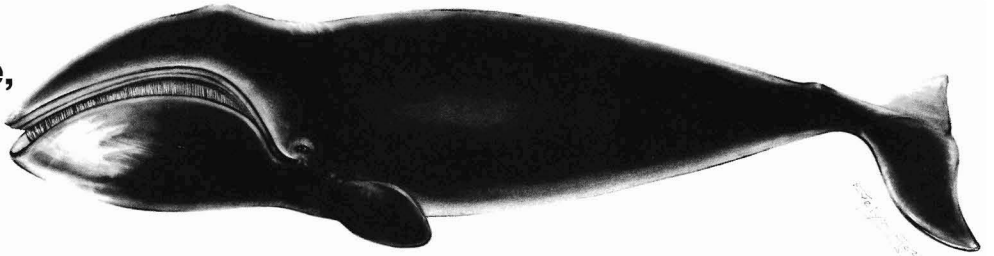


## The Bowhead Whale, *Balaena mysticetus*



HOWARD W. BRAHAM

### Introduction

The bowhead whale, *Balaena mysticetus* (Linnaeus 1758), also called the Greenland right whale, is the only baleen whale which spends its life in and around Arctic waters. It is also one of the rarest of all cetaceans. Heavily exploited for its whalebone (baleen) and oil-producing blubber, the species became seriously depleted throughout its range before the 20th century. As a result, the species was almost eliminated before quantitative biological data could be collected.

Some descriptive information on the bowhead's natural history was re-

corded by astute whalers (Scoresby, 1820; Scammon, 1874; Gray, 1894; Cook, 1926; Bodfish, 1936; Brower, 1942), early scientists (Eschricht and Reinhardt, 1866; Gray, 1886; Southwell, 1898; Allen, 1908; Gray, 1929a, b), and others (e.g., Zor-drager, 1720; Lubbock, 1937). Intensive research on the bowhead did not begin until the mid-1970's, but has developed so rapidly that much of the information published as recently as 1980 already is now either outdated or greatly refined. Much recent work is still unpublished or based on such small sample sizes that it is difficult to assess the status of most bowhead stocks.

### Distribution and Migration

Four or five stocks of bowhead whales are recognized: East Green-

land-Spitsbergen and Davis Strait/Hudson Bay stock(s) in the eastern and western North Atlantic, respectively; the western Arctic stock in the Bering, Chukchi, and Beaufort Seas; and the Sea of Okhotsk stock. A putative fifth stock may occur in Hudson Bay; however, the evidence is not definitive (Reeves et al., 1983), and it will be considered separately for this review.

The current hypothesis is that populations within and between the North Pacific and North Atlantic Oceans are geographically and thus reproductively isolated from each other. Some historical evidence suggests interchange may have occurred during periods of exceptionally favorable ice conditions in the Northwest Passage of North America and across the eastern Arctic of Europe and Asia.

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Eskimos flense a large bowhead whale hauled out on the ice at Point Hope, Alaska. Photo by W. Marquette.

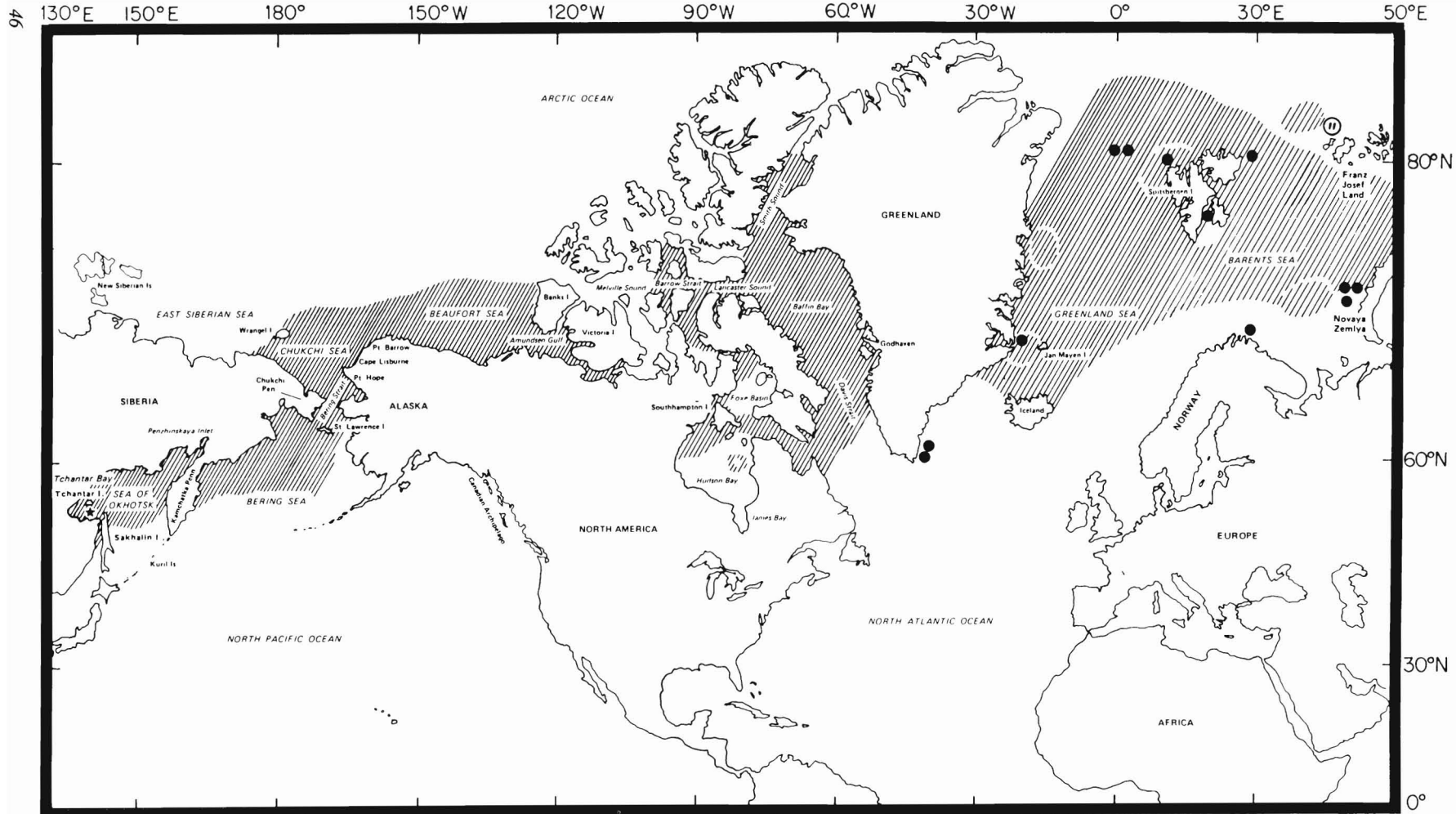


Figure 1. — Approximate world distribution of bowhead whales prior to commercial whaling. Current range of each stock may not be the same. Recent (1958-82) sightings in the eastern North Atlantic of single whales (dots) are from Jonsgård (1981) and of 11 whales sighted in May 1981 north of Franz Josef Land (circle) are from A. Yablokov (text footnote two). Sightings of bowheads in Academy Bay, Sea of Okhotsk (star) of 54 (1967), 35 (1974), and 55 (1979) are from Berzin and Doroshenko (1981). Recent sightings in the Bering, Chukchi and Beaufort Seas, and eastern North American Arctic are too numerous to plot here. The two sightings near the southern tip of Greenland are thought to be right whales (Reeves, R., Arctic Biological Station, Ste. Anne de Bellevue, Quebec, during a conversation at the IWC Scientific Committee meeting, 6 June 1984, Eastbourne, Engl.)

## North Atlantic

### *East Greenland-Spitsbergen Stock*

Bowhead whales in the eastern North Atlantic apparently wintered in the area between East Greenland, Iceland, and Spitsbergen Island (Fig. 1). (Spitsbergen is one of several islands collectively called Svalbard.) Their northeasterly movements in spring were correlated with the recession of the ice front, with some whales arriving at Spitsbergen in April (Scoresby, 1820; for a review see de Jong, 1983). In summer, most of the population was found from east Greenland and Novaya Zemlya to north of lat. 80°N (Eschricht and Reinhardt, 1866; Vibe, 1967).

Jongsgård (1981) reported that only 23 individual bowheads (including two dead) were seen in this area from 1945 to 1980. In 1980 and 1982, July to September, no bowheads were observed during continuous 24-hour-a-day observations from an ice reinforced vessel surveying the Barents Sea (between Svalbard and Franz Josef Land) and the ice front to lat. 83°N (Larsen<sup>1</sup>). Haug (1980) reported that one bowhead was seen by Norwegian whalers on 21 and 25 May 1980 at about lat. 71°00'N, long. 28°51'E along the coast of Finnmark, north Norway. A. Yablokov<sup>2</sup> reported that in May 1981, 11 bowheads were seen in one group about 100-150 km northwest of Franz Josef Land in a pack ice lead. Tomilin (1957) and Vasilchuk and Yablokov (1981) reported evidence of bowhead strandings along Soviet shores during this century, especially from the Kara Sea and Novaya Zemlya.

### *Davis Strait and Hudson Bay Stock(s)*

Bowhead whales in the western

<sup>1</sup>Thor Larsen, Norwegian Polar Research Institute, Oslo, Norway. Pers. commun., 24 February 1983.

<sup>2</sup>Alexey Yablokov, Academy of Sciences of the U.S.S.R., Moscow. Pers. commun., 27 April 1983 during a U.S.-U.S.S.R. bilateral meeting in Santa Cruz, Calif. Subsequently, Randall Reeves passed to me a letter from Yablokov written to Reeves on 1 July 1981 in which Yablokov provides some details.



A bowhead whale rests at the surface in June, late in spring migration. Graying patches of skin along the head, back, and edges of fluke are thought to be areas of molting. Photo by B. Krogman.

North Atlantic range from southern Davis Strait and Hudson Strait, Canada, to Godhavn, West Greenland, in winter, and north to the Canadian High Arctic and northern Hudson Bay (including Foxe Basin), in summer (Fig. 1). Reeves et al. (1983) report that the bowhead's distribution and migration today is probably the same as it was prior to commercial whaling. Summering areas and migration routes include Hudson Strait (lat. 62°N, long. 72°W) into northwest Hudson Bay, Repulse Bay (lat. 66°N, long. 85°W) and Foxe Basin, Baffin Bay, Smith Sound, Lancaster Sound, Price Regent Inlet (lat. 73°N, long. 90°W) and Admiralty Inlet (69°N, long. 101°W), and waters between the islands of the Canadian High Arctic west to Barrow Strait. Sightings during the spring and autumn migrations over the past decade have been made primarily along the northeast end of Baffin Island (West Baffin Bay) (Davis and Koski, 1980), and a few more recently in spring near Godhavn, West Greenland, (Born and Heide-Jorgensen, 1983). Gray (1886) and Southwell (1898) reported that adult males occurred in open water in summer and autumn, while females and young were associated with the pack-ice front.

On the basis of different catch histories, apparent migration patterns, and separate areas of seasonal abundance, Mitchell and Reeves (1981) and Reeves et al. (1983) suggested that two stocks occur in the eastern North American Arctic: The

“Davis Strait Stock” and the “Hudson Bay Stock.” However, as Reeves et al. (1983) pointed out, “The separate identity of these two putative stocks needs confirmation through direct evidence.”

## North Pacific

### *Western Arctic Stock*

Bowhead whales in the western Arctic of North America during the 19th century ranged from the southwestern Bering Sea into the Chukchi and Beaufort Seas (Townsend, 1935; Bockstoce and Botkin, 1983) (Fig. 1). Their range today is virtually the same, although they are probably absent from the southeastern Bering Sea except during years of very heavy ice (Braham et al., 1980b; Dahlheim et al., 1980). Plots of seasonal catches, adapted from Townsend (1935), replotted by month, and reported in Dahlheim et al. (1980) and Braham et al. (1984), suggest that the distribution of bowheads during open-water periods in the mid-19th century was from the Bering Sea to the eastern Beaufort Sea. This implies that their summer distribution included, essentially, their entire range.

Catch data early in the Yankee whaling fishery in the western Bering Sea in July show that some component of the population did not migrate north of lat. 64°N. Anecdotal comments by Cook (1926) further suggest that by the end of the 19th century, bowheads were not found in



Adult bowhead whale resting at the surface among spring ice floes. The light coloration of the inner surface of the flukes is caused by natural markings, while the small white marks on the animal's back and rostrum are perhaps healed wounds in the skin (from unknown causes) inflicted throughout the animal's life.

summer and autumn (July-August) in the Bering Sea. Rather, they were encountered there only near the ice front in spring and early summer. Today bowhead whales are found in abundance in summer (July-August) only in the Beaufort Sea. I conclude from this that the current southern limit of their summer distribution is several hundred miles further north than it was in the 19th century.

Currently, bowhead whales in the western Arctic spend the winter months from December to March in and near the pack ice of the western Bering Sea from St. Lawrence Island south to St. Matthew Island and west to the U.S.S.R. coast (Braham et al., 1980a, b; Bogoslovskaya et al., 1982; Brueggeman, 1982). The spring northward migration usually occurs from April through June in the western Bering and eastern Chukchi Seas, and offshore in the Beaufort Sea (Braham et al., 1980a). The whales follow cracks in the pack ice, called "leads," which are openings in the fracture zone of ice formed when the pack ice moves away from shore during spring breakup as a result of wind, currents, and melting ice. The eastern or Canadian Beaufort Sea serves as the bowheads' primary feeding ground from June to September (Cook, 1926; Fraker and Bockstoce, 1980). During this period,

they occur principally from Amundsen Gulf to Demarcation Bay (lat. 69°40'N, long. 141°20'W), Alaska (Mansfield, 1971; Fraker et al., 1978; Fraker and Bockstoce, 1980; Davis et al.<sup>3</sup>).

The autumn migration westward through the western Beaufort Sea begins in August and September, and occasionally a few whales are seen as late as early November. Most autumn sightings (September and October) in U.S. waters have been of whales near the 20-100 m depth contour between Demarcation Bay and Point Barrow (Braham et al., 1977, 1984; Ljungblad et al., 1980, 1982; Ljungblad, 1981). From Point Barrow, the animals move west across the Chukchi Sea toward Herald and Wrangel Islands (Cook, 1926) and then south and east along the north coast of the Chukchi Peninsula to their winter grounds in the Bering Sea (Johnson et al., 1981; Bogoslovskaya et al., 1982; Marquette et al., 1982). A few recent sightings have been made along the northwest coast of Alaska in the

<sup>3</sup>Davis, R., W. Koski, and G. Miller. 1983. Preliminary assessment of the length-frequency distribution and gross annual reproductive rate of the Western Arctic bowhead whale as determined with low-level aerial photography, with comments on life history. Final rep., 91 p. LGL Ltd., 44 Eglinton Ave. W., Toronto, Ontario, M4R 1A1, Can. (Prep. for Natl. Mar. Mammal Lab., NMFS, NOAA, Seattle, WA 98115.)

Chukchi Sea during the autumn migration (Ljungblad et al., 1982; In press).

#### *Sea of Okhotsk Stock*

Bowheads were formerly found in the northern and western Sea of Okhotsk during spring and summer, occurring as far north as Penzhinskaya Inlet (northern Sea of Okhotsk) and as far southwest as Shantar Bay (also spelled Tchantar Bay) (Fig. 1). Today their seasonal movements are unknown. Three vessel and aerial surveys of the Sea of Okhotsk resulted in sightings of 54 (June-July 1967), 35 (August 1974), and 55 (August 1979) bowheads in and adjacent to Academy Bay (lat. 54°N, long. 138°E) northwest of Sakhalin Island (Berzin and Doroshenko, 1981). On 23 June 1969, a 6.3 m bowhead was taken by Japanese fishermen in Osaka Bay, Japan (Nishiwaki and Kasuya, 1970). This was a very rare event, since central Japan is almost a thousand miles south of the bowheads' historical range in the Sea of Okhotsk.

#### **Life History and Ecology**

##### **Feeding**

Euphausiids (*Thysanoessa raschii*) and copepods (*Calanus* sp.) are the principal prey of bowhead whales, at least in the western Arctic (Lowry et al., 1978; Lowry and Burns, 1980). Bowheads feed while in the eastern Beaufort Sea during the summer and autumn (about June to October), but the percent of time spent feeding, especially at other times of the year, is unknown. Frost and Lowry<sup>4</sup> (summarized in Marquette et al., 1982) estimated that bowheads consume about 3 percent of their body weight per day. The predominant prey taken are, by volume, euphausiids (65 percent), copepods (30 percent), hyperiid

<sup>4</sup>Frost, K., and L. Lowry. 1981. Feeding and trophic relationship of bowhead whales and other vertebrate consumers in the Beaufort Sea. Final report, 106 p. Alaska Dep. Fish Game, 1300 College Road, Fairbanks, AK 99701. (Prep. for Natl. Mar. Mammal Lab., NMFS, NOAA, Seattle, WA 98115.)

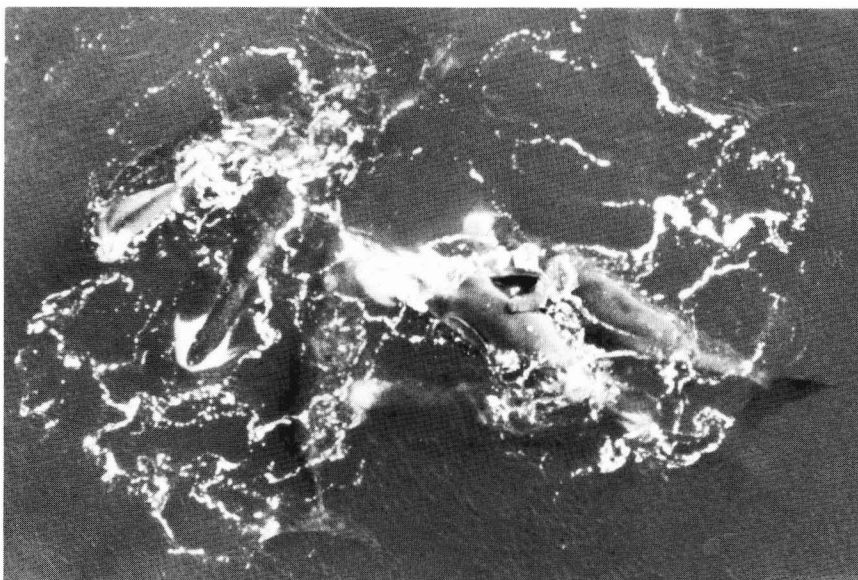
amphipods (1 percent), and other species (4 percent).

Based on a 1-year study of predator interactions in the eastern U.S. Beaufort Sea, Frost and Lowry (footnote 4) concluded that competition for food among predators such as Arctic cod, *Boreogadus saida*; ringed seals, *Phoca hispida*; and seabirds during summer and autumn might adversely affect the feeding and population growth of bowheads in some years if food is limited. Further calculations by Lowry and Frost (1984) suggest that prey density in the Beaufort Sea supplies sufficient energy needs for bowheads during an estimated 130-day feeding season.

### Reproduction

Estimates of vital rates and other life history information on bowhead whales come mainly from the western Arctic (Nerini et al., 1984). Conception is believed to occur primarily in March, although mating behavior has been observed from March to August. Gestation lasts for perhaps 13 months. Calves are apparently born from March into July, but the peak of parturition is during the spring migration, from April to June, with most calves thought to be born in May. Gray (1894) (from de Jong, 1983) also reported seeing "very young" animals (presumably calves) from early May to July in Davis Strait. Biological data from whales landed by Alaskan Eskimos suggest that the pregnancy rate is from 0.15 to 0.33 and that adult females produce a calf once each 3-6 years. Age at sexual maturity and other age-related parameters cannot be estimated at present because methods of ageing bowheads have not been successful (Nerini, 1983). Length estimates at various stages of growth are 4-4.5 m at birth, 8-8.5 m at one year, 13.5-14 m at (female) sexual maturity, and 18-20 m maximum length.

Estimates of the gross annual reproductive rate (i.e., the number of calves in proportion to all other animals counted) ranged from 3.6 to 12.4 percent (Cubbage and Rugh, 1982; Marquette et al., 1982; Nerini et



Group mating behavior of bowhead whales among the spring ice near Barrow, Alaska. Photo by B. Krogman.

al., 1984; Davis et al., footnote 3). After reviewing all estimates, Nerini et al. (1984) concluded that the probable value is less than 11.6 percent, but certainly more than 3.6 percent. Braham (In press) and Chapman (In press) suggest that the estimate lies between 5 and 10 percent. The bowheads' closest living northern relative, the right whale, *Baleana* (or *Eubalaena*) *glacialis*, is reported to have an estimated gross reproductive rate of 4.4-6.9 percent (IWC, 1984), but this is based upon a small sample.

### Natural Mortality

The rate of natural mortality has not been estimated for bowhead whales. The Alaskan Eskimo harvest of about 20 per year is the only mortality factor that can be directly measured. Predation by killer whales, *Orcinus orca*, could, along with Eskimo hunting and ice entrapment, be mortality factors (Mitchell and Reeves, 1982). Mass mortality as a result of ice entrapment does occur, although with unknown frequency (Tomilin, 1957; Mitchell and Reeves, 1982; Nerini et al., 1984).

### Exploitation and Population Size

#### History of Exploitation

Commercial whaling on the East Greenland-Spitsbergen stock began near Spitsbergen in about 1610, and by the late 1600's the Arctic coastal fishery had been exhausted (Zorgdrager, 1720; de Jong, 1978, 1983). This was the first bowhead fishery, dominated initially by land-based European whalers, such as the British, Dutch, Basques, and Germans, and later by pelagic whalers from other nations as well. The early fishery was the "east-ice" fishery from Spitsbergen to the Barents Sea, and then from 1642 to 1688 the "west-ice" pelagic fishery was active off eastern Greenland. Pelagic whaling allowed the whalers to follow the bowheads farther from land, into northern waters, and later in the year. Although bowheads were taken into the early 20th century, the fishery probably reached a low point during the early 18th century (Reeves, 1980; de Jong, 1983).

Soon after the turn of the 18th century, European whalers sailed into Davis Strait and found bowheads to be abundant. Between 1729 and 1738,

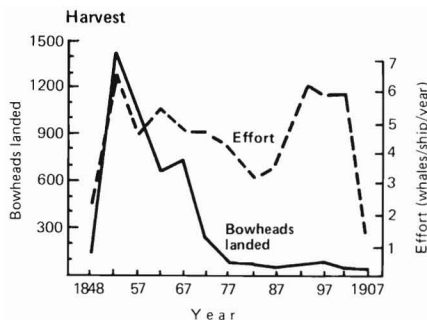


Figure 2.—Most bowhead whales in the western Arctic stock were removed between 1850 and 1870, although whaling effort remained high into the 20th century (Braham et al., 1977).

4,000 were taken (Ross, 1979). By the mid-1700's, bowheads in Davis Strait were thought to be depleted, but large catches continued farther north in Baffin Bay into the 20th century (Reeves et al., 1983; Ross and McIver<sup>5</sup>). For 8 years (1765-72), the Hudson's Bay Company conducted bowhead whaling in Hudson Bay, but commercial whaling did not begin there until 1860 when about 1,000 animals were taken over a 40-year period (Ross, 1974; Mitchell and Reeves, 1982). Important reviews of whaling in the western North Atlantic have been published by Ross (1974, 1979), Mitchell and Reeves (1982), Reeves et al. (1983), and Ross and McIver (footnote 5).

In the North Pacific, commercial whaling for bowhead whales first began in the Sea of Okhotsk in 1845 and in the Bering Sea (western Arctic stock) in 1848 (Scammon, 1874). The Sea of Okhotsk fishery shifted principally to the Bering Sea between 1849 and 1852 after Captain Roys "discovered" bowheads in the Bering Strait region in 1848. In 1849, Yankee crews from 154 ships killed over 1,500 bowheads in the Bering Sea

<sup>5</sup>Ross, W. G., and A. McIver. 1982. Distribution of the kills of bowhead whales and other sea mammals by Davis Strait whalers, 1829-1910. Unpubl. manuscr., 75 p. Arct. Pilot Proj., Petro Can., 550-6th Ave., S.W. Calgary, Alberta, T2P-144, Can.

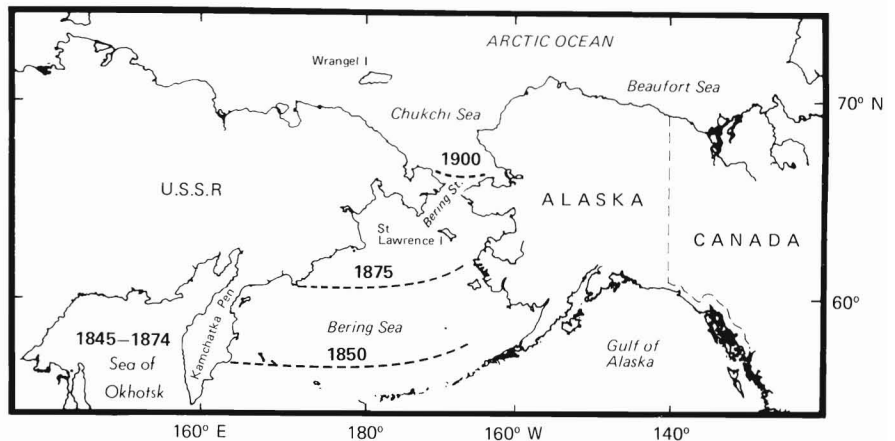


Figure 3.—Commercial bowhead whaling principally occurred in the Sea of Okhotsk from 1845 to 1874, and in the Bering Sea from 1848 to 1917. Within 20 years of the start of the fishery, the stocks were depleted, and no bowheads were taken south of the dashed lines after the dates indicated. Data from Townsend (1935) and Bockstoce and Botkin (1983).

(Bockstoce and Botkin, 1983). By 1852, apparently so few bowheads were found in open water south of the Bering Strait and weather conditions were so poor that the whalers returned to the northern Sea of Okhotsk where they intensively pursued bowheads until 1857 (Kugler and Henderson, In press). In 1858, Yankee whalers in the Sea of Okhotsk once again sailed back through the Bering Strait and intensified the fishery in the Chukchi Sea and Arctic Ocean. Although the Sea of Okhotsk fishery continued into the early 20th century, it had essentially failed by 1874 (Kugler and Henderson, In press).

Within the first two decades of the fishery in the Bering, Chukchi, and Beaufort seas (1850-70), over 60 percent of the stock was removed (Fig. 2), and over the 65- to 70-year history of this fishery, some 18,650 bowheads were killed (Bockstoce and Botkin, 1983). By 1900, pelagic whalers had great difficulty finding bowheads south of Bering Strait from June to October (Fig. 3). A shore-based fishery operated from several U.S. and Soviet Eskimo villages on the Bering and Chukchi Seas from the 1880's to about 1909 (Marquette and

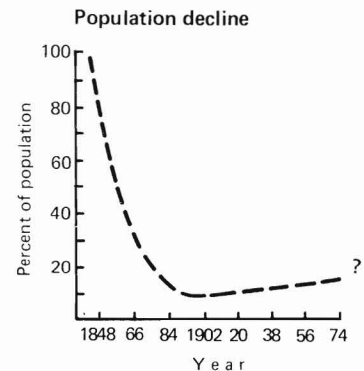


Figure 4.—The population decline and possible increase of the western Arctic stock since the end of commercial whaling is the author's approximated projection using information from Townsend (1935), Eberhardt and Breiwick (1980), Breiwick et al. (1981, 1984), and Bockstoce and Botkin (1983).

Bockstoce, 1980). The low point of the bowhead population probably occurred near the end of the pelagic fishery (about 1914), but the recovery rate during this century is unknown (Fig. 4). Breiwick et al. (1984), in

modelling the population life history parameters, predicted that recovery has been very slow, if at all, in the face of a continued small harvest by Alaskan Eskimos.

### Pre-exploitation and Current Stock Sizes

A summary of estimates of abundance for bowhead whales is provided in Table 1. The East Greenland-Spitsbergen stock is thought to have been the largest of all the stocks, perhaps numbering 25,000 in 1679, about 70 years after the beginning of the fishery (IWC, 1978; Mitchell<sup>6</sup>). The current population size is unknown, but probably is very small, as fewer than 20 live individuals have been seen since World War II. Jongsård (1981) stated his belief that this stock is nearing extinction.

Mitchell and Reeves (1981) estimated that there were at least 11,000 bowheads in the Davis Strait stock in 1825, and 680 in the putative Hudson Bay stock in 1859. Although several field surveys and literature review studies have been conducted since 1971, there is no quantitative estimate of the current stock size in the western North Atlantic. Reeves et al. (1983) stated that the population probably "numbers only a few hundred."

The size of the western Arctic stock in 1848 is thought to have been about 18,000 (IWC, 1983), although other estimates range from 8,000 to 40,000 (Breiwick et al., 1981; Bockstoce and Botkin, 1983; Breiwick and Mitchell, 1983; Tillman et al., 1983). The minimum estimate of current abundance, based on visual census studies conducted since 1978 near Point Barrow, Alaska, is 3,871 with a standard error of 254 (IWC, 1984). These estimates of current population size

Table 1.—Estimates of abundance for the world's stocks of bowhead whales.

Stocks	Population size estimates			
	Early whaling period		Current	
	Year	Estimate	Year	Estimate
North Atlantic E. Greenland- Spitsbergen	1679	25,000	1980	Nearing extinction <sup>2</sup>
Davis Strait	1825	11,000	1983	Unknown <sup>3</sup>
Hudson Bay	1859	680	1983	Unknown <sup>3</sup>
North Pacific W. Arctic Sea of Okhotsk	1848	18,000	1983	3,871
	1845	Unknown <sup>4</sup>	1981	Unknown <sup>5</sup>

<sup>1</sup>International Whaling Commission (1978), Jong (1978), and Mitchell (text footnote six).

<sup>2</sup>Jongsård (1981) believes they are nearing extinction, whereas International Whaling Commission (1978) and Reeves (1980) believe it to be "at a very low level."

<sup>3</sup>Mitchell and Reeves (1981) and Reeves et al. (1983) report these estimates based upon a literature survey and some whalers logbooks and records for the two putative stocks: "Davis Strait Stock" and "Hudson Bay Stock"; the current population size for the eastern North American Arctic may be a few hundred, although this is not based upon quantitative census studies.

<sup>4</sup>The precommercial whaling population size has been variously estimated at no lower than 8,000 (Breiwick et al, 1981) to a high of 40,000 (Bockstoce and Botkin, 1983). Further assessment of the problem resulted in a "best estimate" of 18,000 (International Whaling Commission, 1983).

<sup>5</sup>International Whaling Commission (1983), based upon an evaluation of spring census counts made since 1978, considered this a minimum estimate with a standard error of 254.

<sup>6</sup>Two estimates have been reported: 6,500 by Berzin and Doroshenko (1981), who cite "(J.K., 1979)" but do not list this reference within the literature cited, and about 10,000 by Ivashin (text footnote 7). But no data and no methods of estimation were provided; hence, these estimates cannot be considered acceptable. David Henderson (New Bedford Whaling Museum, New Bedford, MA 02740, during a conversation at the IWC special meeting on right whales, 13 June 1983, Boston, Mass.) reported working on the 19th century Yankee logbooks and whaling records for the Sea of Okhotsk, and I expect a reliable estimate of initial abundance is forthcoming (e.g., Kugler and Henderson, in press).

<sup>7</sup>On the basis of three vessel and aerial surveys in 1967, 1974, and 1979, Berzin and Vladimirov (1981) and Ivashin (text footnote 7) concluded that the population was perhaps a few hundred.

are about 20 percent of the population size prior to the beginning of commercial whaling in 1848.

No satisfactory estimate of abundance is available for any period for bowheads in the Sea of Okhotsk. Ivashin<sup>7</sup> estimated that the population

was at least 10,000 when commercial whaling began (about 1845). An estimate of 6,500 in the IWC literature (IWC, 1983) cannot be verified. None of these estimates seem to be based on comprehensive analyses of available data, such as from whaler's logbooks, journals, or notes, and there is conjecture as to whether right whales and bowheads were separated in the catch data used to make the estimates (IWC, 1983). No estimate of current abundance has been made; Soviet scientists at IWC Scientific Committee meetings have stated since 1981 that there are at least a few hundred. They base this on the three surveys (discussed earlier) in the southwestern Sea of Okhotsk (Berzin and Doroshenko, 1981).

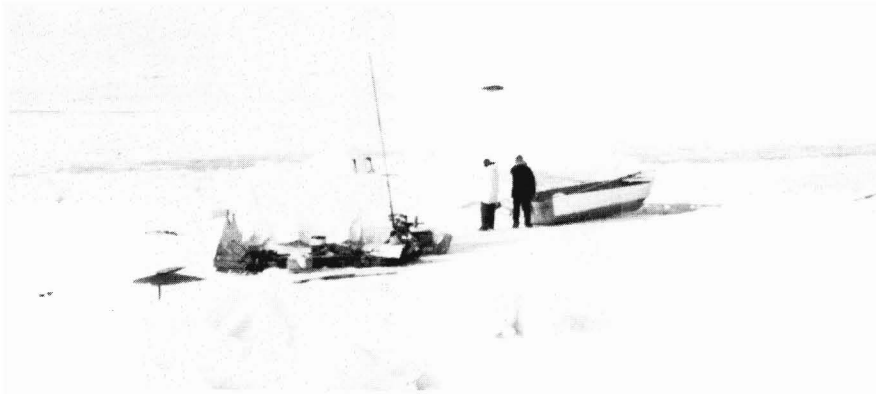
### Management

Two highly visible problems facing management are the American Eskimo subsistence hunt and oil and gas development activities in the Arctic. The Alaskan Eskimo harvest of about 20-25 whales per year is currently under IWC quota: The 1984-85 quota is 43 strikes, with no more than 27 strikes allowed for 1984. It remains unclear if this level of removal will ensure growth in the population but projections using life history and harvest data (including struck and lost mortality estimates) suggest that it may (Breiwick et al., 1984). An Alaskan Eskimo take of bowheads is permitted by exemptions in the Marine Mammal Protection Act of 1972, Endangered Species Act of 1973, and by the current IWC schedule on aboriginal/subsistence whaling. If the number of bowheads in the other stocks is as low as suspected, then certainly no harvest is warranted.

Oil and gas development activities have been underway in the Canadian Beaufort Sea since the early 1970's, and is beginning in Alaskan waters throughout much of the bowhead's range. Those areas of particular concern are 1) the southern Beaufort Sea, which serves as the major feeding

<sup>6</sup>Mitchell, E. D. 1977. Initial population size of bowhead whale (*Balaena mysticetus*) stocks: Cumulative catch estimates. Unpubl. manusc. Arc. Biol. Sta., 555 St. Pierre Blvd., Ste. Anne de Bellevue, Quebec, H9X 3L6, Can. (Submitted to IWC Sci. Comm., Canberra, Aust., June 1977, as SC/29/Doc. 33.)

<sup>7</sup>Ivashin, M. 1982. Russian hunting for right whales in the Sea of Okhotsk (18th-19th centuries). Unpubl. manusc. All-Union Sci. Res. Inst. Mar. Fish. Oceanogr. (VNIRO), Moscow. (Submitted to IWC Sci. Comm., Cambridge, Engl., June 1982, as SC/34/PS21.)



Alaskan Arctic spring ice conditions; a bowhead whale surfaces in the near shore lead. Only a small part of the animal's back is visible to the Eskimo whalers. Photo by G. Carroll.

ground for summering bowheads, in particular from southern Amundsen Gulf, Canada, to Point Barrow, Alaska; 2) the northwest Bering Sea and eastern Chukchi Sea, where bowheads spend the months of March to June migrating, calving, and mating and, September to December, migrating and perhaps feeding; 3) the Bering Strait, an important constriction in their spring and autumn migration; and 4) the central Bering Sea, where bowheads winter and perhaps mate (March). To provide meaningful management advice, greater information is needed on specific migration patterns, behavior (e.g., habitat use), and population production, particularly for the eastern North American Arctic stock(s), as less work has been conducted there in relation to future exploratory activities than in the western North American Arctic.

### Conclusions

All stocks of bowhead whales were severely depleted during the commercial whaling era prior to the 20th century. The western Arctic stock is the least depleted of all stocks, with about 20 percent of the 1848 population remaining today. When commercial whaling came to a halt between 1911 and 1917, the western Arctic stock

was probably not less than 1,000 animals (Eberhardt and Breiwick, 1980) and, given the current population size estimate of about 4,000, it seems reasonable that it was larger than 1,000 in 1917 (Breiwick et al., 1984). However, because of the uncertainties in the 1917 population size, and the difficulty of estimating or measuring certain life history parameters (e.g., natural mortality), the rate of recovery cannot be precisely determined.

Reliable estimates of the current population sizes for the other three or four stocks of bowheads are not available, but they probably number no more than a few hundred individuals each. If so, then all stocks of bowheads, with the exception of those in the western North American Arctic, are no greater than 5 percent of their initial population size.

Because of their low population numbers, their habit of frequenting coastal waters during vulnerable periods of their annual cycle (i.e., calving and feeding), and apparent low reproductive rate, bowheads may be particularly vulnerable to the development activities of humans. With some stocks, removal of a few individuals could be significant. A rigorous policy of habitat conservation and research is needed throughout the Arctic.

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