occur, and moose are occasionally taken when encountered. Inland subsistence activities intensify as breakup approaches, and the cycle begins again (Wickersham and Flavin 1983, Jacobsen and Wentworth 1982).

h. Anaktuvuk Pass. As in the past, the annual subsistence cycle of Anaktuvuk Pass residents revolves around the caribou (fig. 8). Intensive caribou hunting occurs in April and May as animals move through the Brooks Range on spring migrations northward. As spring progresses, hunts for bear, small mammals, and some waterfowl are combined with the caribou-hunting effort. The short

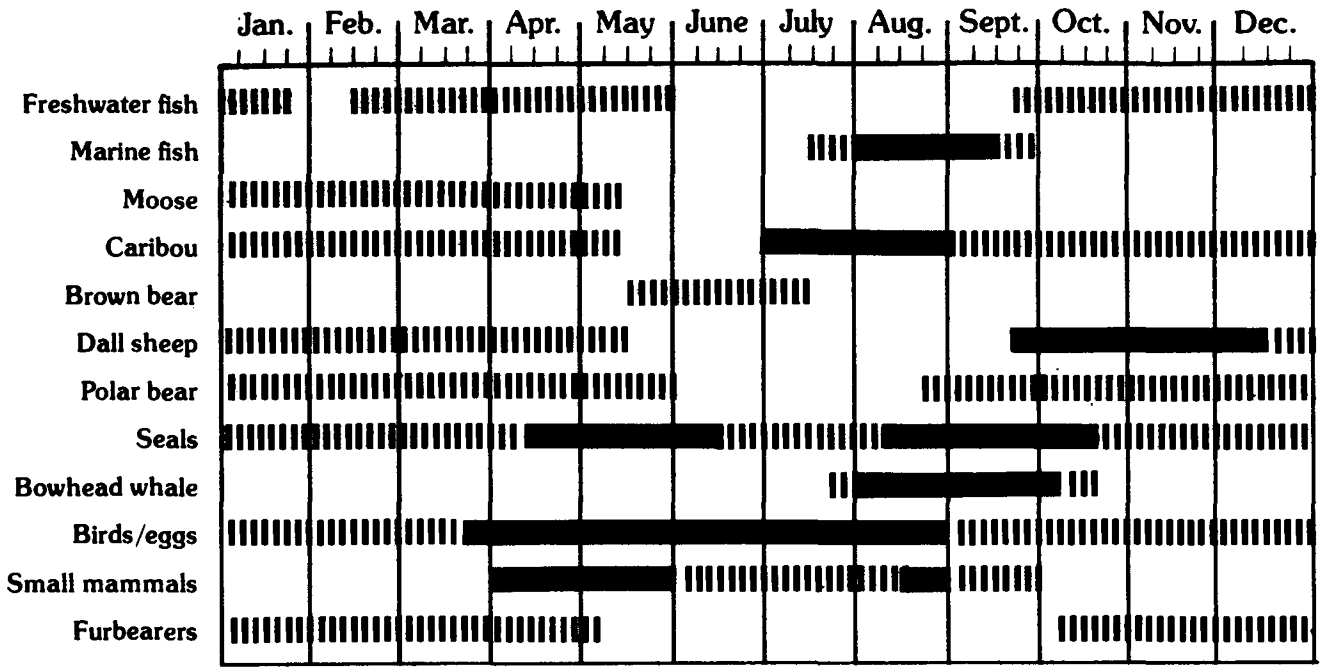


Figure 7. Annual round of harvest activities by Kaktovik residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (Jacobsen and Wentworth 1982).

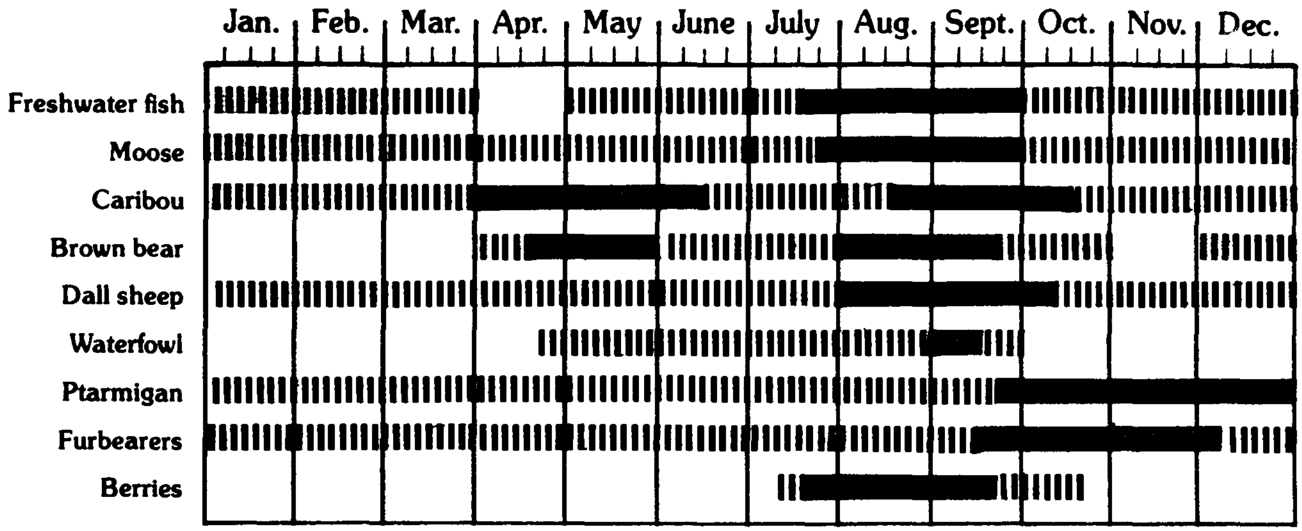


Figure 8. Annual round of harvest activities by Anaktuvuk Pass residents. Solid line indicates time when harvest usually takes place. Broken line indicates occasional harvest effort (North Slope Borough 1978).

summer is marked by wage labor activities and fishing for whitefish and trout from rivers near the village. Caribou hunting intensifies again in the fall as the animals begin to move southward. Sheep, moose, and bear are also taken during these fall hunts following freeze-up. During the winter, caribou are occasionally pursued, but they are in less desirable condition and occur in scattered and dispersed groups. Attention instead is focused on trapping and hunting wolf, wolverine, and fox. Ptarmigan are hunted or snared, and fishing for whitefish and arctic char occurs through lake and river ice. The spring caribou migration marks the beginning of another cycle in Anaktuvuk Pass (Wickersham and Flavin 1983).

2. Contemporary subsistence whaling. As discussed above, bowhead whale hunting had great cultural and economic importance to the Inupiat in precontact and historic times. The above descriptions of contemporary subsistence cycles demonstrate the continued importance of this activity to many North Slope communities today. The annual harvest of bowhead whales by the Inupiat continues today under special federal regulation and international agreement. An international ban on the commercial harvest of bowhead whales has been in effect since 1931. No limit was imposed on the Alaskan Eskimo harvest of bowheads at that time. The Marine Mammal Protection Act in 1972 and the Endangered Species Act in 1973 formally recognized the right of Alaskan Eskimos to continue

whaling and specified certain conditions of harvest. Between 1970 and 1977, an average of 30 bowheads per year were harvested by Alaskan Eskimos. This represented a 100% increase in the average annual harvest recorded between 1911 and 1969 (Alaska Consultants, Inc. and Stephen Braund and Associates 1984). In addition to harvested whales, 194 bowheads were struck but lost between 1973 and 1977 (ibid.). In 1977, the International Whaling Commission (IWC) in consultation with North Slope communities adopted a quota system permitting continuation of a closely monitored subsistence harvest of bowheads in Alaska.

As part of the IWC management plan, the Alaska Eskimo Whaling Commission (AEWC) was established in 1977. Composed of whaling captains from nine Alaskan whaling communities, the AEWC took steps to improve the efficiency of whaling crews and developed a local management plan for the subsistence bowhead harvest. The 1977 quota allowed 12 whales landed or 18 struck, whichever occurred first. Quotas have been reviewed and revised annually. The 1984-1985 block quota allowed 43 strikes, with no more than 27 strikes to be used in either year.

Current whaling methods are a combination of old tradition and new technology. Skin boats are still preferred for their light weight, durability, stability, and quiet ride. Outboard motors, darting guns, and bombs are universally used. Modern whaling crews consist of from 6 to 25 members. The larger crews include those involved in camp activities and individuals who support the crew with cash income through wage employment (Worl 1980). Crew members typically are drawn from an extended kinship system that generally includes a captain, his wife, their sons and/or daughters, brothers, brothers-in-law, cousins, nephews, and grandsons. Crew membership is not rigidly defined, and members may switch from one crew to another from year to year (Worl 1980).

Collectively, the whaling crews form the community's whaling fleet. Activities of the fleet are organized through formal community meetings where whaling captains review regulations, voice grievances, discuss strategy, and organize work parties to carry out specific tasks preparatory to whaling activities.

Subsistence whaling requires a substantial cash outlay for equipment and supplies. Table 5 outlines typical costs associated with whaling equipment in 1977.

When a whale is landed, most of the community is involved in pulling the whale onto the ice, butchering, and preparing for

Table 5. Estimated Costs of Whaling Equipment in 1977

Equipment	Cost
Skin boat frame	$ 600
Six skins for boat covering @50 ea.	300
Sewing for skin boat	300
Two shoulder guns @ 325 ea.	650
Darting gun	350
Bombs (20 bombs)	595
Harpoon	50
Block and tackle	1,000
Floats	116
Rope	150
Outboard motor (25 horsepower)	960
Snowmachine	2,000
Sled	250
Tent frame	200
Camp equipment	200
Gas, food, supplies	1,500
Radio transmitter	140
*Feasts	1,000
Total	$10,361

Source: Worl 1980.

* Successful captains must bear the costs of several ceremonies throughout the year.

ceremonial feasts. Shares of the whale are distributed to individuals and households according to customary law. Each community has its own way of sectioning and distributing whale products.

Technological and cultural changes have not altered the importance of the bowhead whale as a preferred Eskimo food resource. The continued cultural importance of whaling is evident in the ritual distribution of harvested whale meat and muktuk, the traditional ceremonies and feasts associated with a successful whaling season, and the persistence of the whaling crew as an important social unit among Alaskan Eskimos. Readers are referred to Alaska Consultants, Inc., and Stephen Braund and Associates (1984), Worl (1979), and Spencer (1971) for further discussion of the important role of whaling in Alaskan Eskimo cultures. Boeri (1983) also offers some recent personal observations of modern subsistence whaling.

3. Subsistence harvest levels. Reliable, verifiable subsistence harvest data for North Slope communities have not been systematically collected. The most comprehensive estimates of North Slope subsistence harvest levels are offered by Patterson and Wentworth (1977) and presented in table 6. These data are based on averages of estimated annual harvest levels provided by key informants over the five-year period 1969-1973 and, as such, may be subject to a large margin of error. Subsistence harvest levels for a given species typically vary widely from year to year, depending on a variety of ecological, climatic, and socioeconomic factors. Presenting harvest data in terms of annual averages masks these significant variations and relationships. These data also cover a time period prior to major changes that took place on the North Slope in the mid 1970's, including establishment of three new communities, heightened oil development, and increased employment in capital construction projects. Despite these qualifiers, the data presented in table 6 offers the only available harvest estimates for North Slope communities that include fish, fowl, furbearers, and small game. They serve as indicators of the species utilized and provide some basis for comparing harvest levels between communities. If these data are correct, they show that between 700 and 1,500 lb of wild resources are harvested per person each year in North Slope communities. These levels of harvest are among the highest recorded anywhere in the state (Patterson 1974).

For some marine mammal species, more recent subsistence harvest data are provided by Stoker (1983). Tables 7-10 provide estimated harvests for selected marine mammals

Table 6. Estimates of Average Annual Harvest Levels of Subsistence Resources in North Slope Communities, ca. 1973

Resources Harvested			Anaktuvuk Pass	Barrow	Kaktovik (Barter Is.)	Point Hope	Wainwright
Resource	Number	Lb (Dressed Weight)	Number	Number	Number	Number	Number
Mammals							
Bear (brown/grizzly)	14	3,150	5	2	2	2	3
Bear (polar)	19	8,550	---	6	5	5	3
Caribou	6,850	1,027,500	1,000	3,500	100	750	1,500
Fox (arctic)	2,655	*	15	2,000	100	40	500
Fox (red)	205	*	100	60	15	20	10
Hare (arctic snow)	30	90	30	---	---	---	---
Marmot	10	120	10	---	---	---	---
Moose	24	16,800	5	6	5	6	2
Porcupine	7	70	2	---	5	---	---
Sheep (dall)	45	4,500	15	---	30	---	---
Squirrel (ground)	1,480	1,480	200	1,000	250	---	30
Weasel	26	*	---	10	12	---	4
Wolverine	59	*	15	15	5	6	16
Wolf	126	*	75	30	10	4	7
Seal (bearded)	410	164,000	---	150	30	180	50
Seal (hair)	3,485	278,000	---	1,000	75	2,060	350
Walrus	117	110,600	---	33	1	33	50
Whale (belukha)	20	9,000	---	5	---	10	5
Whale (bowhead)	19	912,000	---	12	1	3	3
Birds							
Auk/puffin/murre	550	550	---	---	50	500	---
Ducks	16,600	16,600	---	5,000	1,100	10,000	500
Geese	960	3,840	10	400	100	300	150
Ptarmigan	2,450	2,450	500	1,000	750	100	100
Harvest eggs	3,750 doz	7,500	---	---	few	3,750 doz	---

(continued)

Table 6 (continued).

Resources Harvested			Anaktuvuk Pass	Barrow	Kaktovik (Barter Is.)	Point Hope	Wainwright
Resource	Number	Lb (Dressed Weight)	Number	Number	Number	Number	Number
Fish							
Arctic char	4,700	18,800	100	100	2,500	2,000	---
Ling cod	130	1,300	30	100	---	---	---
Tom cod	3,500	3,500	---	500	---	3,000	---
Grayling	5,650	5,650	1,000	2,500	---	2,000	150
Herring	10,500	5,250	500	10,000	---	---	---
Coho salmon	200	1,000	---	200	---	---	---
Pink salmon	6,250	12,500	---	200	---	6,000	50
Chinook salmon	230	2,990	---	200	---	---	30
Smelt	2,000	2,000	---	---	---	1,000 lb	1,000 lb
Trout	5,750	17,250	500	50	1,000	4,000	200
Whitefish, large	8,000	40,000	---	8,000	---	---	---
Whitefish, small	13,600	13,600	500	8,000	2,500	2,000	600
Totals (lb dressed weight)							
Mammals		2,536,660	156,555	1,284,550	91,500	537,600	469,455
Birds		30,940	540	7,600	2,300	19,300	1,200
Fish		123,840	3,950	61,550	15,500	40,000	2,840
Totals		2,691,440	161,045	1,353,700	109,300	596,900	473,495
Native enrollment, 1973		2,869	124	1,912	127	386	320
Per capita harvest, 1973		938	1,299	708	861	1,546	1,480

Source: Patterson and Wentworth 1977.

* Furbearers are not generally used for human consumption.

Table 7. Annual Harvest of Bowhead Whale and Polar Bear in Kaktovik, 1962-82

Year	Bowhead Whale	Polar Bear
1962	0	---
1963	0	---
1964	2	---
1965	0	---
1966	0	---
1967	0	---
1968	0	---
1969	0	---
1970	0	---
1971	0	---
1972	0	5
1973	3	0
1974	2	0
1975	0	1
1976	2	1
1977	2	4
1978	2	0
1979	5	0
1980	1	22
1981	3	1
1982	0	---

Source: Stoker 1983.

--- means no data were available.

Table 8. Annual Harvest of Bowhead Whale, Walrus, Hair Seal, and Polar Bear in Barrow, 1962-82

Year	Bowhead Whale	Walrus	Hair Seal*	Polar Bear
1962	5	---	450	---
1963	5	165	412	---
1964	11	10	---	---
1965	4	57	114	---
1966	7	12	63	---
1967	3	55	31	---
1968	10	16	102	---
1969	11	7	2,100	---
1970	15	39	2,000	---
1971	13	51	1,800	---
1972	19	150	1,700	6
1973	17	20	1,500	5
1974	9	35	1,000	7
1975	10	15	1,000	10
1976	23	136	1,000	9
1977	20	62	1,000	15
1978	3	30	---	5
1979	3	30	---	1
1980	9	---	---	9
1981	4	---	---	6
1982	0	---	---	---

Source: Stoker 1983.

--- means no data were available.

* Includes ringed and spotted seal. Seal harvest figures are estimates only and are probably on the low side.

Table 9. Annual Harvest of Bowhead Whale, Walrus, Hair Seal, and Polar Bear in Wainwright, 1962-82

Year	Bowhead Whale	Walrus	Hair Seal*	Polar Bear
1962	1	---	328	---
1963	2	132	573	---
1964	1	225	---	---
1965	0	194	345	---
1966	1	140	69	---
1967	0	47	277	---
1968	2	85	40	---
1969	3	92	450	---
1970	0	89	480	---
1971	2	23	250	---
1972	2	56	1,600	3
1973	3	31	250+	4
1974	1	38	250+	5
1975	0	65	250+	4
1976	3	257	250+	10
1977	2	24	150+	9
1978	2	20	---	7
1979	1	36	---	0
1980	1	---	---	9
1981	3	---	---	13
1982	2	---	---	---

Source: Stoker 1983.

--- means no data were available.

* Includes ringed seal and spotted seal. Seal harvest figures are estimates only and are probably on the low side.

Table 10. Annual Harvest of Bowhead Whale, Walrus, Hair Seal, Belukha Whale, and Polar Bear in Point Hope, 1962-82

Year	Bowhead Whale	Walrus	Hair Seal*	Belukha Whale	Polar Bear
1962	6	---	2,000	---	---
1963	3	10	2,752	---	---
1964	1	10	---	---	---
1965	2	6	2,016	---	---
1966	5	16	2,571	---	---
1967	1	3	980	---	---
1968	3	21	264	---	---
1969	3	5	2,300	---	---
1970	8	6	1,900	---	---
1971	6	35	1,800	---	---
1972	14	45	250+	10	5
1973	7	13	700+	55	3
1974	6	69	727	35	14
1975	4	10	700+	35	27
1976	12	4	700+	35	16
1977	2	9	700+	53	11
1978	1	1	---	16	7
1979	3	5	---	11	1
1980	0	---	---	---	10
1981	4	---	---	---	6
1982	1	---	---	---	---

Source: Stoker 1983.

--- means no data were available.

* Seal harvest figures are estimates only and probably on the low side. Includes ringed and spotted seal.

species in Kaktovik, Barrow, Wainwright, and Point Hope from 1962 to 1982. Stoker compiled these data from published sources and information obtained from the ADF&G and USFWS. Caribou harvests for the village of Kaktovik from 1981 to 1984 collected by the Division of Subsistence are summarized in table 11. These data were collected through household interviews in Kaktovik. The harvest of Dall sheep by North Slope residents is now reported to be at least 60 animals per year (Heimer, pers. comm.).

4. Harvest geography. Whereas these more recent data generally correspond to the mid 1970's harvest average estimates offered by Patterson and Wentworth (1977), there is some evidence that caribou harvests for most of the North Slope have been substantially lower in the 1980's than those reported in table 6. Davis et al. (1984), in examining harvests of the Western Arctic Caribou Herd from 1940 to 1984, noted that during the period 1940 to 1975, liberal seasons and bag limits resulted in an annual harvest of ca. 25,000 caribou. The period 1976 to 1980 was marked by reduced seasons and bag limits on Western Arctic caribou due to the ADF&G's concern about their declining numbers (ibid.). These regulations resulted in an annual harvest of ca. 3,000 Western Arctic caribou during this period. The reduced harvest of caribou by North Slope communities during this period is evidenced by the harvest estimates for the 1978-1979 season presented in table 12. Although relatively liberal caribou seasons and bag limits were restored with respect to the Western Arctic Caribou Herd in 1981, caribou harvest levels have generally remained at leass than 50% of their pre-1975 level (ibid.) - despite a 71% increase in the North Slope population between 1973 and 1983 (excluding Prudhoe Bay). Although current, comprehensive harvest data for North Slope communities are lacking, the above data suggest that the per capita harvest levels presented in table 6 may not reflect current harvest levels on the North Slope. Contemporary subsistence land use areas for North Slope communities have been outlined by Pedersen (1979) (map 4). These data show that villages hunt, fish, gather, and trap in identifiable resource use areas. The areas utilized by a community are large in aggregate but vary according to activity, species, and season. In the past, large areas were utilized because of a more dispersed population and seasonal movements between camps. Today, the large areas are accessible from a village setting through the use of motorized boats and snowmachines. Collectively, almost the entire land area of the North Slope is utilized for subsistence. The use areas of neighboring villages frequently overlap. More detailed maps of subsistence land use areas for each North Slope community and major resource categories are included in the Atlas to the Alaska Habitat Management Guide for the Arctic Region.

Table 11. Numbers and Percentages of Caribou Harvested at Inland and Coastal Locations by Kaktovik Hunters During the Regulatory Years 1981-82, 1982-83, and 1983-84

Regulatory Year	Coastal Sites	Inland Sites	Unknown Sites	Total Harvest
1981-82	22 (51%)	15 (35%)	6(14%)	38
1982-83	86 (78%)	24 (22%)	0(0%)	110
1983-84	80 (78%)	22 (22%)	0(0%)	102
3-Year average:	63 (74%)	20 (24%)	2(2%)	84

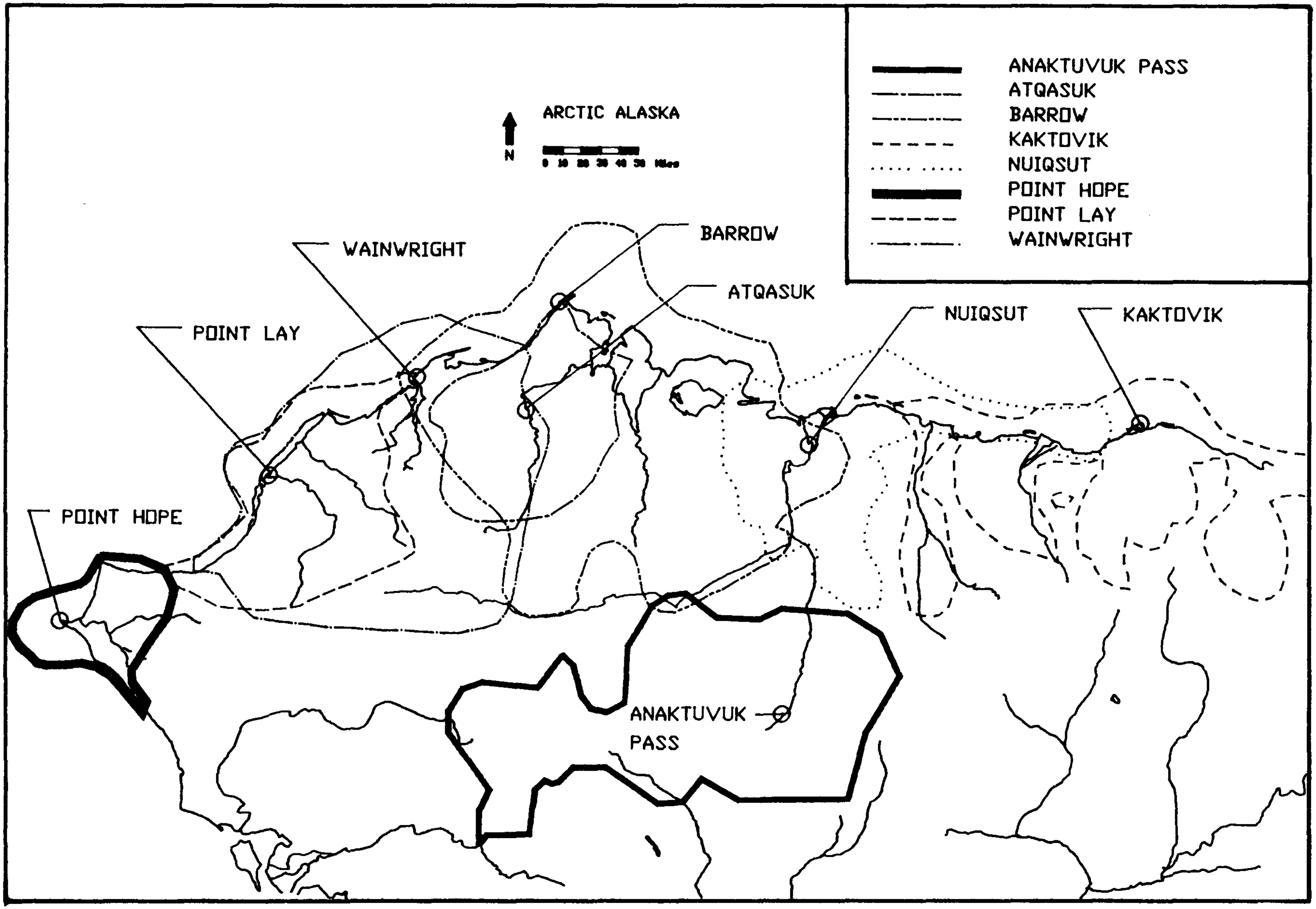
Source: Coffing and Pedersen 1985.

Table 12. Estimates of Fall and Spring Harvest of the Western Arctic Caribou Herd by North Slope Communities, 1978-79

	Estimated Harvest*		
Community	Fall	Spring	Total
Anaktuvuk Pass	81	40	121
Atqasuk	39	33	72
Barrow	741	221	962
Nuiqsut	62	47	109
Point Hope	100	150	250
Point Lay	43	29	72
Wainwright	279	97	376
Totals	1,345	617	1,962

Source: ADF&G 1980.

* Estimate by ADF&G staff based, in part, on permit returns.



Map 4. Subsistence use areas for North Slope communities (Pedersen 1979).

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B. Abbreviations

ACMP	Alaska Coastal Management Program
ADCED	Alaska Department of Commerce and Economic Development
ADCRA	Alaska Department of Community and Regional Affairs
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADL	Alaska Department of Labor
ADNR	Alaska Department of Natural Resources
ADR	Alaska Department of Revenue
AEIDC	Arctic Environmental Information and Data Center
AOU	American Ornithological Union
BBCMP	Bristol Bay Cooperative Management Plan
BLM	Bureau of Land Management
CFEC	Commercial Fisheries Entry Commission
CIRPT	Cook Inlet Regional Planning Team
EPA	Environmental Protection Agency
EPS	Environmental Protection Service (Canada)
ERL	Environmental Research Laboratory
FAO	Food and Agriculture Organization of the United Nations
GMS	Game Management Subunit
GMU	Game Management Unit
IMS	Institute of Marine Science
INPFC	International North Pacific Fisheries Commission
IPHC	International Pacific Halibut Commission
IUCN	International Union of Conservation of Nature and Natural Resources
ISEGR	Institute of Social, Economic and Government Research
LCI	Lower Cook Inlet
MMS	Mineral Management Service
NEGOA	Northeast Gulf of Alaska
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

NPFMC	North Pacific Fishery Management Council
NPS	National Park Service
NWAFC	Northwest and Alaska Fisheries Center
NWR	National Wildlife Refuge
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OMPA	Office of Marine Pollution Assessment
PWS	Prince William Sound
PWSRPT	Prince William Sound Regional Fisheries Planning Team
UCI	Upper Cook Inlet
USDC	United States Department of Commerce
USDA	United States Department of Agriculture
USDI	United States Department of Interior
USDL	United States Department of Labor
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

C. Wildlife Management Goals and Objectives

The following are the goals and subgoals that form the basis for wildlife management by the Alaska Department of Fish and Game. The first goal applies to all species managed by the department. Application of the second goal and the selection of one or more of its subgoals varies by species and/or area managed.

Outline: WILDLIFE MANAGEMENT GOALS*

I. TO PROTECT, MAINTAIN AND ENHANCE WILDLIFE POPULATIONS AND THEIR HABITATS FOR THEIR INTRINSIC AND ECOLOGICAL VALUES SO ESSENTIAL TO THE MAINTENANCE OF A HEALTHY ENVIRONMENT AND THE WELFARE OF MAN.

II. TO PROVIDE FOR OPTIMUM BENEFICIAL USE OF WILDLIFE BY MAN.

   A. To provide for subsistence use of wildlife by Alaskan residents dependent on wildlife for sustenance.

   B. To provide for diversified recreational uses of wildlife.

   C. To provide for scientific and educational use of wildlife.

   D. To provide for commercial use of wildlife.

* Source: 1980 ADF&G Wildlife Management Goals.

WILDLIFE MANAGEMENT GOALS

I. TO PROTECT, MAINTAIN AND ENHANCE WILDLIFE POPULATIONS AND THEIR HABITATS FOR THEIR INTRINSIC AND ECOLOGICAL VALUES SO ESSENTIAL TO THE MAINTENANCE OF A HEALTHY ENVIRONMENT AND THE WELFARE OF MAN.

Wildlife and man are interdependent constituents of an environment shared with all other living things. Recognition of this fundamental relationship is reason enough to preserve wildlife and to maintain its natural role in the environment. In addition, there is great value in assuring for man's benefit and enjoyment the continuance of an environment as biologically rich and diverse in the future as in the present. For the people of the State and the Nation Alaska's wildlife is an invaluable source of inspiration, sustenance, and recreational and economic benefits. It is capable of providing benefits to man in perpetuity if its welfare is safeguarded. Because wildlife is especially vulnerable to human activities, it requires the most careful stewardship man can provide.

The foremost consideration in protecting and maintaining indigenous wildlife populations is providing habitat in the amount, kind and quality necessary to meet the requirements of wildlife species. Wildlife populations cannot survive without adequate habitat, and efforts to protect animals directly without also protecting their habitat or correcting habitat deficiencies often prove to be ineffectual.

Alteration of habitat is one primary way man affects wildlife populations. Although some species can inadvertently benefit from certain habitat alterations resulting from man's activities, many others can be adversely affected. Long-term habitat degradation usually results in reduced numbers and fewer species of wildlife. Even where habitat are purposely modified to benefit populations of particular species, reductions in populations of other species may be unavoidable.

Protection, maintenance, and manipulation of wildlife habitat are important management activities of the Department. Important wildlife habitats will be identified and protective legislation, classification or designation of such habitats will be sought. Land management agencies, organizations, and individuals will be encouraged to protect wildlife habitats from degradation or to minimize adverse impacts of development or other land uses on land under their control. Where appropriate, habitat may be restored or improved to enhance selected wildlife populations.

Wildlife as well as its habitat must be protected from the detrimental influences of man. Disturbances injurious to wildlife must be minimized. Competition and conflicts with domestic animals must also be minimized and the introduction of undesirable exotic animals avoided. The introduction of diseases carried by domestic animals, transplanted wild animals, or animals kept as pets must be prevented. Use of wildlife must be regulated to ensure that allowable use tolerances are not exceeded. Illegal and wasteful uses must be controlled to assure protection of the resource and to maximize human benefits from its use.

Greater public appreciation for and awareness of wildlife and its requirements are necessary for public support for effective programs to protect and benefit wildlife. Successful, progressive wildlife management requires objective decisions based on the best biological information that can be gathered by competent professionals.

II. TO PROVIDE FOR OPTIMUM BENEFICIAL USE OF WILDLIFE BY MAN

Optimum beneficial use of wildlife is that use which 1) does not adversely affect the wildlife populations, 2) results in desirable products of use, and 3) is based on desirable allocations of such products among users. Such use, in the aggregate, serves to maximize benefits to be people of Alaska and the Nation.

Depending on the objectives of management, there are many levels and kinds of use which can be considered "optimum". Wildlife can support a variety of uses on a continual basis so long as its capability to sustain such use is not impaired. Because values placed upon wildlife vary, management must provide opportunities for an array of different uses if benefits are to be realized by all concerned. Also, because there are finite limits to wildlife populations and the uses they can support, management must provide for simultaneous uses wherever possible if benefits are to be optimized. Although different uses are generally compatible, some conflicts do occur, and sometimes provision for some uses may require the exclusion of others. Regulatory separation of incompatible uses in time and space can reduce conflicts and facilitate an optimum level and mix of beneficial uses.

Attainment of the following subgoals should ensure that the people obtain optimum beneficial use from Alaskan wildlife.

SUBGOAL A. To provide for Subsistence Use of Wildlife by Alaskan Residents Dependent on Wildlife for Sustenance.

Direct domestic utilization of wildlife is important to many residents for sustenance and to many other citizens as a valuable food supplement. Beyond directly satisfying food requirements, domestic utilization of wildlife helps preserve Alaskan cultures and traditions and gives gratification to the strong desire of many Alaskans to harvest their own food. These attributes of subsistence use are considered genuinely important to the physical and psychological well-being of a large number of Alaskans. Accordingly, subsistence receives priority among the various beneficial human uses.

Within legal constraints and the limits of resource capabilities, wildlife will be allocated to subsistence users on the basis of need. Needs of individuals, families, or cultural groups differ in type and degree and it is recognized that subjective judgement will be an unavoidable necessity in establishing actual need. Elements considered in establishing the level of need include cultures and customs, economic status, alternative resources (including availability of social services), place of residence, and voluntary choice of life style. Limitations on the productivity of wildlife stocks may limit continued increases in the number of subsistence users.

In some circumstances subsistence users also may be participants in recreational or commercial harvesting. Where subsistence users can satisfy their needs by recreational or commercial methods, special regulations for subsistence priority should be achieved by existing regulatory techniques, such as open and closed seasons, bag limits, control of methods and means of take, and controlled use areas. Even when special regulations are necessary, commercial and recreational uses might not need to be prohibited entirely prior to any restrictions on subsistence uses. But, in any case, traditional and customary subsistence users would continue to receive a priority harvest opportunity in regulatory systems.

Management of wildlife populations for subsistence use may involve manipulation of the numbers and/or sex and age structure of the population. Where possible, differential use or sex or age segments of wildlife populations will be used to accommodate subsistence or other use demands. Wildlife populations generally will be managed to optimize sustained productivity. Recreational and commercial uses will be permitted where and to the extent that they do not interfere with or preclude subsistence resource use.

SUBGOAL B. To Provide for Diversified Recreational Uses of Wildlife

In many areas of the state, recreation, in its various forms, is the dominant use of wildlife. In addition to sport hunting and trapping, recreational uses include observation and photography, both incidental to other activities and as the primary objectives, and wilderness experience, including the aesthetic rewards of being aware of or observing animals in natural interactions with their environment. The Department has the responsibility to provide for these diverse, yet generally compatible uses.

The emphasis of management for recreational use will be to provide opportunities for varied recreational experiences rather than to maximize the yield of animals, even though success in observing or taking animals is recognized as an important element in user satisfaction. Varied experiences are often provided through *de facto* differences in biological, physical, and demographic characteristics of various areas and through regulated factors such as participation rates, methods and means of use, timing of use, and bag limits.

Quality of experience is an important concern to many recreational users. Although aesthetics are a matter of individual preference, elements of quality most commonly identified include low user densities, controlled methods of transport, undisturbed wilderness character, minimal intrusions by other users, and a reasonable expectation of success. The opportunity to observe or be selective for large animals is another aesthetic consideration which may add significantly to the recreational experience.

At the other end of the recreational use spectrum are those uses allowing unrestricted opportunities for user participation. Beyond limiting use to optimum sustained yield levels, management for maximized opportunity provides for unlimited participation and traditional freedom of choice of access methods.

SUBGOAL C. To Provide for Scientific and Educational Use of Wildlife.

The Alaskan environment, including its wildlife, is a unique natural laboratory for the scientific study of ecosystems and wildlife biology, and for the educational enrichment of the people. Such studies are necessary to achieve a scientific basis for identifying and evaluating management options. Scientific study and education have taken place in many areas of Alaska, reflecting the general compatibility of such use with other uses of wildlife. Occasionally, undisturbed or closely controlled conditions are necessary study requirements and justify the designation of areas primarily for scientific and educational purposes. Requirements for such actions specify the extent to which other uses, both consumptive and nonconsumptive, would be encouraged or restricted. In some cases, intensive population or habitat manipulation may be necessary to achieve study objectives.

SUBGOAL D. To Provide for Commercial Use of Wildlife.

Commercial use of wildlife includes the direct consumptive and non-consumptive use of animals where sale of the products or by-products of animals is the primary objective. Indirect commercial use includes services which support recreational or other noncommercial users, and marketing systems utilized for wildlife products. Direct commercial use of wildlife in Alaska today is limited primarily to furbearers and marine mammals which have traditionally supported such use. Principal service industries include guiding, taxidermy, meat processing, photography, and wildlife-related tourist services.
Commercial uses of furbearer and marine mammal resources, responsible for much of the early exploration and settlement of Alaska, still support important industries in rural areas of the state and provide needed supplemental income to many bush residents. However, changing economic and social values and the increasing importance of recreational uses generally are reducing the relative economic importance of direct commercial uses of wildlife. On the other hand, industries serving the continually growing recreational uses of wildlife are becoming more important.

Management will provide for commercial use of wildlife only when it does not threaten the welfare of any wildlife resource, when it is in the economic interest of the people of Alaska, and when it is compatible with other uses. Where commercial use conflicts with other uses it will usually be restricted or eliminated in favor of other uses. Commercial activities which depend on recreational users will usually be restricted or eliminated in favor of other uses. Domestication of wildlife for commercial purposes usually will be opposed, but where allowed it will be strictly regulated to prevent abuse to the resource or inhumane treatment of individual animals.

WILDLIFE MANAGEMENT OBJECTIVES*

Based on these wildlife management goals and subgoals, objectives for the strategic management plans of individual species are selected from the following:

> To protect, maintain, and enhance the (species) population in concert with the components of the ecosystems and to assure its capability of providing sustained opportunities to
>
> 1) view and photograph wildlife;
> 2) subsistence use of wildlife;
> 3) participate in hunting wildlife;
> 4) hunt wildlife under aesthetically pleasing conditions;
> 5) be selective in hunting wildlife;
> 6) scientific and educational study of wildlife;
> 7) commercial use of wildlife;
> 8) protect human life and property in human-wildlife interactions.

Management objectives vary not only according to the concerned species, but also, in many cases, according to the areas involved and the demands made upon the wildlife resource. Because these demands can change with the passage of time, particular management objectives may need to be revised.

Examples of management guidelines are presented in the individual strategic management plans. These guidelines are used to qualify or quantify in a more specific way the recommended management under a specific set of objectives for any particular area. The guidelines are statements about the following:

1. The wildlife population: its size, sex, age structure, and productivity.
2. Use: season length and timing, bag limits, number or distribution of hunters or other users, access, transport, viewing, and aesthetic enjoyment.
3. Habitat: alteration or protection.

* Departmental memo, ADF&G, Division of Game, June 14, 1980.

D. Sea Ice

I. DEFINITIONS OF ICE TERMS

This selective list of ice-related terms is taken from the Handbook for Sea Ice Analysis and Forecasting (Stringer et al. 1984) and is consistent with World Meterological Organization definitions (Stringer, pers. comm.). Terms are arranged to describe the various stages of growth of ice and the various forms and conditions of ice.

New ice. This term includes frazil ice, slush, grease ice, and shuga, all categories of ice up through a thickness of 10 cm. Only grease and slush ice will be defined here.

Slush. Slush is snow that has fallen into sea water that is colder than the snow's melting point, thus creating a viscous floating mass of ice crystals in the water.

Grease ice. When the fine needles, or platelets, of ice first formed in the freezing process (frazil ice) coagulate to form a soupy layer at the sea surface, it reflects less light, has a dark matte appearance, and is called grease ice.

Pancake ice. When new ice (or occasionally even thicker ice) is broken up by swells, roughly circular pieces from 30 cm to 3 m in diameter and up to 10 cm thick often form. These pancakes have a raised rim as a result of striking and rubbing against each other in the swell.

Young ice. The thickness of young ice ranges from 10 to 30 cm. It is subdivided into gray ice (10-15 cm, likely to raft under pressure) and gray-white ice (15-30 cm, likely to break up and form a pile or ridge of broken ice under pressure).

First-year ice. Young ice that is greater than 30 cm in thickness but that has not gone through a melt season is called first-year ice.

Old ice. Old ice has survived at least one melt season and is divided into second-year ice and multiyear ice, although the term multiyear ice is often used to refer to all old ice. Old ice is stronger than ice that has not been through a melt season, when pockets of brine trapped in the ice during the freezing process drain.

Fast ice. Also called landfast ice, fast ice is sea ice that has formed along or become attached to the shore or shoals and that does not move horizontally with respect to the shore, although it may move vertically with fluctuations in sea level. Fast ice can form in place or can be from the attachment and consolidation of individual floes of any age. It may extend a few meters or several kilometers from shore. In shallow water, fast ice may be attached to the bottom (anchor ice) but in deeper water, especially toward its seaward edge, it may be floating.

Flaw. The flaw is the line between the fast ice and drift ice. A variety of conditions may be found in the flaw zone. It may consist of a series of polynyas (see definition below) along the fracture separated by linear regions where drift ice has been piled into a shear ridge (see definition below). Regions of the flaw may be filled with small pieces of floating ice (brash ice) or may refreeze with new or young ice.

Drift ice. This very broad term includes any ice other than fast ice regardless of its arrangement.

Pack ice. Pack ice is drift ice that covers 70% or more of the sea surface.

Fracture. A fracture is any break or rupture, regardless of width, through fast ice, pack ice covering 90% or more of the sea surface, or even a single ice floe. Fractures may be filled with brash ice or young ice. The sides of a fracture usually look as though they could be rejoined to form a uniform ice sheet.

Crack. A fracture less than 1 m in width is a crack.

Lead. A lead is a fracture sufficiently wide to permit navigation by surface vessels. A shore lead or flaw lead is located between the drift ice and the fast ice. The term lead is often incorrectly used interchangably with fracture.

Polynya. A polynya is an irregularly shaped opening enclosed by ice. As opposed to a fracture, the sides of a polynya could not be refitted to form a uniform ice sheet. Polynyas may contain brash ice or young ice. A recurring polynya is one that occurs at approximately the same location every year.

Shear ridge. Shear ridges are usually sinuous piles of ice created as a result of differential motion between two regional ice bodies (often the drift ice against the fast ice). The shear zone is an area of many parallel bands of piled ice, often with vertical walls 2 to 3 m in height.

Pressure ridge. Pressure ridges are relatively short, somewhat irregular piles of ice and are usually more local in nature than shear ridges. They are usually the result of purely compressional forces within the ice rather than of compression plus sliding.

Rough or flat ice. The topography of both fast ice and drift ice is described subjectively by the terms rough or flat ice but can be more precisely defined by giving the percentage of the ice within the area of interest that is deformed from the horizontal and the relief or height of the deformed areas.

II. THE ICE YEAR

The following discussion is taken primarily from Burns et al. (1981) and Stringer et al. (1980) and the references therein.

A. Autumn.

In September or early October, new ice begins to form inshore in the Beaufort Sea, beginning earlier in the west than in the east. In most years, extensive new ice forms in the Chukchi Sea by mid October and by late November or December in the northern Bering Sea. Up to a month before the formation of new ice in the Bering Sea, a few large chunks of multiyear ice from the polar pack drift southward through Bering Strait; they often strand on the north coast of St. Lawrence Island. Surface waters may become supercooled with the frequent strong northerly winds and high seas, with anchor ice formed along exposed coasts and broad strips of grease and slush ice formed at sea parallel to the wind. During calm periods, vast areas of new and young ice form, which raft when compressed by subsequent wind and swells. Protected embayments (e.g., Kotzebue Sound, Port Clarence, Norton Bay) are the first to be iced over completely.

B. Winter.

The winter drift ice is a highly dynamic ice sheet that moves primarily southward. Primarily northerly and northeasterly winds push it against the northern coasts of Alaska and Chukotka, forming extensive masses of jumbled, grounded ice inshore. Although some movement of ice in the Bering Sea is toward the north when the wind is from the south, the net transport of ice is toward the south in winter and early spring. As the drift ice pushes through Bering Strait, it is compressed into pressure ridges in the middle and shear ridges at the edges. South of the strait is a divergence zone, an area of low or no compression; numerous fractures and polynyas develop as the pack expands. New ice forms in the openings, adding to the mass of the pack as it advances.

Not all of the ice in the Bering Sea is derived from the Chukchi; most of it is generated in the Bering Sea itself. The prevailing northerly wind that piles ice in deep, dense masses on the north side of Chukotka, St. Lawrence Island, the Seward Peninsula, and St. Matthew and Nunivak islands also blows the ice away from their southern coasts, forming recurring polynyas where new ice continually is generated.

Near shore, especially in sheltered bays, a sheet of landfast ice forms; the flaw is the area where the relatively stable fast ice interacts with the moving pack ice. Depending on the rate and direction of movement of the pack, the flaw may be a narrow fracture a few millimeters wide or a zone tens of kilometers wide including large amounts of brash and new ice.

At its southern edge, the pack tends to be open and made up of smaller floes than farther north. Tongues of broken and melting ice extend several kilometers into the open sea, forming the ice "fringe." For several kilometers back into the pack from the fringe zone, the ice is subjected to ground swells from the open sea that break up large ice fields, creating large amounts of brash in the interstices and defining the ice "front" zone.

The principal general categories of sea ice habitats used by marine mammals are 1) fast ice, 2) persistent flaw, 3) polynyas that are centers of new ice formation, 4) divergence zones, and 5) the ice front.

C. Spring.

The sea ice generally reaches its southernmost limit for the year in late March or April. The maximum southern extent of the ice can vary by as much as 6° of latitude (about 665 km) from year to year but tends to be not far from the southern edge of the continental shelf in most years.

Although the ice continues to move generally southerly and southwesterly in April, leads and polynyas become larger because the increasing temperature precludes the formation of new ice in polynyas and divergence zones. By late April, winds in the Bering Sea become more variable and weaker, and the ice stops moving south. By mid to late May, rising surface water temperatures have melted thin ice, and numerous holes have formed in thicker floes. In years of maximal advance of the ice (heavy ice years), the rate of melting of the pack is slower than in years of less extensive ice formation. By the end of May, the ice sheet that covered nearly the entire shelf of the Bering Sea is reduced to a few rafted remnants of heavy, broken ice that cover less than one-fourth of that area, and these too disappear in June or early July.

In the Chukchi Sea, the pack remains largely intact through April, although the flaw along the Alaskan coast becomes more persistent and ice-free in March and April. Slightly later, an increasingly evident east-west fracture pattern develops in the southern Beaufort Sea from Barrow toward Banks Island. Usually by late May or early June, the southern part of the Chukchi pack loosens significantly, probably due to the influx of warmer water from the now nearly ice-free Bering. By the end of July,the Chukchi pack is usually reduced to one-third or less of its former extent, and by August, even the Beaufort shows extensive opening.

D. Summer.

The ice sheet is at its annual minimum in late summer, when it exists primarily over the abyssal part of the Arctic Ocean but also extends southward over the continental shelves of the northernmost continents and islands. It is relatively thick and old, comprised mostly of multiyear accumulations of sea ice and glacial ice from the Greenland and Ellsmere ice caps. The polar pack moves generally clockwise around the polar basin (i.e., from east to west off northern Alaska). The average rate of movement of the polar pack relatively nearshore in the Beaufort Sea is on the order of 10 km/day.

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