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A REVIEW OF THE STATUS AND HARVEST OF WHITE WHALES (Delphinapterus leucas) IN THE CUMBERLAND SOUND AREA, BAFFIN ISLAND

by

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The white whale (Delphinapterus leucas) population in the Cumberland Sound area has declined from historic levels of more than 5 000 to about 550 in 1979. In this report, we give results of surveys and observations made in Cumberland Sound from 1979 to 1984 and discuss information from various other sources on the seasonal distribution of white whales in the southeast Baffin Island area. We also present information on white whale hunts in Clearwater Fiord.

Currently, the Cumberland Sound white whale population's estimated size is somewhere in the range of 400-600 animals and its net annual reproductive rate is less than 7.7%. Loss rates from the white whale hunt could not be quantified precisely but they are probably high enough to contribute significantly to the decline of the population. It is probable that hunters from Frobisher Bay and Lake Harbour are also taking whales from Cumberland Sound. Management options are discussed in the light of these results.

Key words: aerial surveys, beluga, management options, population size, seasonal distribution.

RÉSUMÉ

Richard, P.R., and J.R. Orr. 1986. A review of the status and harvest of white whales (Delphinapterus leucas) in the Cumberland Sound area, Baffin Island. Can. Tech. Rep. Fish. Aquat. Sci. 1447: iv + 25 p.

La population de bélougas (Delphinapterus leucas) de la baie de Cumberland a subi un déclin important, passant d'un niveau historique estimé à plus de 5 000 individus à près de 550 en 1979. Dans ce rapport, nous présentons les résultats d'inventaires et d'observations effectués dans la baie de Cumberland entre 1979 et 1984. Des résultats provenant d'autres sources sur la distribution saisonnière des bélougas du sud-est de la Terre de Baffin y sont également discutés. Nous présentons finalement des données et observations recueillies lors de chasses aux bélougas dans le fiord Clearwater.

Présentement, le niveau estimé de la population de la baie de Cumberland se situe entre 400-600 individus, et son taux de reproduction annuel net est inférieur à 7.7%. Le taux de pertes occasionnées par la chasse n'a pu être estimé; cependant, il est probablement assez élevé pour contribuer de façon substantielle au déclin de cette population. Il est probable que les chasseurs de Frobisher Bay et Lake Harbour prennent aussi des bélougas provenant de la baie de Cumberland. À la lumière de ces résultats, nous discutons différentes options de gestion.

Mots-clés: invertaires aériens, bélouga, options de gestion, niveau de population, distribution saisonnière.

INTRODUCTION

The white whale (Delphinapterus leucas) population of Cumberland Sound, Baffin Island, NWT, was commercially exploited by pelagic whalers, the Hudson's Bay Company and others from 1868 at least to 1939 (Mitchell and Reeves 1981). After 1939, the Hudson's Bay Company continued to trade white whale products acquired from local hunters until the late 1950's (Reeves and Mitchell 1981). Commercial catches, which peaked between 1922 and 1939, during which period at least 4 551 white whales were taken, diminished subtantially afterwards.

Between 1966-1971, Brodie (1970, 1971) studied the growth and reproductive biology of this white whale population and estimated the abundance of its summer concentration in Clearwater Fiord at the head of Cumberland Sound. Monthly inshore and offshore surveys of birds and marine mammals around southeast Baffin Island provided numerous sightings of white whales in Cumberland Sound, Frobisher Bay, and adjacent areas. They also served to estimate the summer abundance of whales in Clearwater Fiord (MacLaren-Atlantic 1978; MacLaren-Marex 1979, 1980).

Between the early 1960's and mid-1970's, white whale hunting had continued purely for local consumption of 'muktuk', the edible skin of arctic whales. An estimated 60 white whales were taken on average every year (Brodie et al. 1981). In 1976 and 1978, when Pangnirtung hunters started to sell muktuk to other communities, white whale catches increased to twice and three times that amount. Concerned that the population, estimated to number about 800, could not sustain such a level of harvest, the Department of Fisheries and Oceans (DFO) discouraged hunters from taking that many whales and, after consultation with local people and researchers, an annual quota of 40 landed animals was set for the 1980 hunt. Hunters were also discouraged from taking females accompanied with calves. The quota was provisional. It was to be changed when further studies of the population allowed reassessment of its status.

Because we are faced with the problem of a hunted population which was certainly reduced, and is possibly still declining, we decided to carry out population surveys and hunt monitoring studies to find out how many there are, what effect continued harvest might have on the population's status. We also reviewed published and unpublished survey results to determine if they could also be harvested by other communities than Pangnirtung. In this report, results of our 1979-1984 surveys and observations of the population size and distribution, are presented as well as a review of the above mentioned studies and of more recent studies of white whales around southeast Baffin Island (Finley et al. 1982; McLaren and Davis 1982). Seasonal distribution and stock delineation of the Cumberland Sound population are discussed. Results of 1982 and 1984 hunt monitoring studies in Clearwater Fiord are also presented. Sex and age selection of the catch and sinking or wounding losses due to harvesting are discussed. Finally, estimates of the population's sustainable yield are presented to evaluate the potential effects of present and future management options.

STUDY AREA

Cumberland Sound is a large inlet on the southeast coast of Baffin Island in the Northwest Territories of Canada (Fig. 1), approximately 250 km long and 75 km wide. It has a complex coastline with numerous fiords and small islands. The head of the sound has several large fiords (Nettiling, Kangilo, Kangerk, Clearwater and Shark) and an island-peninsula complex (e.g. Nunatak, Kekertelung, Sanigut islands) with numerous narrow sea channels (Fig. 2) and strong tidal currents.

Clearwater Fiord is a long, narrow fiord in the extreme northwest corner of Cumberland Sound. In summer, the Ranger River discharges relatively warm silt-laden fresh water into the fiord, at about the middle of its length. Millut Bay (66°35' N, 67°28' W) at the mouth of the Ranger River, is the main area of white whale concentration in Cumberland Sound, especially between late July and mid-September (Brodie 1970).

MATERIAL AND METHODS

DISTRIBUTION AND ABUNDANCE

Survey area

In planning surveys and field observations, advice and participation were sought from the Hunters and Trappers Association (HTA) of Pangnirtung and from individual hunters. Their experience indicated that white whales could be found inshore in the summer (late July-mid September) from Pangnirtung Fiord west to Clearwater Fiord and along the southwest coast of the sound. The largest numbers occurred mainly in Clearwater Fiord but also in adjacent areas such as Kangerk and Kangilo Fiords (Fig. 2). The same distribution pattern was described in Brodie (1970) and Brodie et al. (1981). Consequently, survey coverage was most intensive at the head of the sound with the southwest coast covered less intensively. Several hunters participated in the aerial surveys and field expeditions (Table 1).

Survey and cliff observation methods

This report brings together the efforts of different people in different years, with varying resources at their disposal. The methods used for each survey changed accordingly. In 1979, at the request of the Pangnirtung HTA, two DFO researchers and two Pangnirtung hunters made a boat reconnaissance trip at the head of Cumberland Sound (Fig. 3). The trip was useful in planning subsequent surveys. In the following three years (1980-1982) aerial surveys with visual and photographic counts were flown (Tables 1-2).

Because of Clearwater Fiord's attractiveness to white whales, an attempt was made to

survey that area more than once each year. Consequently, the fiord was covered at least once each day of survey (Fig. 4a-6b). With the exception of the 1980 survey, other parts of Cumberland Sound were only surveyed once each year. Because of the study area's size and complex coastline, a systematic survey design would have been complicated and costly. Flight paths were arbitrarily chosen to cover as much area as possible within the coastal zones of the sound identified by local people as occupied by white whales. A systematic transect design was used only in Clearwater Fiord and only for the 1982 photographic surveys.

In 1979 and 1982, during short periods at Clearwater Fiord, some counts were made from vantage points on the surrounding cliffs (Fig. 3,7). In 1983 and 1984, in an attempt to give context to the instantaneous samples provided by the aerial surveys, hourly observations of whale distribution and abundance within Clearwater Fiord were made daily for several weeks (Table 1,3, Fig. 7). Weather permitting, observations were maintained over most of the daylight hours. They were interrupted only when deteriorating visibility conditions (sea-states above Beaufort three or heavy rain and fog) made counting impossible or when hunting took place in Clearwater Fiord, an important disturbance which influenced whale distribution. During hunts, observers concentrated on hunt monitoring (see below).

Population estimation methods

Estimates of the number of white whales in Clearwater Fiord were obtained by correcting for submerged animals and dark-coloured calves in portions of the fiord silted by the runoff of the Ranger River. To allow comparison with previously published estimates, the same correction factors used by Brodie (1970, 1971) were applied here. No correction was applied to aerial counts elsewhere in Cumberland Sound. Owing to the clarity of the water, submerged whales of all colour phases could readily be seen.

Population estimates for the whole of Cumberland Sound were obtained by totalling the corrected counts from Clearwater Fiord and uncorrected counts from other areas. In cases where repeated counts were obtained on a day for a given area, minimum and maximum counts were used as a range for the population estimate.

Mapping of seasonal distribution

Aerial surveys were conducted by consultants to the oil industry between 1977 and 1981 in waters bordering southeast Baffin Island (MacLaren-Atlantic 1978; MacLaren-Marex 1979, 1980; McLaren and Davis 1982). Results of these extensive surveys were collated and added to our own data to produce monthly distribution maps of white whale sightings for the months of March to June and August to December. Some published survey results and incidental sightings were also used in these maps (Smith et al. 1979; Finley et al. 1982). Cumulative sightings from all years (1977-1982) were plotted for each month of survey, or in some cases for two consecutive months when results were not distinguished for those two months. Areas where sightings abounded were cross-hatched while isolated sightings were identified by a symbol. The cumulative survey area by all sources for each month was covered by a single hatching.

HUNT MONITORING AND CATCH COMPOSITION

To describe white whale hunting methods and success in Clearwater Fiord and to estimate the loss rate resulting from such methods, hunting in the fiord was observed in 1982-1984. To describe the catch composition, as many of the landed animals as possible were measured and sexed before hunters flensed them. Detailed methods for the 1982-1983 study was reported by Orr and Richard (1985). Sex and morphometric data for the 1984 animals were obtained from R. Stewart (DFO, Western Region, 501 University Crescent, Winnipeg, Manitoba, personal communication).

CATCH STATISTICS

The reported annual landed catches in the communities of Pangnirtung, Frobisher Bay and Lake Harbour for 1973-1985 were compiled by Field Services (DFO, Western Region, Frobisher Bay, and Yellowknife, NWT).

RESULTS

DISTRIBUTION AND ABUNDANCE IN CUMBERLAND SOUND

Boat surveys and cliff observations, August 1979

On the first day, 1 August, the field party saw no whales while travelling by boat from Pangnirtung to Clearwater Fiord (Fig. 3). In the fiord, the next day, they counted 400-500 animals from a cliff observation site. Little change in numbers was observed over the three days which followed. Hunting took place but was very light. No whales were seen during the reconnaissance trip through Kangilo Fiord on August 7-10 and in Shark Fiord on August 10. Cliff observations resumed on a different cliff in Clearwater Fiord on 11 August when the number of whales observed had diminished considerably, probably as a result of the intense hunting activity which had occurred during the observation interruption: we suspect this activity drove many whales out of the fiord. No more than 100 white whales were seen in Millut Bay on August 11 and approximately 50 were seen the next day. Observations ended on 12 August.

Aerial visual and photographic surveys, August 1980

On the first day of survey, 4 August, a group of 24 adult whales was observed at the head of Kangilo Fiord (Fig. 4a). A second group was photographed in Clearwater Fiord in the silty plume of the Ranger River. The photographs showed 35 white whales visible at the surface. The corrected count for that group is 58 whales (Table 4).

On 5 August, a herd of at least 500 white whales was sighted near the Drum Islands (Fig. 4b). Some whales were being pursued by hunters in canoes and many were moving through the ice away from the disturbance. Directly below the aircraft was a group of about 200 whales. Two attempts were made to photograph that group, one at 2 800 ft (862 m) and another 5 000 ft (1 538 m). Examination of the photographs gave a count of 259 whales. The hunting had caused the herd to disperse too widely for an efficient photo census. Twenty minutes later, 25 white whales were photographed in the turbid water of Millut Bay. The corrected estimate for that group is 41 whales (Table 4).

On 6 August, three white whales were seen in the Drum Island area (Fig. 4c) and later a group of about 40-50 animals was seen in the upper half of Kangilo Fiord on the southwest coast. A larger herd, visually estimated at 120 animals, was found one mile from the head of the same fiord on the east side and photographs taken at 5 000 ft (1 538 m) revealed that the herd contained 160 animals. An additional 15 were seen swimming nearby.

In Clearwater Fiord, white whales were dispersed along the estuarine plume of Millut Bay and three photo transects were flown over the area they occupied. Analysis of the overlapping mosaic of photographs yielded counts between 50-60 white whales visible at the surface. The corrected estimate for the fiord is 83-99 whales (Table 4).

Aerial visual surveys, August 1981

Before the survey, the HTA informed the survey team that hunters living in an outpost camp on Allen Island, east of Hall Peninsula, had seen 10-15 white whales a week earlier. On the first day of survey, 4 August, a group of nine white whales was sighted in Robert Peel Inlet (Fig. 5a). Whales were seen again in Millut Bay at the edge of the turbid water where three successive visual counts yielded a range of 80-144 whales. The corrected estimate is 132-238 whales (Table 4).

The next morning, in Clearwater Fiord, the survey team made five successive visual counts which ranged between 126-268 white whales. The corrected estimate for that herd is 208-443 white whales. Observers noted that some adults were accompanied by calves but the silted water did not allow an accurate calf count. An hour later, four adults and a calf were observed in Nettiling Fiord.

After refuelling in Pangnirtung, the survey continued along the southwest coast of Cumberland Sound in the afternoon (Fig. 5b). A group of nine adults was seen in Brown Inlet and another group of seven adults at Cape Edwards. A last group, consisting of nine adults was sighted at Cape St. David before the survey ended at Brevoort Island.

Boat, cliff observations and aerial visual and photographic surveys, July - August 1982

During cliff observations on 21-27 July, numbers of white whales in Millut Bay and upper Clearwater varied from none to 114. When field observers arrived with the hunters on 21 July, approximately 60-100 animals were counted in the fiord, but after that first day of hunting, few animals remained. Hunting in the fiord ended on 24 July and the number of whales steadily increased to a maximum of 114 on 27 July.

On the first day of the aerial survey (21 August), a lone white whale was sighted in lower Clearwater Fiord (Fig. 7a). In upper Clearwater Fiord, whales concentrated near the turbid water of Millut Bay. On the photographs, 198 animals were counted in silted water and 83 (of which 15 calf- yearling size) in unsilted water. The corrected estimate is 411 whales (Table 4). No animals were seen in Kangerk, Kangilo, or the northern part of Nettiling Fiords but a group of hunters travelling by canoe at the time of the survey reported seeing two white whales in the northwest arm of Nettiling Fiord.

The next day, 22 August, a large herd of white whales was photographed in lower Clearwater Fiord at 610 m (2 000 ft). The photographic count was 138 whales. Photographs at 1 066 m (3 500 ft) of the concentration in Millut Bay, upper Clearwater Fiord, showed 270 animals, of which 30 were classed as neonate-yearling size for corrected total of 408 whales in upper and lower Clearwater Fiord. No other white whales were seen in the south part of Nettiling Fiord or along the southwest coast of Cumberland Sound.

Cliff observations, July-August 1983

White whale counts in Clearwater Fiord in 1983 were variable within days and between days. Detailed analysis of the results will be reported elsewhere but numbers generally rose at the beginning of the field study between 25-29 July. Afterwards, they stabilized around a mode of about 200 animals. The largest counts were recorded on 10 and 21 August when the daily maxima were 379 and 378 whales respectively. The annual hunt took place in Clearwater Fiord on a single day, 15 August. It is not clear whether it caused some whales to leave the fiord because counts in subsequent days were comparable to those made before the hunt. We have no information on numbers of animals which could have occupied other areas of Cumberland Sound during the same period.

Cliff observations, August-September 1984

In 1984, observations in Clearwater Fiord were hampered by continuous bad weather and poor visibility coupled with a longer period of hunting (16-25 August) than in previous years. Consequently, counts were less frequent and more irregular. White whale counts were generally low with the highest numbers observed on the second day of hunting (174) and a week after hunting stopped (173). Otherwise, counts averaged around 50 animals and rarely exceeded 100. Large pods of white whales were seen by hunters outside the fiord during the study period. No pattern in abundance could be deduced from the Clearwater Fiord observations.

DISTRIBUTION IN SOUTHEAST BAFFIN REGION

Published surveys vary considerably in the survey effort expended in different parts of southeast Baffin waters for any given year and in effort from one month to the next. Nevertheless, substantial effort was expended in surveying Frobisher Bay and Cumberland Sound in all months. Surveys of the offshore areas were designed mainly for censusing seals and birds, and had a more variable and sparser coverage, except in March and April when Hudson Strait and Davis Strait were surveyed extensively.

March-April sightings (Fig. 8a) cover the whole of Hudson Strait and part of the coasts of Labrador and Greenland. Few white whales were seen in Davis Strait despite extensive coverage during that period. August and September sightings (Fig. 8d-e) cover a large part of Cumberland Sound and Frobisher Bay. The largest concentrations observed in any area occurred in Cumberland Sound, most often in Clearwater Fiord. In all other months, white whale sightings are found again mainly in those two areas but also at the eastern mouth of Hudson Strait. This distribution pattern suggests spring northward and fall southward movements between Cumberland Sound and wintering areas in Frobisher Bay and Hudson Strait.

CLEARWATER FIORD HUNT MONITORING RESULTS

Orr and Richard (1985) describe the 1982-1984 Clearwater Fiord hunts in detail. Most of the white whales killed were buoyant but during the 1984 hunt, of 12 reported killed, at least one whale (8%) was killed-but-lost by sinking. A bloated whale carcass with several bullet holes was also found floating in lower Clearwater Fiord a week after the hunt. During the same hunt, at least 21 whales were reported struck-but-lost, their degree of wounding unknown. It was not uncommon, in the weeks that followed each year's hunt, to see a whale bleeding from one or more wounds although many whales landed by hunters had well-healed bullet scars, indicating that some wounds are only superficial. But other wounds observed on the carcasses were not healed and showed signs of swelling and infection of the skin and muscles.

Thirty animals landed in 1982-1984 were sexed (Table 5). One third were females and two thirds males (chi-square $P = 0.10$). The mean length of both sexes from our sample (Table 5) was significantly higher than the mean of Cumberland Sound male and female white whales of all age groups (t-test, males: $P<0.001$, females: $P<0.005$) reported by Sergeant and Brodie (1969). On the other hand, our sample was not significantly different from their mean adult length (t-test, males: $P>0.9$, females: $P>0.2$).

SOUTHEAST BAFFIN CATCH STATISTICS

The mean annual reported landed catch for the southeast Baffin communities of Pangnirtung, Frobisher Bay, and Lake Harbour is 84 white whales. Pangnirtung, which has a quota of 40, has exceeded it by several animals in all years but one since its inception in 1980 (mean=44, Table 6). The other two communities have no quota restrictions and reported landed catches have ranged between 2 and 63 in Frobisher Bay and 3 and 75 in Lake Harbour with averages of 18 and 22 respectively (Table 6).

DISCUSSION

SIZE OF THE CUMBERLAND SOUND WHITE WHALE POPULATION

The size of Cumberland Sound, the complexity of its coastline and the clumped distribution of white whales make the estimation of their population size a difficult problem. Because most whales tend to concentrate in Clearwater Fiord from late August to early September (Brodie 1971), efforts were directed mainly towards the estimation of that concentration. Because of water turbidity in some part of the fiord, submerged whales were not easily seen. To allow comparison with previous estimates, Brodie's (1971) correction factors, discussed below, were used to estimate the total number present year. Using his correction factors assumes that diving behavior of whales was identical during each year survey, an untested assumption.

Knowledge that smaller groups could be found scattered throughout the coastal areas of Cumberland Sound prompted some effort to survey those areas. They were not surveyed systematically, but with flight lines which covered as much of the known areas of occurrence as was possible with available resources. For all the above reasons, none of the estimates reported here incorporate estimates of statistical variability. Estimates would best be referred to as indices of abundance rather than absolute numbers of population size. Nevertheless, we obtained and provided a range of estimates and are confident that within this range lies the actual population size.

Anteriorly, Brodie (1971) counted 465 beluga from the air on 30 August, 1967, and estimated that 769 white whales occupied Millut Bay in Clearwater Fiord (Fig. 10). On 16 August, 1977, McLaren- Atlantic (1978) counted 624 whales from a photographic mosaic of the concentration of white whales in Clearwater Fiord yielding a pre-hunt estimate of 803 whales. Brodie et al. (1981) concluded from those results that little change had occurred in the Cumberland Sound population between 1967 and 1977.

But those two estimates were obtained in different parts of the month, using two different methods. Our cliff-based observations indicate that numbers vary between days and within days as whales move in and out of Clearwater Fiord. The aerial photography used by MacLaren-Atlantic (1978) is potentially more accurate because, at a vertical angle, water penetration is greatest and sun glare and sea-state have less influence on visibility than at the shallower angles used in visual counts. For example, two visual estimates reported in our 1980 aerial survey were 75% and 80% of the

photographic counts of the same groups. Confident of the accuracy of aerial photography and because most whales were not in turbid waters, MacLaren-Atlantic did not correct their photo count for submerged animals. The use of overlapping pictures, on the other hand, could have biased the count upwards by counting some groups twice. MacLaren-Atlantic (1978) tried to avoid that bias by eliminating identifiable groups found on overlapping pictures, but the possibility that some groups or scattered individuals were double-counted remains.

The correction factor used by Brodie (1970, 1971) for submerged animals is based on observations from surrounding cliffs. He calculated the average time that animals were visible at the surface compared to the average time they were submerged. Such a measure is a function of the altitude at which observations are made. The time that whales are visible from an aircraft is probably slightly longer than the time observed from the cliffs. Brodie's aerial survey was flown from about 1 200 ft (370 m) (DFO, Bedford Institute, Dartmouth, Nova Scotia, personal communication). None of the cliffs in Clearwater Fiord are that height, therefore his correction factor could have overestimated the number of whales present in the fiord. The correction for missed neonates and yearlings used by Brodie (1970, 1971) is based on an assumption that the two age classes represent about 18% of the total population, not on an exact estimate of their proportion. MacLaren-Atlantic (1978) used it in their estimate. They did not feel confident that neonates and yearlings could be accurately counted at their survey altitude (1 400-1 520 m).

Finally, if daily movements in and out of Clearwater Fiord occur as is suggested by our cliff observations, the proportion of the population actually occupying the fiord may vary. In the previous studies, no estimates were obtained for the whales which may occupy other areas of Cumberland Sound. Because of these different assumptions and biases, there are no means of evaluating the degree of precision of population estimates for Clearwater Fiord and for the proportion of the Cumberland Sound population actually occupying Clearwater Fiord. Therefore, it is difficult to conclude on a trend in population size between 1967 and 1977, except perhaps to say that no major decline had apparently taken place.

MacLaren-Marex (1979, 1980) subsequently made several surveys in Cumberland Sound and reported smaller numbers of animals. The largest counts totalled 550 animals seen twice in a large herd on the 12 and 27 October of 1979. Brodie et al. (1981) acknowledged that small scattered groups might have been missed during those surveys but, nevertheless, concluded that "a short term decline seems probable between 1977 and 1979 and can be correlated with heavy hunting in 1976 and 1978". The caveat of missed groups however should not be dismissed. Also, those surveys were late in the season, some whales might have already left Cumberland Sound for the wintering areas.

Our 1979-1982 August surveys not only covered Clearwater Fiord but also a large portion of the head of Cumberland Sound which, from the experience of locals, constitutes the range of white whales in Cumberland Sound during August. Largest daily estimates for each year ranged between 240-540 whales (Table 4). The caveats of correction factors and missed groups discussed above apply to these results. The photo surveys of 1982 suggest that at least 400 whales were present in Clearwater Fiord that year. None were seen in other areas of the sound but those areas were not covered as intensively and were only surveyed visually. Small scattered groups, like the two seen by hunters in Nettilling Fiord during the 1982 survey, could have been missed by visual observers. The 1980 count of 541+ suggests that there may have been as many as 600 whales in Cumberland Sound at least that year. No estimates exist for the number of white whales which might have occupied Frobisher Bay during the same periods each year. Thus, the size of the Cumberland Sound white whale population probably lies between 400 and 600 animals.

DISTRIBUTION AND STOCK DISCRETENESS OF THE CUMBERLAND SOUND POPULATION

Several arguments have been used to suggest that the Cumberland Sound white whale population is a distinct stock: the size difference between Cumberland Sound whales and whales of neighbouring populations, the long-term decline in abundance of the population and the high incidence of bullet scarring in Cumberland Sound whales. White whales from Cumberland Sound were shown to be larger, on average, than animals of the same age from western Hudson Bay and Lancaster Sound (Sergeant and Brodie 1969). This size difference suggests stock separation of those populations. More recent work by Finley et al. (1982) concluded that white whales collected in Northern Quebec populations were intermediate in size between western Hudson Bay and Cumberland Sound whales. Larger and simultaneous samples are needed for statistical analyses that are conclusive. In the meantime, we cannot rule out on the basis of the available morphometric data that some degree of exchange could exist between Cumberland Sound and neighbouring populations of Northern Quebec.

The long-term decline in abundance inferred from the Cumberland Sound catch records was deemed by Mitchell and Reeves (1981, page 665) to be "the strongest single line of evidence bearing on the discreteness of the Cumberland Sound population". They cautioned, however, that "if there is mixing and the Cumberland Sound 'stock' is only part of a broader Davis Strait/Hudson Strait population, then the decline in abundance in Cumberland may be taken as an index of the depletion of a much larger stock." Finley et al. (1982) documented the decline of the Ungava Bay and eastern Hudson Bay populations. The western Hudson Bay population is thought to have been over-exploited only moderately (Sergeant 1981), but in the absence of pre-exploitation data on population size, the rate of decline in abundance cannot really be estimated (Perrin 1982). Finally, there is no information on trends in abundance of the High Arctic white whale population. Consequently, there is not enough evidence to rule out this

alternative hypothesis of depletion of a much larger stock.

Brodie et al. (1981) argued that the high incidence of bullet scarring observed on Clearwater Fiord white whales is evidence for a high degree of annual homing. However, when one considers the number of communities throughout northern Canada and Greenland engaged in white whale hunting, this argument has little force. Hunting techniques are similar in the other communities we have studied (e.g. Repulse Bay, Igloolik) and scarring inevitably results. Scarred white whales have also been observed at Grise Fiord, Resolute and Eskimo Point by R. Stewart (DFO, Western Region, 501 University Crescent, Winnipeg, Manitoba, personal communication).

Pangnirtung hunters believe that the animals occupying Cumberland Sound in the summer are hunted by Frobisher Bay and Lake Harbour hunters in the spring and fall. This belief is consistent with the timing and distribution of past native white whale hunting (Milton Freeman Research 1976). Frobisher Bay HTA representatives also believe that the whales they hunt in the spring and fall are going to or coming from Cumberland Sound's summer concentration area. On the other hand, the Lake Harbour HTA representatives think that the whales that they hunt, mainly in the fall, come from western Hudson Strait because white whales are usually reported in Cape Dorset before they appear in Lake Harbour. Animals which are taken in the Lake Harbour area could therefore have originated from Hudson Bay summer populations.

Support for both beliefs comes from the monthly distribution of sightings in the southeast Baffin area (Fig. 8a-f). The distribution maps give some indication of a north-south spring and fall migration and the wintering areas of Cumberland Sound whales are probably Frobisher Bay and Hudson Strait. Frobisher Bay and Lake Harbour hunters could be harvesting some animals that summer in Cumberland Sound mixed with animals summering in Frobisher Bay or Hudson Bay.

In absence of conclusive evidence of exchange with other populations, it seems prudent nevertheless to view the Cumberland Sound population as a discrete stock being harvested first by Pangnirtung hunters but also partly by Frobisher Bay and Lake Harbour hunters. The possibility of both these communities having an influence on the decline of this severely depleted stock warrants their inclusion in a future management strategy.

YIELD OF THE CUMBERLAND SOUND POPULATION

Brodie et al. (1981) attempted to estimate the yield of the Cumberland Sound population by calculating a net annual reproductive rate (NARR) from estimates of gross annual reproductive rates (GARR). They used a GARR of 12% based on the ratio of neonates to total animals observed in various estuaries. Because of the similarity of reproductive parameters between white whales and pilot whales (Globicephala melaena), they assumed that mortality rates would be similar in both species and used the juvenile mortality rate of pilot whales (ages 1-8) as an estimate for the gross annual mortality rate (GAMR) of white whales. They calculated NARR as follows:

$$NARR = GARR-GAMR$$

$$= 12\% - 4.5\% = 7.5\%$$

With this NARR estimate, they concluded that the population, estimated to number at least 550 animals in 1979, would yield 41 animals the next year. The 1980 quota of 40 for Cumberland Sound was based on that estimate. But Sergeant (1962) also reported a pilot whale neonate mortality of 30% which was not incorporated in the white whale NARR estimate's calculation. The estimate was also criticized because pilot whales mature later and are longer-lived than white whales, suggesting the two species may have quite different mortality rates (Perrin 1982).

White whale neonates are not easily distinguished from yearlings from the air. Both are dark coloured and, based on their reported sizes (Brodie 1971, Sergeant 1973), they could easily be confused from a distance. Moreover, this neonate proportion would hold true only if it could be shown that other age groups are not under-represented in the estuary. Finally, the neonates were not counted in Cumberland Sound, but in Western Hudson Bay and the high Arctic on populations which may have different GARRs. Estimates obtained by other researchers in various estuaries vary between 5.6% and 12.1% (Braham 1984).

Therefore, the estimate of GARR used by Brodie et al. (1981) could be overestimated while their estimate of GAMR is probably underestimated. In 1982, we counted a total of 687 white whales in the two days of survey in August and no more than 67 or 10% of these were neonate or yearling-size. Because the size classification is somewhat arbitrary, we do not know how close that number is to the true proportion of calves and yearlings in the Cumberland Sound population.

In a second attempt to estimate white whale NARR, Sergeant (1981) reviewed catch records from the Churchill commercial catch and suggested that white whale populations could probably sustain an annual yield of 5% if the sex ratio of the catch was biased towards males, as was the case in that fishery. It was criticized because of the lack of comparative data on the population's size before exploitation which precluded the estimation of the rate of change during exploitation (Perrin 1982). Also, the observed decline in modal length of males was thought to be indicative of over-exploitation (Perrin 1982).

A third approach to estimating yield was used by Brodie (1971). He estimated the "potential" rate of increase(r) of the Cumberland Sound population by solving the survival-fecundity equation:

$$\sum_{x=0}^{n} l_x m_x e^{-rx} = 1$$

where l_x is the probability of survival from age (x) 0 to n and m_x is the age-specific fecundity. Age-specific fecundity is defined as the number of female births to each female of age x. Based on his reproductive study, Brodie (1971) estimated that females reproduced from age 6 to 21 at a rate of 0.1667 female calves per year (0.5 female calves every three years). In the absence of data on age-specific survival, l_x was set at 1 (or 100% survival) for all age classes, for a rate of increase of 9%. We used Caughley (1977)'s computer iterative method to solve the equation and obtained a rate of 7.7%. Hay (1985) also obtained 7.7% by the same method. The reason for the discrepancy is that Brodie's solution was a linear approximation (P. Brodie, DFO, Bedford Institute, Dartmouth, Nova Scotia, personal communication) which caused an overestimate because the regression of trial values of r on the solution is gently curved not linear (Caughley 1977). A survival probability of 100% for all reproductive age classes is of course impossible, therefore this result can only serve as a theoretical upper bound under which the population's crude birth rate lies.

Sustainable yield (SY) is a function of instantaneous birth rate (Caughley 1977). To maintain the population at a zero rate of increase:

$SY = 1-e^{-r}$ and if $r<0.077$ then $SY<1-e^{-r}<0.074$

If the Cumberland Sound population has remained at 400-600 as estimated between 1980 and 1982, the annual sustainable yield is therefore less than 30-44 whales (7.4% of 400-600). Other published NARRs for odontocetes range between 1.7% and 3.2% (Perrin and Reilly 1984). If Cumberland Sound white whales have a NARR within that range, the annual sustainable yield would be between 7-19 whales (1.7% of 400 and 3.2% of 600).

LOSSES AND WOUNDING DUE TO HARVESTING

The rate at which animals are killed but lost during the Clearwater Fiord hunts could not be determined, except for one case in 1984 when it was at least 8%. Published information on loss rates in open water white whale hunts in other areas suggest that they can be as high as 33% (Fraker 1980), but Orr and Richard (1985) observed that all the whales killed and retrieved were buoyant, therefore losses by sinking might not be important in Clearwater Fiord. As described earlier, many whales are wounded during these hunts. This wounding can be superficial and heal, or it can cause infections and possibly even internal damage leading to reduced fertility or latent mortality. Wounding could therefore contribute substantially to reducing the rate of increase of the population and must be taken into account.

Open water hunts outside Clearwater Fiord occur in several camps spread over a wide area and could not be monitored. Orr and Richard (1985) report comments from some hunters that more whales are wounded during those hunts than in Clearwater Fiord because more open area and floating ice pans allow whales to elude hunters more effectively. On one occasion at Drum Islands, two whales were killed and lost before a third one was landed by two hunting boats (R. Stewart, DFO, Western Region, 501 University Crescent, Winnipeg, Manitoba, personal communication). That is probably an extreme example, but it indicates that high losses do take place on occasion. Some hunting also takes place at the floe edge in May and June but few white whales are successfully taken during those hunts. The hunting methods described by Orr and Richard (1985) suggests that wounding and loss rates at the floe edge could be higher than during open water hunts.

SELECTIVE HARVESTING

Animals taken in Clearwater Fiord are adult-sized and, in a large proportion, males. Although past catch composition data are unavailable, Brodie (1970) observed in 1966-1967 that "among the hunted animals, there would tend to be a bias toward younger animals or females accompanying calves since most of the Eskimo hunters were after the edible skin or muktuk, considered superior in younger animals which are also easier to hunt".

This selective harvesting of adults is probably a result of the restriction on hunting females and calves. The change is a result of many HTA and public meetings in Pangnirtung from 1977-1984 when the hunting of calves and females with calves was discouraged. A restriction against catching white whale "females accompanied by calves" was also enacted in the Beluga Protection Regulations (1980). Hunters select large animals unaccompanied by calves and end up mainly with adult males but also with some adult females without calves. The effect of selective harvesting of adults is unclear. It could have a detrimental effect by removing mature females which contribute to the growth of the population. On the other hand, old reproductively senescent females could be selected more often while few or none of the maturing females are taken at all. Reproductive senescence has been demonstrated in females older than 22 taken in northwest Alaska (Burns and Seaman 1985).

Reduction of the proportion of males in a mammal population usually has little effect on the fecundity of females in polygynous or promiscuous species. Most populations contain more males than is needed to fertilize all the females capable of reproduction (Caughley 1977). Mammals have a tendency towards polygyny, particularly those species which show pronounced sexual dimorphism (Eisenberg 1981). White whale males are larger than females (Sergeant and Brodie 1967) and the species presumably has a social system similar to other odontocetes such as sperm whales (Physeter catodon) or bottlenose dolphins (Tursiops truncatus) in which dominant males apparently have greater access to reproductive females (Norris and Dohl 1980; Shane et al. 1986).

Another consequence of selective harvesting of adults is that SY must be calculated from an estimate of the number of recruits which reach adult age because we must consider the

NARR of the harvestable population, not the NARR of the entire population. Again, this suggests a lower SY for the Cumberland Sound population and again we have no estimate of juvenile mortality to calculate this adult NARR.

MANAGEMENT OPTIONS

In the preceeding discussion we showed that hunters from Frobisher Bay and Lake Harbour might also be taking white whales from the Cumberland Sound population, that the size of the population is about 400-600 and that the sustainable yield must be less than 7.4% and could be less than 5%, or within the range of NARR estimates for other odontocetes (1.7-3.2%). SY must also be a function of the harvestable population's NARR, the adult NARR.

Management options are: maintain the status quo, allocate the entire yield to hunters, or allocate part or none of the yield to allow the population to increase. The above discussion suggests that the status quo, a quota of 40 in Pangnirtung with no control on hunting in Frobisher Bay and Lake Harbour, will lead to a continued decline of the Cumberland Sound population.

Allowing the entire yield to be harvested means that the yield will have to be allocated proportionally between Pangnirtung, Frobisher Bay, and Lake Harbour and that provisions for loss and wounding rates will have to be made. A major difficulty to this option is the lack of data on the proportion of the catch in Frobisher Bay and Lake Harbour which is composed of Cumberland Sound whales. The absence of a precise estimate of yield warrants the use of a very conservative estimate considering the depleted level of the population. A rule of thumb used in the United States is to allow a catch of 2% when yield estimates are lacking for a marine mammal population (W. Perrin, NOAA, National Marine Fisheries Service, La Jolla, California, personal communication).

A consequence of continued harvest is that the population thus harvested might not be allowed to increase to its pre-exploitation level or even to maximum sustainable yield level (MSYL). Perrin (1982) suggested that MSYL in odontocetes is likely to be significantly higher than 50% of initial population size. The Cumberland Sound population was estimated to have exceeded 5 000 before the peak commercial harvest period starting in 1923. This estimate was obtained by back-calculation using known commercial and subsistence catches, an assumed rate of increase of 8% and no loss rate. If the rate of increase was smaller, possibly by more than one half as suggested earlier, the initial population could have been substantially larger than 5 000. Assuming that MSYL occurred at 75% of an initial population of 7 500, then MSYL was about 5 600, the present estimated level would be 9-11% of that MSYL and 7-8% of that initial population size.

Another approach to managing the resource is to calculate an optimal sustainable (OSY) level or the level that the population should reach to satisfy the domestic needs of Southeast Baffin hunters while maintaining its growth rate at a small safety margin above zero thus satisfying conservation requirements. Prior to the quota restriction in 1980, the average mean domestic landed catch in Pangnirtung was estimated at 60 beluga per year (Brodie et al. 1981), and the present Frobisher Bay and Lake Harbour mean annual catch are respectively 18 and 22. To obtain a yield of 100, if NARR is 3%, the population must be allowed to increase to 3333 or 6-8 times its present estimated size. At that rate, and with a zero quota, it would take approximately 65 years to reach that level. An advantage to the zero quota is that the population's intrinsic rate of increase could be estimated directly from estimates of its size made at regular intervals during the period of recovery.

CONCLUSIONS AND RECOMMENDATIONS

Considering the depleted state and low yield of the Cumberland Sound population, reduction in the harvest is necessary. Ideally, the simplest and most prudent approach is to set a zero quota in all three communities of Pangnirtung, Frobisher Bay, and Lake Harbour and monitor the population at regular intervals in the following years until OSY or MSY levels are reached.

The second option is to sub-allocate a conservative yield (e.g. 2-4%) to all three communities according to assumptions on the proportion of their catch composed of Cumberland Sound whales and also continue to monitor the population. This second option is not without risk, but it is probably more feasible in view of the cultural significance of white whale hunting to native people of southeast Baffin Island.

In view of the above, we recommend that the following research be undertaken:

1. To estimate more precisely the number of summering white whale in the southeast Baffin, conduct simultaneous August census surveys in Frobisher Bay, Cumberland Sound and surrounding areas, sampling both the offshore and onshore areas with increased coverage.

2. To estimate gross annual reproductive and survival rates, conduct low altitude photographic surveys designed to allow the photogrammetric estimation of size-frequency distribution in concentrations of white whales.

3. To delineate stocks in the southeast Baffin, begin by:

   a) a geographically extensive mark-recapture project with beluga marked in the southeast Baffin as well as in other areas of the eastern Arctic, northern Quebec coast and Hudson Bay,

   b) morphometric and genetic studies of all animals caught, assuming that hunting continues in all three communities,

c) archival research on past white whale harvesting, abundance and distribution in Frobisher Bay and Lake Harbour,

d) and for the same purpose, interviews of hunters from all three communities, under the auspices of their local HTAs.

4. To study the hunting methods and loss rates of different hunts and to obtain accurate statistics of the number of whales landed (assuming that hunting continues in all areas), monitoring of the floe edge and open water hunts in Frobisher Bay and Cumberland Sound.

Finally, local representatives in Pangnirtung, Frobisher Bay and Lake Harbour should be made fully aware of the results and model discussed in this report. Community-wide information sessions should be held with their collaboration and it should be made clear that a voluntary reduction or moratorium on the catch in all communities might prevent the possibility of any further decline in the population, possibly allowing recovery of the "stock". Methods of reducing hunting losses and wounding should also be emphasized through public education.

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Table 1. Cliff counts and surveys, 1979-1984.

Year	Area Covered	Method	Dates	Refer to Figure	Local Participants
1979	Clearwater Fiord Kangilo Fiord Shark Fiord	Cliff counts Boat reconnaissance Boat reconnaissance	Aug. 2-5, 11-12 Aug. 7, 10 Aug. 10	3	Levi Evic, Davidee Evic
1980	Clearwater and Kangilo Fiord	Aerial visual and photographic survey	Aug. 4-6	4a-c	Two hunters(?)
1981	Clearwater, Kangilo fiords and west coast of sound to Brevoort Island	Aerial visual survey	Aug. 4-5	5a-b	Jamisie Mike Sakiasie Sowdluapik, Seemee Angmarik
1982	Clearwater Fiord Clearwater, Kangerk Kangilo, Nettilling fiords and west coast of sound to Blacklead Island	Cliff counts Aerial visual and photographic survey	July 21-27 Aug. 21-22	7 6a-b	Jamisie Mike, Michael Kisaw
1983	Clearwater Fiord	Cliff counts	July 25-Aug. 24	7	Michael Kisaw
1984	Clearwater Fiord	Cliff counts	Aug. 11-Sept. 5	7	Michael Kisaw

Table 2. Survey methods.

Year	Platform	Survey Methods
1979	Freighter canoe	Reconnaissance survey. Two DFO observers and two hunters recorded all whales in sight along boat path (Fig. 3).
1980	Aircraft Twin Beechcraft	Aerial visual and photographic survey. One observer on each side of aircraft recording all whales in sight along flight path (Fig. 4a-c). Altitude 150-305 m (500-1 000 ft) depending on cloud ceiling for visual counts. When large groups encountered, altitude raised between 610-915 m (2 000-5 000 ft) to get maximum photo coverage. Camera Hasselblad 70 mm oriented vertically down. Lens f = 80 mm. Scale range = 1/7 692-1/19 231. Film Kodak Ektachrome 64 Professional Daylight.
1981	Aircraft De Havilland Twin Otter	Aerial visual survey. One observer on each side of aircraft recording all whales in sight along flight path (Fig. 5a-b). Altitude 305 m (1 000 ft).
1982	Aircraft De Havilland Twin Otter	Aerial visual and photographic survey. One observer on each side of aircraft recording all whales in sight along flight path (Fig. 7a-b). Altitude 305 m (1 000 ft) for visual counts and 1 066 m (3 500 ft) for photography except one series at 610 m (2 000 ft). Systematic photographic survey of Clearwater Fiord. Transects spaced latitudinally from south shore of fiord every 0.5 minute of latitude (0.5 naut. mile or 0.7 km). Frame width 0.69 km (0.49 naut. mile). Frame spacing approx. 10% overlap. Camera Linhof Aeroteknica oriented vertically down through rear camera port. Lens f=150 mm. Scale = 1/7 179. Film Kodak Ektachrome 200 Professional Daylight.

Table 3. Cliff observation methods, 1983-1984.

Year	Dates	Methods
1983	25 July-24 August	Every daylight hour (0:00-23:00 at beginning, 4:00-22:00 at end of study period) count made from observation site (Fig. 7) by scanning fiord in single direction. Visual aids = binocular and/or spotting scope. Scanning increments = field of view of visual aid. Scanning time/increment = 30 sec-2 min.; allowing time for individuals in a group to surface 2+ times for complete count; scan time high when group large. Animals classed as white or non-white.
1984	11-22 August	Incidental counts made irregularly. Same method as above.
	23 August-9 September	Hourly daylight counts. Same method as above.

Table 4. Estimates of Cumberland Sound population.

Date	Area: Upper Clearwater Fiord silted water	Area: Upper Clearwater Fiord unsilted water	Other Areas	Total All Areas
4 August 1980	35(58)	-	24	82
5 August 1980	25(41)	-	500+	541+
6 August 1980	50-60(83-99)		218-228	302-327
4 August 1981	80-144(132-238)	-	9	141-247
5 August 1981	126-268(208-443)		30	238-473
21 August 1982	198(327)	83	1	411
22 August 1982	-	270	138	408

( ) = Counts x 1.4 for submerged whales in silted water.
x 1.18 for neonate-yearlings in silted water (Brodie 1971).

Table 5. Sex and size of sampled white whales taken in Clearwater Fiord, 1982-1984.

Animal Year	Sex	Number	%	Total Length (cm) Mean	(n)	Std. Dev.
1982	male	9	90	374.5	(7)	101.1
	female	1	10	n/a	-	-
1983	male	4	44	429.0	(4)	12.0
	female	5	56	353.0	(5)	35.3
1984	male	7	64	418.1	(7)	39.1
	female	4	36	381.3	(4)	15.6
All Years	male	20	66.7	403.6	(18)	69.0
	female	10	33.3	365.6	(9)	30.6

Table 6. Pangnirtung, Frobisher Bay, and Lake Harbour white whale hunt statistics, 1973-1985.

Year	Pangnirtung	Frobisher Bay	Lake Harbour
1973	43	--	--
1974	44	--	75
1975	50	10	20
1976	120	10	41
1977	178	--	26
1978	82	5	3
1979	70	2	35
1980	43†	18	12
1981	45	63	21
1982	47	39*	4
1983	42	8	8
1984	40	10	9
1985	44	19	9
Average	44¶ (n=6)	18 (n=10)	22 (n=12)

*Includes 10 whales taken in outpost camps. Other years minimum estimates because no outpost camp observations.

†Quota of 40 introduced.

¶Average over quota years: 1980-1985

Source: Catches compiled by Field Services, Department of Fisheries and Oceans, Western Region.

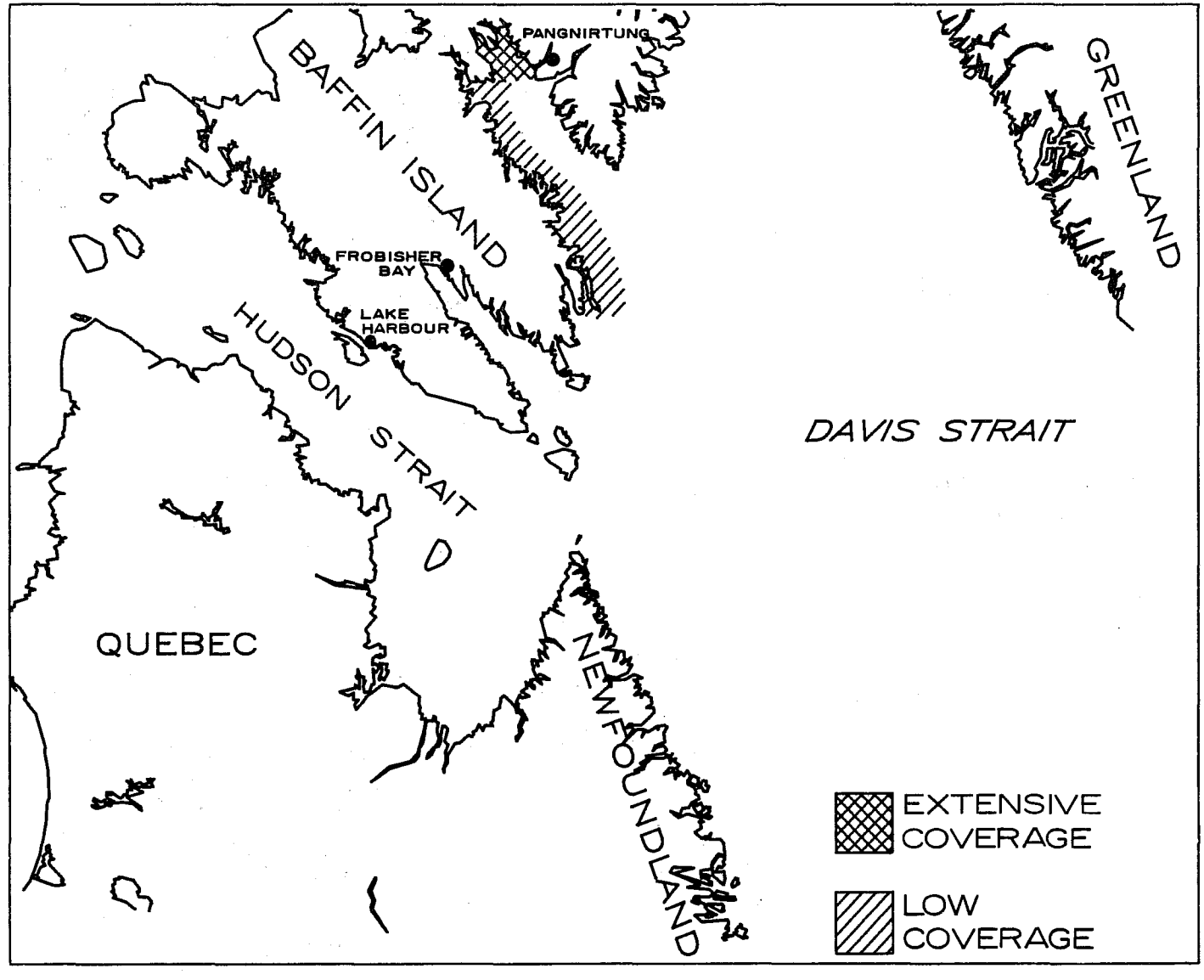

Fig. 1. Location of study area and survey coverage.

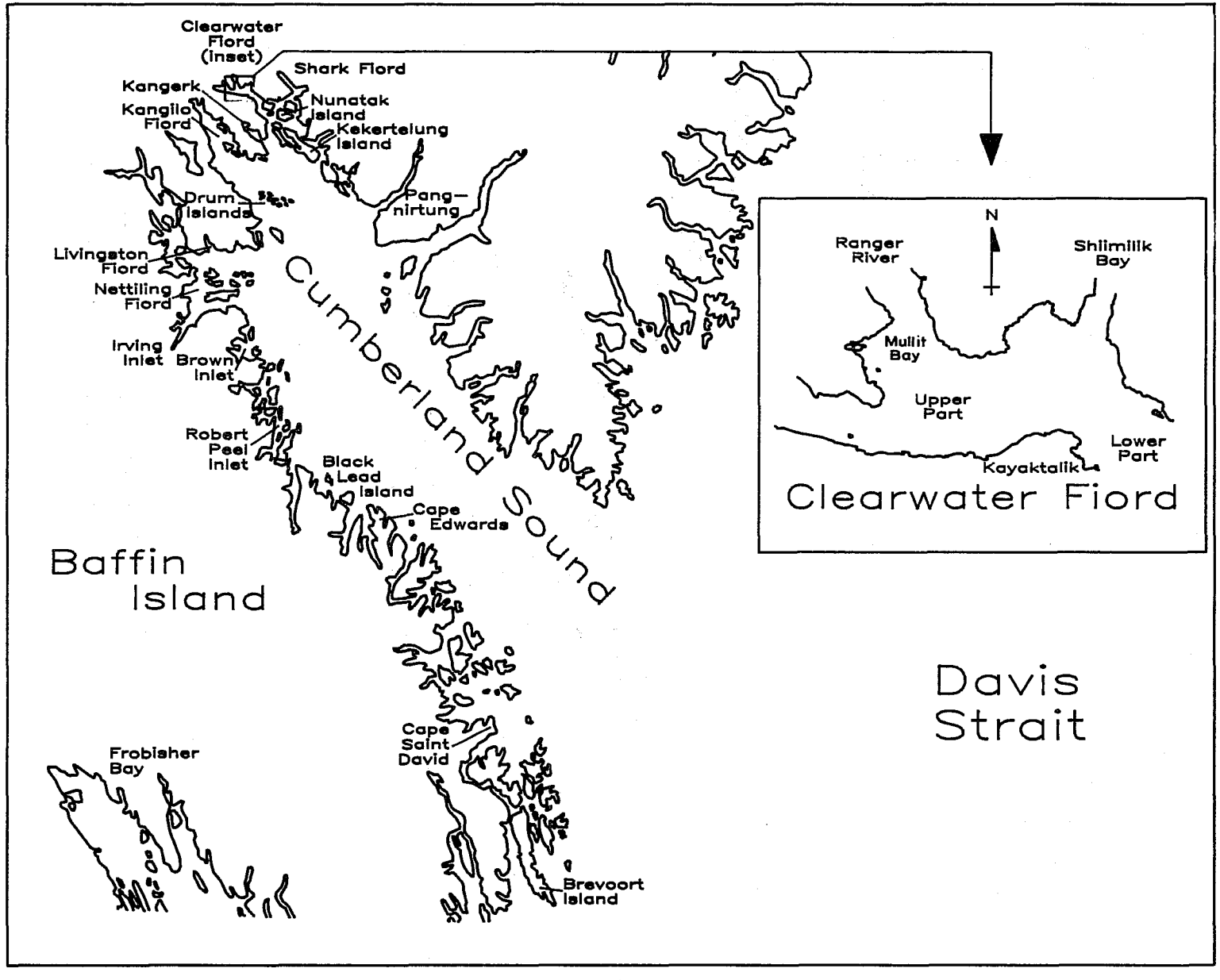

Fig. 2. Study area place names.

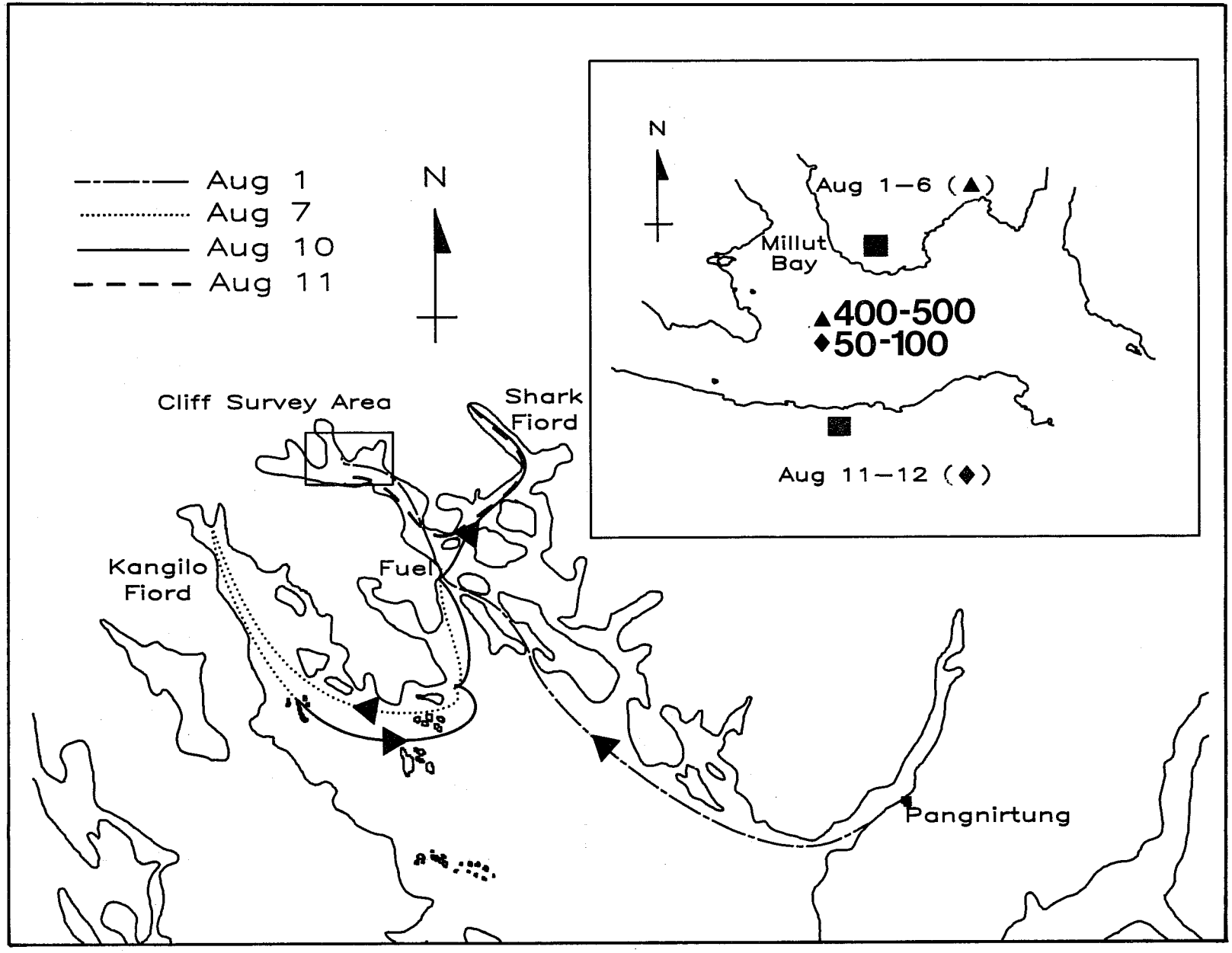

Fig. 3. 1979 boat and cliff survey of Cumberland Sound, August 1-13.

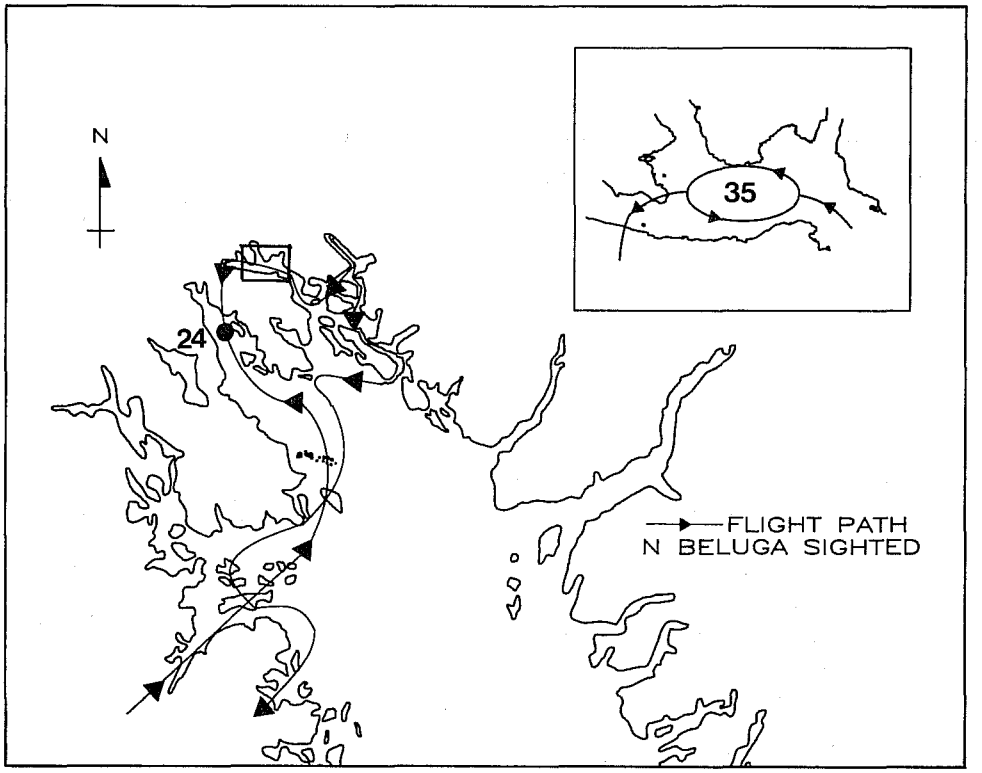

Fig. 4a. 1980 aerial survey of Cumberland Sound, day 1 (August 4).

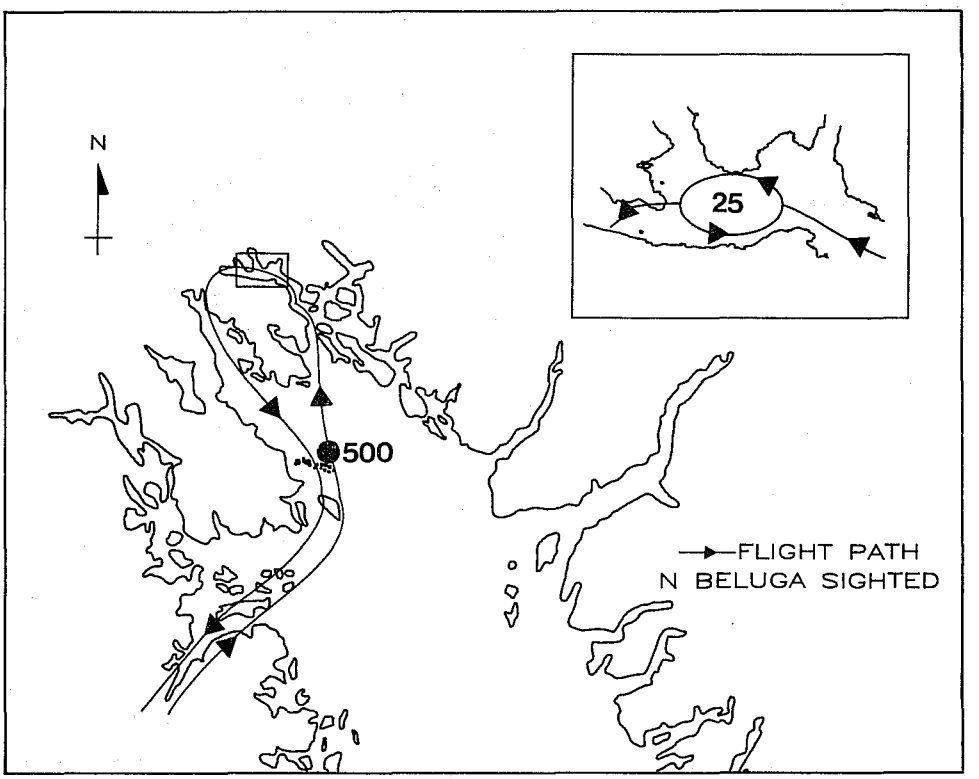

Fig. 4b. 1980 aerial survey of Cumberland Sound, day 2 (August 5).

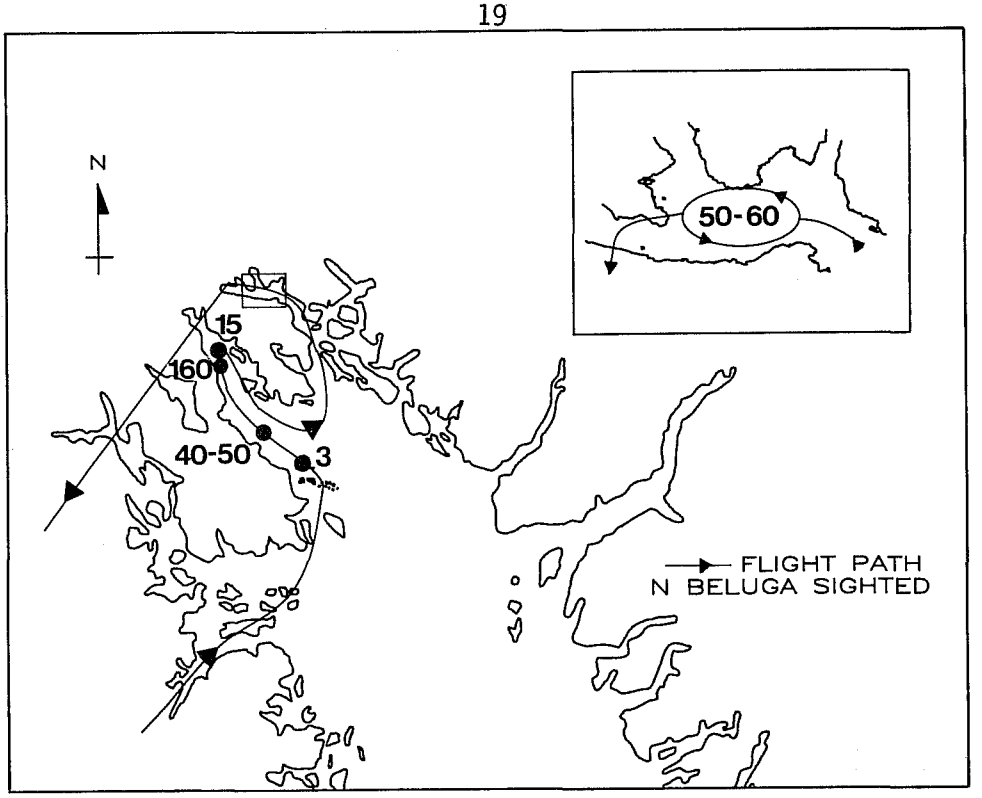

Fig. 4c. 1980 aerial survey of Cumberland Sound, day 3 (August 6).

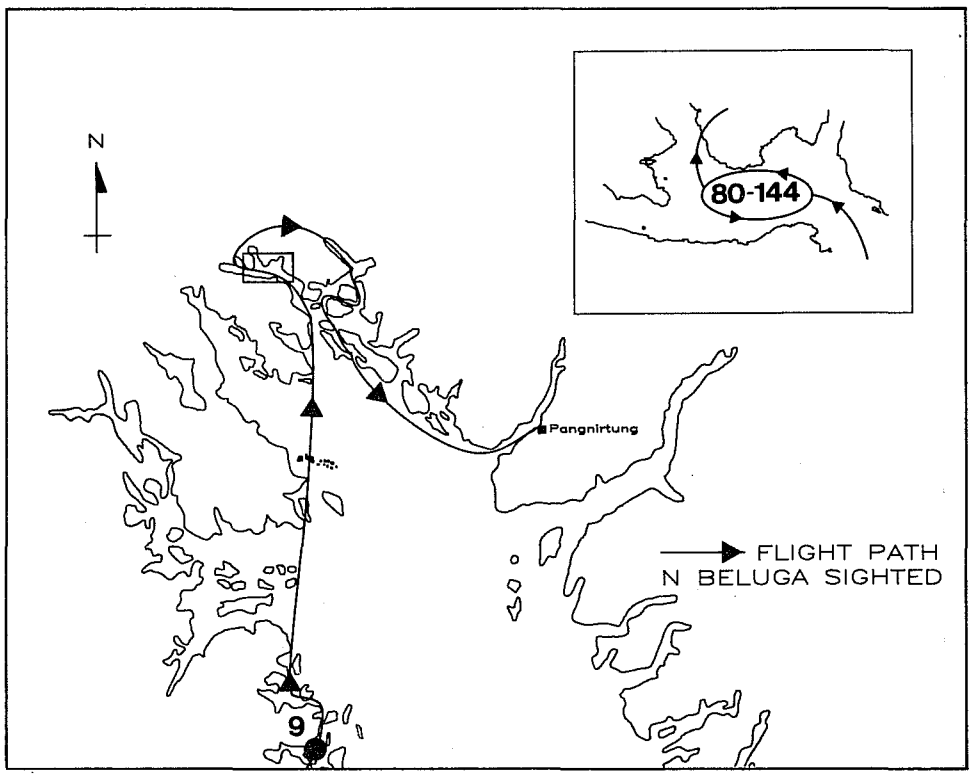

Fig. 5a. 1981 aerial survey of Cumberland Sound, day 1 (August 4).

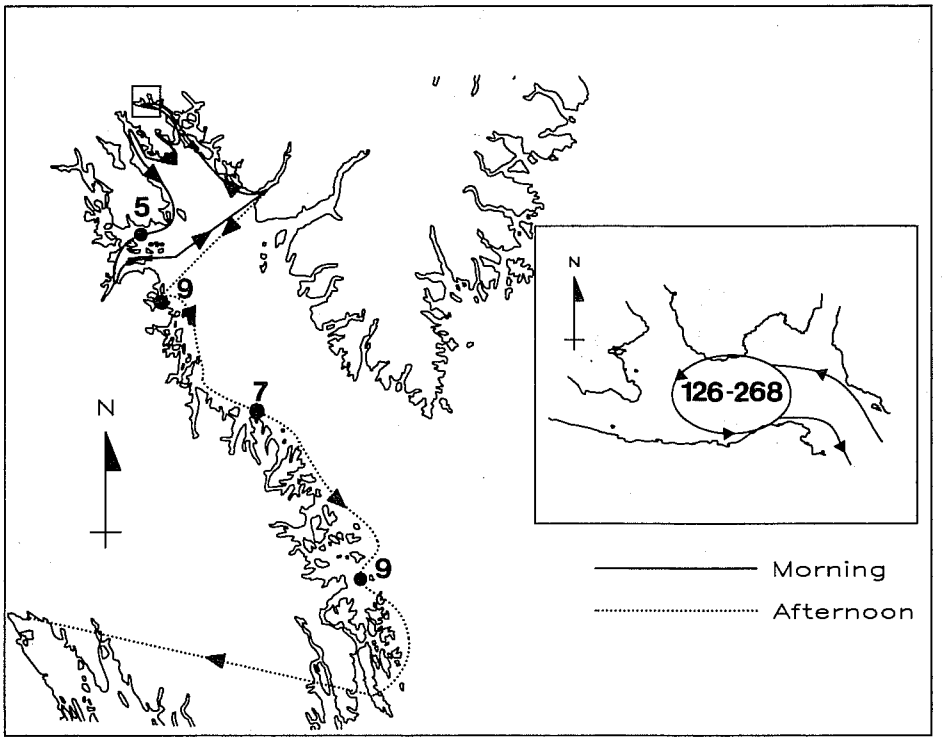

Fig. 5b. 1981 aerial survey of Cumberland Sound, day 2 (August 5).

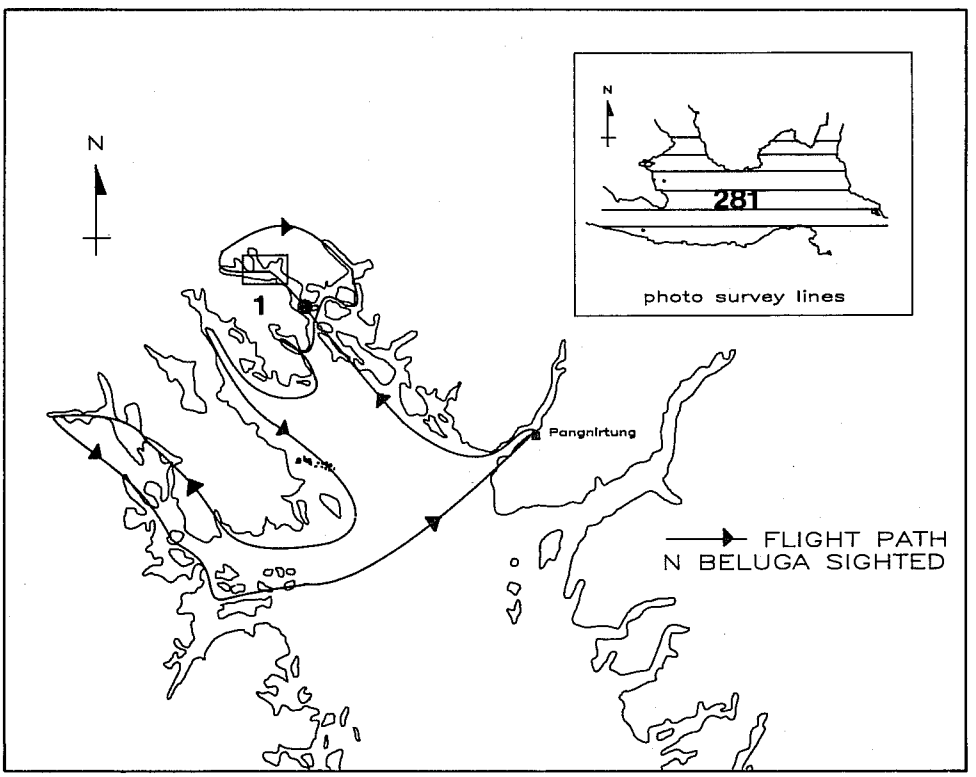

Fig. 6a. 1982 aerial survey of Cumberland Sound, day 1 (August 21).

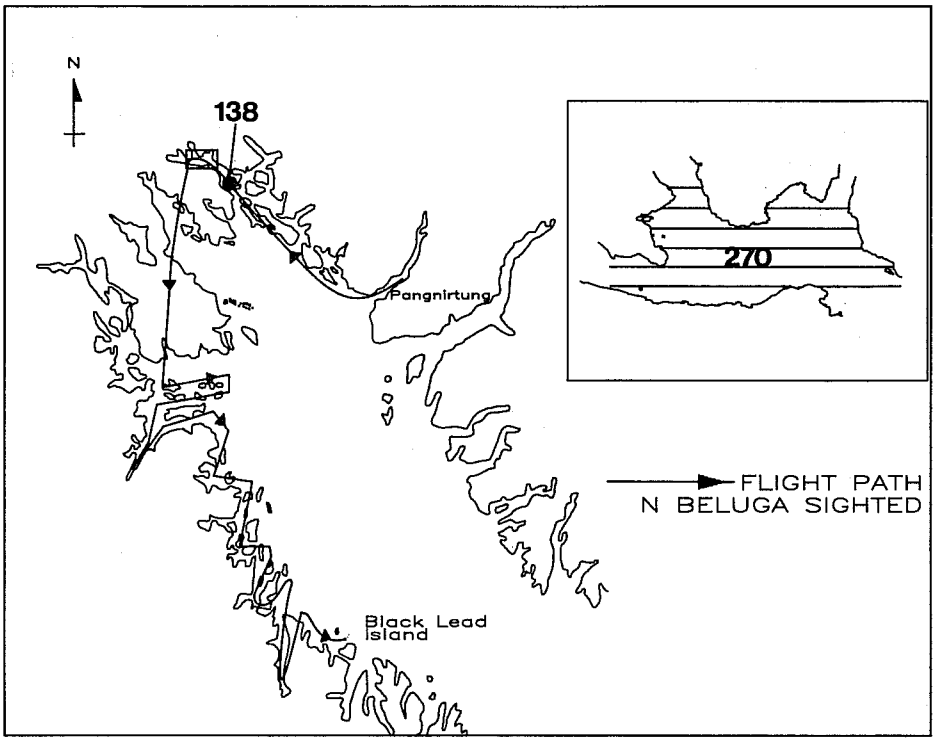

Fig. 6b. 1982 aerial survey of Cumberland Sound, day 2 (August 22).

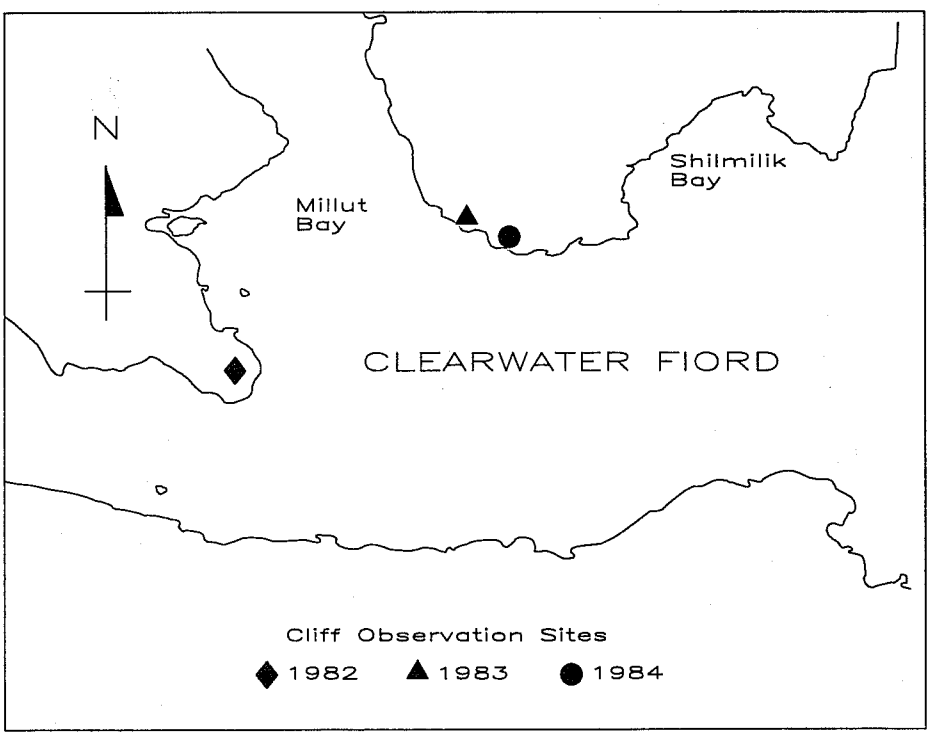

Fig. 7. Cliff observation sites in Clearwater Fiord, 1982-1984.

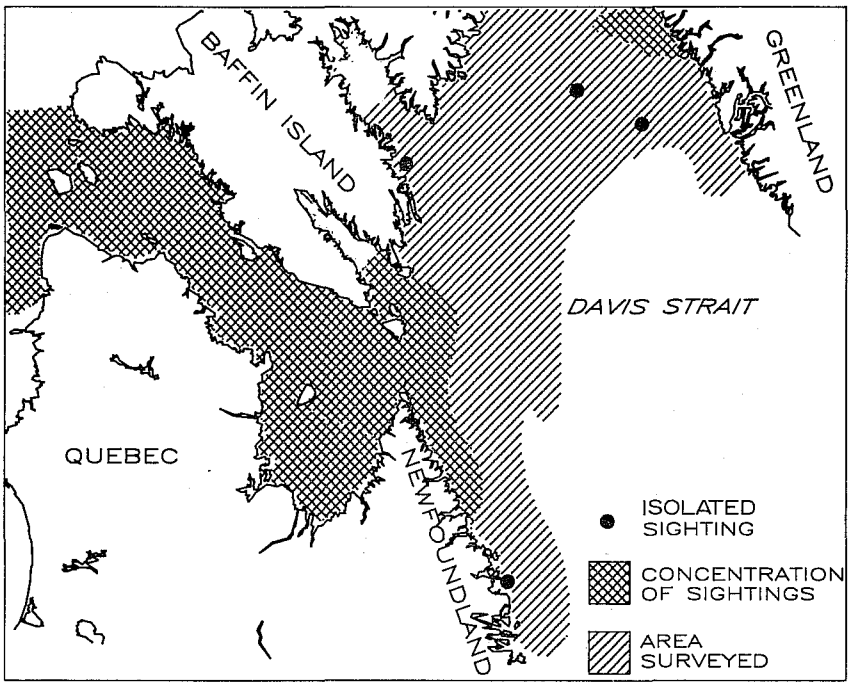

Fig. 8a. March and April sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

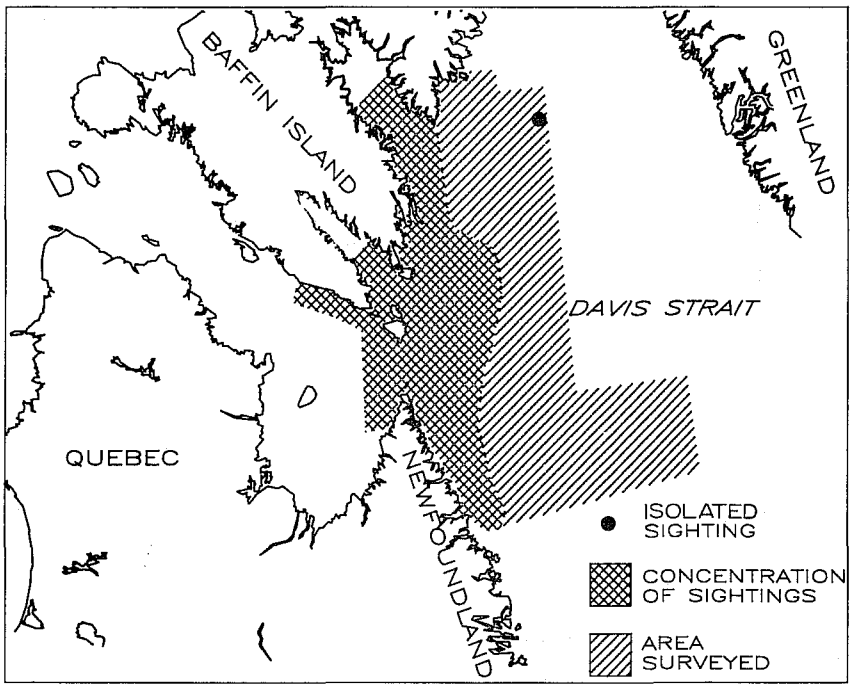

Fig. 8b. May sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

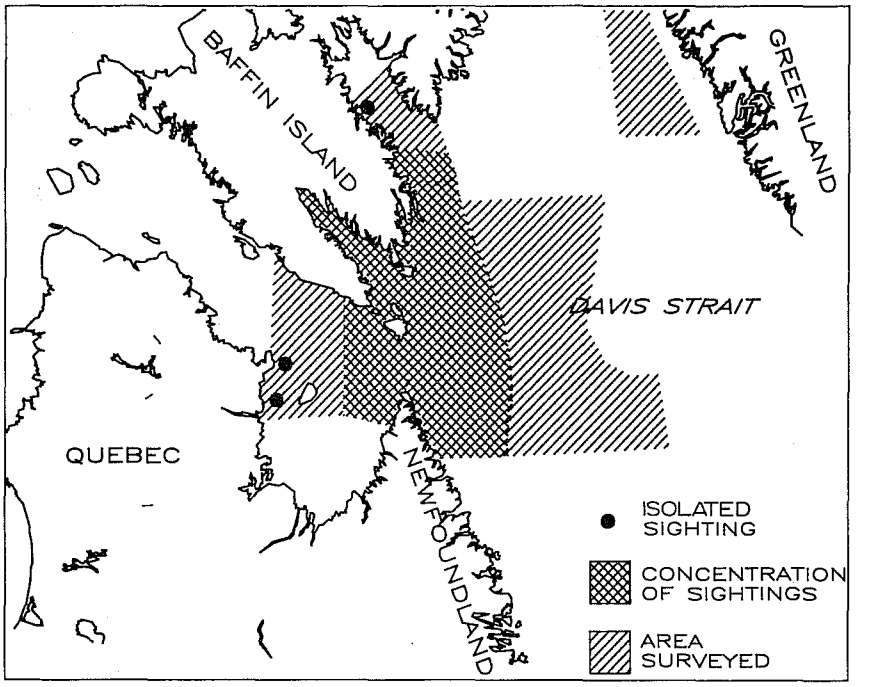

Fig. 8c. June sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

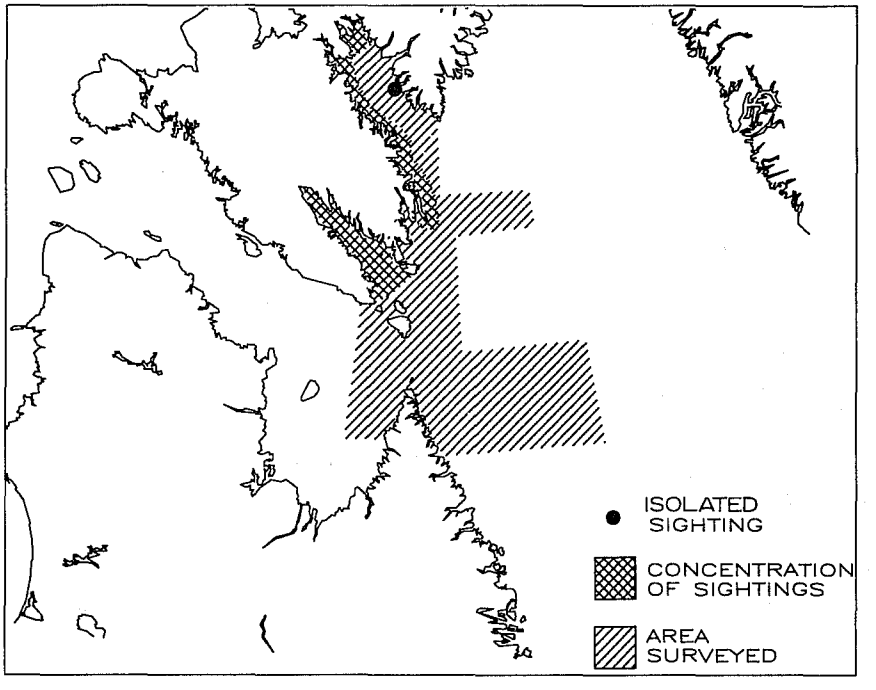

Fig. 8d. August sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

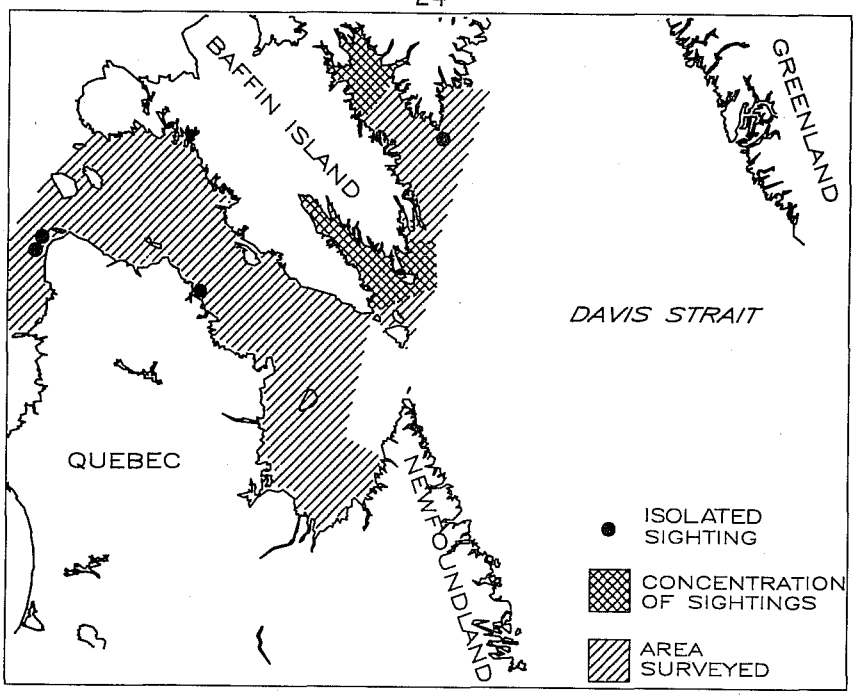

Fig. 8e. September sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

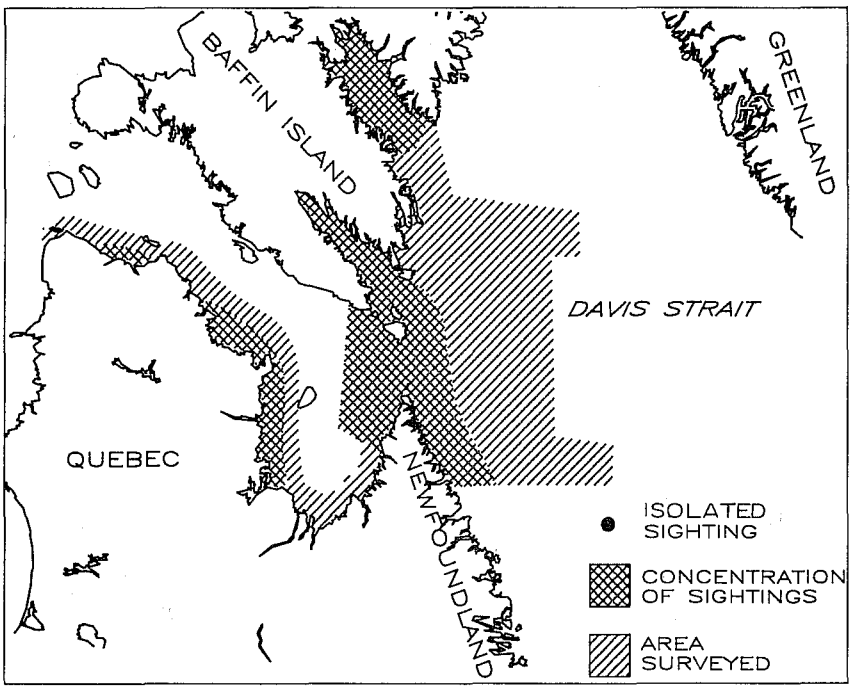

Fig. 8f. October, November and early December sightings of white whales in southeast Baffin waters. (modified from MacLaren-Atlantic Ltd. 1978; MacLaren-Marex Inc. 1979, 1980; McLaren and Davis 1982; and Smith et al. 1979).

APPENDIX 1

OBSERVATIONS OF OTHER CETACEAN SPECIES

NARWHAL

In 1979, the survey party saw narwhals entering Millut Bay, in Clearwater Fiord on 5 August. There were an estimated 15-20 narwhals, including some visibly tusked animals. A female and a juvenile were caught by the hunters present in the fiord.

In Shark Fiord, on August 11, the party encountered an estimated 60 - 70 narwhals, including large tusked animals. Hunters were unsuccessful in capturing any. Five narwhals were reportedly taken in Pangnirtung and one in Kangilo Fiord two weeks earlier.

During May, 1983, while monitoring the floe edge hunt in Cumberland Sound, a group of 60 narwhals was seen at the floe edge on 8 May. Hunters tried to shoot at a group but were unsuccessful in capturing any whales.

BOWHEAD WHALES

Single bowhead whales were twice spotted in Millut Bay by aerial survey observers, first on 5 August, 1981 and again, the following year, on 21 August 1982. The field party members which were in Clearwater Fiord earlier in the month were told that hunters saw a single bowhead in Millut Bay on 22 July 1982. They themselves observed one animal in Millut Bay on 26 July and what they presumed to be the same animal again the next day.

In 1983, an adult bowhead and a calf were seen by field observers on 27 July while a single adult was seen later on 20 August. A third sighting of a single adult bowhead was made on 21 August in Millut Bay. This last animal was described as having a long white scar-like mark on the left side, a mark which was also visible on photographs of the August, 1982, animal.