COSEWIC
Assessment and Update Status Report

on the

Atlantic Walrus
Odobenus rosmarus rosmarus

in Canada

SPECIAL CONCERN
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA

COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

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Atlantic walrus — Drawing of an adult male Atlantic walrus (*Odobenus rosmarus rosmarus*) (Artist Gerald Kuehl; © Canada Department of Fisheries and Oceans, reproduced with permission).

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COSEWIC
Assessment Summary

Assessment Summary – April 2006

Common name
Atlantic walrus

Scientific name
Odobenus rosmarus rosmarus

Status
Special Concern

Reason for designation
Five populations ranging from Nova Scotia to the high Arctic are recognized for management purposes based on geographical distributions, genetics and lead isotope data. Some of the populations appear to be at greater risk than others due to over-hunting, and may be threatened. However, knowledge about population structure is insufficient to assess them separately. The Nova Scotia-Newfoundland-Gulf of St Lawrence population was hunted to extirpation by the late 18th century. Sporadic recent sightings of individuals and small groups in the Gulf of St Lawrence and off Nova Scotia are not considered evidence of re-establishment. The South and East Hudson Bay population is believed to number in the low hundreds, although population size and structure are poorly known. Observations from the late 1930s to the present suggest that numbers declined significantly, but the rate of decline cannot be quantified and it is not known whether the decline is continuing. The small population size suggests it may be vulnerable to disturbances and small increases in hunting effort. The total size of the Northern Hudson Bay-Davis Strait population could be as small as 4,000-6,000 individuals. Its ability to sustain minimum current removals is questionable. Some portion of this population is hunted in Greenland waters. The Foxe Basin population was estimated to be 5,500 in 1989. It is unknown if current exploitation rates are sustainable. Hunting is believed to have reduced the Baffin Bay (High Arctic) population to only a few percent of the number present in 1900. Limited information suggests the current population is small and that a portion of it continues to be hunted at unsustainable levels in the North Water area of Canada and northwest Greenland. However, satellite tracking and genetic information suggest that some animals in this population are resident in the Canadian Archipelago (west Jones Sound and Penny Strait / Lancaster Sound) and are not exposed to over-hunting. Better information is needed on population sizes and composition, seasonal movements, vital rates, and hunting mortality. The biggest threat is over-hunting, particularly on populations that inhabit the southern and northern ends of the species' current range. The species is near to qualifying for threatened status and requires an effective plan to manage hunting. No Management Plans are currently in place for the species. Although quotas have been set in few communities, it is not known if they are adequate to prevent over-hunting.

Occurrence
Nunavut, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland-Labrador, Arctic Ocean

Status history
The Atlantic Walrus in Canada was originally treated by COSEWIC as two separate populations: Eastern Arctic population (Not at Risk in April 1987 and May 2000) and Northwest Atlantic population (Extirpated in April 1987 and May 2000). In April 2006, COSEWIC included both populations in a single designatable unit for Atlantic Walrus in Canada, and the species was designated Special Concern. Last assessment based on an update status report.

COSEWIC
Executive Summary

Atlantic walrus
Odobenus rosmarus rosmarus

Species information

Walruses are large gregarious pinnipeds with front flippers that can support them upright, like otariids, hind flippers that are structured and function like phocid seal hind flippers, upper canine teeth that grow into long tusks, and a moustache of quill-like vibrissae. They are about 120 cm long and 55 kg at birth; males can grow to about 315 cm (~1100 kg) and females to about 277 cm (~800 kg). Their sparsely haired skin is cinnamon brown but can appear pink on a warm day or almost white after a long, cold dive. The Atlantic walrus, *Odobenus rosmarus rosmarus* (Linnaeus, 1758) is one of two extant subspecies of the walrus, the other being the Pacific walrus (*O. r. divergens*). The taxonomic status of walruses inhabiting the Laptev Sea is uncertain.

Distribution

The Atlantic walrus ranged historically from the central Canadian Arctic in the west to the Kara Sea in the east, north to Svalbard and south to Nova Scotia. Four populations have been identified in Canada: 1) South and East Hudson Bay, 2) Northern Hudson Bay-Davis Strait, 3) Foxe Basin, and 4) Baffin Bay (High Arctic). A fifth population—the “Southeast Gulf of St. Lawrence and Scotian Shelf” or “Maritime” population—was abundant along the Atlantic coast of Canada but has been extirpated. The Baffin Bay population is shared by Canada and Greenland. There may also be exchange between the Northern Hudson Bay–Davis Strait and Central West Greenland populations. The four Canadian populations are distinguished by geographical distribution, changes in abundance, contaminants, and lead isotope ratios and signatures but the degree of genetic interchange between them is uncertain. Moreover, each may consist of sub-units that mix little or not at all. Wintering areas at polynyas in pack ice or at ice edges have been documented within the range of each of the putative populations. Walrus distribution appears to have shifted to areas that are less accessible to people.

Habitat

Atlantic walruses occupy a large area but relatively narrow ecological niche. In the absence of humans, they probably require large areas of shallow water (80 m or less) with bottom substrates that support a productive bivalve community, the reliable presence of open water over these feeding areas, and suitable ice or land nearby upon which to haul out. Little protection is afforded to walrus habitat by existing National Parks, Wildlife Areas, Bird Sanctuaries, or other federal lands.

Biology

Walruses haul out on ice and land, sometimes in large herds. They can travel long distances by swimming or by riding ice floes but their seasonal movements are poorly understood. They feed predominantly on bivalve molluscs, for which they may compete with bearded seals (*Erignathus barbatus*). Little is known of their physiological requirements or ability to adapt to changes in food availability or environmental conditions.

Walruses are polygynous. Males compete intensely for females on the ice or in the water from February through April. The stability of the sea ice may be an important determinant of breeding behaviour. Implantation of the embryo is delayed until late June or early July, and gestation is active for about 11 months. Most young are born in late May and early June; some suckle for 25–27 months. Females mature between the ages of 5 and 10 years and give birth to a single calf about once every three years until they reach reproductive senescence. The resulting birth rate is about 0.30 calves per fecund female per year and an annual gross production rate of about 10%. Generation time may be about 21 years. From counts of growth layers in the teeth, walruses may live over 35 years.

Rates of mortality from predation by humans, polar bears (*Ursus maritimus*) and killer whales *(Orcinus orca*) are unknown. Fighting during the breeding season and selective hunting may increase male mortality. Little is known of diseases of walruses or of their response to pathogens.

Population sizes and trends

Five populations ranging from Nova Scotia to the high Arctic are recognized for managing hunting based on geographical distributions, genetics and lead isotope data.

South and East Hudson Bay population. Opportunistic counts suggested there were 270+ animals in the late 1990s, which was lower than earlier estimates of “410+” in 1988 and "500“ in 1995. Data are insufficient to assess whether the population really declined.

Northern Hudson Bay-Davis Strait population. The most recent reconnaissance survey (August 1990) counted 1376 animals in the Coats Island–Southampton Island area and 461 in the Nottingham Island-Salisbury Island area. The number of animals present was roughly estimated in 1988 at 4850–5350 animals, and in 1995 at 6000 animals, based on a few sightings in a wide geographical area over a long period.

Foxe Basin population. In August 1983, 2722 walruses were counted during a helicopter reconnaissance of northern Foxe Basin. In July 1989, a systematic visual aerial survey of central Foxe Basin counted 475 walruses and estimated that 5500 (95%CI 2700-11200) animals were present. These surveys did not cover all of northern Foxe Basin or correct for animals that were submerged beyond view. They provide indices against which change can be measured rather than estimates of the overall population. The 1989 data also provide the best available estimate of abundance.

Baffin Bay (High Arctic) population. In the 1970s and 1980s, 1700–2000 walruses from the Baffin Bay population may have summered in Canadian waters. This estimate was based on data from different seasons and years, most over 20 years old. An aerial survey in 1999 combined with best guesses for areas not counted suggest the population may have numbered about 1500 animals.

Nova Scotia–Newfoundland–Gulf of St Lawrence (Maritime) population. This—formerly numerous—population used land haul-outs in Newfoundland, the Gulf of St Lawrence; Sable I. off Nova Scotia was also frequented. Heavy harvesting, especially in the 17th and 18th centuries extirpated this population. Occasional recent sightings are not considered a sign of its re-establishment.

Limiting factors and threats

Atlantic walrus populations in Canada may be limited or threatened by hunting activities, noise disturbance, and industrial activities. Their narrow ecological niche and restricted seasonal distribution make walruses relatively easy to hunt and vulnerable to environmental changes. Hunting is the cause of most known mortality among Atlantic walruses. It probably poses the most consistent limiting factor and threat to populations in Canada. Managers do not know the size or structure, survival rate, sustainable harvest rate, or rate of removal for any of the currently defined Canadian populations.

The ability of these populations to sustain the existing harvest is unknown. Data on the landed harvests of walruses in Canada are incomplete and vary widely in quality. Total removals may be underestimated by as much as 32%. Average annual Canadian takes since 1989–90 are believed to be 15 from the South and East Hudson Bay population (slight drop in take from 1977 to 1990), 247 from the Northern Hudson Bay–Davis Strait population (abrupt decline in kills, mostly in Nunavut, between 1997 and 2002), 276 from the Foxe Basin population (modest drop from 1977 to 1990), and 24 from the Baffin Bay Population (abrupt decline from 1997 to 2002). It is not known whether the decreases in takes are due to less effort, lower hunter success, or uneven reporting. The contribution of changes in the quality of the harvest data and of uneven reporting are also unknown. The Canadian Baffin Bay population may be vulnerable to hunting in Greenland waters, but this is also not well known. There is a pressing need to obtain better estimates of the walrus populations and removals to ensure that declines in recorded harvests do not signal population depletion.

Human disturbances that cause walruses to leave their haul-outs may impact population dynamics by causing stampedes, interfering with feeding and increasing energy expenditures—particularly among calves—masking communications, impairing thermoregulation and increasing stress levels. Prolonged or repeated disturbances may cause walruses to abandon their haul-outs. Their ability to recolonize areas and to adapt to non-threatening disturbances is unknown. The rarity of animals along the Atlantic coast of Canada since that population was extirpated suggests that re-colonization is at best very slow.

Threats posed to walruses in Canadian waters by industrial activities are low at present. Commercial fisheries could affect them by competing directly for food, damaging areas of seabed where walruses feed, and causing audio and visual disturbances; however, scallop fisheries that might have posed the most direct threat have been tried, and have proved non-viable. Machine noise, particularly from aircraft, disturbs walruses and can cause stampedes into the water. Climatic warming or cooling may expose walruses to greater hunting pressure. The effects of chemical contaminants on walruses are unknown but tissue levels are typically low, except for cadmium and lead from natural sources and organochlorines in animals that eat seals. The vulnerability of the species to disease is unknown.

Special significance of the species

Walruses traditionally provided important staples in the subsistence economy of the eastern Canadian Arctic and Greenland. The hunt and the sharing of its proceeds continue to be of great social and cultural significance, and the economic value of the meat and ivory is substantial. Ecologically, the walrus is important as the only species in its genus and a key link in the Arctic food chain between bivalve molluscs and humans.

Existing protection or other status designations

Atlantic walruses in Canada are afforded limited protection by regulations that manage the hunting, movement, and sale of walrus products (Fisheries Act, Marine Mammal Regulations SOR/93-56, Registered 4 February 1993). Hunts in Nunavut are co-managed by the Nunavut Wildlife Management Board with scientific advice and support from the Department of Fisheries and Oceans (DFO), which manages walrus in other jurisdictions in cooperation with other agencies. Four settlements in the Canadian Arctic have community quotas: Coral Harbour 60/yr, Sanikiluaq 10, Arctic Bay 10, and Clyde River 20. Elsewhere, Inuit and Indian natives of Canada can kill up to four walruses per year without a licence; non-natives require a licence. Trade in edible walrus parts is prohibited in Canada, except among Indians and Inuit, and a DFO permit is required to transport walrus parts within Canada, except for Indians or Inuit who are returning home after the hunt. The regulations prohibit disturbing, killing ineffectually, hunting without equipment to retrieve, waste of edible parts, and abandoning a killed walrus without making a reasonable effort to retrieve it. Invasive research, such as tagging, and live capture are permitted only under licence.

The Atlantic walrus is listed on Appendix III of the Convention on International Trade in Endangered Species (CITES). Anyone wishing to export walrus parts or derivatives from Canada must obtain an export permit from the Canadian CITES administration.

There is no formal cooperation between Canada and Greenland in the management of shared Atlantic walrus populations.

The Atlantic walrus was previously assessed by COSEWIC in 1987 and given two designations: the "Northwest Atlantic" or "maritime" population of Atlantic walruses in Canada was considered extirpated and the Arctic population was designated as not at risk.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2006)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

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COSEWIC Status Report

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Atlantic walrus
Odobenus rosmarus rosmarus

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SPECIES INFORMATION

Name and classification

The Atlantic walrus, *Odobenus rosmarus rosmarus* (Linnaeus, 1758), is a mammal of the Genus *Odobenus* Brisson, 1762, Family Odobenidae Allen, 1880, Suborder Caniformia (synonym Pinnipedia) and Order Carnivora Bowdich, 1821 (ITIS 2003). It is one of two living subspecies of the walrus, the other being the Pacific walrus (*O. r. divergens*)[1]. Common names for the species include walrus (English, Dutch), morse (French), aivik (Inuktitut), hvalros (Danish), mursu (Finnish), rostungur (Icelandic), hvalross (Norwegian), morzh (Russian), morsa (Spanish, Portugese), and valross (Swedish).

Description

The walrus is a large, gregarious marine mammal with front and hind limbs that have developed into flippers (Figure 1). The front flippers can support the animal in an upright position as in the otariids, while the back flippers are structured and function like phocid seal hind flippers. The walrus can be distinguished from other species of marine mammals by its tusks, which are long upper canines, and by its moustache of quill-like whiskers. Adult males are larger than females and have longer, broader tusks (Mansfield 1966; Garlich-Miller and Stewart 1998). Newborn walruses have a coat of silver grey hairs that is soon lost and replaced by a short, sparse coat of brown hair. The sparsely haired skin is cinnamon brown but can appear pink on a warm day, or almost white after a long, cold dive (Bruemmer 1977; Reeves 1995). Adult males have a large muscular neck that is covered by thick, cornified skin. At birth Atlantic walruses are about 120 cm long and weigh about 55 kg (Mansfield 1958); males grow to about 315 cm (~1100 kg) and females to about 277 cm (~800 kg) (Garlich-Miller and Stewart 1998). Pacific walruses grow to a similar length but are heavier on average (MacLaren 1993; Knutsen and Born 1994; Garlich-Miller and Stewart 1998), with longer tusks and a wider skull. Laptev Sea walruses have skull characteristics similar to those of the Pacific walrus and are intermediate in size between the Atlantic and Pacific subspecies.

Detailed reviews are available for the walrus (e.g. Fay 1985) and for its Atlantic (Reeves 1978; Born *et al*. 1995; Stewart 2002) and Pacific subspecies (e.g. Fay 1982), as is a bibliography up to January 1993 (Stewart 1993).

[1] walruses inhabiting the Laptev Sea may constitute a third subspecies (*O. r. laptevi*) but this taxonomy is uncertain (Fay 1982, 1985).

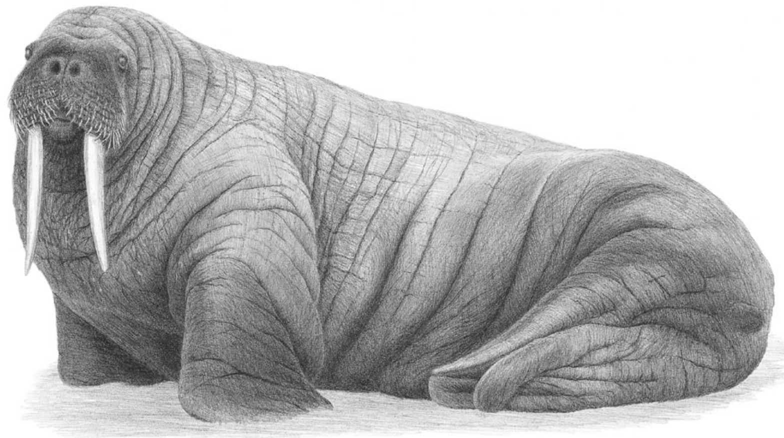

Figure 1. Drawing of an adult male Atlantic walrus (*Odobenus rosmarus rosmarus*) (Artist Gerald Kuehl; © Canada Department of Fisheries and Oceans, reproduced with permission).

DISTRIBUTION

Global range

The walrus has a discontinuous circumpolar Arctic and sub-Arctic distribution with distinct Atlantic and Pacific subspecies (Reeves 1978; Brenton 1979; Fay 1981, 1985; Cronin *et al*. 1994). A connection between the Atlantic walruses of east Greenland and the Pacific walrus has not been demonstrated, although Andersen *et al*. (1998) inferred from the presence of a Pacific haplotype in an east Greenland walrus that one may exist. Atlantic walruses range from the central Canadian Arctic in the west to the Kara Sea in the east, north to Svalbard and south to Nova Scotia (Figure 2). There are two well separated populations within this range, one to the east of Greenland and the other to the west.

Canadian range

In Canada, the Atlantic walrus ranges from Bathurst and Prince of Wales islands eastward to Davis Strait and from James Bay north to Kane Basin (Figures 3 and 4). There are records of walruses in the Canadian Arctic west of this area (Harrington 1966; Stewart and Burt 1994). Those north and east of Victoria Island have tentatively been considered Atlantic walruses on the basis of limited taxonomic information; those to the south and west as Pacific walruses. Walruses are rare south of the Hebron–Okak Bay (57°28'N, 62°20' W) area of the Labrador coast (Mercer 1967; Born *et al*. 1995) but a few have been sighted south to Nova Scotia over the past decade (Kingsley 1998; Camus 2003; Richer 2003).

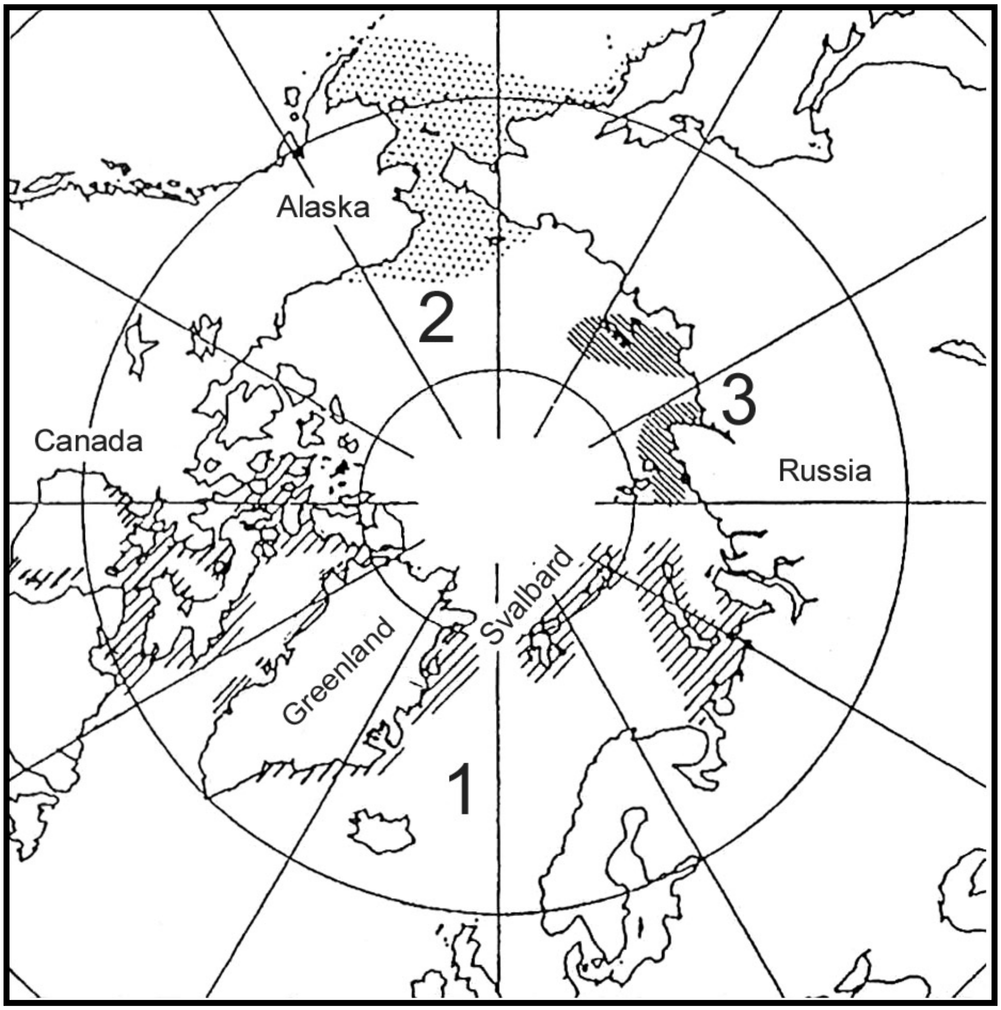

Figure 2. Approximate distribution of: 1) Atlantic walruses, 2) Pacific walruses, and 3) Laptev walruses (taxonomic status uncertain) (adapted from Born *et al*. 1995).

DESIGNATABLE UNITS

Use of the terms "stock" and "population" in the walrus literature has been inconsistent and the basis of delineation (management or genetic) has often not been stated (Stewart 2002). DFO has in the past delineated four stocks for hunt management purposes on the basis of geographical distributions, genetics and lead isotope data. These populations inhabit: 1) South and East Hudson Bay, 2) Northern Hudson Bay-Davis Strait, 3) Foxe Basin, and 4) Baffin Bay (High Arctic) (Figure 4) (Born *et al*. 1995; Outridge and Stewart 1999; Stewart 2002; Outridge *et al*. 2003). Born *et al*. (1995) provide a detailed discussion of the seasonal distribution of walruses within each of these supposed populations.

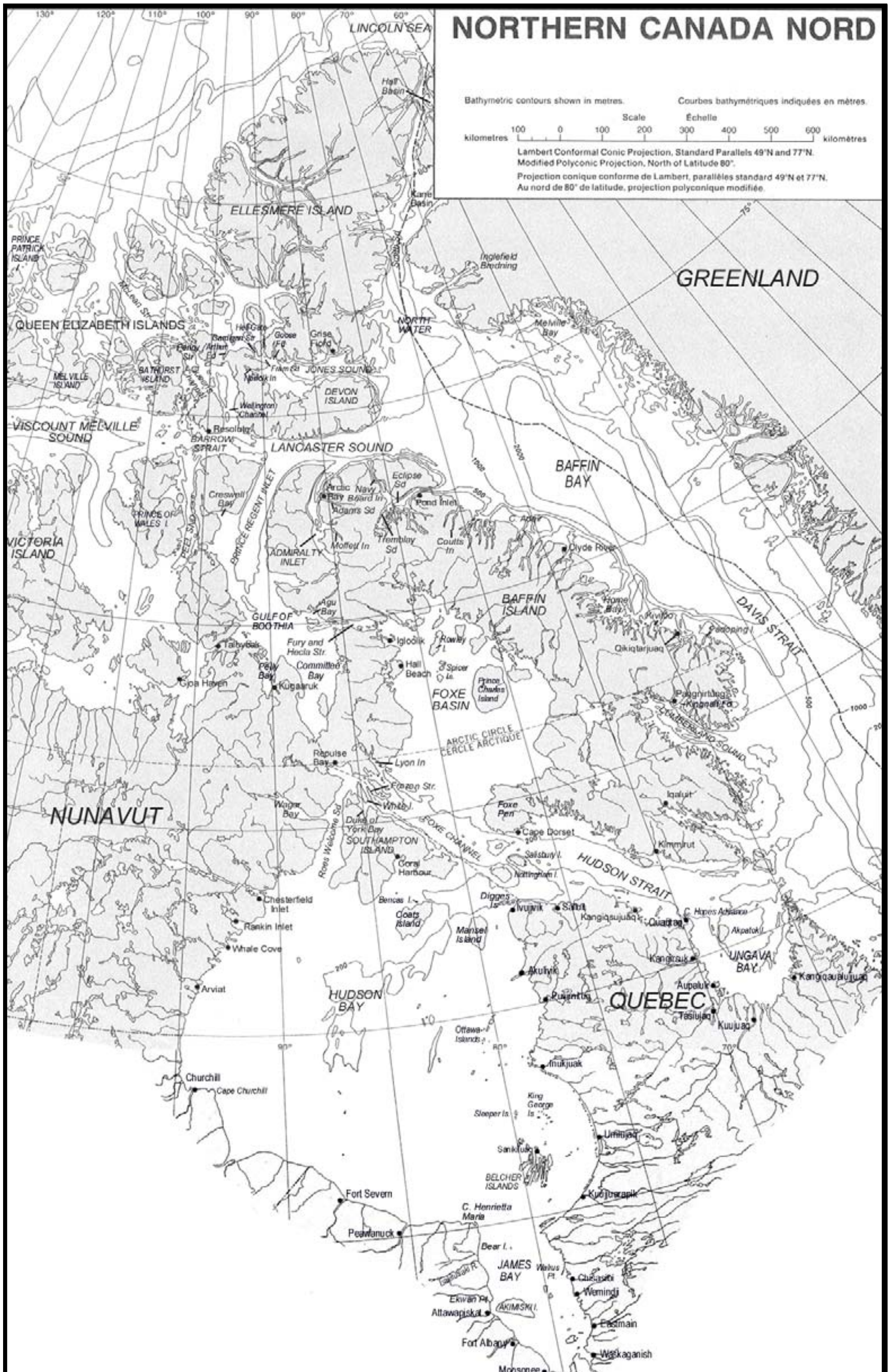

Figure 3. Place names used in text.

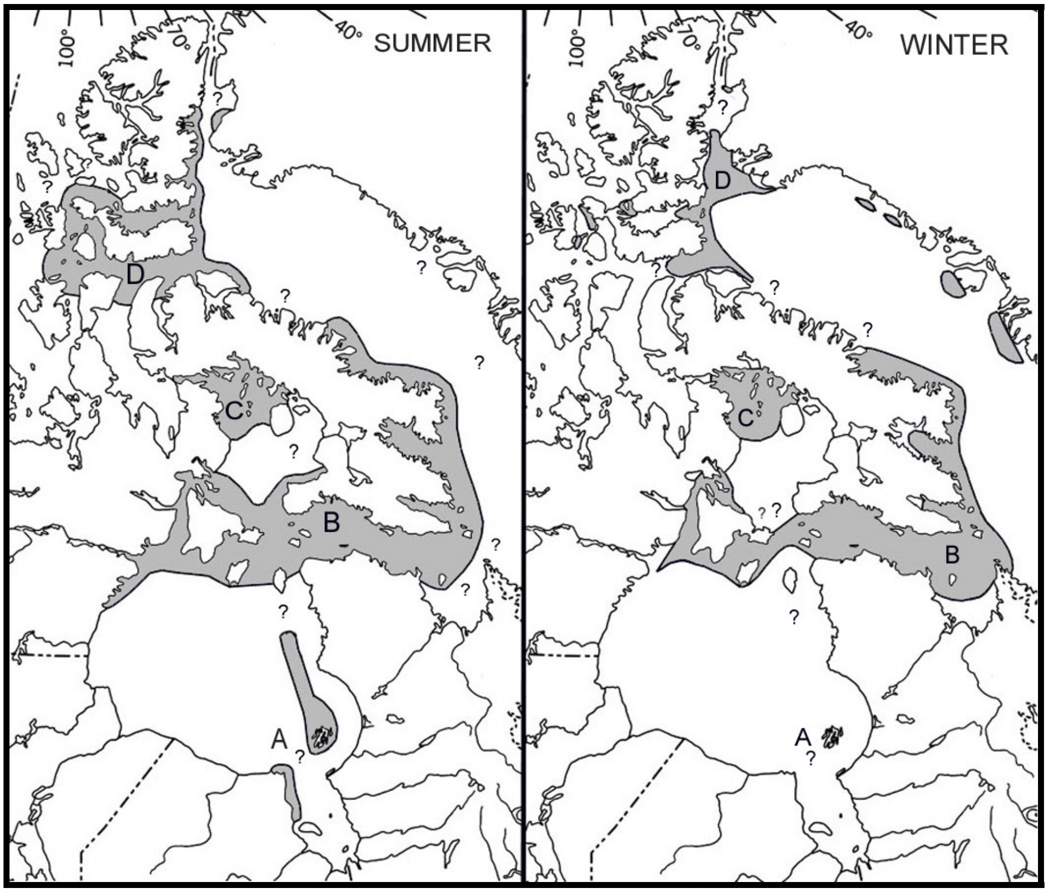

Figure 4. Approximate summer and winter distributions of the South and East Hudson Bay (A), Northern Hudson Bay-Davis Strait, (B), Foxe Basin (C), and Baffin Bay (High Arctic) (D) Atlantic walrus populations in Canadian waters. Question marks (?) indicate uncertainty with respect to distributions and/or movements.

A fifth "Northwest Atlantic" or "maritime" population was once abundant along the Atlantic coast of Canada and in the Gulf of St. Lawrence but has long since been extirpated (Reeves 1978; Richard and Campbell 1988).

These populations may have been contiguous in the past. The degree of genetic exchange between them is uncertain and each may consist of local sub-units that mix little if at all (Outridge *et al*. 2003). Some recent research has heightened doubts as to the homogeneity of some of these stocks; and in particular has raised concerns that some local hunts may be supported by smaller numbers than formerly believed.

COSEWIC faces, and will continue to face, problems of defining 'designatable units' for marine mammals—which may or may not be the same as management stocks—as the techniques available for analysis of population structure become ever more refined. Five populations of Atlantic walrus ranging from Nova Scotia to the high Arctic are recognized for managing hunting based on geographical distributions, genetics and lead isotope data. However, COSEWIC does not feel that the data about population structure is sufficient at this time to recognize and assess these populations as separate designatable units.

Scientific and community knowledge about Atlantic walrus are collected and compiled by management units called stocks or populations. Thus information used to assess the status of walrus in Canada is organized by the five populations recognized and used to manage walrus. However, COSEWIC does not consider these populations to be designatable units.

South and East Hudson Bay Population

The South and East Hudson Bay population is distributed over an area of about 65,000 km^2, from the Ottawa Islands south to the Ekwan Point area of western James Bay (Figure 4). Separation from the Northern Hudson Bay–Davis Strait population has been inferred on the basis of geographical distributions, changes in abundance, and lead isotope ratios. There appears to be a gap in the distributions of these populations between Mansel Island and the Ottawa Islands. The apparent decline in abundance of walruses in the South and East Hudson Bay population has not been accompanied by a similar decline in the Coats Island area, which suggests that immigration from Hudson Strait or northern Hudson Bay is limited (Born *et al*. 1995). Differences in the ratios of lead isotopes ($^{208}Pb/^{207}Pb$) in the teeth of animals harvested by hunters from Akulivik and Inukjuak also support separation of these populations (Outridge and Stewart 1999; Outridge *et al*. 2003). These measurements compare the lead accumulated within the walrus's teeth over its lifetime and indicate that, on average, the animals harvested by these communities inhabit geochemically different habitats over most of their lifetimes. Akulivik traditionally hunts walruses from Nottingham Island and Inukjuak mostly from the Ottawa, King George, or Sleeper archipelagos (Olpinski 1993; Portnoff 1994; Reeves 1995; Brooke 1997).

That the South and East Hudson Bay population is distinct from the Foxe Basin population is supported by differences in their organochlorine signatures (Muir *et al*. 1995), in metal concentrations (Wagemann and Stewart 1994), and lead isotope ratios ($^{206}Pb/^{207}Pb$ and $^{208}Pb/^{207}Pb$) (Outridge and Stewart 1999). However, high-precision analyses of lead isotope signatures in the walrus teeth, using thermal ionization mass spectrometry (TIMS) (see also Evans *et al*. 1995), suggest that part of the group formerly harvested in Foxe Basin by hunters from Hall Beach may have moved southward into eastern Hudson Bay (Stewart *et al*. 2003), perhaps into the Sleeper Islands.

The relationship between walruses in the Sleeper and Belcher archipelagos of eastern Hudson Bay and those to the south at Cape Henrietta Maria and inside James Bay is unknown.

Northern Hudson Bay–Davis Strait Population

The Northern Hudson Bay–Davis Strait population is distributed over an area of about 385,000 km^2, from Arviat on the west coast of Hudson Bay north and east through Hudson Strait to Clyde River on the east coast of Baffin Island (Figure 4) (Richard and Campbell 1988; Born *et al*. 1995; Stewart 2002). Born *et al*. (1995) considered animals at Digges and Mansel Islands to be part of this population. The rationale for distinguishing it from the South and East Hudson Bay population is discussed above.

Distinction of the Foxe Basin population from the Northern Hudson Bay–Davis Strait population is based on distance and on differences in growth patterns and lead isotope ratios. Distance may not completely separate these populations but it must limit interchange between them. The gap between them (Figure 4) is putative, since the seasonal distribution in southeastern Foxe Basin is poorly known. There is some north-south movement of walruses in Foxe Basin but no evidence of concerted movement to or from Hudson Strait (Anderson and Garlich-Miller 1994). Walruses winter in both areas, so they are not moving to seek wintering habitat. Animals sampled from Foxe Basin in the 1980s and 1990s were significantly larger than those sampled from northern Hudson Bay in the 1950s (Garlich-Miller and Stewart 1998). This suggests genetic or habitat separation of animals in these areas. The lead isotope ratios (206Pb/207Pb and 208Pb/207Pb) in teeth of walruses harvested by hunters from Akulivik and Coral Harbour are different from those of walruses harvested from northern Foxe Basin (Outridge and Stewart 1999; Outridge *et al*. 2003). However, lead isotope signatures in the walrus teeth suggest that part of the group harvested by Hall Beach hunters may move southward into northeast Hudson Bay (Outridge *et al*. 2003; Stewart *et al*. 2003).

The Northern Hudson Bay-Davis Strait population may consist of separate sub-populations that inhabit northern Hudson Bay, Hudson Strait, and Davis Strait. These distinctions are supported by measurements of lead isotope ratios (206Pb/207Pb and 208Pb/207Pb)—significantly different between Coral Harbour and Akulivik (Outridge *et al*. 2003)—and by morphometric observations—Inuit have noted differences in body size and tusk length between Nottingham Island (harvested by Akulivik) and Coats Island (harvested by Coral Harbour), and between the Chesterfield Inlet area and the Repulse Bay area (Fleming and Newton 2003).

Separation of the Northern Hudson Bay–Hudson Strait population from the Baffin Bay population has been inferred mostly from information on walrus distribution and movements (Born *et al*. 1995). There may be a gap in walrus distribution along the east coast of Baffin Island between Clyde River and Pond Inlet (Mansfield 1967). In the 1970s, hunters from Clyde Inlet travelled north to Scott Inlet to hunt walruses (Kemp 1976) and hunters from Pond Inlet travelled south to the Cape Macculloch area (Lands Directorate 1981). The intervening stretch of the east Baffin coast is remote from both communities and seldom visited in summer, and has not recently been surveyed; it is uncertain whether there are walruses there or not. Walruses in northwest Greenland have different patterns and levels of organochlorine contaminants in their blubber from those in southeast Baffin Island (Loks Land), which also suggests these animals belong to different populations (Muir *et al*. 2000).

The amount of exchange between the Northern Hudson Bay–Davis Strait and Central West Greenland populations is unknown. Dunbar (1955) and Vibe (1967) both suggested that such a connection might exist. It is supported by observations of walruses offshore over deep waters between southeastern Baffin Island and western Greenland (Born *et al*. 1994) and by a recent movement of a female tagged in West Greenland to southern Baffin I. within one month (R. Dietz, pers. comm.).

Foxe Basin Population

Walruses are widely distributed in the relatively shallow waters of northern Foxe Basin, an area of about 50,000 km^2, where they live year-round (Figure 4) (Mansfield 1959; Loughrey 1959; Crowe 1969; Beaubier 1970; Brody 1976; Orr *et al*. 1986). Genetic analyses support the hypothesis that animals harvested from this area belong to a different population from those in the Resolute Bay–Bathurst Island area (Buchanan *et al*. 1998; de March *et al*. 2002). This suggests that animals may not pass through Fury and Hecla Strait, a movement that both scientists and Inuit have considered to be unlikely (Loughrey 1959; Mansfield 1959; Davis *et al*. 1980; Garlich-Miller cited in Stewart 2002). Walruses are found on occasion in the Gulf of Boothia south to Pelly (Brice-Bennett 1976) and Committee Bays and to Crown Prince Frederik Island (70°02'N, 86°50'W) (Loughrey 1959; Anders 1966). These animals are believed to come from the Baffin Bay population to the north, either as strays (Loughrey 1959) or when ice does not break up in Barrow Strait (Riewe 1976). The reasons for distinguishing the Foxe Basin population from the Northern Hudson Bay–Hudson Strait population are discussed above.

The existence of sub-populations within Foxe Basin is not so far supported by genetic analyses, which did not find significant differences between the walruses harvested by Igloolik and Hall Beach (de March *et al*. 2002). However, differences in lead isotope ratios ($^{206}Pb/^{207}Pb$) in the teeth of walruses harvested by the two communities suggest quite strongly that their hunters are taking animals from different local sub-populations (Outridge *et al*. 2003; Stewart *et al*. 2003), or at least from groups with distinct feeding areas. Inuk elders recognize two groups of walruses in northern Foxe Basin on the basis of differences in size, colour, and distribution (DFO 2000).

Baffin Bay (High Arctic) Population

The Baffin Bay population is distributed over an area of about 150,000 km^2 that extends west to Bathurst Island and north to Kane Basin (Figure 4) and northwest Greenland. It seems to be separated geographically from the other Canadian walrus populations to the south, as discussed earlier, but is shared by Canada and Greenland, as its distribution along the western coast of Greenland extends southward to about Disko Island (Reeves 1978; Richard and Campbell 1988; Born *et al*. 1995). Genetic studies have found significant genetic separation between animals from this population and those of the central West Greenland population to the south (Andersen and Born 2000). They suggest that these populations may be connected by some migration of males but that female migration is very restricted. Walruses do move between

Canadian and Greenland waters (e.g. Degerbøl and Freuchen 1935; Vibe 1950; Born *et al*. 1995), but the number of animals involved and the extent of the movements are unknown. There are extralimital reports of walruses from this population at Prince Patrick and Melville islands and near Taloyoak (Spence Bay) (Harrington 1966).

Sub-structure within this regional population has been the subject of study. Lead isotope ratios ($^{206}Pb/^{207}Pb$ and $^{208}Pb/^{207}Pb$) in the teeth of walruses from Resolute were different from those sampled near Grise Fiord and Thule, Greenland (Outridge *et al*. 2003). The lead isotope signatures in the walrus teeth suggest that hunters from Grise Fiord and Thule kill walruses from the same sub-population, as well as from different sub-populations. About 80% of the Grise Fiord and 20% of the Thule animals had similar isotopic signatures.

Early genetic analyses did not find a significant separation between animals in the Resolute Bay/Bathurst Island area and those in the Grise Fiord area (de March *et al*. 2002), but more recent—and still preliminary—analyses of microsatellites in nuclear DNA have shown some evidence, still not clear, of some differences between groups in eastern Jones Sound, western Jones Sound and west of Devon Island (R. Stewart, pers. comm.). Some of these distinctions have received limited support from tagging studies, which have not shown evidence of movements between western and eastern Jones Sound; tags have not, however, stayed on for more than 3 months.

Nova Scotia–Newfoundland–Gulf of St Lawrence (Maritime) Population

The south-western Gulf, and the Scotian shelf, have extensive shallow waters with flat sandy bottoms, and a numerous stock of walruses originally used land haul-out sites in the St Lawrence system. Sites mentioned were Seven Islands in the north-western Gulf, Miscou Island in the western Gulf, and several sites on and around the Magdalen Islands in the central Gulf. The original distribution in the St Lawrence extended as far up-river as Rivière-Ouelle. Sable Island off Nova Scotia was also frequented by considerable numbers of walruses, as was Ramea Island off Newfoundland (Born *et al*. 1995).

These aggregations were heavily harvested, especially in the 17th and 18th centuries, and by the end of the 18th had been extirpated. There have been occasional sightings in recent decades (Kingsley 1998; Camus 2003; Richer 2003), but these have not been considered indications of a re-establishment of this population.

Changes in Seasonal Distribution

There has been a general shift in walrus distribution away from communities to areas that are less accessible (Born *et al*. 1995). This is not a new phenomenon. It is related to changes in technology that have enabled hunters to range further from home (Brody 1976). It began with the introduction of whaleboats in the 1920s, which extended hunting ranges and enabled open-water hunting; accelerated with the introduction of motorized technology ca. 1940-60; and continues as the range and speed of boats increase (see also Crowe 1969; Beaubier 1970; Orr *et al*. 1986). The extent to which distributional changes reflect declines as opposed to shifts in the walrus populations is unknown but, until increases in other parts of the range have been documented, it is prudent to assume numbers have been reduced (DFO 2000).

Inuit around Hudson Bay have linked the disappearance of walruses from traditional hunting areas variously to natural shifts in the species' distribution, to poor and wasteful hunting techniques, and to low harvest rates (Fleming and Newton 2003). In the past, unregulated hunting from motorboats disturbed animals at *uglit* (haul-outs) in the Belcher and Sleeper islands, and along the west coast of Hudson Bay—possibly with high mortality. Walrus remains were sometimes discarded at the *uglit* and, together with sinking losses, tainted both the *uglit* and feeding grounds causing herds to leave the area. Inuit recognize the sensitivity of walruses to habitat disturbance and to the mortality of other walruses in their traditional knowledge.

> "When I was growing up, I remember, my father and the others used to say never try to kill a walrus where you think it will sink right into the feeding areas, or never cut up the walrus where they usually bask or rest. The elders used to say never to leave the guts near the islands where they bask. If you do that the walrus will move away from there." (Zach Novalinga, Sanikiluaq).

Some eastern Hudson Bay Inuit have, however, suggested that declines in the number of walruses may stem from harvest rates that are too low to maintain the reproductive rate (Fleming and Newton 2003).

South and East Hudson Bay Population. Walruses were once common in the archipelagos of south and east Hudson Bay (Flaherty 1918; Twomey and Herrick 1942; May 1942; Manning 1946; Freeman 1964; Schwartz 1976; Born *et al*. 1995). They have not been common in the Belchers since about the late 1950s, and unsuccessful hunting expeditions (see Olpinski 1993; Portnoff 1994) suggest use of *uglit* in the Ottawa Islands may have declined in the 1990s. In 1993, walruses re-occupied some *uglit* in the North Belcher Islands and Inuit believed the population might be recovering (Z. Novalinga, Sanikiluaq Environmental Committee and Peter Kattuk, Mayor of Sanikiluaq, pers. comm. 1993). However, DFO (2000) reports that walruses continue to be uncommon in the Belchers. To hunt walrus in fall, Inuit from the area generally travel to the Sleeper Islands.

The walrus distribution in James Bay is much reduced. Along the east coast in the Wemindji area, at *Wiipichuutukuwiih*, walrus were once numerous and posed a hazard to paddlers (Fleming and Newton 2003). Cree hunted them in the Wemindji-Waskaganish area until at least 1934. Geographical names suggest that they also hauled out at "Walrus Point" and "Pte. du Morse" near Chisasibi but none have been seen there recently. In the west, walruses occurred south to Attawapiskat. They were seen in the early 1960s on ice floes between Lakitusaki River (Lake River) and Bear Island (Johnston 1961), and in the 1970s at Ekwan Point (Fleming and Newton 2003). Residents of Attawapiskat saw fewer walruses in their area in the early 1990s but reported that they were present on the mainland between Akimiski Island and Ekwan River after spring breakup.

Walruses are still present along the Ontario coast of Hudson Bay near Cape Henrietta Maria. In 1993, local Cree reported that there were “lots” of walruses in the area and that they had been seen in July near Peawanuck (Fleming and Newton 2003).

Northern Hudson Bay-Davis Strait Population. The main changes in seasonal distribution of this population occurred in the early to mid-1900s. They include abandonment of *uglit* along the west coast of Hudson Bay north to Chesterfield Inlet, on Digges Island in northeast Hudson Bay, near the head of Cumberland Sound, and on the Gyrfalcon Islands (59°05'N, 68°57'W) in southern Ungava Bay (Born *et al*. 1995).

In western Hudson Bay, walruses were rare at Churchill, but were increasingly numerous moving northward where the coastline offered more suitable *uglit*. Six animals were seen off the coast near Cape Churchill in October 1954 (Johnson in Loughrey 1959). Walruses are uncommon near Whale Cove but were numerous at islands near the community from 1942 to 1945 (Fleming and Newton 2003). They have abandoned various *uglit* in western Hudson Bay but hauled out in small numbers in summer at Bibby Island (61°53'N, 93°05'W), Term Point (62°08'N, 92°28'W), “Little Walrus Island” in Mistake Bay, Sentry Island (61°10'N, 93°51'W), Wag Island (63°23'N, 90°38'W), Marble Island (62°41'N, 91°08'W), and Fairway Island (63°15'N, 90°33'W) as recently as the 1950s (Low 1906; Degerbøl and Freuchen 1935; Loughrey 1959; Reeves 1978; Born *et al*. 1995; DFO 2000; Fleming and Newton 2003) (Figure 4). Small groups of walruses are sometimes seen at the floe edge south to Whale Cove (Gamble 1988; Fleming and Newton 2003). Inuit report that walruses were more numerous in the Chesterfield Inlet area in the early 1990s than in the past (Fleming and Newton 2003).

Bell (1884: 33DD) found numerous walruses at Digges Island in the 1880s, but they are apparently rare in the region now (Born *et al*. 1995). They were common at the head of Cumberland Sound in the 1800s (Kumlien 1879) and were killed in the Kingnait Fiord area in the early 1900s (Anders *et al*. 1967), but now are uncommon in these areas. Walruses were once common in summer at the Gyrfalcon Islands in southern Ungava Bay (Dunbar 1955), and on islands in Deception Bay, near Sugluk (Loughrey 1959).

In the early 1900s the largest *ugli* on the east coast of Baffin Island may have been at Padlei, just south of Padloping Island (Mansfield 1958; Reeves 1978). Many walruses were harvested from the area, which is still used but apparently by fewer animals.

Foxe Basin Population. The summer distribution of walruses in Foxe Basin has changed over the past 50 years (Anders 1966; Crowe 1969; Beaubier 1970; Brody 1976; Orr *et al*. 1986). Until the 1940s or 1950s, walruses were abundant at *uglit* along the east coast of Melville Peninsula. The establishment of a Hudson’s Bay Company post at Igloolik in 1939 and a DEW Line Station at Hall Beach in 1955–1956 congregated the Inuit of Foxe Basin in this area. This increased local hunting pressure on the walruses and disturbance by boat traffic, and they are now less common. Hunters from Igloolik and Hall Beach do not believe that the number of walruses in northern Foxe Basin has changed over the past 25 years (DFO 2000). They now travel further offshore to hunt in the summer, but attribute this change to a reduction in the ice cover. Three islands in western Foxe Basin continue to have large concentrations of animals in the fall, and three others that had been used for some time are now being used again, but *uglit* along the east coast of Melville Peninsula have not been reoccupied.

Baffin Bay (High Arctic) Population. The main change observed in seasonal distribution of this population has been in the Avanersuaq (Thule) area of west Greenland, where walruses were once abundant in summer but are now absent (Vibe 1950; Born *et al*. 1995).

Nova Scotia–Newfoundland–Gulf of St Lawrence (Maritime) Population. Exploitation of these herds continued for over a hundred years spanning the 17th and 18th centuries, but the records available do not give clues about changes in distribution as a result of this heavy harvesting.

HABITAT

Habitat requirements

Atlantic walruses require large areas of shallow water (80 m or less) with bottom substrates that support a productive bivalve community, open water over these feeding areas, and suitable ice or land nearby upon which to haul out (Davis *et al*. 1980). This is a relatively narrow ecological niche (Born *et al*. 1995).

Walruses often gather in large herds. They are associated with moving pack ice for much of the year. When ice is lacking in summer and fall, they tend to congregate and haul out on land in a few predictable locations (Mansfield 1973). *Uglit* are often situated on low, rocky shores with steep or shelving subtidal zones where animals have easy access to the water for feeding and quick escape (Mansfield 1959; Salter 1979a, b; Miller and Boness 1983). The animals generally move to more sheltered areas when there are strong onshore winds and heavy seas (Mansfield 1959).

Trends

Suitable walrus habitat is decreasing as human activities in the north expand. Hunting and noise disturbance caused by motorized transportation have caused herds to abandon *uglit* near communities in favour of less accessible islands and shores (Born *et al*. 1995). Whether these animals would eventually habituate to disturbance and reoccupy abandoned *uglit* if hunting ceased is unknown.

Post-glacial rebound is slowly raising existing *uglit* relative to sea level over much of the eastern Canadian Arctic. In southern Hudson Bay, near Cape Henrietta Maria, the rate of rebound is about 1.2 m per century (Webber *et al*. 1970). Some *uglit* that were once islands in the Winisk area have become part of the mainland, reducing their use by walruses (Fleming and Newton 2003). Declining use of habitat in the Attawapiskat area has also been attributed to coastal changes, which could, however, be offset by the emergence of new shoals with consequent shifts in walrus distributions.

Habitat protection/ownership

Existing National Parks, National Wildlife Areas, Migratory Bird Sanctuaries, Indian Reservations, and other lands owned and managed by the Government of Canada afford little protection to walrus habitat. Walruses haul out in the Polar Bear Pass National Wildlife Area (Davis *et al.* 1978) but this area only protects a few of their *uglit* along the east coast of Bathurst Island. They also haul out on Coburg Island in the Nirjutiqavvik National Wildlife Area and on the Wollaston Islands, which lie partly within the Bylot Island Migratory Birds Sanctuary (Born *et al*. 1995). Walruses may occasionally haul out at the East Bay Bird Sanctuary on Southampton Island and the Bowman Bay Wildlife Sanctuary on Baffin Island. They may also haul out along the northeast coast of Bathurst Island on lands reserved for a proposed national park. Their use of other National Parks and Bird Sanctuaries is very limited at best. Overall, federal lands only offer temporary protection to a few walruses from the Baffin Bay Population. In itself, this level of habitat protection is certainly insufficient to ensure the long-term survival of the species.

BIOLOGY

General

The age of a walrus is determined from the number of growth layers in the cementum of the lower canines (Mansfield 1958; Garlich-Miller *et al*. 1993; Stewart *et al*. (ed.) 1993), which in captive walruses corresponds closely to known age (0-15 years; Fay 1982), but age validation studies have not been conducted on wild Atlantic walruses. Over 35 cemental growth layers have been counted in wild Atlantic walruses, suggesting that layering of the cementum occurs throughout the life of an animal (Mansfield 1958). Growth layers in the mandible are not reliable indicators of age in mature walruses and underestimate the ages of males that are more than 19 yrs old and females over 9 yrs, probably due to resorption and slower bone growth (Garlich-Miller *et al*. 1993).

Male walruses grow larger than females and geographical differences are apparent. The asymptotic standard body length of male Atlantic walruses taken from northern Foxe Basin in 1983-93 (315.2 cm ±3.8 (SE), n=103) was significantly greater ($P<0.05$) than that of females (276.6 cm ± 3.4, n = 90) (Garlich-Miller and Stewart 1998). The growth patterns reported for standard length were similar to those reported from northwest Greenland (Knutsen and Born 1994). Animals from both populations were significantly larger and reached full maturity older than those sampled from northern Hudson Bay in the 1950s (Mansfield 1958). The Foxe Basin and northwest Greenland walruses grew to lengths similar to that of the Pacific walrus, but did not attain the same body mass. The predictive equation relating log mass (M, kg) to log standard length (SL, cm) for the northern Foxe Basin walruses was: Log10M = - 3.74 + 2.58(Log10SL), n=25, r2=0.98 (Garlich-Miller and Stewart 1998). The largest intact male weighed about 1100 kg and the largest female about 800 kg (Garlich-Miller 1994).

Reproduction

Walruses are gregarious and polygynous, and mature males compete intensely for females (Le Boeuf 1986; Sjare and Stirling 1996; Fay 1981). Relatively little is known about the reproductive behaviour of the Atlantic walrus, since mating occurs in the water in remote areas from February through April (Born 1990, 2003; Sjare and Stirling 1996). Detailed observations of breeding behaviour were made at a high-Arctic polynya surrounded by fast ice (Sjare and Stirling 1996), where males competed for and defended access to females for up to five days. A female was likely to mate with the male that was attending the herd when she became receptive (Sjare and Stirling 1996). Sea ice stability may be an important determinant of breeding behaviour. The mating system in fast-ice habitat differs from that of Pacific walruses breeding in pack ice, which exhibit a lekking behaviour in which several mature males sing from small defended territories very near a herd. It is not known whether the behaviour of Atlantic walruses breeding in pack ice is more like that observed in Pacific walruses,

A low reproductive rate makes the walrus vulnerable to over-hunting and to environmental perturbations. Female Atlantic walruses mature between 5 and 10 yrs of age. Of 79 females from northern Foxe Basin, all aged 7 yrs or older had ovulated, but not all became pregnant (Garlich-Miller and Stewart 1999). Age at first pregnancy ranged from 5 to 12 years. Males mature between 7 and 13 yrs (Born 2003).

Females give birth on average once every three years (Mansfield 1958; Born 1990; Garlich-Miller and Stewart 1999). Most mature females ovulate every second year (Born 1990; Garlich-Miller and Stewart 1999). However, some females live well past their reproductive prime, so not all adult females in a population are fertile (Reeves 1995). Reported pregnancy rates among fecund females are 0.29 in Foxe Basin, 0.35 in northern Hudson Bay (Mansfield 1958), and 0.37 in Greenland waters (Born 1990). Garlich-Miller and Stewart (1999) found a pregnancy rate of 0.33 and birth rate of 0.30 in northern Foxe Basin.

Implantation of the embryo is delayed, occurring in late June–early July (Born 1990; Garlich-Miller and Stewart 1999). Active gestation lasts about 11 months. In the Thule area of Greenland, young are born between early April and mid-July, but mostly in late May and early June (Born 1990). Most Atlantic walrus pregnancies involve a single foetus but twins have been reported in Pacific walruses (Fay *et al*. 1991). Mansfield (1973) estimated the gross annual production rate, or proportion of newborns in the population, at 11%. Recent counts at high-Arctic *uglit* in August, not corrected for sex and age segregation among *uglit*, suggest a calf production of about 10% (Stewart 2002). Generation time, calculated after Pianka (1988) (i.e. the mean of age at first reproduction and age at last reproduction), would be about (7 + ~35) / 2 i.e. 21 yrs.

Young walruses will suckle for up to 25–27 months (Fisher and Stewart 1997). Female walruses take their calves to sea when they forage for food (Kovacs and Lavigne 1992); the young can nurse in the water (Loughrey 1959; Miller and Boness 1983). Calves moult in their first summer and each summer thereafter (Mansfield 1958). The birth-rate is low, but females, and the herd as a whole, are intensely protective of the young, so calf survival is high relative to that of other pinnipeds.

Survival

Survival rates for Atlantic walruses are unknown. Hunting by humans is the greatest cause of mortality. Survival of the young is probably high, owing to the intense maternal care they receive, although they are vulnerable to trampling when a herd is stampeded. Mortality from predation is probably low, given the animal's large size, aggressive defence and dangerous tusks. But competitive fighting during the breeding season may increase the natural mortality of males (Fay 1985). Present contaminant burdens are unlikely to affect survival rates. Mortality due to parasites, diseases, and accidents is unknown.

<u>Trampling</u>

Young walruses and those in poor condition are vulnerable to trampling if herds are stampeded onshore or offshore. These stampedes typically result in few deaths. However, in one incident at St. Lawrence Island in the Bering Sea, where at least 537 Pacific walruses died, trampling may have been one cause of death (Fay and Kelly 1980). Some of the animals examined there had been attacked by killer whales (*Orcinus orca*), which may have stampeded the large herd ashore and caused the death by trampling of many smaller or weaker individuals.

About 400 carcasses also washed ashore from various sources and about 15% of the total mortality consisted of aborted foetuses. The latter likely resulted from physical trauma but an infectious or toxic agent could not be ruled out. Mortality on such a scale has not been reported for Atlantic walruses but stampedes do cause some mortality (Loughrey 1959).

At some 'rocky' summer haul-out sites tusk breakage may be a problem if animals startle and stampede into the water (B. Sjare, DFO, pers. com. 2005).

<u>Ice entrapment</u>

Evidence for the entrapment of walruses in ice is scant. Walruses can break ice with their tusks to keep holes open and can climb out onto the ice using their tusks, and large male Pacific walruses can break through ice up to 20 cm thick by ramming it from below with their heavy, dense skulls (Bruemmer 1977). Walruses can travel over the ice for at least 6 km when they are frozen out (Calvert and Stirling 1990), typically in a straight line regardless of obstacles (Freuchen 1921).

Predation

Polar bears (*Ursus maritimus*) prey on Atlantic walruses; some die in the attempt (Loughrey 1959; Killian and Stirling 1978). Walruses are most vulnerable to bears when they are frozen out of their breathing holes or must rely on a very limited area of open water for breathing and haul-out, particularly where rough ice provides cover for stalking bears (Calvert and Stirling 1990). Sub-adults are more vulnerable than adults, which are aggressive and possess large tusks for defence. While predation rates are unknown, polar bears are important predators of walruses in the central Canadian high Arctic in late winter and early spring.

Killer whales also kill walruses (Lowry *et al*. 1987), but this does not seem to be common. Greenland Inuit report that killer whales are afraid of walruses and will imitate the sound of an enraged bull to deter the approach of these walruses if they encounter them while hunting offshore (Bruemmer 1977).

Diseases and parasites

The susceptibility of walruses to mortality from disease is not well understood. Fay (1982) reviewed information on parasites and diseases in the Pacific walrus. Serological testing of 210 walruses from sites in the eastern Canadian Arctic did not find antibodies to influenza A virus, which can cause high mortality among seals and has been found in ringed seals (*Phoca hispida*) and belugas (*Delphinapterus leucas*) (Nielsen *et al*. 2001b). If walruses were susceptible to this virus, the absence of seropositive animals could mean that they had not been exposed to the virus or that all of the infected animals had died. There is serological evidence for sporadic infection of walruses in the Igloolik area with a bacterium of a *Brucella* sp., which can cause reproductive failure in marine mammals (Nielsen *et al*. 1996, 2001a). Morbillivirus antibodies are common in walruses from the eastern Canadian Arctic (Nielsen *et al.* 2000), indicating exposure to the phocine distemper virus (PDV) or a related virus. The pathology of all these viruses in walruses is unknown.

Walruses are commonly infected by the helmith parasite *Trichinella nativa* Britov and Boev 1972, which causes trichinellosis (or trichinosis) in humans (Campbell 1988; Pozio *et al*. 1992; Serhir *et al.* 2001).[2] Outbreaks of trichinosis due to eating uncooked walrus meat are recurrent among Inuit in the eastern Canadian Arctic, with recent outbreaks at Salluit in 1983 (Viallet *et al*. 1986) and 1987 (MacLean *et al*. 1992), the Kivalliq Region in 1989-95 (Heinzig 1996), Inukjuak in 1997, Qikiqtarjuaq in 1999 (Serhir *et al*. 2001), and Repulse Bay in 2002 (Hill 2003). The pathology of this parasite in walruses is unknown.

Anatomy and physiology

Recent studies have described the cranial bones and their significance for hauling out, feeding, and accommodation of the sensory organs (Kastelein and Gerrits 1990);

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[2]this parasite has been identified in earlier literature as *T. spiralis* (e.g. Brown *et al*. 1948, 1950; Fay 1960; Born *et al*. 1982; see also Manning 1961).

the muscles and their role in feeding and haul-out behaviour (Kastelein *et al*. 1991); the eyes (Kastelein *et al*. 1993) and tongue and their functions in walrus ecology (Kastelein *et al*. 1997); and the ears and their function in aerial and underwater hearing (Kastelein *et al*. 1996).

Walruses are well adapted to cold and ice. They reduce heat losses during extreme cold by constricting blood flow to their peripheral vascular system and vice versa (Ray and Fay 1968). Their thick skin (2–4 cm) and blubber (1-15 cm; Fay 1985) enable them to sleep on the ice at –31°C with a strong wind blowing (Bruemmer 1977). They huddle together and reduce their exposed skin surface by curling into a "foetal position" when it is cold.

Benrischke (2002) described the placental anatomy and histology of a Pacific walrus. Little is known of the endocrinology of the species.

Lead isotope ratios in walrus teeth are proving useful for differentiating groups of walruses and studying movements (Outridge *et al*. 1997; Outridge and Stewart 1999; Stern *et al*. 1999), but whether these differences indicate management stocks, populations, COSEWIC designatable units, or merely feeding groups, is uncertain.

Movements/dispersal

Walruses can travel long distances by swimming or by riding ice floes but their seasonal movements in the Canadian Arctic are poorly known. A walrus tagged in east Greenland was recaptured at Svalbard, a straight-line distance of about 700 km (Born and Gjertz 1993). Wintering areas have been documented within the range of each of the putative populations.

<u>South and East Hudson Bay Population</u>

There is no evidence for a concerted movement of walruses into or out of southeastern Hudson Bay. Instead, there are local seasonal movements between the rocky sites where animals haul out during the ice-free period and their wintering areas (Freeman 1964). In both the Belcher and Sleeper archipelagos, walruses are present at the floe edge in winter and move into the islands and onshore as the pack dissipates in summer (Fleming and Newton 2003; Peter Kattuk, Mayor of Sanikiluaq and Zach Novalinga, Sanikiluaq Environmental Committee, pers. comm. 1993). The winter whereabouts of animals that summer along the Ontario coast is unknown, and the question of whether they move between this area and the Belchers is unanswered.

Lead isotope signatures in the teeth suggest that some males have moved between Foxe Basin and eastern Hudson Bay (Stewart *et al*. 2003), but these isotopic records spanned several years and do not necessarily indicate seasonal movements.

Northern Hudson Bay–Davis Strait Population

Seasonal movements of the Northern Hudson Bay–Davis Strait population are poorly understood. Where environmental conditions permit, some animals remain year-round, apparently moving inshore and offshore in response to changes in the ice. Others appear to undertake significant seasonal migrations. Evidence for the extent of these movements is circumstantial, as it is based on local observations. Whether the wintering and migratory animals represent different genetic populations is unknown (Stewart 2002).

Walruses occupy the north side of Chesterfield Inlet in the spring, are absent near the community in summer, and are present in the Chesterfield Inlet–Roes Welcome Sound area in winter (Brice-Bennett 1976; Fleming and Newton 2003). They occur in Wager Bay when ice is minimal, and Inuit indicate that they prefer areas with strong currents. Walruses are common in the Repulse Bay area but less so when the summer ice concentration remains high. Their presence also depends on the strength of the current, which varies each summer. When the current is stronger they sometimes approach within 60 km of Repulse Bay in the fall; they are sometimes seen at the floe edge in winter.

Walruses are present year-round in northern Hudson Bay and western Hudson Strait (Orr and Rebizant 1987). Tagging studies in the mid-1950s at Bencas, Coats, and Southampton Islands, using harpoon-head tags (147 tagged, 4 recaptured), revealed only local movements (Mansfield 1958; Loughrey 1959). However, hunters report seasonal movements in response to changing ice conditions (Orr and Rebizant 1987). Walruses occur off the floe edge along the south and east coasts of Southampton Island and west and southwest coasts of Foxe Peninsula in winter, favour the floating pack ice of Evans Strait and Hudson Strait in late spring and summer, and move ashore to *uglit* as pack ice dissipates. In the fall they are concentrated at or near *uglit* on Bencas, Walrus, Coats, Mills, Nottingham, and Salisbury Islands and on western Foxe Peninsula. There is a similar shoreward movement of walruses in the Repulse Bay area in the fall (September); some winter in Roes Welcome Sound (Fleming and Newton 2003).

Inuit from Akulivik and Ivujivik have seen walruses moving northward from Hudson Bay into Hudson Strait in the fall (Figure 4; Reeves 1995; Fleming and Newton 2003). Walruses remain in the Ivujivik area year-round but are seldom seen near Akulivik in summer (Fleming and Newton 2003). *Akulik* and *Pilik* Islands, which do not appear on maps, are important sites for these animals. In the early 1990s, Ivujivik hunters would go to *Akulik* when they did not see walruses elsewhere in winter.

There is a general westward movement of walruses through Ungava Bay and Hudson Strait in summer to Nottingham and Salisbury Islands, with a return movement in the fall (Degerbøl and Freuchen 1935; Loughrey 1959). Currie (1963) described an influx of walruses to the southeast coast of Akpatok Island in Ungava Bay as soon as ice conditions permitted in June or early July, and their subsequent dispersal in late July or August northwest past Cape Hopes Advance into Hudson Strait, with a return migration following the same general route but further offshore the cape in September and October. Smith *et al*. (1979) observed a large influx of walruses, apparently from Hudson Strait, into the Hall Peninsula area in mid-September. Some walruses are present year-round near Nottingham and Salisbury Islands, where strong currents maintain polynyas through the winter (Kemp 1976; Orr and Rebizant 1987).

The presence of animals far offshore in the pack ice of Davis Strait suggests that some walruses move between southeast Baffin Island and western Greenland, perhaps in response to changing ice conditions (Vibe 1967; Born *et al*. 1995). The walruses present on West Greenland sea-ice in winter no longer use land haul-outs in West Greenland when the ice disappears from West Greenland waters in summer. Movement of walruses from West Greenland wintering to south-east Baffin summering areas is therefore likely. A female walrus, accompanied by a calf, tagged in West Greenland waters in spring of 2005 was observed in southeast Baffin about a month later (R. Dietz, pers. comm.).

Foxe Basin Population

Most seasonal movements of walruses in Foxe Basin are apparently local in response to changing ice conditions (Mansfield 1958; Loughrey 1959). Movements have been observed between summering areas around the islands in northern Foxe Basin, particularly the Spicers, and wintering areas along the floe edge that forms along the north side of Rowley Island and extends southward, parallel to the Melville Peninsula, to about 67°30’N (Loughrey 1959; Orr *et al*. 1986). There is also some north-south movement by walruses in northern Foxe Basin (Anderson and Garlich-Miller 1994). Recent analyses of lead isotope signatures in the teeth of male walruses harvested by Hall Beach (Stewart *et al*. 2003) support assertions by Degerbøl and Freuchen (1935) that some animals from this population move to Southampton Island and by Loughrey (1959) that some go to Hudson Strait; they do not indicate that these are seasonal movements. Indeed these animals may travel further south to the Sleeper Islands where hunters from Inukjuak often kill walruses. Significant seasonal movements of animals through Fury and Hecla Strait are thought unlikely (Loughrey 1959; Mansfield 1959; Davis *et al*. 1980; Garlich-Miller cited in Stewart 2002).

Baffin Bay (High Arctic) Population

The substantial migrations of walruses that Freuchen (1921) and Vibe (1950) described, northward in the spring along the west coast of Greenland and southward in the fall along the east coast of Baffin Island, no longer seem to occur (Born *et al*. 1995). However, some walruses cross from Greenland to Ellesmere Island in the spring and presumably return in fall.

Walruses move westward along Lancaster Sound into the central Canadian Arctic archipelago as the ice edge recedes in spring (Degerbøl and Freuchen 1935; Tuck 1957; Greendale and Brousseau-Greendale 1976). The main migration occurs from mid-June to mid-July, mostly along the north side of Lancaster Sound, although some animals stray deep into Pond, Milne and Admiralty Inlets (Schwartz 1982). Some enter bays and inlets along the south coast of Devon Island; others continue westward into Barrow Strait, north into Wellington Channel, or south into Prince Regent Inlet (Read and Stephansson 1976; Riewe 1976; Davis *et al*. 1978). They move ashore as ice dissipates. Hunters from Resolute suggest that there is a concerted and brief eastward migration out of the central Canadian high Arctic via Lancaster Sound in the fall (Stewart 2002): an animal tagged in August 1993 at Bathurst Island was killed by Inuit in early June 1994 at Milne Inlet on Baffin Island, about 750 km by sea to the east (Stewart 2002). Another animal using the haul-out in 1993 had wintered near Dundas Island (76°05'N, 94°58'W) (B. Sjare cited in Stewart 2002). There is also a westward influx of walruses from Baffin Bay into Jones Sound in early August (Davis *et al*. 1978). However, walruses also appear to winter every year in the Cardigan Strait–Fram Sound and Penny Strait–Queens Channel areas, at the Hell Gate and Dundas Island polynyas, and in other areas with small polynyas or rotten ice (Riewe 1976; Davis *et al*. 1978; Killian and Stirling 1978; Stirling *et al*. 1983; Sjare and Stirling 1996).

The movements of walruses from this population are being studied with satellite-located radio tags (R.E.A. Stewart, DFO, pers. comm. 2003; see also Nicklen and Lanken 2002).

Nova Scotia–Newfoundland–Gulf of St Lawrence (Maritime) Population

No information has been found describing the historical patterns of movement of this population.

Nutrition and interspecific interactions

Atlantic walruses feed mostly on benthic prey at depths of 10 to 80 m (Vibe 1950; Mansfield 1958; Born *et al*. 2003). Some dives can last 24 minutes (Gjertz *et al*. 2001). They identify suitable prey using their sensitive whiskers (Loughrey 1959; Fay 1981; Kastelein and van Gaalen 1988; Kastelein *et al*. 1990). Disturbed bottom sediments suggest that prey are identified by rooting with the snout and then excavated using jets of water from the mouth (Oliver *et al*. 1983). Bivalves are sucked out from their shells; by retracting and depressing its tongue a walrus can create a vacuum of –87.9 kPa in air, or –118.8 kPa in water (Kastelein *et al*. 1994, 1997). The walrus has good control over its tongue muscles and over both the intensity and duration of suction.

Walruses feed preferentially on bivalve molluscs but also eat a variety of other species (Degerbøl and Freuchen 1935). The stomachs of Atlantic walruses taken by Inuit in July (n = 105) and September (n = 2) from northern Foxe Basin contained benthic invertebrates, including bivalves, gastropods, holothurians, polychaetes, brachiopods, amphipods, isopods, priapulids, and sea urchins (Fisher 1989; Fisher and Stewart 1997). Vibe (1950) and Mansfield (1958) found similar invertebrate prey in the stomachs of animals they sampled. In July, *Mya truncata* contributed 81.4% of the total gross energy to the diet and *Hiatella arctica* 7.5% (Fisher 1989; Fisher and Stewart 1997). Holothurians and the polychaete *Nereis* sp. contributed 3.5 and 2.8%, respectively. Walruses less than 3 years old consumed mostly milk, but also ate some benthic invertebrates. Seasonal feeding patterns are not well known. The two stomachs collected in September both contained more food than the fullest stomach from July, suggesting that walruses may feed more intensively in the fall. In September, *M. truncata* contributed 59.9% of the total gross energy to the diet and the bivalve *Serripes groenlandicus* contributed 37.9%. Males and females have similar diets but the females have a more efficient digestion (Fisher 1989; Fisher *et al*. 1992).

Walrus stomachs often contain only the feet or siphons of bivalves (Vibe 1950; Mansfield 1958; Fisher 1989; Welch and Martin-Bergmann 1990; Fisher and Stewart 1997), but direct observations in the wild show that they remove most of the soft parts of their bivalve prey (Vibe 1950; Born *et al*. 2003). This suggests that the viscera are removed and spat out or else very quickly digested.

Over a 97-hr feeding cycle the estimated daily gross energy intake by a 1200 kg male Atlantic walrus in the wild off east Greenland was 214 kJ per kg of body mass (95% CI: 153-275 kJ) (Born *et al*. 2003). During this period the animal dove 412 times and consumed an average of 53.2 bivalves (SE=5.2, range 34-89, n=10) per dive. This corresponds to the ingestion of 57 kg (95% CI: 41-72 kg) wet weight of bivalve biomass per day. This is higher than the daily food and energy intake reported from studies of captive walruses (Fisher *et al*. 1992; Kastelein *et al*. 2000). Feeding rates in captivity—and probably also in the wild—vary with age, sex, reproductive status, and season (Kastelein *et al*. 2000).

Atlantic walruses are also known to eat ringed seals, bearded seals (*Erignathus barbatus*), fishes and squids (Vibe 1950; Mansfield 1958). Observations on Pacific walruses suggest that most seal-eating is predation rather than scavenging (Lowry and Fay 1984). Inuit recognize the livers of seal-eating walruses by their ‘cooked’ appearance and avoid eating them (Loughrey 1959; Fleming and Newton 2003), as they contain toxic concentrations of Vitamin A (Bruemmer 1977; Reeves 1995). Atlantic walruses also prey on seabirds (Gjertz 1990; Donaldson *et al*. 1995) and scavenge dead whales (Degerbøl and Freuchen 1935; Mansfield 1958). Some large bulls will eat young walruses (Degerbøl and Freuchen 1935).

Bearded seals and Pacific walruses compete for clams in some areas (Lowry and Frost 1981); the same is likely true for Atlantic walruses. The presence of walruses tends to drive away ringed seals (Reeves 1995).

Behaviour/adaptability

Walruses hauled out on the land spend most of their time resting, often lying in contact with one another (Salter 1979a; Miller and Boness 1983). This inactivity enables them to maintain high, stable temperatures in their skin and appendages, which may be crucial during the moult, and possibly for the healing of wounds and the survival of young calves (Fay and Ray 1968; Ray and Fay 1968). Walruses are more active in the water; foraging trips can last 72 h between haul-outs (Born *et al*. 2003).

Conflicts are common at *uglit*, where animals must gain and defend space to avoid being crowded (Miller 1975, 1976, 1982; Salter 1979a,b; Miller, and Boness 1983), but less so in the water. Large body size and long tusks characterize dominant animals. Tusks are used in threat displays by both sexes and are important in fighting. Females with calves favour the central and seaward areas of the *ugli*, where the calves are better protected from polar bears (Miller 1982; Miller and Boness 1983). Males in mixed herds tend to occupy the inland locations. In the water, males tend to be separated from females with offspring, possibly owing to differences in food requirements and to time and energy budgets related to nursing (Miller and Boness 1983).

Conflicts observed on the haul-out beaches in summer and fall are minor compared with the serious battles that take place in the breeding season (Sjare and Stirling 1996; B. Sjare, DFO, pers. comm. 2005). Most of the fights in the breeding season occur in the water and go undetected (there have been few studies of breeding behaviour). The proportion of males injured in the breeding season might not be large, but those actively breeding or struggling to establish themselves sustain serious puncture wounds, gashes, loss of eyes and tusk breakage. In addition, breeding males lose a lot of weight through singing almost continuously and not feeding during February, March and April.

Walruses use a wide variety of vocalizations both in and out of the water to communicate threats, submission, and distress and to maintain contact between females and calves (Miller and Boness 1983; Miller 1985; Stirling *et al*. 1987; Sjare and Stirling 1996; Sjare *et al*. 2003; Stirling and Thomas 2003). During the breeding season, males vocalize (sing) underwater to communicate dominance and attract females. Sjare and Stirling (1996) described the breeding behaviour of Atlantic walruses at the Dundas Island polynya.

When hunted, animals of both sexes aid the injured. Herds that consist only of adults flee, but those with young will return to protect the calves and to encourage them to escape (Burns 1965 in Miller 1985). Adoption may be widespread and important to Pacific walruses (Fay 1982), but has not been studied in Atlantic walruses.

The ability of Atlantic walruses to re-colonize areas where populations have been depleted is unknown. The rarity of animals along the Atlantic coast of Canada since the maritime population was extirpated suggests that re-colonization is exceedingly slow at best.

<u>Sensitivity to disturbance</u>

The level of response by walruses on land to aircraft overflights depends upon the distance and altitude of approach (Salter 1979a). Walruses on Bathurst Island at Brooman Point (75°31’N, 97°24’W) raised their heads to locate the source of the disturbance when a Bell 206 helicopter was up to 8 km away, oriented toward the sea when it was within 1.3 km and sometimes escaped into the water immediately thereafter.

Fright or interest responses caused by disturbances may impact population dynamics by causing stampedes, interfering with feeding and increasing energy expenditures—particularly among calves, and by masking communications, impairing thermoregulation and increasing stress levels (Stewart *et al*. (ed.) 1993). Prolonged or repeated disturbances may cause walruses to abandon *uglit* (Salter 1979a). Their adaptability to non-threatening man-made disturbances, such as ecotourism, is unknown.

Diving behaviour

Gjertz *et al*. (2001) used dive recorders to study the diving behaviour of 9 male Atlantic walruses at Svalbard. On average the animals spent 56 h in the water followed by 20 h hauled out on land. They dove to a maximum depth of 67 m and stayed submerged up to 24 min. Foraging dives to a mean depth of 22.5 m lasted an average of 6 minutes. Satellite-linked data loggers indicate that walruses can dive to at least 180 m (Stewart and Fay 2001).

While slow and awkward on land, walruses are good swimmers. Their cruising speed seldom exceeds 6 or 8 km/h, but they can accelerate to about 30 km/h for a short time when chased (Bruemmer 1977).

Adaptation to captivity

Walruses have been maintained successfully in captivity for many years (Fisher *et al*. 1992; Kastelein *et al*. 1994, 2000; Kastelein 2002; McIntyre 2002). Few captive-born walruses have been raised by their mothers, which are so protective of their young that they tend to spend more time defending the calf than nursing it (Kastelein 2002). Feeding formulae are now available that enable walrus calves to be hand-raised without nutritional deficiencies. The tusks of captive animals wear down on abrasive surfaces in aquaria, and are routinely removed surgically (McIntyre 2002; R.E.A. Stewart, pers. comm. 2003).

POPULATION SIZES AND TRENDS

As the number of whales in the Canadian Arctic and Hudson Bay dwindled towards the end of the 19th century, whalers turned their efforts to hunting other species, including walruses (Low 1906; Degerbøl and Freuchen 1935). Commercial and sport hunting of walruses was banned in Canada in 1928 by an order in the Privy Council (P.C. 1036) (see Mansfield 1973). There are no estimates of the level of exploitation, but walrus populations in the eastern Canadian Arctic are apparently still much reduced (Manning 1946; Schwartz 1976; Reeves 1978; Davis *et al*. 1980; Richard and Campbell 1988; Born *et al*. 1995). There is no comprehensive compilation of historical harvest records that might be used to estimate initial levels of these populations.

There are no complete or recent estimates of numbers for walrus populations in Nunavut (Stewart 2002) or Nunavik. There are index estimates for some populations but they have broad confidence intervals (Cosens *et al*. 1993), so that changes in population size would have to be very large to be detectable. These estimates cannot be corrected for animals that are submerged beyond view or for haul-out dynamics, which determine the proportion of a herd that is on land or ice or in the water at the time of the survey. Data on the number of walrus present in an area often consist simply of counts of animals hauled out at known areas of concentration, or opportunistic sightings, and cannot be used to estimate the total Canadian walrus population (Richard and Campbell 1988).

Greenland walrus populations—West Greenland, North Water, and East Greenland[3]—were recently assessed using a density-dependent population dynamics model with assumed life-history parameters, fitted by Bayesian methods to catch series extending back to the early 1900s or late 1800s, and a single survey estimate for each population (Witting and Born 2005). Conclusions from the analyses of the western Greenland populations (i.e. West Greenland and North Water) were that their pristine sizes had been very much larger, they were now overhunted, and further depletion or extinction was likely. Conclusions were dependent on the survey estimates and the assumptions about life-history parameters—and the data contained no information that could update the prior distributions of life history variables. A review of these assessments by NAMMCO in 2005 recognized that prior distributions of life history variables were not updated by the data. Concerns were also raised about the quality of the surveys. The likely connection between walruses in Hudson Strait and northern Hudson Bay stock with those in West Greenland was also not considered in the assessment by Witting and Born (2005). However, Witting and Born's (2005) findings agreed with the general conclusion that these populations (West Greenland and North Water) are substantially depleted despite the reservations of the NAMMCO Scientific Committee concerning details of the assessment.

South and East Hudson Bay Population

A comprehensive survey of the walrus population in eastern and southern Hudson Bay and James Bay has not been conducted. In the spring of 1955, a herd estimated at over 1000 animals was seen hauled out on the sandspit at Cape Henrietta Maria (Clarke in Loughrey 1959) and in September 1955, the captain of the *Fort Severn* saw a herd off the coast at Winisk (Loughrey 1959). Born *et al*. (1995) have questioned the accuracy of the former estimate, which was told to Clarke, and cautioned against its use in determining population trend. The Ontario Department of Natural Resources (DNR) has recorded opportunistic observations of walruses at shoals off the mouth of the "Brant River" since 1957 (C. Chenier, DNR, pers. comm. 2003). Walruses have been seen on the shoals between 20 July and 18 October. The number of animals varies

[3]note, however, that the West Greenland population is connected in some degree to the Canadian population defined here as the Northern Hudson Bay–Davis St population, while the North Water population is thought to be the same as at least the eastern-Jones-Sound part of the Baffin Bay population.

widely and no trend is apparent in the population. High counts recorded by Ontario DNR have ranged from 310 on 5 October 1978 (J.P. Prevett), to 204 on 9 September 1983 (K.F. Abraham) and from to 330 on 8 September 1986 (K.F. Abraham), to about 221 in August 1999 (C. Chenier).

In the late 1930s, Twomey and Herrick (1942) saw and hunted a herd they estimated at over 400 animals in the northern Sleeper Islands. Since then only smaller herds have been reported from the region. On 4 August 1971, Manning (1976) saw 75 walruses near the south end of the Sleeper Islands, and the next day saw 25 off the west coast of Kidney Island, largest of the Sleeper Islands. A herd of about 30 animals was seen at the Sleepers in October 1996; nine of these animals were harvested (Brooke 1997). In the summer of 1993, a herd of about 30 animals was seen in the Belchers directly north of Sanikiluaq during an aerial survey (J. Desrosier, pers. comm. 2003). Hunters report that there are fewer walruses near the community and on neighbouring islands now, than in the past (DFO 2000).

In the early 1990s, walrus were reportedly numerous along the Ontario coast of Hudson Bay west to the Winisk (Peawanuck) area, and have been seen in July near Fort Severn (Fleming and Newton 2003). This coastline may provide a refuge for the population, since Cree hunters do not have a strong tradition of hunting walruses and take few animals (Johnston 1961).

Richard and Campbell (1988) and Born *et al*. (1995) estimated the size of this population at 410+ and "500?" animals, respectively. Both of these estimates were tentative and based on a few sightings in a wide geographical area over a long period. Taking the largest direct counts of the past decade or so, as did Richard and Campbell (1988), yields an updated estimate of 270+ animals. The data are too few to assess whether a decline has occurred.

Northern Hudson Bay–Davis Strait Population

Aerial survey counts of walruses in the northern Coats Island, Walrus Island and southeast Southampton Island area of northern Hudson Bay were conducted in July or August of 1954 (Loughrey 1959), 1961 (Mansfield 1962), 1976-77 (Mansfield and St. Aubin 1991) and 1988-90 (Richard 1993). They produced maximum counts, respectively, of 2900 (Loughrey 1959: 80), 2650 (Mansfield 1959; 46), 2370 (Mansfield and St. Aubin 1991: 97), and 1376 (Richard 1993: 7) walruses. The real population size is likely greater, as these counts are not based on systematic surveys of the entire area and were not corrected for animals missed by the observers. While they suggest a declining trend, care must be taken in interpreting these data given differences in survey methods and ice coverage, and wide fluctuations in the numbers of animals hauled out at any particular time. Richard's (1993) counts in 1988–90, for example, were above the average of the daily counts in 1976 and 1977. On Coats Island, Gaston and Ouelett (1997) counted about 600 animals at Cape Pembroke on 7 August 1992 and about 500 at Cape Prefontaine on 31 July 1995. Hunters from Coral Harbour have reported an increase in the number of walruses near their community over the past 10 years (DFO 2000).

Walruses were more common and numerous along the west coast of Hudson Bay between Arviat and Chesterfield Inlet in the past (Loughrey 1959; Born *et al*. 1995). They are now found mostly in the area north of Chesterfield Inlet. No counts are available for this region.

Cape Dorset hunters have reported walrus herds of between 500 and 1000 animals on the ice or at *uglit* along western Foxe Peninsula in summer, particularly between Cape Dorset and Cape Dorchester, with a similar number in the area between Salisbury and Nottingham islands (Orr and Rebizant 1987). They also report an increase in the number of walruses near the community over the past 30 years (DFO 2000). An aerial survey in August 1990 counted 461 walruses on Nottingham Island (Richard 1993).

Surveys of the southeast Baffin coast conducted in the summer and fall of 1977 through 1979 located a number of *uglit* (MacLaren Atlantic Limited 1978; MacLaren Marex Inc. 1979, 1980a+b; Smith *et al*. 1979). The number of walrus at each *ugli* was typically between a few and several hundred, with the exception of a small island near Lady Franklin Island, where 600 to 700 animals were seen on 15 August 1979 (McLaren Marex Inc. 1980b).

Currie (1963: 22) estimated the population of walruses that visited Akpatok Island in spring around 1960 as at least 1000 and perhaps over 2000. Indeed, before the 1950s hunters landed 800 animals there in one season, and during the 1950s there were annual harvests of 150 to 200 animals. Residents of the communities around Ungava Bay still hunt walruses each year at Akpatok Island (Olpinski 1990, 1993; Portnoff 1994; Brooke 1997) but the number of animals now present is unknown.

Richard and Campbell (1988) and Born *et al*. (1995) estimated the size of this population at 4850–5350 and 6000 animals, respectively. Both of these estimates were tentative and based on a few sightings in a wide geographical area over a long period. They have very wide uncertainty, but cannot be updated as there are no new data.

Foxe Basin Population

Because Foxe Basin was not a major whaling ground or shipping route its walrus population was not hunted intensively by whalers when larger prey became scarce. While its initial size is unknown the population is likely somewhat reduced by the substantial subsistence harvests. Orr *et al*. (1986) counted 2722 walruses during a reconnaissance helicopter survey of northern Foxe Basin in August 1983. In August 1988 and July 1989, systematic visual strip transect surveys were flown over central Foxe Basin (Richard 1993). In 1988, the number of animals at the surface was estimated at 5200 (95%CI 900-30500) based on a direct count of 440; in 1989 it was estimated at 5500 (95%CI 2700-11200), based on a direct count of 475. These surveys did not cover the whole of northern Foxe Basin or correct for animals that were submerged beyond view. They provide an index against which change can be measured rather than an overall estimate of the population.

Richard and Campbell (1988) estimated the size of this population at 2725+ animals based on direct counts by Orr *et al*. (1986); Born *et al*. (1995) based their estimate of 5500 animals on Richard's (1993) survey data. The latter estimate has wide uncertainty limits but stands as the best available. It suggests a minimum population of well over 2700 animals in 1989. No trend in the population can be established from the data available.

Baffin Bay (High Arctic) Population

No comprehensive survey of the North Water and adjacent areas occupied by this population has been conducted, so only piecemeal information from different seasons and years is available for estimating the population size. Finley and Renaud (1980) counted about 700 walruses in the North Water in March 1979, but saw few during a survey the previous year. During a systematic survey of the area in late March 1993, Richard *et al*. (1998) saw 13 animals, widely dispersed. Davis *et al*. (1978) surveyed terrestrial haul-out sites and adjacent waters in the central Canadian High Arctic in 1977. Between 21 and 23 August they counted 303 animals in the Goose Fiord–Walrus Fiord area of southwest Ellesmere Island and Norfolk Inlet–Arthur Fiord areas of northern Devon Islands; 118 on the east side of Penny Strait, 281 in the Crozier Strait-Pullen Strait-Milne Inlet area, and 71 along the southwest coast of Devon Island. In the last area, a polar bear was present at one of the haul-outs and swimming animals were not counted. The distance that separates these areas and the brief counting period makes it unlikely that animals were double counted. Based on these counts at least 773 walruses were alive in the region in 1977.

These and other data were reviewed in detail by Born *et al*. (1995), who suggested that summering walruses might number: 100 in the Kane Basin region; 300 in the Buchanan Bay (78°58'N, 75°11' W) and Princess Marie Bay (79°20'N, 76°00' W); 300-600 in Jones Sound and along eastern Ellesmere Island south of Pim Island (78°44'N, 74°25' W); and 1000 in the Lancaster Sound area and along southern Devon Island. These numbers were educated guesses because the data were insufficient for an accurate, current assessment. Since then, late summer surveys of the coastal waters of Jones Sound and northern Lancaster Sound over 4 consecutive years (1998-2001) produced an average count of about 350 walruses (DFO 2000; R. Stewart, DFO pers. comm. 2004). This does not alter the estimates but confirms that at least 350 walruses were alive in the region in recent years.

An aerial survey was conducted in August 1999 along the coasts of eastern Ellesmere Island and in Jones Sound, south Devon Island and Cornwallis Island – Grinnell Peninsula. A total of 452 walruses were counted. Witting and Born (working paper cited in NAMMCO 2006) applied a correction factor to this count and estimated there were about 1000 animals in the surveyed area. They further assumed the unsurveyed areas contained about 500 animals. NAMMCO (2006) noted that the total estimate of 1500 for the North Water should not be used in assessments until further information is presented on the survey design and analysis.

Nova Scotia–Newfoundland–Gulf of St Lawrence (Maritime) Population

Originally, this population is believed to have numbered in the tens of thousands. There has been no evidence for the past 200 years of the population's re-establishment.

LIMITING FACTORS AND THREATS

Walruses are gregarious and valuable, and they have a narrow trophic niche and restricted seasonal distribution that makes them relatively easy for hunters to locate and vulnerable to environmental changes (Born *et al*. 1995). At present, hunting is the main limiting factor and threat to the Atlantic walrus in Canada. Contaminant uptake, industrial development, noise disturbance, and climate change are minor threats by comparison. Climate change may affect walruses most by exposing them to increased hunting pressure. The species' susceptibility to disease is unknown.

Subsistence hunting

Data on the takes of walruses in Canada are incomplete and vary widely in quality. They have been collected by different agencies, using various methods and for different purposes. Between 1980 and 1985 harvest estimates by the Baffin Region Inuit Association (BRIA) and DFO differed widely for some communities (Pattimore 1983a, b, 1985; Guinn and Stewart 1985; Donaldson 1988; J. Pattimore, pers. comm. 1986). In some instances they were simply educated guesses. Few data are available on hunter effort. Wide uncertainties in many of the data points—sometimes 200%—coupled with many missing values preclude meaningful analysis. But they do provide information on the seasonality of the hunts and a sense of the magnitude of the harvest by a community or from a population. Efforts are under way to educate hunters about the importance of reporting both landed and lost animals), and DFO and its co-management partners are working with the communities to improve the reporting system (J. Galipeau, NWMB, pers. comm. 2004).

Between 1977 and 1987 walrus harvest records for Nunavut were collected from DFO, Government of the Northwest Territories (GNWT), Royal Canadian Mounted Police (RCMP) and Hudson's Bay Company records (Strong 1989). From 1988 to 1996 records are from annual harvest summaries prepared by DFO (DFO 1991, 1992a, b, 1993, 1994, 1995, 1996, 1997, 1999). These summaries include information from hunts monitored by Fishery Officers or GNWT Renewable Resource Officers, reported by Government Liaison Officers, calculated from long-term averages, or estimated using sales slips and trade records. Records from 1997 to 2003 are those reported by community Hunters and Trappers Organizations (HTOs) (P. Hall, DFO, pers. comm. 2003).

In Nunavik, community agents hired by DFO collected the walrus harvest data for 1977–97 (Brooke 1997) and 1997–99 (D. Baillargeon, DFO Quebec, pers. comm. 2003). The 1999–2003 records are from Makivik's Scientific Research Centre, where samples from each walrus that is taken in Nunavik should be sent for *Trichinella* assays before the animal is eaten (D. Baillargeon, DFO Quebec, pers. comm. 2003). Where differences were found between the DFO and Makivik data in 1997–2003, the higher value was used. Additional hunting data are contained in the Nunavut Wildlife Harvest Study (Priest and Usher 2004) for the years 1996-2001. The reported harvest data were not corrected for hunting losses and do not include information on the age or sex composition of the harvest. Takes of young animals have on occasion gone unreported (Freeman 1969–70).

When the removal rates of walruses are determined, uncertainties in the reported landed harvest are compounded by uncertainty in loss rates. Few estimates of loss rates exist for subsistence hunts, and none for sport hunts. Loss rates can be high when walruses are killed in the water (Beaubier 1970; Orr *et al*. 1986), as they sink quickly. Hunters prefer to kill them on land or ice where they are easier to retrieve and butcher. To reduce losses, animals in the water may be harpooned before they are shot, wounded so they can be harpooned before being killed, or killed in shallow water where they can be retrieved with grappling hooks or at low tide. Harpooning a walrus is dangerous, since animals must be approached to within about 7.5 m, and wounded walruses become very aggressive and can sink or capsize canoes or small boats.

Orr *et al*. (1986) observed a loss rate of 32% at summer hunts in Foxe Basin, and Mansfield (1958) estimated the rate at 30% for the Canadian Arctic. Freeman (1969–70) observed a loss rate of about 30% in two summer (late August) hunts near Walrus Island, and of 38% (Freeman 1974–75) in an autumn (late September) hunt near Southampton Island. These loss rates are higher than those observed at open water hunts in the Avanersuaq (Thule) area of (north-west) Greenland (15-25%; Born and Kristensen 1981 cited in Born *et al*. 1995) and lower than those of the Alaskan walrus hunts, which averaged 42% over the period 1952 to 1972 (Fay *et al*. 1994). About 55% of the animals struck and lost in Alaska died immediately and most of the wounded died shortly after being struck. Improvements in the weapons used for the hunts over the period did not alter loss rates but increased the proportion of outright kills among the lost animals. Inuk hunters believe loss rates to be lower (~5%)(DFO 2000). None of these loss rates consider the indirect mortality of calves that are orphaned while still dependent on their mother's milk.

The hunting mortality that Atlantic walrus populations can sustain is not exactly known. Estimates of sustainable yield range from 3 to 5% for a population that is between 59 and 93% of carrying capacity (DeMaster 1984 cited in Born *et al*. 1995). It is not known where Canadian stocks stand in relation to their carrying capacities. In the absence of information, specific to walrus, on sustainable yield, DFO (2000) uses yield rates of 2–5% inferred from cetaceans with similar life histories and reproductive patterns. Predictions of sustainable removal are unlikely to be accurate since the population estimates they rely upon are dated and incomplete.

Inuit and Cree from around Hudson Bay who participated in the Hudson Bay program of traditional knowledge studies reported that they "knew walrus better when they were still using dog teams" (Fleming and Newton 2003). This supports assertions below that hunting patterns changed and harvests declined with introduction of the snowmobile and reduction in the need for dog food. However, Davis (1981) suggested that demand for ivory ca. 1980 might, conversely, lead to increased hunting, but it is not known whether this has occurred. While the value of raw tusks has been small relative to hunting costs and the value of the meat (Anderson and Garlich-Miller 1994), the economic benefits of carving tusks to create value-added products may be quite significant.

South and East Hudson Bay Population

Hunters from Inukjuak, Kuujjuarapik, Umiujaq, and Sanikiluaq kill walruses from the South and East Hudson Bay population (Figure 5; Table 1). Hunters from Kuujjuarapik and Umiujaq land the occasional animal in some years, typically in the Sleeper Islands or along the coast of the Hudson Bay Arc, while those from Sanikiluaq and Inukjuak land a few on average each year, mostly from the offshore islands (JBNQNHRC 1988; Strong 1989; Olpinski 1990, 1993; Portnoff 1994; Brooke 1997).

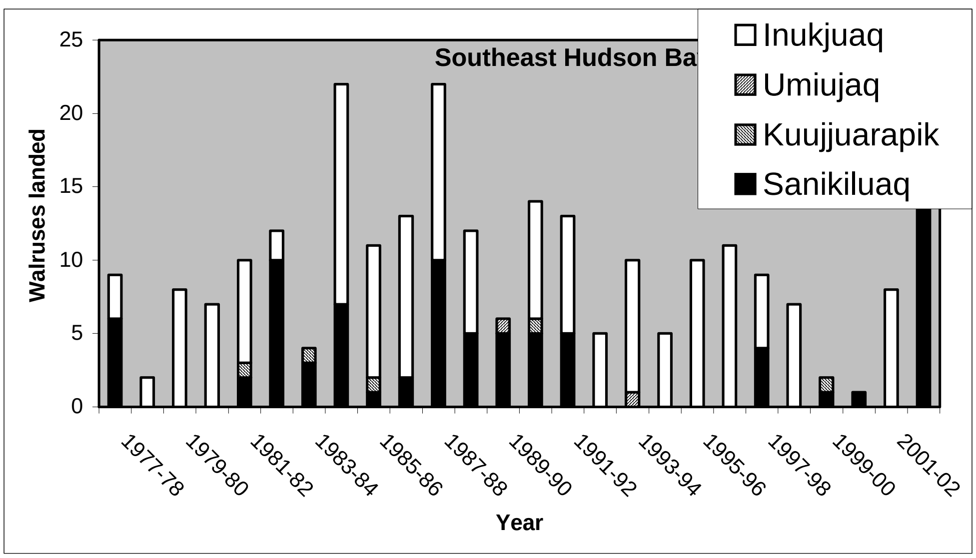

Figure 5. Reported landed harvest from the South and East Hudson Bay walrus population, 1977 to 2002. See Table 1 for data.

Table 1. Reported landed harvest from the South and East Hudson Bay walrus population, 1977-2002. Sources are listed below.

Community	Quota[1]	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Sanikiluaq	10	6	0	n/d[2]	n/d	2	10	3	7	1	2	10	5	5
Kuujjuarapik	-	0	0	0	0	1	0	1	0	1	0	0	0	0
Umiujaq	-	nc[3]	nc	nc	nc	nc	nc	nc	nc	nc	n/d	0	0	1
Inukjuak	-	3	2	8	7	7	2	0	15	9	11	12	7	0
Annual Total		9	2	8	7	10	12	4	22	11	13	22	12	6

Community	Quota	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Sanikiluaq	10	5	5	n/d	n/d	0	n/d	n/d	4	n/d	1	1	0	15
Kuujjuarapik	-	1	0	0	0	0	0	0	0	0	1	0	0	0
Umiujaq	-	n/d	0	0	1	0	0	0	0	0	0	0	0	0
Inukjuak	-	8	8	5	9	5	10	11	5	7	0	0	8	0
Annual Total		14	13	5	10	5	10	11	9	7	2	1	8	15

Community	Quota	2003/4	2004/5
Sanikiluaq		n/d	n/d
Kuujjuarapik		n/d	0
Umiujaq		n/d	0
Inukjuak		n/d	0
Annual Total			

Sources: Sanikiluaq: 1977-78 to 1987-89 (Strong 1989) 1989-90 (DFO 1991), 1990-91 (DFO 1992a), 1991-92 (DFO 1993), 1992-93 (DFO 1994), 1993-94 (DFO 1995), 1994-95 (DFO 1996), 1995-96 (DFO 1997), 1996-97 (DFO 1999), 1997-2002 (DFO unpubl. data); **Kuujuarapik, Umiujaq and Inukjuaq:** 1977-78 to 1996-97 (Brooke 1977), 1997-98 to 2004-05 larger harvest reported by DFO or Makivik (unpubl data from D. Baillargeon, DFO Quebec, pers. comm. 2003; L Cooper, DFO Ottawa, pers. comm.).
[1]Unless a community quota is stated the allowable annual harvest is 4 walrus per Inuk. [2]n/d = no data. [3]nc = no community.

Historically, walruses in southeastern Hudson Bay and James Bay were mainly hunted at *uglit*, in the open water season (Twomey 1939; May 1942; Manning 1946, 1976; Freeman 1964; Olpinski 1990; Reeves 1995; Fleming and Newton 2003). They were also killed in winter and spring at the floe edge or in spring as they slept on floating ice pans. Most recent hunting in this region has taken place in late summer and fall (September and October) at the Sleeper Islands (Manning 1976; Schwartz 1976; Olpinski 1990, 1993; Portnoff 1994; Brooke 1997; Fleming and Newton 2003). In 1992 and 1993, hunters from Inukjuak visited the Ottawa Islands where they failed to locate walruses before travelling to the Sleepers for successful hunts (Olpinski 1993; Portnoff 1994). Indians in James Bay and southern Hudson Bay seldom travel offshore to hunt walruses (Johnston 1961) but hunted them occasionally in the past (Fleming and Newton 2003).

Over the period 1977-78 through 1989-90 the reported landed harvest from this population averaged 10.6±3.3 animals per year (simple mean of reported values ± 95% CI, n = 13); over the period 1990-91 through 2002-03 it averaged 8.5 ± 2.5 (n = 13). The effects on these averages of changes in the quality of the harvest data and of uneven reporting from Sanikiluaq could not be assessed. Assuming a loss rate of 32% (Orr *et al*. 1986), hunters may have removed about 15 walruses on average from the population each year since 1989–90.

Northern Hudson Bay–Davis Strait Population

Over 20 Canadian communities hunt walruses from the Northern Hudson Bay–Davis Strait population (Figure 6, Table 2).

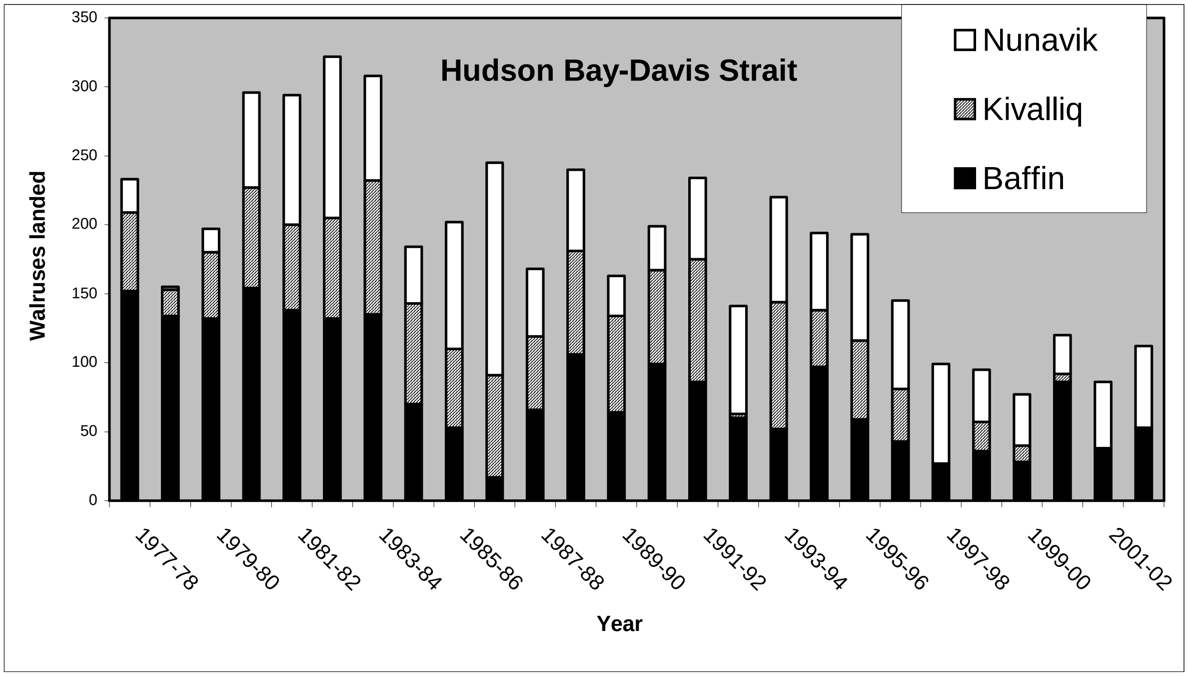

Figure 6. Reported landed harvest from the Northern Hudson Bay-Davis Strait walrus population, 1977 to 2002. See Table 2 for data.

Table 2. Reported Canadian landed harvests from the Northern Hudson Bay-Hudson Strait walrus population 1977-2002. Data include sport harvests. Sources are listed below.

Community	Quota[1]	1977/ 78	1978/ 79	1979/ 80	1980/ 81	1981/ 82	1982/ 83	1983/ 84	1984/ 85	1985 /86	1986/ 87	1987 88	1988/ 89	1989/ 90
Nunavut: Baffin Region:														
Qikiqtarjuaq	-	12	12	n/d[2]	46	n/d	35	6	20	5	9	9	12	15
Clyde River	20	2	7	0	2	3	n/d	6	1	0	0	3	1	0
Cape Dorset	-	72	66	67	20	10	35	59	4	15	n/d	5	35	24
Iqaluit	-	32	12	65	65	58	40	25	39	27	4	29	10	8
Kimmirut	-	3	4	0	1	5	10	6	0	n/d	4	8	4	9
Pangnirtung	-	31	33	0	20	62	12	33	6	6	0	12	44	8
Annual Regional Total		152	134	132	154	138	132	135	70	53	17	66	106	64
Nunavut: Kivalliq Region:														
Arviat	-	n/d	n/d	0	0	0	0	0	0	1	0	0	3	0
Chesterfield In.	-	n/d	0	1	5	4	0	2	7	15	20	n/d	11	9
Coral Harbour	60	42	16	41	54	11	35	67	60	24	43	31	41	45
Rankin Inlet	-	5	0	0	8	13	3	15	1	3	2	4	5	5
Repulse Bay	-	10	0	0	6	33	35	10	5	14	9	18	13	11
Whale Cove	-	n/d	3	6	0	1	0	3	0	0	0	0	2	0
Annual Regional Total		57	19	48	73	62	73	97	73	57	74	53	75	70
Quebec: Nunavik:														
Kangiqsualujjuaq	-	0	0	1	1	0	0	0	0	0	0	3	0	5
Kuujjuaq	-	0	0	0	0	0	0	0	0	0	0	0	0	3
Tasiujaq	-	0	0	0	0	0	n/d	1	1	3	0	0	0	0
Aupaluk	-	0	0	0	0	0	0	1	1	3	0	0	0	0
Kangirsuk	-	9	2	1	8	4	5	7	3	13	3	0	7	5
Quaqtaq	-	7	0	7	10	3	2	6	9	8	7	6	10	4
Kangiqsujuaq		7	0	0	9	0	0	1	0	17	41	2	0	0
Salluit	-	1	0	5	36	30	73	2	27	16	91	1	8	0
Ivujivik	-	n/d	n/d	n/d	n/d	33	29	57	n/d	16	0	19	8	11
Akulivik	-	0	0	3	5	24	8	1	0	16	1	18	10	1
Puvirnituq	-	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	11	0	16	0
Annual Regional Total		24	2	17	69	94	117	76	41	92	154	49	59	29
Annual Total		176	136	149	223	232	249	211	111	145	171	115	240	163

Community	Quota	1990/ 91	1991/ 92	1992/ 93	1993/ 94	1994/ 95	1995/ 96	1996/ 97	1997 /98	1998/ 99	1999/ 00	2000/ 01	2001/ 02	2002/ 03
Nunavut: Baffin Region														
Qikiqtarjuaq	-	10	13	21	0	5	16	0	3	0	0	0	1	33
Clyde River	20	1	7	2	0	0	0	1	0	1	0	0	1	0
Cape Dorset	-	24	7	11	23	24	10	30	8	4	10	46	10	5
Iqaluit	-	16	16	16	29	26	25	9	0	27	15	19	7	1
Kimmirut	-	8	22	7	n/d	2	0	1	n/d	n/d	n/d	6	0	4
Pangnirtung	-	40	21	3	0	40	8	2	16	4	3	15	19	9
Annual Regional Total		99	86	60	52	97	59	43	27	36	28	86	38	52
Nunavut: Kivalliq Region														
Arviat	-	0	0	n/d	0	0	0	0	n/d	0	2	0	n/d	n/d
Chesterfield In.	-	9	9	n/d	6	0	3	12	n/d	0	n/d	5	n/d	n/d
Coral Harbour	60	45	60	n/d	55	31	48	12	n/d	9	8	0	n/d	n/d
Rankin Inlet	-	3	2	3	4	2	6	12	n/d	12	n/d	1	n/d	0
Repulse Bay	-	11	18	n/d	25	8	0	2	0	0	2	0	n/d	0
Whale Cove	-	0	0	n/d	2	0	0	0	n/d	0	0	0	n/d	1
Annual Regional Total		68	89	3	92	41	57	38	0	21	12	6	0	1
Quebec: Nunavik														
Kangiqsualujjuaq	-	0	0	0	1	1	1	1	3	0	0	0	0	0
Kuujjuaq	-	0	5	0	0	0	0	4	2	0	6	0	0	0
Tasiujaq	-	3	2	5	4	5	3	9	0	0	3	3	4	0
Aupaluk	-	3	2	5	3	5	2	2	0	0	0	0	1	0
Kangirsuk	-	n/d	6	7	2	5	10	9	1	4	1	3	0	7
Quaqtaq	-	12	10	9	7	6	20	3	8	11	2	2	3	2
Kangiqsujuaq	-	0	3	6	2	3	2	4	0	5	1	1	4	0
Salluit	-	10	3	15	11	19	19	18	20	7	10	5	10	13
Ivujivik	-	n/d	13	7	33	n/d	20	7	23	1	7	5	14	10
Akulivik	-	4	9	12	1	9	0	3	9	10	3	3	6	14
Puvirnituq	-	n/d	6	12	12	3	0	4	6	0	4	6	6	13
Annual Regional Total		32	59	78	76	56	77	64	72	38	37	28	48	59
Annual Total		199	234	141	220	194	193	145	99	95	77	120	86	112

Community	Quota	2003/4	2004/5
Nunavut: Baffin Region			
Qikiqtarjuaq	-	n/d	n/d
Clyde River	20	n/d	n/d
Cape Dorset	-	n/d	n/d
Iqaluit	n/d	n/d	n/d
Kimmirut	n/d	n/d	n/d
Pangnirtung	-	n/d	n/d
Annual Regional Total			
Nunavut: Kivalliq Region			
Arviat	-	n/d	n/d
Chesterfield In.	-	n/d	n/d
Coral Harbour	60	n/d	n/d
Rankin Inlet	-	n/d	n/d
Repulse Bay	-	n/d	n/d
Whale Cove	-	n/d	n/d
Annual Regional Total			
Quebec: Nunavik			
Kangiqsualujjuaq	-	n/d	0
Kuujjuaq	-	n/d	0
Tasiujaq	-	n/d	0
Aupaluk	-	n/d	0
Kangirsuk	-	n/d	0
Quaqtaq	n/d	n/d	11
Kangiqsujuaq	-	n/d	9
Salluit	-	n/d	10
Ivujivik	-	n/d	0
Akulivik	-	n/d	12
Puvirnituq	-	n/d	0
Annual Regional Total			42
Annual Total			

Sources: Nunavut: 1977-78 to 1987-89 (Strong 1989) 1989-90 (DFO 1991), 1990-91 (DFO 1992a), 1991-92 (DFO 1993), 1992-93 (DFO 1994), 1993-94 (DFO 1995), 1994-95 (DFO 1996), 1995-96 (DFO 1997), 1996-97 (DFO 1999), 1997-2002 (DFO unpubl.

data); **Nunavik:** 1977-78 to 1996-97 (Brooke 1997), 1997-98 to 2004-05 larger harvest reported by DFO or Makivik (unpubl data from D. Baillargeon, DFO Quebec, pers. comm., L. Cooper, DFO Ottawa, pers. comm.). For summary statistics for Nunavut 2003-4 and 2004-5 and for Nunavik 2003-4, see Table 6.
[1]Unless a community quota is stated the allowable annual harvest is 4 walrus per Inuk. [2]n/d = no data.

Communities along the west coast of Hudson Bay hunt animals from the northern Hudson Bay portion of the Hudson Bay–Davis Strait population (Figure 4). These harvests increase from south to north and hunters often have to travel north into the Coats Island area to find walrus herds (Figure 3; Table 2). There are no recent reports of animals being killed at Churchill, Manitoba. They are rarely taken at Arviat and irregularly at Whale Cove, but more commonly further north (Welland 1976; Gamble 1988, Strong 1989; Fleming and Newton 2003). Timing of the hunts varies among communities. All of the communities hunt animals at the ice edge but the largest harvests are typically taken during the open water season in the Repulse Bay (September–October) and Coral Harbour–Coats Island (July–September) areas (Gamble 1984, 1987a, b, 1988).

Residents of Puvirnituq, Akulivik, Ivujivik, and Salluit regularly take walruses from the Hudson Strait portion of the Hudson Bay–Davis Strait population (Roy 1971; Olpinski 1990, 1993; Portnoff 1994; Brooke 1997). Most animals are killed during the open water season—often in September and October, near Nottingham and Salisbury islands. However, hunters from Ivujivik, Puvirnituq and Inukjuak have landed walruses on occasion at Mansel Island. Hunters from Kangiqsujuaq and communities around Ungava Bay take most of their walruses in August through October at Akpatok Island.

Timing of walrus hunts in the Baffin Region of Nunavut varies among communities. Walruses are typically hunted year-round by Cape Dorset hunters, from February through November or December by Kimmirut and Iqaluit; from May through November or December by Pangnirtung and Qikiqtarjuaq; and in May, July and August by Clyde River (Pattimore 1983a & b, 1985; J. Pattimore, pers. comm. 1986). The hunting patterns of the Cape Dorset people changed around 1970 with the introduction of snowmobiles, which reduced the need to feed dog teams, and with concentration of people at the community (Kemp 1976). Nottingham and Salisbury islands had been important as hunting areas but are now seldom visited, and most walruses are landed along the southern coast of Foxe Peninsula (Kemp 1976; Orr and Rebizant 1987). Kemp (1976) reported a similar reduction in the hunting range and harvest by hunters from Kimmirut and Iqaluit. Fall walrus hunts from Iqaluit have apparently been constrained in recent years by the long distance to the hunting area and the lack of boats of suitable size (DFO 2000).

Over the period 1977–78 through 1989–90, the reported landed harvest from this population averaged 231±32 animals per year (simple mean of reported values ± 95%CI , n = 13); from 1990-91 through 2002-03 it averaged 147±30 (n = 13). Sequential five-year averages of the overall harvest from the population for the periods 1977–82, 1982–87, 1987–92, 1992–97, and 1997–2002 showed an abrupt decline in the reported harvest in the most recent period (i.e. mean±95%CI respectively of 172±54, 183±54, 145±31, 129±30, 68±14). Most of this decline was in Nunavut. The effects on these averages of changes in the quality of the harvest data and of uneven reporting could not be assessed. The decline is less but the pattern remains the same when long-term means are substituted for missing values. The Nunavut Wildlife Harvest Study provides additional data on community reported numbers of walrus killed from 1996 to 2001 (Priest and Usher 2004). Assuming a loss rate of 32% (Orr *et al*. 1986), and substituting long-term means for missing values, Canadian hunters may have removed about 247 walruses on average from the population each year since 1989–90. The vulnerability of animals from this population to hunting in Greenland waters is unknown.

Foxe Basin Population

Hunters from Igloolik and Hall Beach (Sanirajak), and visiting sport hunters, kill walruses from the Northern Foxe Basin population year-round, but most animals are landed from June through October (Guinn and Stewart 1986; Figure 7; Table 3). The landed harvest appears to be biased towards males, which are larger and have larger tusks. Only 31 of 98 landed animals examined between 1982 and 1984 were female (Orr *et al*. 1986). From 1977–78 through 1989–90 the landed harvest from this population averaged 218±37 animals per year (simple mean of reported values ± 95%CI, n = 13); from 1990–91 through 2001–02 it averaged 179±42 (n = 12). This difference was due to changes in the recorded takes at Hall Beach, as the means for Igloolik were the same for both periods. The effects on these averages of changes in the quality of the harvest data could not be assessed. Assuming a loss rate of 32% (Orr *et al*. 1986), and substituting long-term means for missing values, hunters may have removed, on average, 276 walruses from the population each year since 1989–90.

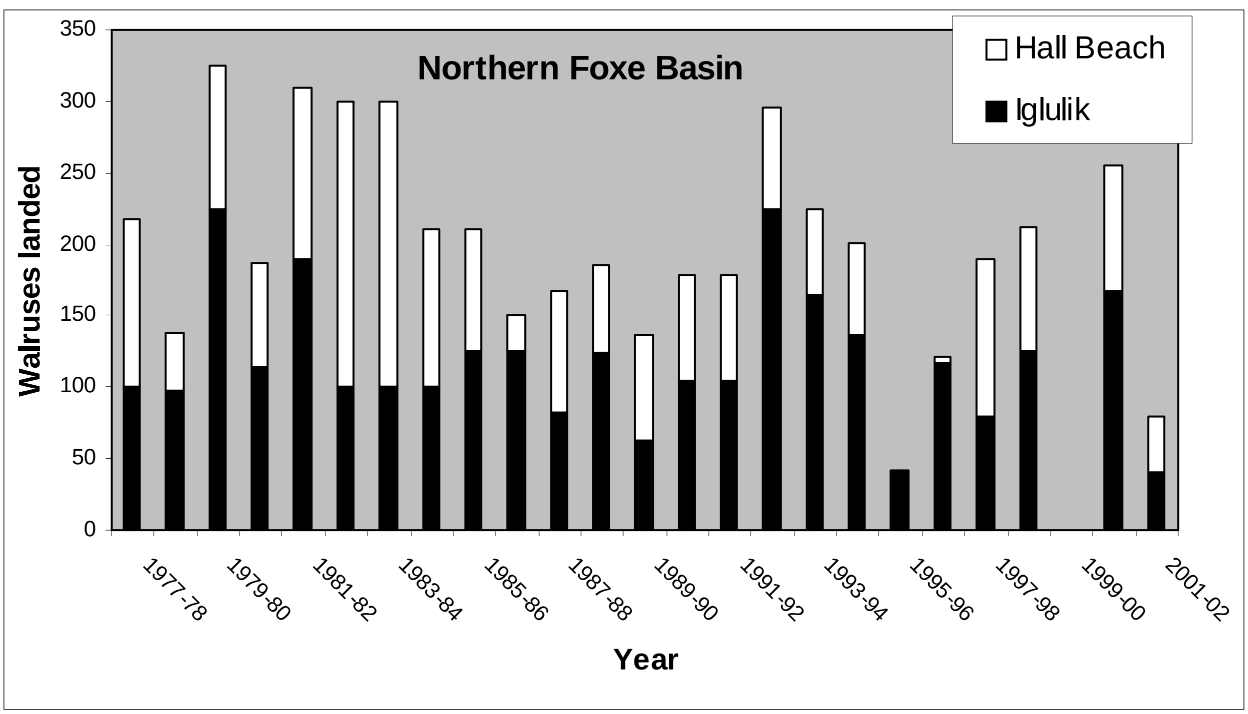

Figure 7. Reported landed harvest from Northern Foxe Basin walrus population, 1977 to 2001. See Table 3 for data.

Table 3. Reported landed harvests from the Northern Foxe Basin walrus population 1977-2001. Data include sport harvests. Sources are listed below.

Community	Quota[1]	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Hall Beach	-	118	41	100	73	120	200	200	110	85	26	86	61	74
Igloolik	-	100	97	225	114	190	100	100	100	125	125	82	124	63
Annual Total		218	138	325	187	310	300	300	210	210	151	168	185	137

Community	Quota	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2001/02
Hall Beach	-	74	74	70	60	64	n/d[2]	4	109	80	n/d	87	40	n/d
Igloolik	-	104	104	225	165	137	42	117	80	125	n/d	168	40	n/d
Annual Total		178	178	295	225	201	42	121	189	205		255	80	

Sources: Nunavut: 1977-78 to 1987-89 (Strong 1989) 1989-90 (DFO 1991), 1990-91 (DFO 1992a), 1991-92 (DFO 1993), 1992-93 (DFO 1994), 1993-94 (DFO 1995), 1994-95 (DFO 1996), 1995-96 (DFO 1997), 1996-97 (DFO 1999), 1997-2002 (DFO unpubl. data).

[1]Unless a community quota is stated the allowable annual harvest is 4 walrus per Inuk. [2]n/d = no data.

Baffin Bay (High Arctic) Population

Hunters from Resolute, Arctic Bay, Pond Inlet, and Grise Fiord kill walruses from the Baffin Bay population (Figure 8; Table 4). Timing of the hunt varies among communities but most animals are taken from May through September (Pattimore 1983a+b, 1985; J. Pattimore, pers. comm. 1986). Hunters from Grise Fiord also land a few walruses in October, November, February and April. There was a sharp decline in the walrus harvest by Resolute ca. 1965-74 (Riewe 1976) and Grise Fiord ca. 1967 (Riewe and Amsden 1977) when snowmobiles were introduced and less meat was needed to feed sled dogs. However, recent re-introduction of dog teams in Grise Fiord has increased interest in hunting walruses (D. Akeeagok cited in Born *et al*. 1995).

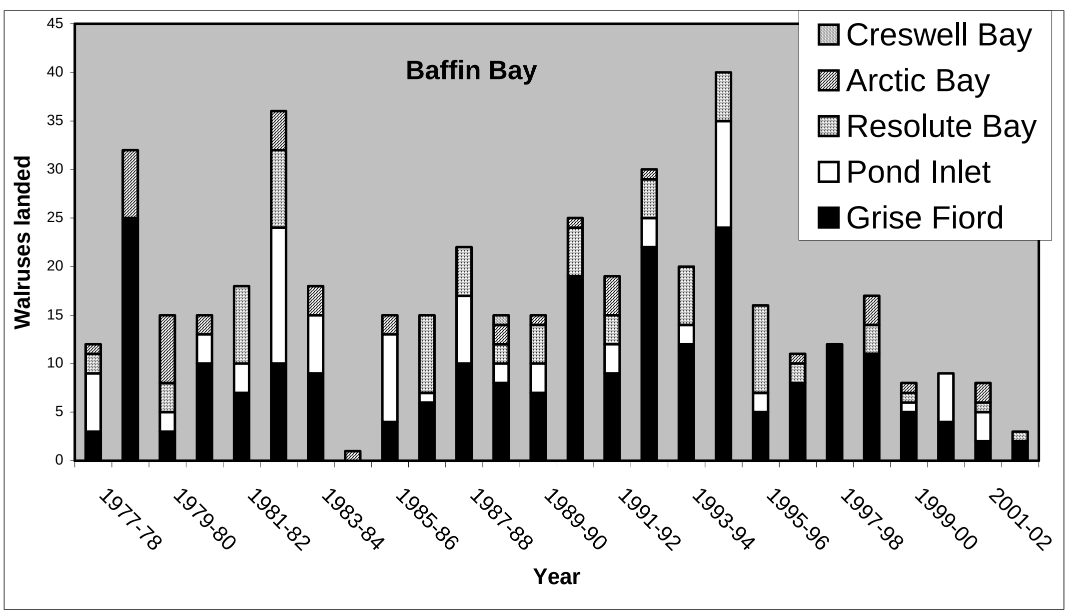

Figure 8. Reported landed harvest from the Baffin Bay (High Arctic) walrus population, 1977 to 2002. See Table 4 for data.

Table 4. Reported Canadian landed harvests from the Baffin Bay (High Arctic) walrus population, 1977–2002. Sources are listed below.

Community	Quota[1]	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Arctic Bay	10	1	7	7	2	0	4	3	1	2	0	0	2	1
Creswell Bay	-	n/d[2]	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	1	0
Grise Fiord	-	3	25	3	10	7	10	9	n/d	4	6	10	8	7
Pond Inlet	-	6	0	2	3	3	14	6	0	9	1	7	2	3
Resolute	-	2	0	3	n/d	8	8	n/d	n/d	n/d	8	5	2	4
Annual Total		12	32	15	15	18	36	18	1	15	15	22	15	15

Community	Quota	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03
Arctic Bay	10	1	4	1	0	0	0	1	0	3	1	0	2	0
Creswell Bay	-	0	0	0	0	0	0	n/d	n/d		0		n/d	
Grise Fiord	-	19	9	22	12	24	5	8	12	11	5	4	2	2
Pond Inlet	-	0	3	3	2	11	2	0	0	0	1	0	n/d	0
Resolute	-	5	3	4	6	5	9	2	0	3	1	0	1	1
Annual Total		25	19	30	20	40	16	11	12	17	8	4	5	3

Sources: Nunavut: 1977-78 to 1987-89 (Strong 1989) 1989-90 (DFO 1991), 1990-91 (DFO 1992a), 1991-92 (DFO 1993), 1992-93 (DFO 1994), 1993-94 (DFO 1995), 1994-95 (DFO 1996), 1995-96 (DFO 1997), 1996-97 (DFO 1999), 1997-2002 (DFO unpubl. data).

[1]Unless a community quota is stated the allowable annual harvest is 4 walrus per Inuk. [2]n/d = no data.

Over the period 1977–78 through 1989–90 the landed harvest from this population averaged 17.6±4.9 animals per year (simple mean of reported values ± 95%CI, n = 13); over the period 1990-91 through 2001-03 it averaged 16.2±5.7 (n = 13). The average annual harvest during the period 1997-2002 (9.2±4.7) was roughly half that of the previous 5-year periods. This pattern did not change when long-term means were substituted for missing values. This change may be real or an artefact of missing data and/or changes in the quality of the harvest data. Assuming a loss rate of 32% (Orr *et al*. 1986), and substituting long-term means for missing values, Canadian hunters may have removed about 24 walruses on average from the population each year since 1989-90.

Hunters in north-west Greenland take many walruses from the Baffin Bay population (Born *et al*. 1995). The estimated annual landed harvest in Avanersuaq is 250 walruses and at Upernavik is about 10, which at a loss rate of 25% may remove about 312 animals from the population each year. The vulnerability of animals that summer in Canadian waters to hunting in north-west Greenland waters is unknown, but may be significant since some of the animals are migratory and hunters in Canada find bullets and harpoon heads from Greenland in their kills and vice versa. On occasion, hunters may also travel between jurisdictions to hunt. On 1 March 2004, an executive order on the protection and hunting of belugas and narwhals came into effect in Greenland (Olsen 2004). Whether the resultant quota restrictions will cause harvesters to shift their focus onto other species such as the walrus is unknown, as are any potential effects on shared walrus populations.

NAMMCO (2006) compiled numbers of walrus killed from 1996-2001 using reports obtained from DFO, Greenland, and the Nunavut Wildlife Harvest Study. They estimated an average of 124 animals was removed each year (110 north water, 4 west

Jones Sound, 8 Penny Strait / Lancaster Sound). NAMMCO (2005) concluded that the levels of harvest were probably unsustainable. They drew a similar conclusion in 1995.

Limited information suggests the current population is small and continues to be hunted at unsustainable levels in the North Water area of Canada and northwest Greenland. Satellite tracking and genetic information suggests that some animals in this population are resident in the Canadian Archipelago (west Jones Sound and Penny Strait / Lancaster Sound) and are not exposed to over-hunting.

Sport hunting

From 1928 through 1994, only Inuit could hunt Atlantic walruses in Canada. Now a limited hunt has been opened for non-resident hunters in order to benefit communities with walrus populations and hunts have been approved annually since 1995 (Table 5; P. Hall, DFO, Winnipeg, pers. comm. 2003). Licences for these hunts require annual approval from the Nunavut Wildlife Management Board (NWMB). Non-resident hunters can take the tusks but must leave the meat in the village. Hunts are primarily arranged through outfitters in Igloolik, Coral Harbour and Hall Beach, but licences have also been approved for Cape Dorset, Salluit, and Qikiqtarjuaq. They are becoming increasingly popular and are advertised widely over the Internet. Most animals are taken from northern Foxe Basin and some from northern Hudson Bay. Sport hunters landed a total of 9.4 ± 1.8 (95%CI) walrus each year on average, over the 5-year period 1997 to 2001.

Table 5. Atlantic walrus sport hunt information (DFO unpubl. data). Landings from sport hunts are included in the annual harvest statistics summaries.

Year	Foxe Basin		Northern Hudson Bay-Davis Strait				Totals	
	Igloolik	Hall Beach	Coral Harbour	Cape Dorset	Salluit	Qikiqtarjuaq		
1995	1 (1:1)[1]	-	-	-	-	-	1	(1:1)
1996	2 (na:2)	-	1 (na:5)	-	0 (na:4)	-	3	(na:11)
1997	4 (na:4)	0 (na:3)	5 (na:8)	-	0 (na:4)	-	9	(na:19)
1998	8 (na:8)	-	0 (na:na)	-	0 (na:4)	-	8	(na:12)
1999	10 (16:14)	1 (3:3)	0 (15:5)	0 (5:5)	0 (8:8)	-	11	(47:35)
2000	6 (16:16)	1 (10:3)	0 (25:5)	0 (5:5)	0 (8:8)	na (20:na)	7	(84:37)
2001	12 (12:12)	0 (10:10)	0 (25:15)	0 (5:5)	0 (8:8)	0 (20:10)	12	(80:60)
Totals	43 (45:57)	2 (23:19)	6 (65:38)	0 (15:15)	0 (24:36)	0 (40:10)	51	(212:175)

[1]Numbers in brackets indicate (licences requested:hunts approved), na = not available.

Table 6. Atlantic walrus in Canada: summary catch statistics for Nunavut for 2003 and 2004.

Year	Nunavut Subsistence Hunt	Nunavut Sport Hunt	Nunavik
2003	242	14	45
2004	93	10	see Tables 1 & 2

Source: L. Cooper, DFO, pers. comm.

Contaminants

Cadmium (Cd) concentrations in the soft tissue of Atlantic walruses from Foxe Basin and northeast Hudson Bay are high relative to other mammals

(0.03-130.9 µg·g –1 wet wt; Outridge *et al*. 1994; Wagemann and Stewart 1994), as are their lead (Pb) concentrations (0.02–0.58 µg·g –1 wet wt; Wagemann and Stewart 1994). Mercury (Hg) levels in the muscle ranged from 0.02 to 1.34 µg·g –1 wet wt (Wagemann and Stewart 1994; Wagemann *et al*. 1995). They were higher on average (0.11 µg·g –1 wet wt, SD 0.13) than those sampled from the Thule area of Greenland in the late 1970s (0.06 µg·g –1 wet wt, SD 0.03; Born *et al*. 1981). The source of cadmium, lead, and mercury in Atlantic walruses in northern Foxe Basin appears to be natural rather than anthropogenic (Outridge *et al*. 1997, 2002). Metal concentrations in the tissue of these walruses paralleled that in the tissue of local clams, with the exception of cadmium (Wagemann and Stewart 1994).

Levels of organochlorine contaminants in walruses are generally low, reflecting the low lipid content of their prey. Because they feed low in the food web, walruses typically have 4–10 times lower concentrations of organochlorine contaminants than belugas from the same area, but a similar pattern of residues (Norstrom and Muir 2000). The highest levels are found in individuals that are thought to eat seals, which accumulate these contaminants in their fat (Muir *et al*. 1995).

The direct and indirect effects of oil on walruses have not been studied. Born *et al*. (1995) believed that several aspects of the species's ecology may make it vulnerable to oil pollution, in particular, its gregariousness, which may spread oil from animal to animal, its preference for coastal areas and loose pack ice where oil may be more likely to accumulate, and its reliance on benthic molluscs which may accumulate petroleum hydrocarbons or succumb to the oil.

The effects of chemical contaminants on walruses are unknown (Wagemann and Stewart 1994; de March *et al*. 1998; Fisk *et al*. (ed.) 2003).

Industrial development

Commercial fisheries that overlap the walrus's range could adversely affect them by competing directly for food, disrupting feeding habitats, and causing disturbance. Scallop dragging has been tried in Cumberland Sound, Hudson Strait, and Ungava Bay, and along the Nunavik coast of Hudson Bay, but these fisheries were uneconomical and are no longer operating (Stewart *et al*. 1993); and walruses feed preferentially on bivalves buried in soft bottoms, not on scallops or on the hard bottoms where they occur. However, the effects of such operations on walrus populations should be assessed if it is proposed to re-open them. Open water trawl or drag fisheries for shrimp, turbot, cod, or other species will not compete directly for food but may disturb walruses or their feeding habitats. Ship noise could displace walruses from their *uglit* and interfere with their communication (Salter 1979a; Born *et al*. 1995; Stewart 2002).

Threats posed to walruses in Canadian waters by hydrocarbon and mineral development and exploration are low at present. Indeed, there is less hydrocarbon exploration going on in the high Arctic today than there was in the 1970s and 1980s. (D.G. Wright, DFO Winnipeg, pers. comm. 2002) Both of Canada's high-Arctic metal mines closed in September 2002 (M. Wheatley, pers. comm. 2003). This will reduce the effects of ice breaking activities on walruses entering Lancaster Sound in the spring. It will also reduce seismic and noise disturbances related to mining activities and the risk of hydrocarbon and heavy metal pollution. However, future developments could reverse this trend. For example, current plans for a diamond mine west of James Bay could increase levels of shipping and other disturbances; other effects, including alteration of the flows and water quality in rivers, could affect marine habitats. The recovery of walrus stocks in southern Hudson Bay and James Bay could be affected.

Industrial developments inland, including dams that would alter seasonal flows in rivers, might possibly affect marine habitats near the mouths of affected rivers. However, there are many hydro dams in the world, and the cumulative evidence that altered flows have had significant effects in the marine environment is not large.

Disturbance from noise or ecotourism

Machine noise, particularly from aircraft, disturbs walruses and can stampede them into the water, causing significant calf mortality and spontaneous abortion of foetuses (Salter 1979a; Born *et al*. 1995). The response depends upon many factors related to the characteristics of the aircraft and its flight, environmental conditions, and the demography of the affected walruses. There is concern that frequent aerial tourist traffic may disturb walruses hauled out along the Ontario coast of Hudson Bay (C. Chenier, DNR Cochrane, pers. comm. 2003). In Russia, aircraft are prohibited within 50 km of most walrus haul-out sites, except by special permit (U.S. Fish and Wildlife Service 1993 cited in Born *et al*. 1995).

The reactions of walruses to vessel noise vary depending upon their previous experiences (Born *et al*. 1995). Animals from hunted populations tend to be skittish when approached by boats but when asleep can sometimes be approached within 10-20 m. Ice breaking activities cause Pacific walruses to enter the water: females and calves when the ship is within 500–1000 m and males when it is within 100–300 m. They move 20–25 km away from the disturbance if it continues, but will return after it stops. Intensive vessel traffic may have a negative effect on walrus distributions. In Russia, uglit are protected by regulations that limit vessel access, usually within 20 km of the site (U.S. Fish and Wildlife Service 1993 cited in Born *et al*. 1995).

International tours bring visitors from the United Kingdom to view walruses at *uglit* on Southampton, Bencas, Coats, and Walrus islands in July and August (http:/www.windowsonthewild.com/wow/Walrus/walrus.htm). The extent and effects of walrus ecotourism has not been documented but there is concern among Inuit and scientists that these disturbances could drive herds further into the pack ice or away from their traditional uglit, or cause stampedes (Stewart 2002; Dueck 2003; C. Chenier, DNR Cochrane, pers. comm. 2003).

The effects of pulsed noise from seismic exploration on walruses are unknown, as is the ability of walrus to habituate to non-threatening noises. Underwater noise might disrupt the transmission of songs during the breeding season.

Climate change

The direct effects of climatic warming or cooling on walruses are likely limited and not necessarily negative. Sea ice cover does not appear to be a critical determinant of walrus populations, since various areas of their habitat are seasonally ice-free (R. Stewart, DFO Winnipeg, pers. comm. 2004) and their pristine distribution extended far south of its present limits. Born *et al*. (2003) hypothesized that a decrease in the extent and duration of Arctic sea ice in response to warming might increase food availability for walruses, by increasing bivalve production and improving access to feeding areas in shallow inshore waters. If sea ice were not available walruses would be more likely to haul out on land. Behavioural and physiological responses to changes in air temperature suggest that Pacific walrus calves can maintain their body temperature at an air temperature of 18°C in still air and shade or under equivalent conditions (Fay and Ray 1968; Ray and Fay 1968). Above this temperature they withdraw into the water to avoid over heating. Air temperatures at or above this level for an extended period might disrupt normal feeding, moulting, and calving schedules.

NAMMCO (2006) noted that hunting pressure on walruses will likely increase as the amount and duration of ice cover in Arctic regions declines. Predation by killer whales and polar bears may also increase in the absence of ice as walrus are forced to use terrestrial sites. Killer whales may also remain in the Arctic for longer periods if there is less ice to entrap or restrict their movements.

The fossil record suggests that between 9000 and 1000 y BP, when walrus occupied areas along the east coast of Canada, the summer surface water temperatures of the area may have ranged from 12 to 15°C (Miller 1997). Whether these animals summered in these relatively warm waters or moved north into cooler waters is unknown.

The indirect effects of climate change may pose a greater threat to walruses than the change itself. In the event of warming, human populations in the north might increase and expand into hitherto unpopulated areas; in the event of cooling, walruses may be forced southward closer to existing communities. In either case, a reduction in suitable habitat is likely and they would become more vulnerable to hunting and disturbance.

SPECIAL SIGNIFICANCE OF THE SPECIES

Walruses are the only living representatives of the Family Odobenidae and an important link in the Arctic food chain between benthic invertebrates and humans. Their importance to Inuit is substantial in both cultural and economic terms. Families spend the summer at traditional hunting camps and in this way help to maintain the Inuk way of life. These cultural values are important but difficult to measure in economic terms. Using various methods, Anderson and Garlich-Miller (1994) estimated the net economic value of products from the 1992 summer walrus hunt to Igloolik and Hall Beach at between $160,000 and $659,000. The lower figure does not consider the effects on Inuit health of substituting foods imported from the south for nutritious walrus meat.

In the past, Inuit used ivory to construct harpoons, to make toggles and handles, to shoe sledges, and to make protective edges on kayak paddles. The thick skin was used to make summer tents and rope. Now, walruses are hunted mainly for their ivory tusks, which are either sold or carved for sale, and for their meat, which is eaten or fed to dogs (Freeman 1964; Schwartz 1976; Anderson and Garlich-Miller 1994; Born *et al*. 1995). They are killed and eaten on a seasonal basis depending upon availability, which varies among communities (Fleming and Newton 2003). The ivory tusks and the baculum are the property of the hunter who shot the walrus but the meat is typically shared in the community. It may be boiled and eaten fresh, frozen for winter consumption, or aerobically fermented to make *igunak* (Orr *et al*. 1986; Anderson and Garlich-Miller 1994). *Igunak* is made by sewing the meat and blubber of walruses landed in summer into a walrus skin bag, burying it on the beach, and then recovering and eating the contents in the spring after they have fermented and aged (R.E.A. Stewart, DFO Winnipeg, pers. comm. 2003). Care must be taken to ensure that the meat does not ferment anaerobically, for example in sealed plastic bags, to avoid botulism (Proulx *et al*. 1997). Hall Beach has traded some *igunak* to other communities and has asked to be allowed to sell it (Cosens *et al*. 1993). Walruses killed too late in the fall to be made into igunak are frozen and eaten during the winter. Inuit consider molluscs in walrus stomachs to be a delicacy (Dunbar 1949; Reeves 1978, 1995).

Indians along the coasts of Hudson Bay and James Bay occasionally hunted walrus in the past to feed dog teams, and made rope from the tough hide (Fleming and Newton 2003). They only ate walrus when there was no other food.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Regulations on the hunting of walruses in Canada, and on the international trade in walrus parts, afford very limited protection for Atlantic walrus populations in Canada.

Canadian harvest quotas and protection

Walrus hunting in Nunavut is co-managed by the Nunavut Wildlife Management Board (NWMB), which is charged under Bill C-133 with making all decisions about wildlife management in Nunavut. The board consists of four Inuit and four Government representatives, plus a Chairperson. Canada's Department of Fisheries and Oceans (DFO) advises the NWMB and hunting communities on sustainable hunting levels and they in turn use this information to manage community hunts. Regional Wildlife Organizations and the local Hunters and Trappers Organizations also play a role in the management of walruses. While the NWMB is the main instrument of wildlife management and the main regulator of access to wildlife in the Nunavut Settlement Area (NSA), government retains ultimate responsibility for wildlife management. Hunting regulations are implemented under the Fisheries Act and the Marine Mammal

Protection Regulations by DFO, which manages walrus in other jurisdictions in cooperation with other agencies.

Inuk and Indian natives of Canada can kill up to four walruses per year without a licence, except where community quotas limit annual catches. Non-natives require a licence under the Marine Mammal Regulations or Aboriginal Communal Fishing Licence Regulation to hunt walruses (DFO 2000; Hall 2003). Sport hunts are managed by limiting the number of licences approved annually. Since 1980, Coral Harbour has had an annual harvest quota of 60 walruses, Sanikiluaq 10, Arctic Bay 10, and Clyde River 20 (Strong 1989). In the other communities, it is the number of Inuit rather than the number of walruses that limits the harvest (Stewart 2002). This latter system of management is clearly contrary to sound population management practices, as it does not consider the ability of the population to sustain the potential kill.

In 2001, there were 1225 people of Aboriginal descent living in Igloolik and 585 in Hall Beach (Statistics Canada 2001 community profiles). Assuming that they were all of Inuk descent, and because the age and sex of an Inuk who is entitled to kill walruses is not defined, each of these people was entitled to land 4 walruses. If non-hunters assigned their harvest rights to a hunter, Inuk residents of the two communities could legally have landed 7240 walruses in 2001, perhaps the entire walrus population of Foxe Basin. The Nunavut Wildlife Management Board is considering new ways of managing the walrus hunt.

Within Canada, trade in edible walrus parts is prohibited except among Indians and Inuit in the Northwest Territories, Nunavut, Yukon Territory, Quebec and Newfoundland (Marine Mammal Regulations SOR/93-56). Beneficiaries of the *Western Arctic* (*Inuvialuit*) *Claims Act* and the *James Bay and Northern Quebec Native Land Claims Settlement Act* must conduct any trade in walrus parts in accordance with the agreement in which the beneficiary is enrolled. The regulations prohibit disturbing, killing ineffectually, hunting without equipment to retrieve, waste of edible parts, and abandoning a killed walrus without making a reasonable effort to retrieve it.

Live capture and tagging are permitted only with a licence. In Nunavut, the NWMB must approve such requests. The Board is currently developing a Live Capture Policy, in consultation with Nunavut hunters and their local and regional organizations (J. Galipeau, NWMB, pers. comm. 2004).

A Marine Mammal Transportation Licence from DFO is required to transport walrus parts within Canada, with the exception of Indians or Inuit who land the walrus in one jurisdiction and are returning to their home in another jurisdiction (Marine Mammal Regulations SOR/93-56).

International trade and cooperation

The Atlantic walrus is listed in Appendix III of the Convention on International Trade in Endangered Species (CITES) (Richard and Campbell 1988; Hall 2003).

Anyone wishing to export walrus parts or derivatives from Canada must obtain an export permit from the Canadian CITES administration. A total of 181 CITES export permits were issued from 1992 to 2001 (Hall 2003). Canada does not consider that additional protective measures are warranted for Atlantic walrus under CITES at the current level of international trade.

There is no formal management agreement between Canada and Greenland in the management of shared stocks of Atlantic walrus. An independent group of international experts on walrus from countries within the species' range, The Walrus International Technical and Scientific (WITS) Committee, has convened several workshops to promote international cooperation among walrus managers and the exchange of scientific information (Stewart *et al*. (ed.) 1993). This group also includes walrus hunters.

Status designations

The "Northwest Atlantic" or "maritime" population of Atlantic walruses in Canada was considered by COSEWIC to have been extirpated (Reeves 1978; Richard and Campbell 1988). Other Canadian populations of the subspecies were designated as Not at Risk in 1987.

TECHNICAL SUMMARY

Odobenus rosmarus rosmarus
Atlantic walrus (English) Morse de l'Atlantique (French) Aivik (Inuktitut)
Range of Occurrence in Canada: Maritime provinces and Hudson Bay north to central and eastern high Arctic

Extent and Area Information	
• *Extent of occurrence (EO)(km²)*	~750,000 km^2
• *Specify trend in EO*	Depends on the time frame but perhaps stable
• *Are there extreme fluctuations in EO?*	No
• *Area of occupancy (AO) (km²)*	Unknown
• *Specify trend in AO*	Depends on the time frame but perhaps stable
• *Are there extreme fluctuations in AO?*	No
• *Number of known or inferred current locations*	Many. Walruses are widespread and some are migratory.
• *Specify trend in #*	Unknown
• *Are there extreme fluctuations in number of locations?*	No
• *Specify trend in area, extent or quality of habitat*	Depends on the time frame but perhaps stable
Population Information	
• *Generation time [(age at first reproduction + age at last reproduction) / 2]*	21 y
• *Number of mature individuals*	No complete comprehensive population survey has ever been undertaken. The number of mature animals is unknown.
• *Total population trend:*	Unknown
• *% decline over the last/next 10 years or 3 generations.*	Unknown
• *Are there extreme fluctuations in number of mature individuals?*	No
• *Is the total population severely fragmented?*	No
• *Specify trend in number of populations*	there is a single overall population
• *Are there extreme fluctuations in number of populations?*	No
• *List populations with number of mature individuals in each:*	
Threats (actual or imminent threats to populations or habitats)	
• **Hunting**: The ability to sustain current removal rates is uncertain. Some portion of the population is vulnerable to hunting in Greenland waters. • **Disturbance**: Walruses are sensitive to noise and habitat disturbances. Human activities on or near traditional haulout sites (*uglit*) can stampede herds causing mortality. Repeated disturbances can cause habitat abandonment.	
Rescue Effect (immigration from an outside source)	
• *Status of outside population(s)?*	Central West Greenland—declining;
• *Is immigration known or possible?*	Immigration is possible but may be very slow.
• *Would immigrants be adapted to survive in Canada?*	Yes

• *Is there sufficient habitat for immigrants in Canada?*	Yes. But the reason walruses disappeared from an area may determine whether it is reoccupied.
• *Is rescue from outside populations likely?*	Unknown.
Quantitative Analysis	Not available
Current Status **COSEWIC:** Eastern Arctic Population: Not at Risk, 1987; Northwest Atlantic Population: Extirpated 1987, reconfirmed in 2000 Combined designation for all Atlantic walrus in Canada: Special Concern, 2006	

Status and Reasons for Designation

Status: Special Concern	**Alpha-numeric code**: Not applicable

Reasons for Designation:

Five populations ranging from Nova Scotia to the high Arctic are recognized for management purposes based on geographical distributions, genetics and lead isotope data. Some of the populations appear to be at greater risk than others due to over-hunting, and may be threatened. However, knowledge about population structure is insufficient to assess them separately.

The Nova Scotia-Newfoundland-Gulf of St Lawrence population was hunted to extirpation by the late 18th century. Sporadic recent sightings of individuals and small groups in the Gulf of St Lawrence and off Nova Scotia are not considered evidence of re-establishment.

The South and East Hudson Bay population is believed to number in the low hundreds, although population size and structure are poorly known. Observations from the late 1930s to the present suggest that numbers declined significantly, but the rate of decline cannot be quantified and it is not known whether the decline is continuing. The small population size suggests it may be vulnerable to disturbances and small increases in hunting effort.

The total size of the Northern Hudson Bay-Davis Strait population could be as small as 4000-6000 individuals. Its ability to sustain minimum current removals is questionable. Some portion of this population is hunted in Greenland waters.

The Foxe Basin population was estimated to be 5500 in 1989. It is unknown if current exploitation rates are sustainable.

Hunting is believed to have reduced the Baffin Bay (High Arctic) population to only a few percent of the number present in 1900. Limited information suggests the current population is small and that a portion of it continues to be hunted at unsustainable levels in the North Water area of Canada and northwest Greenland. However, satellite tracking and genetic information suggests that some animals in this population are resident in the Canadian Archipelago (west Jones Sound and Penny Strait / Lancaster Sound) and are not exposed to over-hunting.

Better information is needed on population sizes and composition, seasonal movements, vital rates, and hunting mortality. The biggest threat is over-hunting, particularly on populations that inhabit the southern and northern ends of the species' current range. The species is near to qualifying for threatened status and requires an effective plan to manage hunting. No Management Plans are currently in place for the species. Although quotas have been set in few communities, it is not known if they are adequate to prevent over-hunting.

Applicability of Criteria

Criterion A: (Declining Total Population): Not applicable.

Criterion B: (Small Distribution, and Decline or Fluctuation): Not applicable.

Criterion C: (Small Total Population Size and Decline): Not applicable.

Criterion D: (Very Small Population or Restricted Distribution): Not applicable.

Criterion E: (Quantitative Analysis): Not applicable.

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D. Bruce Stewart, M.Sc., is a zoologist with training in ecology and physiology. From 1977–86, he planned and conducted baseline research on aquatic resources throughout the NWT and Nunavut for the Northern Land Use Information Series (NLUIS) Mapping Program. He has worked with Inuit on the land to study anadromous Arctic charr populations and in the communities to compile traditional knowledge of the distribution and biology of narwhals and belugas in the Canadian eastern Arctic. As Head of Arctic Biological Consultants, Bruce has provided expert advice on aquatic resources, parks initiatives, and resource developments to government, industry, and native organizations. This work has included preparation of a comprehensive fishery development strategy for the Canadian Beaufort Sea/Amundsen Gulf area for the Inuvialuit; reviews of information on fish populations and harvests in the Nunavut, Sahtu Dene and Metis, Gwich'in, North Slave, South Slave and Deh Cho settlement areas for the Department of Fisheries and Oceans (DFO); and studies that recommend areas for consideration as new National Marine Parks in Hudson Bay and James Bay. In 1991–93, the Ministers of the Environment for Canada and Manitoba appointed Bruce to a six-member panel charged with conducting a public review of the potential environmental effects of the $5.7 billion Conawapa hydroelectric development proposed by Manitoba Hydro. He has also assessed the potential impacts of the Nanisivik Mine and the Diavik and Jericho diamond projects on the aquatic environment, and recently prepared an overview of the Hudson Bay marine ecosystem for DFO, and the narwhal update for COSEWIC. Bruce has written over 70 scientific publications and reports, published popular articles and photographs in Canadian Geographic and The Beaver, and lectured on the Arctic to a wide variety of audiences.

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