INVESTIGATIONS OF BELUKHA WHALES IN COASTAL WATERS OF WESTERN AND NORTHERN ALASKA

I. DISTRIBUTION, ABUNDANCE, AND MOVEMENTS

by

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Final Report
Outer Continental Shelf Environmental Assessment Program
Research Unit 612

November 1986

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

Belukha whales are widely distributed in the marine waters of western and northern Alaska. Seasonal movements are pronounced. During winter belukhas occur principally in the seasonal ice of the Bering Sea, although some may overwinter in the southern Chukchi Sea. Optimal habitat occurs in areas with leads, polynyas, or other areas of predictably open water. The spring migration begins in March and April. Some whales move eastward appearing in coastal waters of Bristol Bay in early April. Others move northward through Bering Strait and through the lead system which extends along the Chukchi Sea coast from Point Hope to Barrow. They then continue north and eastward to Banks Island and Amundsen Gulf where they arrive in May and June. Some of these whales summer in the Mackenzie Delta while others are found offshore in the eastern Beaufort Sea.

Groups of belukhas appear at many locations along the coast of western Alaska shortly after the ice breaks up and moves offshore. Large concentrations are regularly seen near the mouths of the Yukon River, in inner Norton Sound, in Kotzebue Sound, and near Kasegaluk Lagoon. Belukhas have been seen in the Yukon River more than 1200 km upstream from the river mouth.

The abundance of belukhas in coastal waters decreases markedly after August. Large numbers of whales are seen moving westward in the Beaufort and northeastern Chukchi seas in late August and September. During this westward, fall migration the belukhas are associated with the pack ice which is usually 50-100 km north of the Beaufort Sea coast. The path of the migration southward through the Chukchi Sea is poorly known. Whales pass south through Bering Strait during October and November.

Belukhas occur in all proposed Outer Continental Shelf (OCS) lease areas. The Saint Matthew-Hall, Saint George, Navarin, and North Aleutian basins include much of the winter habitat. The spring migration passes through the Norton Basin, Hope Basin, Barrow Arch, and Diapir Field lease areas. Major summer concentrations occur in the North Aleutian Basin, Norton Basin, Hope Basin, and Barrow Arch. During the fall migration very large numbers of belukhas pass through the Diapir Field and Barrow Arch.

Although belukhas still occur in all areas where they were known to occur historically, some distributional shifts have occurred. These are particularly evident in Kotzebue Sound. Increased human activity in the coastal zone may be, in part, responsible for these changes.

The abundance and interrelationships among groups of belukhas are poorly known. Based on available sightings, it appears that belukhas seen in Norton Sound and near the mouths of the Yukon River comprise a single group. Provisionally, the belukhas which summer in the eastern Chukchi Sea are also considered a single group which is seen sequentially at several locations. It is suggested that belukhas in western and northern Alaska comprise four stocks as follows: Bristol Bay - 1,000-1,500 animals; Norton Sound - 1,000-2,000 animals; eastern Chukchi

Sea - 2,500-3,000 animals; eastern Beaufort Sea - 11,500 animals. The minimum total number of animals which pass through the waters adjacent to Alaska is estimated as 13,500-18,000. Considering that belukhas also occur in waters of the USSR, the actual abundance of whales in the Bering, Chukchi, Beaufort, and East Siberian seas may be in excess of 25,000.

ACKNOWLEDGEMENTS

This study was funded primarily by the National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program. Additional support was provided by the Alaska Department of Fish and Game (ADF&G), and the Federal Aid in Wildlife Restoration Program.

This study of belukha distribution did not have the benefit of funding for systematic surveys. Our results and conclusions therefore result from a compilation of many observations from various sources. We thank all the pilots, hunters, fishermen, biologists, and Alaskan residents who have recorded their observations of belukhas and made them available to us. Major contributions were made by John J. Burns, Francis H. Fay, Don K. Ljungblad, and Robert R. Nelson. John Burns was responsible for most aspects of project management and provided editorial comments on the report. Figures were prepared by Jesse Venable.

WORLD DISTRIBUTION

Belukha whales (Delphinapterus leucas) are widely, though not uniformly distributed throughout most seasonally ice-covered waters of the northern hemisphere (Figure 1) . They are circumpolar, occurring off North America, Europe, and Asia (Kleinenberg et al. 1964). Based on a knowledge of seasonal patterns of movement and concentration areas, the presence of major though not complete geographical barriers, and differences in size of adult animals in different areas, it is likely that belukhas occur in a number of somewhat discrete populations and stocks in various parts of their range (Sergeant and Brodie 1969; Gurevich 1980).

In general, belukhas spend the winter in ice-covered offshore waters. They are unable to make and maintain breathing holes in ice more than about 8 cm thick so are found in areas where geographic, oceanographic, or meteorologic factors cause ice motion and the formation of openings (Kleinenberg et al. 1964; Burns et al. 1981). In spring, as soon as the ice begins to break up and move offshore, belukhas move toward the coast, some making extensive migrations in excess of 2,000 km and some moving relatively short distances toward shore. Most belukhas appear to spend most of the summer in coastal waters, especially in shallow bays or estuaries of large rivers, although an unknown proportion of some populations may remain associated with offshore pack ice. In late summer to late autumn they move generally away from the coast, ahead of or with advancing pack ice (Kleinenberg et al. 1964) .

In the eastern hemisphere belukhas occur regularly and in substantial numbers in the White, Barents, Kara, Laptev, East Siberian, and Okhotsk seas (Bel'kovich 1960; Kleinenberg et al. 1964; Ognetov and Potelov 1982) . They are sometimes present off the coasts of Norway, Holland, Denmark, and West Germany, and in cold winters have been sighted as far south as Great Britain (Tomilin 1957; Gurevich 1980).

Belukhas regularly occur throughout the north Atlantic and eastern Canadian Arctic north to 82°30'N near Ellesmere Island, western Greenland, and Spitsbergen and south to the Gulf of Saint Lawrence. They are occasionally present near the coast of Nova Scotia in the Bay of Fundy, and are rare off Labrador and Newfoundland. They are most abundant in Davis Strait, Baffin Bay, Ungava Bay, Hudson Bay, Hudson Strait, Foxe Basin, Lancaster Sound, Prince Regent Inlet, Barrow Strait, Peel Sound, Cumberland Sound, and Jones Sound and have also been observed near Iceland and Jan Mayen (Kleinenberg et al. 1964) . The most southern extralimital record along the east coast of North America is from Avalon, New Jersey (38°55'N). Locations of other extralimital sightings from the east coast include Maine, Massachusetts, and Long Island (Reeves and Katona 1980).

In the western arctic belukhas are found in the Beaufort Sea, Amundsen Gulf, and M'Clure Strait, and westward to the East Siberian Sea (Kleinenberg et al. 1964). Western arctic belukhas are apparently separated from those to the east by heavy pack ice which occurs in the western Canadian arctic islands (Sergeant and Brodie 1975). Belukhas are also found in the Chukchi, Okhotsk, and Bering seas, the latter including the Gulf of Anadyr and Bristol Bay. A small apparently

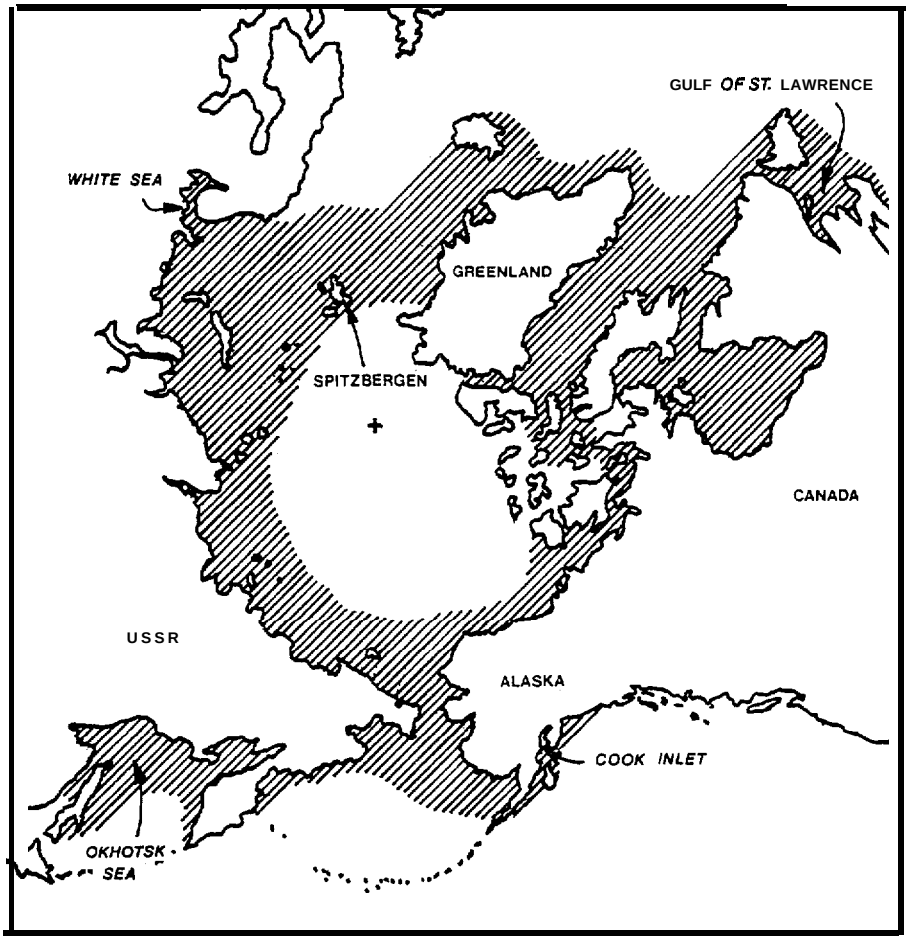

Figure 1. Current world distribution of belukha whales, not including extralimital occurrences.

separate stock occurs in Cook Inlet (Seaman and Burns 1981). In the eastern North Pacific region, extralimital occurrences have been reported from as far south as Tacoma, Washington (47°15'N)(Scheffer and Slipp, 1948).

GENERAL DISTRIBUTION IN ALASKA

Belukhas in Alaska are considered to comprise two populations. One has a center of abundance in Cook Inlet where they are numerous throughout the year (Klinkhart 1966). They are known to range into the northern Gulf of Alaska from at least Kodiak Island to Yakutat Bay (Harrison and Hall 1978). Seasonal movements are poorly known; however, concentrations occur each summer near mouths of rivers flowing into Cook Inlet from the north and east. This project has not dealt with the Cook Inlet population and it will not be considered in the remainder of this report.

The second, much larger group of belukhas ranges seasonally through the Bering, Chukchi, Beaufort, and at least parts of the East Siberian seas. During winter these whales occur throughout the ice fringe and front from the Alaska coast to Siberia, as well as in more northerly regions of the Bering and Chukchi sea pack ice where open water regularly occurs (Kleinenberg et al. 1964; Fay 1974; Seaman and Burns 1981). As the ice recedes in spring, a large segment of the population moves north, some of them passing Point Hope and Point Barrow during April to June (Braham and Krogman 1977; Fraker 1979). Those belukhas are thought to mostly migrate eastward through offshore leads in the Beaufort Sea, then south along the west coast of Banks Island to Amundsen Gulf, then west to the Mackenzie River estuary where they appear in late June (Sergeant and Hock 1974; Fraker et al. 1978; Fraker 1980). Ice conditions allow late migrants to utilize a more direct route to the estuary. Other belukhas migrate less extensively and are seen in coastal waters of the Bering and Chukchi seas shortly after ice breakup in spring. During the summer months belukhas occur in the Bering, Chukchi, and Beaufort seas, primarily in coastal waters and the broad margin of pack ice. Major concentrations in western North American waters occur in Mackenzie Bay, Kugmallit Bay, off Kasegaluk Lagoon, in Kotzebue Sound, Norton Sound (including the Yukon River estuary), and Bristol Bay. They have been recorded in major river systems several hundred kilometers from the ocean (Kleinenberg et al. 1964; Gurevich 1980; ADF&G, unpublished). Belukhas leave the coastal zone in late summer to late autumn. Animals in the northern part of their range move southward ahead of and with the advancing ice pack, most of them passing through Bering Strait and into the Bering Sea (Fay 1974; Seaman and Burns 1981).

SEASONAL DISTRIBUTION IN ALASKA

We have compiled available distribution information for belukhas in the Bering and Chukchi seas, the Beaufort Sea, including Mackenzie Bay, and the eastern part of the East Siberian Sea (see also Gurevich 1980 for a review of the seasonal distribution of belukhas in Siberian waters). Data have been compiled by two-month periods beginning in January and are summarized in Figures 3-8. Major locations are shown in Figure 2.

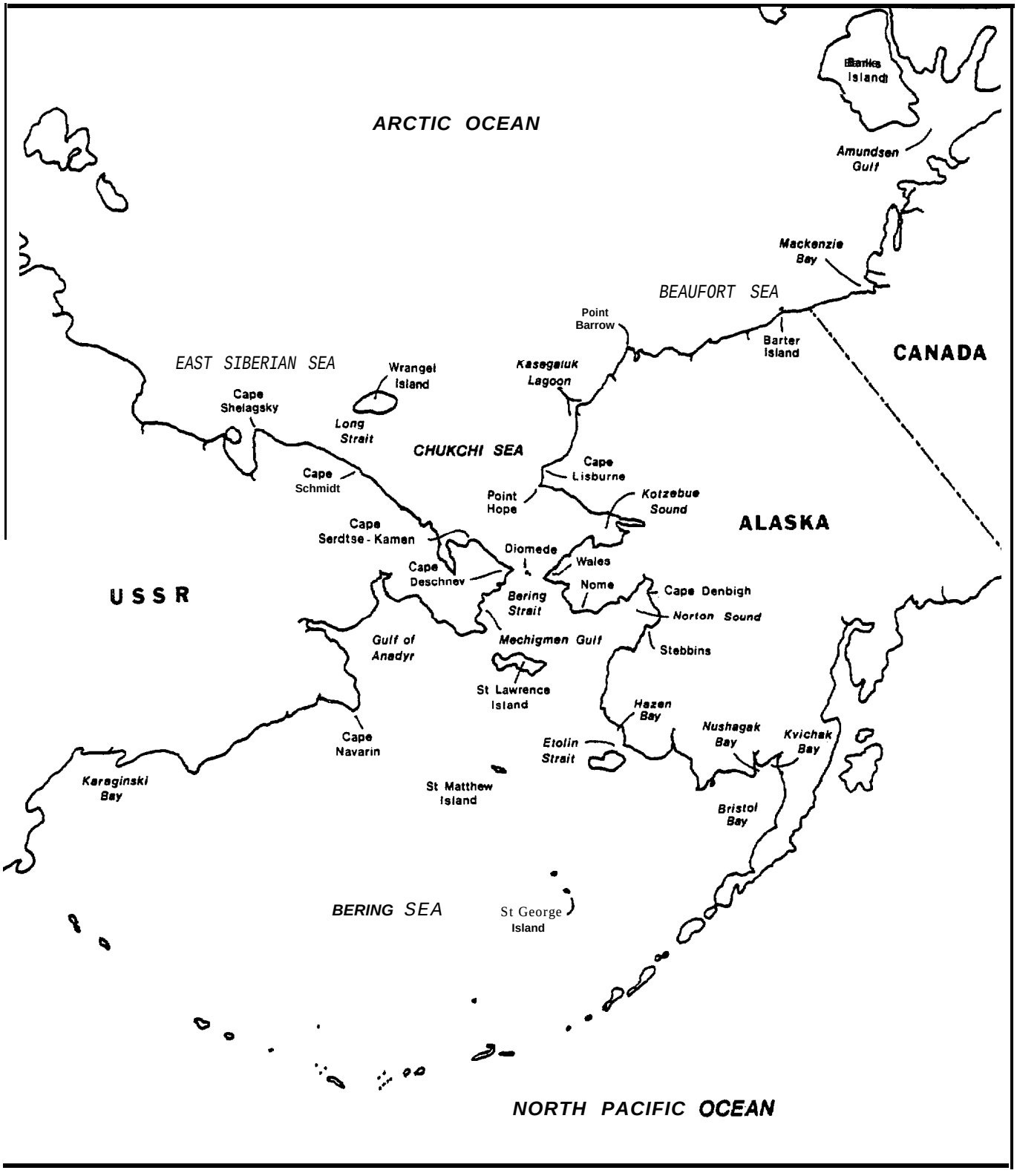

Figure 2. Map of the Bering, Chukchi, and Beaufort seas showing major locations mentioned in the text.

January-February (Figure 3)

Belukhas overwinter in both the Bering and southern Chukchi seas. Most midwinter sightings have been made from Point Hope and coastal villages to the south. Belukhas probably do not regularly overwinter in the Beaufort or northern Chukchi seas since the ice cover there is heavy, without extensive leads, polynyas, or other areas of predictably open water (Fay 1974). They may occasionally become entrapped by ice, however, and be forced to remain in unsuitable regions (Freeman 1968). Mortality in such instances is probably high (Porsild 1918; Freeman 1968).

During January-February in the southeastern Chukchi Sea, belukhas have been observed from Point Hope to Bering Strait. Sightings have been by residents of Point Hope, Shishmaref, Wales, and Diomede. Winter distribution in the Chukchi Sea is probably variable depending on annual severity of ice conditions. Along the southwestern Chukchi coast they have been reported during winter from Cape Dezhnev (East Cape) and Serdtse Kamen Cape (Kleinenberg et al. 1964). In the Bering Sea they occur in Mechigmen Gulf and Provideniya Bay on the Siberian coast, south and west of Saint Lawrence Island, and occasionally along the Alaskan coast from Norton Sound to Bristol Bay. In Bristol Bay belukhas are rarely seen by coastal residents during the coldest winter months (Brooks 1954; ADF&G, unpublished). They generally occur in the outer regions of Bristol Bay and the Bering Sea at that time (Lensink 1961).

March-April (Figure 4)

Observations from March and April indicate that belukhas are widely distributed in the Bering and Chukchi seas. They are present along the southern edge of the seasonal sea ice from Bristol Bay westward (Seaman and Burns 1981). Although sightings are widely dispersed throughout ice-covered regions of Bristol Bay and the Bering Sea, the greatest number of sightings has been in western Bering Sea from the ice edge to Bering Strait, including southeast of Saint George Island, south and southwest of Saint Matthew Island, around Saint Lawrence Island, and around the Diomede Islands and Cape Prince of Wales (Kenyon 1972; Braham et al. 1984; ADF&G, unpublished). On the Siberian side they have been observed from Cape Navarin, Mechigmen Gulf, Serdtse Kamen Cape, and Cape Dezhnev (Kleinenberg et al. 1964; Seaman and Burns 1981).

Belukhas in large numbers are first seen in nearshore waters of Bristol Bay in April as areas become ice-free, frequently congregating at or near the mouths of large rivers to feed and sometimes ascending the rivers until their upstream movements are impeded by ice (Brooks 1956; Frost et al. 1983a; Frost and Lowry, unpublished). They appear north of Bristol Bay along the coast in Etolin Strait and Hazen Bay in April, and are also commonly sighted off the shore ice in Norton Sound near Saint Michael, Shaktoolik, Cape Denbigh, Cape Nome, and the city of Nome.

Sightings in the Chukchi Sea in March and April occur mainly near the coast from Bering Strait to Cape Schmidt on the Siberian side and Point Barrow on the Alaskan side (Seaman and Burns 1981). The first sightings of belukhas off Point Hope are in March with larger numbers observed in

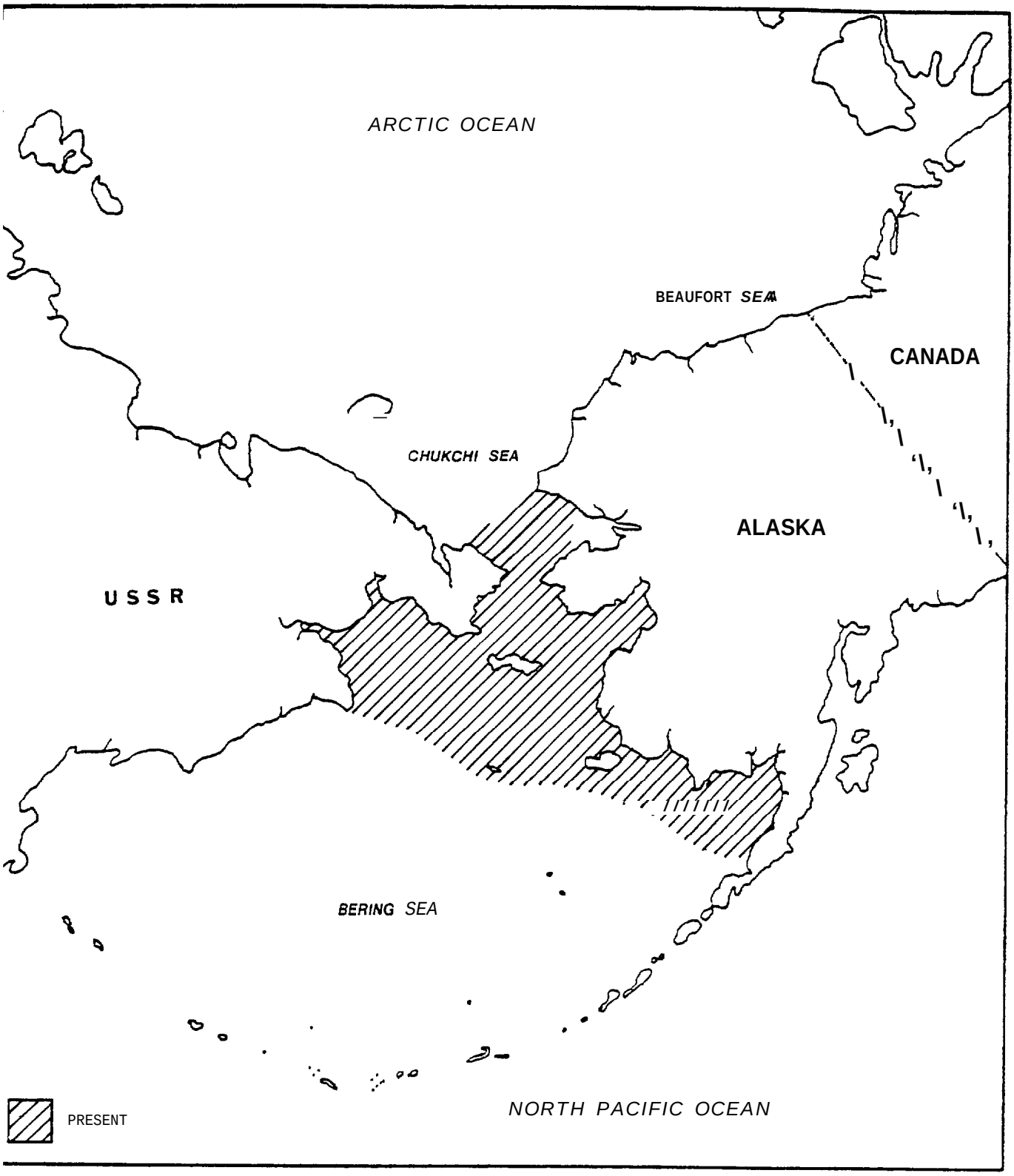

Figure 3. Distribution of belukha whales in January and February.

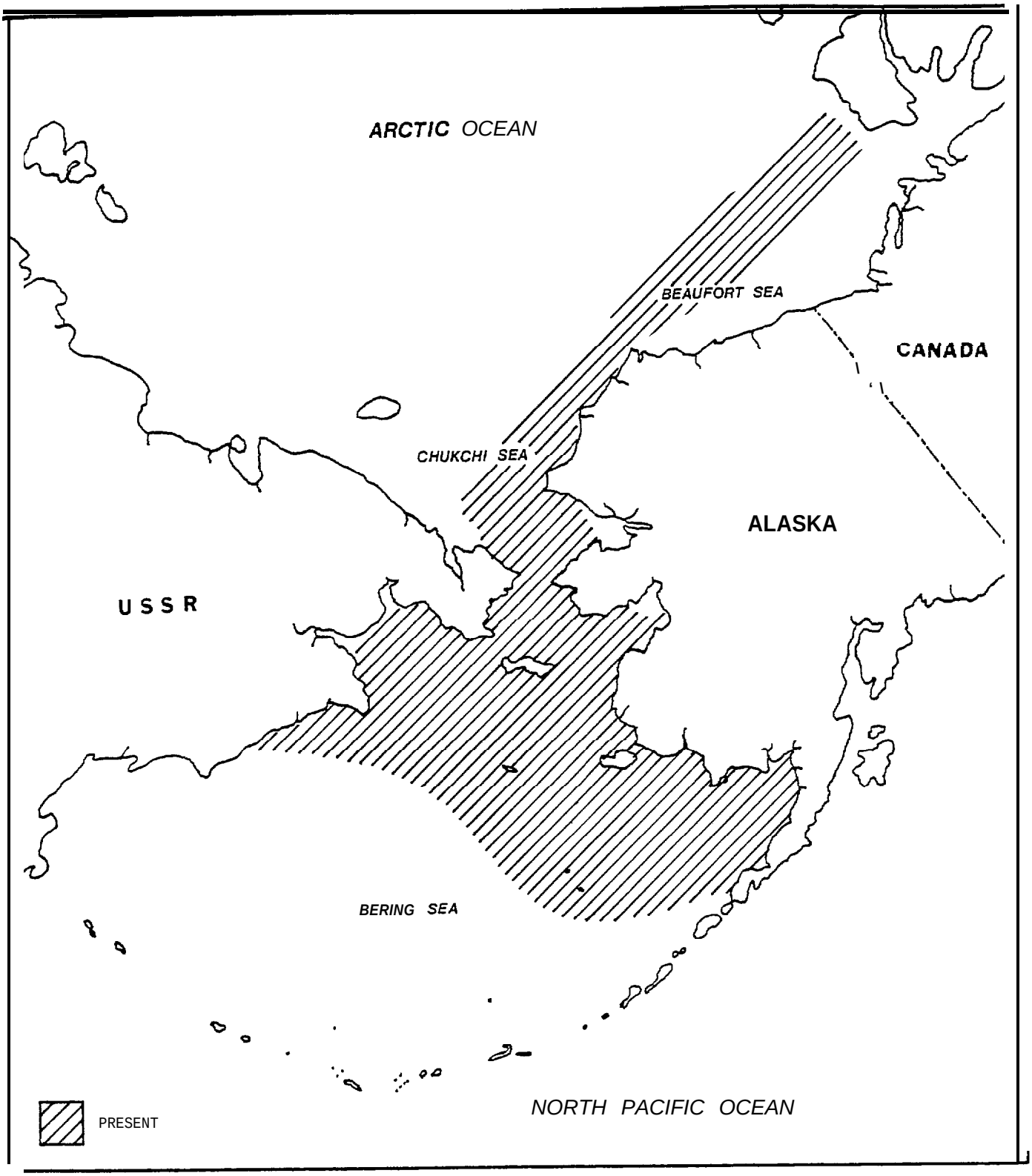

Figure 4. Distribution of belukha whales in March and April.

April and May (Marquette 1976, 1977, and 1979; Braham and Krogman 1977; Frost et al. 1983b). Belukhas first appear off Barrow in early to mid-April but most pass by in May (Braham and Krogman 1977; ADF&G, unpublished) .

May-June (Figure 5)

In May and June belukhas are still reported throughout the northern Bering Sea. However, there are fewer offshore sightings and the majority of sightings are relatively near shore. On the Siberian coast sightings occur along the coast from Cape Navarin to Cape Dezhnev (Tomilin 1957; Kleinenberg et al. 1964). In Alaskan waters belukhas occur from southeastern Bristol Bay to Bering Strait and northward past Point Barrow. Most sightings are from Bristol Bay and Norton Sound (Brooks 1954, 1955; Lensink 1961; Klinkhart 1966; Seaman and Burns 1981; Frost et al. 1983a).

By June many belukhas have moved northward into the Chukchi Sea and arrived in the eastern Beaufort Sea where they congregate near Banks Island and Amundsen Gulf before moving into the Mackenzie River estuary. Most sightings in the Chukchi Sea are from the Alaskan side, extending from Kotzebue Sound well into the Beaufort Sea northeast of Barrow (Childs 1969; Seaman and Burns 1981; Braham et al. 1984). Sightings during this period have also been made on the Siberian side near Serdtse Kamen and along the coast as far west as Cape Schmidt (Kleinenberg et al. 1964).

July-August (Figure 6)

July and August are the months during which peak use of coastal waters occurs in most areas. Along the Siberian coast belukhas are apparently rare in Karaginski Bay and common in the Gulf of Anadyr, western Bering Strait, and along the northern coast of the Chukchi Peninsula to the vicinity of Long Strait. There are few sightings during these months from the East Siberian Sea (Tomilin 1957; Kleinenberg et al. 1964). The distribution in Alaska during this period is generally continuous from Bristol Bay to the western Beaufort Sea and into Canadian waters of the eastern Beaufort Sea (Seaman and Burns 1981; Davis and Evans 1982) .

The largest number of sightings, and generally the largest groups of belukhas, are seen in inner Bristol Bay, particularly in Nushagak and Kvichak bays (Brooks 1955; Lensink 1961; Frost et al. 1983a); in Norton Sound near the Yukon River estuary, near Stebbins, Unalakleet, Shaktoolik, Koyuk, and Elim; in Kotzebue Sound; between Cape Lisburne and Point Barrow (mainly in and adjacent to Kasegaluk Lagoon) ; north of Barrow in late August and September (Seaman and Burns 1981; Frost et al. 1983b; ADF&G, unpublished); and in Canadian waters of the eastern Beaufort Sea (Fraker 1977). Groups of whales have also been sighted along the margin of the pack ice from Barrow southwest to Icy Cape and east to Barter Island (Harrison and Hall 1978; Braham et al. 1984; ADF&G, unpublished) .

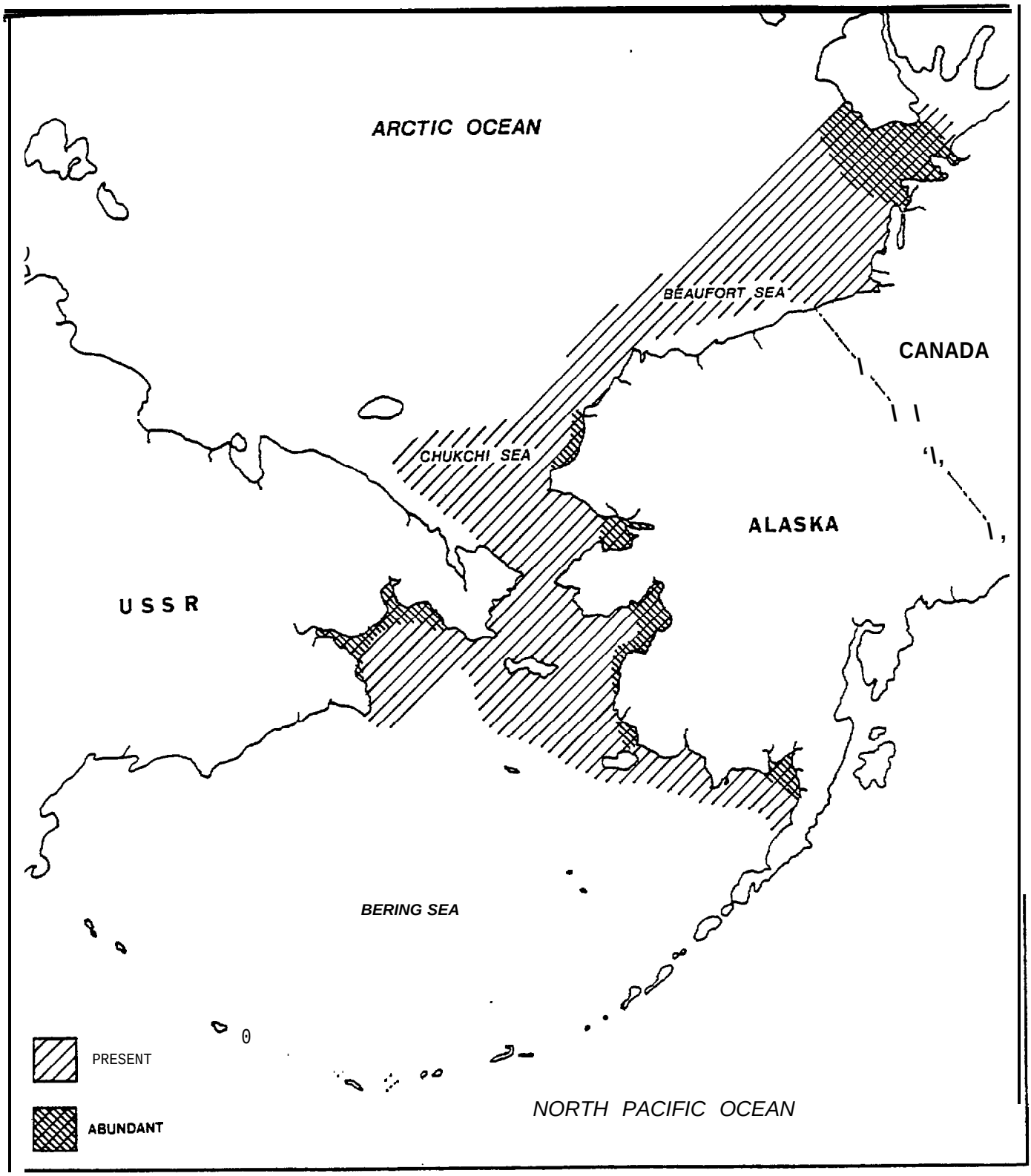

Figure 5. Distribution of belukha whales in May and June.

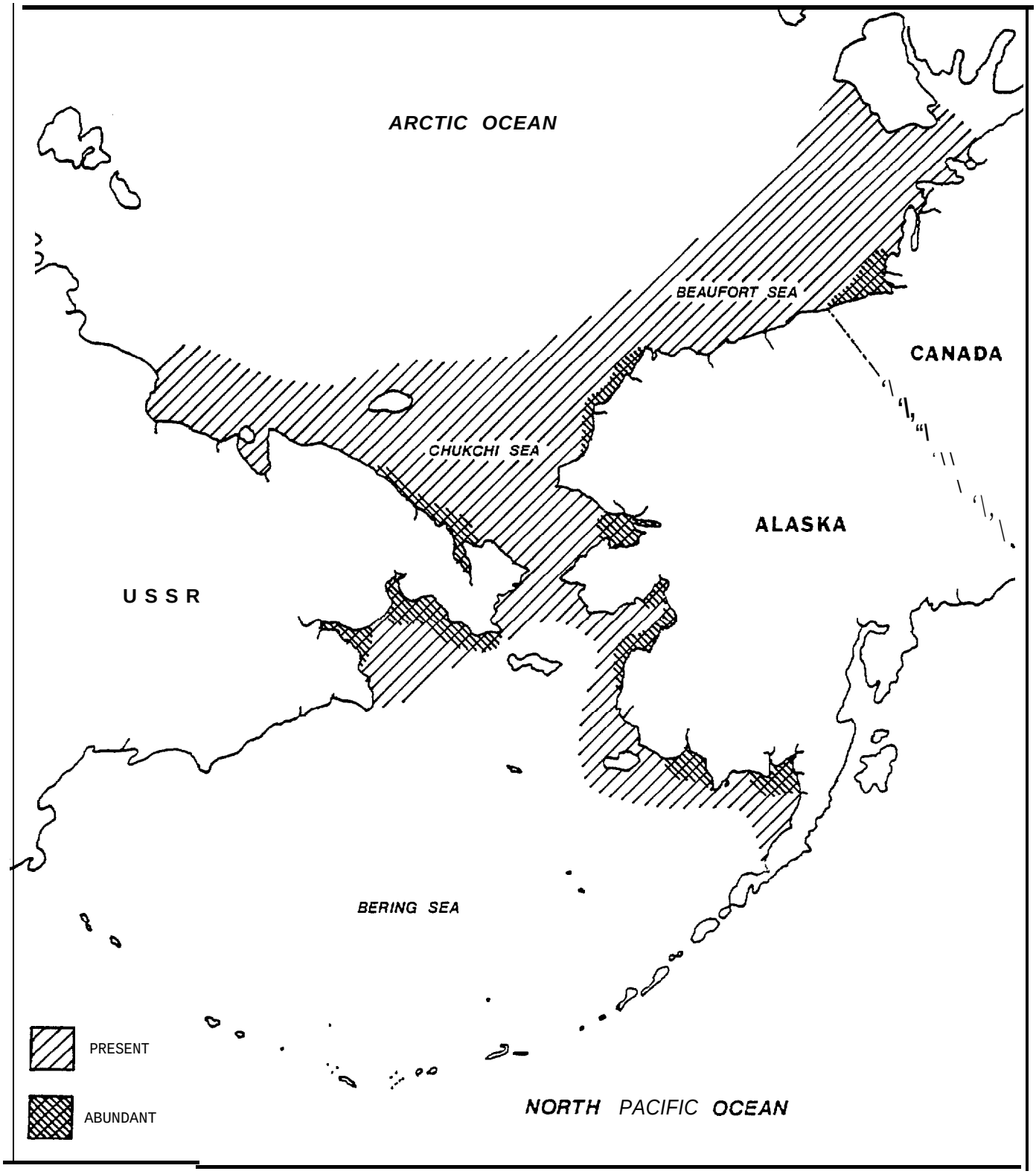

Figure 6. Distribution of belukha whales in July and August.

September-October (Figure 7)

The pattern of whale distribution changes markedly in September and October. Fewer whales are observed in coastal waters, and there is a general increase in offshore sightings. In the far north, animals from Siberia move east and seaward, while those from the eastern Beaufort move westward. Consequently, most sightings in September and October have been from the northern Chukchi Sea between Wrangel Island and northeast of Point Barrow (Seaman and Burns 1981) .

Very large aggregations of belukhas have been seen at this time of year; sightings of 500 to more than 1,000 whales were made northeast of Barrow in September 1978 and October 1979 (J. Bitters and L. Zimmerman, personal communication) and of several thousand (perhaps more than 5,000) in the central Chukchi Sea in September 1974 (G. C. Ray and T. Dohl, personal communication).

Some sightings have also been made in the area from south of the pack ice to Bering Strait. Coastal residents of Bering Strait report belukhas moving southward in advance of the ice in October (Kleinenberg et al. 1964; ADF&G, unpublished). Sightings along the Alaskan coast from Cape Prince of Wales to Bristol Bay become progressively less common as winter approaches.

November-December (Figure 8)

There are few sightings of belukha whales in November and December. Most have been in the Bering Sea with a few in the Chukchi Sea from Point Hope southward (Seaman and Burns 1981). In general, sightings have been by coastal hunters and commercial airline pilots since survey efforts have been minimal during these months. Sightings of belukha whales from villages in Bering Strait indicate a predominantly southward movement (Kleinenberg et al. 1964; F. Fay, personal communication; ADF&G, unpublished). The southward movement characteristically peaks in November and early December with or in advance of the appearance of seasonal pack ice, but continues through midwinter (Kleinenberg et al. 1964) .

It appears that belukhas maintain an association with sea ice in winter, and that the timing of their southward migration is closely related to the timing of freezeup and southward advance of the pack ice. Their distribution in March and April suggests that they winter throughout the Bering Sea from the ice front to Bering Strait and in the southern Chukchi Sea.

REGIONAL DISTRIBUTION AND ABUNDANCE

North Aleutian Basin

For the purpose of this discussion the North Aleutian Basin is defined as the waters of Bristol Bay from Cape Newenham to Unimak Pass (Figure 9).

Our information on belukha whales in Bristol Bay comes from a variety of sources. From 1954 to 1958, J. Brooks conducted extensive studies on

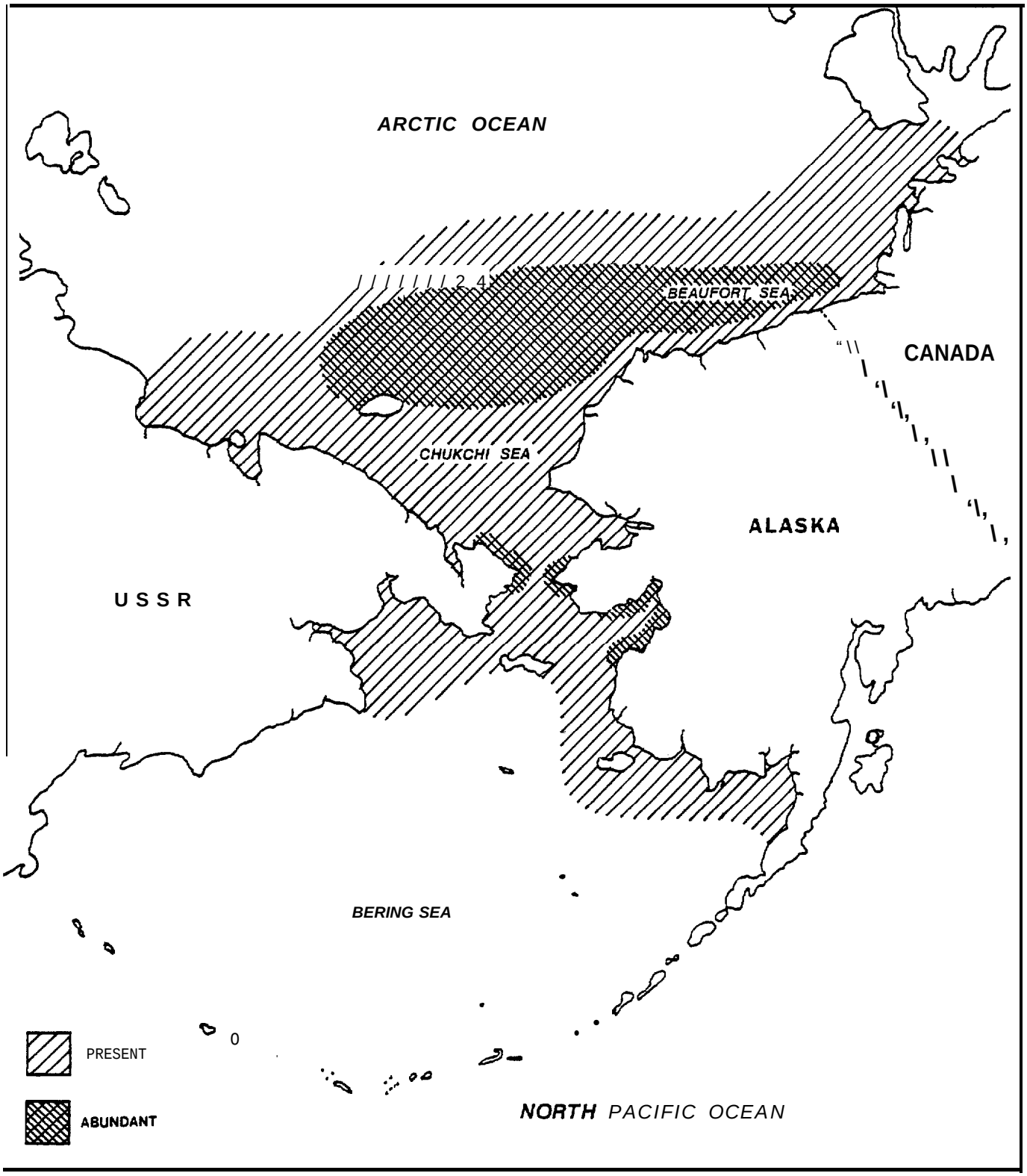

Figure 7. Distribution of belukha whales in September and October.

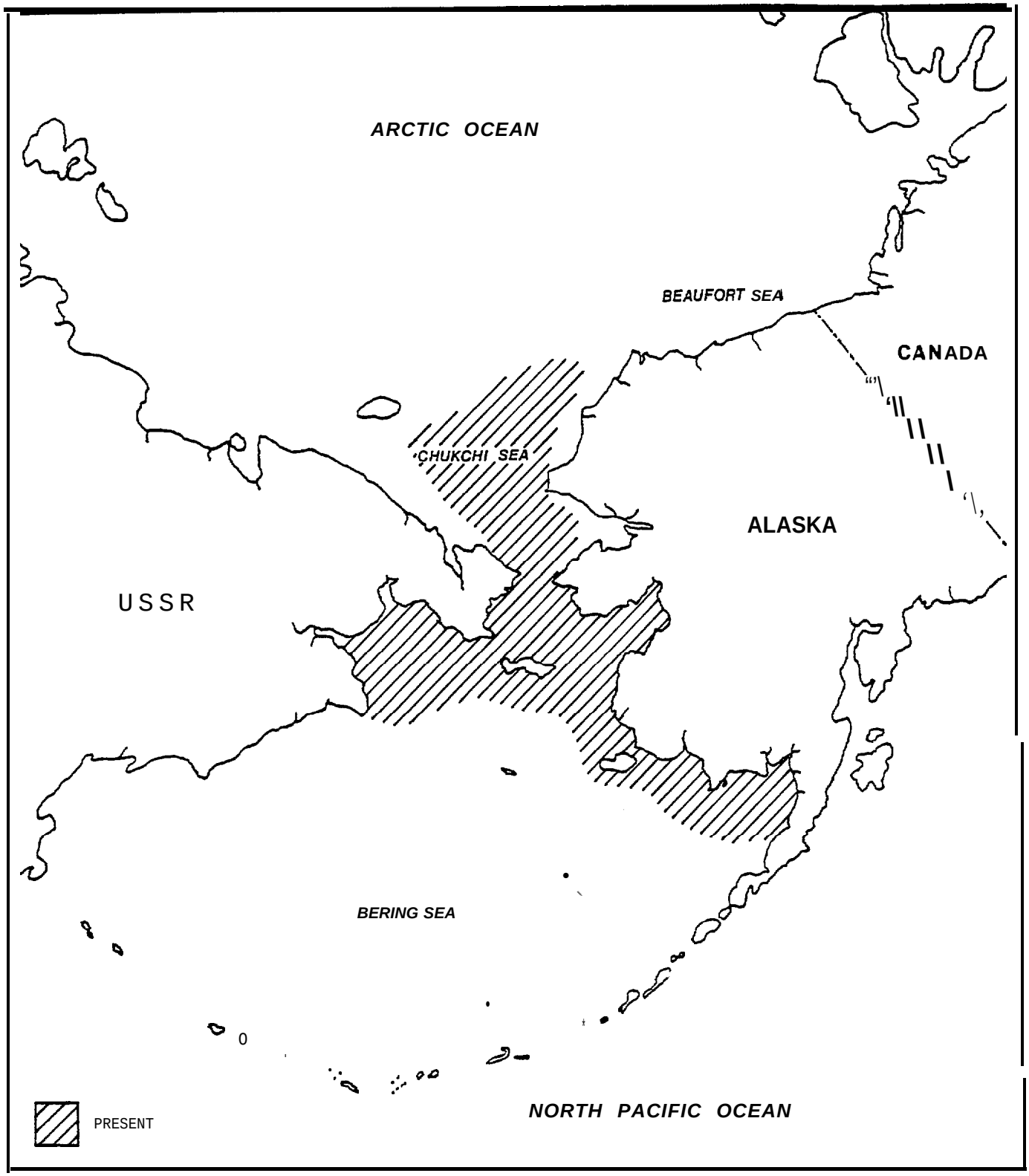

Figure 8. Distribution of belukha whales in November and December.

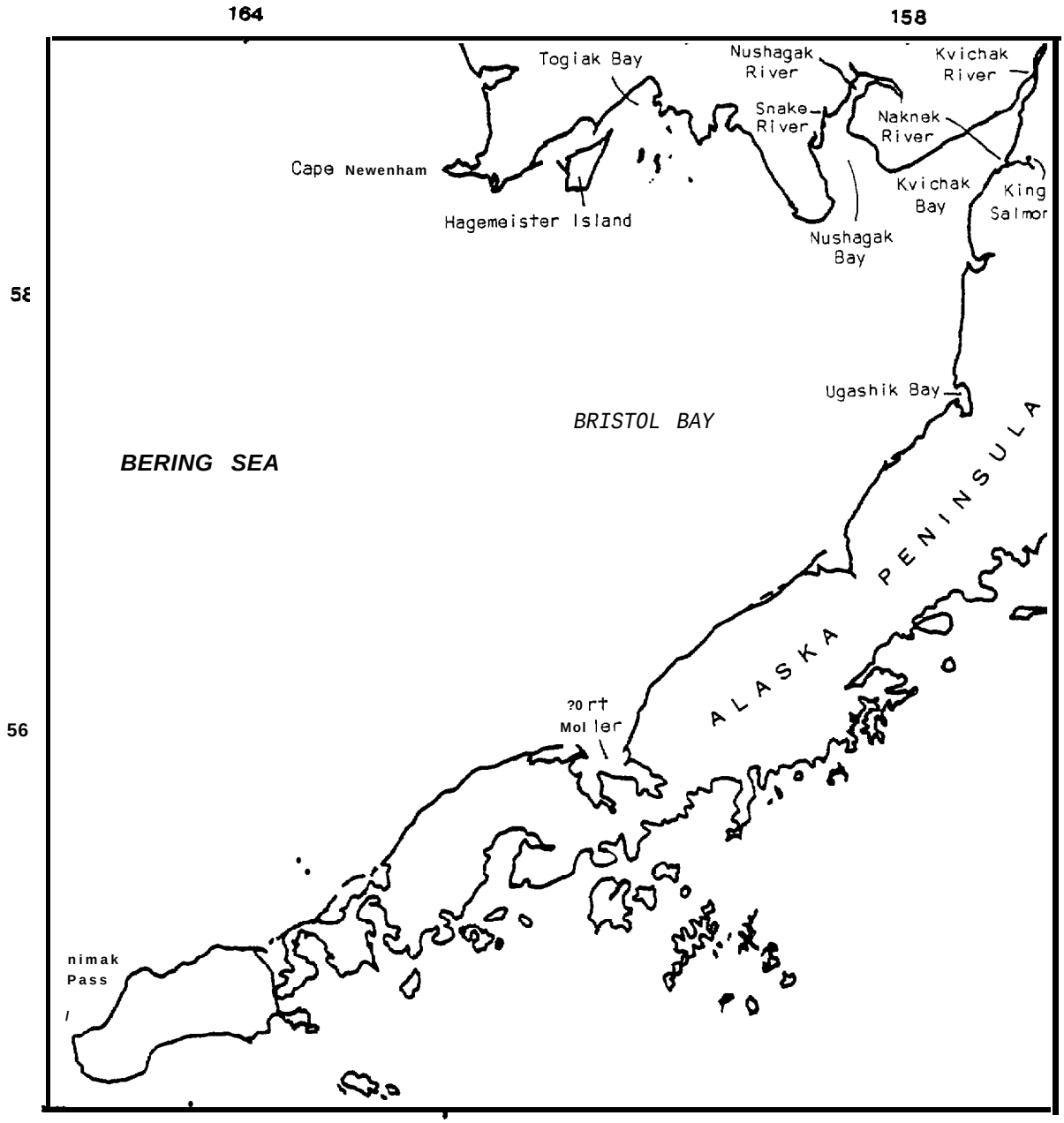

Figure 9. Map of the North Aleutian Basin showing locations mentioned in text.

the distribution, movements, and feeding of belukhas in inner Bristol Bay. Lensink (1961) summarized Brooks' work and added information for areas north of Bristol Bay. More recent studies include the work of Harrison and Hall (1978) primarily in the Bering Sea, and Fried et al. (1979); Lowry, Frost, and Nelson (1982); Frost, Lowry, and Nelson (1983); and Frost et al. (1984) in Nushagak and Kvichak bays. Other information is from the authors' unpublished observations, ADF&G unpublished data, interviews with area residents, and correspondence with biologists working in the area.

Belukhas utilize the Bristol Bay area throughout the year. They are most common and occur in the largest concentrations in nearshore waters during ice-free months (Frost et al. 1983a). Although small groups are occasionally observed near shore in inner Bristol Bay during winter, they are considered uncommon there at that time (Brooks 1954, 1955; Lensink 1961; ADF&G, unpublished).

In general, during winter-early spring belukhas are widely distributed in outer Bristol Bay and the southeastern Bering Sea (Lensink 1961; ADF&G, unpublished) and are believed to occur in close association with seasonal sea ice. They are probably more common during relatively heavy ice years, when the seasonal ice extends south into the Bay, than in years of less extensive ice cover. Leatherwood et al. (1983) sighted belukhas in Bristol Bay on surveys conducted in September, late October-early November, January, and February. Most sightings at this time of year are of groups of one to five whales. A notable exception occurred on 13 April 1976 when over 300 whales were sighted northwest of Port Moller (Braham and Krogman 1977). Examination of satellite imagery indicates that this sighting occurred close to the southern edge of the seasonal pack ice, which extended unusually far to the south at that time (Burns et al. 1981).

In April, as the seasonal ice starts to disintegrate and recede northward, belukha whales begin to move into coastal regions (Brooks 1956; Frost et al. 1983a). Whales are found both offshore and near shore at this time with sightings recorded from Hagemeister Island, Togiak Bay, and eastern Bristol Bay (Kenyon 1972). In April and May, concentrations of up to several hundred animals occur at the river mouths in Kvichak Bay (Brooks 1956; Frost et al. 1983a, 1984) . The first concentrations usually occur in mid-April in and at the mouth of the Naknek River where the whales feed on smelt (Osmerus mordax). Belukhas, sometimes in groups of up to several hundred, ascend the Naknek River as soon as the ice goes out, moving at least as far upstream as King Salmon (30 river km from the mouth) . When the ice in the Kvichak River breaks up (usually several weeks after breakup in the Naknek) belukhas move to the Kvichak River where, twice daily, groups of whales move upriver on flooding tides and downriver on ebbing tides. The period during which belukhas make daily movements up and down the Kvichak River coincides with the seaward migration of post-spawning smelt and with the peak outmigration of red salmon (Oncorhynchus nerka) smelts. Belukhas remain in Kvichak Bay during the adult salmon runs in June-August, when they are most often found between the western side of the bay and the Kvichak River mouth (Frost, Lowry, and Nelson 1983, 1984) . Belukhas also occur in Nushagak Bay where they are first seen in

mid-April in and near the Snake and Igushik rivers, along the west side of the bay, and off Etolin Point (Brooks 1956; Frost et al. 1983a; Frost, Lowry, and Nelson 1983, 1984). In May-July, whales are most commonly seen between the mouth of the Snake River and Clarks Point, and in the northern part of the bay near the junction of the Wood, Little Muklung, and Nushagak rivers (Lowry, Frost, and Nelson 1982; Frost, Lowry, and Nelson 1983, 1984).

Prior to the mid-1960's belukhas moved into several of the major rivers of Bristol Bay from breakup until mid-June (Lensink 1961) . Beginning in 1965 tape recorded sounds of killer whales (Orcinus orca) were used to repel belukha whales from the mouth of the Naknek River and later the Kvichak River (Fish and Vania 1971; N. Steen and D. Bill, personal communication) . This effort was designed to reduce belukha whale predation on outmigrating red salmon smelt by keeping the whales away from areas with the highest smelt concentrations. The belukha "spookers" were normally in operation from the end of May through the first two weeks of June and effectively displaced belukhas from the Naknek and Kvichak rivers during that period. When the use of spookers was discontinued in late June, belukhas again ascended these rivers but in low numbers. Attempts were made to extend the program to the Nushagak River but tides and other hydrological conditions prevented the establishment of a permanent program. After 1978 the belukha spooker program was discontinued, and belukhas have since resumed use of these river systems during the smelt outmigration (D. Bill and R. Randall, personal communication; Frost, Lowry, and Nelson 1983, 1984).

Belukhas are abundant in inner Bristol Bay through the remainder of the summer, but become progressively less common in autumn (Brooks 1954; Frost et al. 1983a). They are observed there with some degree of frequency until October when the whales are presumed to move offshore and westward. They have been reported east of Hagemeister Island in September (G. C. Ray, personal communication) and near Ugashik Bay in October (Harrison and Hall 1978). Local fishermen suggest they frequent the outer portions of the Bay. An October sighting near the Pribilof Islands confirms that belukhas do occur offshore over the continental shelf at this time (Harrison and Hall 1978). The degree to which belukhas utilize these offshore waters during summer and autumn is unknown. Sightings and changes in coastal abundance suggest that offshore habitats are not utilized extensively during the summer, but that they may be utilized during autumn; These changes correspond with the sharp decrease in abundance of anadromous fish in coastal waters during autumn.

The spring and summer movements of belukhas in Kvichak Bay are reported to be closely related to tidal movements. Brooks (1954) and Lensink (1961) found that belukhas generally swam up the Kvichak River and over the tidal flats on flooding tides. They usually returned to the bay on ebb tide, although they occasionally remained in the deeper portions of the river through the tidal cycle. Recent observations confirm this movement pattern in the Kvichak River and Kvichak Bay (Frost, Lowry, and Nelson 1983). In Nushagak Bay, Fried et al. (1979) observed belukhas a considerable distance up the Nushagak River on all phases of the tidal cycle. Other recent observations (Frost, Lowry, and Nelson 1983 and

unpublished) also indicate that in the lower portions of the Snake River movements of whales are not closely correlated with tides although the direction of tidal flow has a major influence on river currents. The reason for this apparent difference in behavior of belukhas in Kvichak and Nushagak bays is unknown.

It has been suggested that belukhas avoid areas of heavy boat traffic during the commercial salmon fishing season. For example, Lensink (1961) attributed the decreased numbers of belukhas ascending the Kvichak River in mid-June to increased boat traffic in the river. However, since the early 1970's when salmon canneries located up the Kvichak closed down, boat traffic upriver no longer increases markedly during the salmon fishery, yet few belukhas use the upper river after mid-June. Frost, Lowry, and Nelson (1983 and unpublished) concluded that decreased use of the river coincides with the end of the red salmon smelt outmigration. In 1983, belukhas were last seen in large numbers in the Kvichak River on 6 June, by which time 90% of the smelt outmigration had occurred.

Fried et al. (1979) and others have suggested that whales gather near the Snake River to avoid boat activity since that area is closed to commercial fishing. However, Frost, Lowry, and Nelson (1983) observed that the same group of whales moved regularly between the Snake River mouth and the east side of Nushagak Bay near Clarks Point, where there was constant boat activity and where most of the processing fleet was anchored. On several occasions, they observed a large group of belukhas swimming among the boats at Clarks Point. Local biologists also have reported that belukhas are frequently numerous around Clarks Point (K. Taylor, personal communication). Thus , it seems unlikely that the absence of boat activity entirely explains the whales' preference for the Snake River mouth. Topography may be one of the factors affecting the suitability of the area. Although several rivers flow into Nushagak Bay, the most extensive mud flats begin at the mouth of the Snake River and extend south to the mouth of the Igushik River. The red salmon run in the Snake River is smaller than in any of the three other major rivers, but the extensive shallows may make those salmon easier to catch. In Kvichak Bay, belukhas are also frequently seen swimming near fishing boats and nets, and it is probable that the availability of salmon, tidal stage, and bottom topography rather than the presence or absence of vessels, determines distribution of the whales.

Belukha whales calve in Bristol Bay in June and July. Although Fried et al. (1979) did not see neonates during late May and June surveys of the lower Snake River and its mouth, they noted that local residents and fishermen reported calving to occur there. Neonates may have been present during the surveys, but due to their small size, dark coloration, and poor survey conditions they could not be seen (S. Weston, personal communication). In 1982, neonates were observed near the Snake River mouth during early July. In late June-early July of both 1982 and 1983 there was a substantial increase, thought possibly to be a calving concentration, in the number of belukhas using the Snake River mouth area; an estimated 400+ whales were present in mid-July of both years (Lowry, Frost, and Nelson 1982; Frost, Lowry, and Nelson 1983) . In addition, beachcast neonates and floating afterbirth were

observed in the area at that time. Calving also occurs in Kvichak Bay during late June or early July. Lensink (1961) reported seeing the first newborn calves in the lower Kvichak on 14 June. In 1983, females with new calves were observed near the Kvichak River mouth on 7 July (Frost, Lowry, and Nelson 1983). Afterbirths and several dead neonates were found in late June and early to mid-July,

It is difficult to determine the abundance of whales in Bristol Bay; survey conditions are poor due to turbid water, and dark-colored juveniles are particularly difficult to see. Sergeant (1973) in Hudson Bay and Fraker (1980) in the Mackenzie Estuary surveyed belukhas under similar hydrological conditions. Sergeant thought that belukhas spend a third of the time at the surface and the remainder of time underwater and thus multiplied his actual counts by 3 to account for unseen animals. Fraker assumed, since his view of an area was not instantaneous but lasted over 15 seconds, that he would see a higher proportion; he multiplied the number of whales sighted by 2 to obtain the total number present. Frost, Lowry, and Nelson (1983) used surface-time to dive-time information obtained from radio-tagged whales to calculate an average correction factor of 2.75 at a survey speed of 183 km/hr. Comparison of simultaneous aerial and boat counts yielded a similar multiplier of 2.4-2.8.

The abundance of belukhas in Bristol Bay has been estimated by Brooks (1955, 1956) and Frost et al. (1984). Brooks estimated that at least 1,000 belukhas *were* present in Bristol Bay in 1954, and approximately half that number in 1955 and 1956 (Table 1). In the late 1970's fishermen reported belukhas to be moderately abundant (R. Baxter and M. Nelson, personal communication) . Sightings of up to 100-200 whales were regularly made in the Naknek River in April and May (D. Bill and N. Steen, personal communication). In late June 1979, during a flight over the north side of Kvichak Bay, R. Randall (personal communication) counted at least 250 belukhas and estimated that half the animals present were counted. During another flight in summer of 1979, he counted 400 to 500 whales in Kvichak and Nushagak bays combined. Lowry, Frost, and Nelson (1982) estimated that 400-600 whales were in the vicinity of the Snake River mouth in early July 1982. During April to August 1983, Frost *et* al. (1984) conducted twice-monthly surveys of Kvichak and Nushagak bays and estimated that approximately 1,000 belukhas older than neonates were in the area (Table 2). Based on recent and historical observations, we estimate that approximately 1,000-1,500 belukhas summer in Bristol Bay and the North Aleutian Basin.

Saint Matthew-Hall Basin

The proposed Saint Matthew-Hall OCS lease area, as discussed here, includes the coastal region of western Alaska from the southern Yukon Delta to Cape Newenham and westward to 174°W longitude (Figure 10) . Use of the Yukon River estuary by belukha whales is discussed in detail in the section dealing with the Norton Basin.

In winter and early spring belukhas occur throughout the Saint Matthew-Hall lease area except in the immediate nearshore region where they may be excluded by shorefast ice. During occasional episodes of

Table 1. Estimated numbers of belukha whales in inner Bristol Bay in 1954 and 1955 (Brooks 1955). Estimates were based on surface and aerial observations and interviews with fishermen and local residents.

1954	May	June	July	August
Kvichak Bay	250	250-400	?	600
Nushagak Bay	?	250-400	400	400
Total, both bays, about 1,000				
1955				
Kvichak Bay	100	150-250	?	50-100
Nushagak Bay	?	250	250-500	450
Total, both bays, about 525				

Table 2. Estimated numbers (# counted x correction factor) of belukha whales in Nushagak and Kvichak bays, April-August 1983 (from Frost et al. 1984). Neonates are not included.

Date	Nushagak Bay	Kvichak Bay	Total	Adjusted Total[1]
15 April	218	474	692	747
2/5 May	41	584	625	675
17 May	85	274	359	388
31 May	27	212	239	258
14 June	49	259	308	333
24 June	182	55	237	286
29 June	347	572	919	993
14 July	496	181	677	731
14 Aug	0	309	309	334

[1] Total increased by 8% for yearlings which are not seen during aerial surveys (Brodie 1971) .

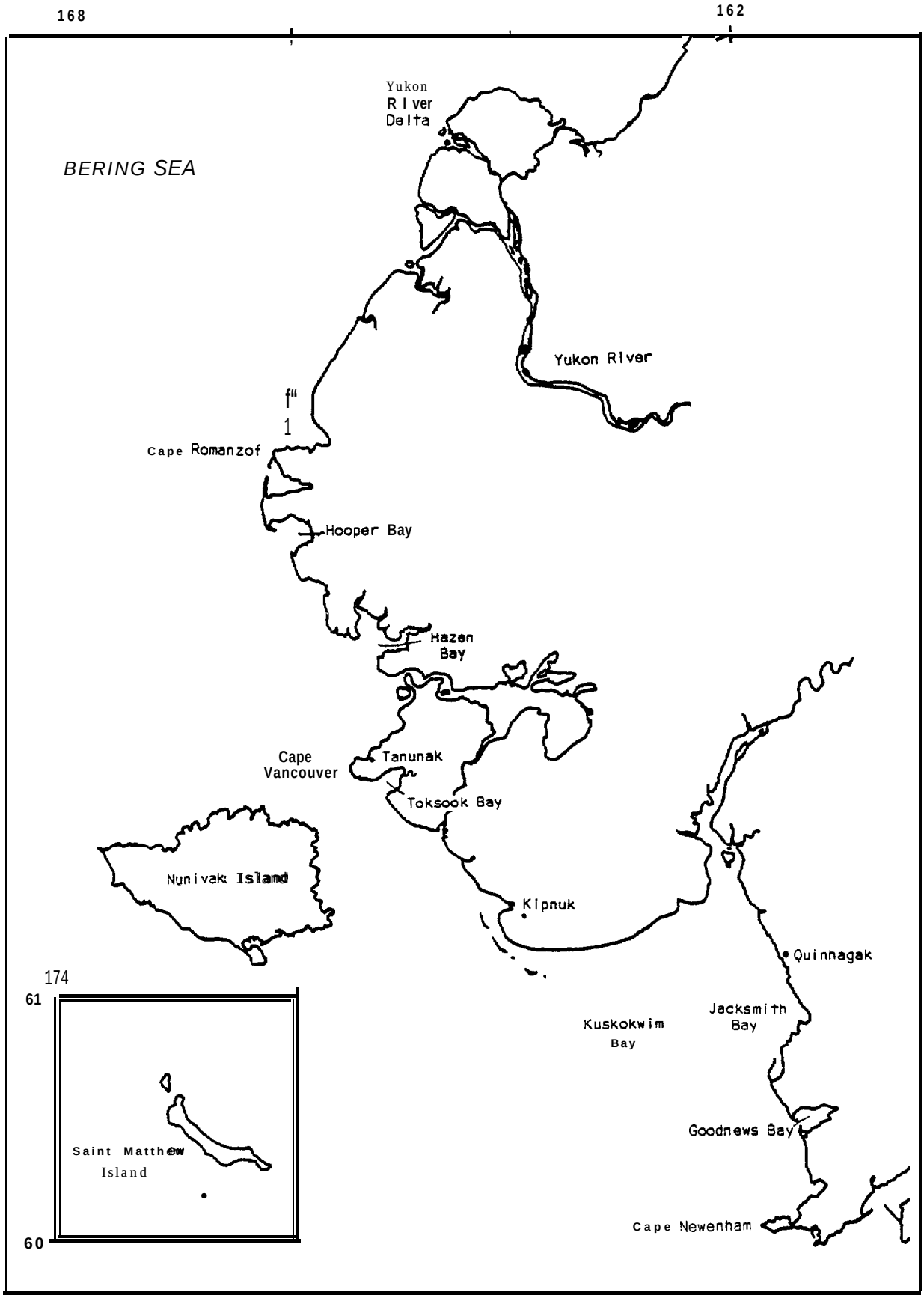

Figure 10. Map of the Saint Matthew-Hall Basin showing locations mentioned in text.

strong easterly winds which may break up the shorefast ice and move it offshore, belukhas have been seen near the mouths of the Yukon. River, off Cape Romanzof, near Hooper Bay, and in Kuskokwim Bay (Nelson 1887; Seaman, unpublished) . Residents of Hooper Bay report that such sightings occur during most winters (Seaman, unpublished). Nelson (1887) reported that large numbers of belukha whales utilized the coastal regions south of Cape Vancouver during winter. Recent interviews with residents of coastal villages in that area generally confirm Nelson's observations (ADF&G, unpublished) .

Most winter and early spring observations of belukhas in the offshore portion of this basin during March and April have been west of 170°W. This is at least partially a result of the distribution of survey efforts. Belukhas are quite abundant in the large polynya and pack ice west and south of Saint Lawrence Island and are commonly sighted along the west and south shores of Saint Lawrence Island (see section on Norton Basin) . They have also been frequently sighted in polynyas south and southwest of Saint Matthew Island in March and April (ADF&G, unpublished; Brueggeman, et al. 1984) . Leatherwood et al. (1983) made sightings of belukhas south and east of Saint Matthew Island and between Saint Matthew and Saint Lawrence in February and March.

From breakup in May or June until freezeup in October or November belukhas occur throughout coastal waters between the Yukon River estuary and Cape Newenham. Their appearance and abundance is frequently associated with the availability and movements of various anadromous and marine fishes. In recent years their appearance in Kuskokwim Bay is reported by local residents to be irregular and of short duration. Sightings have been reported from Quinhagak, Toksook Bay, and Kipnuk (ADF&G, unpublished) . Belukhas were considerably more common in Kuskokwim Bay earlier in the century (R. Baxter, personal communication). The last year belukhas were reportedly seen in large numbers near Quinhagak was around 1955. Belukhas have not been seen for many years in Goodnews Bay where they were previously very common (ADF&G, unpublished). Formerly, belukhas regularly entered the shallow waters of the Bay during the summer and were hunted by local residents.

Belukhas were formerly very abundant in the shallow waters of Jacksmith Bay (R. Baxter, personal communication). A village was located near there which depended to a large extent on an annual summer belukha hunt. It is said that in the early 1920's a large vessel came to Kuskokwim Bay and traded motor boats for king salmon (Oncorhynchus tshawytscha) . The next year, about 1925, a very large belukha hunt took place in Jacksmith Bay in which it was reported that "all" the whales were killed. Belukhas failed to return to Jacksmith Bay in subsequent years and the settlement there was abandoned (R. Baxter, personal communication). This may have been a cause and effect situation, but there is also the possibility that, as in other parts of Kuskokwim Bay, there was a general consolidation of many small settlements during this period.

Belukhas frequent the coastal waters between Cape Vancouver and the Yukon River estuary during the spring, summer, and autumn. Observations by residents of Tanunak and local pilots indicate that belukhas are common in the Hazen Bay area where small groups are sighted every year during late

spring and early summer. They are present but less common there in autumn. Belukhas also occur around Nunivak Island during the ice-free months but the degree of use at different times of the year is unclear. Historically, residents of Nunivak Island caught belukhas in nets during the autumn (Curtis 1930).

Belukhas are occasionally observed near and inside of Hooper Bay during the ice-free period, particularly during the late spring and early summer when their presence is closely tied to runs of king and chum (Oncorhynchus keta) salmon (Frost et al. 1983a). The number of whales in the area varies greatly from year to year. Belukhas are also common just north of Hooper Bay near Cape Romanzof where they are often seen in May in association with schools of herring (Clupea harengus) (Frost et al. 1983a). By early summer most whales leave this area and are believed to move to the Yukon River estuary where they are very commonly seen during summer and autumn.

Based on available information about seasonal movements of belukhas in Norton Sound, Bering Strait, and the Saint Lawrence Island region, it appears that a large portion of the whales that seasonally migrate through the Bering Strait to summer in the Arctic Ocean spend the winter in the Saint Matthew-Hall lease area. However, the actual number of belukhas either wintering in the area or passing through it during migration is unknown.

Saint George Basin

The Saint George Basin lease area encompasses a large portion of the southeastern Bering Sea (Figure 11). The northern portion of this area is on the continental shelf. The southern portion is off the shelf, with depths ranging from 200 m to more than 1,500 m. The extent and characteristics of seasonal ice cover are highly variable from year to year (Burns et al. 1981). During the "average" year, ice is usually present in the northern and northeastern portions, generally north of the Pribilofs. During cold winters and "heavy" ice years the ice may extend southward to approximately the continental shelf break, while in light ice years it may be entirely absent from the lease area.

It is difficult to assess the distribution and abundance of belukha whales in the Saint *George* Basin due to the scarcity of surveys and belukha sightings there. Most sightings have been made in conjunction with aerial and ship surveys directed at other species such as bowhead whales (Balaena mysticetus), walruses (Odobenus rosmarus), and ice-associated seals. Since these surveys are frequently restricted to particular habitats (ice front, shelf edge, etc.) where the target species are more likely to occur, they may not provide a reliable indication of the use of the area by belukhas.

We know of only one sighting of belukha whales in the Saint George Basin during the summer. Leatherwood et al. (1983) reported seeing a single animal southeast of the Pribilof Islands on 8 August 1982. This was the only belukha they sighted in four surveys conducted in the Saint George Basin between late May and September 1982. Harrison and Hall (1978) and Braham et al. (1984) surveyed a large portion of the Saint George Basin

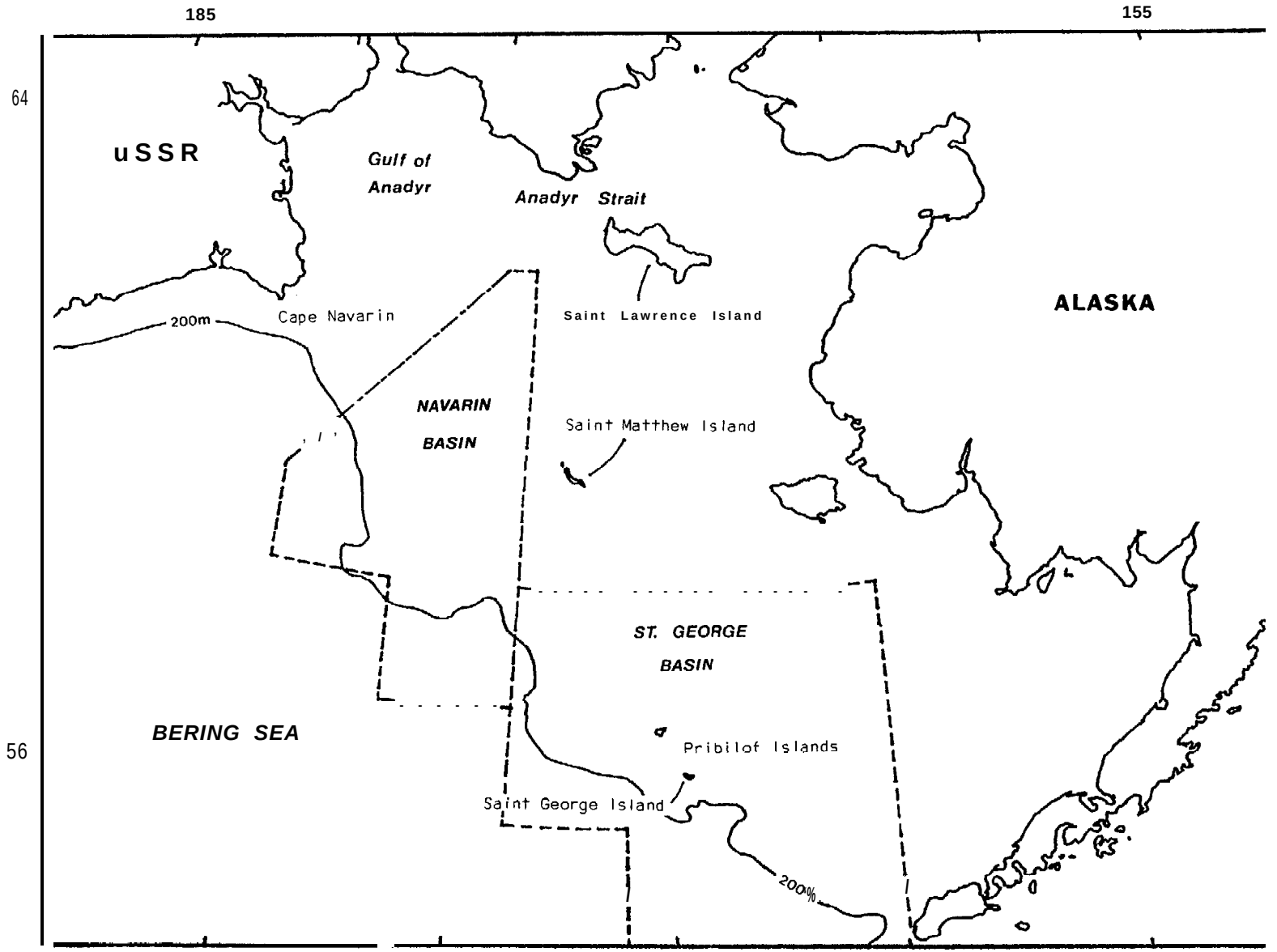

Figure 11. Map of the Saint George and Navarin basins showing locations mentioned in text.

during summer and saw no belukhas. It is possible that they occur in small numbers since they have been seen in the area during the spring and autumn (Harrison and Hall 1978; ADF&G, unpublished). When present, belukhas are probably restricted to the relatively shallow waters overlying the continental shelf and may be somewhat more common in the northeastern portion of the lease area which is closest to the coast.

In late summer and early autumn, belukhas start to leave the Bering Sea coast and by mid to late autumn there is a clear decrease in abundance in some nearshore areas, including in Bristol Bay. This decrease frequently parallels a decrease in the abundance of primary prey species. It is unclear where these whales go at this time, but since there is little evidence of a shift to neighboring coastal areas, it is likely that at least some utilize the more offshore regions of the Bering Sea including the northern portion of the Saint George Basin. Harrison and Hall (1978) observed two belukhas on 11 October 1976, approximately 110 km southeast of Saint George Island. Several species of suitable prey are abundant in this area (Pereyra et al. 1976).

Belukhas probably occur in greatest abundance in the lease area during winter and spring when seasonal ice excludes them from many nearshore regions. They may be most common in Saint George Basin during heavy ice years when they have been observed in March and April near the Pribilof Islands, in western Bristol Bay, and south of Nunivak Island. They are probably less common when seasonal ice in Saint George Basin is minimal or absent. A significant but unknown proportion of the whales that winter in the Saint George Basin *lease* area probably summer in the coastal waters of the eastern Bering Sea and Bristol Bay.

We cannot presently estimate the number of belukhas utilizing the Saint George Basin. Based on limited sightings, the availability of apparently suitable habitat, and the area's proximity to coastal areas regularly used by belukhas, the Saint George Basin lease area may be important to a large number of whales. We expect that the use of the lease area varies annually with peak use during winter and spring when sea ice is present.

Navarin Basin

The Navarin Basin includes a large portion of the central Bering Sea west of the Saint Matthew-Hall and northwest of the Saint George Basin lease areas (Figure 11). The northern portion is on the continental shelf, while the southern part occurs over very deep water. Navarin Basin is remote; the closest land masses are Saint Matthew Island to the east, Saint Lawrence Island to the northeast, and the coast of the USSR to the west.

It is difficult to assess utilization of the Navarin Basin by belukha whales due to the lack of settlements in the area and the near absence of sightings from any months except March, April, and early May. Aerial sightings of belukhas here have been on an opportunistic basis in conjunction with surveys for other species.

It appears that the portion of the Navarin Basin overlying the continental shelf is an important part of belukha winter range. In the autumn and

early winter large numbers of belukhas are consistently observed moving south into this region through Anadyr Strait (Kleinenberg et al. 1964; F. Fay, personal communication; Seaman, unpublished) . In March and April belukhas have frequently been sighted during the course of survey flights over the Navarin Basin (H. Braham, personal communication; ADF&G, unpublished) . Brueggeman et al. (1984) observed several hundred belukhas west of Saint Matthew Island in March 1983. Belukhas are also common east and west of the Navarin Basin during the same period. Although there are no sightings available for January and February, distribution then is probably similar to that in March and April although generally more northerly. As winter progresses the whales move southward with the advancing pack ice. Belukhas are thought to be rare or uncommon south of the continental shelf because they are generally shallow water feeders, and the ice with which they are usually associated in winter rarely extends south of the shelf break (Burns et al. 1981) .

Belukhas appear to move inshore or northward out of the Navarin Basin in spring. Residents of Gambell see these whales passing through Anadyr Strait in March and April, with the numbers diminishing in May (Seaman, unpublished) . Kleinenberg et al. (1964) observed several hundred whales in late May moving northward by Cape Navarin into the Gulf of Anadyr. Some belukhas may remain until June in association with an ice remnant which predictably occurs in the northern Navarin Basin each year (Burns et al. 1981) , then move west to coastal areas of the Gulf of Anadyr where they are common until freezeup (Tomilin 1957; Kleinenberg et al. 1964). Belukhas are probably uncommon in the ice-free waters of the Navarin Basin in summer and early autumn when they are abundant in coastal areas, but return in autumn when coastal areas freeze over.

Many of the belukhas which summer in the Chukchi, Beaufort, and East Siberian seas probably occur seasonally in the Navarin Basin. Some may utilize the area for a major portion of those months when ice is present, while others may occur there for only a few days. The abundance of belukhas in Navarin Basin is probably highly variable depending on ice and feeding conditions, but is likely to be greatest during years of extensive ice cover.

Norton Basin

For the purpose of this discussion Norton Basin includes Norton Sound, the southwest coast of the Seward Peninsula, and the Chirikof Basin including Saint Lawrence Island (Figure 12).

Belukha whales are uncommon during the coldest winter months in inner Norton Sound due to the usual presence of an extensive, comparatively unbroken ice cover. Hunters from Elim have reported sightings and occasional entrapment of belukhas in openings in the ice south of that village (Seaman, unpublished) , but such sightings are uncommon since leads in the ice are not regularly present in areas accessible to local hunters.

Belukhas utilize the coastal areas of Norton Sound including the Yukon River estuary during the entire ice-free period from breakup in May or June until freezeup in October or November. Belukhas have often been sighted as early as April off the shorefast ice near Shaktoolik and Cape

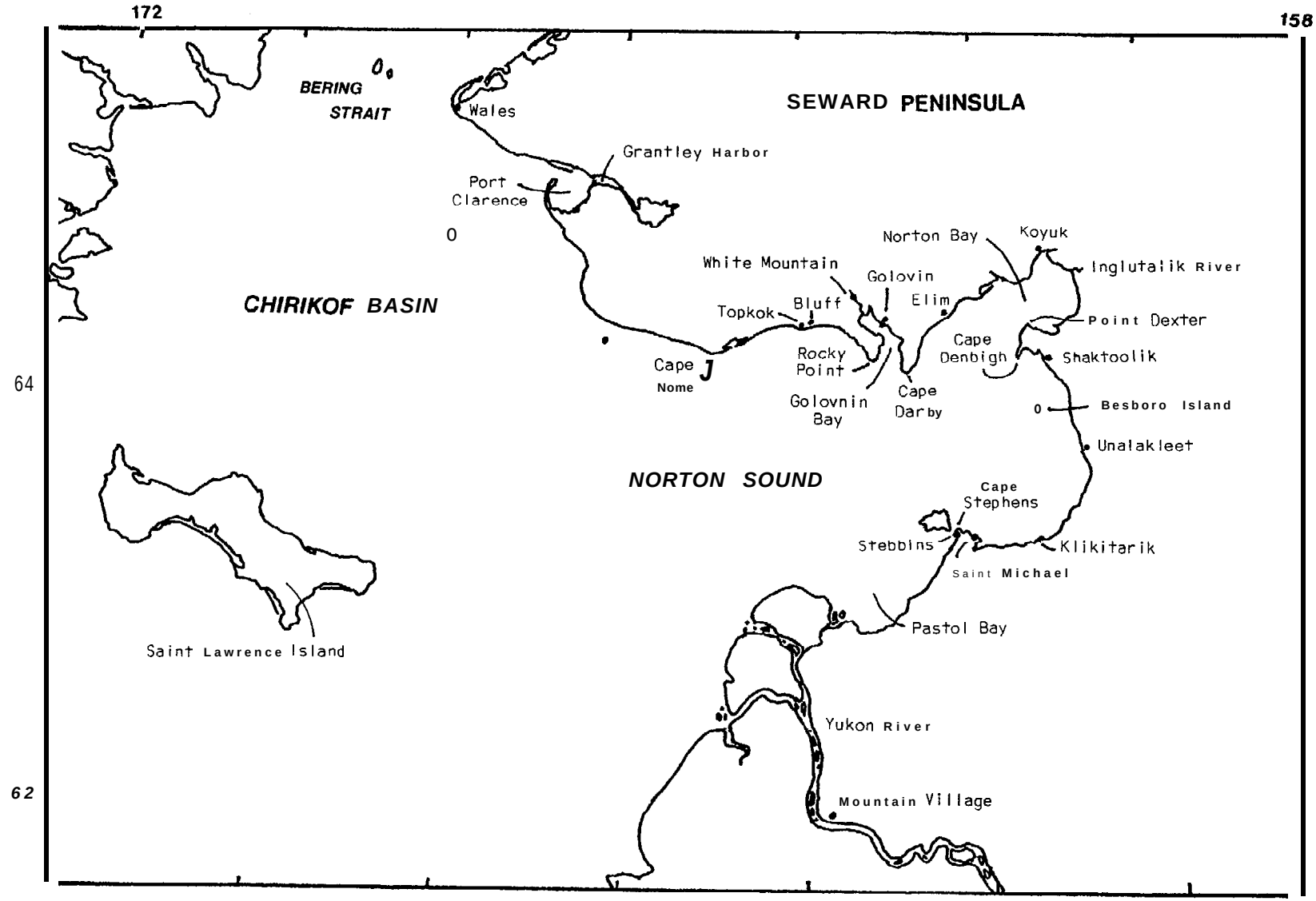

Figure 12. Map of the Norton Basin showing locations mentioned in text.

Denbigh. They are most common near the eastern Norton Sound villages of Stebbins, Saint Michael, Unalakleet, Shaktoolik, Koyuk, and Elim from late May through June and from September until November, although they are present throughout the summer (Frost et al. 1983a). People from Stebbins, Saint Michael, and Elim believe that belukhas seen in spring frequent the mouths of and nearshore waters off the Yukon River during the summer. Ray (1964 and 1975) identified the historically important belukha hunting areas in Norton Sound as Pastel Bay, the mouth of the Inglutalik River (Norton Bay), and Golovnin Bay. Nelson (1887) found that belukhas were very common in southern Norton Sound near Saint Michael and near the mouths of the Yukon River. Residents of Golovin and White Mountain confirm that belukhas were historically common in Golovnin Bay and Golovnin Lagoon (ADF&G, unpublished).

Belukhas begin to utilize the coastal areas of Norton Sound at the same time that migratory and anadromous fishes arrive there. During herring spawning, which commences in late May or early June as breakup occurs (Barton 1979), belukhas are regularly seen following schools of herring, particularly near Golovnin Bay, Cape Denbigh, Point Dexter, and near Saint Michael (Nelson 1887; Giddings 1967; L. Barton, personal communication; Frost et al. 1983a). Local pilots have also seen belukhas feeding on herring in mid-June near Besboro Island. In 1981, belukhas were seen chasing and eating herring off Klikitarik in late April and Cape Stephens in mid-May (ADF&G, unpublished) . At least 100 were present and feeding on herring in the shallows near Point Dexter in late May 1981. Runs of herring are followed slightly later by capelin (Mallotus villosus) and salmon, which are also important prey of belukhas.

Throughout the summer and autumn belukhas are found near and in the mouths of the Yukon River where they feed on salmon. In 1980, they were common near the southern mouth in late May and June; and in early July over 150 were seen regularly near Big Eddy, just upstream from Emmonak (J. Burns Jr., personal communication). In July 1981 over 100 belukhas were seen feeding just off the northern mouth of the Yukon and another smaller group was sighted to the east in outer Pastel Bay (Ljungblad et at. 1982) . King, chum, red, and silver (Oncorhynchus kisutch) salmon enter the Yukon River from late May to early September (Geiger and Andersen 1978) . There are numerous historical accounts of belukhas swimming upriver several hundred kilometers above tidal waters, probably following salmon. They have been reported from Nulato and Koyukuk, over 800 kilometers from the river mouth, both historically and as recently as 1981 (Nelson 1887; Collins 1945; Lensink 1961; ADF&G, unpublished). Residents of Tanana remember seeing belukhas near their village in the early 1900's. A group of four or five belukhas was reported several km upriver from Tanana (1,200 km from the river mouth) in June 1982 and at the same general time a single large adult was reported 130 km further upriver above Rampart (F. Andersen, personal communication). In recent years belukhas have been observed occasionally at Mountain Village, 110 km upriver.

In general, belukhas appear to move up the Yukon River less frequently than they did 50-75 years ago. They are still very common, however, around the mouths of the river where they feed in the shallows. Although

the use of those waters may have been altered to some extent by increased fishing and related motorboat activity, the changes are not reported to be great (ADF&G, unpublished).

Near Saint Michael from midsummer to' freezeup Nelson (1887) found that belukhas fed extensively on saffron cod (Eleginus gracilis). He observed that feeding occurred mainly at night and *in* the early morning in the bay near Saint Michael and in the many tidal creeks south to Kuskokwim Bay. In late September and October of 1976 and 1981 groups of 30-60 belukhas were feeding during daytime on schools of saffron cod near Cape Darby and Rocky Point at the entrance of Golovnin Bay (Lowry, Frost, and Burns 1982). About 150 belukhas were seen between Topkok and Bluff in early September 1981 (R. Nelson, personal communication).

Along the coast of the Seward Peninsula from Cape Nome to Wales, belukhas are seen from spring through autumn. They are sometimes seen in the pack ice off Cape Nome and the city of Nome as early as April. They were seen in early May of 1979 by Eskimos hunting walrus between Nome and Sledge Island. Cape Woolley and Cape Nome were once productive hunting sites for belukhas, with whales present throughout the ice-free periods but most common in early summer and again in autumn (Ray 1964; Seaman, unpublished). In November 1977, 150-200 belukhas were seen moving by Cape Nome; in November 1979, approximately 250 were seen there; and in November 1980, 75-100 whales were observed feeding just offshore (R. Nelson, personal communication).

During spring and summer, belukhas appear to move through the area from Cape Nome to Wales, sometimes foraging along the way, but not forming any major local concentrations. Near Cape Nome in spring and early summer they feed on schools of saffron cod and later have been observed following schools of herring (L. Barton, personal communication). 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. Historically large numbers of belukhas occurred in Port Clarence and Grantley Harbor, but today they are seen only occasionally and in small numbers (Ray 1964 and 1975; Seaman, unpublished). In previous years when belukhas were common in Port Clarence and Grantley Harbor their appearance coincided with that of spawning herring.

Near Wales, belukhas are reportedly most common from mid-March through mid-May when movement is generally northward, and in October and November when most movement is southward (Curtis 1930; Thornton 1931; Van Valen 1941; Ray 1964; Seaman unpublished). Sightings in March and early April are probably of whales migrating to the Beaufort Sea, while later spring sightings may be of whales headed for the Chukchi coast. During summer, belukhas are not common and may be seen moving to either the north or the south.

Near Saint Lawrence Island belukhas are seen commonly in the spring, and occasionally in autumn and winter, particularly when saffron and arctic (Boreogadus saida) cod are abundant (Seaman, unpublished). In April, large groups of belukhas (some of over 100 whales) have been observed moving north by Gambell, Southwest Cape, Southeast Cape, and East Cape. G. C. Ray (personal communication) and Braham et al. (1984) reported many

belukhas in this area in spring, particularly north and northwest of the Island. Belukhas are rarely observed during the summer, usually as single animals or in very small groups of both gray and white individuals (F. Fay, personal communication; Seaman, unpublished) .

In some years large numbers of belukhas are seen along the north and west shores of Saint Lawrence Island prior to freezeup. Occasional whales are seen in late October but most arrive from the north in November and December. Local residents report that belukhas are seen more often in the autumn at Gambell than at Savoonga; whales seen at Savoonga are usually following the coast of the island toward the west, occasionally remaining in the area for several days. Either before or shortly after the ice appears, belukhas move southward, at least some of them moving into the Gulf of Anadyr (Kleinenberg et al. 1964) . F. Fay (personal communication) reported at least a thousand animals north of Saint Lawrence Island in late November and early December 1957. This group followed the north coast past Gambell, headed toward the Gulf of Anadyr. Sightings of equal or greater numbers were made north and west of Saint Lawrence Island in November of 1974 and 1976 (Seaman, unpublished). Smaller groups (15-25) are seen in December-March along the western and southern shores in areas of open water created by strong ocean currents and prevailing northwesterly winds. Groups of up to 250-300 have been reported near Southwest Cape (Seaman, unpublished).

There have been no systematic surveys directed toward determining the abundance of belukhas in Norton Sound or adjacent areas of Norton Basin. The best available information on abundance is based on the observations of local residents and biologists working in the area. In combination, those sources suggest that the number of belukhas utilizing the coastal waters of eastern Bering Sea from Bering Strait south to Kuskokwim Bay during summer at least equals and probably exceeds the number in Bristol Bay. A conservative estimate is 1,000-1,200 whales, possibly as many as 2,000. Although calving occurs in Norton Sound, specific calving areas have not been identified.

Hope Basin

Hope Basin includes the southeastern Chukchi Sea from Bering Strait north to Cape Lisburne (Figure 13). Most of our information on the distribution and movements of belukha whales in the coastal regions of the Hope Basin is based on field studies undertaken by the Alaska Department of Fish and Game at Point Hope and in Kotzebue Sound, and on interviews and conversations with long-time residents of coastal villages. Most of this information is reported in Frost et al. (1983b) . There is little other published information regarding belukhas in this area.

During winters of years with “light” ice conditions, belukhas are not “uncommon in the southern Chukchi Sea. Eskimo hunters from Wales see them in nearshore leads throughout the winter. In the 1950's when seal hunting was still a major winter occupation at Shishmaref, belukhas were occasionally seen by hunters traveling to the shore lead. On 5 March 1976, hunters reported a group of 35 belukhas trapped in the ice about 45 km southwest of Shishmaref (ADF&G, unpublished).

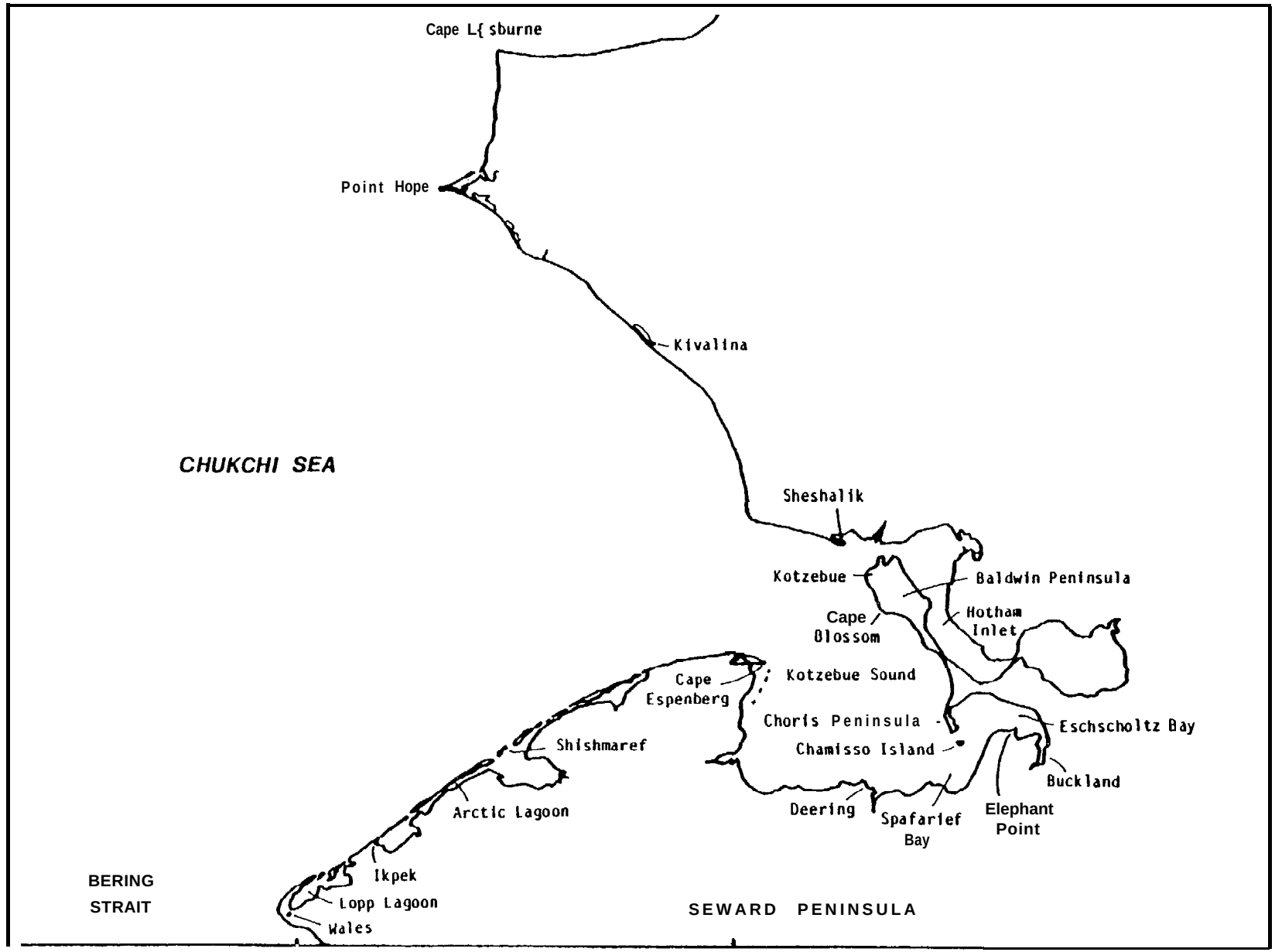

Figure 13. Map of the Hope Basin showing locations mentioned in text.

According to older residents of Shishmaref and Wales, belukhas were once common along the northern Seward Peninsula from Ikpek to Cape Espenberg during breakup and throughout the summer (Seaman, unpublished). In the early 1900's, reindeer herders from Shishmaref and Wales saw from a few to several hundred belukhas inside Lopp and Arctic lagoons in late June and July. If left undisturbed, whales would remain in the lagoons for extended periods. Belukhas occasionally entered Shishmaref Lagoon in July during periods of high water, and occurred along the nearby coast until freezeup when they were sometimes caught in nets set in the drifting ice near the village (Seaman, unpublished). At one time some of the people from Kotzebue Sound spent their summers fishing and hunting seals, caribou, and belukhas along the coast from Shishmaref to Cape Prince of Wales (Nelson 1887; Curtis 1930; Hall 1975; ADF&G, unpublished).

Belukhas have been infrequently sighted near Shishmaref in recent years. One group of about 20 was sighted in the ice 7 km west of the village cn 4 June 1979 (Frost et al. 1983b). Residents of Shishmaref think there have been fewer whales near their village since the introduction and increased use of outboard-powered boats. Undoubtedly, large numbers of belukhas pass along the north side of the Seward Peninsula in spring on their way to Kotzebue Sound and locations further to the north, but this migration is probably far enough offshore to pass unnoticed by coastal residents.

Belukhas have been reported as common summer residents of Kotzebue Sound for as long as there are published records for the area (Nelson 1887; Curtis 1930; Foote and Cooke 1960; Ray 1964 and 1975; Foote 1965; Foote and Williamson 1966; Saario and Kessel 1966; Hall 1975; Giddings 1967; Seaman and Burns 1981; Frost et al. 1983b). Belukhas arrive in Kotzebue Sound in late May to mid-June, usually during or shortly after breakup when ice is still present but is broken and scattered. They are often first seen in pockets of open water in the northern Sound from Sheshalik to Cape Blossom. In 1978 the first confirmed sighting in Kotzebue Sound was made on 11 June southeast of Chamisso Island by a Kotzebue hunter enroute to Elephant Point. In 1979, a pilot from Kotzebue reported a group of about 30 whales on 1 June south of Cape Blossom. A group of 80-100 was seen at the same location on 6 June, and was observed approaching Sheshalik spit from the southwest shortly thereafter (G. Barr, personal communication). These first sightings in 1978 and 1979 were probably somewhat earlier than usual, since in both years the winters and springs were unusually warm and breakup occurred early. Foote and Cooke (1960) found that the first belukhas usually appeared near Sheshalik in mid- to late June.

Eschscholtz Bay is a large shallow bay in the southeastern corner of Kotzebue Sound about 85 km southeast of Kotzebue. It is presently the most productive belukha hunting site in the Kotzebue Sound area. Belukhas normally appear in Eschscholtz Bay in mid-June, slightly later than in northern Kotzebue Sound. In 1978, hunters from Deering sighted a group of at least 50 on 12 June, 6 km west of Elephant Point, and in 1979 over 200 were seen on 8 June along the northwest shore (N. Lee, personal communication). Belukhas appeared somewhat later in 1982 with the first whales seen on 21 June. When in the area, belukhas normally move into Eschscholtz Bay each day on the flood tide and leave on the ebb tide, but

sometimes remain in the bay through the tidal cycle. They follow a deep channel which extends from Chamisso Island and parallels the north shore toward the Buckland River. On high tide and the first part of ebb tide, the whales commonly disperse along the north and east shores of the bay. On some flood tides they do not deeply penetrate the bay but concentrate in the shallow waters along the northeast shore. This may be due in part to avoidance of boat traffic near Elephant Point and the Buckland River. In June they are usually intercepted by hunters who herd or drive them into shallow waters of the inner bay. In June 1978, 1979, 1981, and 1982 belukhas continued to move in and out of the bay for a week to 10 days, presumably until hunting activity disturbed them to the the point they would no longer enter (Seaman and Burns, unpublished) . In some years after hunting ceases and all hunters leave, some whales return to Eschscholtz Bay and remain until at least mid-July (Seaman, unpublished) .

There appears to be considerable local movement of belukhas in Kotzebue Sound. The whales seen near Sheshalik, Kotzebue, and Cape Blossom are almost certainly part of the same group seen in Eschscholtz Bay. In 1979, during times when belukhas were not seen in Eschscholtz Bay, many whales were seen off Sheshalik, in Kotzebue Sound proper, and in Spafarief Bay just west of Eschscholtz Bay. On several occasions when there was much boat activity near both Sheshalik-Kotzebue and Eschscholtz Bay, belukhas were seen near Cape Blossom and seaward of Sheshalik. The residents of Deering say that belukhas are not seen near their village. Historically as well as in recent years the whales seem to have preferred the northern and eastern parts of the Sound.

The utilization patterns and movements of belukhas in Kotzebue Sound appear to be markedly different today than in the early 1900's (Seaman and Burns 1981; ADF&G, unpublished). Residents of Noatak and Kotzebue have noted that the greatest change occurred shortly after the introduction of outboard-powered boats in the 1920's and early 1930's. Foote and Cooke (1960) stated that before motorboats were used belukhas came very close to shore and often entered the shallows behind Sheshalik spit as well as Hotham Inlet. In the 1940's and 1950's there was a large increase in both the number and size of motorboats near Kotzebue and Sheshalik. Hunting became more difficult as fewer belukhas came into the shallows near these sites. By the 1960's boat traffic in northern Kotzebue Sound was heavy, traditional hunting methods gave way to less organized hunts, and fewer belukhas were seen in these shallow areas. With few exceptions, belukhas are now even less common near Sheshalik than in the 1960's although they are still common offshore. Many people from Kotzebue believe that the noises associated with modernization, such as electrical generation, construction, barge traffic, and low-flying aircraft have compounded the problem.

Noticeable changes in utilization patterns and movements of belukhas have also occurred in Eschscholtz Bay. Traditionally only the people from the small village of Buckland and occasionally Deering hunted belukhas in Eschscholtz Bay. In the early 1900's the village was located on the lower Buckland River, and residents seasonally moved downriver to Eschscholtz Bay for the belukha hunt. The whales, which were present in large but variable numbers every year, were hunted from umiaks and kayaks for one or two weeks in late June or July, or until enough meat was obtained. After

the boat hunt was over (usually mid-July) belukhas returned to the bay and frequently stayed for days at a time moving over the tidal flats on flood tide and to the deep water at ebb tide. The older people remember that very large numbers of whales were present after the hunt in July in the shallows east of Elephant Point and along the north shore. Belukhas frequented these areas until early August, after which time they were more commonly seen in western Eschscholtz Bay, near Chamisso Island and the Choris Peninsula, or in Spafarief Bay.

In the early 1920's a reindeer processing plant was established at Elephant Point. About the same time the Buckland people moved their summer hunting camp from the north side of the bay to this location and by the late 1930's the village of Buckland was situated at Elephant Point year-round. With the increase in noise and activity, belukhas spent more time on the northern side of the bay and came less frequently into the shallows east of Elephant Point. However, boat traffic was generally moderate prior to the 1950's since the village was located very near the hunting area. Boat traffic increased somewhat about 1954 when the village was relocated up the Buckland River to above tidewater and people began moving regularly back and forth. In the late 1960's a few hunters from other areas began to come to Eschscholtz Bay to hunt and by 1975 there were many additional boats, particularly from Kotzebue. Hunters are of the opinion that uncontrolled boat traffic in June and early July, particularly during flooding tides, acts to reduce the number of belukhas entering Eschscholtz Bay and to decrease hunting success (ADF&G, unpublished) .

Belukhas are known to both feed and calve in Kotzebue Sound. As in Norton Sound, the whales probably follow local movements of fish, feeding on species which are particularly abundant at certain times (Seaman and Burns 1981; Seaman et al. 1982). In Eschscholtz Bay there are substantial runs of herring, smelt, char (Salvelinus alpinus) , and salmon, in addition to large numbers of saffron cod (Barton 1979; Burns, Frost, and Seaman, personal observation).

Calving has been reported in all coastal regions of the Sound; however, it is unknown whether calves are born only in shallow coastal regions or whether calving also occurs offshore. Most observations of calving are from near Sheshalik and from the eastern end of Eschscholtz Bay. Sheshalik may be of lesser importance at present due to avoidance by whales as discussed above.

The actual number of whales using the Kotzebue Sound area during the ice-free months is poorly known. Our estimate of abundance is based on our field studies, interviews with local residents, and occasional observations of local pilots and biologists working in the area. In July 1962, Burns (unpublished) saw 900-1,200 belukhas north of Chamisso Island, moving northward along the Choris and Baldwin peninsulas. On 8 July 1978 a resident of Buckland (N. Lee) saw an estimated 900-1,000 belukhas scattered in the shallows along the northwest shore of Eschscholtz Bay. At least 500 whales were seen from boats in Eschscholtz Bay on the first hunt in June 1978 and, based on hunting success, that is a very conservative estimate of the numbers of belukhas in the area that year. Local hunters reported that belukhas were also very abundant in 1977. In

1979 and 1981 hunters reported low numbers of whales which was reflected in very low harvests. In 1982 belukhas were very abundant in southeastern Kotzebue Sound and were also common near Sheshalik. Considering all observations we estimate that the peak number of whales in Kotzebue Sound during summer ranges from 500 to perhaps 2,000+ with considerable year-to-year variability which cannot at present be explained. This estimate is based primarily on observations made in southeastern Kotzebue Sound and may poorly reflect whale abundance in other portions of the Sound. Systematic surveys of the area are needed in order to refine these estimates.

Belukhas appear off Kivalina and Point Hope, which are along the migratory route of whales headed to the eastern Beaufort Sea, much earlier than they do in Kotzebue Sound. The northward spring migration past Point Hope has been documented by Foote (1960), Fiscus and Marquette (1975), Marquette (1976, 1977, and 1979), and Braham and Krogman (1977) . At Point Hope belukhas are seen moving north through leads in the ice as early as March. The earliest recent sighting was on 21 March 1976 when two groups of approximately 80 and 120 whales were seen moving north through a lead southeast of Point Hope (Seaman, unpublished) . In late March 1978 more than 100 were seen moving through the leads near Point Hope and about 1,000 were seen on 19 May 1980 (D. Smullin, personal communication) . Belukhas are commonly seen and hunted throughout April and May, although hunting for belukhas takes place primarily when bowhead whales are not available (Marquette 1977; Braham and Krogman 1977). During spring most belukhas are seen swimming north, although in May 1976 several small groups were seen swimming south. Most sightings near Kivalina are in April and May and again in late June and early July (Frost et al. 1983b; Seaman, unpublished).

Hunters from Point Hope frequently see belukhas while hunting seals among the ice floes in late June and early July. During July, August, and early September, many belukhas are occasionally seen along the coast between Kotzebue Sound and Point Hope (Nelson 1887; Foote 1960; Frost et al. 1983b; Seaman, unpublished). Residents of Kivalina commonly see belukhas during the first part of September, usually swimming northwest along the coast toward Point Hope; they are rarely seen after that time. Seal hunters from Point Hope report seeing belukhas moving southward by the village during September and October. Belukhas are uncommon off Point Hope during midwinter, although they are occasionally seen south of there in January and February, following periods of strong northerly winds that form leads and polynyas in the ice.

Barrow Arch

The Barrow Arch area includes the Chukchi Sea coast from Cape Lisburne to Point Barrow (Figure 14). Most of the information presented below is based on our field studies conducted from 1978 to 1981, including interviews with local residents of Barrow, Wainwright, and Point Lay, and aerial surveys of the coast between Barrow and Cape Sabine. Specific sighting information is presented in Frost et al. (1983b) . There is little published information on belukhas in this area.

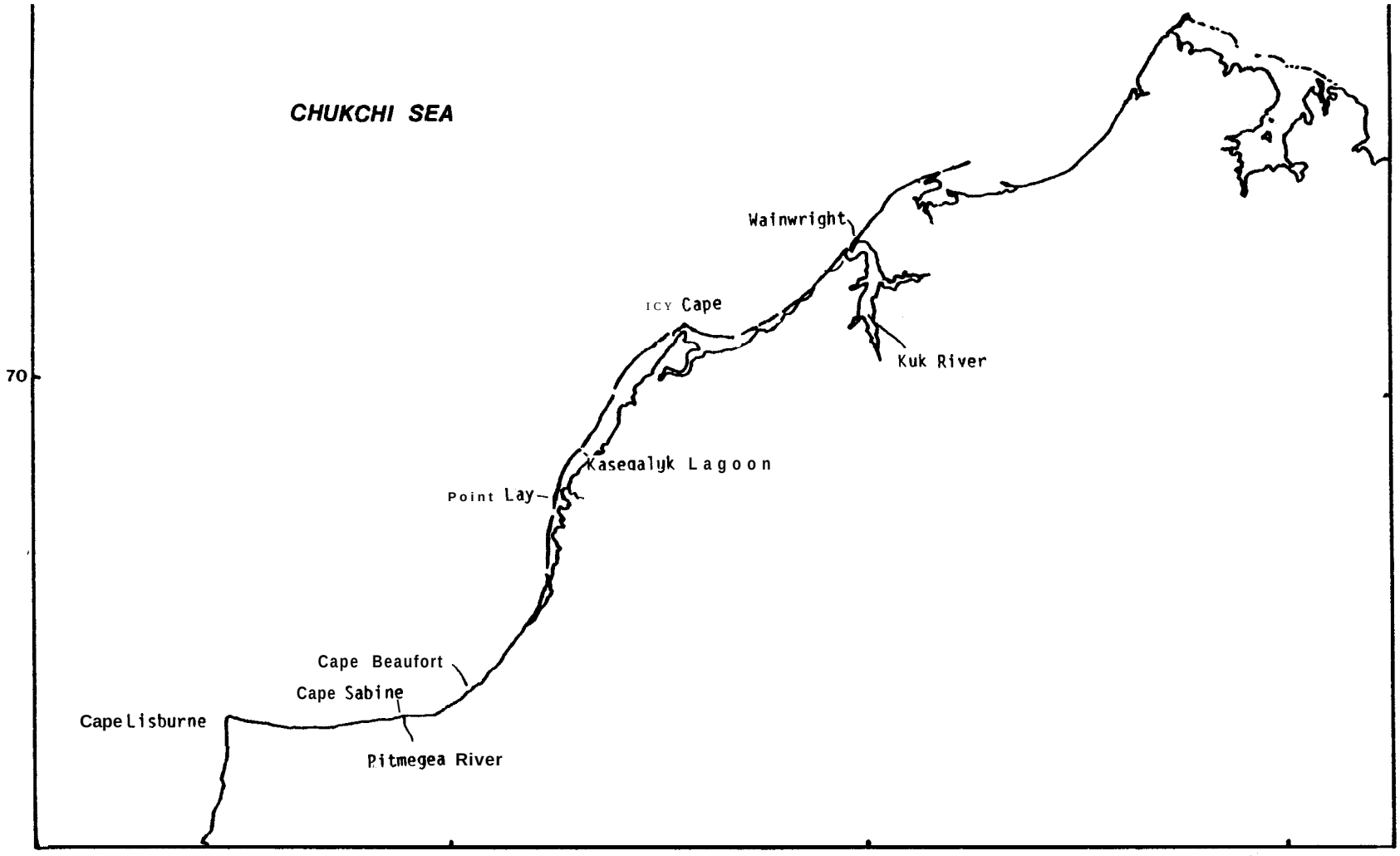

Figure 14. Map of the Barrow Arch region showing locations mentioned in text.

Belukhas are present in two "waves" along the northern Chukchi Sea coast. The first comprises whales migrating northward through leads in the pack ice during March-June and the second consists of whales that move into the coastal zone in June or July after the ice moves offshore. The timing of breakup is variable from year to year, with the ice moving out of the southern regions such as Ledyard Bay earlier than Peard Bay and Point Barrow to the north. On the average, the shore ice leaves Cape Sabine and Cape Beaufort regions in mid-June and Point Barrow about one month later.

Northward migrating belukhas move by Wainwright through leads in the ice as early as March (Nelson 1969; ADF&G, unpublished) . However, the peak of the spring migration past Wainwright and Barrow occurs in April and May (Braham and Krogman 1977; Seaman and Burns 1981). Groups of from 10 to several hundred whales have been seen in the flaw zone between Cape Lisburne and Barrow. The spring migration is largely complete by late May with most whales moving into the eastern Beaufort Sea to summer in coastal waters off the Mackenzie River estuary (Fraker 1979) .

The coastal area of the northern Chukchi Sea used most intensively by belukhas in June and July is Kasegaluk Lagoon and, particularly, the adjacent marine waters. Belukhas characteristically appear in the southern part of this region near Ledyard Bay in mid- to late June, then move gradually northward following the retreat of seasonal ice. Childs (1969) reported a group of 50 or more belukhas near the Pitmegea River on 24 June 1958. On 3 July 1982 an estimated 2,000-2,500 whales were observed in a loose aggregation moving northward along the coast in the area between Cape Sabine and Cape Beaufort (R. Quimby, personal communication) . Calves were observed within the aggregation. Residents of Point Lay regularly see whales near Cape Beaufort prior to their arrival at Kasegaluk Lagoon.

Belukhas first appear near the village of Point Lay in late June or early July . In 1978 the people of Point Lay saw the first "summer" belukhas (as opposed to spring migrants on their way to the Mackenzie River estuary which may be seen in April and May) of the year in Naokok Pass on 2 July. At least 100 whales were moving northward close to the shore. In 1979 the first summer whales, a group of at least 100, were seen at Kukpowruk Pass on 22 June. This is one of the earliest recorded sightings in this area and was probably due to a very early breakup that year.

Although belukhas sometimes use the deeper portions of Kasegaluk Lagoon, they are most often seen in the nearshore waters outside the barrier islands (Figures 15-17). The whales are usually concentrated near major passes, particularly Kukpowruk, Utukok, Icy Cape, and Akoliakatat, and to a lesser extent, Akunik. At a given time, most of the whales in the area usually concentrate at the same pass, either in or just outside of the pass itself, or in the downstream plume of lagoon water. Most have been observed within 1/2-3/4 km from shore, usually with a few small groups or solitary animals (mostly adults) farther offshore in deeper water. On 10 July 1978 a large group of whales observed near Kukpowruk Pass was concentrated in and south of the pass; the nearshore current was moving south that day. Whales seen at Akoliakatat Pass on 13 and 15 July 1979 were in and to the northeast of the pass; the current was moving to the

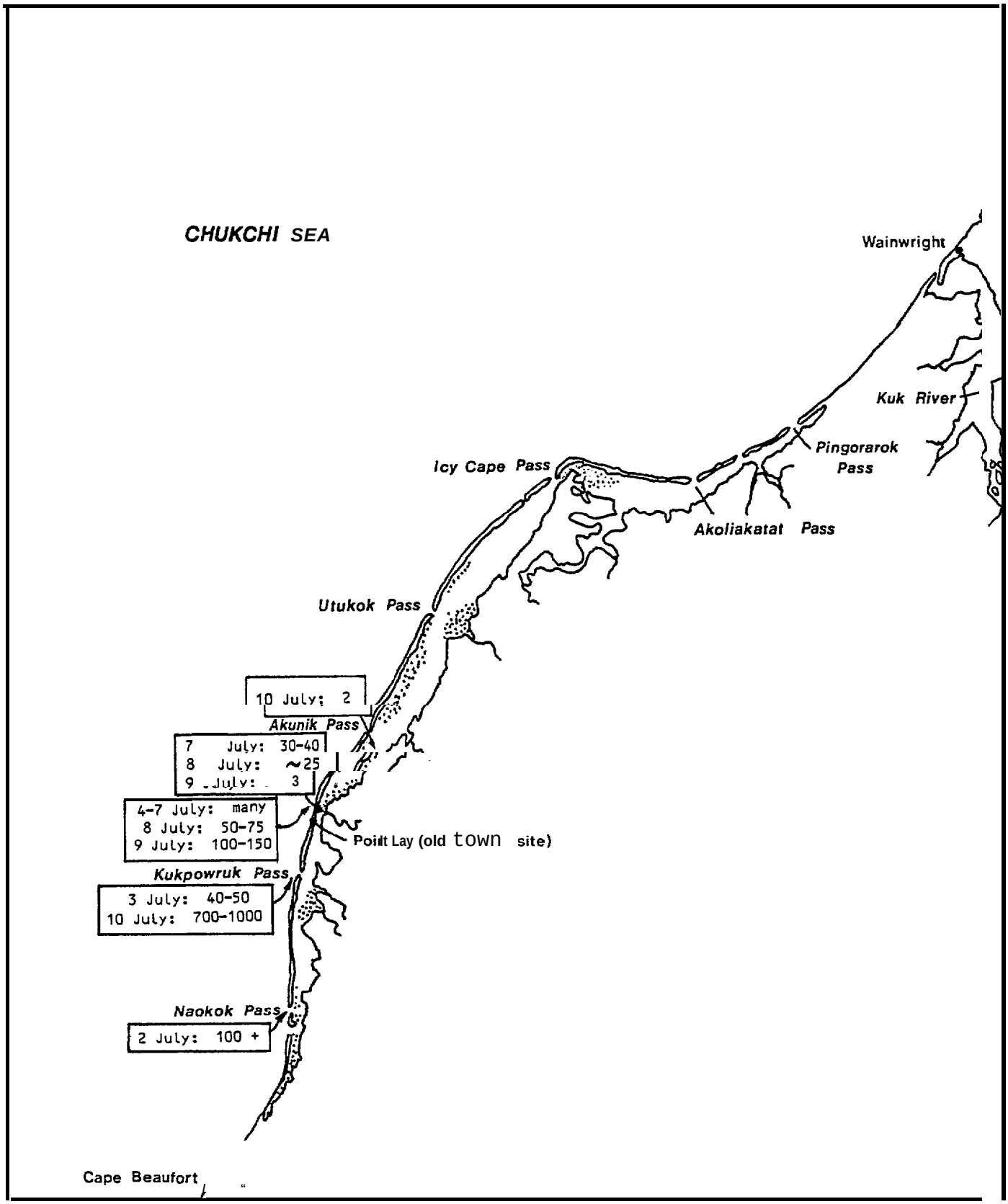

Figure 15. Sightings of belukha whales near Kasegaluk Lagoon, 1978.

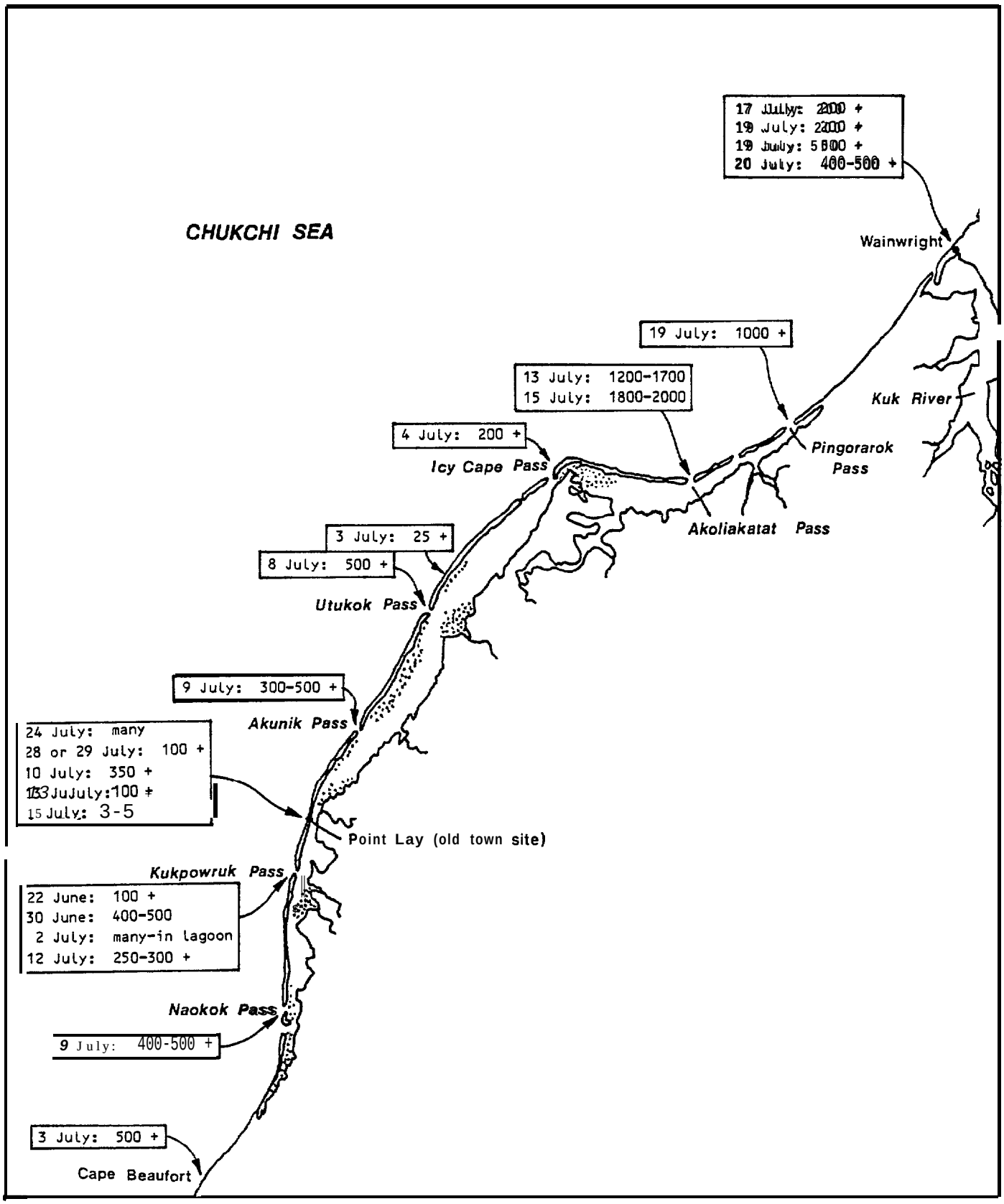

Figure 16. Sightings of belukha whales near Kasegaluk Lagoon, 1979.

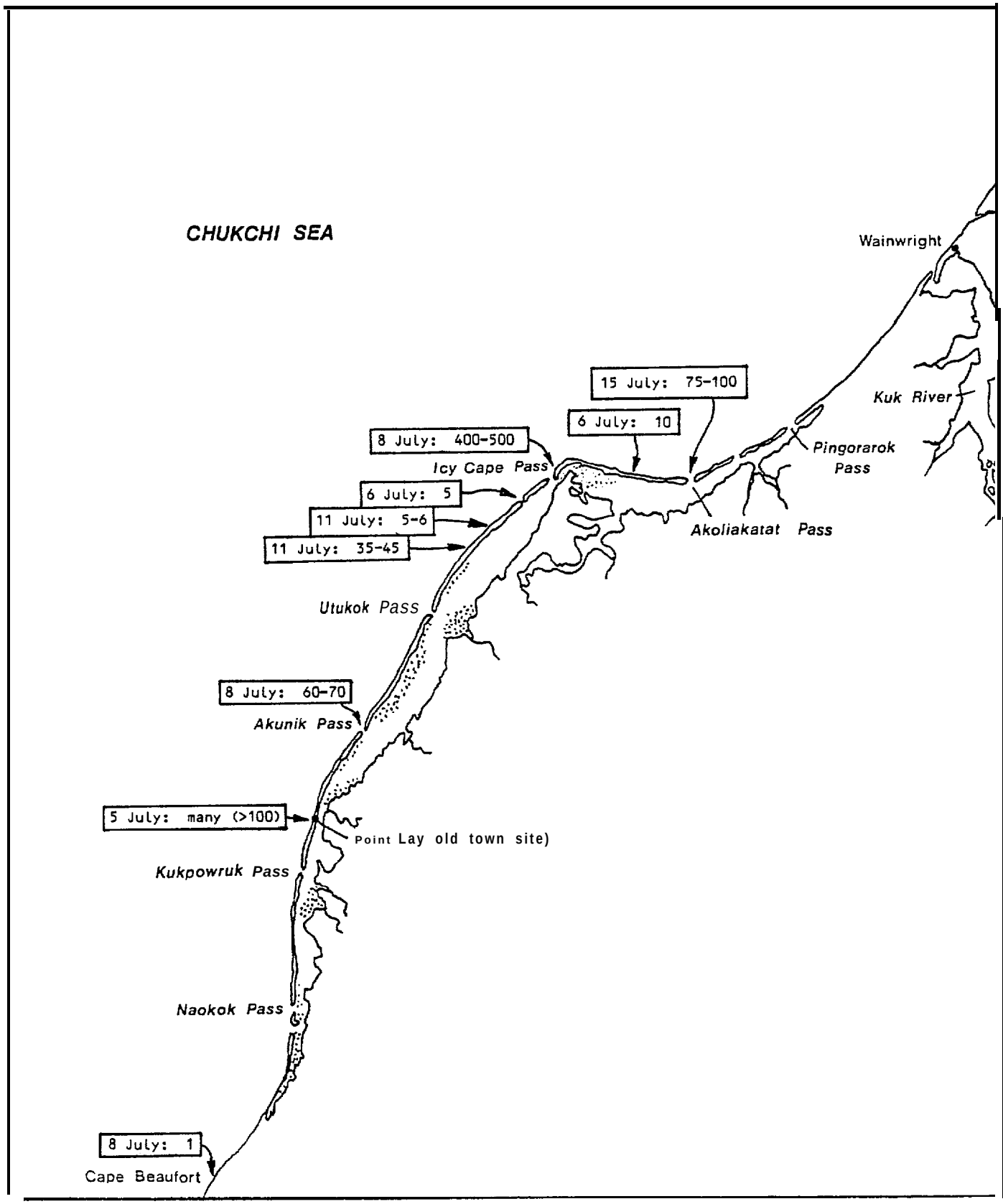

Figure 17. Sightings of belukha whales near Kasegaluk Lagoon, 1981.

northeast. Water temperatures in these lagoon plumes were as much as 2°c warmer than nearby marine waters (Seaman, unpublished) .

Belukhas also occur in the deeper channels inside Kasegaluk Lagoon. Point Lay residents report that whales only enter the lagoon when water is moving out a pass. They often enter by one pass and leave by another. In some years, many whales enter the lagoon, while in others very few do so. The reason for this variability is unknown.

Sightings from 1979, the year for which our data are most complete, illustrate some aspects of the movement of belukhas within the area. By late June the shore ice had moved offshore along the southern third of the lagoon; the pack ice remained close to shore near Utukok Pass and Solivik Island. The first belukhas were seen and hunted on 22 June at Kukpowruk Pass, after which they reportedly moved northward and offshore. They were next seen on 24 June moving southward along the beach near Point Lay and at the same location on 28 June moving northward. A pilot estimated 400-500 whales near Kukpowruk Pass on 30 June. None were seen on 1 July but many *were* present near shore and inside of the lagoon near Kukpowruk Pass on 2 July. There appeared to be some movement of whales between the coast and the edge of the ice pack a short distance to the north.

On 3 July the coast was surveyed from Naokok Pass to Point Barrow. The pack ice extended south parallel to the coast to approximately midway between Utukok and Icy Cape passes. Several small groups of belukhas were seen along the ice edge north of Utukok Pass. At approximately the same time, over 500 were reported by a hunter about 125 km to the south at Cape Beaufort. No whales were seen between the two points. On 4 July a southwest wind blew the ice to just north of Icy Cape and a pilot *saw* approximately 200 whales near Icy Cape Pass. On 8 July over 500 whales were seen at Utukok Pass and on 9 July sightings of 300-500 animals were made in the vicinity of both Akunik and Naokok passes.

The last large sighting of belukhas made at Point Lay in 1979 was on 13 July. Over 100 whales were moving northward from Kukpowruk Pass where whales were seen the day before. At Akoliakatat Pass, approximately 1,600-2,400 belukhas were present from 13 to 18 July, at which time they moved farther east and north. Whales were sighted at Pingorarok Pass (1,000+ animals) on 19 July moving northward, and at Wainwright, 40 kilometers to the northeast between 17 and 20 July, with peak numbers late on the 19th (500+) and on the 20th (400). No whales were seen at Akoliakatat Pass on 19 July. Based on the timing of observations, the belukhas seen at Wainwright on the 19th and 20th were the same animals that were observed at Akoliakatat Pass a few days earlier.

According to the residents of Point Lay, belukhas left the Kasegaluk Lagoon region unusually early in 1979. They are usually seen at Point Lay until at least the end of July and sometimes, as in 1978, until the middle of August. In 1981, however, no belukhas were seen on aerial surveys flown after 15 July (Frost et al. 1983b). The whales usually depart to the north, occasionally following the coast where they are seen at Wainwright and, less commonly, at Barrow. The factors affecting the timing of belukha movements are poorly known, but may include ice conditions, water temperature, food availability, human disturbance in the

form of hunting or aircraft overflights, and the presence of killer whales (*Orcinus orca*) (Bel'kovich 1960; Fish and Vania 1971; Sergeant 1973; ADF&G, unpublished).

Belukhas are known to calve in the Kasegaluk Lagoon area. On aerial surveys in July 1978 and 1979, neonates were observed among the adult and subadult whales. Twice, on 8 and 10 July 1978, belukhas were observed giving birth in the lagoon (Seaman, unpublished).

Our best estimates of the abundance of belukhas along this sector of the coast come from aerial photographic counts of whales at concentration areas. At Kukpowruk Pass on 10 July 1978, 703 whales were counted. At Akoliakatat Pass in 1979, 1,104 were counted on 13 July and 1,601 on 15 July. There are many problems associated with deriving an estimate of the total number of whales in concentration areas from aerial counts (Brodie 1971; Sergeant 1973; Fraker 1977). Some of the animals are underwater at any given time and, depending on turbidity of the water and the depth to which the belukhas dive, they may or may not be visible to an observer. Animals outside the main concentration areas (farther offshore) were more widely dispersed and appeared to remain underwater longer and therefore were not adequately represented in aerial photographs. Neonates and yearlings are also undoubtedly under-represented because their small size and dark color makes them difficult to see. By applying correction factors to account for the above problems in sightability, we estimate the total number of belukhas at Kukpowruk Pass on 10 July 1978 as 1,138, and at Akoliakatat Pass on 13 and 15 July 1979 as 1,575 and 2,282 (Table 3). Based on the above observations and those of local residents, we estimate that 2,000-3,000 belukhas may occur near Kasegaluk Lagoon in most years, although in some years the abundance of whales in the area may be considerably less.

Belukhas appear only occasionally at Wainwright and Barrow during the ice-free periods. Van Valin (1941) described a belukha hunt in "late spring" (presumably July) at Wainwright after the ice had gone out. Belukhas were seen and hunted there on 17 and 18 July 1979. Nelson (1969) noted that during the ice-free season, belukhas were most commonly seen in late July and August, and were usually moving northeast along the coast. Informants from Wainwright confirmed that information, and added that "long ago" belukhas sometimes congregated at the mouth of Wainwright Inlet and moved into the Kuk River during summer. They are occasionally seen near Wainwright in September. They were reported to be numerous off Wainwright on 3 September 1975 and small groups were seen off the coast between Wainwright and Barrow on 11 and 13 September of that same year (Fiscus et al. 1976).

Hunters near Barrow occasionally see belukhas moving along the shore in summer and early autumn. Murdoch (1885) reported that in 1881, 1882, and 1883 large groups of belukhas passed by Barrow as soon as there was open water near the beach and appeared again a week to 10 days later. He saw 100 or more whales pass by Barrow within 200 yards of the shore on 28 September 1881 but noted that September sightings were uncommon. Several older residents of Barrow indicated that belukhas were once commonly seen near the village every summer. Boat traffic and noise

Table 3. Counts from photographs, correction factors and total estimated numbers of belukhas, excluding neonates, seen near Kasegaluk Lagoon on survey flights in 1978 and 1979.

	Kukpowruk Pass	Akoliakatat Pass	
	10 July 1978	13 July 1979	15 July 1979
Photographic count	703	1104	1601
Correction factor for whales underwater and therefore not observed[1]	(140) 20%	(221) 20%	(320) 20%
Correction factor for areas where whales were not included in photos[2]	(211) 25%	(133) 10%	(192) 10%
Correction factor for yearlings not observed[3]	(84) 8%	(117) 8%	(169) 8%
Total estimated number of belukhas in concentration	1138	1575	2282

[1] Brodie (1971) working in clear water in Cumberland Sound estimated that he missed counting 40% of the animals because they were underwater and too deep to see. He did not use aerial photographs. Sergeant (1973) believed that he saw only 33% of the total animals while working in the murky waters of Hudson Bay. Seaman is of the opinion that he was able to count a much greater proportion of the total animals present in and adjacent to Kasegaluk Lagoon through the use of aerial photographs. On the average, whales were observed for 15-20 seconds and appeared on as many as three or four frames.

[2] Outside of the main concentration areas--the area covered by photographs--there were widely scattered individuals or small groups of whales that could not be included in photos taken on a single pass of the airplane. We assume that the age composition of those whales was similar to the main concentration.

[3] We used Brodie's (1971) estimate of 8% yearlings. Neonates are not included in the total estimates.

from large generators, vehicles, aircraft, etc., or other unknown factors may have discouraged whales from passing by near shore in recent years.

There is little information on the distribution and numbers of belukhas in the Barrow Arch portion of the northwestern Chukchi Sea. Burns (unpublished) recorded 13 whales in five scattered locations from 74°20'N to 74°41'N and 160°54'W to 167°24'W on 12 September 1974. On aerial survey flights conducted 10 through 20 September 1980, belukhas were sighted at four locations from 72°35'N to 73°00'N and 164°00'W to 169°00'W (Burns, unpublished). Recent detailed observations of autumn distribution in the northern Chukchi and western Beaufort seas are discussed in Burns and Seaman (1985).

Diapir Field

The Diapir Field planning area includes the Alaskan Beaufort Sea and a portion of the northeastern Chukchi Sea east of 162°W longitude (Figure 18). The continental shelf is quite narrow in the Beaufort Sea, generally extending offshore less than 100 km. Nearly continuous ice cover exists through much of the winter with a few offshore leads developing in the spring (Fraker 1979; Burns et al. 1981). Shorefast ice usually persists through June. In most years the pack ice retreats northward in mid to late summer leaving the coastal waters ice-free until freezeup in late September to early November (Burns et al. 1981) . In some years the ice never leaves the coastal waters of the Beaufort Sea, while in other years the southern edge may be a hundred kilometers or more north of the coast.

Belukha whales are absent from the Diapir Field during most of the winter, from late November through March. Ice and weather conditions do not produce areas with predictable open water, and favorable wintering conditions for belukhas generally do not occur. Small numbers of whales may become entrapped by ice during the autumn migration, but the incidence of this is probably low. Observations of entrapped belukhas in the eastern Canadian Arctic (Porsild 1918; Freeman 1968) suggest that attempts to overwinter under these conditions frequently result in high mortality.

Belukha whales are common and at times very abundant in the Diapir Field during the spring, summer, and autumn. The majority of belukhas that seasonally occur in the Beaufort Sea are part of a group of at least 11,500 whales that summer in the Canadian Beaufort Sea and overwinter in the Bering and southern Chukchi seas (Braham and Krogman 1977; Fraker 1979; Davis and Evans 1982). The spring migration of belukha whales in the Chukchi Sea past Point Hope commences in mid- to late March (see Hope Basin and Barrow Arch planning area discussions). The earliest recorded sighting of belukha whales passing Point Barrow was on 2 April 1977 when a Barrow hunter, Arnold Brewer (personal communication) , sighted over 60 animals moving through a narrow lead off the shorefast ice. Four days later several hundred whales were seen. It is possible that belukhas occasionally pass by Barrow as early as late March. Belukhas are known to utilize offshore leads during the spring migration (Braham et al. 1984) and it is likely that some pass Point Barrow unnoticed by local hunters.

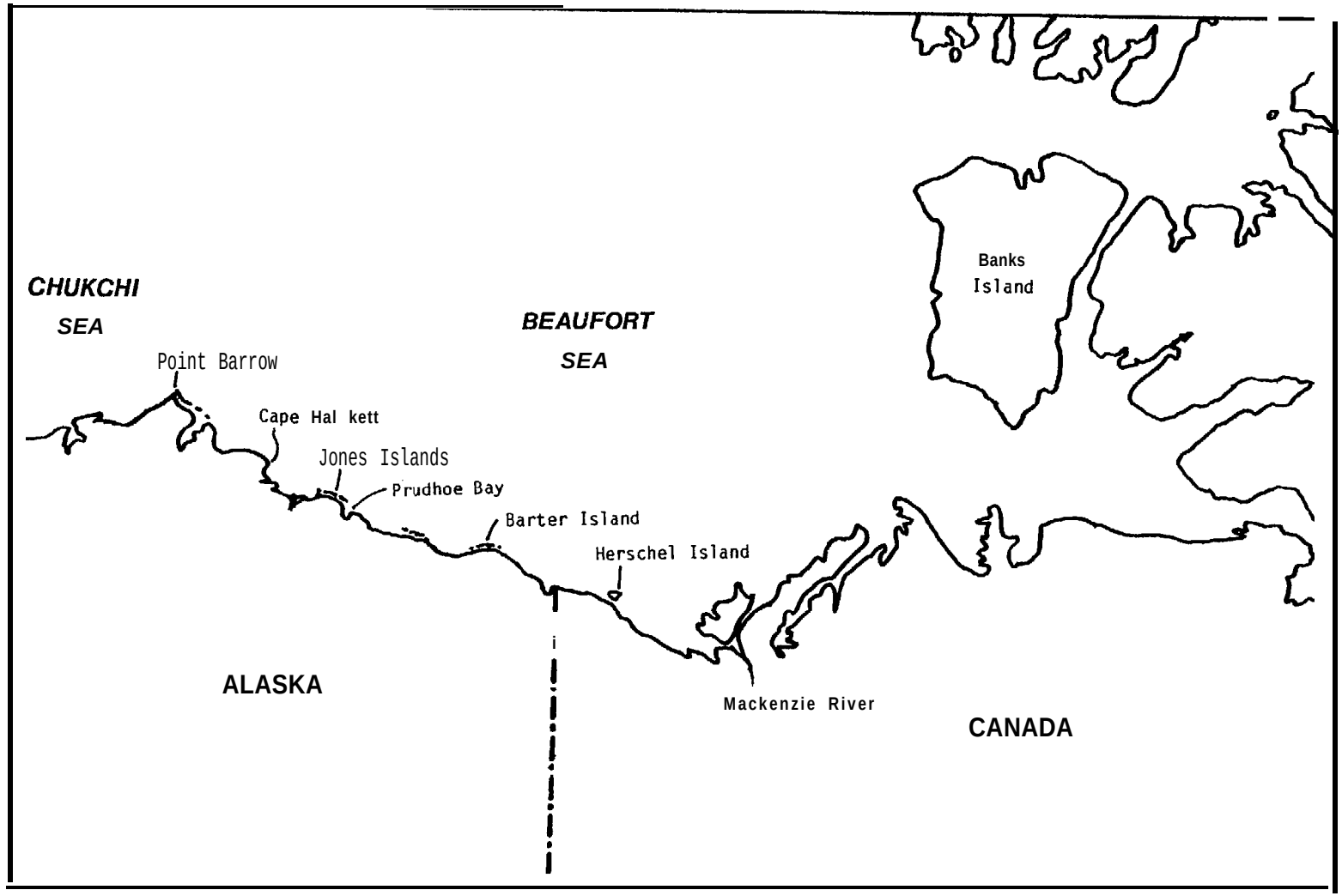

Figure 18. Map of the Diapir Field showing locations mentioned in text.

The peak of the spring migration past Point Barrow occurs from late April to the third week of May and varies in relation to ice conditions (Braham and Krogman 1977; G. Carroll, personal communication). The general north and east migration past Point Barrow continues through at least early July. Braham et al. (1984) observed belukhas north of Barrow up until their last aerial surveys in late June. Harrison and Hall (1978) observed two groups of 9 and 23 belukhas north of Barrow the first week of July and Murdoch (1885) reported whales along the coast at Barrow in the middle of July immediately following breakup.

The proposed migration route of belukha whales from Point Barrow to the eastern Beaufort Sea is described in detail by Fraker (1979) . Observations by Ljungblad (1981) confirm that in late May and June migrating whales utilize offshore leads in pack ice which extend northeast from Barrow, into the Beaufort Sea. 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 are observed in some of the bays (Fraker et al. 1978). However, some belukhas have been seen moving eastward in Alaskan waters as late as 27 June and 15 July (Ljungblad 1981; ADF&G, unpublished).

Belukha whales have never been observed in large numbers during the summer in the coastal waters of the Alaskan Beaufort Sea. This is in marked contrast to the Canadian portion of the Beaufort Sea where up to 7,000 whales have been observed in the Mackenzie River estuary during July and August (Fraker 1980). Long-time residents of the Alaskan mid-Beaufort region, Jim and Harmon Helmericks (personal communication) , indicate that belukhas are common off the shorefast ice until it moves away from the coast, usually between late June and mid-July. During the remainder of the summer, belukhas are rarely observed in the ice-free coastal waters of the Alaskan mid-Beaufort Sea.

During summer, belukhas are occasionally observed in the pack ice or ice-free waters near Barter Island. In July, these whales are typically observed moving eastward close to shore in small groups of 5 to 15. During August belukhas occur in groups of similar size, but are observed to move both east and west along the coast. Hunters of Kaktovik on Barter Island killed several belukhas on 19 August 1980.

There have been very few sightings of belukha whales within 120 km of the coast in the waters and pack ice of the Beaufort Sea during July and early August. Harrison and Hall (1978) saw four whales on 18 August 1976, approximately 75 km north of Cape Halkett, and Ljungblad et al. (1982) made three sightings of 26 animals at 96, 220, and 270 km north of Prudhoe Bay on 22 August 1981. Considering the substantial effort that has been devoted to offshore aerial surveys in this region north to about 71° N (e.g., Harrison and Hall 1978; Ljungblad et al. 1980, 1982; Ljungblad 1981), it appears that belukhas are uncommon in the open water areas of the Alaskan Beaufort Sea during July and early August.

Sightings of belukha whales in the eastern Beaufort Sea become increasingly infrequent in late August and September. Whales are seen headed

west past Herschel Island during September; a group of 2,000 was sighted near there on 21 September 1972 (Fraker et al. 1978). It appears that most whales move offshore prior to entering the Alaskan Beaufort Sea since they are rarely reported in nearshore waters. Johnson (1979) reported two sightings of whales swimming westward just offshore of the Jones Islands; a group of 75-100 was seen on 15 September 1977 and approximately 35 were seen on 23 September 1978. Cummings (personal communication) heard vocalizations of belukha whales near Prudhoe Bay in September 1980. No belukha whales were seen during marine mammal research done from a small boat in the nearshore Alaska Beaufort Sea from 20 August to 21 September 1980 and 16 August to 11 September 1981 (Frost and Lowry 1981; Lowry et al. 1981). The majority of belukha whales seem to remain well offshore throughout their westward migration out of the Beaufort Sea. Large numbers of whales have been seen on several occasions in September and early October in the region 35-220 km north of Point Barrow. During September they may be dispersed over a wide area. For example, on 21 September 1977, 100 were seen north of Prudhoe Bay and 2,000 were seen near Herschel Island. On 20 September 1980, Burns and Seaman (1985) observed numerous belukhas in a 140 km long band of pack ice north and east of Barrow.

DISCUSSION AND CONCLUSIONS

While belukha whales are a widespread, abundant, and comparatively well-known species in arctic and subarctic regions, many aspects of their distribution and movements are poorly understood. A basic question of considerable practical significance is how various groups of belukhas, which are mostly observed, studied, and exploited in spring and summer, relate to one another in terms of population identity.

Although some researchers have implied that reproductive isolation occurs among summering groups by referring to them as populations or stocks, such assertions probably do not apply to belukhas in western Alaskan waters. Breeding activity occurs in spring, prior to the arrival at summering areas, at a time when considerable mingling of animals can occur. Unfortunately, virtually no research has been done in areas where belukhas are presumed to breed so that an assessment of population identity must be made based on geographical considerations, as well as the fragmentary results of tagging and morphometric studies. We use the term population to refer to groups of whales that probably have low genetic interchange with other groups due to isolation during the reproductive period. Other groupings or concentrations of whales should be called aggregations, within which there may be herds. In areas where aggregations have been shown to be resident and largely isolated from adjacent groups the term stock may be applicable.

Whales in the North Pacific region are divisible into three populations. Those occurring in the Okhotsk Sea and the Cook Inlet area are resident and geographically isolated from the group that ranges throughout much of the Bering, Chukchi, Beaufort, and East Siberian seas. We refer to this latter group as the Bering Sea population. Contrary to the implication of Figure 6 in Gurevich (1980), we know of no evidence to suggest that interchange occurs between the Bering Sea and Cook Inlet populations through Unimak Pass, though it is possible. The separation

between the Eurasian and the Bering Sea populations occurs in the western part of the East Siberian Sea (Gurevich 1980) . Heavy pack ice effectively separates the belukhas from the Bering Sea population that summer in the western Canadian arctic from those to the east (Sergeant and Brodie 1975) .

Favorable wintering habitat for belukhas (i.e., seasonal pack ice with adequate leads and polynyas) occurs in much of the Bering and southern Chukchi seas and the few available sightings indicate that whales are dispersed throughout this area. Compressive forces resulting in tightly packed ice (see Burns et al. 1981) likely exclude belukhas from some areas north of large islands (i.e., St. Lawrence and St. Matthew) and immediately north of Bering Strait.

With the first loosening of pack ice in March, a large component of the belukha population begins an extensive migration that eventually brings them to the eastern Beaufort Sea-Amundsen Gulf area (Fraker 1979). Since the shorefast ice is still intact during the migration period, these animals are excluded from the coastal zone until late June when they reach the Mackenzie estuary. The remaining animals move to coastal areas of Alaska and the USSR at breakup, which can occur as early as April in southern locations such as Bristol Bay.

During late spring and summer, belukhas occur in most coastal regions of the eastern Bering and Chukchi seas (Frost, et al. 1983a, 1983b). However, they are not seen in all locations at the same time, nor do they necessarily occur in each area every year. In the Bering Sea, whales are resident throughout the summer in inner Bristol Bay and the Norton Sound/Yukon River mouth region but are seen only sporadically in the area from Cape Constantine to Cape Romanzof. Considerable local movements of whales may occur. For example, belukhas that are seen in eastern and northern Norton Sound chasing schools of herring in late May and June are thought to move to the Yukon River estuary in summer to feed on salmon. These may be the same animals seen near Nome and Golovnin Bay in October and November feeding on saffron cod. We estimate that a minimum of 2,000-3,500 belukhas summer in Alaskan waters south of Bering Strait.

Along the Chukchi coast, belukhas are seen in two “waves.” The first moves through the shore leads and offshore pack ice, passing Point Hope mainly in late April and May and Point Barrow slightly later (Fraker 1979) . The second wave entails groups of animals that appear in coastal areas shortly after breakup from mid-June through July and occasionally into August.

Although direct evidence is lacking, it is likely that the summer whales in the Chukchi Sea are part of a single group which occurs sequentially at various locations along the coast. The timing of occurrence of whales in recent years at several locations is shown in Table 4. These data are based mainly on opportunistic observations and may not in all cases reflect the peak period of abundance at each location. Nonetheless, a clear pattern is evident which shows whales appearing later in the summer at more northerly points, with little overlap between periods of occurrence at adjacent locations. On the average,

this group of whales moves from southeastern Kotzebue Sound to the vicinity of Wainwright, a distance of approximately 625 km during a period of 30 days, much of which may be spent in concentration areas such as Kasegaluk Lagoon. Although the pattern is generally repetitive, considerable year to year variations in abundance and residence time in specific areas have been noted and are discussed in previous sections of this report. We estimate that this group consists of 2,500-3,000 belukhas.

Table 4. Dates of sightings of belukha whales at selected locations on the eastern Chukchi Sea coast (from Frost et al. 1983b and this report) .

Year	Kotzebue Sound	Kivalina	Cape Sabine	Point Lay	Wainwright
1978	11 June-9 July	21-24 June		2-10 July	15 July
1979	8-25 June		3 July	22 June-19 July	17-20 July
1980	13-23 June			11 July	20 July
1981	12-19 June		8 July	5-15 July	
1982	7-23 June	29 June	3-6 July	5 July	

The whereabouts of this group of whales after they leave the Kasegaluk Lagoon region and move northward toward Barrow is poorly known. Sightings off Wainwright indicate that they sometimes follow the coastline toward Point Barrow. These whales probably move generally north to the pack ice and remain in the northeastern Chukchi/western Beaufort seas until the autumn migration occurs. During three aerial surveys made in mid-September, the largest numbers of belukhas were encountered in the region generally north of Point Barrow, though herds occurred sporadically along the entire ice margin in the Chukchi Sea and were seen regularly in the western Beaufort Sea (Burns and Seaman 1985) .

However, there is also a possibility that belukhas which are in the coastal zone of eastern Chukchi Sea during June to early August may move eastward across the Beaufort Sea and become part of the groups which are in Amundsen Gulf and the Mackenzie Bay region in mid-August. Aerial surveys of the eastern Beaufort Sea and Amundsen Gulf in 1981 detected a major increase in numbers of belukhas between late July and mid-August (Davis and Evans 1982). For the period 5-17 August, the minimum estimated number of whales was 11,500, which was an increase of over 7,000 whales from the previous survey period (18-25 July). During the

mid-August surveys, researchers noted whales moving into their study area from the north. For belukhas to move from Point Barrow to the eastern Beaufort Sea would require a movement of about 640 km over a period of 15-30 days, which is somewhat more rapid than their probable rate of movement along the Chukchi Sea coast. However, this possibility remains speculative since belukhas are occasionally present near Wainwright in early to mid-August and large herds of eastbound whales have not been seen in the Alaskan Beaufort in late July or early August.

As previously indicated, large groups of whales have been observed in September in offshore waters and pack ice of the western Beaufort and eastern Chukchi seas. These groups, which probably include both Chukchi Sea and eastern Beaufort Sea herds, may move westward and join whales which have summered along the coast of the Chukchi Peninsula prior to heading southward through Bering Strait. Large groups of belukhas have been seen near Wrangel Island in early October, headed eastward toward Bering Strait (Kleinenberg et al. 1964).

Based on our review of distributional information, we conclude that belukha whales that summer in the eastern Bering, the Chukchi, and the Beaufort seas probably comprise four summering groups (Table 5). A minimum population estimate of belukhas which pass through waters adjacent to Alaska, derived by summing the low estimate for each group and assuming that Chukchi Sea animals were counted during eastern Beaufort Sea surveys, is 13,500. The maximum estimate is 18,000. It must be noted that both of these estimates are conservative since surveys of the eastern Beaufort Sea did not include the entire area and no corrections were made for submerged animals which were not counted (Davis and Evans 1982). Considering these factors and the unknown number of whales summering in the northern Chukchi Sea as well as in waters of the USSR, the actual abundance of belukhas in the Bering Sea population may be in excess of 25,000.

Table 5. Estimated abundance of stocks of Alaskan belukha whales.

Stock Name	Estimated Abundance
Bristol Bay	1,000-1,500
Norton Sound	1,000-2,000
Eastern Chukchi Sea	2,500-3,000
Eastern Beaufort Sea	11,500

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