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## Spring Migration of the Western Arctic Population of Bowhead Whales

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### Introduction

Each spring the western Arctic population of bowhead whales, *Balaena mysticetus*, migrates from the Bering Sea, through the Chukchi Sea, and into the Beaufort Sea. For centuries, coastal Eskimos of western Alaska and eastern Siberia have taken bowheads during spring as the whales moved past their villages soon after openings formed in the pack ice. Traditionally, Eskimos sailed or paddled their boats out into cracks and open water areas in the ice, called leads and polynyas, respectively, from April to June to hunt the whales. The breakup of the pack ice and migration pattern of the whales are so regular that the whales are reliably accessible to whalers each spring, but only for a few weeks. At St. Lawrence Island, Alaska,

for example, present-day whaling occurs from approximately the first week in April to about the first week in May; at Barrow, Alaska, the peak of both migration and whaling activity occurs from the last week in April to the last week in May (Braham and Krogman<sup>1</sup>; Marquette<sup>2</sup>, 1979; Braham et al., 1979; Braham et al.<sup>3</sup>).

<sup>1</sup>Braham, H., and B. Krogman. 1977. Population biology of the bowhead (*Balaena mysticetus*) and beluga (*Delphinapterus leucas*) whale in the Bering, Chukchi and Beaufort Seas. Processed rep., 29 p. Natl. Mar. Mammal Lab., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

<sup>2</sup>Marquette, W. M. 1977. The 1976 catch of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos, with a review of the fishery, 1973-1976, and a biological summary of the species. Processed rep., 80 p. Natl. Mar. Mammal Lab., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

<sup>3</sup>Braham, H., B. Krogman, and G. Carroll. 1979. Population biology of the bowhead whale (*Balaena mysticetus*) II: Migration, distribution, and abundance in the Bering, Chukchi, and Beaufort Seas, with notes on the distribution of white whales (*Delphinapterus leucas*). Unpubl. final rep., OCSEAP Contract No. R7120807, 118 p. Natl. Mar. Mammal Lab., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

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Townsend (1935) plotted the locations of bowheads killed by Yankee whalers operating in the Bering Sea and Arctic Ocean from 1848 to 1919. His map suggests that bowheads may have formerly occurred in the Bering and Chukchi Seas, as well as in the Beaufort Sea, during the summer months, well beyond the present-day whaling season. Data collected since 1974, however, indicate that bowheads do occur in the eastern Beaufort Sea during the summer (Fraker and Bockstoce, 1980), but that probably only a few occur in the Bering and southern Chukchi Seas during summer (Braham et al., footnote 3; Braham, Krogman, Nerini, Rugh, Marquette, and Johnson, 1980; Dahlheim et al., 1980).

Although the general timing and pattern of movements of bowheads during the spring migration are known (Bailey and Hendee, 1926; Tomilin, 1957; Foote<sup>4</sup>; Durham<sup>5</sup>; McVay, 1973; Braham and Krogman; footnote 1), the precise pathway that they take has not been fully described—especially in the largely frozen Beaufort Sea. In this paper we discuss the spring migration route, March through June, and describe ice conditions encountered by the whales. In addition to gaining an understanding of an important part of

<sup>4</sup>Foote, D. C. 1964. Observations of the bowhead whale at Point Hope, Alaska. Unpubl. manuscript, 73 p. McGill Univ., Montreal, Quebec, Can.

<sup>5</sup>Durham, F. E. 1972. Biology of the bowhead whale (*Balaena mysticetus*) in the western arctic. Unpubl. manuscript, 93 p. Dep. Biol., Univ. South Calif., Los Angeles, CA 90007.

the species' annual cycle of movements, the primary objective of our study of migration and distribution is to determine what portion of the bowhead population migrates past the National Marine Fisheries Service whale-counting ice camps, described by Braham et al. (1979) and Krogman (1980), to ensure the best possible estimate of the population size.

### Study Area and Ice Conditions

The study area included the northern Bering Sea, the Chukchi Sea east of long. 171°W, and the Beaufort Sea and Amundsen Gulf west of approximately long. 120°W (Fig. 1).

Ice is a dominant feature of the study area and a knowledge of its characteristics is critical to understanding bowhead migration. In March or April, the pack ice reaches its maximum extent in the Bering Sea (Shapiro and Burns, 1975). Ice breakup begins as temperatures rise and wind direction shifts from northeast to south or southwest, pushing the ice northward. In the northwestern Bering Sea, between the Chukchi Peninsula and St. Lawrence Island, strong currents further help to break up the ice and form an open-water corridor. North of the Bering Strait, a shear or flaw zone forms parallel to the Alaskan coast causing numerous small leads to develop along and near this zone. An intermittent lead system forms from the Bering Strait through outer Kotzebue Sound to Point Hope and on to Point Barrow (Fig. 2). This lead system usually consists of a single, major nearshore lead that lies between landfast ice and the pack ice.

In the Beaufort Sea, two closely related phases of spring ice movement (Marko, 1975) are relevant to whale migration. First, there is a southwestward movement of ice in the northern Beaufort Sea that results in a major shear zone projecting northeastward into the eastern Beaufort Sea, toward Banks Island (Fig. 3). North of this east-west trending shear zone, an extensive system of interconnecting north-south rectilinear leads develops. The shear zone and perhaps the extensive lead system to the north serve as avenues for bowhead and white whales, *Delphinapterus leucas*, migrating eastward through the Beaufort Sea.

Second, a general westward drift of ice in the eastern Beaufort Sea results in extensive lead and polynya development in the eastern portion of the study area. Easterly winds in the eastern Beaufort Sea during spring, in concert with the clockwise rotation of the Beaufort gyre, cause a major north-south lead west of Banks Island and another (often connected) lead north of the landfast ice of the Tuktoyaktuk Peninsula (Fig. 3). During spring, the ice in Amundsen Gulf begins to break up to form a major polynya, which expands and becomes continuous with the leads off Banks Island and the Tuktoyaktuk Peninsula.

### Sources of Data

The major sources of data for this paper were aerial surveys and compilations of sightings by NMFS scientists working in the Bering, Chukchi, and western Beaufort Seas 1976-79 (Braham and Krogman, footnote 1; Braham et al., 1979, footnote 3; Brueggeman<sup>6</sup>) and by Fraker in the eastern Beaufort Sea (Fraker et al., 1978; Fraker, 1979). Additional data on location and timing of bowhead movements were also obtained from village residents along Alaska's northwest coast; observers at land and ice camps in northwest Alaska (Braham and Krogman, footnote 1; Braham et al., 1979); researchers on the NOAA ship *Surveyor* operating in the Bering Sea; Soviet investigators<sup>7</sup>; Canadian Wildlife Service scientists and other persons in Canada during 1971-77 (Fraker, 1979); and State of Alaska, Federal, and other scientists who have worked in Alaska over the past 20 years.

Over 150 aerial surveys totaling about 170,000 km in length were carried out in the study area 1974-79. Most surveys were conducted in April and May; others were flown in March and June. Fixed-wing aircraft were used,

most often a DeHavilland Twin-Otter<sup>8</sup> and a Grumman Goose (N780) equipped with Global Navigation 500 navigational equipment. Flights were either systematic or opportunistic depending on the extent of ice cover, weather, and survey location. For detailed accounts of equipment, survey designs, and methods, see Braham and Krogman (footnote 1); Braham et al. (footnote 3, 1979); Braham, Krogman, Nerini, Rugh, Marquette, and Johnson (1980); Fraker et al. (1978); and Fraker (1979).

### Spring Migration

#### Migration Routes and Timing

During average ice years, bowhead whales spend the winter (January to March) in the pack ice from St. Lawrence Island south to St. Matthew Island (Braham et al., footnote 3; Brueggeman, footnote 6). During years when the pack ice is extensive, such as in 1976 and 1977, the whales can occur as far south as the Pribilof Islands. Only two bowheads have been sighted in open water south of the ice front in the spring (Fig. 4).

Aerial survey data collected since 1976 reveal that the bowhead migration begins in the western part of the northern Bering Sea. From the area west of St. Matthew Island and southwest of St. Lawrence Island, bowhead whales migrate past the west end of St. Lawrence Island taking at least two routes (Fig. 5). First, some whales approach St. Lawrence Island near Southeast Cape where a polynya frequently forms; these animals then head west along the south side of the island and then north along the west side, passing the village of Gambell<sup>9</sup>. Some of these animals may migrate around the east end of St. Lawrence Island; however, this area does not appear to be an important migration route (Braham et al., footnote 3). Second, a portion of the population also approaches St. Lawrence Island near Southwest Cape and then migrates northwestward offshore

<sup>6</sup>Brueggeman, J. 1979. Early spring distribution of bowhead whales in the Bering Sea. Unpubl. manusc., 22 p. Natl. Mar. Mammal Lab., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

<sup>7</sup>G. Fedoseev, Pacific Scientific Research Institute of Fisheries Oceanography (TINRO), Magaden, Nagaevskaya 51, 685013, U.S.S.R., and A. Berzin, TINRO, Vladivostok, U.S.S.R. Pers. commun.

<sup>8</sup>Reference to trade names or commercial firms does not necessarily imply endorsement by the National Marine Fisheries Service, NOAA, or LGL, Ltd.

<sup>9</sup>C. Oozeva, R. Silook, and V. Slwooko, Gambell, AK 99742. Pers. commun.

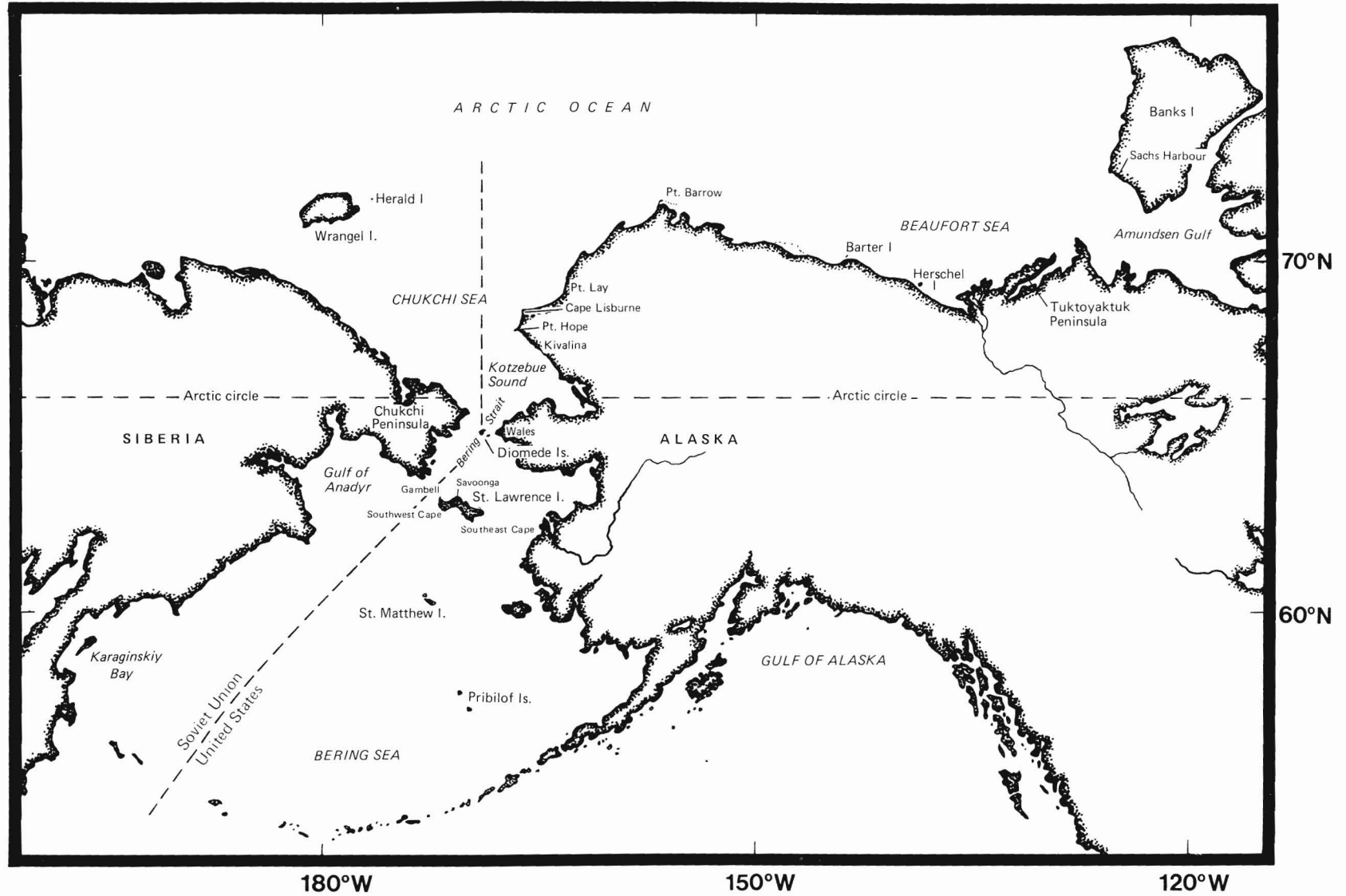


Figure 1. — Western Arctic bowhead whale population study area.

to near the coast of Siberia well away from the village of Gambell (Fig. 5). Therefore, some animals migrate close to the west end of St. Lawrence Island and others far offshore. Although we have not been able to confirm this specific migration near St. Lawrence Island, Eskimo whalers there are convinced of it.

Survey results from 1976 to 1978 suggested that bowheads migrate north through the northwestern Bering Sea and the western part of the Bering Strait. It is the available open water that governs what part of the Strait they use; in some years the east side is undoubtedly used. Apparently, few of the bowheads moving toward the Bering Strait travel near the coast of Alaska. Eskimo whalers at Wales, Alaska, occasionally take a whale near their village during spring (Marquette, footnote 2) when ice conditions permit the whales to use the eastern part of the Strait.

On 24-26 April and 22 May 1978, we conducted six aerial surveys of the Bering Strait. As in April 1976 and 1977, ice cover was extensive across the Bering Strait but somewhat more broken on the Soviet side than the U.S. side. Sixty-seven bowheads, including three calves, were observed just north of the Diomed Islands; they had apparently moved north through the western two-thirds of the Strait (Fig. 4). Their mean true heading was  $35.5^{\circ}\text{N}$  ( $n=32$ ), which is in direct line to Point Hope.

Upon entering the Chukchi Sea, the whales move northeastward across outer Kotzebue Sound in recurring leads seaward of the landfast ice (Fig. 2; small leads not apparent in this photograph). Bowheads appear to migrate in these leads in outer Kotzebue Sound. Some whales move into a polynya that typically forms between Kivalina and Point Hope, but the extent of use of this polynya is unknown. Figure 2 shows that open water was prevalent inside Kotzebue Sound on 26 April 1978. Often this is not the case; characteristically a prominent lead develops along the edge of landfast ice extending in a direct line from the Bering Strait to Point Hope (Fig. 3).

Some Eskimo whalers suggest that a segment of the bowhead population moves northwestward from the Bering

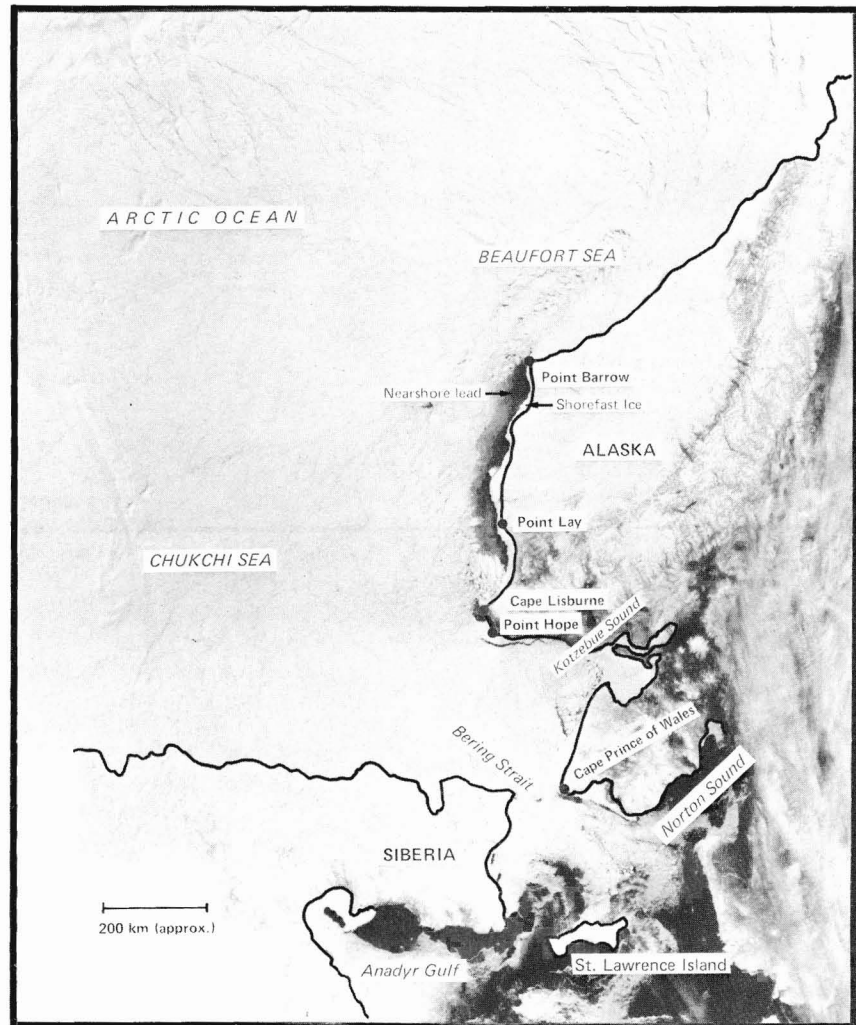


Figure 2. — NOAA satellite image, 26 April 1978, of the spring lead system which forms from the Bering Strait to Point Barrow. Light areas are ice, dark areas are water or thin ice (newly refrozen lead).

Strait into the western Chukchi Sea in the spring. We believe that this is unlikely as there is usually complete ice cover north of the Chukchi Peninsula and west of long.  $169^{\circ}30'W$  with few leads present (Shapiro and Burns, 1975; Fedoseev, footnote 7). A few flights were made over Soviet waters in March, April, and June 1976 and May and June 1978; the area was almost completely ice covered and no whales were seen. Because the whales we observed north of the Bering Strait in April 1978 were heading east of north, and because ice cover was so complete to the west, it does not seem likely that bowheads were present west of long.

$169^{\circ}30'W$ . Furthermore, although Siberian Eskimos living along the east side of the Chukchi Peninsula hunted bowheads in the spring, those along the north coast never did (Tomilin, 1957). North coast Siberian Eskimos hunted bowheads only in the autumn (Marquette and Bockstoe, 1980).

Proceeding on a heading of  $35^{\circ}$ - $45^{\circ}$  true, bowheads follow open leads northward past Cape Thompson and Point Hope, and then northeastward to Cape Lisburne and Point Barrow. The migration past Cape Lisburne seems to follow two or more corridors occurring 2-10 km offshore, but a few sightings have been made up to 15 km offshore

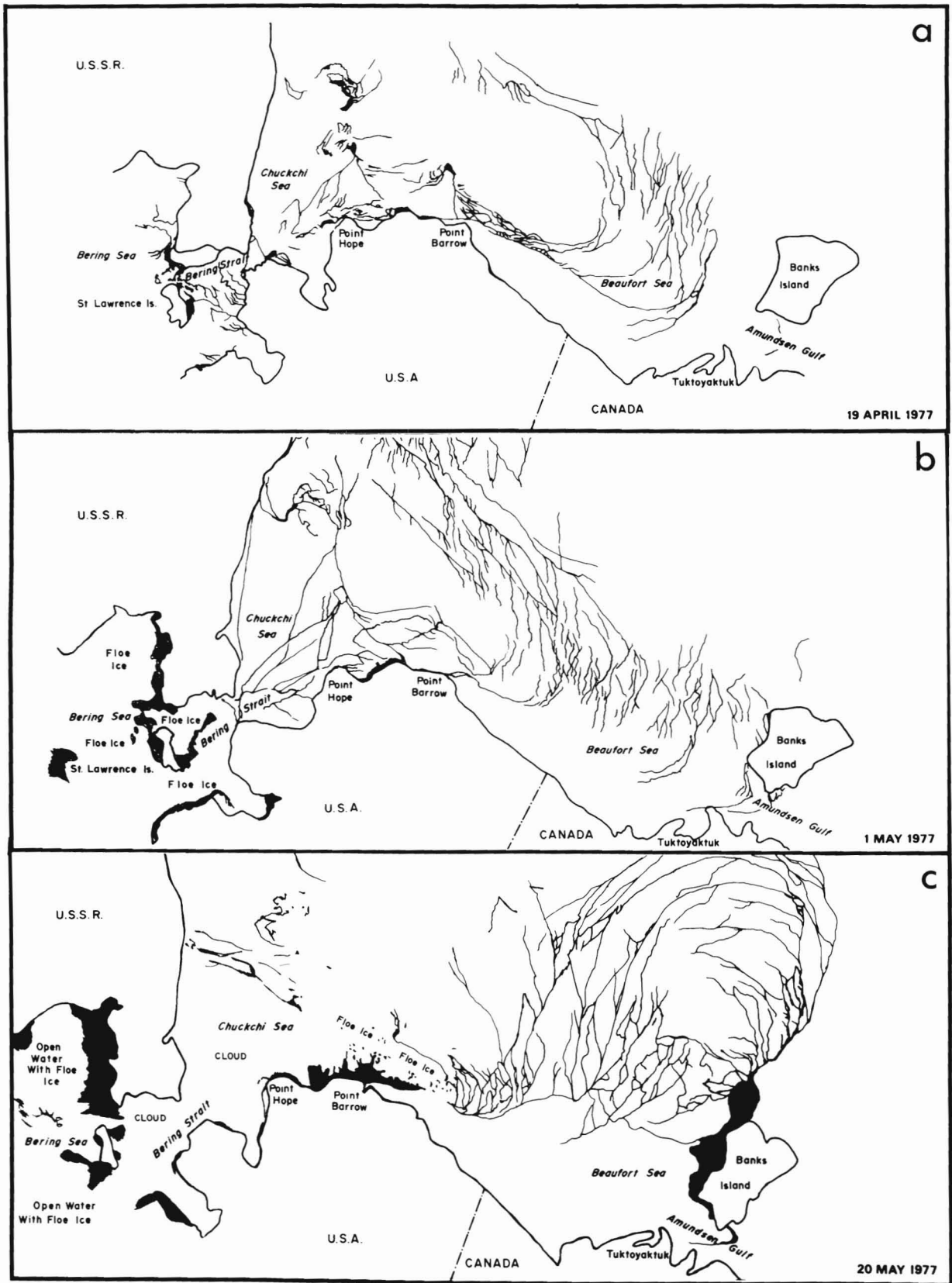


Figure 3.—Pattern of lead development in the Bering, Chuckchi, and Beaufort Seas, April and May 1977. Drawn from NOAA satellite imagery; differences in proportions between drawings are due to differences in satellite position.

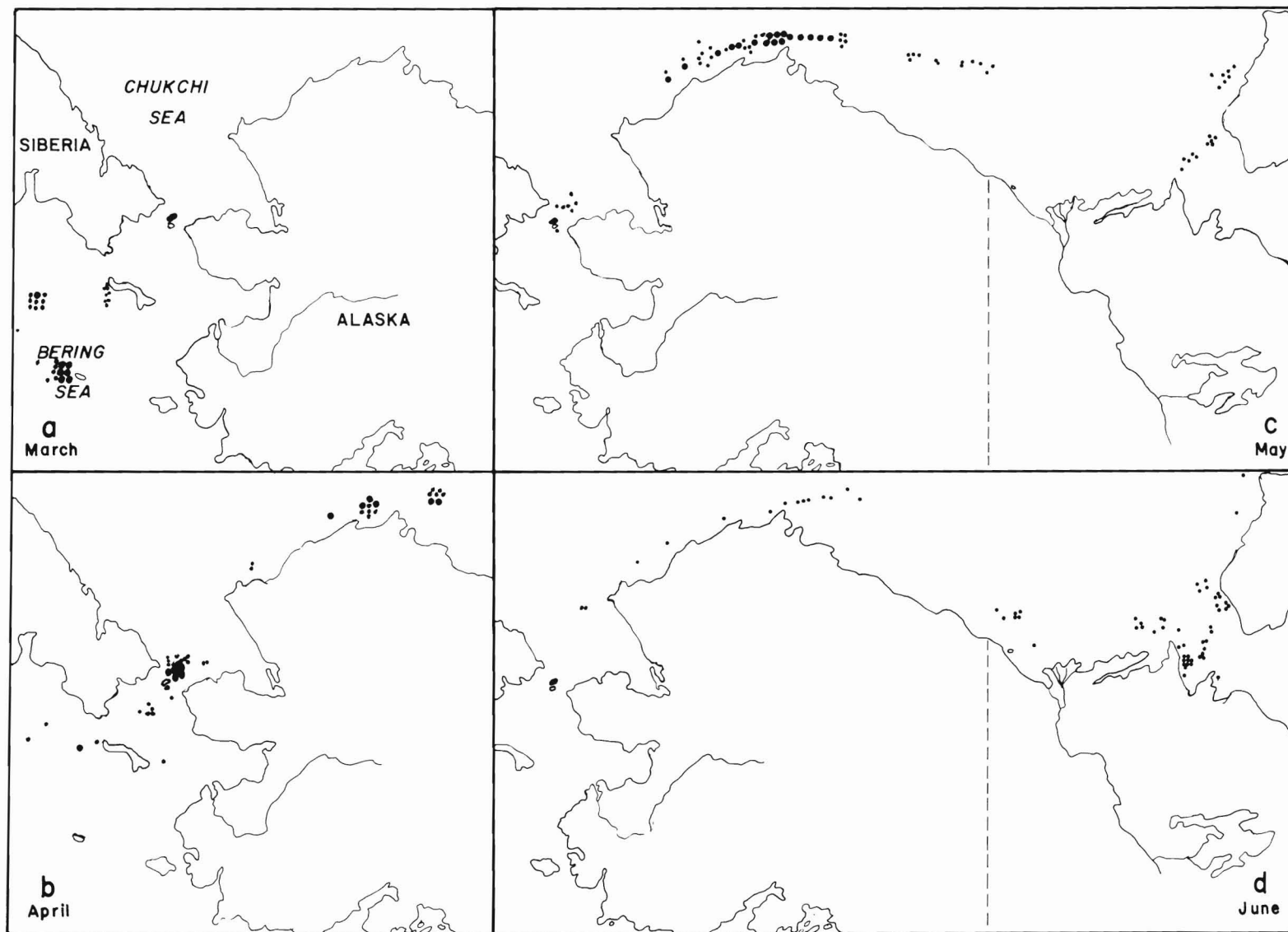


Figure 4. —The location of observations of bowhead whales, 1974-79. Small dot = 1 whale; large dot = 10 whales.

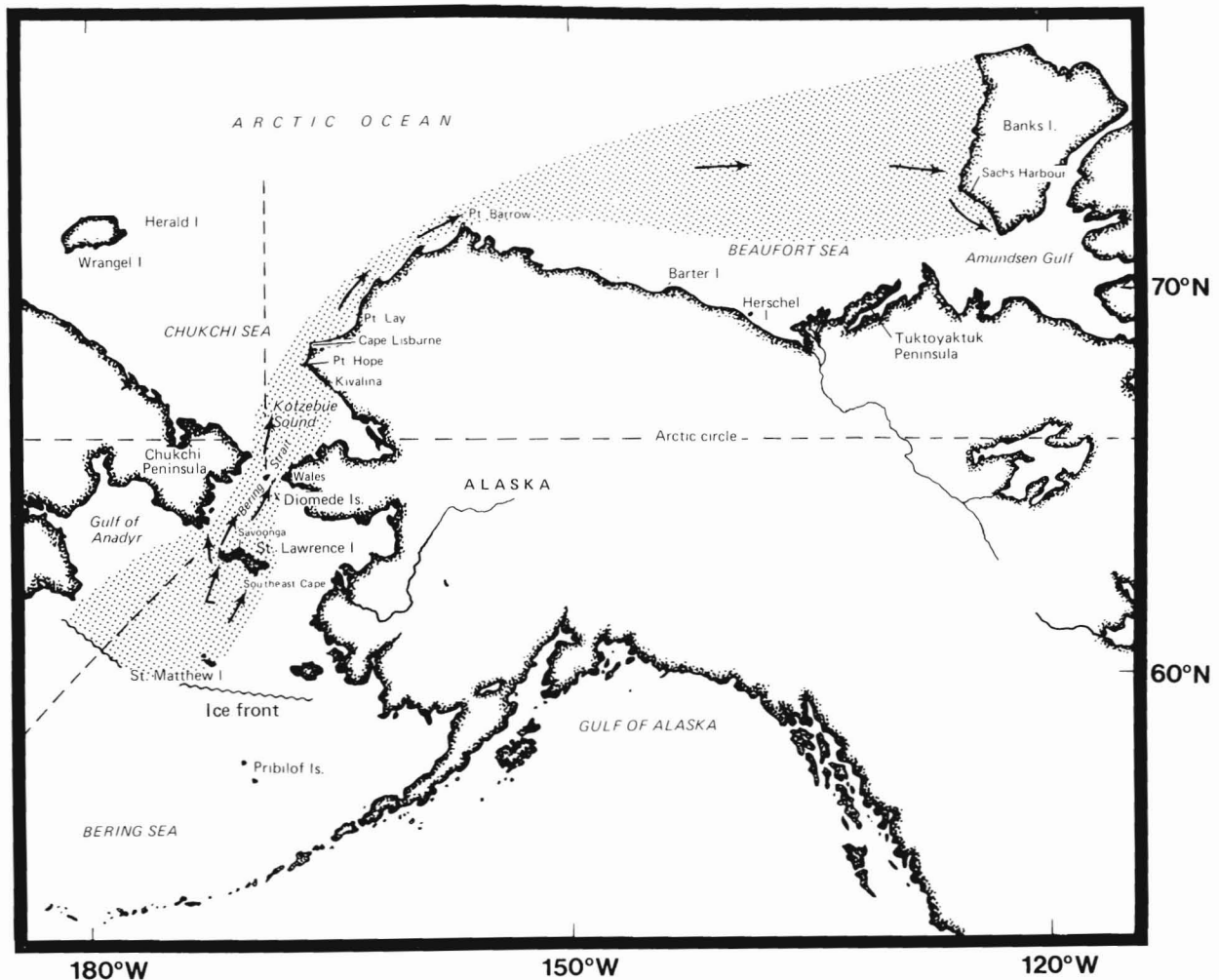


Figure 5. — Generalized spring migration route of the western Arctic population of bowhead whales. Data compiled from aerial surveys and interviews with Alaskan Eskimos, 1976-79.

(Rugh and Cubbage, 1980). Northeast of Cape Lisburne, bowheads apparently migrate only in the nearshore lead. During 4 years of aerial surveys we have observed bowheads only in the lead adjacent to the landfast ice between Point Lay (northeast of Cape Lisburne) and Point Barrow, even though aerial survey time was divided about equally between offshore (to 100 km) and nearshore areas.

The earliest known recording of bowhead whales arriving at Point Hope was 19 March (Foote, footnote 4) and at Barrow on 29 March (Brower, 1942). These dates are considerably

earlier than normal, perhaps a reflection of light ice years. Usually bowheads begin going by Point Hope and Barrow in mid-April. The earliest date in April bowheads have been seen at Point Hope was 11 April (Johnson et al., 1966) and 16 April at Barrow (Brower, 1942). Recent studies conducted by NMFS biologists since 1974, which generally started before mid-April, have not resulted in observations of bowheads before those dates listed above. The latest confirmed bowhead sightings beyond the whaling season (April-June) between Point Hope and Barrow were on 19 June (Braham et al., footnote 3). The

main portion of the migration along the northwest coast of Alaska past Barrow begins in the last week in April and continues through May (Maher and Wilimovsky, 1963; Fiscus and Marquette<sup>10</sup>).

Marquette (footnote 2), Foote (footnote 4), and Eskimo whalers have stated that the bowhead migration along the northwest coast of Alaska occurs in

<sup>10</sup>Fiscus, C. H., and W. M. Marquette. 1975. National Marine Fisheries Service field studies relating to the bowhead whale harvest in Alaska, 1974. Processed rep., 23 p. Natl. Mar. Mammal Lab., NOAA, 7600 Sand Point Way N.E., Bldg. 32, Seattle, WA 98115.

“waves” or “pulses.” At least two pulses were evident at Point Barrow in each year of our study 1976-78 (Figure 2 in Krogman, 1980). One pulse occurred in late April-early May, and the other in mid-May. A third pulse may occur between late May and mid-June, but our data are incomplete for this period. The significance of this bimodal, or possibly trimodal, distribution is unknown, but it may be associated with age and/or sexual segregation within the population. Eskimo whalers state that cows with calves, and large males, do not arrive at Barrow until late May and June. NMFS sighting data collected from ice camps in 1978, probably the most representative year because of nearly continuous survey effort, showed that calves were present throughout the migration period. However, the hypothesis that there is a sex-age segregation is so widely contended by Eskimos living along the northwest coast of Alaska that we believe it has basis in fact.

From Point Barrow, bowheads travel northeastward along an offshore route to the eastern Beaufort Sea, where the first individuals arrive by early to mid-May (Fig. 5). We have observed the whales departing from Point Barrow northeastwardly toward Banks Island at an oblique angle to the Beaufort Sea coast, and even though there are often less extensive leads closer to the coast than those offshore we have never seen whales in them. In April and May 1979 during flights conducted to 330 km offshore in the western Beaufort Sea, bowheads were only observed offshore, though small leads were common nearshore (Ljungblad<sup>11</sup>).

Braham and Krogman (footnote 1) and Fraker<sup>12</sup> independently proposed the hypothesis that bowheads and white whales follow a far offshore route while migrating through the Beaufort Sea during spring. Support for this comes from the following evidence:

<sup>11</sup>Ljungblad, D. 1979. Investigations of the occurrence, population density, and behavior patterns of endangered whales in the vicinity of the Beaufort Sea lease area. Unpubl. final rep. for the Bureau of Land Management, 20 p. Naval Ocean Systems Center, San Diego, CA 92152.

<sup>12</sup>Fraker, M. A. 1977. The 1976 white whale monitoring program, Mackenzie Estuary, N.W.T., Unpubl. rep., 73 p., by F. F. Slaney & Co., Ltd., Vancouver, B.C., for Imperial Oil Ltd., Calgary, Alberta.

1) NOAA satellite imagery of the Beaufort Sea ice cover shows the recurring east-west shear zone in offshore waters, with extensive development of interconnecting leads north of the shear zone (Fig. 3; Marko, 1975; Fraker 1979). These leads in the northern Beaufort Sea are the only avenues apparently available to whales during much of the spring migration period. Nearshore waters of the southern Beaufort Sea are covered by a broad sheet of landfast ice during spring, and the pack ice immediately seaward of the landfast ice usually contains very little open water.

2) No bowheads have been sighted nearshore in the western Beaufort Sea during spring surveys conducted from 1976 to 1979. Instead, all surveys (out to 330 km) indicated that the whales were moving well offshore (Braham and Krogman, footnote 1; Braham et al., footnote 3; Ljungblad, footnote 11).

3) The headings of bowheads observed traveling in leads northeast of Point Barrow are directed northeast and east (Braham et al., footnote 3; Braham, Krogman, Johnson, Marquette, Rugh, Sonntag, Bray, Brueggeman, Dahlheim, Nerini, and Savage, 1980), which would take them well offshore and essentially directly to Banks Island.

4) Fraker (1979) observed white whales migrating through leads up to 600 km north of the coast in the Canadian Beaufort Sea in May and June 1977. Results of systematic surveys conducted during June 1974-77 showed that both bowhead and white whales were distributed similarly offshore in the Canadian Beaufort Sea (Fraker, 1979); this implies that both species follow a similar route.

5) Some bowheads arrive near the west coast of Banks Island and Amundsen Gulf more than 2 months before they arrive in the Mackenzie River delta area (Sergeant and Hoek, 1974; Fraker, footnote 12; Fraker and Bockstoce, 1980).

6) Alaskan Eskimo whalers have never hunted bowheads in the Beaufort Sea in the spring; instead, they wait until autumn (Brower, 1942; Marquette, footnote 2).

7) Yankee commercial whalers overwintering at Herschel Island, Yukon Territory, along the Beaufort Sea

coast, tried unsuccessfully to whale from the ice edge during spring (Cook, 1926; Bodfish, 1936; Bockstoce, 1977; Fraker and Bockstoce, 1980).

The earliest known sighting of bowheads in the southeastern Beaufort Sea occurred 6 May 1979 when two bowheads were observed south of Banks Island<sup>13</sup> (Fig. 4). Two bowheads were observed in a polynya west of northern Banks Island 8 May 1978 by pilots from the Naval Arctic Research Laboratory, Barrow, Alaska. Six bowheads were observed 14 May 1974 in leads just west of Banks Island; but none were seen during surveys conducted there 21-24 April and 1-5 May 1974 (Fraker et al., 1978) or 13 May 1978 (Braham et al., 1979). One bowhead was observed in western Amundsen Gulf 18 May 1977 and two 21 May 1977 about 90 km south-southwest of Sachs Harbour, Banks Island (Fraker, 1979). These sightings show that bowheads can reach Amundsen Gulf by early May.

At the time that early migrating bowheads are moving through the Beaufort Sea, the shear zone and the leads to the north offer the only apparent avenues available. Such whales, traveling northeastwardly, would eventually intercept the north-south lead west of Banks Island (Fig. 3, 5, 6). Once in this lead, the whales can travel south to Amundsen Gulf. All May sightings of bowheads support this hypothesis (Fig. 4). During late May and June, leads form farther south in the ice cover, and thus it is possible for late-migrating whales to travel there (Fig. 5, 6). Sightings made during mid-to late June include some bowheads in the southern Canadian Beaufort Sea (Fig. 4). Fraker (1979) found migrating white whales in the northern Beaufort Sea in late May and early June 1977; later in June he found them farther south.

Some bowheads in the western Arctic population may not complete the spring migration into Canadian waters; they may spend the summer months in the northern Chukchi Sea and/or western Beaufort Sea. A few Eskimo whalers at Barrow state that occasionally

<sup>13</sup>D. Andriashek, biologist, Canadian Wildlife Service, 9942-108 Street, Edmonton, Alberta T5K 2J5 Canada. Pers. commun.



bowheads are seen near Point Barrow during summer, and some have been seen feeding east of Point Barrow close to shore (Braham et al., footnote 3).

### Effect of Ice Cover on Migration

Ice plays a major role in the ecology of Arctic marine mammals (Fay, 1974), including bowhead whales, the most pagophilic (ice-loving) of baleen whales. Sea ice covering the Chukchi Sea begins to advance southward in early October from the limit of its maximum summer retreat near lat.  $72^{\circ}$ - $74^{\circ}$ N, and extends south over the entire Chukchi Sea and the northern Bering Sea from January into June (Shapiro and Burns, 1975). Pack ice is present during winter and spring over most of the intercontinental shelf of the northern and eastern Bering Sea, but occurs infrequently in the southwestern Bering Sea. During late winter and early spring, at the initial stages of spring migration, bowheads are found in waters with 35-50 percent ice coverage (Brueggeman, footnote 6). Brueggeman (footnote 6), reported observing early spring bowhead concentrations in two areas, one west-southwest of St. Lawrence Island and the other west of St. Matthew Island (Fig. 4). He concluded that a corridor of 35-50 percent ice cover occurs persistently from March to May between these islands, and this apparently provides enough open water for whales to migrate through the pack ice each spring.

The pack ice in spring north of St. Lawrence Island and throughout the northeastern Bering Sea is usually medium to thick, with 70-100 percent coverage (Fay, 1974; Shapiro and Burns, 1975; Braham et al., footnote 3). Driven by late spring winds and strong ocean currents converging west of St. Lawrence Island from the central Bering Sea and Gulf of Anadyr (Coachman et al., 1975), the pack ice breaks up and moves northeastward through the Bering Strait. This results in ice coverage of <50 percent in the northwestern Bering Sea, conditions which bowheads take advantage of during migration.

North of the Bering Strait spring ice conditions change drastically. A large, wedge-shaped flaw zone with many



Figure 6.—NOAA satellite image of ice conditions in the eastern Chukchi and Beaufort Seas, 30 May 1977. Light areas are ice, dark areas are water or thin ice (newly refrozen lead)

small leads occurs as a result of strong northeast winds during the winter and early spring (Shapiro and Burns, 1975). Bowheads apparently select the most persistent of these leads, but so few sightings have been made here that we have had to estimate their route based upon the recorded bearings of whales near the Bering Strait. Some whales may deviate eastward from our hypothesized heading of  $35^{\circ}$ - $45^{\circ}$  true to enter nearshore leads that sometimes occur in outer Kotzebue Sound and near Kivalina (Fig. 2).

From Point Hope to just north of Cape Lisburne the shifting pack ice often results in extensive areas of open water up to 50 km offshore. This means that the whales are not restricted to nearshore areas. Farther west and north, however, the number of offshore leads diminishes. In contrast, northeast of Cape Lisburne the nearshore lead adjacent to the landfast ice opens in

April. As the whales pass Cape Lisburne, their direction of travel, which we determined using a theodolite, was  $45^{\circ}$ - $50^{\circ}$  true (Rugh and Cabbage, 1980). At Cape Lisburne, the bowheads apparently adjust their direction of movement to follow the northeasterly nearshore lead that parallels the coast. Although many leads extend northward near Cape Lisburne, it seems that at Cape Lisburne the whales adjust their direction of movement to follow the only persistent lead that continues to Point Barrow. Since 1976, NMFS scientists have not seen any bowhead whales outside the nearshore lead from northwest of Cape Lisburne to Point Barrow, but they have been seen farther offshore in areas west and south of Cape Lisburne.

As the whales approach Point Barrow, the nearshore lead narrows (Fig. 7), and the movement of most whales is correspondingly constricted. The

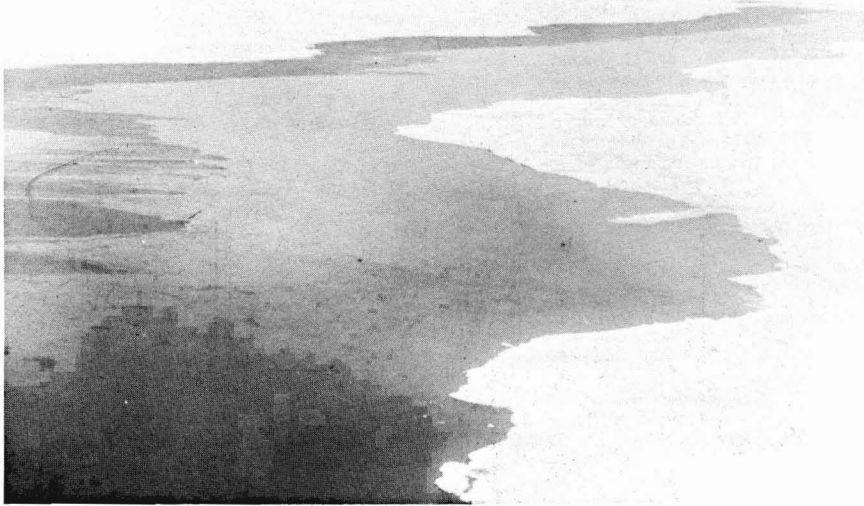


Figure 7. —Photograph taken 10 May 1977 of the nearshore (shorefast ice) lead which occurs each spring along the northwestern coast of Alaska from Point Lay to Point Barrow.

NMFS has exploited this bottleneck effect during studies designed to census the population. Because no whales have been seen offshore to the west, we have concluded that essentially the entire population migrates past Point Barrow in the nearshore lead (Braham et al., footnote 3; 1979).

Northeast of Point Barrow the shear zone and extensive lead system in the northern Beaufort Sea permit the whales to travel to the vicinity of Banks Island and the Amundsen Gulf region during May and early June. Restriction of ice near Point Barrow and development of offshore leads northeast of the Point provide the migration pathway, a result of converging water masses from the Chukchi and Beaufort Seas and shifting winds, generally from the east and northeast. It is probably advantageous for whales to use these recurring leads, as opposed to those in the southern Beaufort Sea where there is less ice movement and where the availability of open water is less predictable.

A detailed study of the development of these leads in the eastern Beaufort Sea during the spring migration period of bowheads is available only for 1977 (Fraker, 1979). In April, open water became extensive in the Bering Sea and leads were well developed in the Bering

Strait and Chukchi Sea (Fig. 3a). In the Beaufort Sea the shear zone was present, and a limited number of leads was apparent; the Amundsen Gulf polynya was also beginning to develop. Striking changes in the ice cover occurred in May 1977. Off the northwestern Alaska coast, there were large expanses of open water (Fig. 3b, c). Very extensive lead complexes developed in the ice cover of the northern Beaufort Sea, while the southern portion remained largely intact. The Banks Island lead became prominent in May, as did the Amundsen Gulf polynya. By month's end, the pack ice in the northern Beaufort Sea was a maze of leads and there was much open water west of Banks Island and in Amundsen Gulf (Fig. 6). The nearshore lead lying north of the Tuktoyaktuk Peninsula was well established by this time, but it did not extend west of the Mackenzie River delta region.

### Conclusions

The spring migration of the western Arctic population of bowhead whales from the Bering Sea to the Beaufort Sea occurs from April through June. The availability of open water dictates the pathway taken during their northward migration. The only persistent leads

which occur in the Bering and Chukchi Seas correspond with traditional places where U.S. and Siberian Eskimos have hunted for bowheads each spring, and where the whales have been consistently observed during our 4 years of research. The hypothesis that bowheads migrate in leads other than those along the northwest coast of Alaska, such as along the north side of Siberia (Chukchi Peninsula) seems implausible because of extensive, persistent ice cover. An offshore migration of bowhead whales west of Barrow, Alaska, is also unlikely and therefore we are confident that essentially the entire western Arctic population can be censused over a short period of time each spring near Point Barrow.

Bowhead whales do not migrate nearshore during spring in the Beaufort Sea. Although some open water is available in the southern Beaufort Sea, offshore leads appear to provide the only suitable habitat for migration to Canadian waters. Whether some bowheads do not complete the migration into the Canadian Beaufort Sea has not been confirmed.

### Acknowledgments

We wish to thank the following persons for assisting us in data preparation, and for providing valuable support and advice: T. Bray, R. Everitt, C. Fiscus, C. Goebel, W. Marquette, M. Nerini, D. Rugh, R. Sonntag, M. Tillman, and D. Withrow, National Marine Mammal Laboratory, Seattle; S. Leatherwood, Hubbs-Sea World Research Institute, San Diego, Calif.; R. Storro-Patterson, University of California Extension, Berkeley, Calif.; C. Oozeva, R. Silook, and V. Slwooko, Gambell, Alaska; J. Adams and A. Brower, Barrow, Alaska; A. Andriashek and I. Sterling, Canadian Wildlife Service, Edmonton, Canada; A. Berzin, Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO), Vladivostok, U.S.S.R.; and G. Fedoseev and V. Gol'tsev, TINRO, Magaden, U.S.S.R.; and R. Davis and W. Richardson, LGL Limited, Toronto, Canada.

Portions of this research were supported by NOAA's Alaska Outer Continental Shelf Environmental Assessment Program (OCSEAP) under inter-agency agreement with the U.S. Department of the Interior, Bureau of Land

Management, administered by the OC-SEAP Juneau Project Office in Alaska.

Canadian studies were funded by the Fisheries and Marine Service and the Beaufort Sea Project, and we acknowledge the support of M. Mercer, A. Milne, R. Peet, G. Robins, and B. Smiley.

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## Migration of Bowhead Whales Past Cape Lisburne, Alaska

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### Introduction

Cape Lisburne is one of the most striking promontories along the east coast of the southern Chukchi Sea bordering the bowhead whale, *Balaena mysticetus*, spring migratory route. These whales are known to pass northeast along the Arctic coast from Point Hope to Point Barrow as they migrate

from their wintering areas in the Bering Sea to their summer habitat in the Beaufort Sea. Presumably they follow the coastal contour to take advantage of the sea ice shear zones which are generally associated with the shoreline.

In the past, Eskimo whalers seasonally used the now extinct village of Wevok near the Cape Lisburne Air Force Station. They often watched for

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whales from the westernmost bluff known as Alokut or "The Jaw". This 280 m high bluff has an abrupt western face providing whalers an excellent overview of a great expanse of ocean as far south as Point Hope and an unobstructed view to the west and north (Fig. 1, 2).

A pilot study was made during 5-17 May 1977 to investigate the feasibility of a systematic bowhead whale research effort at Alokut. The wide viewing perimeter, persistently open polynyas (areas free of sea ice), and the position of the Cape relative to the migratory corridor encouraged us to take