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POPULATION ASSESSMENT OF ATLANTIC WALRUS

NORSK POLARINSTITUTT

MEDDELELSER NR. 138
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(*ODOBENUS ROSMARUS ROSMARUS* L.)

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PREFACE

The exploitation and conservation status of Atlantic walruses (*Odobenus rosmarus rosmarus* L.) has never become an issue of widespread public controversy, as it has for whales, and some seals. However, a coordinated approach to walrus conservation was given some impetus in 1987 when the government of the Netherlands proposed that the walrus be listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Although this proposal was withdrawn before being put to a vote at the 6th Conference of the Parties to CITES, an agreement was reached among the walrus range states to exchange scientific information on a regular basis (Stewart *et al.*1993:56). An International Workshop on Population Ecology and Management of Walruses, held in Seattle, Washington, USA, in March 1990 (Fay *et al.*1990), constituted the first meeting of the Walrus International Technical and Scientific Committee, which includes representatives from Norway, Greenland/Denmark, the USA, Canada, Russia and the Netherlands. This workshop, which was followed by a second in January 1993 in Winnipeg, Manitoba, Canada (Stewart *et al.*1993), was the first attempt to address concerns about walrus conservation on an international, range-wide basis.

No formal bilateral, multilateral or international body had been assigned, or had assumed, the responsibility for assessing and conserving the stocks of Atlantic walruses until the North Atlantic Marine Mammal Commission (NAMMCO) included Atlantic walruses on its list of priority species (Anon. 1993a). In 1994 the Council of NAMMCO requested advice from its Scientific Committee on matters relating explicitly to the Atlantic walrus. Specifically, the Commission asked for: 1) advice on stock identity for management purposes, 2) an assessment of abundance in each stock area, 3) an assessment of the long-term effects on stocks caused by present removals in each stock area and 4) an assessment of the effects of recent environmental changes (*e.g.* disturbance, pollution) and changes in the walrus's food supply.

The present report, which was prepared in response to a request from the Scientific Committee, was intended to provide the background of available information needed to evaluate the present status of the Atlantic walrus at the meeting of the NAMMCO Scientific Committee in Copenhagen, 31 January – 2 February 1995. The report covers the entire range of *Odobenus rosmarus rosmarus*.

ABSTRACT

This report summarizes available information on distribution, numbers and exploitation of Atlantic walruses (*Odobenus rosmarus rosmarus* L.) for an assessment of their present status. The effects on walruses of various human activities other than hunting (*e.g.* disturbance, pollution, fishery interactions) are also evaluated. Although few studies have been done to explicitly address questions of the genetic relatedness of different groups of Atlantic walruses, eight putative stocks have been proposed on the basis of distribution, history of exploitation, and the existence of independent management regimes. These stocks are: 1) Foxe Basin, 2) Southern and Eastern Hudson Bay, 3) Northern Hudson Bay – Hudson Strait – Southeastern Baffin Island – Northern Labrador, 4) Western Greenland, 5) North Water (Baffin Bay – Eastern Canadian Arctic), 6) Eastern Greenland, 7) Svalbard – Franz Joseph Land, and 8) Kara Sea – Southern Barents Sea – Novaya Zemlya. Several of these stocks are shared by different countries (*i.e.* Canada, Greenland, Norway and Russia).

Throughout their range Atlantic walruses were heavily exploited, primarily by European whalers and sealers, causing reductions in their range and numbers. Atlantic walruses are still hunted by residents of Canada and Greenland. In nearly all areas Atlantic walruses apparently remain well below historical levels of abundance. An evaluation based on estimates of current population size, landed catch and loss, and an annual net recruitment rate of 2-5% indicates that the Western Greenland (4) and North Water (5) stocks are currently subject to over-exploitation and probably are declining. The Foxe Basin (1) stock appears to be stable, whereas the status of other Canadian stocks (2, 3) is unknown. There are recent signs that the eastern Atlantic stocks of walruses (6, 7, 8) are either stable or increasing. Although walruses can be negatively affected by various human activities apart from hunting, quantification of the long-term effects of these activities cannot be achieved with the data presently available. This report emphasizes that serious gaps exist in the information necessary for assessing the current status of Atlantic walruses. More and better data are needed in relation to population delineation and size, landed catch, unreported kill and losses, reproduction rates, natural mortality and population responses to human activities other than hunting.

INTRODUCTION

The walrus, *Odobenus rosmarus*, has a disjunct circumpolar distribution. Two subspecies – the Atlantic walrus, *O. r. rosmarus*, and the Pacific walrus, *O. r. divergens* – have long been recognized. A third subspecies, *O. r. laptevi*, confined to the Laptev Sea, was suggested by Chapskii (1940). The status of this taxon is, however, questionable (Fay 1982, 1985).

The Atlantic walrus, which is the focus of this report, ranges from the eastern and central Canadian Arctic eastward to the Kara Sea. Several more or less well defined subpopulations or stocks exist within this range (Figs 1 and 3, Reeves 1978).

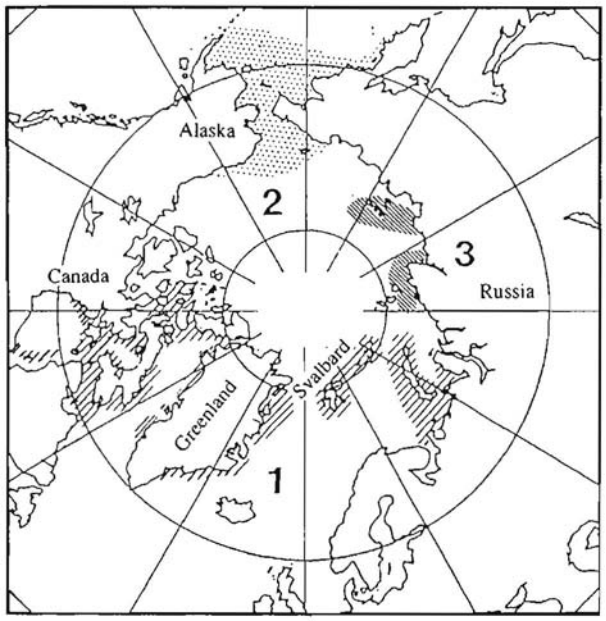

Fig. 1. Approximate normal limit of present distribution of walruses. 1: Atlantic walruses, 2: Pacific walruses, 3: Laptev walruses; taxonomic status uncertain (modified from Fay 1985).

The total population of Atlantic walruses prior to the European discovery of North America (including Greenland), Svalbard, and the islands of far northern Eurasia must have been at least in the hundreds of thousands. This conclusion is inescapable when one considers the observations reported by early explorers, whalers and sealers, as well as the magnitude of the killing. The commercial exploitation of walruses for their oil, tusk ivory and hides proceeded on an enormous scale, with no checks whatsoever to ensure sustainability. As a result, by the mid 20th century the aggregate population of the Atlantic walrus had been reduced in nearly all areas and its range had shrunk substantially. Large herds that once hauled out on island and mainland beaches in cold temperate and subarctic latitudes have been exterminated, and the bulk of the population is now confined to remote parts of the Arctic.

The walrus was always important to Inuit economy; in many areas it was a critical subsistence resource. Walrus meat is excellent food for sled dogs as well as people; the hide is strong and durable; the blubber produces good-quality oil for burning; and the ivory has always been popular for constructing tools and weapons and, more recently, for carving. Availability of walruses, particularly during winter, influenced settlement patterns in the eastern Canadian Arctic and Greenland. The rapid depletion of walrus stocks by foreign commercial hunters severely compromised the resource base of many northern communities. This loss, or at least greatly reduced availability, of a valuable resource has helped limit the options of northern people as they seek to re-establish economic self-sufficiency and political independence.

We stress that certain biological characteristics of walruses make them particularly vulnerable to exploitation and to changes in the environment:

Walruses have a comparatively narrow ecological niche. Their populations probably depend on: 1) the availability of large areas of shallow water (80 m or less) with suitable bottom substrate to support a productive bivalve community, 2) the presence of reliable open water over rich feeding areas, particularly in winter when access to many feeding areas is denied due to ice cover, and 3) the presence of haul-out areas in close proximity to feeding areas. Haul-out platforms are usually ice pans although terrestrial haul-out sites (uglit; ugli in singular – terminology borrowed from Inuktitut) are used in the ice-free summer and autumn period (Davis *et al.* 1980).

Their narrow trophic niche and restricted distribution make walruses vulnerable to environmental changes and also relatively easy to hunt. These animals' gregariousness and dependence on uglit made it possible for European and American whalers and sealers to exploit them very intensively even before the development of mechanized transport and modern weapons. Their tusks make them economically valuable to present-day Inuit hunters. With modern hunting technology involving

Fig. 2. A male walrus hauled out at Andréetangen, Edgeøya, in Svalbard. Male Atlantic walruses may grow as heavy as their Pacific counterparts (Wiig and Gjertz in press). The stout tusks and numerous skin tubercles are characteristic of adult males. Photo: I. Gjertz

long-ranging boats and powerful firearms, hunters now have access to nearly all of the habitat that is still occupied by walruses. Adult females and males, with their comparatively high yields of ivory and meat, are hunted selectively. Furthermore, in all areas where walruses are hunted, losses appear to be high. This harvesting pattern involves a high risk of further depleting the stocks of Atlantic walruses.

Structure of this Report

1. Overview: A brief summary of the status of Atlantic walruses, by region, is presented at the front of the report for readers who wish only to have such an overview. In the main body of the report, following the summary, we present the detailed information on which the summary is based.

When the available information was considered sufficient, we attempted a crude analysis of sustainable yield and compared the result with the estimated removal rate for the stock. Simulation of a hypothetical walrus population indicated that maximum net productivity (MNP) ranges between 2 and 5% of the total population size (DeMaster 1984). For a population at carrying capacity, K, MNP may be lower than 2% (Fay *et al.*1989), whereas under favorable environmental conditions (and low density of walruses in relation to K) MNP may perhaps be as high as 7% per year (Sease and Chapman 1988). In our crude analyses of the effects of removals we assumed that annual sustainable yield – or replacement yield – of Atlantic walruses ranges between 2 and 5% of the stock estimate.

The overview also includes the conclusions of our assessment of the effects on walruses of disturbance, pollution and changes in food availability.

2. Distribution, Catch History and Status, by Region: Separate sections are devoted to geographical regions which may or may not represent "stock" areas in a strict sense (see Report of *ad hoc* Working Group on the Atlantic Walrus; NAMMCO 1995). The partitioning into stocks was made on the basis of our knowledge of major ecological factors that determine distribution of walruses such as ice cover, polynyas, distribution of shallow banks with suitable walrus habitat, migration routes and availability of terrestrial haul-out sites. Within each of the geographically defined sections, we tried to include information on historical and current distribution, seasonal movements, age and sex composition, stock identity, population size (past and present), hunting methods, catch levels and composition of catches and hunting loss (for estimation of total removals).

3. Summary of Regulatory Actions: Regulations applying to walrus stocks in each of the range states are summarized.

4. Assessment of Environmental Problems: Separate summaries are given for the various types of known, suspected or potential threats to Atlantic walrus stocks, other than hunting. These summaries are not subdivided by geographical region.

5. Walrus Life History and Parameters: This brief overview of the biology and ecology of walruses is provided as background only.

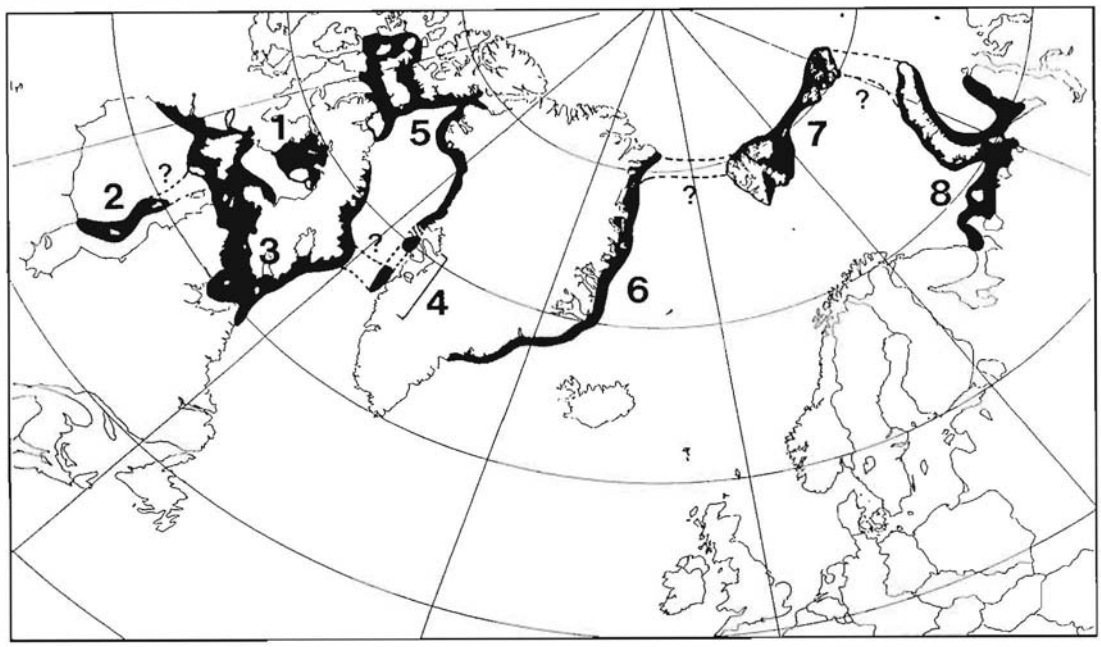

Fig. 3. Delineation of proposed stocks (sub-units) used in this review of the status of the Atlantic walrus.

SUMMARY OF STATUS

The status of eight presumed stocks of walruses (see also Report of *ad hoc* Working Group on the Atlantic Walrus; NAMMCO 1995) is reviewed in this report. These stocks are:

1. Foxe Basin, 2. Southern and Eastern Hudson Bay, 3. Northern Hudson Bay – Hudson Strait – Southeastern Baffin Island – Northern Labrador, 4. Western Greenland, 5. North Water (Baffin Bay – Eastern Canadian Arctic), 6. Eastern Greenland, 7. Svalbard – Franz Joseph Land, and 8. Kara Sea – Southern Barents Sea – Novaya Zemlya (Table 1, Fig. 3).

Stock 1 – Foxe Basin

Walrus distribution, movements and body growth patterns indicate that the group in Foxe Basin is largely isolated from other groups to the north (via Fury and Hecla Strait) and south (western Hudson Strait and Southampton Island area).

Aerial surveys have confirmed that walruses are now distributed mainly on the east side of northern Foxe Basin during the open-water season (Orr *et al.*1986). Although it is generally believed that the distribution of walruses has changed since the 1940s and 1950s so that they are now much less common on the western side of Foxe Basin, the stock is still large relative to those in other parts of the subspecies' range.

Available data are not sufficient for rigorously assessing trends in the population in northern Foxe Basin. Cosens *et al.*(1993:12) indicated that the population numbers about 5500 animals based on incomplete aerial surveys in 1988 and 1989. The estimated current removal rate of about 300 animals per year may exceed sustainable yield (Table 1).

Stock 2 – Southern and Eastern Hudson Bay

The large gap in walrus distribution along the west coast of Hudson Bay (approximately from Dawson Inlet south to Cape Henrietta Maria) provides a basis for considering the walruses in southern and eastern Hudson Bay as separate from those in northwestern Hudson Bay. However on the east side of the bay the distribution of walruses may have been continuous historically from the Belcher Islands northward to the mouth of Hudson Strait. The apparent decline in numbers and reduced range of walruses in eastern Hudson Bay, with no obvious corresponding changes in northern Hudson Bay and western Hudson Strait, can be interpreted as suggesting that there is limited exchange between eastern Hudson Bay and these areas.

We have no recent information on the status of the groups of walruses that hauled out, at least until the 1970s, on the Belcher, King George, Sleeper, and Ottawa islands. They are undoubtedly fewer in number and less widely distributed than earlier this century, but it is possible that hunting pressure is now less severe than it was during the days when sled dogs were the primary means of winter transportation.

The walruses in southern Hudson Bay are not hunted off the Ontario coast, when they haul out in

Table 1. Assessment of Atlantic walrus by stock area. The current status (D) of different stocks of Atlantic walruses is evaluated based on estimates of stock size (A) and total annual removal (landed catch plus losses, B and C.) Qualifiers are added to indicate quality of underlying data.

STOCK AND AREA	Stock size (A)	Quality of (A)*	Landed catch (B)	Quality of (B)*	Loss# % (C)	Total removal (B and C)	Females % of (B)	SY	Stock status (D)	Assess-ment quality*
1 Foxe Basin	5500	P	200	F	32	300	33	110-275	Stable?	F
2 S and E Hudson Bay	(500)?	P	35+	P	30##	50	?	10-25	Unknown	P
3 N Hudson Bay - Hudson Strait- SE Baffin Isl. - N Labrador	6000	P	230	P	30##	330	?	120-300	Unknown	P
4 Western Greenland	500	F	46	P	30##	65	58	10-25	Declining	F
5 North Water (Baffin Bay - E Canadian Arctic)	3000	P	280	P	25	375	40	60-150	Declining?	P
6 Eastern Greenland	500-1000	P	20	P	23	25	5	10-50	Stable/incr.?	F
7 Svalbard - Franz Joseph Land	<2000	F	0**	F	0	0	0	-	Increasing	F
8 Kara Sea - Barents Sea - Novaya Zemlya	<500	P	?**	P	?	?	?	-	Increasing?	P

*: G = Good (minimal bias, acceptable precision)
F = Fair (problems with quality of data, precision uncertain)
P = Poor (considerable uncertainty, bias or few data)
**: These stocks have been protected since the 1950s, there are indications of some catch (see text).
#: Percentage lost of all struck
##: Where no stock-specific data were available, 30% was used (similarity with Foxe Basin in hunting methods).
SY: Sustainable yield is based on the stock size estimate (A), times the maximum net productivity of the population (2% to 5% of the stock).

summer and autumn in the vicinity of Cape Henrietta Maria. The reference to about 1000 walruses at Cape Henrietta Maria in 1955 (Loughrey 1959) is not particularly reliable, so no decline should be inferred from the maximal recent direct count of 310.

Available information suggests that the number of walruses in southern and eastern Hudson Bay is in the hundreds (perhaps about 500). The current removal of about 50 animals likely exceeds the sustainable yield (Table 1). Data for this region are, however, very limited.

Stock 3 – Northern Hudson Bay – Hudson Strait – Southeastern Baffin Island – Northern Labrador

In the absence of any direct evidence for stock identification (*e.g.* genetic analyses, tagging, morphometry), it may be inferred from the evidence on distribution and movements that the walruses in northern Hudson Bay, Hudson Strait and southeastern Baffin Island and off northern Labrador comprise a common stock. This stock may have some connection with southern and eastern Hudson Bay and with Central West Greenland. It cannot be ruled out that sub-units exist within the range of Stock 3.

Available information is insufficient for assessing the status of walruses along the Keewatin coast of western Hudson Bay, but all evidence indicates that they are now much less common there than they were earlier in the present century.

Crude comparisons of counts in 1954 (Loughrey 1959), 1961, and 1976-77 in areas around Southampton and Coats islands (Mansfield and St. Aubin 1991) could be interpreted as suggesting a decline, but the basis for comparing these counts and estimates is very weak.

Walruses are apparently much less abundant along both the Baffin Island and northern Québec coasts of Hudson Strait today than they were 50-100 years ago, as evidenced by the fact that hunters from Cape Dorset, Ivujivik, Salluit and other settlements travel long distances to hunt them on the offshore islands.

Walruses occur year-round along portions of the coast of eastern Baffin Island south of Clyde Inlet and in Hudson Strait. Although areas of summer concentration have been identified (*e.g.* outer parts of Cumberland and Hall peninsulas, Lady Franklin Island group, Loks Land) the walruses tend to occur in small, scattered groups in these areas. Some of these groups may undertake fairly long migrations while others are thought to move relatively short distances according to ice conditions and availability of food. Although connections have been suggested between the walruses in these areas and

those found year-round in Hudson Bay and during winter in Central West Greenland, the present distribution indicates that walruses along eastern Baffin Island and in Hudson Strait may have become more sedentary, or at least that the populations are now discontinuous rather than continuous.

Walruses have been eliminated from some areas where they were known to be present historically. For example, Soper (1928:9) reported that they had been common at one time around Bon Accord Harbour in upper Cumberland Sound but that none had been seen there for many years by the time of his visit in the mid 1920s (also see Stevenson 1993). Walruses may have declined in upper Cumberland Sound already by the 1870s (Kumlien 1879:63-64). They are said to have become "very rare" in the Clyde area due to commercial hunting during the 1930s and 1940s (Wenzel 1991:93). The availability of walruses has declined off Labrador since the "pre-settlement period" (before 1960) (Brice-Bennett 1977:129), but details are lacking. Nowadays the southern limit of walruses along northern Labrador appears to be in the Hebron-Okak Bay area.

Although commercial hunting driven by demand for hides, ivory and oil was stopped by governmental regulation in 1931, substantial catches continued to be made by Inuit, police, missionaries and traders in order to secure winter supplies of dog food. The availability of large boats made it possible to travel to offshore islands where walruses were still relatively abundant in the 1930s and 1940s. With the decline of dog teams in the 1960s, the urgency of obtaining large amounts of walrus meat abated. At some settlements much less effort was devoted to walrus hunting, and it is possible that stocks had a chance to make some recovery. We are unaware of any clear recent evidence of trends in the walrus population off eastern and southern Baffin Island.

We estimate that the population of walruses in northern Hudson Bay, including about 3000 around Southampton and Coats islands and at least 1000 in western Hudson Strait and southeastern Foxe Basin (Orr and Rebizant 1987, Richard and Campbell 1988, Richard 1990, Mansfield and St. Aubin 1991), totals about 4000 animals. Available information indicates that perhaps 2000 walruses are found along eastern Baffin Island, in Ungava Bay and in eastern Hudson Strait. The estimated current total removal rate of about 330 walruses per year may exceed the sustainable yield of the combined stock in area 3 (Fig. 3, Table 1).

Given the great amount of uncertainty about stock identity, population size, total removals (including hunting loss), and age/sex composition of the kill, however, any judgment about sustainability of the present harvest is highly speculative. It is important to bear in mind the possibility that the same population of walruses is hunted off Central West Greenland.

Fig. 4. Adult male walruses hauled out on Coats Island in mid-August 1967. Note the broken tusks and wrinkled skin, signs of old age, of the upper animal. Photo: F. Bruemmer.

Stock 4 – Western Greenland

Walruses winter off Central West Greenland. Apparently the walruses that winter along the western coast of Disko Island belong to a different stock than those found farther south off Aasiaat-Sisimiut. The northern group is thought to belong to the North Water stock (Stock 5), whereas the southern group perhaps is connected with walruses along eastern Baffin Island (Stock 3).

Vibe (1956) and Mansfield (1973) stated that the decline in the Greenland catches of walruses after 1940 reflected a decline in the walrus population. There is no evidence of a reduced hunting effort during the period of declining catches after approximately 1940. On the contrary, despite the difficulty of selling walrus hides on the European market (experienced already by the late 1930s; Anon. 1937), and despite the drop in international oil prices in 1930 (Anon. 1946), the trade of walrus hides and oil to the Royal Greenland Trade Department remained high in Central West Greenland (Born *et al.* 1994a). This supports the statements by Vibe (1956) and Mansfield (1973).

The shallow feeding banks off Central West Greenland provide important wintering habitat for walruses. A comparison between historical and recent information on occurrence, abundance and exploitation indicates clearly that the number of walruses in this area and the extent of undisturbed wintering habitat available to them have declined during the 20th century. Increased fishing activities since the 1960s in areas where walruses winter, and catches which remain high relative to the estimates of abundance, pose a threat to the survival of walruses in Central West Greenland.

The number of walruses on the Central West Greenland wintering grounds is estimated to be about 500 animals (Born *et al.* 1994a), or in the low hundreds (Heide-Jørgensen and Born 1995). The reported catch in Central West Greenland (from Uummannaq south) in the period 1980-1987 averaged about 46 walruses per year. This figure likely underestimates the actual landed catch. To the reported catch figure an overall loss of 30% is added (see Born *et al.* 1994a), resulting in an estimated total removal of about 65 walruses per year. We therefore believe that walruses in Central West Greenland are being harvested above their sustainable (= replacement) yield.

Fig. 5. A dog team is used for hauling a walrus onto the ice at Saunders Island (Avanersuaq/Thule area, NW Greenland) in May 1978. Photo: T. Kristensen.

Fig. 6. A group of adult male walruses at Tusenøyane, Svalbard. The majority of walruses in Svalbard are males. The females tend to occur further east, in Russian waters. Photo: I. Gjertz

Stock 5 – North Water (Baffin Bay – Eastern Canadian Arctic)

The walruses in the North Water (NOW) area probably belong to one population which has its main summering grounds along the southeast coast of Ellesmere Island, in Jones Sound and along the north shore of Lancaster Sound. Some, presumably few, walruses may summer farther north – in the Kane Basin region, and west – in the Canadian high arctic archipelago. The NOW population is thought to include walruses that winter in the eastern Canadian Arctic and along the west coast of Greenland as far south as Disko Island. The NOW population apparently no longer makes large-scale spring and fall migrations along either the northeast coast of Baffin Island or the west coast of Greenland.

No complete population estimate is available for the NOW stock but the available data suggest that it may contain no more than perhaps 3000 individuals.

During this century walruses have abandoned their uglit on the Greenland side of the NOW area and their summering range has diminished. Decreased access to two important ecological elements – undisturbed haul-out sites and summer feeding grounds – is thought to have had a negative impact on this population.

Historically, large catches of walruses in the NOW area were made by foreign commercial sealers and whalers. Since about the 1960s the effort devoted to walrus hunting by local Inuit has increased in the Avanersuaq (Thule) area (NW Greenland), where the bulk of the catch of walruses from this stock is normally made.

The actual catch of walruses in northern Baffin Bay is not well documented. However, we estimate that during the last two decades the annual removal rate (including loss) in the Avanersuaq and Upernavik areas (Greenland) and the eastern Canadian high Arctic has averaged about 375 walruses. To ensure sustainability an annual yield of 375 walruses necessitates the presence of a population of between about 7500 and about 19000 animals. Our estimate of the size of the walrus stock in the NOW area is only a few thousand. Thus the current exploitation appears to be unsustainable (Table 1).

Stock 6 – Eastern Greenland

Walruses occur along the east coast of Greenland north of about 63° N. Their main distribution is, however, north of about 70° N. Information on seasonal and geographical distribution indicates that walruses in eastern Greenland form a geographically separate unit. This stock apparently has some exchange, presumably infrequently, with walruses at Svalbard-Franz Joseph Land and in Davis Strait.

Large catches around the turn of the last century led to the disappearance of walruses at several of their uglit, and these catches presumably also caused a serious reduction in overall numbers. Recent surveys indicate that the recovery has been slow, perhaps reflecting the low productivity of these regions. It is estimated that the stock now numbers 500 to 1000 walruses. The estimated current removals from this stock are 20-30 animals per year, primarily males. This removal rate may approximate sustainable (= replacement) yield of the stock (Table 1).

Stock 7 – Svalbard – Franz Joseph Land

In Svalbard (Norway) and Franz Joseph Land (Russia), and possibly also in the other areas within Russian jurisdiction, stocks of Atlantic walruses are in an early phase of recovery from severe depletion. Their present numbers are, however, only a fraction of what they once were.

It has been demonstrated that Svalbard and Franz Joseph Land have a common walrus population. A possible connection with groups of walruses in other parts of the western Russian Arctic cannot be excluded. Walruses are in the process of repopulating the Svalbard archipelago from the east. The majority of animals summering in Svalbard are males; the rest of the population is distributed primarily east of Svalbard and in Franz Joseph Land. This stock of walruses is estimated to number at least 2000 animals. The stock probably has a very good food supply and is likely experiencing optimal feeding conditions (Table 1).

Stock 8 – Kara Sea – Southern Barents Sea – Novaya Zemlya

The situation for the stocks of Atlantic walruses in other parts of the eastern section of their range is less well known. The relationships between groups of walruses at Novaya Zemlya and in the southern Barents Sea, White Sea and Kara Sea areas are not well understood. Surveys to determine distribution and size of populations have not been conducted recently, and comprehensive population figures are not available. The limited available information indicates that some hundreds, or perhaps more than a thousand, walruses are now present in these regions. Presumably, walruses in these parts of their range have a more than adequate food supply, but recovery of their population(s) is probably being slowed or prevented by other limiting factors, such as the effects of marine nuclear waste, large-scale shipping and pollution. Some hunting occurs in these areas, but it is poorly documented. The available information is too limited to allow for an evaluation of the effects of hunting on the populations (Table 1).

Anthropogenic effects apart from those due to hunting

In response to the questions raised by the NAMMCO Council concerning the potential effects on walruses of recent environmental changes (*i.e.* disturbance, pollution), and changes in food supply, we reviewed the following topics:

1. Disturbance from different sources of noise
   1a: Aircraft and vessel traffic
   1b: Offshore hydrocarbon exploration and operational activities
   1c: Military activity
2. Pollution
   2a: Oil spills etc.
   2b: Heavy metals and chlorinated hydrocarbons (CHCs)
   2c: Radioactivity and nuclear activity
3. Changes in food abundance and interactions with fisheries

Our conclusions are summarized below.

1. Disturbance from different sources of noise

1a. Aircraft and vessel traffic

Although their reactions are variable, walruses usually flee into the water when an aircraft gets close. In some cases this can lead to stampeding, with the result that calves are crushed to death. Walruses also react to noise from boats and ships and they usually exhibit an escape response if a vessel gets too close. However, the degree of responsiveness is highly influenced by the type of noise and its source level, the social and behavioral situation of the walruses, and their previous experience with vessel noise, especially whether it was associated with more drastic effects such as hunting. Cases in which walruses have permanently abandoned uglit (*e.g.* western and eastern Greenland) have involved factors in addition to noise disturbance, such as hunting and the smell of humans, dogs, offal etc., that could have been as or more significant.

We are not in a position to evaluate whether walruses, like many other species, habituate to noise from aircraft, ships and boats. Nor do we have sufficient information for evaluating the long-term effects of such disturbance.

Because most walrus populations have been subjected to hunting pressure, in many cases intensive and over many years, and because various other human activities have modified walrus habitat through time, it will be very difficult to demonstrate long-term effects,

Fig. 7. Walruses are highly gregarious. When frightened by aircraft noise, they flee into the water. During such stampedes calves are sometimes crushed to death. Photo: I. Gjertz

at the population level, caused specifically by exposure to noise.

1b. Offshore hydrocarbon exploration and operational activities

Oil and gas exploration is now occurring in many offshore areas inhabited by Atlantic walruses. This activity is large-scale in some areas, for example around Svalbard and in the western Russian Arctic. In the latter the oil fields overlap the summer distribution of walruses and therefore large-scale petroleum activities pose a potential threat to walruses.

In a study of the effects on Pacific walruses of offshore drilling, the animals were found to exhibit only weak short-term behavioral responses to the drilling activities *per se*. They reacted more strongly to the icebreaking activities associated with these operations by moving away for a brief time. However we are not aware of any studies that support conclusions about the long-term effects of various exploration and operational activities on walruses.

1c. Military activity

We are not able to evaluate to what extent military activity (*e.g.* rocket launching, explosions) in different areas (*e.g.* southern Barents Sea) may have adversely affected walruses.

2. Pollution

2a. Oil spills etc.

Apparently no studies have specifically addressed the direct or indirect effects of oil on walruses.

Studies of seals have shown that surface contact with oil causes stress, and temporarily irritates the eyes, skin and lungs. Ingestion of oil leads to physiological and chemical changes, possibly affecting reproduction. Inhalation of aromatic hydrocarbons from an oil spill caused mental debilitation in harbor seals (*Phoca vitulina richardsi*) in Prince William Sound (Alaska). Most evidence of internal organ and tissue damage from oil ingestion by seals is, however, inconclusive for walruses. Walruses exposed to an oil spill are likely to show some of these reactions. However, walruses depend almost entirely on blubber to minimize heat loss. Their sparse pelage presumably is of little value as insulation, and their skin is thick and very tough. It is therefore unlikely that exposure of the skin to oil would have any appreciable thermal effect except perhaps in newborn walruses. Oiling of newborns that have not yet accumulated a thick insulating blubber layer could affect their ability to keep warm. Consequently, oil spills during the walrus calving season (late May-early June) in areas where females and young are present could, theoretically, have a greater adverse impact than spills at other times and in other areas.

We believe that some features in the ecology of walruses make them more vulnerable to the harmful

effects of spilled oil than are many other marine mammals:

1. Due to the high level of gregariousness in walruses, an oil spill that affected one would likely affect at least several individuals. Furthermore, the oil from a spill in one area could be transferred by individuals to other walruses on clean sites (for example oil-fouled walruses will rub oil onto the skin or into the eyes of other individuals during haul out).

2. Walruses tend to inhabit coastal areas and areas of relatively loose pack ice. Spilled oil is likely to accumulate in such areas. Walruses therefore have a high risk of being fouled not only in the water but also when they haul out on land.

3. Because they are benthic feeders, walruses may be more likely to ingest petroleum hydrocarbons than are most other pinnipeds. Benthic invertebrates are known to accumulate petroleum hydrocarbons from food, sediments and the surrounding water. The implications for walruses may be serious since contaminants in their food are certain to build up in their own tissue. Oil contamination may also reduce the biomass or productivity of the invertebrate communities that sustain walruses, forcing the animals to seek alternative food or feeding areas. It cannot be assumed that such alternatives are actually available, however.

2b. Heavy metals and chlorinated hydrocarbons (CHCs)

Two classes of pollutants are of particular concern in marine mammals: heavy metals and chlorinated hydrocarbons (CHCs). Few studies have been made of these pollutants in walruses, however.

The three metals of greatest concern are mercury (Hg), cadmium (Cd) and lead (Pb). Levels of heavy metals have been found to be very high in Pacific walruses; in certain organs they exceed the levels considered safe for human consumption. In Atlantic walruses, however, heavy metal levels have generally been found to be less than in Pacific walruses. High concentrations of some metals have been found in walruses from Foxe Basin (Cd), southern Hudson Bay (Pb and Hg) and northwestern Greenland (Hg).

CHCs are anthropogenic chemicals which accumulate mainly in blubber. They are of concern because of their potentially harmful effects on walrus reproduction, the walrus immune and hormone systems, and human health through consumption of contaminated walrus tissue. Walruses have generally low concentrations of CHCs. Especially high concentrations have been found, however, in eastern Hudson Bay compared with other parts of Canada, northwestern Greenland and Alaska. These high concentrations might be due to the fact that these individuals consumed significant amounts of ringed seal (*Phoca hispida*) blubber. It is worrisome that comparatively high levels of CHCs have been found in some Atlantic walruses, but the significance to walruses or people who consume them is unclear.

2c. Radioactivity and nuclear activity

Only a few studies have been made on radioactive elements in walruses. However, the levels of plutonium and other radionucleides such as ^{137}Cs reported so far from analyses of marine mammals are not considered high enough to pose a health risk to the animals.

No documentation is available concerning the effects on walruses of nuclear activities in the Novaya Zemlya region. Second-hand Russian sources indicate, however, that certain walrus haul-out sites in Novaya Zemlya were deserted in the 1960s due to the nuclear testing on this island.

3. Changes in food abundance and interactions with fisheries

Changes in the density and availability of food will likely influence the size of walrus stocks. Fluctuations in stocks of walrus prey might be caused by changes in both abiotic and biotic conditions driven, for example, by predator-prey relationships or anthropogenic factors. There is no information available to determine whether or to what extent such changes have influenced the stocks of Atlantic walruses. It is worth noting, however, that mere abundance of walrus prey does not necessarily trigger or sustain population growth. Despite the fact that walrus food must have been abundant in the Svalbard region for a long time, and that walruses have been completely protected there since 1952, they have only recently moved into the area. This may indicate that in the case of a walrus population which has been seriously reduced by hunting, factors other than prey density and availability govern the animals' ability or willingness to exploit a food resource. Walruses are conservative in their choice of food and selection of habitat. So factors such as the need to learn or inexperience may have played a role in the evident failure of the walruses at Svalbard to take full advantage of the rich feeding areas available to them.

Although the direct and indirect effects of fisheries on Atlantic walruses are basically unknown, some effects probably do occur. Fishing with

bottom draggers has destroyed potential walrus feeding habitat at Svalbard. The noise from fisheries in or near walrus habitat and the disturbance of the sea floor caused by trawling have probably contributed, perhaps synergistically, to the continued depletion of the stock of walruses wintering off Central West Greenland. Intensive fisheries along the coasts of Svalbard and elsewhere in the Barents Sea also may have prevented walruses from repopulating areas that, from a purely trophic perspective, appear still to be suitable walrus habitat.

DETAILED DESCRIPTIONS OF THE PUTATIVE STOCKS

1. Foxe Basin

Distribution and Stock Identity

Summer and winter distributions of walruses in Foxe Basin are shown in Figs 8-9, respectively. Places mentioned in the text and locations of uglit are shown in Fig. 10.

The shallow waters of northern Foxe Basin have always been known to support large numbers of walruses (Tremblay 1921, Loughrey 1959, Crowe 1969, Brody 1976). Walruses are present in northern Foxe Basin year-round and they are widely distributed in this area (Crowe 1969:7, Riewe 1992). Their movements are apparently local in response to changing ice conditions. Loughrey (1959) stated that walruses wintered from the northern tip of Melville Peninsula to Cape Wilson, and especially off the floe edge at Foster and Parry bays. In contrast to the situation at Southampton and Coats islands and at the islands in western Hudson Strait, walruses in northern Foxe Basin apparently haul out on land relatively infrequently, *e.g.* at South Ooglit Island in autumn (Mansfield 1958). On the east side of northern Foxe Basin, concentrations occur in summer off the Spicer Islands and around Koch, Rowley and Bray islands (Riewe 1992:195). Beaubier (1970) and Vestey (1973) provided some details on the seasonal distribution of walruses in northern Foxe Basin. The possible uglit shown on Fig. 10 are based on information supplied by H. Ivaluardjuk (pers. comm. 1995).

The distribution of walruses has changed since the 1950s when Hall Beach and Igloolik became major settlement sites (*cf.* Brody 1976). Large herds no longer occur along the east coast of Melville Peninsula, and walruses are much less common in the Foster Bay area than they were in the 1930s (Beaubier 1970). Crowe (1969:5) stated that boat traffic and hunting had "driven the walrus from

Fig. 8. Approximate summer distribution of walruses in Canada and Central West Greenland.

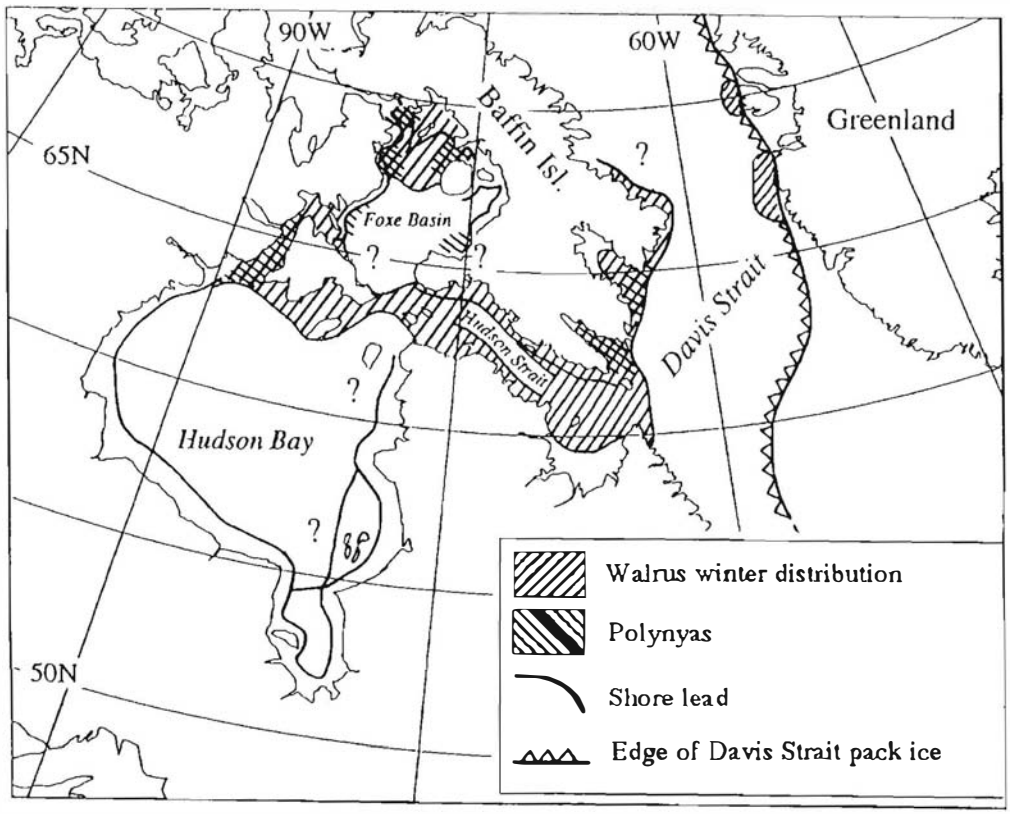

Fig. 9. Approximate winter distribution of walruses in Canada and Central West Greenland. The Davis Strait pack-ice limit is shown. An overlap between walrus wintering areas and locations of polynyas is indicated.

Richards Bay and other former haunts, eastward to the less accessible islands". He also noted that the walruses whose presence had once made boat crossings of Hooper Inlet dangerous had been "driven from there or exterminated by 1948" (Crowe 1969: 69). At the time of Mathiassen's (1928) visit in the early 1920s walruses were abundant in Hooper Inlet.

Mansfield (1958) proposed that the walruses in the northern half of Foxe Basin were effectively isolated from those at Southampton Island, arguing that deep water in the southern areas precluded their dispersal in that direction. Inuit knowledge indicates that there is a hiatus in walrus distribution in southern Foxe Basin (Riewe 1992), thus supporting the hypothesis of separate stocks. Garlich-Miller (1994) corroborated, with new specimen material collected at Igloolik and Hall Beach 1983-93, Mansfield's (1958) finding that walruses in northern Hudson Bay are smaller than those in northern Foxe Basin.

In the southeastern corner of Foxe Basin, walruses sometimes occur along the north coast of Foxe Peninsula and they haul out in summer and fall at capes Dorchester and Weston (Soper 1944, Riewe 1992:198). Soper (1944) claimed that there was no evidence that walruses were present along the west coast of Baffin Island from Bowman Bay to Murray Maxwell Bay, but Inuit told him that good catches had been made in the past (pre 1920s) on islands many miles north of Cape Dorchester. There is little evidence of movement by walruses through Fury and Hecla Strait (Riewe 1992), so the northern Foxe Basin population is also effectively separate from that in northern Prince Regent Inlet (which we assume to consist of migrants from the Lancaster Sound region). It should be noted, however, that at least small numbers of walruses were observed in Fury and Hecla Strait in the 1920s and early 1930s (Bethune 1934:79), so the apparent lack of movement through the strait may be a recent development.

Population Size

Crowe (1969:5) cited the guess of Mansfield (1973) that there were about 4000-5000 walruses in northern Foxe Basin during the 1960s. Helicopter surveys in August 1983 produced a count of 2722 walruses (Orr *et al.*1986), which accounts for Richard and Campbell's (1988) assignment of "2725+" to this area. Even though Orr *et al.*(1986) considered their helicopter survey to have been done under optimal conditions for detecting and counting walruses, they recognized that their count did not represent the entire northern Foxe Basin population.

Visual surveys using systematic strip transects flown in Foxe Basin resulted in estimates of 5200 (95% CI 900-30500) animals at the surface in 1988,

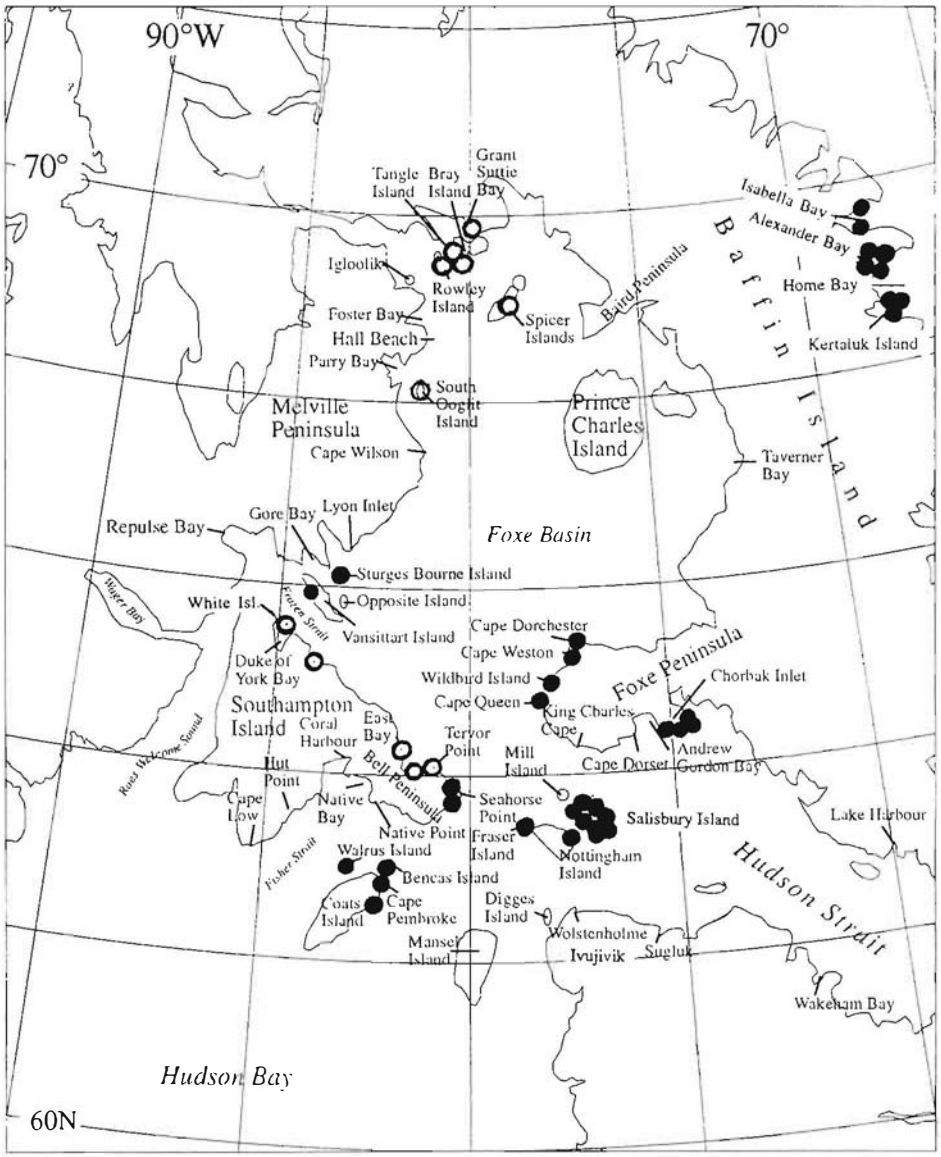

Fig.10. Locations of terrestrial haul-outs (uglit) in Foxe Basin, northern Hudson Bay, western Hudson Strait and parts of eastern Baffin Island (see also Figs. 12 and 16). Legend: Black dots = haul-outs still known or believed to be used by walruses. Open circles = historical haul-outs; present status unknown.

Note: Canadian haul-out sites in this and subsequent map figures are indentified and classified on the basis of information in Anon. (1981-87), Riewe (1992), and personal communications cited in the text.

and 5500 (95% CI 2700 – 11200) in 1989 (Cosens *et al.*1993). As the surveys did not cover the entire walrus distribution area and as no correction has been made to account for diving animals, these estimates are believed to be negatively biased (R.E.A. Stewart pers. comm. 1995).

Exploitation

Hunting methods: Descriptions of hunting methods for western Hudson Bay and Hudson Strait (see Manning 1944, Beaubier 1970, Vestey 1973) apply more or less equally to Foxe Basin. Brody (1976) referred to a major change in the pattern of walrus hunting in this area when whale boats were introduced during the 1920s. The hunting range expanded as hunters were then able to hunt walruses in open water. More recently (1940s-1950s?) the hunting shifted farther offshore, "away from the coastal areas around Jens Munk and Igloolik islands, and Foster and Parry bays, following changes in the animal's seasonal movements – fewer and fewer walruses were coming into the bays and along the coastal areas" (Brody 1976:164; also see Crowe 1969, Beaubier 1970). Whale boats and Peterheads were largely replaced by motorized freighter canoes in the 1960s (Beaubier 1970).

In the 1980s walrus hunting at Igloolik was done mainly from large canoes with outboard motors (20-90 hp) during July and August. Hunters hunted selectively for the larger tusked animals, and they preferred to hunt those hauled out on ice pans. When walruses were hunted in the water, an attempt was made to wound them with body shots and then to harpoon them before killing (Orr *et al.*1986).

The main products from contemporary walrus hunting in northern Foxe Basin are meat and organs for human consumption or dog food. The value of the tusks was high enough in the 1980s to approximately cover the costs of obtaining a walrus at Igloolik (Orr *et al.*1986). Nevertheless "head chopping" (*i.e.* saving only the head and discarding

Fig. 11. A whale boat with sail hunting walruses at Igloolik (northern Foxe Basin) probably at the middle of this century. Photo: Archives of Eskimo Museum, Churchill, Manitoba.

the rest of the carcass) was apparently a "rare practice" with Igloolik hunters (Orr *et al.*1986).

Catch levels: The annual landed catch in northern Foxe Basin was estimated as about 425 in the 1950s (Loughrey 1959) and was reported as 203 between 1973 and 1985 (Orr *et al.*1986). Assuming that about a third of the animals killed are lost, the average annual removals would appear to have declined from 637 in the 1950s to 305 in the 1970s and early 1980s. As pointed out by Orr *et al.*(1986), the crudeness and incompleteness of the catch data make the usefulness of such comparisons highly questionable. It should be noted that Beaubier (1970; also see Beaubier *et al.* 1970) summarized four years of data from the Royal Canadian Mountain Police (RCMP) from 1964-69 indicating catches at Igloolik ranging between 100 and 180 walruses. Moreover, Donaldson (1988:63), after analyzing the data obtained from a harvest study during the early 1980s, concluded that the official catch statistics for Igloolik and Hall Beach in the early 1980s were too high. The harvest study estimated the combined landed catch for these two settlements during 1981-83 as about 169 per year, while the official combined estimate from Department of Fisheries and Ocean (DFO) was somewhat more than 300 per year (Donaldson 1988:table 8).

The reported landed catches for Foxe Basin during 1988-93 (5 years) averaged about 200 (range: 124-319. Hall Beach: ca. 75; Igloolik: ca. 125) (Anon. 1991...94; R.E.A. Stewart *in litt.* 1995). Anderson and Garlich-Miller (1994 *fide* Garlich-Miller 1994) estimated the annual catch in 1992-93 in Foxe Basin as 215.

Hunting loss: A dead walrus with no air trapped in its lungs has a negative buoyancy. Consequently it easily sinks if it has not been harpooned or otherwise anchored to a float. Because walruses usually are not harpooned before being shot nowadays (except during the thin ice hunt in Avanersuaq, NW Greenland; see section Regulations), losses during walrus hunting are sometimes substantial.

Beaubier (1970) sampled the walrus hunt at Igloolik in 1968-69 and recorded that of 19 walruses shot, 3 were "wounded" and lost, while 3 more were "sunk" and lost. These data suggest a loss rate of 16-32%. During hunts observed at Igloolik in 1982-84, 40 out of 124 walruses shot were lost (32%; Orr *et al.*1986).

Catch composition: The sample of the catch at Igloolik examined by Orr *et al.* (1986) in 1982-84 consisted of 33% females.

2. Southern and Eastern Hudson Bay

Distribution and Stock Identity

Summer and winter distributions of walruses in southern and eastern Hudson Bay are shown in Figs 8-9, respectively. Places mentioned in the text and locations of uglit are shown in Fig. 12.

Walruses formerly hauled out on the Paint

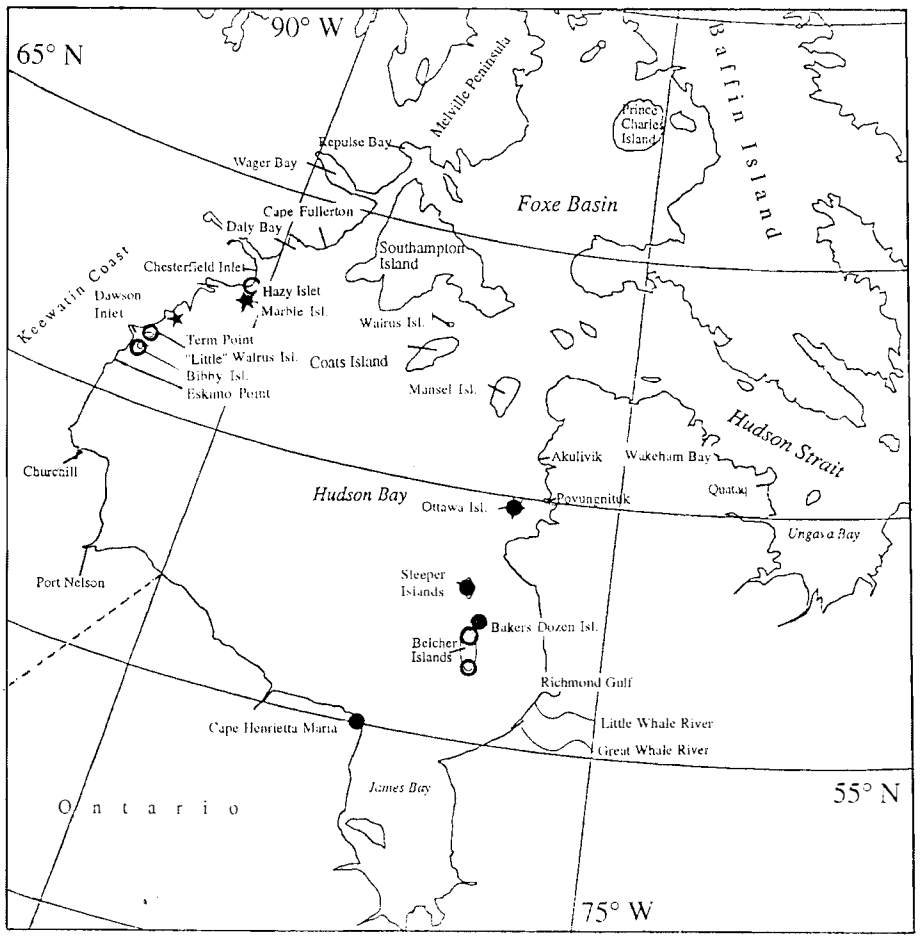

Fig. 12. Locations of terrestrial haul-outs (uglit) in southern, eastern and northwestern Hudson Bay. Legend: Black dots = haul-outs still known or believed to be used by walruses. Open circles = historical haul-outs; present status unknown. Stars = Abandoned haul-outs.

Islands in eastern James Bay but are now essentially absent south of about 57°N along the east coast of Hudson Bay (the Belcher Islands; Tremblay 1921:177).

We have found little evidence that walruses approached the mainland coast of eastern Hudson Bay (the Eastmain), although late 19th and early 20th century trade records occasionally refer to walrus catches or products in connection with Little Whale River, Richmond Gulf and Great Whale River (Francis and Morantz 1983:148, HBC Archives). Already by 1847 the mainland Inuit were said to travel to the "Sea Horse Islands" (Belcher Islands) to hunt walruses (Francis and Morantz 1983:142). Preble (1902) cited a report from 1879 indicating that walruses had formerly been seen "occasionally" as far south along the mainland coast as Little Whale River. They apparently have not been hunted by the Inuit south of Great Whale River in recent times (*cf.* Schwartz 1976).

Walruses were still plentiful on various islands off the Eastmain coast during the late 19th century (Bell 1885:14, Wakeham 1898:73) and probably until well into the 20th century. As elsewhere, in northeastern Hudson Bay walrus meat, blubber and skin were important sources of winter dog food. Thus much of the hunting by Inuit, trading companies, and police detachments was driven mainly by the need to secure their annual supply of dog food (*e.g.* May 1942). Loughrey (1959) speculated that the relocation of Inuit from the Sleeper Islands to the Québec mainland in 1954 could have had a beneficial effect on the walruses around the Sleepers.

Walruses were still sufficiently common at the Belcher Islands in the 1940s and 1950s for the Inuit from Port Harrison (Inukjuak) to come there (as well as to the Sleeper Islands) for walrus hunting (Manning 1946, Evans 1958). The main hunting areas were near the North Belcher Islands, south and east of Split Island, the south coast of Johnson Island, south of Kugong and Flaherty islands, and the Sleeper Islands (Twomey 1939, Twomey and Herrick 1942, Evans 1958, Schwartz 1976). At the Belcher Islands, the availability of walruses had become substantially reduced by the late 1950s/ early 1960s, and their importance in the local subsistence economy had become "almost negligible" (Freeman 1964:62). This change in availability was attributed by Freeman (1964) to a shift in walrus distribution: "It appears that very recently the herds shifted their location and now occur in the extreme southwest of the archipelago in the fall only. They are no longer found at other seasons on the Islands,

apart from the time they are migrating along the western coast en route to the southwestern hauling-out sites". According to Schwartz (1976) the hunting areas were reduced by the early 1970s "because some walruses have reinhabited the Sleeper Islands [?], and because people have moved to Sanikiluaq." The Belcher Islanders still hunted walruses in a small area at the southeastern extremity of Churchill Sound and another at the southern extremity of Robinson Bay, as well as at the north end of Moore Island, around the King George Islands, and most importantly at the southern and northern ends of the Sleeper Islands (Schwartz 1976, Freeman 1982).

The statement by Manning (1976), that Belcher Island hunters had to consider going to the Sleeper Islands for walruses because of a decline in local availability, was contradicted by Riewe (1992:161), who stated: "Good populations of walrus occur around the Belcher Islands and Bakers Dozen Islands [NE of the Belchers]. Frequent walrus haulouts occur on Bakers Dozen Islands." Riewe (1992:47) mapped walrus sites in the northern Belchers off northern Kugong, Flaherty, and Tukarak islands, in the northern and southern Bakers Dozen Islands, and at the King George and Sleeper islands. He also indicated that walruses were "particularly common" in the southern Belchers at the southeastern extremities of Churchill Sound and Robertson Bay (pp. 93, 203). The time scale of Riewe's (1992) observations is uncertain.

Walruses were traditionally hunted at the Ottawa Islands in the northeastern corner of Hudson Bay. Special expeditions were made in late summer or autumn (late August through October) from Povungnetuk and Port Harrison on the mainland (May 1942, Evans 1958:23).

Most walrus hunting at the offshore islands apparently was conducted in summer and autumn. Walruses of both sexes and various ages, including mothers with dependent calves, were present on the islands at this time (*e.g.* Twomey and Herrick 1942:334).

We have found no evidence to contradict Loughrey's (1959) speculation that the walruses occurring in summer and autumn on the chain of islands in eastern Hudson Bay overwinter in nearby leads and are thus basically non-migratory. It is reasonable to regard them, tentatively, as comprising a separate stock for management. We regard the walruses formerly found to the north of the Ottawas – at Digges and Mansel islands – as being part of a wider northern Hudson Bay-Hudson Strait population. The evidence for a separation of stocks in northeastern Hudson Bay is, however, not strong.

A few hundred walruses haul out in summer and fall on shoals off Brant River, Ontario, near Cape Henrietta Maria in southern Hudson Bay (Preble 1902, Loughrey 1959, Richard and Campbell 1988). This group of animals apparently includes females and young. Their stock affinities are entirely unknown. Mansfield (1958) considered them to be associated with eastern Hudson Bay (see above), while Loughrey (1959) mentioned them in connection with the population in western Hudson Bay. The group of walruses which occur near Cape Henrietta Maria may winter in the vicinity of the Belcher Islands and thus mix with the eastern Hudson Bay population (*cf.* Mansfield 1958).

Population Size

Virtually nothing is known about historical or current sizes of walrus populations in this area. Richard and Campbell (1988) assigned the number "100?" to the area. Twomey and Herrick (1942:334) estimated that the herd they observed and hunted at the northern Sleeper Islands in the late 1930s had at least 400 individuals (at least 50 are pictured in a scene at one ugli – Twomey 1939, Twomey and Herrick 1942). Manning (1976) reported seeing about 75 walruses hauled out on the Sleeper Islands and another 25 on Kidney Island, about halfway between the Sleeper and King George islands, in early August 1971.

The highest count of the Cape Henrietta Maria group was 310 walruses in October 1978 (from photographs taken during a goose survey; K.F. Abraham, Ontario Department of Natural Resources, *in litt.* to P. Richard 1985; N. Wilson, DNR, pers. comm. 1995).

Exploitation

Hunting methods: The hunt at the Sleeper Islands in the late 1930s described by Twomey (1939) and Twomey and Herrick (1942) involved the shooting and harpooning of animals in the water, from aboard an engine-powered boat. Although the Twomey expedition was mainly to obtain museum specimens, local Inuit and their equipment were used for the hunt. Another powered vessel from Port Harrison on the mainland, manned by an Inuit crew, was hunting at the same time in the same area using the same methods. Hunters at least occasionally went ashore on the offshore islands and stalked the walruses, shooting them at close range on shore (May 1942). The group of Inuit from Povungnetuk with whom May hunted apparently harpooned swimming walruses before shooting them.

Kayak, floe-edge, and on-land hunting of walruses at the Belcher Islands was described by Freeman (1964).

Catch levels: Information on historical catch levels is sketchy. As noted previously, no systematic compilation of walrus catch data has been attempted. For such a compilation, it would often be necessary to estimate catches from production data, including boatloads of walrus products, pounds of hide or ivory, gallons of oil etc. A Peterhead boat, fully loaded, could have on board the products (meat, hides, and tusks) of up to 32 walruses (Russell 1966:6 reported 65 walruses in two boats). A boatload of walruses obtained at the Sleeper Islands in 1939 included the remains of at least 23 walruses (Twomey and Herrick 1942:328). Freeman (1970:163) estimated that the hold of a Peterhead could carry the remains of about 20 adult walruses, while a whaleboat could carry only three or four. Mansfield (1966) gave 15 walruses as a full load for a Peterhead.

May (1942) reported securing a full boatload of meat during an autumn walrus hunt at the Ottawa Islands in 1939, suggesting a catch of perhaps 15-25 animals (May's account documents the capture of at least five). Such hunts were a regular feature of life at the trading posts in northwestern Québec, so it can be assumed that similar kills were made in most years.

Evans (1958:23-24) estimated annual catches during the 1950s as 20 at the Ottawa Islands, 20 at the Sleepers, and 30 at the Belchers for a total of about 70 from the region. This compares with the estimate of 60-80 given by Loughrey (1959:see p. 78 and appendix II) for this area. [Note that the figure of 169 per year cited from Loughrey by Reeves (1978), for "western Québec", includes the catches from settlements that hunt mainly in western Hudson Strait (Wakeham Bay, Sugluk, and Ivujivik).] Expeditions in August-September 1953 (3 from Povungnetuk and 3 from Port Harrison) accounted for 24 walruses at the Ottawas and 22 at the Sleepers (RCMP game report from Port Harrison 1953).

By the end of the 1950s the catch at the Belcher Islands had greatly declined (3 in fall 1959, 4 in fall 1960; Freeman 1964). The annual catch at the Belcher Islands was reported to be about 10 in the early 1970s (Reeves 1978), and it appears to have declined to about 5 since then (Richard and Campbell 1988; R.E.A. Stewart *in litt.* 1995). The combined average annual catch at Akulivik, Povungnetuk, and Inukjuak in the latter period was 35 (range 0-65) (Richard and Campbell 1988). The catch statistics for these areas are, however, of poor reliability (R.E.A. Stewart pers. comm. 1995).

Estimated annual landed catches of walruses during the mid 1970s are as follows (NHRC 1976): Great Whale 1, Inukjuak 6 and Akulivik 14. Data were not available for Povungnetuk and Ivujivik where the catches were probably greater.

Hunting loss: We have no recent information on hunting loss in these areas. Evans (1958:23) described walrus hunting in northern Québec as "extremely inefficient," with as many as two thirds of the shot animals sinking [also see Tremblay 1921:178].

Catch composition: We have been unable to locate any recent information on the catch composition for this area.

3. Northern Hudson Bay – Hudson Strait – Southeast Baffin Island – Northern Labrador

Distribution and Stock Identity

Summer and winter distributions of walruses in these areas are shown in Figs 8-9, respectively. Places mentioned in the text and locations of uglit are shown in Figs. 10, 12, 16 and 17.We describe the situation for Stock 3 going from west to east.

Keewatin coast: Along the west coast of Hudson Bay (Keewatin) walruses apparently have always been scarce south of Dawson Inlet. Only a few stragglers occurred as far south as Churchill (Preble 1902). For this reason it seems unlikely that there is (or perhaps has ever been) regular exchange with the eastern Hudson Bay population via a southern route. On the other hand, it seems likely that the groups of walruses along the west coast of Hudson Bay northward from Dawson Inlet would be continuous with the walruses of northern Hudson Bay (and possibly with those in at least southern Foxe Basin and western Hudson Strait as well).

Walruses were formerly common on Bibby Island, Term Point, "Little" Walrus Island, and Marble Island (Preble 1902, Loughrey 1959). They were formerly hunted during winter and spring along the floe edge of the Keewatin coast to the north of Dawson Inlet (Welland 1976). In summer they were hunted in the Rankin Inlet area and among the coastal islands, particularly "Little" Walrus Island, and occasionally as far south as Eskimo Point (Welland 1976:86). Farther north, they were hunted at uglit from Cape Jones in the south to just south of Karmarvik Harbour in the north, and in the Bury Cove area. Hunters were said to venture as much as 30 miles offshore in open boats to hunt walruses in this area (Welland

1976:88). Welland (1976:104,110) noted that walruses were formerly hunted from Bibby Island in the south to Baker Foreland and Cape Fullerton in the north, and seaward to a distance of 10 miles from Marble Island. Although they were scarce by the 1970s south of Chesterfield Inlet, they were still said to be common in the Daly Bay area (*Ibid.*:110). Hunting records reported in Ross (1984) demonstrate that walruses wintered near shore around the southern entrance of Roes Welcome Sound. They were also present in the sound, as well as in Wager Bay, in summer (Welland 1976:90).

According to Welland (1976:102) walruses have become "very scarce" in areas along the southern Keewatin coast, *e.g.* among the islands east of Bibby Island where they were formerly common (also see Loughrey 1959). People from the Rankin Inlet area must now travel in large boats to Roes Welcome Sound or to Walrus Island near Southampton Island to get walruses (Welland 1976:104).

Hazy Islet near Rankin Inlet (ca. 62°50'N) and "Little" Walrus and Bibby islands may still be used by a small number of walruses (Riewe 1992:63,81,175,191), but there is no evidence of significant numbers farther south along the Keewatin coast. Riewe (1992:145,256) indicated that a "small population" is present year-round between Eskimo Point and Wager Bay.

Northern Hudson Bay and western Hudson Strait: The area around Southampton Island has always had large numbers of walruses (Tremblay 1921:338, Mansfield 1958, Loughrey 1959). Major uglit were (and still are) on Coats, Bencas and Walrus (Akpatorardjuk; in Fisher Strait) islands and at Seahorse Point on the east coast of Southampton Island (Mansfield 1958, Freeman 1970, Riewe 1992). Other uglit were on the north side of Southampton Island, in Frozen Strait, and near the entrance of Lyon Inlet (Mansfield 1958:figure 1). Walruses were available in winter at the floe edge near Native Point and were hunted in winter at the floe edge in Smith, Native and Duke of York bays and between Hut Point and Cape Low (Welland 1976:95,112). Large numbers have been reported at the floe edge off Ruin Point and in South Bay, and groups of less than 100 are commonly observed in winter between Leyson and Hut points (Orr and Rebizant 1987). In spring and early summer walruses were hunted from Native Point to Ruin Point, in the Duke of York Bay area and along the coast of Bell Peninsula as far north as Terror and Gore points, as well as on Walrus, Bencas and Coats islands (Welland 1976:96,112). Walruses were also present in the water all the way across the channel between Southampton and Coats islands and in Duke of York Bay (*Ibid.*). Spring concentrations have been reported in recent years (mid 1980s) at the floe edge near Renny Point and at break-up near Leyson Point (Orr and Rebizant 1987). The recent summer and fall distribution was, according to Orr and Rebizant (1987), among the floating pack ice in Evans Strait, near the islands, along the coast of

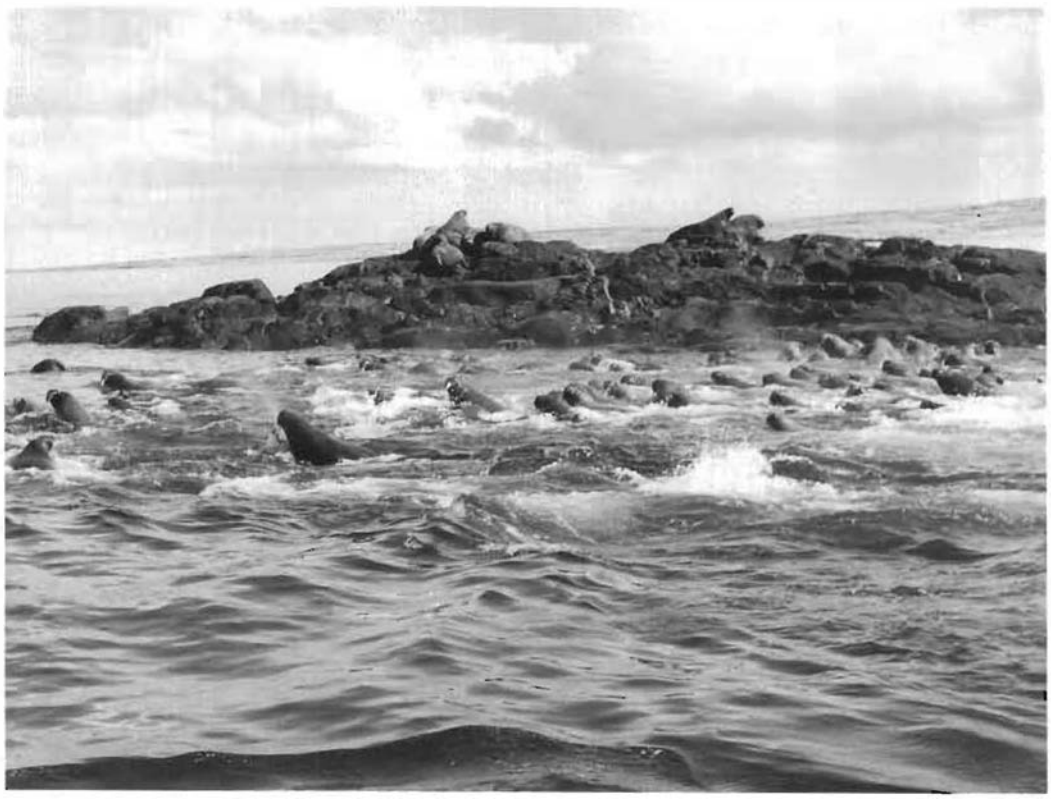

Fig. 13. Walruses at Coats Island, Hudson Bay, in mid-August 1967. Coats Island is still an important haul-out site (ugli). Photo: F. Bruemmer.

Fig. 14. Tagging walruses on Bencas Island, Hudson Bay, 1954. A harpoon-head metal tag was thrust through the tough skin of the walrus (see text). Photo: H. Norden-Andersen.

Southampton Island from Seahorse Point to Ruin Point, and in Duke of York Bay.

Brice-Bennett (1976) gave the following detailed information on where walruses were hunted by Repulse Bay Inuit (who, incidentally, were not known as major walrus hunters): Walruses were hunted at the spring floe edge and in open water off the west coast of Vansittart Island to Gore Bay, in Hurd Channel, Repulse Bay and the southwestern part of Roes Welcome Sound, off the south coast of Opposite Island, around the Sturges Islands, in Duke of York Bay and around the Savage Islands at the mouth of Wager Bay. They were "most intensively hunted" (pre-1962) around the Sturges Islands, Bluhme, October and Bushnan islands in Frozen Strait, and the Harbour Islands and Ubliardjuk area near Gibson Cove in Repulse Bay, and along the southwest coast of Roes Welcome Sound in the Ublialuk area north of Bury Cove. After 1962 most walruses were apparently taken around the Harbour Islands and near Gibson Cove in Repulse Bay (Brice-Bennett 1976:66).

To determine movement patterns and stock identity, tagging studies were conducted in the summers of 1954, 1955 and 1956 at Bencas, Coats and Southampton islands (Mansfield 1955, 1958, Loughrey 1959). However, these studies provided little information on movements. Of a total of 115 (Mansfield 1958) and 32 (Loughrey 1959) walruses tagged with harpoon-head tags (Figs 14-15), only three were recovered during the fall of 1954. The tag-recoveries revealed only local movements in the Southampton – Bencas islands area (Loughrey 1959).

The distribution of walruses in the northern Hudson Bay-western Hudson Strait region apparently has changed little during the past half-century. Donaldson (1988) claimed that the Baffin Island harvesting study of the 1980s led to discovery of "a previously unknown wintering area for walrus," by virtue of the relatively high catches at Cape Dorset during February-April. Walruses are believed to drift eastward on the ice from south-eastern Southampton Island during late summer and fall, passing Cape Dorset and dispersing into Hudson Strait where many overwinter (Riewe 1992: 198). They are also found along the floe edge of southern Foxe Peninsula throughout the winter.

Although walruses formerly occurred in East Bay, their continued use of this area has not been confirmed by recent surveys (Riewe 1992:243). In addition to the former hunting areas described above, Welland (1976:112) stated that walruses were still found along the shores of Bell Peninsula north to Terror Point, all around Coats Island and in the straits between Southampton and Coats islands. Some walruses ("a small population") are still present in Roes Welcome Sound year-round (Riewe 1992:244). They also remain year-round in Frozen Strait, hauling out on ice pans or rocky shores in summer and keeping in leads through the winter (Riewe 1992:244).

Researchers studying seabirds in the region of Digges Sound during 1979-82 (Gaston *et al.* 1985) observed no walruses (or even old walrus bones) on or near Digges Island; they were told by residents of Ivujivik that walruses are never seen there today (A.E. Gaston *in litt.* 1985), yet Roy (1971) indicated that walruses were hunted occasionally around

Fig. 15. A walrus being tagged off Seahorse Point (eastern Southhampton Island, Hudson Bay) in 1954. Photo: H. Norden-Andersen.

Digges Island and along the mainland coast in summer and fall as well as along the east coast of Mansel Island and among the Imiliit Islands in fall. Bell (1885:33) had found walruses "numerous" at Digges Island during late summer.

Historically walruses were always abundant and widespread in northern Hudson Bay and western Hudson Strait. Particular areas were noted as reliable sites for finding them at specific times. Mansfield (1958) suggested that there was a gap in walrus distribution along the north side of Hudson Strait, from about Amadjuak to the Middle Savage Islands.

Along the north shore of Hudson Strait walruses were fairly common off Amadjuak Bay at any season as long as the ice conditions were right (Soper 1928:48) as well as in Andrew Gordon Bay and Chorkbak Inlet (Soper 1944). They were even more common, however, at Mill and Salisbury islands and off King Charles Cape (Gordon 1885: 301, Soper 1928:48). The most reliable site for walruses near Salisbury Island was said to be 25-30 km east of the Island, "where a reef runs east and west, with part of it a rock about 400 yards long by 250 wide, called Nooshwetuk" (Russell 1966:4).

Walruses usually arrived at Nottingham Island on the ice in late August (Manning 1944:148), and this island, along with Salisbury Island, was a favorite hunting ground for communities in southwestern Baffin Island and northwestern Québec. Occasionally the animals were caught on land, but most of the hunting was done on the ice or in the water (Manning 1944:144). Bell (1885:30) reported seeing only a few walruses near Nottingham Island but many in the ice south of it on 20 September.

The walruses at Nottingham Island have continued to be relatively intensively exploited in recent years. People from Ivujivik carry out an annual walrus hunt there (Roy 1971), and people from Cape Dorset, Sugluk, Wakeham Bay and possibly Koartak also hunt them there (A.J. Gaston, *in litt.* 1985). In general it seems fair to conclude that the necessity of making long, costly trips to offshore islands for walruses demonstrates the unavailability of these animals along mainland shores. This is apparently the situation on both the north and south shores of western Hudson Strait today.

Orr and Rebizant (1987) reported that walruses were present in winter all along the floe edge near Foxe Peninsula, from Cape Dorchester to Chamberlain Island, with concentrations around Cape Dorchester and the offshore islands. The main seasonal change in distribution is apparently that walruses become less common in the vicinity of Cape Dorset during summer and fall, when they are particularly abundant along the west coast of Foxe Peninsula from Lloyd Point to the islands north of Cape Dorchester, as well as around the south, west, and north coasts of Salisbury Island and the southeast coast of Nottingham Island.

Ungava Bay, central and eastern Hudson Strait: Much information about the occurrence of walruses in the Ungava Bay – Hudson Strait – eastern Baffin Island – Labrador region was summarized by Loughrey (1959), Reeves (1978), Davis *et al.* (1980) and Richard and Campbell (1988). Few studies focusing on walruses have been carried out in this large area. Land use studies during the 1970s (Freeman 1976) and 1980s to early 1990s (Anon. 1981-87, Riewe 1992) have provided traditional knowledge and incorporated much of the survey data from consulting companies and government scientists. Systematic aerial surveys of marine mammals were conducted during the late 1970s and early 1980s in late winter (McLaren and Davis 1982) and in summer and fall (MacLaren Atlantic Ltd. 1978, MacLaren-Marex 1979, 1980a, 1980b) in Hudson Strait and Ungava Bay, along the southeast coast of Baffin Island and off northern Labrador. These surveys provided useful information on the recent distribution and relative abundance of walruses.

There is ample evidence that walruses were formerly common in parts of Ungava Bay, including Akpatok Island (winter: Elton 1942; summer: HBC Archives, see below) and the Gyrfalcon Islands (summer: Dunbar 1955). Except possibly at the Gyrfalcon Islands they have apparently always been rare in southern Ungava Bay (Mansfield 1959). Human communities living along the shores of Ungava Bay made annual walrus hunts at the offshore islands, especially Akpatok in June-September (HBC Archives, post journals from Diana Bay, Payne Bay, Leaf River, and Fort Chimo). Loughrey (1959) and Currie (1968) provided detailed speculations about walrus movements in Ungava Bay based on information obtained from local Inuit and long-time white residents of the area. It was suggested that walruses arrived at Akpatok from the east in late June and July, then swam westward or northwestward in late July and August. They supposedly passed Cape Hopes Advance and dispersed into Hudson Strait during August. Although Loughrey (1959) considered most of the

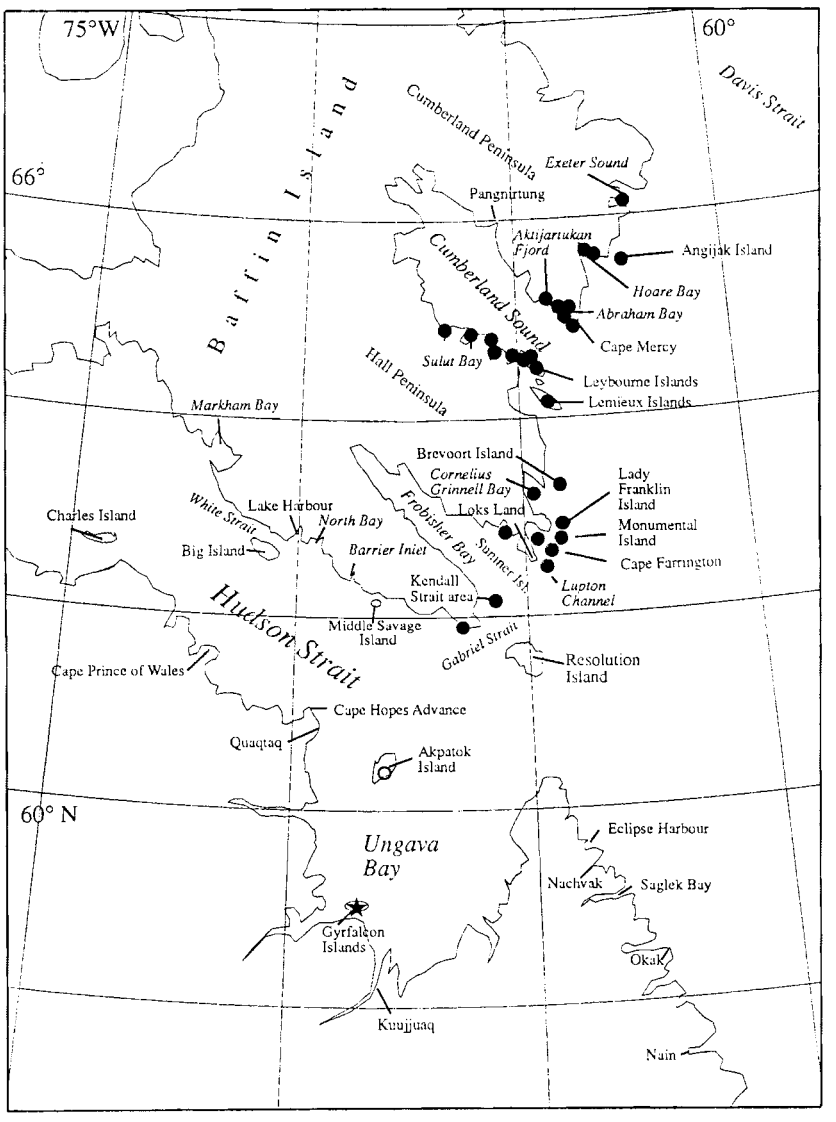

Fig. 16. Locations of terrestrial haul-outs (uglit) on southeastern Baffin Island (see also Fig. 10) and in Ungava Bay. Legend: Black dots = haul-outs still known or believed to be used by walruses. Open circles = historical haul-outs; present status unknown. Stars = Abandoned haul-outs.

eastward movement of walruses in autumn to be along the north shore of Hudson Strait, Currie (1968) referred to a southeasterly migration past Cape Hopes Advance in September-October, well offshore.

The historical distribution and movements of walruses along the south coast of Hudson Strait are poorly known. Bell (1885:27-28) was told by Inuit living at Cape Prince of Wales that it was a good site for walrus hunting "at most seasons of the year". He observed walruses there and in Ashe Inlet in mid August and was told that Ashe Inlet was also a good place for walrus hunting in winter (Bell 1885:25). Walruses were observed and hunted year-round in Stuparts Bay and Fisher Bay during the 1910s and 1920s, but by the 1930s the hunting from the Stuparts Bay HBC post seems to have been done mainly in late summer and fall at Nottingham Island (HBC Archives).

In the northeastern part of Hudson Strait, walruses were said to frequent Gabriel Strait from November to May but to be present between Gabriel Strait and Lake Harbour for only a short period during winter (Public Archives of Canada, RG85, Vol. 1045, file 540-3, part 3-C). In at least some years small groups were present off Pritzler Harbour through the winter. A small group of walruses was said to occur around the Middle Savage Islands between Resolution and Big islands, mainly from October until May (Mansfield 1958, Higgins 1968:150). Higgins believed that this group was separate from the walruses at Resolution Island and Loks Land at the entrance of Frobisher Bay. Rather, he believed that these walruses occasionally drifted on ice westward to North Bay, near Lake Harbour.

Inuit knowledge, as summarized by Kemp (1976), identified two sites in the Lake Harbour region as especially good for walrus hunting: 1) a narrow zone from Pritzler Harbour to Shaftesbury Inlet, especially in Pritzler Harbour and Observation Cove; and 2) at East Bluff on the southern tip of Meta Incognita Peninsula. Walruses were also hunted along the floe edge of Juet Island and at Fair Ness. They were also said to occupy uglit in North Bay and White Strait during summer and to be present in North Bay in winter (Kemp 1976).

The present distribution mapped by Riewe (1992:91,129) off southern Baffin Island is approximately as described by Kemp (1976) and others, with the suggestion that walruses migrate east and west along the south coast of Baffin Island. His descriptions of the current range (pp. 202-203, 237) indicate that they occur "in large numbers" around the Middle Savage Islands in spring and late fall, winter along the floe edge and throughout the offshore pack ice of Hudson Strait and in North Bay and White Strait, and occasionally enter Markham Bay in late summer after break-up. Riewe also refers to an ugli on Spicer Island, and to the fact that walruses occasionally drift westward on ice from the Middle Savage Islands to North Bay during winter.

Aerial surveys in March 1981 showed that walruses winter in Hudson Strait and Ungava Bay (McLaren and Davis 1982). The sightings reported by MacLaren-Atlantic (1978), MacLaren-Marex (1979), and McLaren and Davis (1982) indicate that walruses are still present at Akpatok Island and elsewhere in central and eastern Hudson Strait.

The almost complete lack of observations of walruses by Finley *et al.*(1982) during a shore-based survey of belugas, mid October to early December 1980, at Cape Hopes Advance (one eastbound walrus sighted on 3 December) is consistent with the widely held view that the eastward fall migration of walruses through Hudson Strait (assuming that it occurs) is either well offshore or along the north side of the strait.

Mansfield (1990) noted the absence of any recent information, other than that from the aerial surveys mentioned above, on the distribution of walruses in Hudson Strait and Ungava Bay.

Generally, information about migration and relationships among groups of walruses in these areas is difficult to interpret, and sometimes seems contradictory. Aerial surveys in March showed that walruses winter in Hudson Strait and Ungava Bay (McLaren and Davis 1982), which is consistent with Inuit knowledge and historical information. Inuit at Cape Dorset observe walruses during winter along the south coast of Foxe Peninsula, between Nottingham and Salisbury islands and at Chamberlain Island in western Hudson Strait (Orr and Rebizant 1987). According to Elton (1942) walruses wintered in Ungava Bay near Akpatok Island. Although walruses winter in Hudson Strait there apparently is also an eastward migration out of Hudson Strait in fall. This outmigration in October may be two pronged, with some groups moving south along the northern Labrador coast and others (probably the greater proportion) following the coast of Baffin Island (Loughrey 1959) and perhaps dispersing offshore. Walruses were seen off the northern tip of Labrador during aerial surveys in March (McLaren and Davis 1982). Local people of Labrador were of the opinion that the Akpatok Island summer population winters along north-eastern Labrador (Anon. 1978).

Apparently walruses in these areas winter in

small groups in cracks and leads among the ice, in the shore lead along southeastern Baffin Island, and in polynyas off northern Labrador, at the entrance to Frobisher Bay and off Hall Peninsula (and possibly Cumberland Peninsula).

Southeastern and eastern Baffin Island: Historically, walruses apparently occurred along the entire east coast of Baffin Island (Freuchen 1921, Vibe 1950, Loughrey 1959). This is also indicated by the location of walruses killed by British whalers along the east coast of Baffin Island. However, citing Inuit informants from the Pond Inlet area, Bisset (1968) stated that walruses very infrequently occurred along the northeast coast of Baffin Island between Cape Macculloch and Clyde Inlet. The current near-absence of walruses along this stretch of coast was confirmed during aerial surveys in both 1978 and 1979 and during coastal watches in the fall of 1978 (Koski and Davis 1979, Koski 1980).

Kills made by British whalers indicated that walruses were especially numerous in inshore areas in September and October in the Cape Searle-Home Bay area (Ross and MacIver 1982). Freuchen (1935) and Loughrey (1959) mentioned Clyde Inlet as an important haul-out area. Padloping Island had an important ugli. Hjort and Ruud (1929) observed "great numbers" of walruses in Exeter Sound on 24 July 1924.

The coastal areas to the north and south of the mouth of Cumberland Sound, Nuvuk Point to Cape Mercy and the Leybourne Islands to Abraham Bay, respectively, are important areas for walruses today (Schledermann 1975:27, Stevenson 1993). Kumlien (1879:63) reported that walruses had been much more common in the upper parts of the sound in the past. Judging by catch records of commercial whalers, the areas around Kekerton and Blacklead islands also had good numbers of walruses in the second half of the 19th century and early in the 20th. Although walruses have been mapped as occurring off and southeast of Bon Accord and in Kingnait Fiord, upper Cumberland Sound (Anon. 1981-87), they are no longer common in Cumberland Sound north of Nuvuk Point (Anders 1967); only occasional individuals are encountered towards the head of the sound, *e.g.* off Nettilling Fiord (Schledermann 1975:27, Stevenson 1993).

A hunter from Pangnirtung reported that walruses still occur all around Cape Mercy and westwards to Kingnait Fiord and northwards to Angijak Island (A. Papatsie pers. comm. 1995). Five uglit are still used by walruses in the Cumberland Sound area: 1) just west of the mouth of Ujuktuk Fiord, 2) on an island in Ujuktuk Fiord, 3) on an island between Angijak Island and Ingnit Fiord (north of Hoare Bay), 4) on a little island west of Kekertuk Island and near the mainland in the mouth of Exaluin Fiord, Hoare Bay, and 5) on an island on the east side of the mouth of Tonak Fiord, Hoare Bay (A. Papatsie, *op cit.*). The same hunter indicated that two uglit in this region were no longer used by walruses: one on Miliakdjuin Island (allegedly abandoned after 1947 because of disturbance by motorboats) and the other on a little island off Kekertukdjuak in the mouth of Kingnait Fiord. Walruses are said to winter in parts of Abraham Bay and to move into Ujuktuk Fiord with spring break-up. Those in the Hoare Bay area are said to winter off the coast between Muingmak and Angijak islands and to begin moving into the fiords in spring (A. Papatsie, *op cit.*).

Walruses are present throughout the Lemieux Islands from August to November, and perhaps year-round (Anon. 1981-87). The mouth of Winton Bay in outer Robinson Sound is an important walrus site (Anon. 1981-87). Walruses were hunted during the period 1928-62 along the south shore of Cumberland Sound, from near Iglootalik and all the way to the Leybourne Islands (Kemp 1976:138). Kipisa and Utusivik have been mapped as areas where Inuit from Pangnirtung go for walruses in this area (Anon. 1981-87). The general pattern was for the walruses to move close to shore in spring and summer and out into Cumberland Sound in winter (Kemp 1976:138). Some overwinter in outer Cumberland Sound (Anon. 1981-87). Hundreds of walruses are said to haul out at Cape Mercy, and there is another ugli on an island at the mouth of Ujuktuk Fiord (in Abraham Bay) (Anders 1967, Anon. 1981-87). The Leybourne Islands and Sulut Bay have been mapped as good walrus areas (Anders 1967, Anon. 1981-87). On the opposite side of Cumberland Sound, during the period 1928-82, walruses were hunted from the mouth of Kingnait Fiord all the way to Cape Mercy, with hunting especially good in Abraham Bay, Ujuktuk Fiord and the mouth of Aktijartukan Fiord (Kemp 1976). Along the east coast of Cumberland Peninsula they were hunted during summer in Hoare Bay and north to Clephane Bay and Exeter Sound (*Ibid.*). From 1962 to 1974 walruses were hunted in southern Cumberland Sound mainly near Kipisa, Utusivik, the mouth of Salut Bay and among the Leybourne Islands; along the eastern sound from the mouth of Iqalujuak Fiord to Kumlien Fiord and Wareham Island; and south of there from the mouth of Aktijartukan Fiord and near Kekertaluk Island in Hoare Bay (Kemp 1976:142). Broughton Island hunters hunted walruses during 1927-55 mainly in

the Alexander Bay area of Home Bay, northwest of Kekertaluk Island, in the mouth of Okoa Bay and the Nedlukseak Island area, between the northwestern headland of Kivitoo Peninsula and Nedlukseak Island, and among the islands in the southwest part of Kivitoo Bay (Kemp 1976:143). Important summer and fall walrus hunting sites were the southeast corner of Broughton Island, the islands directly south of Broughton Island, Duck and Padloping Islands, Cape Searle and Durban Island in Merchants Bay, as well as in a narrow zone southward from Cape Durban to Cape Dyer. Less important hunting areas were in the Totnes Road part of Exeter Sound, throughout Kairolik Fiord, near Kekertuk Island and in Hoare Bay (Kemp 1976:143).

Walruses are said to have become "much less plentiful" in the Padloping area during the late 1950s and early 1960s but to have increased in numbers there during the late 1960s and early 1970s (Kemp 1976:144). They were hunted during this latter period around Durban and Padloping islands, Cape Searle and occasionally just west of the islands in Canso Channel, near the southeastern corner of Broughton Island, and off the south shore of Kivitoo (*Ibid.*). In some years they were also taken around Nedlukseak Island and Brodie Bay, just north of Kekertaluk Island, in Nudlung Fiord and around some of the smaller islands in northwestern Home Bay (*Ibid.*).

Frobisher Bay was traditionally an important walrus hunting area. Besides hunting walruses intensively in the mouth of Hudson Strait (from the Middle Savage Islands southeast along the coast of the Meta Incognita Peninsula to the vicinity of Nanuk Harbour), the Inuit from this area also hunted them during 1925-55 in Ward Inlet and just south of Fletcher Island, both areas towards the head of Frobisher Bay, in a large area from Hamlen Bay, south along the east coast of Frobisher Bay, around Loks Land, and north to Beekman Peninsula, terminating at Cape St. David (Kemp 1976:134). Although walrus hunting remained intensive after 1955 in Hamlen Bay, Lupton Channel, and along Beekman Peninsula, the decline of dog teams during the 1960s and early 1970s made this activity less important. By the early 1970s most of the walrus hunting by the people of Frobisher Bay was limited mainly to areas along the east and west coasts of Blunt Peninsula, including Cyrus Field Bay (Kemp 1976:136). Records of the Hudson's Bay Company post in upper Frobisher Bay during the late 1920s to late 1930s indicate that walruses were hunted in summer and fall (July-November) as well as in winter (February-March) (HBC Archives, unpublished data).

A detailed report of a walrus hunt in September 1942 by the RCMP detachment at Lake Harbour (Public Archives of Canada, RG85, Vol. 1045, file 540-3, part 3-C) contains useful information on walrus distribution. The motorboat left Lake Harbour on 7 September and followed the coast east to Resolution Island, then north to Loks Land and finally Brevoort Island. Walruses were scarce when the vessel arrived (16 September) but began appearing from the north within several days. The total catch was 26 walruses, taken between 17 and 26 September at Brevoort Island, Loks Land, and in Robinson Sound. At least 8 animals were killed and lost due to poor weather. The meat, blubber, and skin were cached for dogfood on winter police patrols. All apparently were harpooned and killed in the water. A similar hunt in 1937 produced 21 walruses between 13 and 29 September in Jackman Sound (Frobisher Bay) and Cyrus Field Bay at Loks Land, and near the foot of the glacier on Grinnell Peninsula. RCMP records indicate that walruses were consistently "plentiful" in Cyrus Field Bay and Robinson Sound and along the coast from Robinson Sound to the Lemieux Islands during the 1930s and 1940s, especially in the autumn.

According to a local hunter, walruses are found today in spring at several sites along the west sides of Blunt Peninsula and Loks Land (E. Papatsie, pers. comm. 1995). In summer and fall they are present among islands off eastern Loks Land and in the mouth of Cyrus Field Bay (*Ibid.*). Land use maps call attention to many areas around the mouth of Frobisher Bay used by walruses (Anon. 1981-87, Riewe 1992). These essentially agree with previously published information, but there are some inconsistencies with the fine details. It is not possible to reconcile these inconsistencies here. Walruses may still occur during summer and fall in Ward Inlet, and there is a summer or fall ugli on some very small islands just southwest of Sumner Island (Riewe 1992).

According to Smith *et al.* (1979) walruses overwinter in the open areas of Frobisher Bay, where they are hunted along the floe edge in late winter and spring (Anon. 1981-87). During aerial surveys in March walruses were observed in this area, off Hall Peninsula and at northern Labrador(MacLaren-Marex 1979, McLaren and Davis 1982), and approximately 50 were seen along the floe edge just north of the western entrance of Chappell Inlet in January 1984 (Anon. 1981-87). Uglit on islands at the south end of Lupton Channel are occupied in autumn (*Ibid.*). Some of the walruses from these areas may move across Davis Strait to winter off central West Greenland at the edge of the Davis

Strait pack ice – the West Ice (Freuchen 1921, Dunbar 1956, Vibe 1967).

During aerial surveys walruses were observed in April and May at the entrance to Hudson Strait, and along the northern Labrador and Hall Peninsula coasts (MacLaren-Marex 1979). Between June and September, walruses occur along the outer coastline of southeastern Baffin Island, from Gabriel Strait north to Clyde Inlet (MacLaren Atlantic Ltd. 1978, MacLaren-Marex 1979, 1980a, 1980b, Smith *et al.*1979). They were observed in June at Akpatok Island in Ungava Bay (MacLaren Atlantic Ltd. 1978). During summer concentrations have been observed off Hall Peninsula, around Lady Franklin and Monumental islands (where they apparently feed), and near Brevoort Island and Cape Dyer (MacLaren- Marex 1980b). Walruses were present in the Loks Land and Lemieux Islands areas from early July. A large number of walruses, apparently coming from Hudson Strait, entered the Hall Peninsula area in mid-September (Smith *et al.*1979). Other terrestrial haul-out sites are found in the Lemieux Islands, on the west side of Brevoort Island, in Cyrus Field Bay, and in Hoare Bay (MacLaren Atlantic Ltd. 1978, MacLaren Marex 1979, 1980a, 1980b).

Uglit on eastern Baffin Island (see Figs 10 and 16): In the Hudson Strait-Ungava Bay area walruses are reported to have hauled out on Akpatok Island, the Eider Islands near Cape Hopes Advance, and several of the islands along the southern coast of Hudson Strait such as Wales, Weggs and Charles (Loughrey 1959). They were formerly found on islands near Sugluk, in Deception Bay and on Digges Island but apparently had been largely killed off at (or driven from?) these sites some time after 1909 (*Ibid.*). The most populated uglit in the Hudson Strait region are unquestionably those at Nottingham and Salisbury islands, which are discussed more fully under the section on Northern Hudson Bay and Western Hudson Strait.

In the early part of this century, the biggest ugli along the east Baffin coast may have been at Padlei, just south of Padloping Island (Mansfield 1958). Bethune (1934) mentioned a second-hand report that one company took over 4000 skins per year, but the catch locality (or localities), and the period or number of years involved, were not clearly stated. Mansfield (1958) and Reeves (1978) interpreted Bethune's text to mean that this very large number of walruses was taken annually at Padlei. However, without corroborating evidence of some kind, Bethune's statement, and the subsequent interpretations of it by other authors, need to be viewed with a degree of skepticism. Nevertheless it is certainly true that the Padloping Island area had a great many walruses at one time.

Recent information on uglit in the Padloping Island area and elsewhere along the east coast of Baffin Island is summarized in Figs 10 and 16. A relatively large number of sites are reported as still being used, at least sporadically by a few walruses. These are primarily on islands near the outer coasts of Hall and Cumberland peninsulas. Lady Franklin Island has one of the largest uglit at present.

Gulf of St. Lawrence and Nova Scotia: Walruses were historically abundant in Canadian east coast waters from Labrador south as far as Sable Island (approximately 43°N) and the Gulf of St. Lawrence (Fig. 17). It has been claimed, in fact, that the walrus herds on the Magdalen Islands, Gulf of St. Lawrence, represented "the greatest concentration of walruses in the world" before their discovery by Europeans in the 16th century (Bruemmer 1992). The crew of one ship reportedly killed 1500 walruses in one season at Sable Island in 1591, and kills of similar or greater magnitude were reported at the Magdalen Islands as recently as the 1770s (Allen 1880). Mowat (1984:304, 318) claimed that the Magdalen Islands had 100,000 walruses as late as the mid 18th century and that Sable Island had "at least that many". He referred to a catch of 25,000 walruses in one year (1760s), made from only three of the 11 uglit at the Magdalen Islands. Mowat is prone to exaggerate numbers and as a secondary source is not particularly reliable. Before trusting his account, it would be necessary to examine his primary sources, which we have not done. However regardless of whether Mowat's (and Bruemmer's) statements are literally true or not, the numbers of walruses in the Gulf of St. Lawrence and off the coast of Nova Scotia must have been very large, by any standard.

Walruses in southeastern Canada were said to haul out and give birth on islands between April and June (Allen 1880). Whether these large herds migrated over long distances, and whether their distribution was continuous northward along the Labrador coast, is uncertain. There is no evidence that walruses have begun to recolonize this part of their former range (Reeves 1978), and we accept the judgment of Richard and Campbell (1988) that the Atlantic walrus is now extinct in this part of its range.

Labrador: Walruses were formerly present along much of the Labrador coast and were regularly observed and hunted in winter and spring (mid February to June) to at least as far south as Okak Bay (Hawkes 1916:32, Hantzsch 1932, Taylor 1974, 1977, Taylor and Taylor 1977, Brice-Bennett 1977,

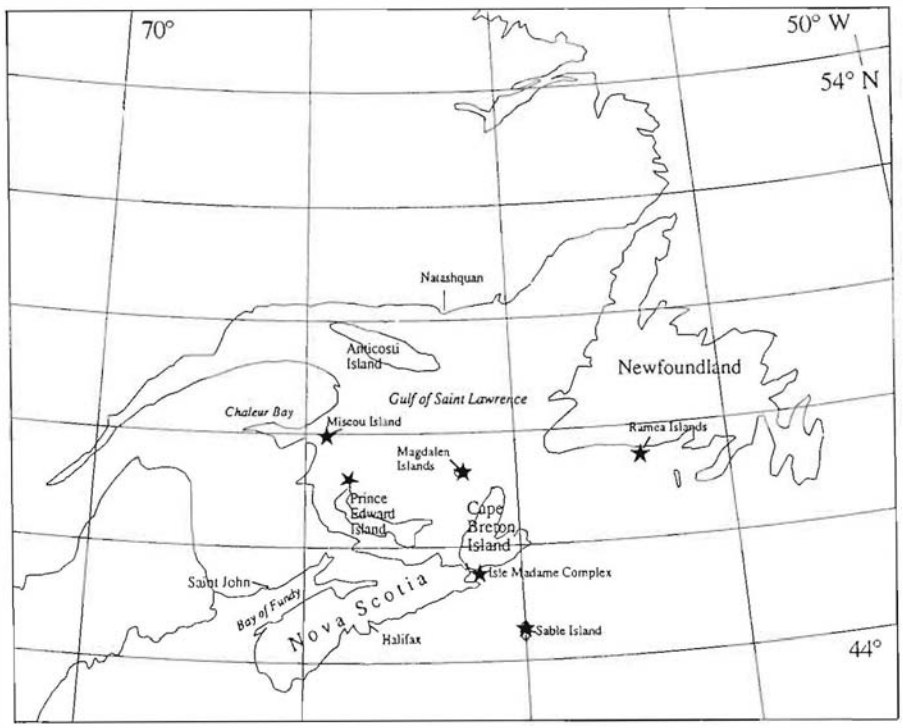

Fig. 17. Locations of abandoned terrestrial haul-outs (stars) in the Gulf of St.Lawrence and Nova Scotia region.

HBC Archives). The main hunting areas were in the northern Okak and Hebron districts (Brice-Bennett 1977:121). According to an archaeologist the traditional walrus hunting grounds were at the Galvano Islands and at Chance Rocks and Ashe Rocks off Mount Bache Point, both at the mouth of Eclipse Harbour (S. Loring, pers. comm.).

All accounts suggest that the animals were migratory and occurred off central Labrador only in winter and spring. It is not known how far south walruses migrated on the Labrador coast. Hawkes (1916:32) observed a large herd in heavy ice off Davis Inlet in 1914, and Freuchen (1935) claimed that females and young moved all the way south to Battle Harbour, near the Strait of Belle Isle. It appears, however, that by the 1920s and 1930s only stragglers reached as far south as Okak. Brice-Bennett (1977:173) concluded on the basis of interviews with Inuit elders that walruses had never been abundant as far south as Hopedale. Loughrey (1959) gave the normal southern limit as Hebron (= Nachvak). In February 1977 walruses were observed at 59°N, 62°W, about 50 km east of Saglek Bay (Anon. 1978).Although walruses were hunted "occasionally" near Port Burwell prior to 1960, they were no longer hunted there by the early 1970s (Val 1976).

Hunting methods: Taylor (1974:46) described the methods used for walrus hunting in the Okak area during the early 20th century. The animals were killed with harpoons and lances while hauled out on an ugli at the east end of the island Operngevik-soakh. They were also hunted at aglus (*i.e.* breathing holes in ice) by Inuit working cooperatively. Near Uvingayokh Island walruses were harpooned at the floe edge, sometimes by solitary or paired hunters. Kayak hunting of walruses occurred in the 19th century; for example the Inuit at Okak killed 10 walruses, apparently using this method, in spring 1844 (Taylor 1974:47).

Inuit in the area of Nachvak, Labrador, regularly hunted walruses during winter and spring in the early 1900s. HBC journals document catches of at least 11 walruses between 7 March and 5 May 1903, one in April 1904, two in February 1905, and eight between 26 February and 31 May 1906. Walrus hunting was clearly seasonal in this area, beginning in February and lasting into May most years (HBC Archives, unpubl. data).

Population Size

Western Hudson Bay: A report from the early 1930s at Chesterfield Inlet refers to at least 1500 walruses hauled out in early October on an unspecified island (Currie 1987:10). It is not clear which island is meant, and it could have been one of the large uglit in the Southampton – Coats Island area rather than along the west coast of Hudson Bay. As many as 40 walruses were seen at "Little" Walrus Island in late September 1956 (RCMP game report from Eskimo Point), and 400-500 were said to be present at Depot Island near the coast north of Chesterfield Inlet in spring 1961 (RCMP game report from Chesterfield).

We are not aware of any recent counts or estimates of walrus numbers from the Keewatin coast.

Northern Hudson Bay and western Hudson Strait: The Southampton Island area is one of the few in Canada where relatively intensive studies of walrus numbers have been attempted, beginning with the efforts of Mansfield (1958) and Loughrey (1959), followed most recently by those of Mansfield and St. Aubin (1991). Vessel surveys in 1953 and 1954 suggested a population of at least 3000 walruses on and around the major uglit at Southampton and Coats islands (Mansfield 1966). Aerial and boat surveys in 1961 resulted in an estimate for the population at Coats Island and Seahorse Point of 2650 walruses (Mansfield 1962), a figure close to the 3000 observed by Loughrey (1959) from an aerial survey in August 1954. These figures would not account, of course, for the walruses present elsewhere in the region at the time, including those in the water, on ice and at other uglit.

Aerial surveys of Fisher and Evans straits and the coasts of southeastern Southampton Island and Coats Island in 1976-77 (July-August) produced a maximal count of about 2400 animals (Mansfield and St. Aubin 1991). Miller (1982), whose purpose was to study behavior rather than to census walruses, counted more than 1500 hauled out on the northeast coast of Coats Island in early August 1978, and he counted about 500 at a different haul-out site (Cape Pembroke) on Coats Island at the end of July 1980 (Miller and Boness 1983). Numbers for the Southampton-Coats Island area summarized by Riewe (1992:244-45, 249) include: 29 in the entrance of Duke of York Bay and near Cape Deas in July 1982, 12 in the Peterson Bay area in August 1981, up to 1500 hauled out at Coats and Bencas islands in July and August 1981, as many as 2000 hauled out at Walrus and Bencas islands "in some years", and 2000 at Seahorse Point in 1954.

The number assigned to the southern Southampton-Coats Island area by Richard and Campbell (1988), "2350+", refers only to the animals counted during an aerial survey and is therefore negatively biased. Richard (1990) reported "total sightings" of about 1500 walruses during aerial surveys in both 1988 and 1989, indicating a "best estimate" that the population of walruses in northern Hudson Bay "may be as large as" 2600.

Richard and Campbell (1988) assigned numbers of "500-1000?" and "1000?" to the areas of western Hudson Strait and southwestern Foxe Basin, respectively. Their basis for these numbers was: 1) reported observations of about 200 walruses at Salisbury Island in fall of 1985 and 1986; 2) reports by hunters of seeing herds containing 500-1000+ walruses hauled out at Mill, Salisbury, and Nottingham islands in late summer and autumn (Orr and Rebizant 1987); and 3) other reports by hunters indicating that groups of 1000+ walruses had been seen in summer along the west coast of Foxe Peninsula, especially between Cape Dorchester and Cape Queen (Orr and Rebizant 1987).

During aerial surveys for seabirds along the west coast of Nottingham Island in the early 1980s, walrus counts in the "low hundreds" were recorded (A.J. Gaston, *in litt.* 1985). These seabird surveys covered only the northwest and southeast ends of Salisbury Island, and no walruses were sighted.

Ungava Bay and central and eastern Hudson Strait: Currie (1968) estimated that at least 1000 to 2000 walruses visited Akpatok Island each year. It is not known what proportion of the Hudson Strait population now uses Ungava Bay. From aerial surveys conducted in late winter it was estimated that a minimum of 850 animals wintered in Hudson Strait and Ungava Bay (McLaren and Davis 1982). According to Mansfield (1990) the number of walruses in Ungava Bay and most of Hudson Strait appears to be small at present.

Southeastern and eastern Baffin Island: On 15 August 1978 an estimated 600-700 walruses were hauled out on a small island in the Lady Franklin Island group directly east (but far offshore) of Cape Haven (MacLaren-Marex 1980b). This group of walruses is thought to make seasonal onshore-offshore movements (*e.g.* Anon. 1981-87) and thus may be related to the concentrations in the Loks Land, Cyrus Field Bay and Lemieux Islands areas. We have no reliable information on the age or sex composition of the walruses hauled out at Lady Franklin Island.

From aerial surveys conducted in late winter it was estimated that a minimum of 223 walruses were present in southwestern Davis Strait (McLaren and Davis 1982).

Richard and Campbell (1988) assigned the number "1000+" to the area of southeastern Baffin Island from Gabriel Strait north to Clyde Inlet, as a guess at the current population size. The apparent basis was the series of aerial surveys noted above.

We suggest that the aggregate population of walruses found during summer in northern Labrador, Ungava Bay and Hudson Strait and along the east coast of Baffin Island south of Clyde numbers between 1000 and 2000 walruses. The actual number is probably nearer the high than the low end of this range, and we emphasize that there could be considerably more than 2000 walruses in this large region. The basis for any estimate of walrus abundance is, in this instance, extremely weak. Moreover, it is possible that regular movement of walruses takes place through the entire length of Hudson

Strait, which could mean that the walruses in southeastern Baffin Island, northern Labrador and eastern Hudson Strait/Ungava Bay are part of a much larger and wide-ranging stock.

Exploitation

Hunting methods: Before the introduction of whaleboats and rifles, walruses were hunted cooperatively by harpoon and lance from the floe edge; by stalking them on shore, cutting off their access to water, and attacking them with lances; and by approaching them in kayaks and harpooning them while they were hauled out on ice pans or the floe edge (Ross 1975:105). Guns were introduced in northwestern Hudson Bay in the middle of the 19th century, whaleboats somewhat later. By the end of the century both were widely distributed in both northwestern Hudson Bay and along the north shore of Hudson Strait. They made walrus hunting "less dangerous and more productive" (Ross 1975:105; Fig. 18).

Kayaks had been entirely replaced by whaleboats and Peterhead boats in western Hudson Bay and on Melville Peninsula by the early 1940s (Manning 1944). Canvas freight canoes were used more at Repulse Bay than elsewhere, "perhaps because walrus are rarely hunted" (Manning 1944:140).

Freeman (1970, 1975) provided detailed information on the methods used by Inuit at Southampton Island to catch walruses. These included floe-edge hunting from canoes in spring and open-water hunting from larger boats in summer and autumn. In the open-water hunts if the walruses were encountered over deep water, the hunters tried to drive them into shallower water before killing them.

Walruses hunted in late September near the HBC post at Wolstenholme during the 1920s were shot in

Fig. 18. The "Agpa", a boat used at the Hudson's Bay Company post at Wolstenholme (near present-day Ivujivik, western Hudson Strait) for autumn walrus hunting at Nottingham Island during the 1920s. Photo: courtesy of Hudson's Bay Company Archives, Public Archives of Manitoba, A. 74/34, fo. 440, taken in 1924 by Ralph Parsons.

the water to wound them, then harpooned. Two or three animals were taken at a time, tied alongside the boat and cut up in the water (Lyall 1979:47- 48).

Inuit traditionally hunted walruses in Hudson Strait from kayaks, using harpoons, lances, and later rifles (Gordon 1887:64). The killing of walruses on land, by cordoning them off from the water with a row of hunters with rifles, took place in Hudson Strait as recently as the late 1940s and 1950s (Russell 1966:7). Manning (1944:140) noted that kayaks were still used by some Inuit living along the coasts of Hudson Strait. However they increasingly were obtaining Peterhead boats that could be used to reach the offshore walrus grounds, "undoubtedly contributing to destruction of the walrus at the more accessible places" (Manning 1944:149).

At Koartak (Diana Bay, near Cape Hopes Advance) the Inuit shot walruses from land and pursued them in kayaks as recently as the early 1960s (Currie 1968:19, 69). At this and other settlements in western Ungava Bay (Hopes Advance Bay, Payne Bay, and Koartak) the availability of Peterheads essentially determined whether walrus hunts took place at Akpatok Island (Currie 1968).

Loughrey (1959) described the walrus hunt in the Southampton Island region, and stated that similar hunting methods were used throughout the eastern Canadian Arctic. The bulk of walruses were taken during the open water season.

Communities on the east and south coasts of Baffin Island (to as far west as Lake Harbour and including the present-day settlements of Clyde River, Broughton Island, Iqaluit (Frobisher Bay) and Pangnirtung) may hunt walruses that belong to the same stock as those hunted by Inuit from Central West Greenland. The possibility that people from Cape Dorset in western Hudson Strait, as well as residents of northern Labrador, Ungava Bay and northern Québec also hunt from this stock cannot be entirely excluded.

During the days when dog teams provided the main means of winter transportation, police detachments, mission stations, and trading establishments depended, as did the Inuit, on walrus catches in the autumn to provide winter supplies of dog food and to a lesser extent fox bait. The use of walrus meat and organs as human food seems to have varied by locality. In some areas, such as northern Hudson Bay and Foxe Basin, walrus meat is reasonably popular as human food. On the other hand, Kemp (1976) reported that many Inuit at Lake Harbour had an aversion to walrus meat. As a consequence their interest in walrus hunting declined substantially with the introduction of snowmobiles to replace dog teams in the 1960s. By the early 1970s most walrus hunting at Lake Harbour was done in conjunction with hunts primarily for seals and ducks.

Catch levels – Walrus catch by commercial whalers: Walrus hunting became commercialized to some extent at the end of the whaling era (late 1800s and early 1900s). Ross (1975:109) noted that some 3000 walrus hides were obtained in trade by Scottish whalers/traders between 1900 and 1915, presumably mainly from northwestern Hudson Bay (as well as from stations along the north shore of Hudson Strait; see Lubbock 1937 for some returns). Commercial whalers, sealers, traders and explorers caught walruses, at least opportunistically (*e.g.* Wakeham 1898:72-73, Vollan 1951), along the east coast of Baffin Island (especially around the mouths of Cumberland Sound and Frobisher Bay; Ross and MacIver 1982) and in Hudson Strait. A "considerable number" of walruses were killed at the British trading and whaling stations (*e.g.* Low 1906), either by white employees or by Inuit hunters for credit in trade goods. For example catches of 150 in 1899, 138 in 1900, and 149 in 1901 walruses were reported for the Cumberland Sound stations (Lubbock 1937). To date, however, no attempt has been made to compile the commercial walrus catches from this and other areas of eastern Canada in a systematic and comprehensive manner.

The Hudson's Bay Company post at Churchill sent an expedition north along the west coast of Hudson Bay each spring to obtain walrus blubber, hides and ivory (Tuttle 1885:208). Walruses were also hunted by the commercial whalers in northwestern Hudson Bay, and Inuit catches contributed to the food supply of overwintering whalers during the late 19th and early 20th centuries (Ross 1975, 1984). Although plenty of data are available in archives and literature, no systematic effort has been made to compile historical catches of walruses for this area.

Inuit subsistence hunting: Inuit along the northern Keewatin coast hunted walruses for subsistence, depending on the meat for dog food and the blubber oil for heat and light (Welland 1976:88, 91).

Loughrey (1959:appendix II) gave the following averages and ranges of annual walrus catches along the Keewatin coast during the 1950s: 10 (2 to 15) at Eskimo Point, 6 at Tavani, 20 (4 to 26) at Chesterfield Inlet and 12 at Repulse Bay. These were based on sporadic RCMP, Canadian Wildlife Service and missionary reports. Catches at Chesterfield Inlet ranged to as high as 18 in the 1960s (RCMP Game Report from Chesterfield, 1960-61).

For settlements in western Hudson Bay the

following annual average catch levels have been reported officially: in 1973-75 (from D.H. Dowler *in litt.* 1976) no catch at Eskimo Point and Whale Cove, 10 at Repulse Bay, 4 at Chesterfield Inlet, and 2 at Rankin Inlet; in 1972-85 (Richard and Campbell 1988) no catch at Eskimo Point, 2 (0 to 6) at Whale Cove, 12 (0 to 35) at Repulse Bay, 4 (0 to 15) at Chesterfield Inlet, and 5 (0 to 15) at Rankin Inlet; in 1988-93 (Anon. 1991...94) no catch at Churchill, 2 in 1988-89 but otherwise none at Whale Cove, 3 in 1988-89 but otherwise none at Arviat (Eskimo Point), 13 (11 to 18) at Repulse Bay, 10 (9 to 11) at Chesterfield Inlet, and 4 (3 to 5) at Rankin Inlet. A harvest study based on hunter recall in 1983-85 (years expressed as, *e.g.* October 1983 to September 1984) gave the following estimates of landed catch (Gamble 1987a, 1987b): 0 in 1983-84 and 1 in 1984-85 at Eskimo Point, 0 at Whale Cove, 5 and 18 at Repulse Bay, 7 and 16 at Chesterfield Inlet, and 1 and 5 at Rankin Inlet. The months of catch reported in the harvest study were May at Eskimo Point, July-September at Repulse Bay, January-March and June at Chesterfield Inlet, and February, May and July at Rankin Inlet (Gamble 1987a, 1987b).There is little information on magnitude of the walrus catches by subsistence hunters before the 1950s.

Northern Hudson Bay and western Hudson Strait: The subsistence use of walruses by Inuit living on or near Southampton Island is especially well documented. "Large caches of walrus meat were stored along the coast of Southampton Island in areas where people expected to camp or trap during the winter" (Welland 1976:96). In more recent times, with the declining reliance upon dog traction for winter transportation, fewer walruses have been taken. They are important in the Southampton Island area mainly as human and dog food and for their ivory. Walrus meat was also traditionally important as fox bait (Welland 1976:112).

Loughrey's (1959:appendix II) estimate of the annual walrus catch at Southampton Island, 1950-54, was 204 (range: 101-261). The total subsistence catch during 1951-61, according to Freeman (1970), averaged 187 (range 101-172, excluding the 77 in 1957 when effort was reduced) (Freeman 1970). Calves, however, which constituted an estimated 20% of the catch, were not reported (or claimed against the quota?) (Freeman 1970). The quota of 7 animals per married hunter and 3 per unmarried hunter was apparently observed during the 1950s and early 1960s. Between 1961 and 1972, with the declining need for dog food as snowmobiles replaced dog sleds, the reported average annual catch of walruses at Southampton Island declined substantially (Freeman 1975).

Official statistics on the annual average landed catch at Southampton Island (Coral Harbour) in 1973-75 was 110 (D.H. Dowler *in litt.* 1976), and Richard and Campbell (1988) listed the average during 1972-85 as 46 (range: 11-103). Most recently (1988-93) the reported catch has averaged 48, ranging between 41 and 60 (Anon. 1991...94, R.E.A. Stewart *in litt.* 1995). Gamble (1987a, 1987b) estimated the landed catch at Coral Harbour (based on hunter recall surveys) in 1983-84 and 1984-85 as 44 and 29, respectively. Although the highest catches were in August and September, some walruses were taken in every other month except February, June, November and December.

The settlement quota for Coral Harbour under the Marine Mammal Regulations is 60 walruses per year (Richard and Campbell 1988).

Catches at the offshore islands in western Hudson Strait have not been compiled systematically or comprehensively, so it is difficult to make meaningful estimates of removals there during the first three quarters of the 20th century. We can present only some examples that may or may not be representative. Soper (1944) reported that one hunter near Cape Dorset killed 25 walruses one autumn (apparently in the 1920s), providing his family with enough meat for humans and dogs, and enough lamp oil, to last the winter. It is fair to say that subsistence hunting of walruses was intensive throughout much of the region. At Nottingham Island in 1953, 117 walruses were taken by people from Sugluk and Ivujivik in organized hunts using boats supplied by the RCMP and the Roman Catholic mission, respectively (RCMP game report from Port Harrison). The estimated annual catch at Ivujivik during the late 1960s was somewhat more than 30 walruses, taken principally at Nottingham and Salisbury islands (Roy 1971).

Donaldson (1988:62-63) noted that official statistics on the landed catch at Cape Dorset were negatively biased. For the years 1981-83 the official catches were reported as 10, 35 and 59, respectively, whereas the estimates made from hunter recall surveys were 89, 54 and 66, respectively. The hunters sampled during the harvest study actually reported catches of 40, 74, 33 and 57 for 1980-83, respectively (*Ibid.*).

Ungava Bay and central Hudson Strait: In addition to one exceptionally large pre-1950 catch of 800 walruses made in one year at Akpatok Island (Currie 1968), catches of 150-200 were made there during the 1950s when trips from coastal settlements were feasible (*i.e.* when seaworthy Peterhead boats were available). Without Akpatok trips, the

average annual total catch in western Ungava Bay during the early 1960s was only about 40 walruses (Currie 1968). A catch of 20 was made at Cape Hopes Advance in 1956 (Evans 1964:17).

We have scattered records from other areas along the south coast of Hudson Strait. In the 1970s annual estimated landings were (NHRC 1976): Sugluk 58, Wakeham Bay 4, Koartak 11, Payne Bay 13, Leaf Bay 0, Fort Chimo 0, George River 1 and Port Burwell 3. It should be noted that much or all of the large catch at Sugluk was probably made at Nottingham or Salisbury Island in western Hudson Strait.

Southeastern and eastern Baffin Island: Loughrey (1959) estimated the annual catch of walruses along the east and south coasts of Baffin Island (from Cape Christian to Lake Harbour) at about 219 per year during the 1950s. It is not clear whether this includes all commercial and subsistence catches (by Inuit, police, and trading companies). During the 1960s the RCMP post at Pangnirtung had a quota of 12 walruses per year, taken for dog food. Most of this catch was made at the Leybourne Islands (Anders 1967). It was noted at the time that the Inuit of Cumberland Sound did not find it "profitable" to hunt walruses because of the great distances to the areas where walruses were still found (Anders 1967:43).

Dowler (1976, *in litt.*) gave an estimate of 156-206 per year landed during 1973-75 at Lake Harbour, Iqaluit (Frobisher Bay), Pangnirtung and Broughton Island, combined. The combined estimate for these same settlements (plus Clyde River) given by Richard and Campbell (1988) was 108 per year for the period 1972 to 1985. Adding the "minimum" and "maximum" catches recorded during the latter period for these settlements, the lowest potential catch in one year would be 17, the highest 298 (Richard and Campbell 1988:table 1). The catches for 1981-83 estimated from hunter recall surveys agree reasonably well with the official figures although in a few cases there are substantial discrepancies – *e.g.* in 1981, 35 vs. 58 for Iqaluit and 36 vs. 62 for Pangnirtung (Donaldson 1988:62). In the period 1988-93 (5 years) the reported average catch in these areas totaled about 62 walruses per year (range: 29-110; Anon. 1991... 94, R.E.A. Stewart *in litt.* 1995). The reason for the apparent decline in the reported landed catch is not clear.

Hunting loss: Most observers of walrus hunting in Canada have commented on the high losses (*e.g.* Manning 1944, Dunbar 1949), with estimates ranging from as high as three or four animals killed for every one secured (Low 1906) to as "low" as one or less than one being lost out of every four killed (Loughrey 1959). Smith and Taylor (1977:7) described a hunt (locality not specified) in which 50-70% of the walruses shot [and killed?] were lost, with "further considerable wounding loss" likely.

Manning (1944) observed that less than 10% of the walruses taken in northern Hudson Bay were killed on land. Although some were still harpooned in the water before being killed, the proliferation of hunting from whaleboats and Peterhead boats meant that increasingly the animals were shot first, then harpooned if possible. Manning estimated that 75% of the walruses killed could be secured if the hunters worked in an organized and cooperative manner. Since they did not, the loss rate was high. Manning implied that this would not necessarily be the case at a place like Coats Island where the animals were usually shot in shallow water and retrieved at low tide.

At Southampton Island 40 of 50 walruses that were "hunted" during the summer open-water hunt in 1961 were "actually killed", and of these none were lost (Freeman 1970). In this hunting, walruses were harpooned after being wounded with body shots. In the same year 5 of 13 walruses killed in the spring hunt from canoes were lost (Freeman 1970).

Even when walruses were harpooned before being killed, there could be significant hunting loss. For example, during a hunt near Salisbury Island Russell (1966:6-7) and his crew were forced to abandon seven walruses that had been harpooned and were ready to be taken on board. Thus the catch actually delivered to the trading post was less than what was in fact secured.

In the absence of rigorously collected recent data from the area of interest, we consider the general average of 30% loss to be appropriate for estimating total removals.

Catch composition: Freeman's (1970) data from Southampton Island indicate a ratio in the annual catch of three adults to one subadult and one calf. However, since calves were not reported in the catch statistics, the pro-ration is not straightforward. Freeman (1970) also noted that the sexual dimorphism in body and tusk size is not as extreme in the walruses at Southampton Island as it is elsewhere. From this, one can infer that selectivity on the basis of sex may not have been a prominent feature of walrus hunting there. During the period of his study, walruses were hunted at Southampton Island for the meat which was needed as dog food. Freeman (1970:170) stated that the value of ivory and walrus meat and blubber for household consumption was "secondary if not negligible at the present time."

No useful information was available for

assessing the catch composition in a meaningful way in other areas within the range of Stock 3. Official catch statistics are reported in terms of numbers of animals killed. However assuming that the hunters are constrained by the Marine Mammal Regulations (*cf.* Richard and Campbell 1988) allowing each licensee to take no more than four walruses per year, it is reasonable to suppose that the catch in most areas of Stock 3 is selective for large animals with large tusks (*cf.* Orr *et al.* 1986).

4. Western Greenland

Distribution and Stock Identity

The approximate summer and winter distributions of walruses in western Greenland are shown in Figs 8 and 9, respectively. Places mentioned in the text are shown in Figs 19-21.

Based on a variety of sources, Born *et al.*(1994a) summarized the historical and current status of walruses in western Greenland south of 76°N (Melville Bay). The following description is based largely on Born *et al.*(1994 a). Only when it is judged particularly relevant is the original source cited.

Southwestern Greenland south of 65°30' N: Walruses are not known ever to have been common in southwestern Greenland but stragglers occasionally were reported in the past as well as in recent years. Apparently walruses sometimes hauled out on land in two places near Nuuk (Fig. 19-20).

Central West Greenland (65°30' N to 70°30'N): Historically, the coastal waters between Nordre Isortoq and Attu (Figs 19 and 20) comprised the most important area for walruses in West Greenland.

From fall until spring, walruses occurred at the entrance of Kangerlussuaq (Søndre Strømfjord), close to the town of Sisimiut (Holsteinsborg) and at the entrance to Nassuttooq (Nordre Strømfjord). Mainly mixed herds of adult females with young and subadults occurred in the shallow coastal waters of these areas. Adult males were reported to prefer offshore areas with deeper water.

Beginning in September, both male and female walruses hauled out on uglit situated on small islands and on the mainland coast between approximately 67° 25' N and 67° 47' N, an area devoid of humans between October and April-May (Fig. 20). Apparently the walruses left the uglit in November-December. According to Freuchen and Salomonsen

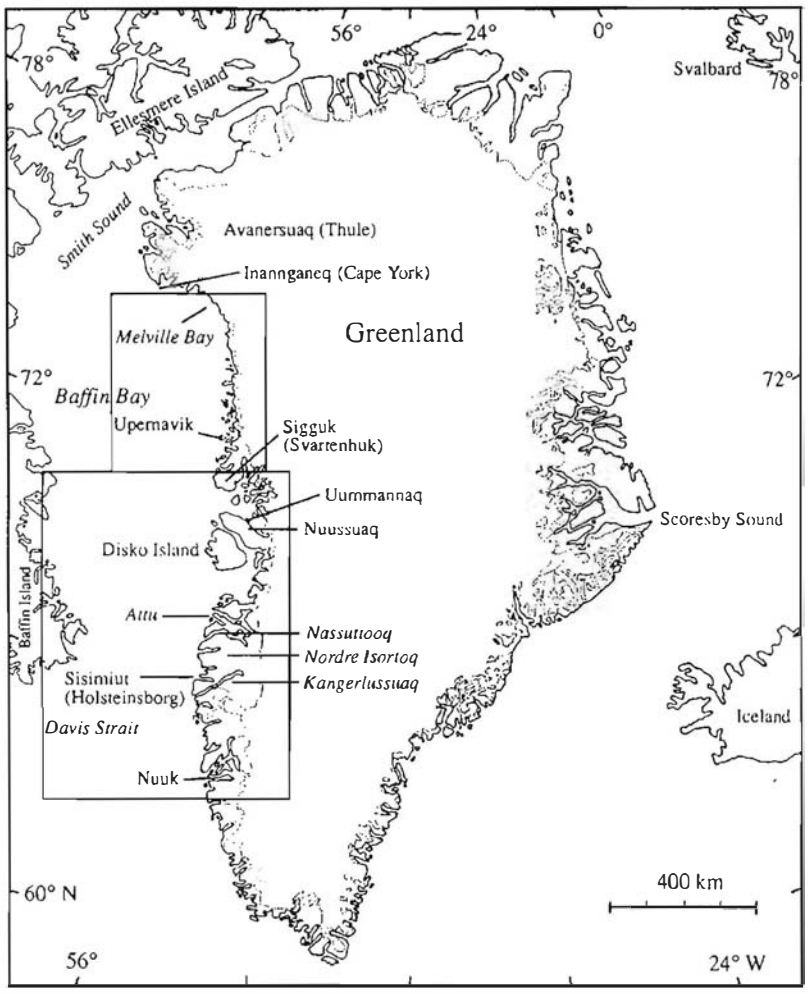

Fig. 19. Names of places in western Greenland (see also Figs. 20-21)

(1961) the number of walruses in this area increased in February, presumably due to immigration of animals from the Canadian side of Davis Strait.

Walruses rarely frequented the uglit after the late 1930s, and since the early 1950s no one has reported them as having hauled out on land in this region. Undoubtedly, the increased hunting at the uglit caused the walruses to abandon them. However, it cannot be determined with certainty whether the group of walruses that hauled out on land was extirpated or, instead, these animals learned to avoid the uglit and began wintering in the edge of the Baffin Bay-Davis Strait pack ice (the "West Ice").

In April the walruses retreated from the coastal regions to the eastern edge of the Davis Strait pack ice. Apparently they followed the westward retreat of the edge of the West Ice during spring. From around mid-June walruses were no longer found at the margins of the West Ice.

Information on the biology of walruses in these areas is scarce. In February males and females occurred together, whereas by late April adults were segregated by sex. By then the adult males occurred farther offshore and in denser ice than females with young.

Walruses were rarely seen near Aasiaat and in Disko Bay. They wintered, however, along the western coast of Disko Island. The walruses appeared in this area in October, and were reported to be abundant at the entrance to Kangerluk (Diskofjord) and were often observed near Kangersooq (Nordfjord) on the northwest coast of Disko. Since 1932, walruses have been caught from April until mid-June, 50-80 km west of Disko Island, at the margin of the pack ice. Large herds have been observed in June near Qeqertarssuatsiaq (Hare Island).

Occasionally, walruses hauled out on the small island of Saattut at the entrance to Kangerluk (Fig. 20). Apparently they no longer hauled out there after the 1950s. Walruses were also reported to haul out on land occasionally at Qeqertarssuatsiaq and on the north coast of Disko Island.

Systematic aerial surveys conducted in 1981, 1982, 1984, 1990, 1991, 1993 and 1994 (McLaren and Davis 1981, 1983, Born *et al.*1994a, Heide-Jørgensen and Born 1995) showed that walruses still occupy their former wintering range in the margin of the West Ice, between approximately 66° N and approximately 70°45' N. Apparently their occurence in this area is due to the availability of shallow feed-

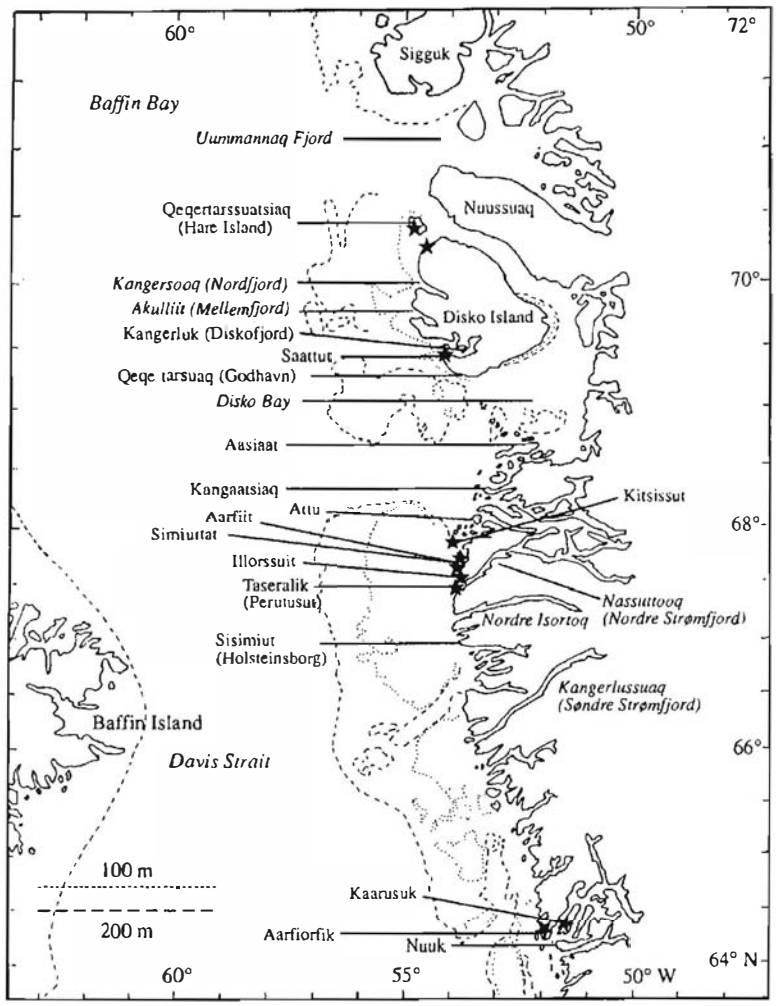

Fig. 20. Locations of abandoned terrestrial haul-outs (stars) in Central West Greenland.

ing grounds and suitable ice for hauling out. Walruses are absent from the entrance of Disko Bay where water depths exceed 200 m. Hence, their recent winter distribution off Central West Greenland is similar to that indicated by historical information. The major differences are their present absence from uglit, and the timing of migration.

From February until late May walruses are found in the pack ice about 30 to 100 km off the coast between Sisimiut and Kangaatsiaq (approx. 68°15' N).

Walruses are reported to arrive at the banks off the west coast of Disko in October-November. During winter they occur along the coast of northwestern Disko Island and around Qeqertarssuatsiaq (Hare Island). Subadults and females with young are generally reported to occur closer to the coast than males.

The walruses off Central West Greenland prefer areas with dense pack ice (usually more than 60% ice cover) in water that is less than 100 m deep. Several of the walrus's prey species inhabit these shallow banks. Most walruses observed during the aerial surveys were either single or in pairs. Larger congregations numbering one to two hundred have occasionally been reported from Central West Greenland.

Observations of newborn calves in this area are extremely rare. The walruses apparently have left these regions prior to the calving season. Recordings of underwater sounds indicate that walruses mate in these areas.

According to informants in Qeqertarsuaq (Godhavn) walruses are never observed moving southward south of the town of Qeqertarsuaq during fall, whereas those wintering near the northwest coast of Disko Island are believed to move north in May. Observations made during aerial reconnaissances flown along the coast between southwestern Disko and Sigguk (Svartenhuk) during spring 1982 indicated that the walruses wintering along the west coast of Disko progressively moved north in the shear zone between the fast ice and the pack ice. The timing of the catches in the Uummannaq and Upernavik areas, compared with that of catches farther south, supports this finding. However, scattered observations offshore in Davis Strait in March-July suggest that some walruses may migrate across Davis Strait from western Greenland to eastern Baffin Island during spring. The absence of walruses at the entrance to Disko Bay and in the bay proper, the information about migration and the differing response to exploitation indicate that the walruses that winter in Central West Greenland belong to two groups: one along the west coast of Disko representing the southern extreme of the North Water population (Stock 5), and a southern group off Attu-Sisimiut, presumably connected with Stock 3.

Northwestern Greenland (70°30' N to 76°N): Between Nuussuaq (70°45' N) and Inannganeq (Cape York) at the margin of the "North Water" polynya, the dense Baffin Bay pack ice lies close to the shorefast ice, leaving the walruses only limited space to overwinter in the Uummannaq and Upernavik areas.

Generally, the historical and present distribution of walruses in the Uummannaq and Upernavik areas appear similar. Walruses are not numerous in these areas and they appear to be mainly transient. A limited number can occur during winter in cracks and leads in the shear zone between the fast ice and the Baffin Bay pack ice. Northward migrating walruses are observed along the edge of the fast ice in the Uummannaq area during spring, but they rarely enter Uummannaq Fjord where the water is deep.

Farther north, migrants occur along the ice edge at the outer archipelago of the Upernavik area during spring (Fig. 21). Occasionally, walruses also are observed closer to the mainland coast. Walruses are more likely to be encountered in certain areas: Kiatassuup qeqertarsui (Ryders Islands, approx. 74°45' N), and between Kiatassuaq (Holms Island) and Nuussuaq (Kraulshavn), and at Kitsissorsuit (Ederfugle Islands).

Walruses were reported to haul out occasionally on the small islands near Eqqorleq.

According to Freuchen (1921) and Vibe (1950) the walruses crossed Melville Bay/Qimusseriarsuaq far offshore during their spring migration north into the Smith Sound region.

Although there are indications that some walruses move north in the shear zone between the shorefast ice and the Baffin Bay pack ice during spring, a "large scale" spring migration north along the western coast of Greenland as indicated in Freuchen (1921) is not witnessed nowadays.

The connection between walruses occurring in parts of the Baffin Bay and Davis Strait area is poorly known. However, in some areas walruses were caught with harpoon heads or rifle bullets that originated from other areas. This was interpreted to mean that a connection existed between walruses in different areas of northern Baffin Bay; for example between Avanersuaq (Thule) and the Ummannaq area in western Greenland, and between Pond Inlet in Canada and western Greenland (Freuchen 1921, 1935, Vibe 1950, Bisset 1968).

Freuchen (1921) and Vibe (1950, 1956) suggest-

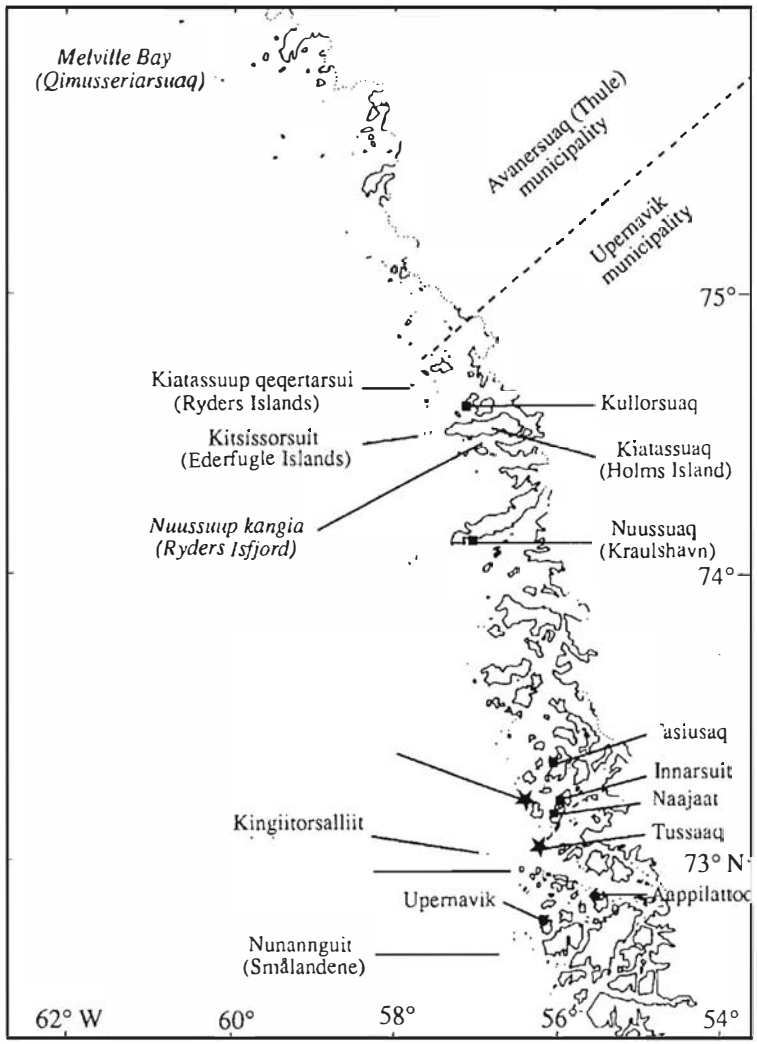

Fig. 21. Locations of abandoned terrestrial haul-outs (stars) in the Upernavik municipality in northwestern Greenland. Villages are shown as black squares.

ed that the walruses from Central West Greenland moved northward during May and June to join the walruses wintering in the northern Baffin Bay - Smith Sound region. In October there appeared to be a southward movement along the east coast of Baffin Island and the northwest coast of Greenland. From Baffin Island the animals were believed to move across Davis Strait to reappear in the central parts of West Greenland in the fall. Vibe (1967) assumed that the majority of the Baffin Bay summering population moved from the Avanersuaq (Thule) area in the fall to Lancaster Sound, and that from there some crossed Baffin Bay to western Greenland. Walruses off Central West Greenland were believed to stay in the Davis Strait pack ice or to cross the strait and join the population at south-eastern Baffin Island in severe winters (*Ibid.*).

Loughrey (1959) and Mansfield (1973) suggested that Atlantic walruses had more sedentary habits than Pacific walruses, and Mansfield (1973) questioned whether the large-scale, counter-clockwise migration cycle in the Baffin Bay-Davis Strait area suggested by Freuchen (1921) and Vibe (1950) actually occurred. Mansfield (1973) also indicated that walruses apparently had become scarce along the northeast coast of Baffin Island. In this area the Inuit did not witness any southward movement according to Bisset (1968). Nor did Koski and Davis (1979) and Koski (1980) during their systematic aerial surveys find any indication of a major southward fall movement along the northeast coast of Baffin Island. The absence of a substantial southward migration during fall along this coast was confirmed by the fact that there was only one sighting of walruses (seven on an ice floe on 5 October) during 260 h of observations for marine mammals conducted from Cape Adair between 13 September and 10 October 1978 (Koski and Davis 1979). We note with interest that according to Kemp (1976) the people of Clyde hunted walruses, mainly in fall, in five main areas during 1923-54: 1. the mouth of Alexander Bay and associated fiords; 2. central Isabella Bay and haulout sites off Henry Kater Peninsula; 3. Clyde Inlet and the mouth of Inugsuin Fiord; 4. the south side of Eglinton Fiord; 5. Scott Inlet.

From the dates when walruses appeared at various locations, Dunbar (1956) suggested that the

Hudson Bay, Hudson Strait and Frobisher Bay groups might comprise one large population. He suggested that the population moves into Hudson Strait in spring and out again in late fall, wintering perhaps in the neighborhood of the ice edge in Davis Strait, where they may well join the walruses occurring off Central West Greenland, as also suggested by Freuchen and Salomonsen (1961) and Mansfield (1973). It is still not clear, however, whether walruses from eastern Hudson Strait mix with walruses in Hudson Bay (Orr and Rebizant 1987).

Born *et al.*(1982) found indications of a northward movement in spring along the west coast of Disko Island. However, scattered observations of walruses in May-July in the middle of Davis Strait suggest that some walruses cross Davis Strait from Greenland to southeastern Baffin Island.

The finding of six haplotypes in analyses of mitochondrial-DNA from 10 walruses sampled during spring off Attu-Sisimiut in Central West Greenland (Cronin *et al.*1994) may reflect a mixing in this area during winter of walruses from different areas – for example northern Baffin Bay and southeastern Baffin Island.

Indications that walruses no longer migrate in any significant number southward in the fall along either the northeast coast of Baffin Island or the northwest coast of Greenland can be interpreted to mean that walruses occur in more sedentary groups nowadays, and that their numbers have decreased substantially.

Population Size

There are no historical estimates of abundance of walruses in western Greenland. Apparently several hundred used the uglit during fall. On 21 September 1897, about 300 animals were estimated to be present at the islands of Taseralik. In 1919 an estimated 600-800 walruses hauled out on the promontory of Illorssuit. In the fall of 1929, 600-700 animals were present on the islands south of Attu.

Catches during several decades of many hundreds of animals indicate, however, that several thousand walruses wintered in Central West Greenland at the beginning of this century.

The estimates of abundance based on aerial surveys between 66°N and 70°30' N from 1981-1982 and 1990-1991 revealed no trend since 1981 (Born *et al.*1994a). The line transect estimates in 1990 and 1991 produced a point estimate of the visible population wintering in Central West Greenland, between approximately 66°15' N and 70° 30' W, of about 500 animals (95% CI: 204-1512). Aerial surveys during late winter in 1993 and 1994 confirmed that the number of walruses wintering in Central West Greenland is in the low hundreds. These estimates are not corrected for animals which could have been submerged during the surveys. There were indications of a decline during the 1980s and early 1990s in numbers in the southern wintering area (Attu-Sisimiut) (Heide-Jørgensen and Born 1995).

Exploitation

Hunting methods – Central West Greenland (65° 30' N to 70° 30' N): The walruses were caught for their hide, blubber and tusks. In Greenland the meat was also used for human food and as food for sled dogs. Salted walrus hides, blubber and tusks were exported by the Greenland Trade Company (Vibe 1967, Born *et al.*1994a).

Traditionally, walruses were hunted from kayak, and often the skin-covered boats – umiat – were used for transportation. Some, presumably few, walruses were also taken during winter at their breathing holes in new ice – for example along the west coast of Disko Island, along ice edges, or when they hauled out on the shorefast ice.

However, of most significance were the walrus hunts by Greenlanders at the uglit in fall, and from 1932 the catch offshore during spring and early summer. Foreign whalers and sealers also caught walruses along the coast of western Greenland. These three types of hunting operations are described briefly in the following.

Traditionally, Greenlanders conducted co-operative walrus hunts during fall at the uglit at the entrance to Nassuttooq. Skin-covered boats and kayaks were used for transportation. However, in 1911 the Greenland Administration provided a motorized schooner which served as an auxiliary vessel during the walrus hunts at the uglit. This initiated an era of increased catches. For the period 1911-1937, a total catch of 1737 walruses was recorded for these hunts at the haul-out sites. This represents a minimum for the catches in these areas. Although these hunts were organized to some extent, many severely wounded walruses escaped into the sea, and losses could be high in some cases. Furthermore, in some years many walruses were killed but not reported. The annual catches were highly variable. For example, in 1898, 44 walruses were caught, and in this area more than 200 animals were killed in 1905. Despite the use of a larger vessels after 1911, the annual catch was still very variable due to the adverse weather conditions prevailing during fall.

Fig. 22. Greenlanders hunting walruses in the "West Ice" off the coast of Central West Greenland, presumably in the late 1930s. Photo: Archives of Arktisk Institut, Copenhagen. Photographer unknown.

A rapid increase in the population of Greenlanders led to an increased demand for hunting products and cash income. During the period 1911 to 1945, the human population in western Greenland almost doubled. During the same period the hunting technology changed dramatically. The number of motorized boats in western Greenland increased from one in 1925 to 390 in 1951. In 1939, 42% of the privately owned motorized vessels were registered in Sisimiut and Aasiaat, two of the most important walrus hunting communities. In 1949 this figure was 57.5%. A major reason for the relatively large number of motorized boats in these towns was that in these areas hunting, particularly of walruses, could be combined with fishing.

The Greenlanders began to use motorized vessels to take walruses offshore in 1932. In the beginning the Greenland Administration supplied the hunters with the vessels free of charge, but soon both vessels owned by the Greenland Administration and privately owned motorized vessels participated in the catch.

During cold winters the edge of the West Ice lies close to the coast (Vibe 1967). Apparently, the mild weather after about 1920 made ice conditions at the edge of this ice less severe during spring, thereby facilitating access by the vessels to walrus habitat. Hence, the combination of increased size of the fleet of motorized fishing vessels and lighter ice conditions during spring may have had a synergistic effect, causing the catch of walruses in Central West Greenland to increase rapidly during the 1920s.

Both British and Norwegian whalers and sealers caught walruses in the Davis Strait and Baffin Bay regions. Many of these walruses were taken along the coast of western Greenland off Sisimiut and Disko Island (Ross and MacIver 1982, Born *et al.* 1994a).

The British whaling operations in these areas ceased around 1910 (Ross and MacIver 1982). However, by that time Norwegian sealers and whalers commenced their walrus hunt in the West Ice between Sisimiut and Disko (*e.g.* Isachsen 1922, Isachsen and Isachsen 1932, Vollan 1951). The Norwegian offshore operations in western Greenland continued until World War I, and were resumed for the period 1919-1923 (Isachsen and Isachsen 1932, Vollan 1951). Prices of walrus hides dropped in 1921 and the Norwegian sealers discontinued

Fig. 23. Greenlanders butchering walruses in the "West Ice", presumably in the late 1930s. Photo: Archives of Arktisk Institut, Copenhagen. Photographer unknown.

their walrus hunt in Davis Strait until 1931, when two vessels again took walruses there (*Ibid.*).

The fact that foreign sealers made large catches of walruses close to the west coast of Greenland was used in Greenland as an argument for commencing the "rational" exploitation of walruses by Greenlanders, involving the use of motorized vessels (*e.g.* Müller 1906).

Northwestern Greenland (70°30' N to 76° N): In the Uummannaq and Upernavik areas walruses are either caught when they winter in the shear zone between the fast ice and the Baffin Bay pack ice, or when they move along the ice edge in spring. The seasonal distribution of the catch indicates that relatively many "late stragglers" are taken in the Uummannaq area. Walrus hunting practices in the Uummannaq and Upernavik area differ appreciably from those in the more southern districts. In the Uummannaq and Upernavik area, walruses were and are still caught by boat during fall, and from the ice edge during winter and spring; larger vessels are not used for walrus hunting.

Catch levels – Catches by Greenlanders in Central West Greenland: According to Rink (1877), the annual walrus catch in western Greenland hardly exceeded 200 animals in the first half of the 19th century. The catch in South Greenland (*i.e.* south of Maniitsoq) was estimated to be 10-20 per year at the beginning of this century (Müller 1906).

During the 1930s the offshore catch of walruses was intensified. According to the Hunters' Lists of Game (HLG) the highest landed catches were reported for 1938 (625 walruses) and 1940 (621 walruses), whereafter the catches decreased by an aver-

Fig. 24. A 20 ton fishing vessel during a walrus hunt in the "West Ice" off Sisimiut/-Holsteinsborg, Greenland, in April 1982. Photo: R. Dietz.

age of 3% per year until about 1965. According to the HLG, a total of 12306 walruses were landed by Greenlanders in western Greenland (Avanersuaq-Thule area not included) between 1900 and 1987 (last year of reporting). Due to loss of mortally wounded and killed walruses, and under-reporting of the landed catch, this figure represents an absolute minimum of the total removals of walruses during the period. Furthermore, the catch taken by foreign sealers and whalers should be added to these figures.

About 89% of the total catch was reported from the communities between Sisimiut and Nuussuaq in Central West Greenland (between 67°N and 70° 30' N); 74% were reported from Aasiaat, Attu and Sisimiut alone. About 7% of the total catch was reported from the Uummannaq and Upernavik areas, and only about 4% from areas south of Sisimiut.

Since about 1965 the reported catches of walruses have remained low. For the period 1965-1987 the annual catch in western Greenland, according to the HLG, averaged 56 animals (SD= 19.7, range: 19-101, n=23 annual reports). However, about 1975, the numbers of hunters reporting catches decreased. To compensate for this development, the catch figures reported for 1979-1985 in the published HLGs include estimates of unreported catches. Hence catch figures since about 1975 are not reliable. The numbers of reports received from Sisimiut – traditionally an important walrus hunting community – have been particularly insufficient in recent years. For example, in 1983 and 1984, when in each year an estimated 10 walruses were caught in Sisimiut according to the HLG, 40 and 74 walruses were taken, respectively, according to information obtained from residents in Sisimiut (Born *et al.* 1994a).

During the period of intensified exploitation in the 1930s and 1940s reproductive females were hunted selectively. The adult females occurred closer to land than males and were considered more valuable economically. The yield of blubber was relatively high in adult females and the ivory from their tusks was good for making tools and artifacts (Born *et al.* 1994a).

Catches by Greenlanders in northwestern Greenland: According to the HLG the annual catch of walruses in the Uummannaq and Upernavik areas decreased between 1940 and 1987. The average annual catch in the period 1940-1959 in the Upernavik and Uummannaq areas combined was around 22 walruses; between 1960 and 1987 the catch averaged 11 walruses per year. Over the entire period, the catch in the Uummannaq area amounted to about 20 % of the total catch of walruses in these two municipalities.

Catches by foreign whalers and sealers: Between 1859 and 1910, a minimum of 3734 walruses were taken in the Davis Strait and Baffin Bay regions by British whalers. The actual catch of walruses by British whalers probably was much higher. A substantial portion of these catches was taken off Central West Greenland during spring (Ross and MacIver 1982). In some years catches were high. For example, in 1906 a whaler took 300-400 walruses in the West Ice (Müller 1911).

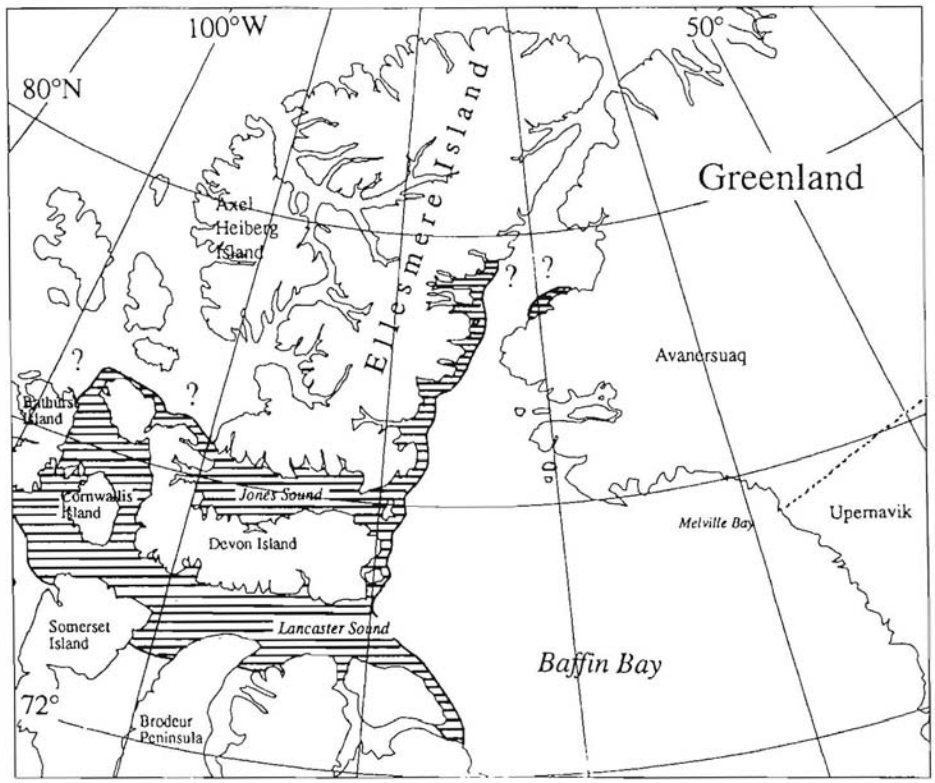

Fig. 25. Approximate summer distribution of walruses belonging to the North Water stock.

Information on the positions and the magnitude of the Norwegian catches of walruses at the beginning of this century is generally incomplete. However, in some years the Norwegian catch of walruses off western Greenland was high, sometimes several hundred animals (Born *et al.*1994a).

Hunting loss: No quantifiable data on hunting loss are available for western Greenland. An eyewitness account from 1937 from the hunt in the West Ice indicated that losses could be considerable. During those days the hunting practice was similar on board other vessels, and often the walruses were not harpooned before being shot (Born *et al.*1994a).

Due to the similarity in hunting practice between Greenland and Canada where losses from 20 to 50% have been reported (Mansfield 1973, Smith and Taylor 1977, Orr *et al.*1986), an overall loss rate (proportion of all animals killed or mortally wounded that are not retrieved) of 30 % is suggested for the kill in western Greenland.

Catch composition: A sample (n=26) taken offshore in the Sisimiut-Attu area (1982-1989) indicates that at present old and large walruses are hunted selectively. Sexually mature females (here, 5 years and older) constituted about 58% of the sample (Born *et al.*1994a).

5. North Water (Baffin Bay – Eastern Canadian Arctic)

The North Water (NOW) situated in northern Baffin Bay is the largest recurring polynya (*i.e.* area of open water surrounded by ice; Stirling and Cleator 1981) in the Canadian and West Greenland Arctic (*e.g.* Smith and Rigby 1981). Smaller persistent open (or semi-open) water areas exist at the entrance to Jones Sound off Coburg Island, in Hell Gate-Cardigan Strait in western Jones Sound and in Lancaster Sound off the southeast coast of Devon Island (*e.g.* Sverdrup 1903, Vibe 1950, Kiliaan and Stirling 1978, Smith and Rigby 1981, Fig. 26). Such open water areas are found in Greenland around Northumberland Island, and between Saunders Island and Wolstenholme Island (Vibe 1950).

For this report we include under the NOW area the entire eastern Canadian high Arctic, encompassing the Lancaster and Jones sound regions and their adjoining inlets and fiords.

Distribution and Stock Identity

Approximate summer and winter distributions of walruses in the NOW area are presented in Figs 25 and 26, respectively. Names of places mentioned in the text and terrestrial haul-out sites, are shown in Fig. 27.

Walruses winter in the NOW, in the polynyas connected with it, and in leads and holes in the

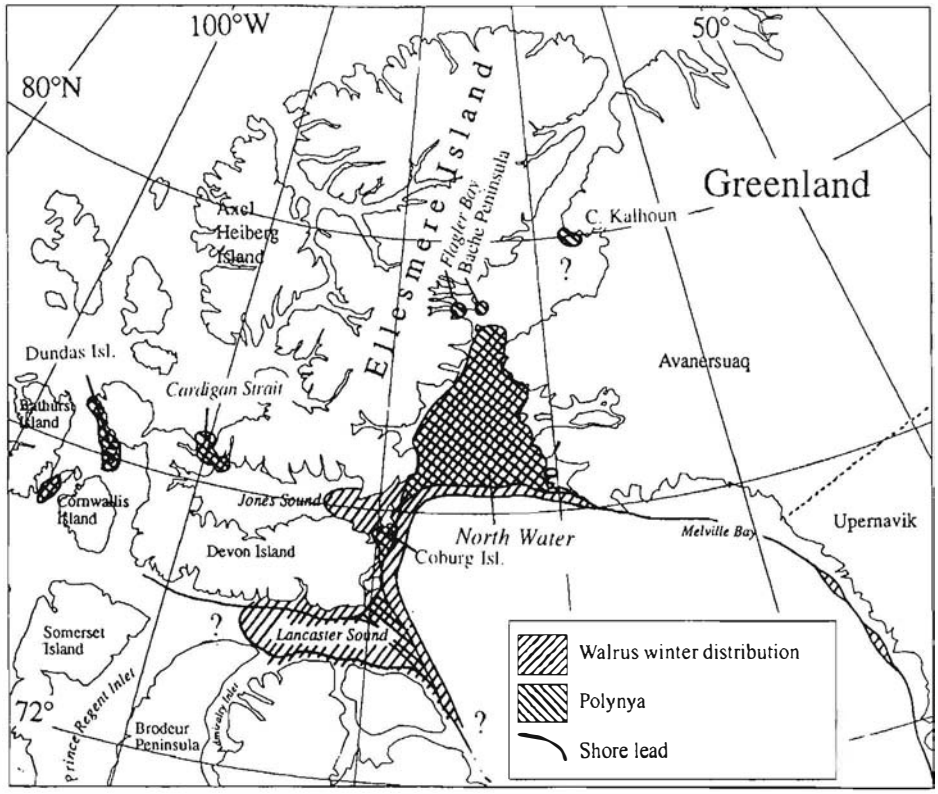

Fig. 26. Approximate winter distribution of walruses belonging to the North Water stock.

consolidated ice of adjacent areas (*e.g.* Kane 1892, Vibe 1950). It has been suggested that walruses might also winter in small polynyas in the Kane Basin region, for example in Flagler Bay (Schledermann 1980), off the tip of Bache Peninsula, and near Cape Kalhoun on Washington Land (Vibe 1950).

The following description of the distribution and movements of walruses in the NOW area proceeds from winter through fall.

In the eastern parts of the NOW area walruses winter in the Avanersuaq (Thule) area between Qeqertarsuaq (Wolstenholme Island) and Cape Inglefield (*e.g.* Kane 1856, Hayes 1867, Peary 1898, Freuchen 1921, Vibe 1950, Born 1987). The thin ice

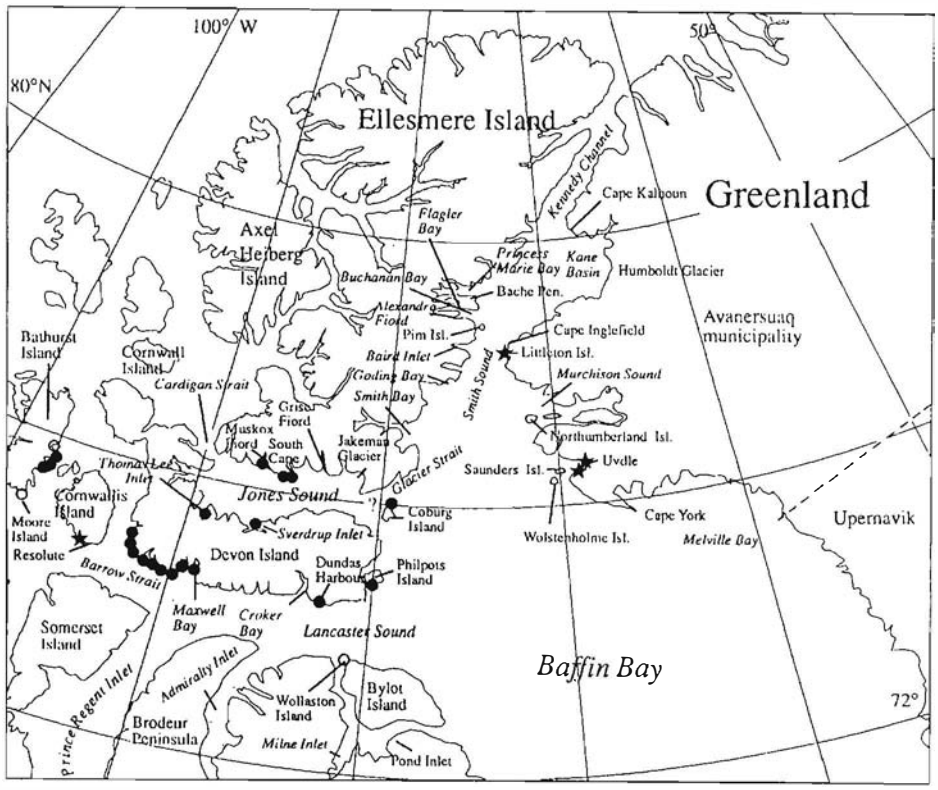

Fig. 27. Terrestrial haul-out sites used by the North Water stock of walruses. Legend: Black dots = haul-outs still used by walruses. Open circles = historical haul-outs; present status unknown. Stars = Abandoned haul-outs.

Fig. 28. In the Penny Strait-Queens Channel area (Canadian High Arctic), some walruses overwinter in heavy consolidated pack ice. They keep breathing holes open or surface in cracks and leads. Photo: E.W. Born.

there is frequently broken up by storms, giving the walruses access to shallow feeding banks (Vibe 1950, Born and Kristensen 1981). During winter walruses are hunted on the thin ice or from the edge of the fast ice. Walruses in the Avanersuaq area are segregated on the basis of sex and age class, with females and subadults generally occurring farther north than adult males (*e.g.* Peary 1917, Freuchen 1921, Vibe 1950, Born unpubl. data).

Walruses also winter in the outer half of Jones Sound (Freuchen 1921, Vibe 1950, Loughrey 1959, Riewe 1976, 1977), including Glacier Strait (Riewe 1992:180). Occasionally some individuals become stranded in Jones Sound by a quick freeze-up and are forced to maintain aglus in the ice throughout the winter (Riewe 1976, 1977, Riewe and Amsden 1979, Kiliaan and Stirling 1978). In May 1972 a hundred walruses were reported to be present in the Hell Gate-Cardigan Strait polynya in western Jones Sound (Kiliaan and Stirling 1978), where walruses are known to winter (Sverdrup 1903, Riewe and Amsden 1979, Stirling *et al.*1983). Walruses winter in the Cardigan Strait-Fram Sound and Penny Strait-Queens Channel areas (Stirling *et al.* 1983).

In connection with polar bear studies the Flagler Bay polynya and the open water at the eastern tip of Bache Peninsula were surveyed

Fig. 29. Hot-iron branding of a male walrus at the Dundas Island polynya (Canadian High Arctic) in April 1988. The animal, which was immobilized with Zoletil ® (Stirling and Sjare 1988), was unconscious during the branding. In the late 1980s a total of nine male walruses were branded and tagged in the Dundas Island polynya – Kerr Island area by Canadian Wildlife Service scientists. These animals have not been resighted outside the tagging area (I. Stirling ***in litt.*** 1995). Photo: E.W. Born.

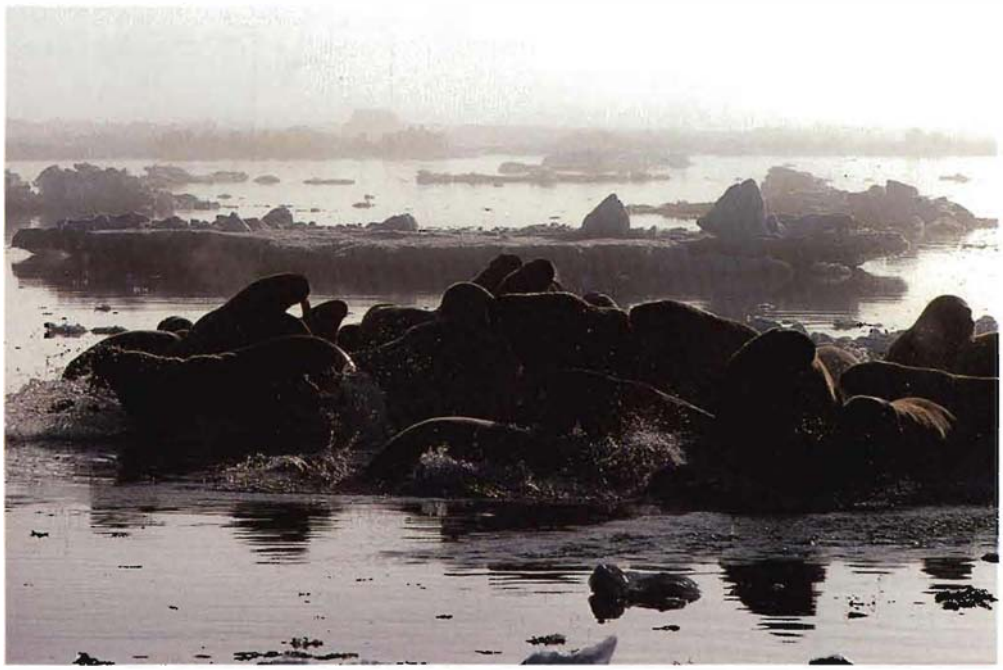

Fig. 30. A mixed herd of walruses hauled out on the pack ice in northern Smith Sound in July 1977 (see text). Photo: T. Kristensen.

between 29 April and 2 May 1994. No signs of walruses were detected in these areas. This was also true of the polynya off Cape Kalhoun (at southwestern Washington Land, *cf.* Vibe 1950) where open water was found at 80°08' N-67°30' W on 1 May 1994 (Born unpubl. data). It thus appears that walruses usually do not winter in these polynyas, which were separated during late April and early May 1994 by consolidated pack ice from the suitable walrus habitats farther south in the Smith Sound region.

In the past, walruses arrived in Avanersuaq (Thule) from the south during spring (Freuchen 1921, Vibe 1950). These migrants joined the animals that had overwintered there. Although information from local people indicates that some walruses still do come from the south during spring (Born unpubl. data), it appears that the pronounced influx during June and July, described by Freuchen (1921) and Vibe (1950), no longer takes place. During aerial surveys conducted in the periods 2 to 18 May 1992 and 4 to 8 May 1993 in the Melville Bay area (including the shore lead between 74° 30' N and 76°N) only two walruses were observed (Born *et al.*1992, Rosing-Asvid 1993). This supports the conclusion that there is no longer any substantial northbound spring migration of walruses along the west coast of Greenland.

Walruses are present at the floe edges of Pond Inlet and Lancaster Sound in spring (Riewe 1992); there is no strong evidence to suggest that these animals are from wintering areas along the east coast of Baffin Island. Aerial surveys during spring 1978 and 1979 revealed no major movement of walruses towards the NOW area from the south along the east Baffin coast (Koski and Davis 1979, Koski 1980). The westward movement of walruses as the ice breaks up makes them available to hunters all along the south side of Lancaster Sound and up to 15 km offshore (Schwartz 1982). According to Schwartz (1982), much of whose data came from interviews with hunters, walruses also penetrate well inside Pond Inlet, Milne Inlet and Admiralty Inlet during late spring and summer.

From April until sometime in June the walruses that wintered in Avanersuaq migrate north along the edge of the shore-fast ice (Freuchen 1921, Vibe 1950, Born 1987). Until about mid-July the ice dam in northern Smith Sound between Pim Island and Cape Inglefield prevents them from migrating farther north into the Kane Basin region. In June and July concentrations of walruses can occur along the edge of the pack ice in northern Smith Sound (*e.g.* Born 1987, Born and Knutsen 1988, Born and Knutsen 1990a) and along eastern Ellesmere Island south of Pim Island (Vibe 1950, Koski and Davis 1979). When the boat hunting is allowed to commence in Avanersuaq on 15 May, after which date thin ice usually does not form, the walruses retreat to the eastern coasts of Ellesmere Island, apparently as a reaction to the hunting (Born unpubl. data).

During aerial surveys conducted over the NOW area in 1978 walruses were observed in May-June along the edge of the shorefast ice off Ellesmere Island, the Lancaster Sound ice edge and the southeast coast of Devon Island. However, small numbers were also consistently sighted along eastern Devon Island, east of Coburg Island, and in Jones Sound (Koski and Davis 1979). During aerial surveys flown over the NOW area during the period 9 May-

2 July 1979 walruses were found in or north of Lancaster Sound. Other areas of importance to walruses were: 1. Coburg Island, 2. the Jones Sound ice edge, 3. southeastern Devon Island, and 4. the Navy Board Inlet ice edge (Koski 1980).

During summer (mid-June to mid-September) the central parts of the Avanersuaq area is devoid of walruses, except for a few stragglers (Born unpubl. data).

When cracks form in the consolidated pack ice in the Kane Basin – Nares Strait region walruses moved northward from Smith Sound; some were reported to penetrate the Kennedy Channel region (*e.g.* Kane 1856, Greely 1888, Rasmussen 1921, Freuchen 1921, Vibe 1950). According to the Inuit of the Avanersuaq area some walruses, predominantly males, still migrate via cracks and leads in the pack ice north along the coast of Inglefield Land to summer off the Humboldt Glacier (Born and Knutsen 1988). Presumably the number of walruses summering in the Kane Basin area varies a great deal from year to year, depending on ice conditions. However, there are no indications that in any year significant numbers summer there.

Officers stationed at an RCMP post in Alexandra Fiord during the 1950s and 1960s regularly reported large numbers of walruses, including a large proportion of females and calves, hauled out on the pack ice in Buchanan Bay and Hayes and Flagler fiords (RCMP game reports). The animals generally arrived in July or early August and left the area by mid September when new ice began forming in the embayments and along the coast. The occurrence of walruses in these areas and in Princess Marie Bay appears to be fairly regular (Freuchen 1921, Vibe 1950, Burton 1980, Schledermann 1980, Born and Knutsen 1988). A small recurring polynya in the Flagler Bay area is thought to attract walruses (Schledermann, 1980). Walruses reach this area in late June or early July (Schledermann 1978), following leads in the ice from the NOW (K. McCullough *in litt.* 1988).

Freuchen (1921) stated that according to Inuit, walruses migrate south along the east coast of Ellesmere Island, where they could meet those that spend the summer in or near Jones Sound (Vibe 1950). According to Greely (1888) Baird Inlet was a favorite feeding ground for walruses. On 7 August 1894 Ohlin (1895) found walruses in great numbers in Talbot Inlet west of Cape Faraday. At the end of July 1987 considerable numbers of walruses were seen at Cape Clarence Head; many females accompanied by calves were observed in Goding Bay (J. Schneller, pers. comm. 1989).

Walruses summer in Jones Sound, entering mainly from the east as the fast ice begins to break up in June or July (Riewe 1992:75,131,185,238). Females and young congregate along the lip of Jakeman Glacier, while males reportedly travel farther west towards the Hell Gate area (Riewe 1976, 1977, Riewe and Amsden 1979). This influx of walruses in late June and early July to Jones Sound was observed during aerial surveys of the NOW area. On 13-15 September relatively small congregations (<15) of walruses were observed along the coasts of Jones Sound west of South Cape, in Baad and Muskox fiords, along the ice edge at Hourglass Bay and off Viiks Fiord (Koski and Davis 1979). Riewe (1976) stated that walruses often haul out during the open-water season on the lowland west of South Cape and in Muskox Fiord. During this period mixed groups that are feeding are regularly observed off the settlement of Grise Fiord (D. Akeagok pers. comm. 1994 and 1995).

The walruses that congregate along the Lancaster Sound ice edge in May and June migrate westward following the receding ice edge (*e.g.* Degerbøl and Freuchen 1935, Bissett 1968, Johnson *et al.* 1976, Greendale and Brousseau-Greendale 1976, Davis *et al.* 1978). The main migration into Lancaster Sound apparently occurs between mid-June and mid-July from the northeast. During the open-water season walruses remain in considerable numbers along the south and southeast coasts of Devon Island (Koski and Davis 1979, Koski 1980, Renewable Resources Consulting Services Ltd. 1976). Along this coast, which has several terrestrial haul-out sites, they prefer Croker Bay, Dundas Harbour and the shallows north of Cape Sherard. The north and east coasts of Bylot Island seem to function primarily as a migration route (Renewable Resources Consulting Services Ltd. 1976). A few walruses may still haul out on the Wollaston Islands in the mouth of Navy Board Inlet, where they are hunted by the Inuit of Pond Inlet (Schwartz 1982).

Walruses were observed regularly from late September until early November off Dundas Harbour in the 1930s (Hudson's Bay Company Archives, Dundas post journals, unpubl. data). They were also present near the post in mid February and between Cape Warrender and Maxwell Bay from early March through July. In 1935 they were described as "exceptionally abundant" at the floe edge of this area on the first of May. They were hunted between Croker Bay and the southwest corner of Devon Island throughout July (*Ibid.*).

Resolute hunters report that walruses winter in the loose ice of Lancaster Sound, arriving at Resolute in late spring as the ice breaks up. In the past, westward migrating walruses entered Barrow

Strait through Resolute Passage, then moved into McDougall Sound, Queen Channel, and Penny Strait. They supposedly stopped going through Resolute Passage because of ship traffic, pollution, and other human disturbances associated with the development of Resolute. The walruses now migrate south of Griffin Island to reach the areas farther north. McDougall Sound, Queens Channel and Penny Strait were still considered walrus summering areas in the mid 1970s (Riewe 1976).

In years when the ice in Barrow Strait fails to clear, large numbers of walruses are said to move into Prince Regent and Admiralty inlets or into Wellington Channel. They are hunted relatively intensively in the vicinity of Cape Clarence and along the north coast of Somerset Island (Schwartz 1982). There was (and may still be) an ugli at Rapid Point on Bathurst Island. In the 1950s there were small uglit on one or two islands on the west side of Allen Bay, southwestern Cornwallis Island, where the Inuit from Resolute regularly hunted walruses (Manning and Macpherson 1961). These were no longer occupied by walruses in the 1960s "because of human disturbance" (Riewe 1976:178).

Manning and Macpherson (1961) reported that in August 1954 small groups of walruses, including calves, were present in western Barrow Strait around the western entrance of Baring Channel. They also claimed that walruses were killed occasionally in northern Peel Sound (Browne Bay). In fact, these authors surmised that the "scattered records" of walruses all the way west to Coronation Gulf and Amundsen Gulf probably involved mainly Atlantic walruses that had strayed westward, perhaps through Peel Sound or Bellot Strait (also see Bethune 1934, Harington 1966, Finley *et al.* 1974, Stewart and Burt 1994 for other "extralimital" records and interpretations).

Walruses have apparently always been rare in the waters near Pelly Bay (southwestern Gulf of Boothia) and Spence Bay (James Ross Strait) (Villiers 1970, Brice-Bennett 1976, Lyall 1979). Those that reach these areas are most likely wanderers from the Lancaster Sound/Barrow Strait region. The Pelly Bay people reportedly caught individual walruses in the 1960s or early 1970s at the mouth of the Kellett River and the southern end of St. Peter Bay (Brice-Bennett 1976).

Judging by the sparseness of records and the fact that walruses are not mentioned among the resources used by Inuit in Prince Regent Inlet and Gulf of Boothia (*cf.* Schwartz 1982), it can be assumed that these areas are unimportant as walrus habitat.

During fall walruses migrate eastward through Lancaster Sound to their wintering grounds in the northern Baffin Bay region. This migration is less conspicuous than the spring migration into Lancaster Sound. For example the eastward migration of walruses through Lancaster and Jones sounds was not even detected during studies in 1978. A southward migration from Lancaster Sound along northeastern Baffin Island was not observed during coastal watches until 10 October 1978 (Koski and Davis 1979). Neither were movements of walruses along the coast of northeastern Baffin Island observed in 1979 (Koski 1980).

Substantial numbers of walruses were present in Jones Sound in late summer and fall 1979 (Koski 1980). Prior to freeze-up walruses congregate in hundreds in the vicinity of Cape Sparbo in Jones Sound (Riewe 1977). Some migrate eastward (Schwartz 1982) and a few overwinter in cracks and aglus (Riewe 1977, Kiliaan and Stirling 1978). Walruses winter in leads and cracks in the eastern Canadian High Arctic as far west as Penny Strait (approx. 98° W; Kiliaan and Stirling 1978). They also winter near small areas of open water in Baird Fiord and Copes Bay as well as in the more extensive open water of Hell Gate (Riewe 1976). In October and November (the actual timing apparently being related to the formation of new shorefast ice) walruses of both sexes and all age groups reappear in the Avanersuaq area where they are hunted along the coast between Etah (Foulke Fiord) and Appat (Saunders Island; Born 1987).

There is no indication of any substantial southward migration along the west coast of Greenland from Avanersuaq to the Upernavik area. Some walruses are reportedly seen, however, migrating south in the Upernavik area during fall (Born *et al.* 1994a).

There are indications that the walruses occurring in the NOW area belong to a different group than those that occur along southeastern Baffin Island and on the southern wintering ground (Attu-Sisimiut) in western Greenland. A uniform haplotype was found in analyses of mt-DNA in a sample of 10 walruses from Avanersuaq (Cronin *et al.*1994). Using protein electrophoresis, walruses (n=93) from this area were also found to have low levels of genetic variation (Simonsen *et al.* 1982). An adult male walrus which was tagged on 18 June 1989 at Cape Inglefield was killed by a hunter on 17 May 1991 about 70 km south of the tagging site (Born 1991). The fact that walruses in Avanersuaq grow to a larger body length than walruses in Hudson Bay (Knutsen and Born 1994) indicates that there is no connection between walruses in these two areas.

Some connections exist, however, between the

Fig. 31. A walrus wearing a satellite-linked radio transmitter is given an additional drug dose by hand injection on Brooman Point, Bathurst Island (Canadian High Arctic), August 1993. One of the walruses tagged at this site was later shot at the entrance to Lancaster Sound (see text). Photo: E.W. Born

walruses in the NOW area and those that winter farther west in the eastern Canadian Arctic (*e.g.* Davis *et al.* 1978) and off the west coast of Disko Island, Central West Greenland (see section: Western Greenland). Walruses appear to winter annually in polynyas of the Cardigan Strait-Fram Sound and Penny Strait-Queens Channel areas (*e.g.* Stirling *et al.*1983). It cannot be excluded that walruses that move westward through Jones Sound and Lancaster Sound during late spring mix with this group of walruses, which probably hauls out on Bathurst Island during summer. This assumption was supported by the fact that one of ten walruses tagged in August 1993 at Bathurst Island was killed by Inuit off Bylot Island in June 1994 (R.E.A. Stewart information in NAMMCO 1995).

There are indications that some walruses move from Avanersuaq south along the coast of western Greenland as far south as Disko Island (Born *et al.* 1982, 1994a).

Uglit: Uglit identified in recent times in the NOW region are shown in Fig. 27. Terrestrial haul-out sites on the Greenland side of the NOW area are no longer used by walruses. Hence the walruses in this region now rely entirely upon access to uglit in Canada or haul out on floating ice. Until some time in the beginning of this century walruses hauled out on Littleton Island and on the Greenland coast opposite this island (Hayes 1867, Peary 1917, Freuchen 1921). According to information given by the Inuit in Avanersuaq to Vibe in 1939-40 (Vibe 1950), walruses also hauled out on land in two other places in the Avanersuaq area in the past (Fig. 27).

The available information indicates that there are no uglit along the east coast of Ellesmere island north of Jones Sound. However, this coast has not been visited frequently during summer, and the hunters from Grise Fiord do not go this far north during the open-water season (L. Audlaluk pers. comm. 1995).

Hundreds of walruses are said to haul out on Coburg Island in the entrance of Jones Sound (Riewe 1992:131,238). Along the north shore of Jones Sound, there are two uglit at and just west of South Cape, another (up to 50 animals) on the east side of Muskox Fiord, and one with "hundreds" of walruses at the base of Jakeman Glacier (Riewe 1992:71,180).

Information obtained from residents of the settlement of Grise Fiord (D. Akeagok and L. Audlaluk pers. comm. 1994, 1995) confirmed that walruses – primarily males – haul out west of South Cape at approximately 76°35' N, 85°15' W at a place called "Sannialuit" (*i.e.* the place with bones). After walruses had been killed on land at Sannialuit they abandoned this ugli. However, recently it has been re-occupied by a group of 50 to perhaps 100 walruses. Walruses still haul out on land in Muskox Fiord (76° 55' N, 87° 25' W). During the open-water season many walruses – primarily females with calves – congregate in the Anstead Point – Jakeman Glacier area east of Grise Fiord, but information conveyed to us (*Ibid.*) did not support the statements by Riewe (1992) that walruses haul out on land in this area, or on Coburg Island.

According to Koski and Davis (1979) there are uglit in Thomas Lee and Sverdrup inlets on the south coast of Jones Sound (*i.e.* north coast of Devon Island). During summer the Grise Fiord hunters usually do not go as far as to the southwest

Fig. 32. On 10 August 1993, 43 walruses were hauled out on Brooman Point. Eight others, including females with newborn calves, were in the water. Photo: E.W. Born

coast of Jones Sound and therefore less is known about uglit in this area. In connection with fishing for Arctic char (*Salvelinus alpinus*) walruses have, however, been seen hauling out on a small island at Cape Newman Smith (Sverdrup Inlet) on the south coast of Jones Sound (L. Audlaluk pers. comm. 1995).

Riewe (1992) identified several uglit along southern Devon Island – on the east side of the entrance to Dundas Harbour, at the southwest corner of Philpots Island, and along the southwestern part of Devon Island at Innes Point, Kearney Cove, Beechey Island, Cape Ricketts, and Cape Hurd and near the head of Maxwell Bay (<100 at each site). In the Queens Channel and McDougall Sound areas there are uglit at Brooman Point, Markham Point and occasionally Milne Island (Riewe 1992:157). Salter (1979) studied walrus behavior at the Brooman Point ugli on southeastern Bathurst Island that is occupied in July-August by as many as 194 walruses (Johnson *et al.* 1976).

Uglit on the Wollaston Islands in northern Navy Board Inlet and on the south coast of Devon Island were traditionally the main sites for walrus hunting by Inuit of the Pond Inlet region during the open-water season (Miller 1955, Ellis 1957, Brody 1976). According to Koski and Davis (1979), who cited Miller (1955) and Bisset (1968), the Inuit from Pond Inlet reported that the Wollaston Island haul-out was used by 200-300 walruses. During aerial surveys conducted in 1976 and 1978 walruses were not seen on the Wollaston uglit although small groups (30 animals) were present on ice pans near the site in late July 1976 (Johnson *et al.* 1976, Koski and Davis 1979).

Systematic surveys of all uglit used by walruses in the Canadian section of the NOW area have not been carried out. Information about the quantitative importance of the various uglit is fragmentary, but evidently the numbers using the different sites vary between years depending, among other things, on variable ice conditions (Koski and Davis 1979). Together, the uglit in Union Bay, Maxwell Bay, Thomas Lee Inlet and Sverdrup Inlet were used by at least 250 walruses in August 1977 (Davis *et al.* 1978). These four uglit were not occupied by walruses in mid September 1978 when they were surrounded by fast ice (Koski and Davis 1979).

Change in distribution: The absence of walruses from the Avanersuaq area during summer is in contrast to the situation earlier when walruses apparently were abundant in, for example, Murchison Sound during the open-water season (*e.g.* Sverdrup 1903, Peary 1917, Vibe 1950).

Apart from this decrease in the length of the period that walruses occur in the Avanersuaq area, their geographical range during summer has also decreased. They previously occurred farther east in Wolstenholme Sound and also penetrated McCormick Fiord (Vibe 1950).

Most likely, these changes have been caused by increased hunting. Between the mid 1950s and the mid 1970s the human population in Avanersuaq more than doubled to about 700 Inuit. This population increase was accompanied by an increased demand for hunting products and cash income. Since the 1960s there has been a substantial change in hunting technology, with an increased use of motorized boats with increased motor power (Born 1987, Born unpubl. data).

Fig. 33. A harpooned walrus surfaces in a lead near Dalrymple Rock/Iganaq, May 1975. Photo: T. Kristensen.

Population Size

Information about numbers of walruses in the NOW and adjacent areas has been collected at different seasons and in different years. Both aerial surveys and ship-borne surveys have been used and the entire range has not always been covered. Hence any numbers must be treated with caution.

Aerial surveys of the NOW during late winter 1978, 1979 and 1993 were intended to sample the entire wintering stock of walruses (Finley and Renaud 1980, Richard *et al.*1993). During the March-April 1978 survey only a few walruses were observed, but during the March 1979 survey approximately 700 were counted along the ice edge between Jones Sound and Talbot Inlet (Finley and Renaud 1980). A comparable aerial survey during 20-26 March 1993 resulted in a total count of only 10 walruses in the Glacier Strait-Cape Norton Shaw area (Richard *et al.* 1993).

Summer concentrations of walruses have been observed in several parts of the NOW area. On 12 July 1978 a minimum of 700 walruses of both sexes and all age classes were seen on the pack ice about 4 to 10 km west of Cape Inglefield (northern Smith Sound) (Born and Kristensen 1981). Between 18 June and 8 July 1989 a minimum of about 170 animals were observed along the ice edge across Smith Sound. Females, calves and subadults were found in the vicinity of Pim Island, while the only adult males observed were in the pack ice close to Cape Inglefield on the Greenland coast (Born and Knutsen 1990a).

Riewe (1992:39,154) indicated that "thousands" of walruses were found along the east coast of Bache Peninsula and also that the population scattered along the east coast of Ellesmere Island in summer represents the third greatest concentration of walruses in Canada (after the Southampton Island and northern Foxe Basin areas). The basis, however, for the statements by Riewe (1992) is not clear. RCMP game reports from Alexandra Fiord refer to a herd of 500-800 in Flagler Bay in summer 1956 and a group of 400, mainly females with calves, near Cape Sabine in early September 1962 (RCMP game reports). In July 1978 Schledermann (1978, 1980) saw about 300 walruses in the Flagler Bay polynya in western Buchanan Bay. The timing indicates that these animals were probably the same group as seen by Born and Kristensen (1981) in Smith Sound. In 1979 at least 250 walruses were observed in the Buchanan Bay area (Schledermann 1980). These estimates of numbers in Buchanan Bay were considered to be conservative (K. McCullough *in litt.* 1988). During an aerial reconnaissance on 31 August 1985 an estimated 300 walruses were observed in Buchanan Bay (Born unpubl. data) where on 21 August 1988 a minimum of 171 walruses were present (Born and Knutsen 1988).

The population estimate obtained from aerial surveys in July 1976 for Lancaster Sound was 309 walruses, the majority of which were along the south coast of Devon Island (Renewable Resources Consulting Services Ltd. 1976). Based on densities of walruses recorded between 9 and 15 July 1979 on coastal, nearshore and offshore transects, 468 walruses were estimated to have been present in parts of eastern Lancaster Sound (*i.e.* all non fast-ice

Fig. 34. A boat approaches a group of walruses in dense fog at Avanersuaq/Thule in June 1977. The hunters attempt to kill the hauled-out walruses instantly by firing a bullet at the head. Wounded animals that escape into the water are harpooned and shot. Photo: E.W. Born.

areas between 79° 30' W and 83° 30' W; Koski 1980).

Davis *et al.* (1978) estimated that 300-500 walruses move westward in the Canadian High Arctic via Lancaster Sound and an estimated 200-300 animals via Jones Sound. They concluded that a minimum of 1000 walruses summer between Devon Island and Bathurst Island. Riewe (1992:185) suggested that less than a thousand walruses remain in Lancaster Sound for the winter.

Based on these fragments of information we tentatively suggest that during summer the numbers of walruses in the NOW area are: 1) Avanersuaq (from Cape York to Cape Inglefield): 0; 2) Kane Basin region: 100; 3) Buchanan Bay and Princess Marie Bay: 300; 4) eastern Ellesmere Island south of Pim Island, and Jones Sound: 300-600; 5) southern Devon Island and Lancaster Sound: 1000.

Hence we conclude that approximately 1700-2000 (perhaps as many as 3000) walruses are present in the entire NOW area during the open-water season.

Exploitation

Hunting methods: The walrus hunt is very important in the subsistence harvest of the Inuit in Avanersuaq. On an annual basis walruses provide an estimated 25% of the meat and other edible products obtained from hunting (Born 1987). The majority of the tusks are sold to the Greenland Trade Company; some are sold directly to tourists.

During the first half of this century walruses were primarily taken from kayaks and on thin ice (Vibe 1950). According to Freuchen (1921) a few were taken during summer from a small schooner that operated from the trade station at Dundas in North Star Bay. Since the mid-1960s there has been an increased use of boats with outboard engines and small "Peterhead"-type boats.

There are two major hunting seasons: 1) The winter hunt takes place from November to mid May (peak March-April) on the walrus feeding banks. The animals are harpooned as they surface, then shot, in thin ice or at the ice edge. 2) The open-water season commences on 15 May when, according to a local rule, motorized vessels are allowed to be launched from the ice edge. This hunt has peaks in June-July and in fall, usually in October. It ends when the formation of new ice prevents navigation (Born 1987). Most of the walrus catch is made during the open-water season. Walruses are first hunted from boats until about mid-July, when the majority of animals have retreated to the east coast of Ellesmere Island, apparently as a reaction to the hunt. In the period September to November, with some variation from year to year, walruses reappear in the Avanersuaq area and are again hunted from boats.

According to local regulations, walruses must be harpooned before being shot (see section: Regulations). This only happens, however, during the thin-ice hunt. In order to secure a walrus during the open-water hunt, the hunter first wounds it with a body shot, sometimes from a long range. This makes it possible to approach the animal closely enough to harpoon it. After the harpoon is secure, the hunter dispatches the animal with head shots. When walruses are hauled out on ice floes, the hunters try to kill them instantly with head shots.

The harpoon is used afterwards to secure mortally wounded animals that have escaped into the water (Born pers. obs.).

We have little information about contemporary hunting methods in the Canadian parts of the NOW area. The Grise Fiord Inuit typically hunt walruses from motorized freighter canoes during summer and fall, approaching individuals and small groups that are either swimming or hauled out on ice floes (Riewe 1976, 1977, Riewe and Amsden 1979). The harpooning and killing methods appear to be similar to those described for Avanersuaq. In some cases walruses hauled out at aglus are stalked. In the past the Inuit used the entire carcass for various purposes. However today walruses are killed primarily for their ivory, and only a small portion of meat is brought back to the village for consumption by people and dogs. Since 1967, when snowmobiles were adopted by hunters, the walrus harvest has diminished at Grise Fiord (*Ibid.*). In recent years, however, there has been an increased interest in hunting walruses, partly because the demand for dog food has increased after the re-introduction of dog teams in Grise Fiord (D. Akeagok pers. comm. 1995).

Inuit of the Pond Inlet region traditionally made expeditions to the Wollaston Islands with the explicit purpose of hunting walruses (Bissett 1968, Brody 1976, RCMP game reports). However according to Treude (1977), whose field work was in 1972-73, "special walrus hunts" no longer occurred at Pond Inlet by the time of his visit. Walruses were, and still are, hunted by the people of Pond Inlet and Admiralty Inlet mainly at the floe edge during spring and early summer, and opportunistically during the open-water hunting directed primarily at phocid seals and monodontid whales (Brody 1976:164, Schwartz 1982, Reeves pers. obs.). This is at least partially due to the fact that large herds of walruses are not available. Hunting methods are presumably similar to those mentioned above for Grise Fiord.

The Resolute hunters hunt walruses in conjunction with seal and whale hunting just outside Resolute Bay in the spring, and also around Cunningham Inlet in the spring and fall (Riewe 1976). Other walrus hunting areas for the Resolute people are in Penny Strait, around Baring and Crozier islands, and along the south coast of Bathurst Island. According to Riewe (1976) the kill of walruses at Resolute declined sharply after the mid 1960s because of the reduced number of sled dogs needing food.

Catch levels – Catches by foreign whalers: In the late 19th century and until 1910 British whalers took numerous walruses in the NOW area. Particularly large kills were recorded for Smith Sound, around Coburg Island, at the entrances of Prince Regent Inlet and Navy Board Inlet, and in Croker and Maxwell bays (Ross and MacIver 1982). Walruses were killed on uglit at the Wollaston Islands at the entrance of Navy Board Inlet, and the large kills in Croker and Maxwell bays may also have been made on uglit. At around the turn of the century large catches of walruses were also sometimes made, by members of exploratory and scientific expeditions (*e.g.* Sverdrup 1903, Peary 1917; see summaries from Allen 1880 etc. in Reeves 1978). In 1949 and 1951, a Norwegian sealing vessel caught 623 and 1175 walruses, respectively,

Fig. 35. A pile of walrus skin, blubber and meat brought back to the settlement of Siorapaluk from a hunt in northern Smith Sound, July 1978. The small "Peterhead"- type boat can bring back the products of 5 to 10 walruses, depending on their size. Photo: E.W. Born.

Fig. 36. Walrus skulls are cleaned before they are sold to the Greenland Trade Company in Avanersuaq/Thule. Photo: T. Kristensen.

in the Davis Strait and Baffin Bay areas. Another vessel took some hundred walruses in 1951. Although the exact positions of the high catches in 1949 and 1951 are not well documented, there are indications that they were taken in the northern Baffin Bay region (Born *et al.*1994a). These latter catches led to a Norwegian hunting regulation in 1952 (Anon. 1952, Rasmussen 1952) which totally banned the hunting of walruses by Norwegians anywhere.

Catches by Greenlanders: The annual catch of walruses in the Thule area around 1940 was estimated at 200 (Vibe 1946, 1950). Bruemmer (1971) estimated the annual catch in the Thule area to range between 100 and 130 animals, to which figures an estimated 30 to 40 animals lost should be added (*i.e.* estimated loss 20-30%). According to Mansfield (1973) an annual average catch of 132 walruses was reported in the HLG for the period 1948 to 1965. Based on information obtained from the walrus hunters in the Thule area, Born and Kristensen (1981) estimated an annual catch of about 215 walruses for the late 1970s. Generally, the reporting in the HLG has been insufficient, and for some years is lacking entirely. The average annual catch during the 1970s and early 1980s was estimated at 250 animals (loss not included) by Born (1987), who pointed out that the walrus catch showed great annual fluctuations, determined mainly by variable ice conditions. In 1988 samples were obtained from 114 walruses, and according to a local informant a minimum of 150 walruses were taken that year (Born unpubl.). According to a new system of collecting catch statistics (introduced in 1993), a total of 217 walruses were landed in Avanersuaq in 1993 (Department of Fisheries, Nuuk).

In some years catches are high. According to the HLG, 290 and 440 walruses were reported for the years 1957/58 and 1961/62, respectively.

As stated earlier, walrus hunting was an important activity at the Hudson's Bay Company trading post at Dundas Harbour during 1934-36, when a total of at least 115 kills were recorded in the post journal (Hudson's Bay Company Archives unpubl. data).

Walruses were killed for dogfood by the RCMP stationed at Alexandra Fiord, Buchanan Bay, during the 1950s and 1960s. Smith and Taylor (1977:26) indicated that a total of 70 was taken in two years with records after 1962. From 1953 to 1962 the annual catch averaged about 16, of which less than 20% were females (7 years with records, RCMP game reports unpubl.).

Loughrey (1959:appendix II) estimated that Pond Inlet, Arctic Bay and Clyde accounted for about 42 walruses per year during the mid 1950s and that an additional 76 were taken each year in the areas of Resolute, Dundas Harbour, Craig Harbour and Alexandra Fiord, combined, during this same period. These totals certainly declined by the late 1960s as the need for dogfood diminished.

Recent reported catches in the Canadian parts of the NOW area (defined as including Resolute, Arctic Bay, Pond Inlet and Grise Fiord) averaged about 23 per year during the period 1972-1985 (Richard and Campbell 1988) and 21 for 1988-1993 (5 years; range: 13-30) (Anon. 1991...94, R.E.A. Stewart *in litt.* 1995).

We estimate that annual removals (including loss) from the NOW walrus population average approximately 375 animals. This estimate is derived in the following manner: annual landed catch in Avanersuaq = 250 walruses to which a loss rate of 25% is applied (see: Hunting Loss); Upernavik = about 10 walruses per year plus a loss rate of 25%; reported catches from the same population in Canada have averaged about 20 walruses per year,

subject to an overall loss rate of 30%. To these catches from the NOW walrus stock another 10 walruses landed in the Ummannaq municipality and in the Disko Island area may be added.

Hunting loss: In the Avanersuaq area losses during the open-water season ranged between 15% and 25% (based on 34 hunting trips, in which 112 animals were retrieved in 1977 and 1978). The highest figure includes animals that escaped during the hunt (newborn young and wounded animals) and whose fate was unknown (Born and Kristensen 1981). Presumably the majority of the injured animals eventually die from their wounds (Fay *et al.*1994). Although adoption in walruses may occur (Fay 1982:204) we consider it likely that many of the orphaned calves die. Hence, the loss rate tends to be closer to the upper end of the range. Hunting loss undoubtedly occurs in the Canadian sector of the NOW area even though there has been no systematic effort to estimate the loss rate from field observations. We assume that the rate is similar to those in other parts of Canada (*e.g.* Orr *et al.*1986) - about 30%.

Catch composition: Information on the age and sex composition of catches in Avanersuaq are available for a full hunting cycle ("a year") during 1977-78 and for two full hunting cycles during 1987-90. In all cases the samples presumably represent more than 50% of the actual take and can be considered representative for the total catch in the area (Born unpubl. data). Young and subadult animals are under-represented in the catch. Females are usually not recruited to the catch until 5-7 years of age, and males not until 7-9 years of age (*i.e.* age at sexual maturity). Similar age compositions showing that hunters select for larger animals with more yield of meat and larger tusks have been reported from Foxe Basin (Orr *et al.* 1986) and the Bering Strait region (*e.g.* Fay and Bowlby 1994).

Sexually mature females (5 years and older) represented 35% (1977-78), 37% (1988-89) and 48% (1989-90) of the Avanersuaq catch. Overall, 40 % of the catch consisted of females five years and older (Born unpubl. data).

We have no information about the catch composition in the Canadian parts of the NOW area. It would be reasonable to expect some selection of larger individuals, considering that the numbers of walruses that can be taken are restricted by quota and that ivory is a relatively valuable product of the hunting.

6. Eastern Greenland

Information about the occurrence of walruses in eastern Greenland was summarized by Dietz *et al.* (1985) and Born (1990). The following review is based mainly on these sources. When relevant, the original source is cited. Some additional recent information is also presented.

Distribution and Stock Identity

Summer and winter distributions of walruses in eastern Greenland are shown in Fig. 37-38 respectively. Places mentioned in the text and uglit are shown in Fig. 41.

The few historical observations of walruses along the coast of southeastern Greenland, between the Tasiilaq area (Ammassalik) and the entrance to Kangertiittivaq (Scoresby Sound), are concentrated around the fjord of Kangerlussuaq and at the shallow banks along the northern parts of the Blosseville Coast, just south of the entrance to Scoresby Sound. Walrus food items were reported by Thorson (1934) from the Kangerlussuaq area.

When the Inuit community at the entrance to Scoresby Sound was founded in 1924/25, walruses were common there; they also hauled out on land in this area (Rasmussen 1925, Pedersen 1926). They occurred only rarely in the inner parts of Scoresby Sound. Walruses wintered in the polynya at the entrance to this fjord system (Pedersen 1926). Walrus food items have been reported from the north coast of the entrance to Scoresby Sound and from Hurry Inlet.

In August 1924 about 30 walruses were observed in Hvalrosbugten close to where the settlement of Ittoqqortoormiit/Scoresbysund was founded. On 7 August 1924 a Norwegian sealer took "quite a few" walruses at the entrance to Scoresby Sound (Isachsen 1925). During 1925/26, 70 walruses were caught by the Inuit in this area, whereas during the following years only 10, 6 and 2 animals were secured (Pedersen 1931, Mikkelsen and Sveistrup 1944). After that time walruses were scarce in Scoresby Sound, and only old males were observed occasionally during summer hauled out on floes (Pedersen 1931). This indicates that a resident group of walruses probably had been exterminated.

Historical observations of walruses between Scoresby Sound and Clavering Island are few, presumably because there is little or no suitable walrus habitat in this area. The waters are deep in the fjords along this stretch of coast.

Walruses were common and used several uglit in

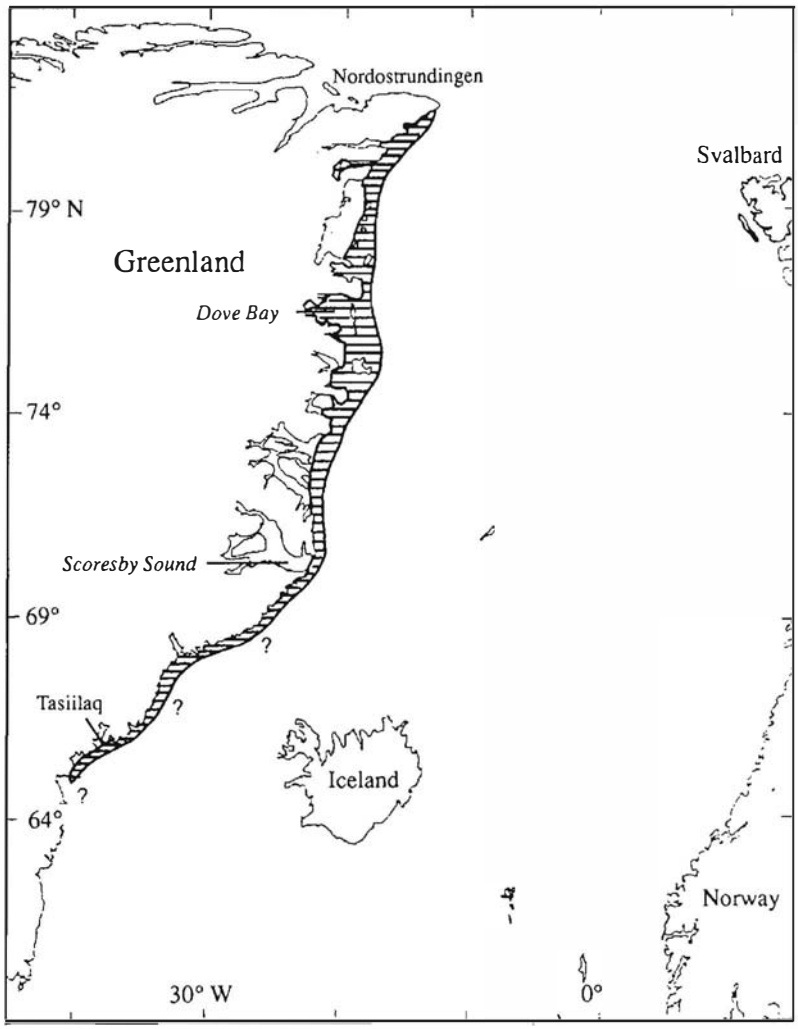

Fig. 37. Approximate summer distribution of walruses in eastern Greenland. Stragglers may occur south of the main concentration area.

the Clavering Island – Hochstetter Bay areas (Knudsen 1890, Giæver 1937). Sizeable concentrations were seen occasionally. For example, on 26 May 1932, 26 walruses were shot from a herd of about 200 at Cape Herschell according to Jennov (1945), who stated that the number of walruses around Clavering Island had decreased around 1940.

Several observations of walruses have been reported at Cape Borlase Warren, Cape Wynn, Sabine Island, Hvalros Island and Lille Pendulum Island at the promontory of Wollaston Forland. They also occurred in the Kuhn Island area and along the south coast of Shannon Island. In these areas there can be open water during winter, and a polynya is present along the south coast of Shannon Island (*e.g.* Koch 1945, Mikkelsen 1994).

Walruses were common in the Dove Bay area where they also hauled out on land (Friis 1909, 1925, Johansen 1910, Jennov 1945). Observations reported by Trolle (1908) and Johansen (1910) showed that walruses occurred along the coast from Dove Bay north to 81°10' N at Nordostrundingen (*i.e.* the northeastern cape of Greenland).

Recent observations indicate that the distribution of walruses in eastern Greenland is essentially similar to that described above.

A few walruses are occasionally caught in the Tasiilaq area (Dietz *et al.* 1985, Born 1990), and they are observed from time to time at the entrance to Kangerlussuaq (Glahder 1992). The seasonal distribution of catches for the period 1950-1983 indicates that walruses can occur in southeastern Greenland at all seasons (Dietz *et al.*1985, Born 1990). Stragglers that reach Iceland are likely to be from eastern Greenland (Born 1988).

At all times of the year, but particularly from February until late June, single walruses or groups of 2-3 animals of both sexes and all age groups (except newborn) may occur at the entrance to Scoresby Sound, where they feed along the north coast (Born 1983, Sandell and Sandell 1991). According to inhabitants of the area, the number of walruses frequenting this area has increased in recent years. The people ascribe this increase to the fact that walruses have been protected since the 1950s in the areas north of Scoresby Sound (Born 1983).

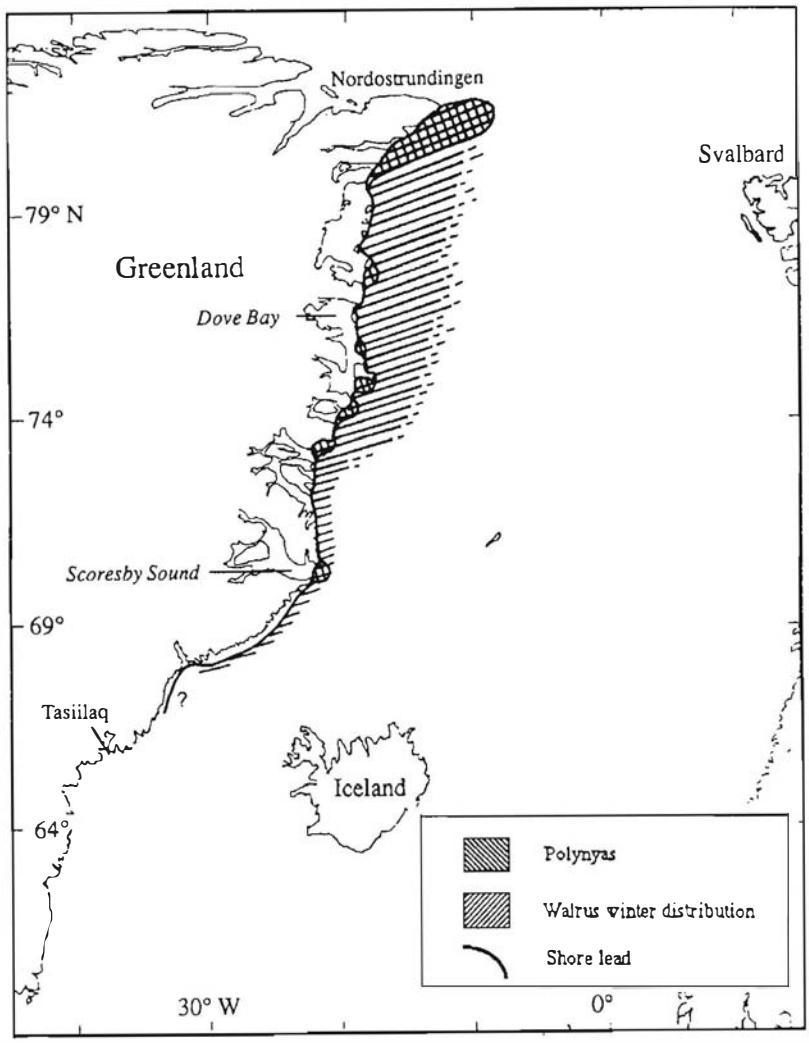

Fig. 38. Approximate winter distribution of walruses in eastern Greenland. Walruses can winter offshore in the moving pack ice over deep waters.

Small groups of walruses are observed along the coast between Hold with Hope and Dove Bay, and in the Dove Bay area. In these areas, regularly used uglit are found only on Sandøen (Young Sund) and Lille Snenæs (Dove Bay), although a few individuals have been observed while hauled out on land in other places.

North of Dove Bay walruses have been observed in several places along the coast between Skærfjorden (approx. 77°30' N) and Kilen (approx. 81° 14' N). Apparently they prefer the coastal areas between Dijmpha Sound (approx. 80° N) and Kilen (approx. 81°10' N) where the water is shallow. During aerial surveys of the coastal areas between Norske Islands and Nordostrundingen 26 May-18 June 1993 walruses were observed several times (Born and Thomassen 1994). Most notably, a total of 108 walruses were observed close to the coast between Kilen and Henrik Krøyer Holme on 3 June 1993 (Born *et al.*1994b). During a survey of the same area on 25 July, 93 walruses were seen, of which 17 were recorded as small calves (Tahon and Vens 1994).

Various sources indicate that walruses winter in the following areas of eastern Greenland: the entrance to Scoresby Sound, the Gael Hamkes Bay area, along Wollaston Forland and at Sabine Island, at Shannon Island and the southern tip of Store Koldewey Island, and farther north off Amdrup Land in the Eskimonæs and Antarctic Bay area. In these areas there are recurring polynyas with shallow water. Tracking of walruses instrumented with satellite-linked radios revealed that they can winter in the pack ice up to about 200 km offshore, between about 78°N and 81°N (Born and Knutsen 1992). The presence of polynyas at Île de France and at Hold with Hope (Pedersen 1942, Koch 1945) suggests that walruses may also winter there.

Observations of walruses between eastern Greenland and Svalbard suggest that some animals swim all the way across the Greenland Sea and Fram Strait (Dietz *et al.*1985, Born and Knutsen 1991). Such a connection was proven by the observation at Svalbard in 1992 of a walrus that had been tagged in eastern Greenland (77°N) in 1989 (Born and Gjertz 1993). Studies of the variation in mitochondrial DNA in a limited number of walruses showed the haplotype of those from the Scoresby

Fig. 39. Walruses at the ugli on Sandøen, Young Sound on 26 August 1994. Photo: E.W. Born.

Sund area to be different from that of walruses from Avanersuaq (Thule) in northwestern Greenland. However, three walruses in a sample of ten from Central West Greenland had a haplotype also found in walruses from eastern Greenland (Cronin *et al.* 1994). This indicates that some genetic mixing has occurred between eastern Greenland and Central West Greenland. In southwestern Greenland walruses are sporadically caught in the period January to August (Born 1990). These could be stragglers from either eastern Greenland or Central West Greenland.

Uglit: We are not aware of reports of uglit south of the entrance to Scoresby Sound. North of Scoresby Sound only two uglit are used regularly at present: Sandøen and Lille Snenæs (Figs 39, 40, 41). Both are used by males.

Around the mid-1920s walruses hauled out on Fame Islands in Hurry Inlet (Rasmussen 1925) and on the beach in Hvalrosbugten near the settlement of Scoresbysund (Pedersen 1926 Fig. 4). These uglit were soon abandoned due to hunting. Before the turn of the century other uglit were used by walruses in the Young Sound and Kuhn Island areas. For example, in 1889 more than 100 animals were killed on land at Cape Berghaus in Young Sound. Large kills were also made at an ugli situated somewhere in the Kuhn Ø area (Knudsen 1890, Giæver 1937, Jennov 1945). Due to hunting, these uglit were abandoned at the beginning of this century.

Fig. 40. The haul-out Lille Snenæs in northern Dove Bay in August 1990. Photo: E.W. Born.

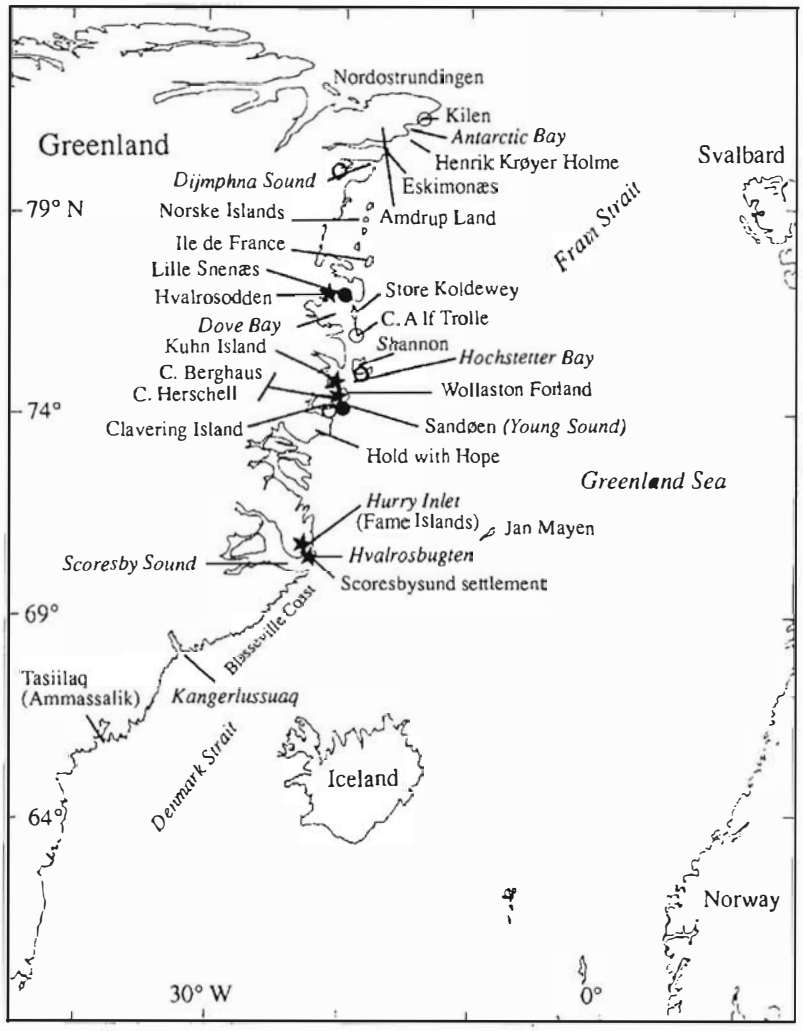

Fig. 41. Terrestrial haul-out sites used by walruses in eastern Greenland. Legend : Black dots = haul-outs still used by walruses. Open circles = places where walruses have been observed on land; present status unknown. Stars = Abandoned haul-outs.

Fig. 42. Walruses at the haul-out in Hvalrosbugten ("Walrus Bay") at the entrance to Scoresby Sound, East Greenland, in August 1924. It is apparent from the photo (bottom) that adult males, females and calves used this haul-out which was soon abandoned due to hunting (see text). Photo: A. Pedersen.

At present the Sandøen ugli is used regularly by a group of 20-30 up to perhaps as many as 50 walruses, primarily males. Walruses have also recently been observed on land at Cape Berghaus, on the southern coast of Clavering Island and on Shannon Island (Dietz *et al.* 1985, Born unpubl.).

Walruses formerly hauled out on land at Hvalrosodden ("walrus point") in northwestern Dove Bay. During the "Danmark Expedition" (1906-1908) about 30 walruses were shot in the northern Dove Bay area. Several of these were killed on the beach at Hvalrosodden. After this the walruses tended to avoid this ugli (Friis 1909, 1925, Johansen 1910, Jennov 1945, Dietz *et al.*1985). However, in 1933 they were observed on a new ugli at Lille Snenæs, about 10 km east of Hvalrosodden (Pedersen 1934). In July and August 1933 about 50 walruses were seen on this beach (Pedersen 1942, Jennov 1945).

Observations during the last decades have confirmed that Lille Snenæs is used as a haul-out site for adult males from late July until late September - early October (Dietz *et al.* 1985, Born and Knutsen 1992). A Petersen-estimate obtained from resightings of individually recognized walruses suggests that about 50 males used this haul-out site in 1989 and 1990 (Born and Knutsen 1990c).

Walruses have also been observed on land at Cape Alf Trolle (southern tip of the island of Store Koldewey) (Dietz *et al.*1985). Farther north, they have been observed on land in the Dijmphna Sound and Hanseraq Fiord areas (Dietz *et al.* 1985, Born unpubl. data).

Population Size

Andersen (1984), who was traveling along the coast in a kayak, recorded a total of 329 walruses between Nordostrundingen and Scoresby Sound. About 240 of these were observed between Kilen and Norske Islands. Based on aerial surveys in June 1993, Born *et al.* (1994b) tentatively concluded that not more than about 200 walruses were present between Eskimonæs and Nordostrundingen. This crude estimate is similar to that of Andersen (1984) and refers to those parts of the areas covered by Andersen (1984) where he found the highest concentrations of walruses. Various observations indicate that each of the two summering areas for males, Dove Bay (Lille Snenæs) and Young Sound (Sandøen), has about 50 adult males during the open-water season. Hence, about a hundred animals may tentatively be added to the 329 recorded by Andersen (1984). Consequently, a highly conservative estimate of the total population of walruses in eastern Greenland would be about 400. As this estimate is not corrected for walruses which may have been present in areas not covered by the surveys or for animals submerged and out of sight during the surveys, a rough estimate of 500 to 1000 animals in the eastern Greenland stock is tentatively suggested.

Exploitation

Hunting methods: Some, presumably few, walruses were traditionally taken by the Inuit of eastern Greenland (*e.g.* Sandell and Sandell 1991). Due to a general scarcity of walruses in southeastern Greenland, the catch in this region has been very small. Since 1966 walruses have been shot sporadically in Kangerlussuaq in the northern part of the municipality of Ammassalik (Siegstad 1989, Glahder 1992). The limited records available indicate that walruses may be caught in the Ammassalik area at any season, with a peak in August-Septem-

Fig. 43. Danish trappers ready to flense adult male walruses at Hvalrosodden (Dove Bay) in the summer of 1934 (year uncertain). Usually the walruses were towed into shallow water to be butchered at low tide. Photo: presumably P. Poulsen.

ber. We have no details about hunting methods but assume that they are similar to those described below for Scoresby Sund.

In the Scoresby Sound area walruses are usually taken between April and August at the entrance to the fjord complex (Born 1983, Sandell and Sandell 1991). According to Sølberg (1975) they are shot either from land or from the ice edge when they are observed during the hunt for ringed seals. Sometimes when walruses haul out on ice they are shot from dinghies powered by outboard engines. Rifles with calibres of 7.62 or larger are used to shoot the walruses either in the head, neck or spine (*Ibid.*). A harpoon is usually not used. Walruses that sink in shallow water are retrieved with a hook (J. Thygesen pers. comm. 1988).

Catch levels – Catches by foreign sealers etc.: During a period of 40 to 50 years beginning in 1889, more than 1000 walruses were killed by foreigners primarily Norwegian and Danish sealers and trappers mainly in the areas around Clavering Island and the island of Shannon and in Dove Bay. The majority were taken during the first half of this period (*e.g.* Jennov 1945; Fig. 43). Jennov (1945) believed that walruses had decreased in northeastern Greenland as a result of overexploitation. An unknown presumably limited number of walruses were also taken between the 1940s and 1960 by Danish and Norwegian trappers (Mikkelsen 1994).

Catches by Greenlanders: During the late 1920s an average of one walrus per year was taken in southeastern Greenland (Pedersen 1931). According to the Hunters' List of Game (HLG), the catch of walruses in the municipality of Ammassalik averaged 3.5 walruses per year (SD=4.4, range:1-10, four years of reporting) between 1980 and 1987 - the last year for which there was a record.

In the period 1980-1987 the catch in the Scoresby Sound area averaged 12.1 walruses (SD=7.0, range: 2-22, six years of reporting) according to the HLG.

The reporting in the HLG in eastern Greenland generally has been insufficient. We estimate that the annual landed catch of walruses in eastern Greenland ranges between 15 and 25 animals. With an overall loss rate of 23% (see below), the total annual kill would be approximately 20 to 30 walruses.

Hunting loss: Losses are not well documented. Dietz (pers. comm. 1986), who witnessed the kill of three walruses during the spring hunt, suggested that an overall loss rate of about 30% appeared likely. Three of nine walruses killed during April 1983 at Cape Swainson (entrance to Scoresby Sound) sank and were lost (Born 1983). Information about the fate of 23 walruses killed during the spring hunt in 1986-1988 (J. Thygesen pers. comm. 1988) indicates a loss rate of about 17% (four lost of 23 killed). Hence these observations, combined, indicate that the overall loss rate is about 23 %.

Catch composition: We have no information about the composition of the catch south of Scoresby Sund. The majority of the catch in the Scoresby Sund area consists of old males (J. Thygesen pers. comm. 1988, Born unpubl. data; but see Fig. 44). This catch composition presumably reflects the general distribution of walruses in

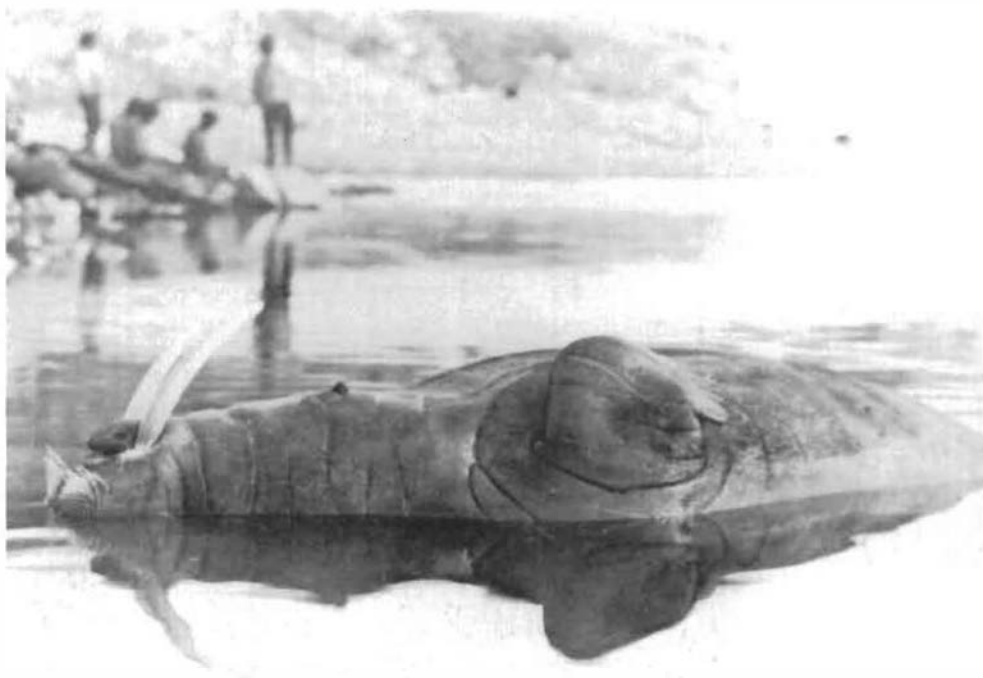

Fig. 44. Greenlanders waiting for low tide so that they can butcher an adult female walrus killed near the settlement of Scoresbysund in the mid-1920s. Note the plug in the throat. After the walruses were killed the Greenlanders would often inflate the carcasses, through a hole in to the lungs, to make them float. Thereafter the hole was plugged to prevent the air from escaping. Photo: A. Pedersen

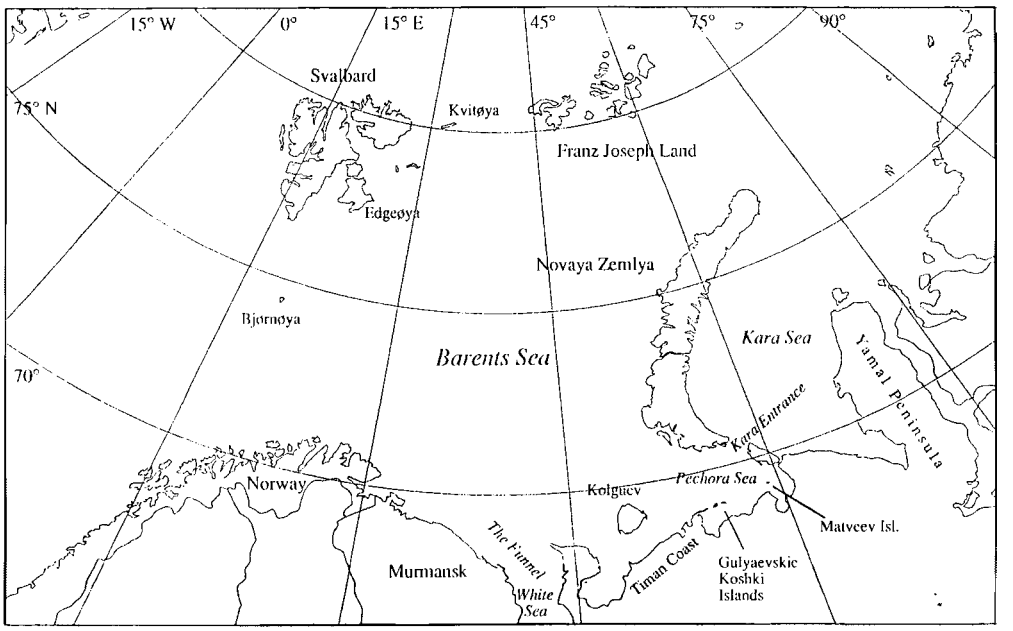

Fig. 45. The Barents Sea and Kara Sea region.

northeastern Greenland, with the males occurring farther south than the females.

7. Svalbard – Franz Joseph Land

Little is known about the walruses of the western European Arctic. Recent studies have been undertaken in Svalbard, and in parts of Franz Joseph Land, but recent scientific information on walruses from the Russian Arctic is largely non-existent. However it is clear that walruses in all areas of their European Arctic range were over-harvested up to the mid 1950s. The result was that they were virtually exterminated in several of these areas. In Svalbard they were more or less exterminated, but there were apparently still a few hundred left in Franz Joseph Land (Norderhaug 1969). The largest remaining groups were probably in the Franz Joseph Land – Kara Sea area. Today there are signs, at least in Svalbard and the White Sea area, that walruses are recolonizing their former distribution area.

Distribution and Stock Identity

Places mentioned in the text are shown in Fig. 45. Summer and winter distributions are shown in Figs 46-47, respectively. Locations of uglit are depicted in Figs. 48-49.

Walruses were once very abundant in the Svalbard archipelago. However three and a half centuries of commercial exploitation had caused the

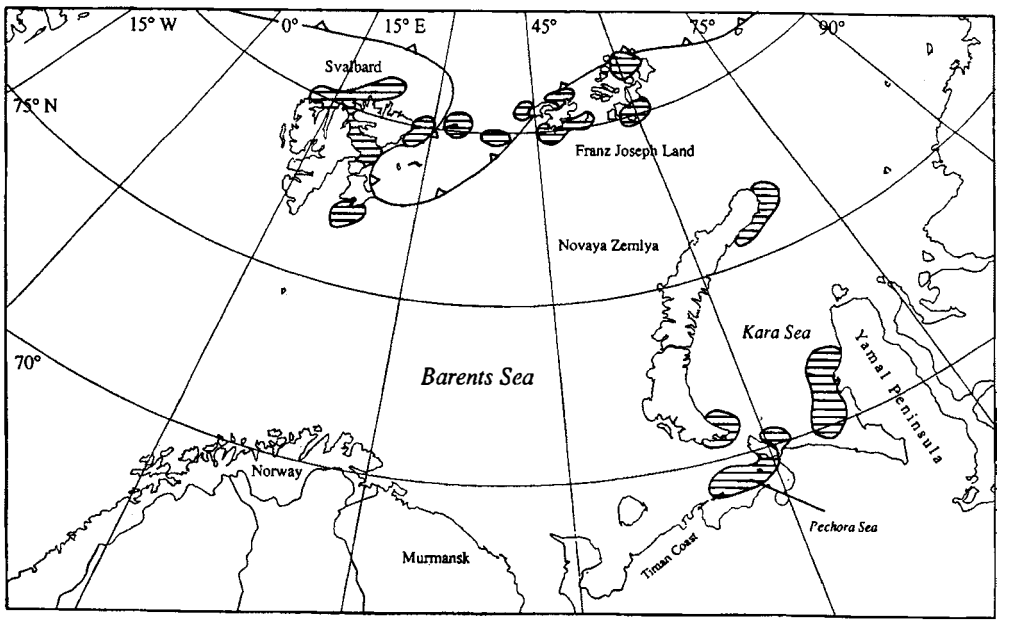

Fig.46. Approximate summer distribution of walruses in the Norwegian High Arctic and western Russian Arctic. A generalized picture of the extent of the polar pack ice is indicated.

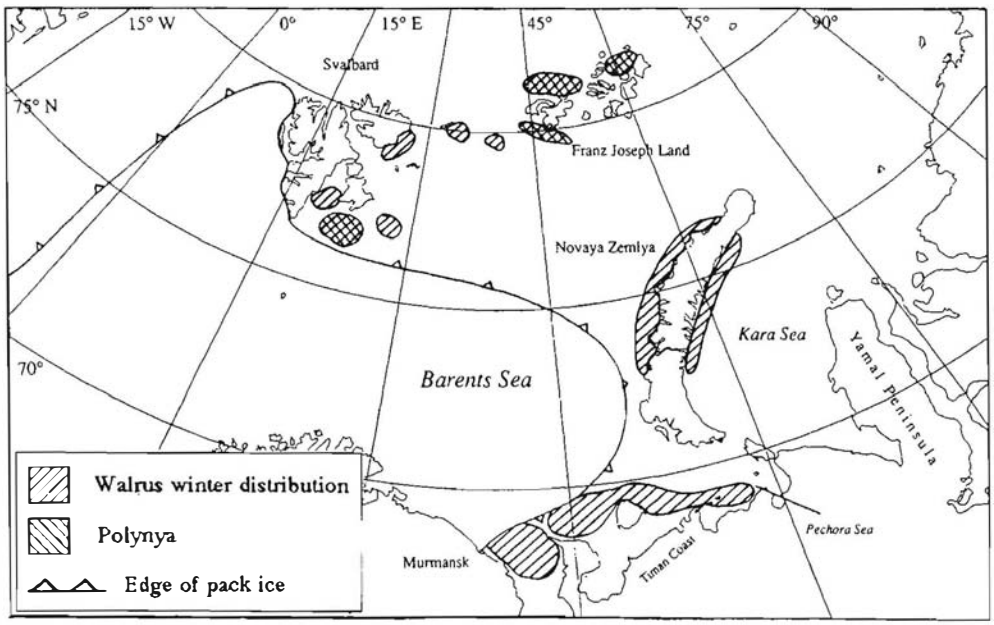

Fig. 47. Approximate winter distribution of walruses in the Norwegian High Arctic and western Russian Arctic. Several wind-driven polynyas exist in these parts of the Arctic. The walrus wintering areas are not well known, but walruses are thought to winter in these polynyas. The approximate position of the pack ice edge during winter is indicated.

walrus to be on the verge of extinction in this region when it finally was totally protected in 1952 (Norderhaug 1969). The hunting started in the most accessible parts of the archipelago, but as catches declined the hunters pushed further and further into the more remote parts of Svalbard (Lønø 1972). Lønø (1972) postulated, based on catch statistics, that the Svalbard stock must have consisted of partially stationary groups that had some contact with each other. This would explain why walruses still could be found in the more remote parts of the archipelago after they had been exterminated along the western coasts. Lønø (1972) found no indication of an annual migration between the northeastern parts of Svalbard and Franz Joseph Land.

In the 1970s walruses started reappearing in Svalbard. Born (1984) concluded, based on opportunistic observations and surveys between 1954 and 1982, that about 100 walruses, primarily bulls, summered in Svalbard. He suggested that the observations indicated that Svalbard was in the process of being repopulated by dispersal of the popul-

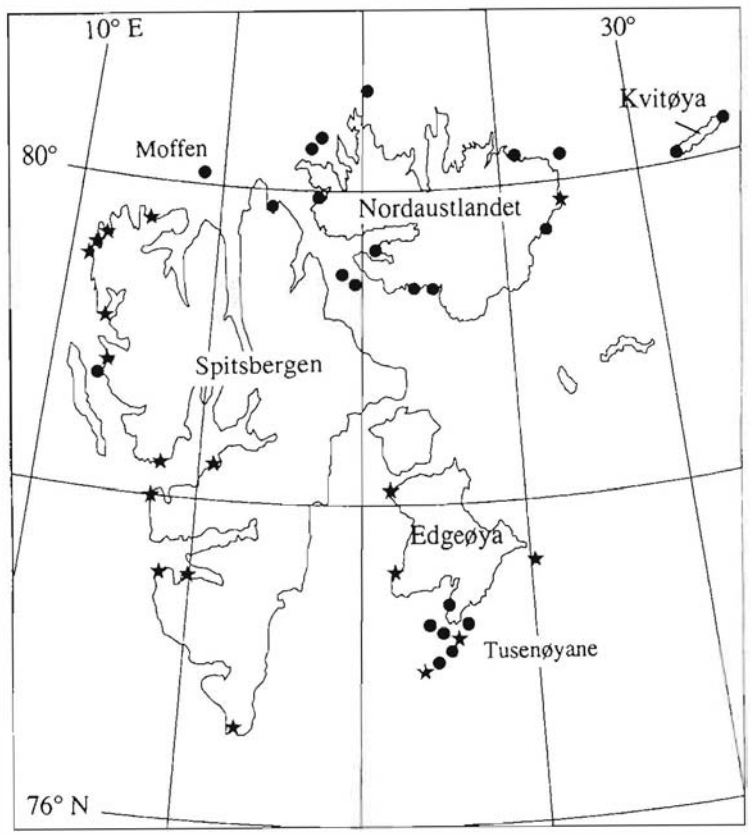

Fig. 48. Locations on Svalbard of walrus haul-outs still and formerly used. Little information was available to the authors concerning haul-outs in the Russian sector of the Atlantic walrus's range. Legend: Black dots = haul-outs still used by walruses. Stars = Abandoned.

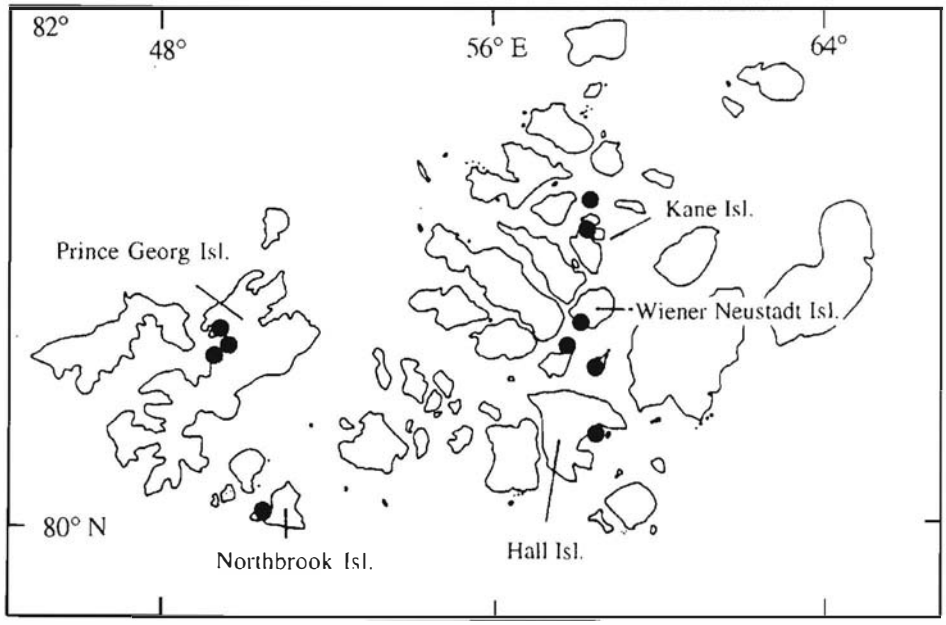

Fig. 49. Locations of haul-outs presently used by walruses on Franz Joseph Land.

ation centered at Franz Joseph Land.

Franz Joseph Land had a large walrus population when the archipelago was discovered in 1873. Because ice conditions were much more severe at Franz Joseph Land this group of islands was much less accessible than Svalbard. At Franz Joseph Land walrus hunting therefore first became significant around the turn of the century and it lasted until the early 1930s (Gjertz *et al.*1992). Harvests of walruses in Franz Joseph Land continued on a limited basis until 1953 (Lønø 1972). Atlantic walruses were totally protected in Russian waters in 1956 (Beloborodov and Timoshenko 1974). The distribution of walruses in Franz Joseph Land was described and mapped by Gjertz *et al.*(1992).

Based on ground and aerial surveys Gjertz and Wiig (1994) showed that walruses in Svalbard today are predominantly males (Fig. 50), although some females and calves are present in the northeasternmost part of the archipelago. Cows and calves were found to be abundant in the western part of Franz Joseph Land (*Ibid.*). It was therefore concluded, in concordance with Born (1984), that the majority of walruses in Svalbard in summer are males that probably belong to a common Svalbard – Franz Joseph Land stock.

In the period 1990 to 1993 thirty-four walruses (28 at Svalbard and six at Franz Joseph Land) were fitted with satellite-linked radio transmitters in order to study their movements. All of the instrumented animals were adult males except for one adult female caught at Franz Joseph Land (Gjertz

Fig. 50. In some parts of Svalbard, like here at Kalvøya, male walruses haul out as much as several hundred meters from shore.
Photo: I. Gjertz.

Fig. 51. More than 500 walruses hauled out on Kræmerpynten (Kvitøya, Svalbard) on 23 July 1984. Photo: L. Åby.

and Wiig 1993, Knutsen 1993, Wiig *et al.* in press). The results of the satellite trackings showed that male walruses move among most of the walrus areas in Svalbard and Franz Joseph Land. In particular, it seems that movement by males from southern Edgeøya to Kvitøya (Fig. 51), Victoria Island and Franz Joseph Land (Fig. 52) is common. The walruses winter in the southern parts of Svalbard as well as within the pack ice off north-eastern Svalbard. The only walrus at Franz Joseph Land that was followed until mid winter stayed in the same area. This observation supports the view that walruses also winter there. The results of the telemetry support the hypothesis of Born (1984) that the majority of walruses in Svalbard are males from a common Svalbard-Franz Joseph Land stock (Wiig *et al.* in press).

It is important to bear in mind, however, that walruses in both archipelagos, but especially in Svalbard, constitute a recovering population. The current distribution and behavior therefore very likely differ from that found in former times when walruses were abundant in these areas.

Population Size

The pre-exploitation size of the walrus population in the Barents and Kara seas is not known, but Fedoseev (1976) concluded that it could not have numbered less than 70 to 80 thousand animals.

Fig. 52. Walruses hauled out on the ice off the ugli on Appolonoff Island (Franz Joseph Land) in August 1992. Photo: L.Ø. Knutsen.

During the period 1989-1993 walrus haul-out sites in Svalbard were mapped, and age and sex composition at the haul-outs was determined (Gjertz and Wiig 1995). Aerial surveys were conducted in 1992 and 1993. The results of the surveys indicate that at least 723 males are present in Svalbard during summer. The bulk of the females and calves associated with these males are believed to be in Franz Joseph Land. Assuming a 1:1 sex ratio in the population, the Svalbard – Franz Joseph Land stock of walruses is therefore thought to number 2000 individuals. This is a conservative estimate, and the actual number is believed to be considerably higher. This is because undoubtedly some walruses in Svalbard were not counted, and because no survey has been conducted in Franz Joseph Land, where males, in addition to those counted in Svalbard, may be found.

In Svalbard three possible threats to the walrus population can be identified: conflicts with fishing interests, especially scallopers, disturbances by tourists, and planned petroleum development.

Exploitation

See under stock 8.

8. Kara Sea – Southern Barents Sea – Novaya Zemlya

Distribution and Stock Identity

Walruses are believed to have been more or less resident along parts of Finnmark (northern Norway) in former times (Lund 1954), but they were exterminated there. Today only stray individuals are encountered along the Norwegian coast and farther south in Europe, and these are believed to come from Russia or Svalbard (Lund 1954, Brun *et al.* 1968, Born 1988, Gjertz *et al.*1993).

Historically there was a large trade in walrus ivory between northern Russia and both Europe and the Muslim world. This ivory came predominantly from the White and Pechora seas (Chapskii 1939, Storå 1987).

Popov *et al.* (1990) reviewed information on the former distribution areas in the White Sea. Timoshenko and Popov (1990) indicated when and where walruses have been observed in the White Sea in recent years. Most observations have been in the Funnel, *i.e.* the northernmost part of the sea. Belkovich and Khuzin (1960) claimed that these animals usually have been young, with tusks of 20 cm length or longer (*sic!*). Popov *et al.* (1990) stated that the animals usually are encountered in pairs or as single individuals. They believed that the regular occurrence of walruses in the White Sea, though small in numbers, reflected the inclination of animals to return to their former habitat. Thus according to these authors there is good reason to believe that the Funnel of the White Sea is now a normal part of the walrus's range. Born (1988) suggested that an increase since about 1970 in the number of walrus stragglers appearing along the western coasts of Norway and the European continent perhaps reflected an expansion of the range of the population(s) in the western Russian Arctic.

According to Popov *et al.* (1990) walruses occur in the southeastern part of the Barents Sea throughout the year, though numbers are small. The most frequent occurrences are off the Timan coast near Gulyaevskie Koshki and near Kolguev and Matveev islands.

Beloborodov and Timoshenko (1974) mentioned several observations of herds of walruses in this area, also in mid winter. One of the herds (55 individuals) consisted of adults, subadults and calves. Lukin (1978) observed walruses on 4 January 1977 near Gulyaevskie Koshki islands in northern Pechora Bay. Quite remarkable was the observation of six adults with what were thought to be newborns. Lukin (1978) suggested that the period of birth in this area was late December-early January. The total number of walruses wintering in the southeastern Barents Sea was estimated not to exceed 100-120 animals. Haug and Nilssen (1995) reported observations between 5 and 17 February 1993 of a total of 138 walruses (including 21 mother-calf pairs) along the northeastern coasts of the Kanin Peninsula and in the western Pechora Sea. These observations suggest that the Pechora Sea is a wintering area for walruses from the Barents and Kara seas.

Walruses in the Kara Sea and Novaya Zemlya region are believed to belong to a stock that is distributed over a larger area; the animals presumably migrate into and out of the Kara Sea.

Arsenev (1976), based on Chapskii (1936), described in detail the supposed seasonal migrations of walruses in the Kara Sea as follows: Atlantic walruses inhabiting Russian waters in winter and spring are situated mainly in the southeastern part of the Barents Sea. In October they haul out on the coast in the vicinity of the Kara Entrance. With the formation of ice, the animals move onto the ice. Possibly in June the walruses abandon this area. They enter the Kara Sea via two routes – through the Kara Entrance and around the north end of Novaya Zemlya. The animals that pass through the Kara Entrance are found in the second half of July

and in August inhabiting the ice along the west coast of Yamal Peninsula. Under the influence of easterly winds in August, the ice goes out from there, and the walruses withdraw with it. In October these animals appear on the southern coast of Novaya Zemlya, near the Kara Entrance. There they congregate on coastal haul-out sites until freeze-up. The other walruses, which migrate northward with the ice, around the end of Novaya Zemlya, are found on the floating ice in nearshore waters in July and August. Toward September, when the drifting ice breaks away from the coast of Novaya Zemlya, these animals begin to concentrate very close to shore, usually at the northeast end of the island. There they form herds on shore in the area from Oransk Islands to Cape Sporyi Navolok. Probably new ice begins to form on the north coast of Novaya Zemlya by October. At this time the walruses vacate the nearshore waters, transfer to the drifting ice, and pass with it into the Barents Sea. There they proceed along the west coast of Novaya Zemlya, and by the end of the month reach their winter habitat in the southeastern Barents Sea.

Other authors have suggested that walruses in the Kara Sea – Novaya Zemlya area also migrate to other areas. Tsalkin (1937) suggested, based on differences in the sexual composition of groups of walruses in Franz Joseph Land and Novaya Zemlya, that they belong to a widely distributed population inhabiting the waters of the European Arctic. On the other hand Popov *et al.* (1990) suggested that walruses from the Pechora Sea move into the Kara Sea in summer.

The eastern distribution of walruses in the Kara Sea is somewhat unclear. According to Ivashin *et al.* (1972) walruses are observed on the drift ice in the region of the small arctic islands lying south and southeast of Franz Joseph Land (Vize, Ushakova and Schmidt islands). Further east at Severnaya Zemlya they are more rarely seen (*Ibid.*). Bychkov (1975) claimed that these were Atlantic walruses. According to Arsenev (1976) walruses at Severnaya Zemlya are mostly found on the east side of the archipelago; and in the Laptev Sea walruses are principally found in the western parts along the eastern Taimyr coast and near the Lena Delta. According to Chapskii (1936) walruses in the Laptev Sea form a subspecies (*O. r. laptevi*) which morphologically is intermediate between the Atlantic and Pacific subspecies. The taxonomy of the walruses in the Laptev Sea is, however, still disputed (see Fay 1981, 1982, 1985). Chapskii (1936) believed that the ranges of the Laptev and Atlantic walruses met at Severnaya Zemlya and western Taimyr, but that the animals near Vilkitski Strait (between Severnaya Zemlya and the mainland coast) were predominantly Laptev walruses. S. Belikov (pers. comm. 1994) confirmed that walruses in western Severnaya Zemlya are Atlantic walruses whereas those found in the eastern part of the archipelago and southward past Vilkitski Strait are Laptev walruses. Presently available information is, however, insufficient to determine whether these walruses have separate geographical distributions or are morphologically distinct.

Population Size

According to Lukin (1978) the total number of Atlantic walruses wintering in 1977 in the south-eastern Barents Sea apparently did not exceed 100-120. The number of walruses observed in the southern Barents Sea has increased in recent years (Popov *et al.* 1990, Haug and Nilssen 1995), and Lukin's (1978) figure is probably too low. Popov *et al.* (1990) referred to an observation of a herd of 100 animals, which can be interpreted as confirming that there are well over 120 walruses in the Barents and Pechora seas.

No new population figures are available for the Kara Sea – Novaya Zemlya region and all estimates are outdated. Chapskii (1936) estimated that there were no more than 1200-1300 walruses in the Barents and Kara seas in the mid-1930s. Popov (1960) estimated the stock to be 2000-2500 off the northern extremity of Novaya Zemlya and in Franz Joseph Land in 1952-55. According to Bychkov (1975) the Novaya Zemlya stock consisted of no more than 400 animals in 1969-1970. According to Popov *et al.* (1990) there are 1500-1700 walruses in the northern Novaya Zemlya – Franz Joseph Land area. This, however, is the same figure that has been presented previously (Nazarenko and Timoshenko 1983, Timoshenko 1984).

Bychkov (1975) and Popov *et al.* (1990) suggested that predation by polar bears may be one reason for the decrease in numbers and poor recovery of the walrus population in the western Russian Arctic. They also cited anthropogenic factors, such as industrial development in the haul-out areas, year-round shipping, petroleum and gas development and poaching as possibly contributing to the situation. One additional threat to the walrus population is the large amount of nuclear waste that has been dumped into the Kara Sea and west of Novaya Zemlya.

Exploitation (Stocks 7 and 8)

Walruses in Norwegian waters, including Svalbard, became totally protected in 1952 (Anon. 1952; see

Fig. 53. Numerous skulls and bones on the beach at Kapp Lee (Edgeøya, Svalbard) in 1982 bear witness to the massive slaughter of walruses by European hunters in former days. Photo: E.W. Born.

also section Regulations; Fig. 53). In Norwegian waters poaching is not very likely to occur since walruses are relatively scarce and are mostly found in inaccessible and uninhabited parts of the Svalbard archipelago. Moreover well-equipped law enforcement authorities patrol the main areas of walrus distribution on a regular basis. Walruses were given complete protection in the Northeast Atlantic Arctic in 1958 (see section: Regulations). Poaching may, however, be somewhat of a problem in Russia. Since the collapse of the Soviet Union law enforcement has been slack in the arctic areas, and Russian scientists admit that poaching, especially for polar bears and walruses, takes place. Frantzen (1992) documented one case of poaching in Franz Joseph Land, but other cases are also known. The size of this illegal hunt in Russia is not known.

One of the authors (Gjertz) has been contacted both by private persons and by foreign governmental agencies regarding offers from Russian sources in the Murmansk Region, Russia, to provide walrus calves for the international market. No such sales are known to have taken place, but the fact that offers have been made suggests that certain parties can and will provide illegally caught walruses. This can be viewed as a part of the large illegal trade in protected wildlife which has flourished in Russia since the collapse of the Soviet Union.

REGULATIONS

Uncontrolled hunting led to the depletion of Atlantic walruses in nearly all areas of their range. Regulations were introduced, belatedly, to control the hunting and to protect the walruses from extermination.

In Canada regulations intended to conserve the stocks of walruses have been in force since 1928 and have been amended numerous times (see Mansfield 1973, Reeves 1978, Richard and Campbell 1988). The regulations limit hunting mainly to indigenous people. Under the Marine Mammal Regulations only licensed hunting is permitted, but Indians and Inuit are allowed to take up to 4 walruses (per person per year) without a license "for food, social or ceremonial purposes" (Government of Canada 1993). In addition there is an annual quota system for four settlements: Coral Harbour, Sanikiluaq, Arctic Bay and Clyde River. These communities have annual quotas of 60, 10, 10 and 20, respectively (Government of Canada 1993).

As mentioned by Richard (1993) the Nunavut Land Claim agreement has changed some aspects of walrus management in Canada. The Nunavut Wildlife Management Board and its constituent Regional Wildlife Organizations, which consist of representatives of local Hunters and Trappers Associations, "will have considerable influence in shaping every aspect of management and conservation of Canadian walrus populations" (Richard 1993:18).

The Marine Mammal Regulations include a reporting requirement stating that a hunter must keep a record of his catch for two years and report this to a fishery officer "when requested to do so." The record is supposed to include the date and location of the catch, the animal's sex and its colour (!) (Government of Canada 1993). Catch data for settlements in northern Québec are supplied to the Department of Fisheries and Oceans through a contract with Makivik Corporation (S. Olpinski pers. comm. 1995).

Regulations for walrus hunting in Greenland were reviewed by Born (1990) and Born *et al.* (1994a). The latest amendments to the regulations were made in 1994 (Anon. 1994b).

The walrus hunt in the Avanersuaq (Thule) area has been regulated since the late 1920s (Rasmussen 1929). The present hunting regulations are essentially unchanged. It is permissible to hunt walruses at any time. While there is ice cover, shooting at walruses is not permitted before they have been harpooned. It is permitted, however, to shoot at walruses that appear in small leads or cracks in the ice, where they can then be harpooned. During the open-water season, it is not permitted to shoot more walruses than can be transported back to the hunter's home. Walruses are not allowed to be shot in the head before they have been harpooned. Hunters are permitted, however, to shoot at walruses before harpooning if the walruses are swimming along the ice edge, where they can be dangerous.

In Central West Greenland, changes in walrus hunting practices, and in particular the high catches in 1937, led to a discussion in the Local Political Council (Landsrådet) where it was proposed to regulate the walrus hunt. However, hunting regulations were not introduced until 1949 when walruses in the West Ice were protected between 20 May and 31 December. New hunting regulations came into force in 1956. Originally walruses were not allowed to be hunted at the uglit of Kitsissut and Aarfiit in Kangaatsiaq municipality between 15 October and 31 January. This paragraph was, however, canceled in 1959. The regulations were amended in 1978 and 1994 (see Born 1990 and Born *et al.* 1994a for reviews of regulations before 1994). According to the 1978 amendments, there was no quota for boats smaller than 40 tons, but after 1978 boats larger than 40 tons were permitted to catch five walruses per year. By the 1994 amendments boats above 40 tons are no longer allowed to catch walruses (Anon. 1994b). According to the latest regulations (*Ibid.*) the hunting of walruses in Greenland is only permitted to licensed persons resident in Greenland. Between 1 June and 31 December the take of walruses between 66°N and 75°N is prohibited. Between 1 April and 31 December females and young are protected in the same areas. All walruses are protected in western Greenland south of 66°N. Only vessels less than 40 tons and dog sleds can be used for hunting walruses. There are restrictions concerning the types of weapons and bullet types that can be used. It is stated explicitly that wounded walruses must be harpooned before they are killed. Municipal councils can, if they desire, place further restrictions on walrus hunting. It is now mandatory that hunters report the catch (number, sex, age, date etc.) (Anon. 1994b). According to a special regulation (Anon. 1990d) the hunting of walruses is allowed in the municipality of Kangaatsiaq between 1 February and 14 October. This regulation was not included in the recent amendment.

In 1938 hunting regulations were made for the Danish trappers working for the company "Nanok" in Northeast Greenland primarily north of 73°30' N. According to these regulations, the hunting of walruses at uglit or within 1 km of such sites was not allowed. Care was to be taken to ensure that

only walrus bulls were hunted. Females with calves were to be fully protected. All walruses became completely protected in 1956 in all areas of East Greenland north of the Scoresby Sound area (*i.e.* north of approx. 72° N; Anon. 1938, Born 1990).

In 1952 the walrus was given complete protection within Norwegian territory and walrus hunting by Norwegian citizens in other areas was prohibited (Anon. 1952, 1959, Øritsland 1973). In 1973 about half of Svalbard was included in nature reserves and national parks (*e.g.* Mehlum 1989). These areas include a major part of the walrus habitat.

Since 1921 various steps have been taken to regulate and minimize the harvest of Atlantic walruses in Russian territory (Bychkov 1973). In 1935 the harvest from sealing vessels run by the Soviet State ceased and in 1949 the killing of walruses by the fishing and sealing industry was prohibited. From 1956 hunting for Atlantic walruses was banned for all Soviet citizens, excluding a limited harvest by native peoples for subsistence purposes and by expeditions.

The Norwegian-Soviet Sealing Agreement of 1958 (Anon. 1959), which applies to northeast Atlantic waters east of Cape Farewell (*i.e.* southern tip of Greenland), also includes provision that the catching of walruses is forbidden throughout the year. This agreement thus confirms both the Soviet total prohibition of walrus hunting in the western Russian Arctic since 1956 and ship-borne hunting of Atlantic and Laptev walruses in 1935, and the Norwegian total protection since 1952 (Øritsland 1973).

In 1971 the Novaya Zemlya population of Atlantic walruses was included in the list of Rare Animals of the USSR (Bychkov 1971, 1973). In 1994 Franz Joseph Land became a national park (zapovednik), and most of the walrus habitat in this archipelago is therefore officially protected.

At Canada's request the walrus was included in Appendix III of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), beginning in 1975. The walrus is included in Appendix II of the Convention on the Conservation of European Wildlife and Natural Habitats of 1979 (the Bern Convention; Born 1992).

ANTHROPOGENIC EFFECTS APART FROM THOSE DUE TO HUNTING

Like other wildlife, walruses are affected by many human activities other than those involving their deliberate killing. In this section we identify the human activities, apart from hunting, that are known or suspected to have negative impacts on walruses, and we review the available evidence concerning the nature and degree of these impacts on populations.

Disturbance from different sources of noise

Various sources of disturbance that might affect walruses and the potential consequences of such disturbance have been listed previously (*e.g.* Mansfield 1983, Anon. 1990c, 1993b, U.S. Fish and Wildlife Service 1993). In the present review we consider only the potential effects on walruses of in-air and underwater noise from aircraft, ships, off-shore drill-sites and seismic activities. Potential negative effects of noise on walruses include: 1) trampling of calves during stampedes, 2) insufficient rest, increased stress and energy expenditure, 3) insufficient suckling of calves, 4) interference with feeding, 5) masking of communication and 6) impaired thermoregulation in calves that spend too much time in water. Few studies have actually addressed questions about disturbance of walruses.

Walruses react to man-made disturbance by an escape response, presumably triggered by visual, auditory and olfactory cues (Loughrey 1959). The walrus's senses of smell and hearing are keen, whereas its vision is not particularly good (Loughrey 1959, Fay *et al.* 1984, Kastelein *et al.* 1993a, b). Walruses are highly vocal both in air and underwater (*e.g.* Ray and Watkins 1975, Miller and Bonness 1983). During the mating season in late winter and early spring, walruses use a complex array of vocalizations underwater. Displaying bulls produce sounds such as rasps, clicks, bell tones, strums etc. to attract females in estrous (*e.g.* Stirling *et al.* 1987). Most calls are within a frequency range of 50 Hz to 4 kHz. These sounds are transmitted underwater up to at least 10 km (*e.g.* Stirling *et al.* 1987, Anon. 1991). Underwater acoustic studies off Round Island (Alaska) indicate that walrus vocalizations can raise calm-water ambient noise levels by 11 dB (USFWS 1991 unpubl. data *fide* Anon. 1991). A study of the hearing ability of walruses in the wild indicated that they are sensitive to sounds between 250 Hz and 4 kHz. (Kastelein *et al.* 1993b).

The intensity of a walrus's reaction to human-made noise can be highly variable, and in some cases walruses may even be attracted by human presence (Fay *et al.* 1984, Anon. 1993b). Factors such as sex and age of the animal, the size and location of its group (on ice, in water, on land), distance from the disturbance, the type and intensity of the disturbing factor, the animal's previous experience with disturbance, the weather and the animal's behavioral state (*e.g.* hauled out in sunny weather and drowsy) can all affect its responsiveness. On ice or on shore, male walruses tend to be less shy than females, and solitary individuals tend to be less shy than groups. Females with calves appear to be most sensitive to disturbance (*e.g.* Salter 1979, Miller 1982, Fay *et al.* 1984).

Aircraft traffic: Richardson *et al.*(1989) and Davis *et al.*(1990) summarized information about marine mammal reactions to noise and concluded that seals and walruses were probably the most susceptible to disturbance by aircraft.

The sound and sight of an aircraft moving rapidly overhead appear to be particularly disturbing to walruses (*e.g.* Fay *et al.* 1984). Studies of walrus reactions to aircraft noise (Salter 1978, 1979, Fay 1981, Fay *et al.* 1984, Born and Knutsen 1990 c) have shown that the response varies with aircraft type, range, flight pattern, altitude and environmental factors such as, for example, wind speed and wind direction. The reactions of the walruses also depend on age and sex, group size and behavior (*e.g.* Salter 1978, 1979, Fay 1981, Orr *et al.*1986). Usually walruses that are hauled out react by lifting the head when the noise from a helicopter or other aircraft becomes audible to humans. An acute escape response, with animals fleeing into the water, is usually not observed until the aircraft is within 1-2 km of a group. However, there are exceptions to this, and in certain cases walruses can be scared by helicopter noise and escape into the water when the helicopter is even further away (Gjertz, unpubl. observation). Adult females, calves and subadults are more likely than adult males to enter the water during disturbance. This can result in a stampede, sometimes causing calves to be crushed to death. Tomilin and Kibal'chich (1975 *fide* Fay 1981) reported how an aircraft overflight caused Pacific walruses to stampede, leading to the trampling to death of some calves and the abortion of some fetuses. The passing of an aircraft at 800 m altitude over an ugli on Wrangel Island caused a stampede in which 102 walruses of all age and sex classes died. Many traumatized animals that were able to leave the ugli died later (Ovsyanikov *et al.*

1994). To reduce disturbance, overflights of most walrus haul-out sites in Russia are prohibited within 50 km except by special permit (U.S. Fish and Wildlife Service 1993).

Smith *et al.* (1979) noted that direct observations of walrus responses to aircraft flying over haul-out areas, disturbance by boats, and chronic disturbance by the construction of DEW (distant early warning) line sites and associated activities near haul-out areas all point to the sensitivity of walruses to any change in their environment. Chronic disturbance may lead to permanent abandonment of an ugli (Gol'tsev 1968, 1975 *fide* Fay *et al.* 1984). Richardson *et al.* (1989), however, stated that some walruses that were exposed to repeated aircraft disturbance at haul-out sites close to airstrips, *e.g.* at Cape Lisburne (Alaska), seemed to become more tolerant of the aircraft noise, *i.e.* they became partially habituated.

Vessel traffic: Walruses usually do not react to small boats with outboard engines before these are less than about 400 m away (Salter 1979, Fay 1981). However, drowsy walruses can sometimes be approached slowly to within about 10-20 m in small skiffs with outboard engines. In such cases the escape reaction often appears to be triggered by the sense of smell or sight. The reaction of the walruses is clearly related to their previous experience with skiffs. In hunted populations, *e.g.* that in Avanersuaq (Thule) in northwestern Greenland, walruses are much more skittish than they are in unhunted populations, *e.g.* at Svalbard (Born, unpubl. observations). According to Fay *et al.*(1984), Pacific walruses reacted to the icebreaking activities of a ship, starting when the ship was as much as 2 km away. These authors believed that the walruses reacted more to the sound of the ice breaking than to the sounds of the ship's engine. When the ship was 100-300 m away, male walruses on ice went into the water. Females with young usually went into the water when the ship was 500-1000 m away, apparently as a response to both the sight and the sound of the ship. Low-frequency diesel engines appear to cause less disturbance than high-frequency outboard engines (Fay *et al.* 1984). However, the opposite sometimes might be the case (Anon. 1991).

Haul-outs in Russia have been protected by regulations limiting access; the distance varies with the site but is usually 20 km (U.S. Fish and Wildlife Service 1993). It is, however, not clear from this source whether these regulations apply to all areas of Russia.

The reactions of walruses to drilling operations involving icebreaker activity were studied in the Chukchi Sea between late June and early October 1989 (Brueggeman *et al.* 1990, 1993). Walruses moved 20-25 km away from the ice-breaking operations deeper into the pack ice where noise levels approached ambient. Once the ice-breaking activities stopped or became more focused at the drill site, the walruses began returning to previously occupied areas. Under these circumstances, walruses displayed some behavioral responses which rapidly decreased at distances beyond 0.46 km from the ice breaker. They showed little response to other drilling operations. These studies demonstrated that walruses react to icebreaker activities, but responses varied according to the intensity of the ice management. According to Brueggeman *et al.*(1993) the variability of walrus responses to different activities offers opportunities to minimize disturbance to walruses during drilling and other industrial operations.

Intensive year-round ship traffic, including the use of large ice breakers in winter, reportedly has had a negative impact on walruses in the western Russian Arctic, particularly in the southern Barents Sea (Timoshenko 1984). In recent years, hunters from several villages along the northwest coast of Alaska have commented to the United States Fish and Wildlife Service that the abundance of walruses in the retreating spring pack ice declined at about the time when large ocean-going tugs arrived in the area, pulling barges of supplies destined for more northerly villages and industrial sites (U.S. Fish and Wildlife Service 1993).

See also section: Interactions with fisheries and changes in walrus food resources.

Offshore hydrocarbon exploration and operational activities: Sources of man-made underwater noise considered here include: 1) offshore drilling and production, 2) underwater "explosions" (high explosives, airguns, gas exploders and vibrators) associated with seismic activity (Davis *et al.* 1990). Seismic exploration usually involves the production of sounds with high source levels, making them audible many kilometers away. Vibroseis (use of vibration vehicles on the ice to project sounds into the water) creates low-frequency sounds with source levels greater than 185 dB (*Ibid.*).

In a study of the effects on walruses of offshore drilling, the animals were found to exhibit only weak short-term behavioral responses to the drilling activities *per se* (Brueggeman *et al.* 1990). According to Davis *et al.*(1990), detailed studies of how pinnipeds react to noise from seismic exploration have not been published, and there is little information on how they react to impulsive sounds generally. The available information is not conclusive, but

what there is suggests that, in some cases at least, seals will tolerate intense impulsive sounds, *e.g.* if they are strongly attracted to an area for feeding or reproduction.

Underwater noise could interfere with walrus mating activities in the wintering areas and thereby reduce their reproductive capacity. Fay *et al.* (1984) assumed that some inhibition of communication through garbling or "drowning out" of underwater vocalizations could take place if the noise level was high enough. Underwater noise might affect walruses in three ways: 1) by "masking" ordinary communication and thus preventing individuals from locating one another, 2) by "masking" vocalizations of displaying bulls and thereby preventing them from attracting females in estrus, and 3) by scaring walruses away from critical habitats, *e.g.* feeding banks (Anon. 1990 b,c).

Military activity : We are not able to evaluate to what extent military activity (rocket launching, explosions) in different areas (*e.g.* southern Barents Sea) may have adversely affected walruses.

Pollution

Oil spills etc.: Oil and gas exploration and development pose several potential risks to walruses and their habitat: 1) harassment, such as stampede induced by noise etc. from ships, seismic activities and installations, or crushing from direct contact with ships, 2) negative effects of noise (for example masking of communication), 3) contact with or ingestion of oil from oil spills etc., 4) damage or destruction of essential habitats, such as haul-out sites and feeding banks, from oil spills.

Potential risks associated with items 1 and 2 are discussed elsewhere in this report, and only items 3 and 4 are considered here.

Documented and hypothetical effects of oil spills on marine mammals have been reviewed by, for example, Griffiths *et al.* (1987), Richardson *et al.* (1989), and Boertmann *et al.* (1994). However, as far as we know, no studies have specifically addressed the direct or indirect effects of oil on walruses, and little specific information is available. Speculations and hypotheses about the potential impact of oil spills on walruses were given in Anon. (1990c).

Studies of seals have shown that surface contact with oil causes stress, and temporarily irritates the eyes and skin. Some studies have indicated that ingestion of oil leads to physiological and chemical changes, but most evidence of internal organ and tissue damage from oil ingestion by seals is inconclusive (see review by Richardson *et al.* 1989). Inhalation of aromatic hydrocarbons from an oil spill caused mental debilitation in harbor seals – *Phoca vitulina richardsi* (Frost and Lowry 1993). Walruses exposed to an oil spill are likely to show some of these reactions. However, walruses depend almost entirely on blubber to minimize heat loss. Their sparse pelage presumably is of little value as insulation, and their skin is thick and very tough (Fay 1982). It is therefore unlikely that exposure of the skin to oil would have any appreciable thermal effect except in newborn walruses. Perhaps the oiling of newborns that have not yet accumulated a thick insulating blubber layer would affect their ability to keep warm. Consequently, oil spills during the walrus calving season (May-June) in areas where females and young are present could, theoretically, have a greater adverse impact than spills at other times and in other areas.

Richardson *et al.* (1989) stated that hair seals (Phocidae) often do not actively avoid spilled oil, but Burns and Frost (1979 *fide* Richardson *et al.* 1989) mentioned circumstantial evidence that some bearded seals (*Erignathus barbatus*), ringed seals and walruses avoid waters that have been contaminated by fuel.

We believe that some features in the ecology of walruses make them more vulnerable to the harmful effects of spilled oil than are many other marine mammals:

1) Due to the high level of gregariousness in walruses, an oil spill that affects one would be likely to affect at least several individuals.
2) Their pronounced thigmotactic behavior on ice and on land makes it likely that oil-fouled walruses will rub oil onto the skin or into the eyes of other individuals.
3) Walruses tend to inhabit coastal areas and areas of relatively loose pack ice. Spilled oil is likely to accumulate in just such areas (Griffiths *et al.* 1987). Walruses therefore have a high risk of being fouled not only in the water but also when they haul out on land.
4) Because they are benthic feeders, walruses may be more likely to ingest petroleum hydrocarbons than are most other pinnipeds. Benthic invertebrates are known to accumulate petroleum hydrocarbons from food, sediments and the surrounding water (see Richardson *et al.* 1989, Anon. 1990c). Mortality of several species of benthic invertebrate, including bivalve mollusks, has been observed as a direct effect of oil spills (North 1967, Percy and Mullin 1975, both *fide* U.S. Fish and Wildlife Service 1993). Furthermore, sub-lethal effects on the behavior,

Fig. 54. A walrus devouring a ringed seal on the ice at Kong Karls Land (Svalbard) on 24 July 1991. It is suspected that the high levels of chlorinated hydrocarbons found in some walruses are related to their seal-eating habits. Photo: M. Forsberg.

physiology, and productivity of benthic mollusks may result from exposure to petroleum products (Clark and Finley 1977). The implications for walruses may be serious since contaminants in their food are certain to build up in their own tissue. Also, if oil contamination were to reduce the biomass or productivity of the invertebrate communities that sustain walruses, there would obviously be some secondary impact on the walruses themselves. However, information about population dynamics of marine mammals and the effects of oil on prey species is generally too incomplete to allow a meaningful assessment of the potential indirect long-term effects of oil spills (for a review see also Richardson *et al.* 1989).

5) Walruses are stenophagous (*i.e.* narrow feeding niche) and depend on access to mollusk banks in shallow water. Oil spills in certain feeding areas could force walruses to seek alternative food or relocate to other feeding areas. It cannot be assumed that alternative types of food or feeding areas are actually available, however, so such a scenario could prove detrimental to the walruses.

Activities associated with oil and gas exploration are now occurring in many areas inhabited by Atlantic walruses. In some areas these activities are large-scale. For example, around Svalbard there has been extensive offshore exploration for oil since the early 1980s (Moe 1994), and exploratory drilling is presently underway a little south of Bjørnøya. The feasibility of exploitation on the Spitsbergen Banke between Bjørnøya and the island of Hopen is being evaluated, and exploitation is expected to begin before the end of this century. One of the world's largest fields of liquified natural gas, the Stockmann Felt, is in the Barents Sea (Gjertz, unpubl. information).

In the western Russian Arctic there are large oil and gas fields in the southern Barents Sea from the White Sea northeast to southern Novaya Zemlya, and along the west coast of Novaya Zemlya. Furthermore, large fields in the Kara Sea stretch eastward to the Yamal Peninsula (Anon. 1992, Moe 1994). Seismic surveys started in 1971, and exploratory drilling in 1981. There are several drilling platforms along western Novaya Zemlya and in the Kara and Pechora seas, and oil is now produced on Kolgujev Island (*Ibid.*). These oil fields overlap the summer and winter distribution of walruses and therefore large-scale petroleum activities pose a potential threat to walruses in these areas.

Problems of oil spills or leaks on land in northwestern Russia are of concern for many reasons, among them the possibility that massive contamination will eventually reach marine waters and affect marine organisms. Of special interest in this regard are the walruses in outer Pechora Bay and the nearshore southern areas of the Pechora Sea (*cf.* Haug and Nilssen 1995).

At present, there is no exploitation of nonrenewable resources in Greenland. Since 1991, however, there has been marine seismic activity related to oil exploration along the coasts north to 79°N in eastern Greenland and 77°N in western Greenland (for a review see Born 1995).

We are not aware of any offshore petroleum development activity that is occurring in the eastern Canadian Arctic in areas presently occupied by walruses.

Heavy metals and chlorinated hydrocarbons (CHCs): Two classes of pollutants have given particular cause for concern in marine mammals: heavy metals and chlorinated hydrocarbons (CHCs) (for a review see Reijnders *et al.* 1993). Few studies have been made of heavy metals, PCBs and other CHCs in walruses.

Heavy metals: The three metals which give greatest cause for concern are mercury (Hg), cadmium (Cd) and lead (Pb) (Reijnders *et al.* 1993).

Concentrations, on a wet weight basis, of Hg in Atlantic walruses from northwestern Greenland, males and females combined, were 1.78 μg/g (SD = 1.54) for liver and 0.08 μg/g (SD = 0.05) for muscle (Born *et al.* 1981).

Wagemann *et al.*(1993) reported regional differences in heavy metal burdens in Atlantic walruses sampled between 1982 and 1990 in southeastern Hudson Bay, Foxe Basin and southeastern Baffin Island. Concentrations of Pb and Hg in Hudson Bay animals (8.0 and 0.58 μg/g dry weight Pb and Hg in the liver, respectively) were approximately twice as high as those in animals from Foxe Basin. Metal concentrations, except Cd, in walrus tissues appeared to parallel those found in clam tissues. Cd levels were relatively high in liver and kidney of walruses, and the spatial trend was opposite that for Hg and Pb, decreasing toward the south. The Cd concentration in liver of walruses from Foxe Basin (on average 38 μg/g dry weight) was twice as high as that in animals from southeastern Hudson Bay. Cd concentrations in tissues of walruses from Foxe Basin were also high compared with those in other marine mammals. The concentrations of Pb and Hg in animals from southeastern Hudson Bay were unexpectedly high compared with animals from the other locations.

Mean concentrations of mercury in liver of Pacific walruses (1981-1984) were as high as 1.85 μg/g (SD=2.59) in males and 4.00 (SD=8.41) in females. Cadmium in kidney reached 66.25 μg/g in males (SD=14.78) and 44.29 μg/g in females (SD=18.80) (Taylor *et al.* 1989). Further results of this study (1986-1989), which involved only adult animals, were presented in Warburton and Seagars (1991, 1993). Analyses were completed for 23 elements. All tissues had Pb, Cd, Ar, Zn and Hg in detectable quantities. Mean Cd concentrations were 27.6 μg/g (1.0-86.7 μg/g) in liver and 166.5 μg/g (3.6-457.6 μg/g) in kidney. In kidney and liver tissues, mean Hg concentrations were four times higher and Cd concentrations three times higher than reported previously. Mean Cd concentrations exceeded levels (13μg/g) considered by the EPA (Environmental Protection Agency) to interfere with organ function in some animals. Mean Hg concentration in liver exceeded the EPA standard (1 μg/g) considered safe for human consumption. Male and female tissues differed significantly in mean concentrations of Ar (liver and kidney) and Se (liver). Warburton and Seagars (1993) were unable to assess, conclusively, the meaning of their results with respect to the health of walruses.

CHCs, chlorinated hydrocarbons: PCBs are anthropogenic chemicals. They accumulate mainly in blubber and are of concern because of their potentially harmful effects on walrus reproduction, the walrus immune system, and human health through consumption of contaminated walrus tissue (Anon. 1993b). Norstrom and Muir (1994) identified 45 PCB congeners in walruses from the Canadian Arctic, but walruses typically contain low levels of CHCs (Anon. 1993b). These generally low burdens in walruses are likely explained by their diet. Walruses appear to be more efficient than ringed seals in metabolizing PCBs, but the difference could be diet-related (Norstrom and Muir 1994). It has been suggested that the comparatively high levels of PCBs found in some individual walruses in Canada were due to these walruses' seal-eating habit (Wagemann *et al.* 1993).

Concentrations of DDT in blubber from walruses in northwestern Greenland were 0.09 μg/g (wet weight; SD = 0.13) in males and 0.05 μg/g (SD = 0.05) in females (Born *et al.* 1981). Concentrations of total-PCB in blubber were 0.36 μg/g (SD = 0.31) and 0.18 μg/g (SD = 0.12) for males and females, respectively (Born *et al.* 1981). These values are relatively low compared with those reported for Pacific walruses (Norstrom and Muir 1994) and Atlantic walruses in eastern Hudson Bay (Segstro *et al.* 1993).

Blubber from walruses in eastern Hudson Bay, Foxe Basin and SE Baffin Island was analyzed for PCB congeners and other persistent CHCs (DDT, toxaphene, chlordanes, dieldrin, mirex) by Segstro *et al.* (1993) and Wagemann *et al.* (1993). Samples from 17 of 58 individuals had concentrations of total-PCB ranging from 1 to 20 μg/g; the remaining individuals had much lower concentrations (0.05-0.6 μg/g). Especially high concentrations were found in the sample from eastern Hudson Bay. Compared with previous studies from Greenland and Alaska these levels were unexpectedly high. Local contamination was ruled out, and Segstro *et al.* (1993) suggested that the high levels of the different CHCs found in some individuals in their study might have been caused by the fact that these animals had consumed ringed seals as a significant proportion of their diet (Fig. 54).

Compared with some other marine mammals, walruses have generally low concentrations of heavy metals in their tissues, and their concentrations generally are not significantly different from those reported for other pinnipeds (Wagemann and Muir 1984). This is also the case for CHCs (chlorinated hydrocarbons). The effect of CHCs on walrus physiology and reproduction is not known, but the comparatively high concentrations of these substances reported from some individuals give cause for concern. The contamination of walruses with CHCs warrants further study.

Radioactivity and nuclear activity: Only a few studies on radioactive elements in walruses have been made. In 1968 a USAF B-52 bomber crashed in the Avanersuaq area (Thule area, northwestern Greenland). In connection with this accident plutonium was released from the nuclear bombs to the surroundings (Anon. 1970a, b). Analyses of plutonium in sediment, bivalves (including walrus food items) and other benthic organisms collected at the crash site showed values elevated from background levels (Aarkrog 1970, 1971). Therefore, there is a risk that some walruses have become, and more will continue to become, contaminated with radioactive waste through their food. Aarkrog (1970) concluded that the animals at higher trophic levels such as birds, seals, and walruses showed plutonium levels hardly significantly different from the fall-out background.

In analyses of plutonium in liver and jaw tissues of 15 and five walruses sampled in northwestern Greenland (1977-78, 1989) and Central East Greenland (1989), respectively, very low values were detected in two jaws and seven livers. In the remainder of samples, values were below detection limit (Aarkrog, Nielsen and Born, unpubl. data). However, in this study, and in that reported by Aarkrog (1970, 1971), it was unclear to what extent the walruses analyzed had actually been feeding close to areas potentially contaminated by nuclear waste.

In general, nuclear weapon tests in different parts of the world caused widespread fall-out of plutonium. However, the levels of this element and other radionucleides, such as ^{137}Cs, reported so far from marine mammals are not considered high enough to pose a health risk to the animals (A. Aarkrog pers. comm. 1995).

No information is available about the effect on walruses of the nuclear activities in the Novaya Zemlya region. Thus we have no basis for determining if these large-scale activities, some of which were within or close to walrus habitat (see Stokke 1994: 147), have affected the walrus population by contaminating the walruses or their prey. If there has been an effect, it would most likely be in the form of direct killing by the shock waves, killing by acute nuclear "poisoning", or noise disturbance.

Second-hand information from Russian sources indicates that certain walrus haul-out sites in Novaya Zemlya were deserted in the 1960s due to the nuclear testing on this island. These walruses supposedly moved to Franz Joseph Land and have not returned (Gjertz, unpubl. information). This information may be connected to Bychkov's (1975) assumption that only 400 walruses remained of the Novaya Zemlya stock , and that their numbers were declining despite total protection. Although walrus population estimates in the Novaya Zemlya region are not very reliable, there are indications that both the population in this region, and the number of terrestrial haul-outs, have decreased since the 1950s (Bychkov 1975, Timoshenko 1984, Popov *et al.* 1990).

Interactions with fisheries and changes in walrus food resources

Walruses typically feed on bivalve mollusks in shallow continental shelf waters (*e.g.* Vibe 1950, Fay 1985). They have a narrow feeding niche and are therefore forced to inhabit specific areas for a major part of the year. Fishing activities in such areas may have direct or indirect negative effects on walrus populations.

Fishing activities may affect walrus populations in the following ways: 1) a fishery can compete directly with walruses for a food resource or damage their food supply by disturbing the ocean floor, 2) fishing activities produce noise and other forms of disturbance that can cause stress to walruses.

In none of the areas occupied by Atlantic walruses are the effects of interactions with fisheries understood, although major commercial fisheries have been developed during the present century in walrus habitats off western Greenland, around Svalbard and in the Barents Sea region. Sufficient information is available only for Svalbard and western Greenland to allow us to consider potential conflicts between fisheries and walruses.

In the Svalbard area concentrations of Icelandic scallops (*Chlamys islandica*) are found between 20 and 70 meters depth. From the mid-1980s there has been an intensive fishery for Icelandic scallops on the continental slope around Svalbard (J. Sundet pers comm. 1990). In 1986, 26 trawlers (all about 2000 GRT) took scallops (*Ibid.*); in 1987, 15-20 trawlers participated in the fishery (Anon 1990b). In

the period 1985-1990, the largest trawlers took 10-50 tons of living scallops per day, and during the operations the large ships had three dredges, each up to 5 m width, in operation at the same time (J. Sundet pers. comm. 1990). This fishery peaked in 1986 and 1987 when about 720 and 4000 tons, respectively, of scallop meat (adductor muscles) was processed. Thereafter the fishery collapsed (*Ibid.*). In Svalbard most of the important walrus habitat lies within protected areas (*i.e.* nature reserves and national parks). Apart from shrimp trawling at depths greater than 100 m, trawling and dredging in these areas are prohibited. One of the best-known terrestrial haul-outs for walruses in Svalbard, the island of Moffen, is located at the center of the richest scallop banks in Svalbard. In the mid-1980s this led to a siege of Moffen by a fleet of trawlers that, whenever given a chance, violated the protected area. This activity occurred in spite of increased surveillance by the coastguard and police (I. Gjertz unpubl. information).

It is not known to what extent walruses feed on scallops. In the Canadian Arctic, Mansfield (1958) found remains of scallops (*Pecten* sp.) in four walruses; scallops were the dominant prey in two of these animals. Scallop eating by walruses in the Svalbard area, has not been documented, but Gjertz and Wiig (1992) found some indications that Svalbard walruses do eat scallops. Walruses also feed on a large variety of other benthic organisms (*e.g.* Fay 1982). According to Anon. (1990c:133) the non-selective dredging technique that was used at Svalbard radically altered the sea floor. It is therefore reasonable to assume that the large-scale dredging in and around important walrus feeding grounds in Svalbard damaged benthic communities and reduced their biological diversity. Thus walruses presumably have been affected regardless of whether they feed on scallops.

In West Greenland a small-scale commercial fishery for Icelandic scallops began in 1983. Catches have ranged from 410 tons in 1984 to 1966 tons in 1991 (Pedersen 1994). The main fishing area is between Nuuk and Disko Island. The scallop beds are located close to the coast, and the fishery is confined to summer and autumn. Icelandic scallops are usually found on hard substrate (shell gravel, gravel, stones, rocks, sand and less frequently mud) in areas associated with strong tidal currents. These are not areas where typical walrus food items are found. The relatively small size of this fishery and its spatial and temporal location indicate that it probably has had no major effect on the stock of walruses wintering off western Greenland.

In contrast, the noise caused by another intensive fishery in walrus habitat off West Greenland may have had a negative impact on walruses. Since about 1920 fishing activities have increased in western Greenland, and the development of commercial fisheries has been especially rapid since the 1960s (*e.g.* Born *et al.* 1994a). At the beginning of the 1970s trawling for shrimp was initiated in offshore areas, including parts of Store Hellefiske Banke in the Sisimiut-Aasiaat area. Walruses occur in winter and spring on this bank in areas where water depths are less than 100 m. In spring 20-25 large trawlers and some smaller vessels operate close to the edge of the West Ice (Born 1990). As soon as ice conditions permit, the fishery commences on Store Hellefiske Banke. This may be as early as March, and during April and May fishing activity increases in this area. Similarly, the large trawlers operate along the west coast of Disko in or close to walrus habitat as early as May (P. Kanneworff pers. comm. 1995).

Most underwater sounds associated with fishing vessels are generated from propeller cavitation and are in relatively low frequencies (40 Hz-4 kHz). Measurements of a medium-sized trawler's underwater sounds showed source levels of 169 dB when transiting (at 10 knots) and 157 dB when trawling (at 5 knots) (Urick 1983). Small to medium sized ships operating at full power produce sound source levels of 165-175 dB (Malme *et al.* 1989). Underwater sounds produced by vessels are within the frequency range of those produced by walruses. It is therefore possible that intense vessel noise could mask the calls of walruses and impair the efficiency of signaling between individuals (Anon. 1991). In addition to the underwater sounds, airborne sounds of various kinds are associated with fishing activities (engines, generators, deck activities etc.)

Compelling circumstantial evidence indicated that yellowfin sole (*Limanda aspera*) fishery operations were causing airborne and submerged acoustic disturbance responsible for a significant decline (up to 60%) in the number of Pacific walruses reported hauling out at Round Island, the Twins, and Cape Pierce in Alaska. Many walruses from Round Island may have moved to other haul-out areas in Bristol Bay (U.S. Fish and Wildlife Service 1993). In order to reduce the negative impact of this fishery on the walruses, a 12-nautical-mile buffer zone has been established around the Walrus Island State Game Sanctuary and Cape Pierce (Anon. 1991, U.S. Fish and Wildlife Service 1993).

LIFE HISTORY AND VITAL PARAMETERS

In order to give the reader a background for evaluating the information presented in this report about the status of Atlantic walrus populations, the life history of walruses is briefly described. We emphasize aspects that are important for evaluating information about distribution, survey results, population recruitment and trends. Fay (1981, 1982) and Born (1992) gave more thorough reviews of the biology of walruses.

Taxonomy: The walrus genus, *Odobenus*, has only one species: *rosmarus*. Two subspecies are recognized (*e.g.* Heptner *et al.* 1976, Reeves 1978, Fay 1985): Atlantic walrus, *O. r. rosmarus* (Linnaeus 1758) and Pacific walrus, *O. r. divergens* (Illiger, 1815). On the basis of morphological variation and geographical isolation the existence of a third subspecies, *O. r. laptevi* , confined to the Laptev Sea, was suggested by Chapskii (1940). This taxon has generally been accepted by Russian scientists (*e.g.* Heptner *et al.* 1976, Belikov *et al.* 1984, Vishnevskaia and Bychov 1985), but was considered questionable by Fay (1981, 1982, 1985).

Only the Atlantic subspecies occurs in the northwestern and northeastern Atlantic Arctic.

Distribution: Today the walrus has a disjunct circumpolar distribution between the latitudes of approx. 55°N and 81°N (Heptner *et. al.* 1976, Reeves 1978, Fay 1985). The Atlantic walrus ranges from the eastern Canadian Arctic eastward to the Kara Sea (Reeves 1978). Several more or less well-defined subpopulations or stocks exist within this range (Fig. 3).

Body size: Walruses are the largest pinnipeds of the Arctic. Male Atlantic walruses reach a standard body length of about 300 cm and can weigh about 1200 -1500 kg. Females reach a body length of about 250 cm and a total body weight of 600-700 kg (Loughrey 1959, Mansfield 1958, Knutsen and Born 1994). Wiig and Gjertz (in press) have recently found that male walruses at Svalbard can reach a standard body length of about 380 cm corresponding to an estimated total body weight of nearly 2000 kg (Fig. 55). There are indications of differences in total body length in different stocks in the western Atlantic Arctic (Mansfield 1958, Knutsen and Born 1994). Chapskii (1936) reported body lengths of Atlantic walruses from the Kara Sea. However, in his study the methods of age determination and measuring differed from those of the authors cited above and his data are therefore not comparable.

Reproduction: On the basis of body and tusk size Chapskii (1936) estimated that male Atlantic walruses in the Kara Sea became sexually mature at 5 or 6 years of age. With more accurate methods of determining ages but on a relatively small sample, Mansfield (1958) judged that males in the eastern Canadian Arctic reached sexual maturity at 6 or 7 years of age. In *O.r.divergens* spermiogenesis commences between 7 and 10 years of age. The capa-

Fig. 55. Weighing an immobilized adult male walrus in Svalbard, where large males may weigh close to 2000 kg (Wiig and Gjertz in press). Photo: I. Gjertz

Fig. 56. Adult female with 1-year-old calf at Svalbard. Walruses give birth to a single calf at intervals of 2 or more years. Photo: I. Gjertz.

bility of fertilizing females is usually not achieved until later, when social or full physical maturity has been reached. Physical maturity is accompanied by a secondary growth spurt in males of *O. r. divergens* (Fay 1982); this growth pattern has not been observed in *O. r. rosmarus* (Mansfield 1958, Knutsen and Born 1994).

The majority of *O. r. rosmarus* females experience their first ovulation at 7 years of age (range: 5 to 10 years). According to Mansfield (1958) ovulations in 5-year-olds presumably usually do not result in successful pregnancies. However, Garlich-Miller and Stewart (1993) found one pregnant six-year-old in a sample of 71 females from Foxe Basin. In northwestern Greenland first ovulation occurs at five years of age. About 50% of the females experience their first ovulation at around the age of six and all have ovulated before the age of 10 (Born 1990). In *O. r. divergens* about 10% of females ovulate at 4 years, the majority of 6-year-olds have ovulated at least once and all have ovulated by the age of 10. The rates of reproductive failure in walruses appear to be high, and in any given year about 20% of the sexually mature females are resting. Females may experience reproductive senility. In *O. r. divergens* an onset of decline in productivity of females by age 16-18 has been observed (Fay 1982, Anon. 1990a).

In *O. r. rosmarus* potent bulls have been found between November and late May (Mansfield 1958) and the mating season is believed to be between late January and March-April (Mansfield 1966, Born 1990). In *O. r. divergens* spermiogenesis peaks in December-January for mature males and about 2 months later for adolescents (Fay 1982, 1985). Like in other pinnipeds, implantation is delayed in the walrus for 4-5 months (Fay 1982, Born 1990). Although unseasonal births have been reported (Vibe 1950, Lukin 1978), the main period of birth in *O. r. rosmarus* lasts about two months with a peak between mid-May and early June (Vibe 1950, Mansfield 1966, 1973). According to Fay (1985) calves of *O. r. divergens* are born mainly from mid-April to mid-June. Hence, pregnancy lasts about 15 to 16 months (Mansfield 1973, Fay 1985) and individual walruses therefore give birth to a calf at intervals of 2 or more years (Mansfield 1958, Fay 1982, 1985, Born 1990; Fig. 56).

Vital parameters: The segregation of different sex and age classes for most of the year, and the selective hunting pattern of the Inuit, make it very difficult to obtain unbiased samples for determining vital biological parameters (*e.g.* Fedoseev and Gol'tsev 1969, Fay 1982, DeMaster 1984). Sex ratio at birth is 1:1 with a slightly higher, but not significantly higher, proportion of males (Fay 1982, Fay *et al.* 1984). The sex ratio in the population is not well known. On the assumption that walruses are polygynous, an adult sex ratio of 1 male to 3 females has been suggested (Fay 1982, Fay *et al.* 1984, Sease and Chapman 1988). Generally, the low rate of reproduction (between 35 and 40% of fecund females give birth to a single calf in any given year; Mansfield 1958, Fay 1982, Born 1990) is believed to be balanced by a low rate of natural mortality, mainly secured by a prolonged period of parental care, and a higher recruitment to breeding age than in other pinnipeds (Fay 1982). Low reproductive capacity is probably also counterbalanced by the highly developed sociality

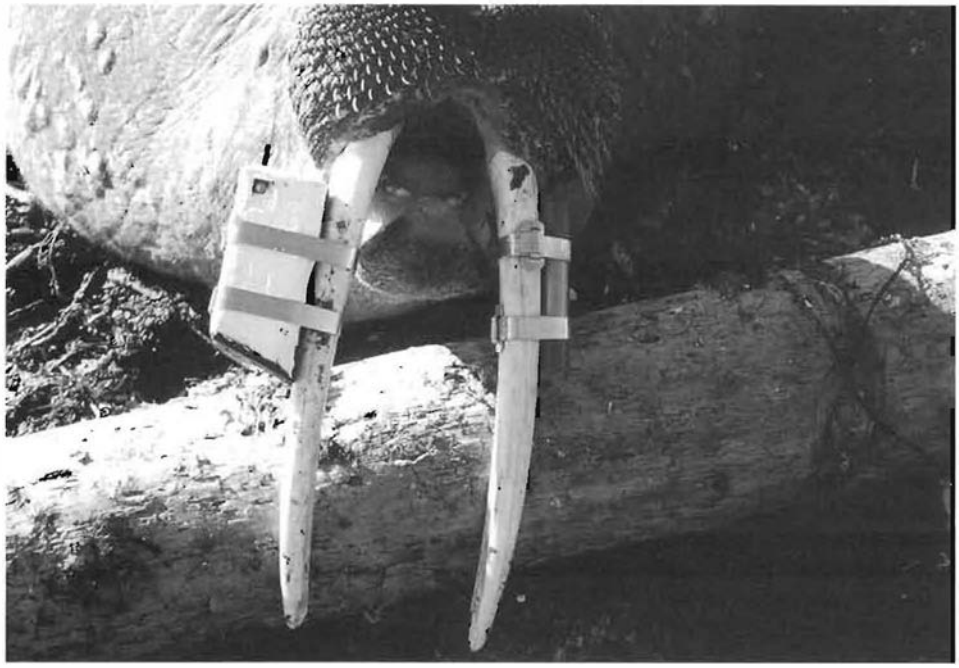

Fig. 57. A satellite-linked radio transmitter (the larger unit) and a time-depth recorder (TDR) attached to the tusks of an adult male walrus at Svalbard. The satellite-radios have been used for studies of movements (Born and Knutsen 1992, Wiig *et al.* in press). The TDR demonstrated a mean dive duration of 5.2 min (SD = 2.8 min, range = 0.2-12.7 min.) of which 81% of the time was spent at the bottom (Wiig *et al.* 1993). Photo: I. Gjertz

of walruses at all seasons (Fay 1985) and their long lifespan (up to about 40 years; Fedoseev and Gol'tsev 1969). The population birth rate (fraction of neonates in the total population) has been estimated at 0.07 (Mansfield 1966) or 0.11 (Mansfield 1973) in *O. r. rosmarus* and between 0.12 and 0.17 in *O. r. divergens* (Fedoseev and Gol'tsev 1969, Fay 1982). The differences in these estimates likely reflect sample variance rather than actual differences at the subspecies level. In *O. r. divergens* total annual mortality (A) for adult males has been estimated at 13% (Burns 1965). DeMaster (1984) suggested an A of about 9% for adult males and considered it likely that total annual mortality of adult females was much lower. Fedoseev and Gol'tsev (1969) estimated A for the entire population of *O. r. divergens* at 8-10%. The natural mortality rate is not known but has been estimated to be 3 to 5 % for the entire population of *O. r. divergens* (DeMaster 1984, Fay *et al.* 1989). An annual hunting mortality of 5 to 7% of the total population is therefore believed to be sustainable (Fay 1985). DeMaster (1984) estimated that maximum sustainable yield of adult females (4 years and older) would be 5.1% of the total population of females. He suggested that an adult female harvest of 1 to 5% could be sustained. Based on a variety of assumptions, maximum sustainable yield of a hypothetical walrus population has been estimated at 3 to 5% for a population between 59 and 91% of carrying capacity (*Ibid.*).

Instantaneous net growth rate of the population of Pacific walruses during the late 1950s to mid-1970s was estimated at 0.067 (Tavrovski 1971, Sease and Chapman 1988), indicating a finite growth rate of about 7% per year for a population in a phase of growth under favorable environmental conditions with no food limitations.

Estimates of abundance: Attainment of abundance estimates is hampered by the fact that the population usually occupies a very large area and has a clumped distribution. Furthermore the fraction of the population which is hauled out and visible at any given time is highly variable. In addition, walruses are "cryptically" colored and can be difficult to see in water (Estes and Gilbert 1978, Estes and Gol'tsev 1984, Gilbert 1989). During feeding, walruses are submerged and hence are not detectable for 80-85% of the time. (Fay 1982, Born and Knutsen 1992, Wiig *et al.* 1993; Fig. 57).

Ecology: As they feed mainly on bottom-dwelling bivalve mollusks, walruses are largely confined to continental shelves, where water depths are not greater than 80 to 100 m (Fay 1982, Wiig *et al.* 1993). Walruses are able to break through ice up to about 20 cm thick, but when the ice grows thicker than this walruses are forced to retreat to areas with drift ice. Hence, in winter walruses inhabit those regions of the drifting ice where leads and polynyas are numerous and where the ice is thick enough to support their weight (Burns *et al.* 1981, Fay 1982). They show a strong preference for hauling out on floes of first-year ice with a surface area between 50 m^2 and 400 m^2 (Wartzok and Ray 1980, 1981). Some walruses winter at high latitudes in polynyas (Vibe 1950, Finley and Renaud 1980, Stirling *et al.* 1981, Born 1984, Born and Knutsen 1992). In summer, males rest and molt while hauled out on land on traditional sites (uglit) often situated close to their feeding grounds (Tsalkin 1937, Mansfield

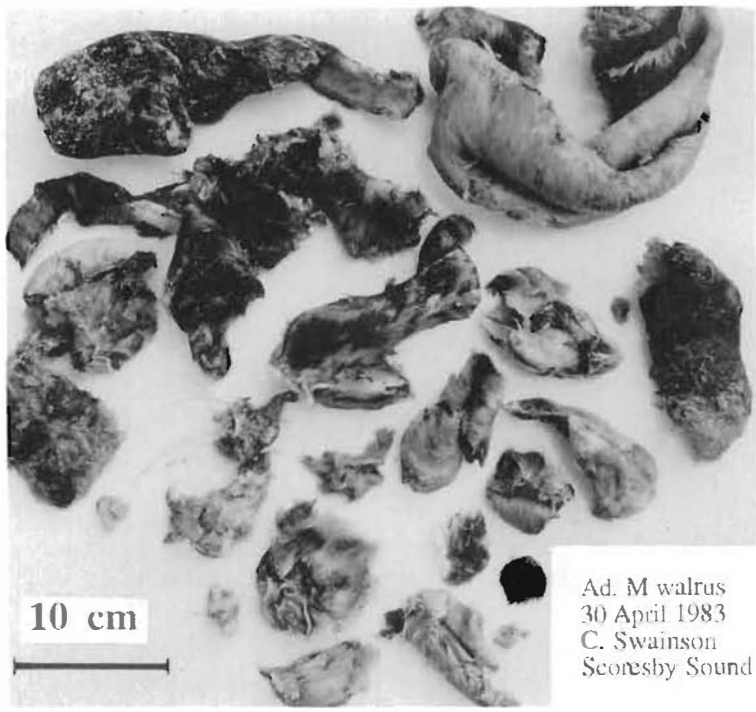

Fig. 58. Contents of the stomach of an adult male walrus killed at the entrance to Scoresby Sound (East Greenland) on 30 April 1983. The walrus had sucked out pieces of ringed seal skin and blubber. (See also Fig. 54). Photo: E.W. Born.

1958, Loughrey 1959, Fay 1982). Females and calves tend to occur farther off shore in association with the drifting ice (Fay 1982, 1985), although in some areas they also haul out on land (Miller 1982, Miller and Boness 1983).

Food and feeding: Walruses are stenophagous and depend on the soft parts (mainly feet and siphons) of bivalve mollusks for about 95% in numbers and weight of their food (Fay *et al.* 1977, Fay and Stoker 1982). This food is taken at water depths of less than about 80 m (Vibe 1950, Fay 1982). The principal food items are the bivalves *Mya truncata*, *Astarte borealis*, *Serripes groenlandicus* and *Hiatella arctica* (Vibe 1950, Heptner *et al.* 1976, Fay 1982, Gjertz and Wiig 1992). Other benthic invertebrates are also ingested to a varying extent (Fay 1982). Although reports of fish in walrus stomachs are rare (Fay 1982), piscivory may play a role in periods when other food is not available. Atlantic walruses have also been reported to prey on birds (Gjertz 1990). Walrus predation on seals is well documented (*e.g.* Johansen 1910, Fay 1982, Lowry and Fay 1984, Smith *et al.* 1979; Fig. 58). Apparently, the habit of seal-eating occurs in both sexes but apparently is confined largely to older subadults and adult walruses (Lowry and Fay 1984). In seasons and areas where the distribution of seals and walruses overlap considerably or when ice conditions make the mollusk feeding-banks inaccessible to walruses, seals may well be an important food source. This could be the case, for example, in northeastern Greenland. There is indirect evidence (trace metal and chlorinated hydrocarbon contaminant levels, ^{13}C analysis of tissues) that walruses in eastern Hudson Bay regularly prey on seals (Wagemann *et al.* 1993).

Natural enemies: Apart from man, the main predators of walruses are killer whales (Fig. 59) (*Orcinus orca*) and polar bears (*Ursus maritimus*) (Fay 1982). Interactions between killer whales and walruses occur in spring, summer and autumn, when the range of the two species may overlap (Fay 1982). Several instances of killer whales attacking and killing walruses, primarily young and calves, are summarized in Fay (1982). Several reports exist of polar bears attacking walruses. Apparently mainly calves and subadults are vulnerable to predation from bears (*e.g.* Parovschikov 1967, Fay *et al.* 1984, Calvert and Stirling 1990, Rugh 1993), although also adults are taken (Parovschikov 1967). A variety of other causes of natural mortality other than aging can be listed: adverse weather, freeze-out, disease, intraspecific interactions such as aggression during the breeding season, crushing of calves, and stampedes (Anon. 1990a). Although predation by bears and killer whales cannot be ruled out as a primary cause of natural mortality in regions where those predators are concentrated or seasonally abundant, the relative importance of the different causes of natural mortality is difficult to assess.

Behavior: Walruses are highly gregarious. They almost invariably occur in small groups and sometimes haul out on land in herds numbering thousands of individuals (Fay 1982, Miller and Boness 1983). The number of walruses hauled out at a given ugli can vary enormously from day to day (Salter 1979,

Fig. 59. An encounter in the ice near Svalbard between a polar bear and an adult walrus. Polar bears occasionally attack walruses but usually show respect toward adults (see text). Photo: L. Åby.

Miller 1982, Miller and Boness 1983). Walruses are polygynous; the sex ratio of adults in the breeding area is about one male per ten females. In the mating season, adult males fight intensively in the water, evidently in competition for display sites near females (Fay *et al.* 1984). During courtship displays the male walrus emits a stereotyped sequence of underwater sounds consisting of taps, knocks, pulses and "bells" (Schevill *et al.* 1966, Ray and Watkins 1975, Stirling *et al.* 1983, 1987, Fay *et al.* 1984). Probably, this acoustical display serves as an advertisement to females and as a warning to other males (Fay *et al.* 1984). Females choose a mate from among the displaying males and copulation occurs in the water. Hence, the mating system of the walruses is unique among pinnipeds. It resembles a lek in that: 1) dominant males display for females while congregated in a traditional location, 2) subdominant males take peripheral positions, and 3) the female appears to take the active role in consorting with the male of her choice within the "arena" (*e.g.* Fay *et al.* 1984, Le Boeuf 1986). However, Sjare (*e.g.* 1989, 1993), who studied the Atlantic walrus in the Canadian High Arctic, found no obvious indications that female choice was an important factor in determining which male was dominant. The mating behavior of Atlantic walruses may be more similar to female defense polygyny than to a mobile lek as described for the Pacific walrus.

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