

Recent status of bowhead whales, *Balaena mysticetus*, in the wintering grounds off West Greenland

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Reeves, R.R. & Heide-Jørgensen, M.P. 1996: Recent status of bowhead whales, *Balaena mysticetus*, in the wintering grounds off West Greenland. *Polar Research* 15 (2), 115–125.

Bowhead whales, *Balaena mysticetus*, belonging to the Davis Strait/Baffin Bay stock, have historically wintered in Baffin Bay and Davis Strait, including waters along the west coast of Greenland in and near the entrance of Disko Bay. Aerial surveys of the Disko Bay region during late winter (1981, 1982, 1990, 1991, 1993 and 1994) showed that it was still visited regularly by a few tens of whales. Commercial whaling on bowheads in Baffin Bay and Davis Strait ended in about 1915, but occasional killing continued until as recently as the 1970s. The low numbers of bowheads observed off West Greenland in recent years are consistent with the results of surveys of the summering grounds in the eastern Canadian Arctic, indicating that any recovery has been exceedingly slow. The only conclusion supported by the data is that the current stock size is a small fraction of what it was prior to commercial whaling.

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Introduction

The stock of bowhead whales, *Balaena mysticetus*, centred in Davis Strait and Baffin Bay (the Davis Strait/Baffin Bay stock) consisted of at least 12,000 whales in 1820 (Woodby & Botkin 1993). Since the whaling grounds off West Greenland had already been depleted by then (Ross 1993), the abundance prior to the start of commercial whaling in this region (early 1700s) must have been considerably greater than 12,000. The current stock size has been estimated at about 250 (Finley 1990) or 350 whales (Zeh et al. 1993). By far the largest concentrations of bowheads in the eastern North American Arctic occur in Isabella Bay, northeastern Baffin Island, Canada, the site of the only dedicated field study ever conducted on this stock (Finley 1990). One individual photographed in Isabella Bay in late September 1986 was re-photographed in the pack ice near the entrance of Disko Bay in early April 1990 (Heide-Jørgensen & Finley 1991).

Eschricht & Reinhardt (1866) summarised information on the bowhead's occurrence off West Greenland, deriving data mainly from journals kept at whaling stations on shore. Since then, little has been published about this species in Greenland apart from reports of opportunistic observations. Born & Heide-Jørgensen (1983) summarised observations near Qeqertarsuaq

(Godhavn; see Fig. 1 for localities), and Kapel (1985) reported the capture of a young bowhead in a net set for white whales, *Delphinapterus leucas*, near Upernavik. During a 29-day ice-breaker cruise in Davis Strait and Baffin Bay, February–March 1976, Turl (1987) saw one bowhead off the mouth of Disko Bay (ca. 68°N, 54°W).

Systematic aerial surveys of marine mammals in West Greenland waters have provided some quantitative data on bowheads. We have analysed these data and evaluated the current distribution and abundance of bowheads in this part of the Davis Strait/Baffin Bay stock's range.

Material and methods

Systematic aerial surveys of West Greenland waters were conducted during March 1981 and 1982 with the principal objective of documenting the distribution and abundance of marine mammals along a proposed liquid natural gas tanker route (McLaren & Davis 1981, 1983). Another series of aerial surveys, stratified to provide intense coverage of the core winter distribution of the Baffin Bay stock of white whales, was conducted during March 1991, 1993 and 1994 and April 1990 (Heide-Jørgensen et al. 1993; Heide-

Jørgensen & Reeves 1996). Some of the effort in these latter surveys, especially to the north of the main white whale strata, was intended to cover the winter distribution of walrus, *Odobenus rosmarus*, off central West Greenland (Born et al. 1994).

The present study uses sightings and effort data from all six sets of surveys to assess bowhead distribution and abundance. For the 1981 and 1982 surveys we extracted data from the figures presented by McLaren & Davis (1981, 1983), whereas for the other four surveys we used the original field data. It was assumed that the criteria and methods for surveying white whales in the 1990s surveys, e.g. low wind speeds (sea states ≤ 3 on the Beaufort scale), good visibility

(>1 km), slow flying speed (160–170 km/hr) and a target survey altitude of 750 ft (228 m) above sea level, also ensured optimal conditions for detecting bowheads. The 1981–82 surveys were flown at a lower altitude (150 m) and higher speed (about 220 km/hr), probably rendering them less efficient for detecting animals in the surveyed strips.

From the positions of 23 (92%) of the 25 bowheads sighted in the aggregate data set, a stratum for bowhead late-winter (March–April) distribution off West Greenland was constructed (Fig. 1). This stratum has an area of 21 260 km². It is delimited to the west and north by heavy pack ice at 56°W and 69°10'N, respectively, to the south by large expanses of open water and to the

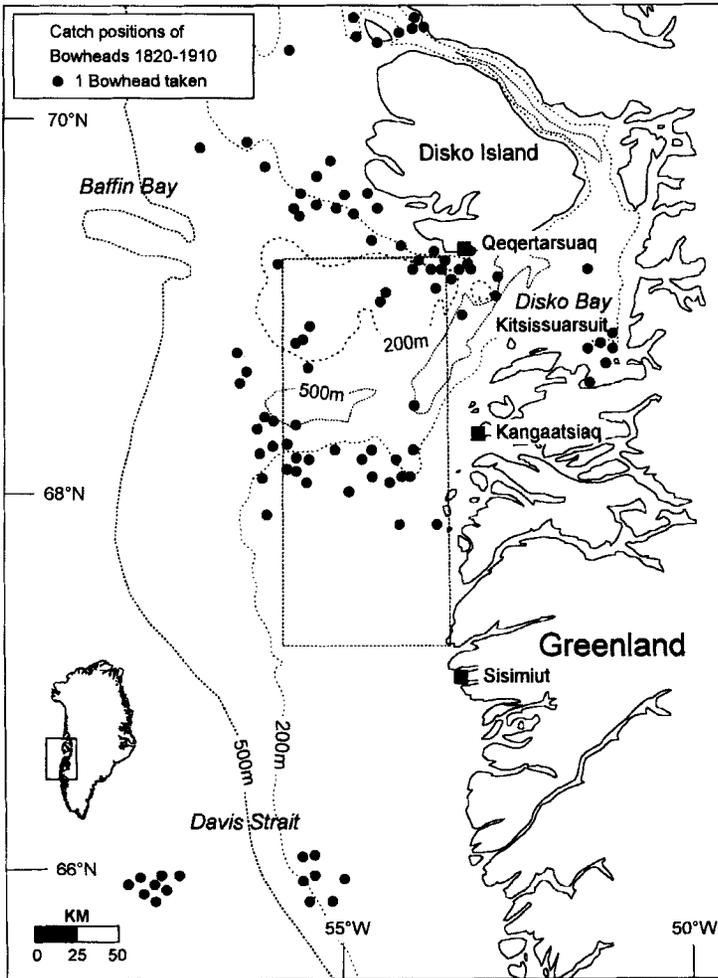


Fig. 1. Baffin Bay and Davis Strait regions showing places mentioned in text and the bowhead stratum used in this paper for abundance estimation off West Greenland. Dots are positions of bowhead kills, April–June, as recorded in whaling logbooks and journals from British and North American archives, 1829–1910 (Ross & MacIver 1982). The kill positions are illustrative only. Additional kills were recorded outside the mapped area.

east by land. The two sightings outside the bowhead stratum were within about 75 and 25 km of its borders, respectively.

The low number of sightings precluded any detailed statistical scrutiny of the abundance estimation technique. Instead, simple strip-census estimates were calculated for each year. An effective strip width of 700 m on either side of the aircraft was assumed for all years. This strip width is reasonable for the distribution of sighting distances obtained in the 1990s surveys (Fig. 2). McLaren & Davis (1981, 1983) limited their search to an area within 800 m on either side of the flight path. Two sightings (3 animals) in 1994 were at distances greater than 700 m and therefore were not used for calculating that year's abundance estimate.

Results

The observed winter distribution of bowheads was fairly consistent off West Greenland from year to year. Sightings in March and early April tended to be clustered in an area off the mouth of Disko Bay south to Kangaatsiaq (68°00'N) (Figs. 3–8).

Bowheads were sighted at least once in all of the surveys. Point estimates of relative abundance ranged from as few as 6 in 1993 to 51 in 1991, but all of the estimates had low precision (Table 1). The only conclusion supported by these data is that at least a few tens of bowheads were present in West Greenland waters in the years with surveys.

Most of the bowhead sightings were of solitary individuals although groups of up to 3 or 4 closely associated animals have been reported occasionally (Born & Heide-Jørgensen 1983). A group of 4 was seen in the 1982 survey, and a closely associated pair of large animals was seen in 1994.

Discussion

Distribution and seasonal movements

Historically, bowheads were found in winter as far south as Labrador in eastern Canada and about 64°N in West Greenland (Eschricht & Reinhardt 1866; Reeves et al. 1983). The area surrounding the mouth of Disko Bay, where the tongue of permanently open water along the east side of Davis Strait ends, was well known for its winter

and spring concentration of bowheads (Fig. 1). According to journals of the whaling station at Sisimiut (Holsteinsborg; 66°56'N) from 1780 to 1839, bowheads usually arrived there in mid December and began migrating north by mid March (Eschricht & Reinhardt 1866). Somewhat farther north at Qeqertarsuaq (69°14'N) the whales were usually present until mid June (Eschricht & Reinhardt 1866). Assuming that the present-day migratory schedule is similar to the historical one, the timing of the 1990s surveys reported here, as well as those of McLaren & Davis (1981, 1983) and Born & Heide-Jørgensen (1983), should have been about right for catching

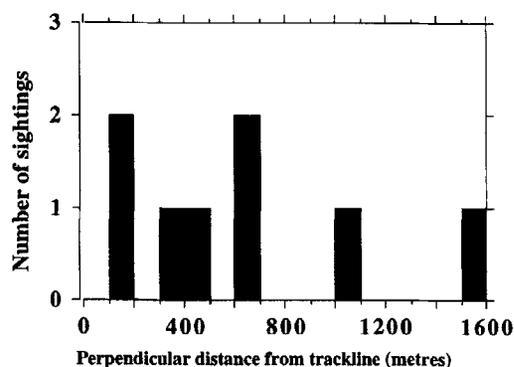


Fig. 2. Perpendicular distances to sightings of bowheads in 1990, 1991, 1993 and 1994. The two sightings more than 700 m from the trackline were not used for abundance estimation. Note that the counts (y-axis) are sightings and not individuals; some of the sightings were of more than one individual.

Table 1. Strip-census estimates of bowhead abundance in the bowhead stratum off West Greenland. Data from 1981–82 were extracted from McLaren & Davis (1981, 1983).

Year	Effort (km)	Observations (individuals)	Density n/km ²	Abundance (95% CI)
1981	1615	3	0.0013	28 (10–79)
1982	2121	6	0.0020	43 (5–333)
1990	993	1	0.0007	15 (2–90)
1991	2101	7	0.0024	51 (21–119)
1993	2271	1	0.0003	6 (1–44)
1994	2890	2*	0.0005	11 (3–37)
Sum		20**		

* Two sightings (3 individuals) in 1994 were outside the 700 m strip width.

** A total of 23 observations within the bowhead stratum, 3 of which were outside the strip; 2 additional sightings of single bowheads were made outside the stratum—one in 1981 (Fig. 3) and one in 1982 (Fig. 4).

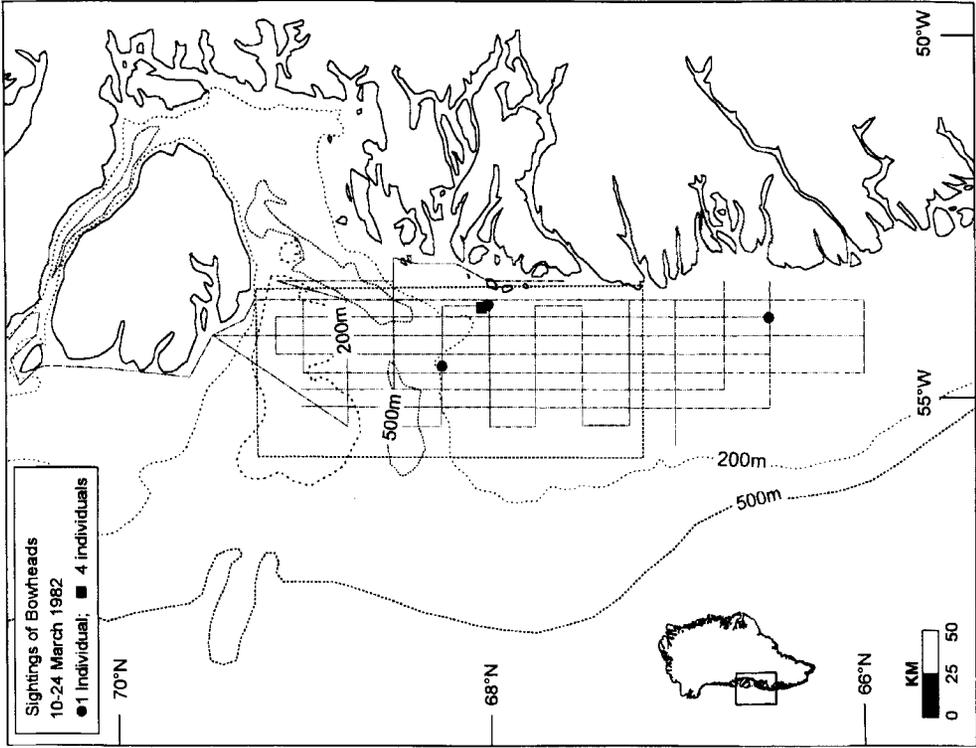


Fig. 4. Transects flown (solid lines) and bowheads sighted in 1982 (redrawn from McLaren & Davis 1983). The bowhead stratum is bounded by broken lines.

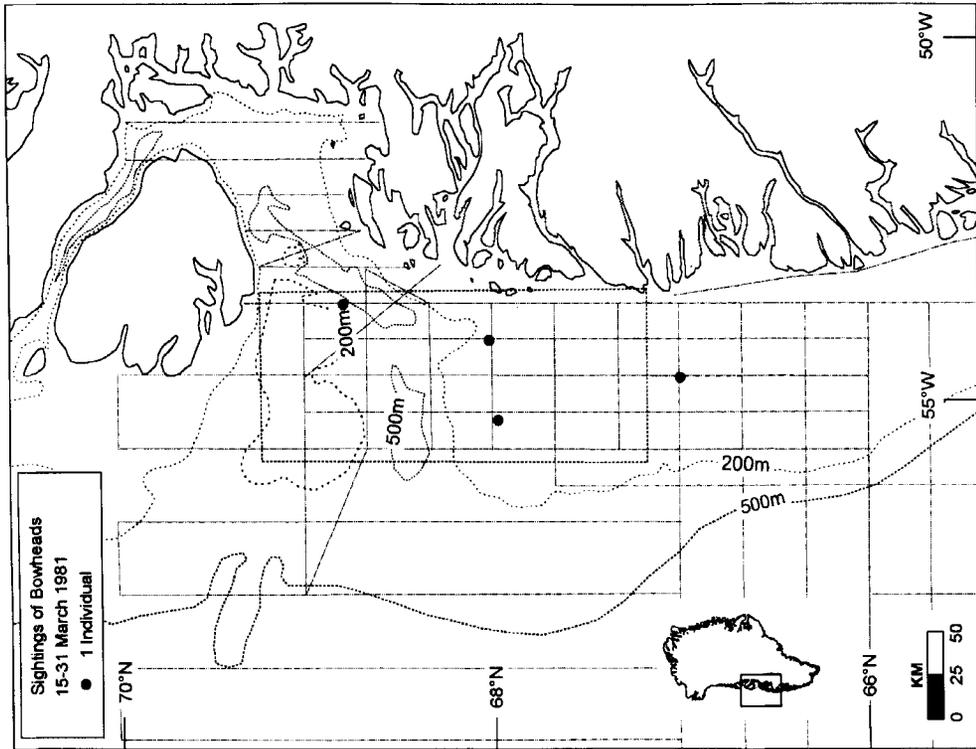


Fig. 3. Transects flown (solid lines) and bowheads sighted in 1981 (redrawn from McLaren & Davis 1981). The bowhead stratum is bounded by broken lines.

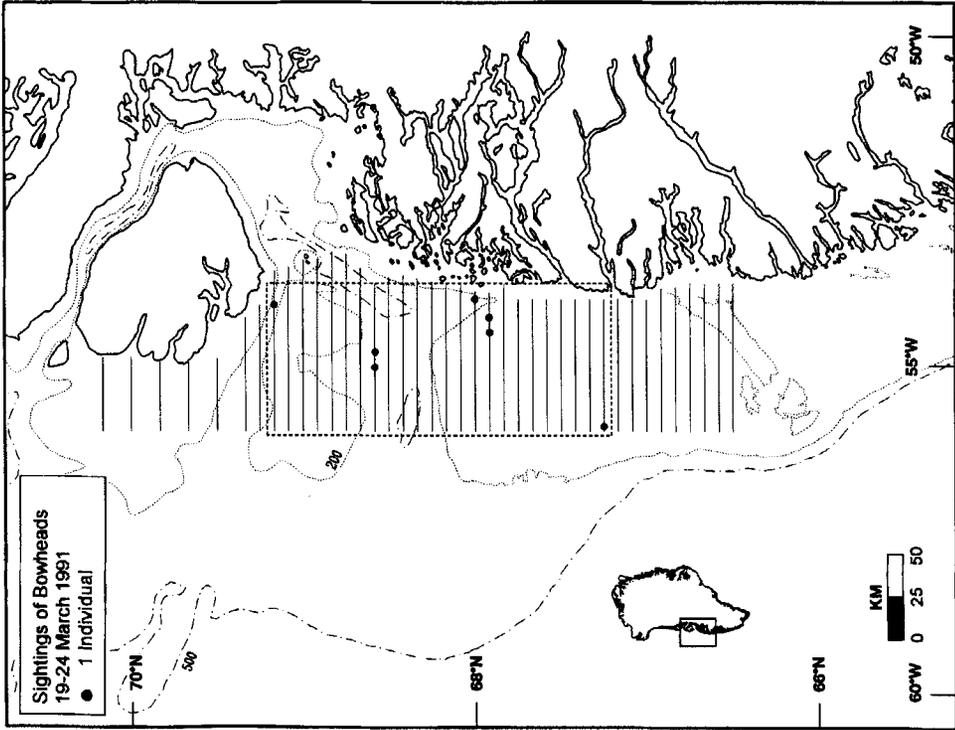


Fig. 6. Transects flown (solid lines) and bowheads sighted in 1991. The bowhead stratum is bounded by broken lines. Note that the two animals on latitude 67°55'N were seen together at 54°17'W.

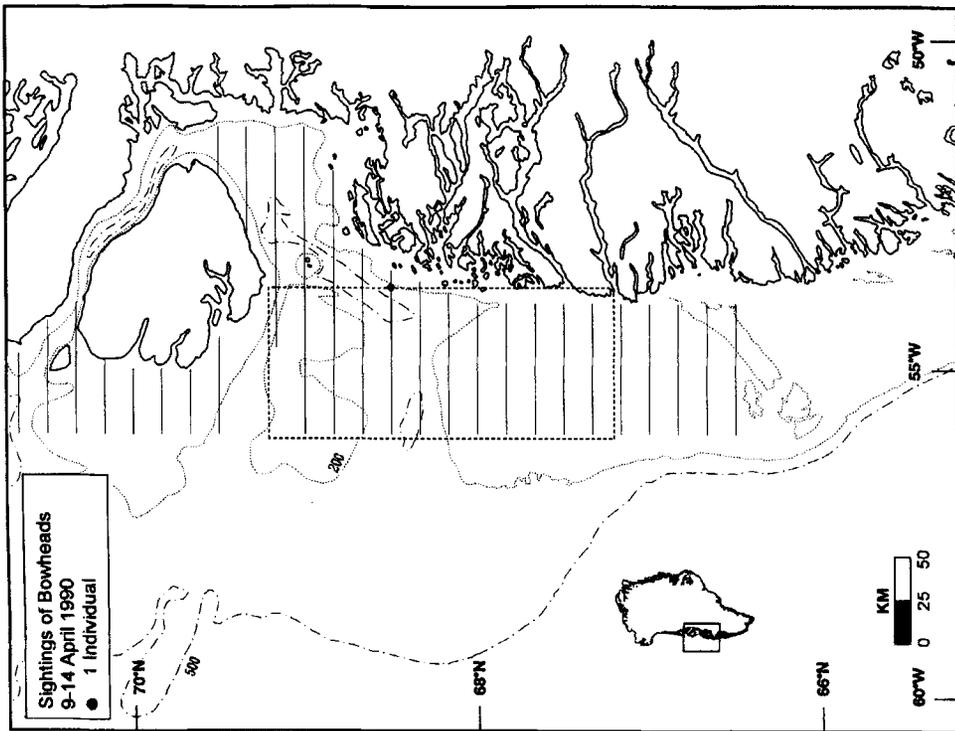


Fig. 5. Transects flown (solid lines) and bowheads sighted in 1990. The bowhead stratum is bounded by broken lines.

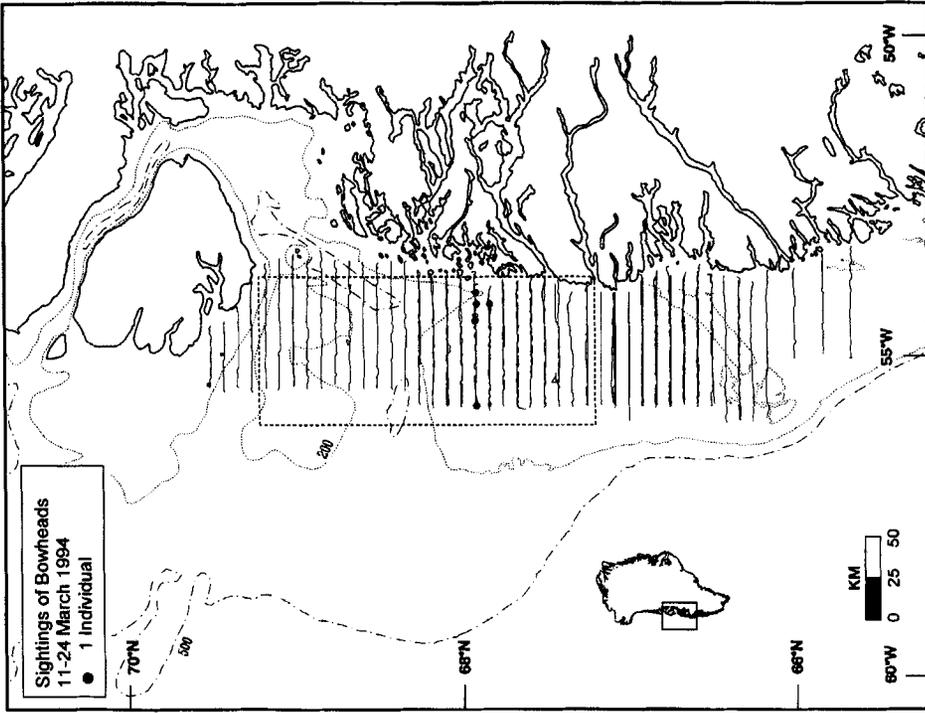


Fig. 8. Transects flown (solid lines) and bowheads sighted in 1994. Irregularity of the lines is due to the fact that they show actual routes flown. The bowhead stratum is bounded by broken lines. Note that two of the animals on latitude 67°55'N were seen together at 54°27'W.

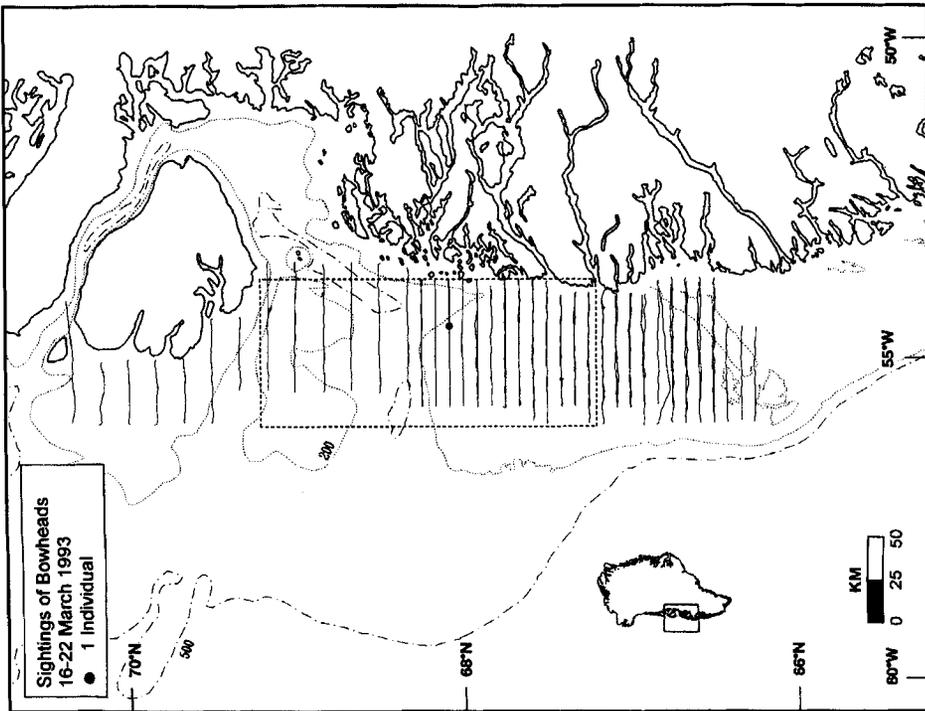


Fig. 7. Transects flown (solid lines) and bowheads sighted in 1993. Irregularity of the lines is due to the fact that they show actual routes flown. The bowhead stratum is bounded by broken lines.

the peak residency of bowheads in at least the northern portion of our bowhead stratum. It is not surprising that the bulk of recent sightings in March and April have been in or just outside the mouth of Disko Bay (Born & Heide-Jørgensen 1983; Figs. 3–8). Bowheads can still be seen in this general area until well into mid May. For example, Heide-Jørgensen (unpubl. data) sighted one at 68°50.40'N, 53°24.70'W on 7 May 1992 during a cruise to the north and at 68°54.40'N, 53°42.67'W on 15 May 1992 during his return passage south. D. Boertmann and A. Mosbech of the National Environmental Research Institute in Copenhagen (pers. comm.) observed bowheads in this same area during low-altitude aerial surveys of seabirds between 29 April–4 May 1996 (4 sightings, 5 animals).

Bowheads in the West Greenland wintering area at any one time represent only a part of the Davis Strait/Baffin Bay stock. According to present understanding, this stock includes all of the whales that summer in the eastern Canadian High Arctic or Northwest Greenland and migrate southwards in autumn along either the east coast of Baffin Island or West Greenland. Finley & Renaud (1980) found no bowheads in the Baffin Bay "North Water", a flaw lead system (or polynya) in northern Baffin Bay, during aerial surveys in March–April 1978 and March 1979, but two sightings were made during a similar survey in March 1993 — one animal at the mouth of Jones Sound and another northwest of Coburg Island (P.R. Richard, Canadian Department of Fisheries & Oceans, Winnipeg, pers. comm.). Two bowheads engaged in courtship behaviour were seen along the ice edge in Smith Sound at 77°N, 72°W on 10 May 1996 (A. Mosbech, pers. comm.). Bowheads have also been seen during February and March in heavy ice well away from the Greenland coast to as far north as 67°30'–69°00'N (e.g. Duncan 1827; M'Clintock 1860). The stock affinities of bowheads that winter off southeastern Baffin Island and in the Labrador Sea are uncertain, as some or all of them may be migrants from the summering areas in northern Hudson Bay and Foxe Basin (cf. Reeves and Mitchell 1990).

Kapel (1985) interpreted the capture in autumn at Upernavik (mentioned above) as demonstrating the continued use of a traditional southward migration route along the west coast of Greenland. While some whales may use this route, the paucity of bowhead observations by Greenlandic

hunters, who are regularly at sea hunting white whales, narwhals, *Monodon monoceros*, and seals during the autumn (cf. Heide-Jørgensen 1994), is in striking contrast to the situation off north-eastern Baffin Island, where a nearshore autumn migration is well documented from scientific investigations (Davis & Koski 1980; Finley 1990) and observations by local hunters (Anonymous 1995).

Numbers and trends

It is important to bear in mind that bowheads can dive for periods of at least 40 min and that they may spend 80% or more of their time below the surface and thus be unavailable for sighting (Dorsey et al. 1989; Würsig & Clark 1993; Finley & Goodyear 1993). The availability bias in survey results presented here is not measurable, as the percentage of time at the surface depends on activity state (e.g. feeding, socialising, travelling, resting) and other confounding variables (Richardson et al. 1995).

The settlement Kitsissuarsuit (Hunde Ejlund) is situated in the southern part of the mouth of Disko Bay. The Inuit there derive a large part of their annual sustenance and income from hunting narwhals. During February–April they keep daily look-outs for whales, but bowheads have been observed only occasionally (e.g. one to the west of the island on 27 March 1990; Heide-Jørgensen, unpubl. data; also see Born & Heide-Jørgensen 1983). The hunters have not noted any increase in sightings despite the fact that more dinghies are being used each winter to search a larger and larger area for whales.

The fishing banks off West Greenland are visited by shrimp trawlers and other types of vessels, e.g. cutters and dinghies, at all seasons, including periods in late winter and spring when the pack ice is navigable. In addition, the land-fast ice along the mouth of Disko Bay is used for hunting trips by dog sledge. The combined effort of all these types of traffic has increased enormously during the post-war period, especially during the past 30 or 40 years with the advent and proliferation of mechanical transportation (Mattox 1973; Horsted 1978; Rask 1993), in combination with rapid human population growth (Lyck & Taagholt 1987). In Qeqertarsuaq municipality alone, the vessel fleet in 1989 consisted of four large multi-purpose trawlers and 19 smaller fishing cutters, as well as several hundred

dinghies (= skiffs) with 40+-horsepower outboard motors (Caulfield 1993). Yet in spite of the regular and widespread human presence at sea, few reports of bowheads have been received from this or any other area of West Greenland.

Some bowheads presumably follow the shore lead (the commercial whalers called it the "land-water") along the coast of West Greenland during their northward spring migration, much as the 19th century British whalers did (cf. Scoresby 1820; Barron 1970). The shore lead along the west coast of Disko Island during March and April is extremely narrow (usually <2 km wide), bordered by land or land-fast ice to the east and by the dense pack ice of Baffin Bay to the west. To a certain extent, the shore lead can be perceived as a bottleneck for whales travelling north from the relatively extended wintering grounds in Davis Strait and the Labrador Sea. The same lead west of Disko Island is also used by hunters as they pursue white whales, narwhals, walrus and seals during the late winter and early spring. Although these hunters do observe bowheads, the numbers are few (<10 sightings per year; e.g. Born & Heide-Jørgensen 1983). If a major increase in local bowhead abundance had occurred over the last few decades, it definitely would have been noticed by the Greenlanders. It is important to recognise, however, that ice cover does not restrict bowhead movements to nearly the same degree as it does vessel passage, so it should not be assumed that all, or even most, of the whales migrate northwards through the shore lead off Disko.

Group size, group composition and behaviour

It is unlikely that the small mean group size from the aerial survey data ($1.6 \pm \text{SD } 1.2$) is an artifact of survey procedures because the routine practice (at least during the four sets of surveys in the 1990s) was to interrupt level flight and circle above bowhead sightings for photography. In these circumstances, additional animals in the vicinity should have been detected.

Bowheads in other stock areas are known to migrate in waves or pulses, with young (weaned but immature) animals often travelling separately from adults (Braham et al. 1984; Moore & Reeves 1993). Similar segregation has been reported on the summering grounds in the Beaufort Sea (Cubbage & Calambokidis 1987). Finley (1990) found that the late-summer "resident" whales in

Isabella Bay consist mainly of large adults, with few calves and small subadults present. Whaling manuscripts from the late 19th and early 20th centuries, along with recent observations of large adults accompanied by small calves off northern Baffin Island, reinforce the idea that the Davis Strait stock is segregated to some degree during the summer and autumn (Finley 1990; Finley & Darling 1990; Reeves & Mitchell 1991). Relatively few observations of bowheads have been made on any of the wintering grounds (Reeves et al. 1983; Moore & Reeves 1993). The observations reported here include animals subjectively classified as small subadults (<10 m) as well as sexually mature adults (>13 m; see Koski et al. (1993) and Schell & Saupé (1993) for discussions of size at age in bowheads). No calves were seen during the aerial surveys, but several sightings of calves have been reported by local hunters in West Greenland (Anonymous 1981; Born & Heide-Jørgensen 1983).

Although sexual activity in bowheads can be observed at various times of the year, most conceptions are believed to occur in the late winter or spring (Koski et al. 1993). Eschricht & Reinhardt (1866) reported that boisterous sexual activity was typical of bowheads near Sisimiut during January and February. Two large animals that we observed off Kangaaatsiaq on 14 March 1994 were interacting vigorously at the surface, rubbing bodies and rolling in apparent courtship.

Exploitation, protection and prospects for recovery

In a reconstruction of the Davis Strait stock's catch history, Mitchell & Reeves (1982) concluded that no bowheads had been killed by Greenlanders after 1956. However a published summary of Greenland hunting statistics (Anonymous 1977), supplemented by unpublished correspondence (letters between L. Vesterbirk, Ministry for Greenland, Copenhagen, and E. Vangstein, International Whaling Statistics, Sandefjord, Norway, 1973-74), indicates that one bowhead was taken at Qeqertarsuaq in April 1973. Thus, although commercial whaling for bowheads had ended in both Canada and Greenland by about 1915, some killing continued in both countries into the 1970s (Mitchell & Reeves 1982). Documented post-1915 kills in Greenland include one at Qeqertarsuaq in April 1928 (Rosendahl 1957) and one in the Atammik-Napasog area

(approx. 64°30'–65°00'N) in March 1956 (Freuchen & Salomonsen 1958) in addition to the one at Qeqertarsuaq in 1973.

Bowheads have been legally protected by international agreements for more than 50 years, although the International Whaling Commission (IWC) sanctions continued hunting by Alaskan Eskimos for subsistence (Gambell 1993). The Greenlanders' hunting of minke whales, *Balaenoptera acutorostrata*, and fin whales, *Balaenoptera physalus*, is managed by a quota system under the IWC's aboriginal subsistence whaling scheme (Gambell 1993; Caulfield 1993). The bowhead is fully protected in Greenland waters.

Canada withdrew from the IWC in 1982, and bowhead whaling was initiated on a small scale in the western Canadian Arctic (Bering-Beaufort-Chukchi Seas stock) in 1991 (Freeman et al. 1992). A similar initiative in the eastern Canadian Arctic began prematurely in 1994 when a small bowhead was taken illegally in northern Foxe Basin (Anonymous 1994; George 1995). The establishment of a "total allowable harvest" of at least one bowhead in the eastern Canadian Arctic was mandated under the recent Nunavut land-claim agreement (Indian & Northern Affairs Canada 1993). Initiation of whaling was to be preceded by the commencement of "an Inuit knowledge study to record sightings, location and concentrations of bowhead whales in the Nunavut Settlement Area" (Indian & Northern Affairs Canada 1993, p. 38). Early results from the study reflect the firm belief by Inuit that bowhead numbers have increased substantially since the end of commercial whaling (Anonymous 1995). Aerial surveys in northern Foxe Basin and north-western Hudson Bay in 1994 and 1995 have been interpreted as suggesting that at least 200–300 bowheads summer there (Anonymous 1996). A large bowhead was taken in a legal hunt at Repulse Bay, northwestern Hudson Bay, on 15 August 1996 (Russell 1996).

Intensive scientific monitoring of some other severely depleted stocks of baleen whales has demonstrated that they are recovering under protection or conservative hunt management (Best 1993). The data presently available from surveys are clearly inadequate for demonstrating recent or current trends in the Davis Strait/Baffin Bay stock of bowheads. They do indicate, however, that the total population size remains a small fraction of what it was prior to commercial whaling. Substantial recovery seems not to have occurred in the

Greenland portion of this stock's range. Hunters and fishermen in West Greenland have reported few encounters with bowheads and have not suggested that the stock is increasing. The paucity of sightings cannot be explained by too little time spent at sea in late winter and early spring. In fact, much boating and shipping activity takes place in the open water and loose pack ice along the west coast of Greenland, where bowheads were once seasonally plentiful. The rarity of sightings during aerial surveys is consistent with the shortage of reports by local people.

If the Davis Strait/Baffin Bay bowhead stock were increasing, it would appear to be doing so mainly in the western part of its range. Our data from West Greenland corroborate the conclusions of Davis & Koski (1980), Finley (1990) and Zeh et al. (1993) that the stock is at a small fraction of its pre-whaling level of abundance and that any recovery since the early 1900s has been very slow.

Initiation of whaling on bowheads in the eastern North American Arctic must be considered in an international context. Some whales move back and forth between Canada and Greenland, possibly on an annual basis. Others may occur during the winter in the Labrador Sea outside any coastal state's Exclusive Economic Zone. If an objective of management is to allow for substantial population recovery, and we believe that it should be, then complete or nearly complete protection from hunting will be necessary for decades into the future. Also, we believe that Canada has an obligation to seek international cooperation on bowhead conservation and to subject its programmes of bowhead population assessment and hunt management to independent scrutiny.

Acknowledgements. – We are grateful to the Fisheries Directorate of the Greenland Home Rule Government for sponsoring the white whale and walrus surveys during 1990–94. Our fellow whale spotters, J. Teilmann, J. Jensen and L. Petersen (who also piloted the aircraft), deserve special thanks. The surveys in 1981 and 1982 were conducted by LGL Ltd. and funded by the Arctic Pilot Project. J. Jensen kindly compiled the information on post-1915 bowhead hunting in Greenland. D. Boertmann and A. Mosbech of the Danish National Environmental Research Institute, Department of Arctic Environment, Copenhagen, very generously allowed us to cite their unpublished bowhead observations. P. Barry helped prepare the map figures. Data analysis and manuscript preparation were made possible by the support of the Greenland Institute of Natural Resources, Nuuk, and by a grant from the Whale & Dolphin Conservation Society, Bath, Avon, U.K.

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