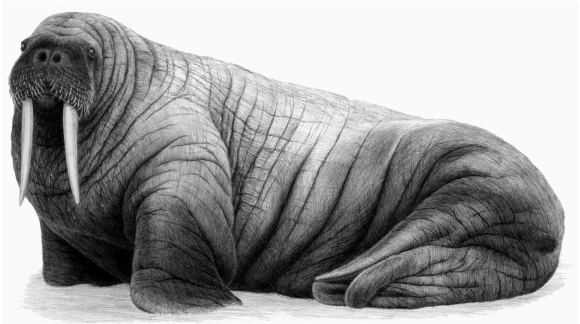
Atlantic Walrus



Background

Atlantic walrus (Odobenus rosmarus rosmarus) have been divided into two populations, one east of Greenland and one in western Greenland and Canada. They occur throughout the eastern Canadian Arctic. Four stocks have been identified in Canada (Fig. 1): South and East Hudson Bay (SEHB), Hudson Bay-Davis Strait (HBDS), Foxe Basin (FB), and Baffin Bay (BB). The Maritime stock that once extended south to Nova Scotia is considered to have been extirpated.

In Canada, the main period of commercial harvesting started in the late 1800s and continued well into the 1900s (Reeves 1978). Commercial hunting of walrus was banned in 1928 by the Walrus Protection Regulations (Richard and Campbell 1988).

Walrus hunting is subject to the terms of the Nunavut Land Claims Agreement and is legislated under the Marine Mammal Regulations of the Fisheries Act. Currently an Indian or Inuk can take, without licence, 4 walrus per year unless there is a community quota (Section 26). Current community quotas are: Coral Harbour - 60; Sanikiluaq - 10; Arctic Bay - 10; and Clyde River - 20. Non-aboriginals may take walrus only when licenced under Marine Mammals Regulations or Aboriginal Communal Fishing Licence Regulations. Sport hunts for walrus are becoming increasingly popular. Walrus are not in any COSEWIC category. Domestic transport of walrus parts from Nunavut and among provinces is permitted under DFO permit, and international trade is permitted under CITES (walrus are listed on CITES Appendix III). The Nunavut Wildlife Management Board is currently reviewing the quota system and considering new ways of managing the walrus hunt. This assessment is being done in support of these management discussions.

Summary

- Between 1997 and 2001, hunters reported the average annual kill (landed) for each stock as: South and East Hudson Bay – 4/year; Hudson Bay/Davis Strait – 48/year; Foxe Basin – 180/year; Baffin Bay – 9/year. Records are incomplete, and are not corrected for hunting losses. Sequential five year harvest averages for all stocks have declined over the last 20 years. Hunters attribute this to a decreased use of dog teams and/or other factors.
- The few existing studies of struck-and-lost rates estimate rates of 30-32%. Struck-and-lost rates likely vary with season, weather, location, hunter experience, and animal behaviour. Hunters believe loss rates are low (~5%).
- Scientific evidence for stock identity is based on distribution and genetic and lead isotope data; four distinct stocks have been identified: South and East Hudson Bay (SEHB), Hudson Bay-Davis Strait (HBDS), Foxe Basin (FB), and Baffin Bay (BB). These four stocks may be complexes.
- There are no complete or modern estimates of numbers for any walrus stock in Nunavut; index estimates available for some stocks have broad confidence intervals and cannot be corrected for submerged animals or haulout dynamics; only very large changes in population size would be detectable; current estimates of stock size are: South and East Hudson Bay - a few hundreds; Hudson Bay/Davis Strait stock complex (includes northern Hudson Bay, Hudson Strait, Davis Strait, and west Greenland) -

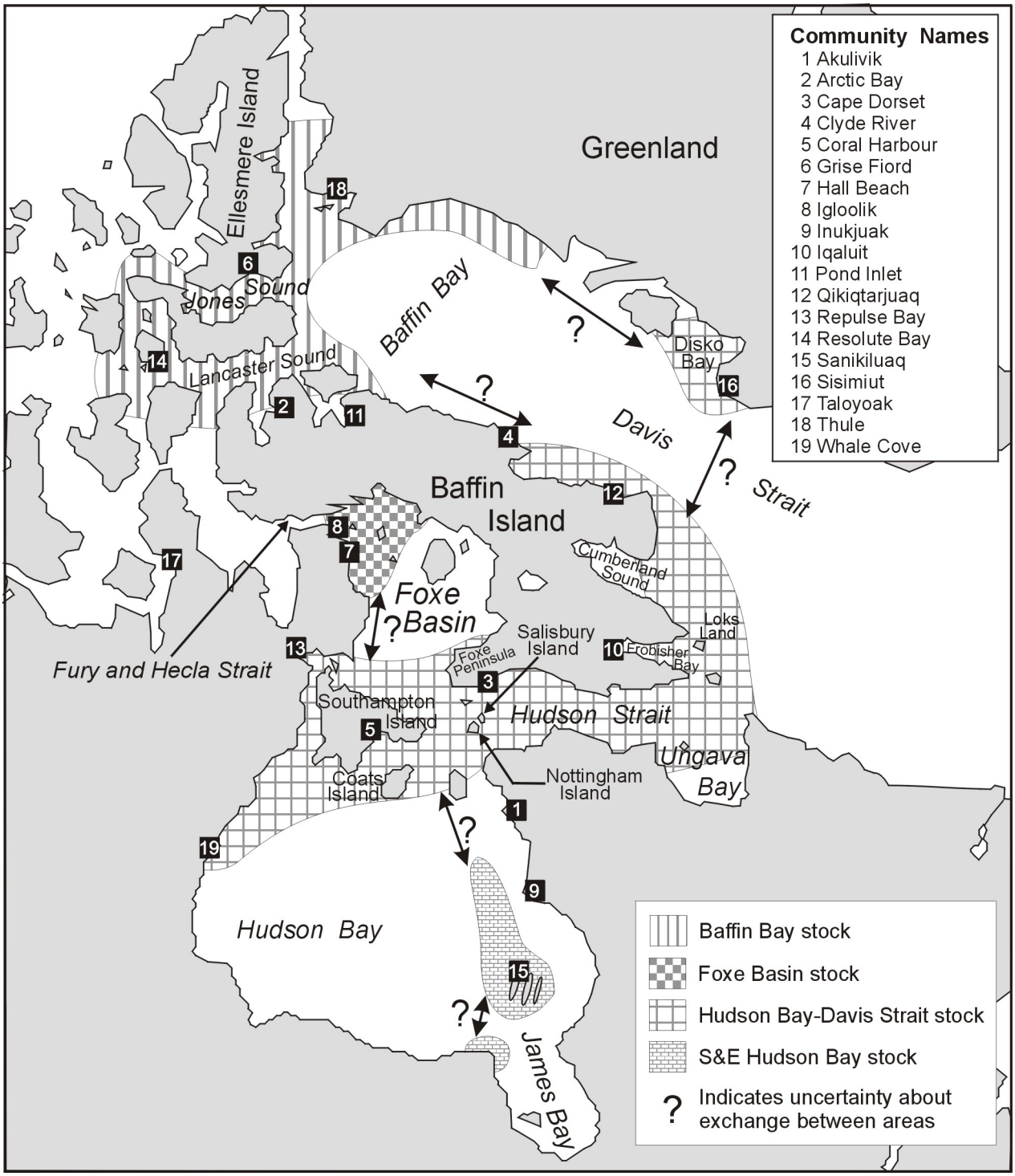


Figure 1. Map of the range and distribution of Atlantic Walrus stocks in eastern Canadian waters.

5500; Foxe Basin - 5500; Baffin Bay - 1,700-2,000.

- Reviews of walrus distribution indicate that walrus have disappeared from many areas or that the range of walrus in many areas has been reduced since the 1800s.
- Hunters in Coral Harbour and Cape Dorset report that walrus are now seen in greater numbers than in the past and are closer to their

communities than in the past; in Sanikiluaq, hunters report that there are fewer walrus near the community and neighboring islands; in Foxe Basin hunters believe that walrus numbers are unchanged, but that a change in distribution has occurred due to changes in ice distribution; hunters have not observed any change in abundance or distribution of walrus in Frobisher Bay.

- Using the lower boundary for minimum counts and estimated replacement yield of 2-5% (used for cetaceans with similar reproduction patterns), estimated sustainable yields are: Foxe Basin, 110-275; for the segment of the Hudson Bay-Davis Strait stock that summers near Coats Island, approx. 30-70 (based on partial counts); for haul-outs in Lancaster and Jones Sound, 14-15.
- Sources of uncertainty regarding stock status include stock identity, estimates of stock size and trend, rates of natural mortality and reproduction, age of maturity, and the relationship of walrus to environmental variables, incomplete harvest statistics and struck-and-lost rates, and existing data that are limited in geographic and temporal scope.
- Uncertainties necessitate caution in management decisions; management based on local aggregations rather than larger stock units will reduce the risk of overexploitation which is inherent in assuming that stocks cover large geographic areas.

Species Biology

The walrus (aivik, *Inikutitut name*) is Canada's largest pinniped. Both males and females are about 125 cm long at birth but adult males are significantly longer (315 cm) than adult females (277 cm) (Garlich-Miller and Stewart 1998). In both sexes, the upper canine teeth develop into long tusks that start to appear when the animal is about 2 years old. In adult males from Foxe Basin, tusks averaged about 28.5 cm in length with a circumference at the base of about 16.7 cm. Tusks of females may be as long (~28.1 cm) but are more slender, with a base circumference around 13.2 cm (Orr *et al.* 1986).

All walrus routinely haul-out onto ice or land in all seasons and show a high degree of fidelity to haulout sites and feeding areas. It is thought that females and their young return to certain sites more faithfully than do adult males. Although some hauled out groups may contain animals of all ages and both sexes, walrus tend to segregate by age and sex most of the year. Walrus distribution is thought to be influenced not only by the availability of haul-out sites, but also shallow water for feeding on bivalve molluscs, their main prey, and other invertebrates (Fisher and Stewart 1997). Most feeding is believed to take place in water less than 100m deep although walrus can dive deeper. Some walrus also eat seals, a behaviour that may be more common when they do not have access to shallow water areas. Hunters distinguish seal-eating walrus by their yellow tusks.

The mating system of walrus involves males competing for and defending access to females for mating for periods of up to five days. The mating season is in January to April. Implantation in the uterus appears to occur in late June to early July and the calf is born the following May-June. Age of first ovulation varies among populations. For example, in Foxe Basin it occurs at 5-7 years of age (Garlich-Miller and Stewart 1999) but in Greenland, it occurs at 6-10 years of age (Born et al.

1995). The calving interval is generally 3 years. The overall pregnancy rate among mature females is 33-35% (Mansfield 1959, Garlich-Miller and Stewart 1999). Twin births occur but are uncommon (Fay et al. 1991).

The Hunt

Annual harvests are reported for the periods 1 April - 31 March (DFO 1991, 1992a, 1992b, 1993, 1994, 1995, 1996, 1997, 1999, Itorcheak, personal communication), incorporating long-term or five-year averages for missing data.

For most areas and seasons, there are no estimates of struck-and-lost rates. A loss rate of 30% was applied to the eastern Canadian Arctic in the 1950s, as an approximate estimate (Mansfield 1966). Hunters believe loss rates are low (~5%).

Table 1. Summary of walrus harvests in the eastern Canadian Arctic, including sport hunts. For the periods described, data are for April of the given year to March of the following year. Numbers for the periods 1977-87 and 1988-96 are annual averages (totals for the period in brackets). Annual totals are given for the years 1997 to 2001. Harvest data are based on data available to Fisheries and Oceans Canada, and are not corrected for lost or unreported kills. n/d means no data are available for that year.

Stock	1977-1987[1] Yearly mean (total for period)	1988-1996[2] Yearly mean (total for period)	1997[3] Total	1998[3] Total	1999[3] Total	2000[3] Total	2001[3] Total
South-East Hudson Bay[4]	5 (41)	5 (20)	4	n/d	1	0	8
Hudson Bay - Davis Strait[5]	170 (1868)[8]	180 (1620)[9]	27	57	40	60	53
Foxe Basin[6]	229 (2517)	174 (1562)	189	205	n/d	248	80
Baffin Bay[7]	18 (199)	21 (191)	12	17	8	2	5

1. Data compiled by DFO from various sources, including DFO, GNWT, RCMP and Hudson Bay records of marine mammal harvests; values are not corrected for lost or unreported harvests.
2. Data compiled from DFO Annual Harvest Studies (DFO 1991, 1992a, 1992b, 1993, 1994, 1995, 1996, 1997, 1999). Values are not corrected for lost or unreported harvests but, in some cases, potential reporting errors were estimated as a percentage of the reported harvest.
3. The 1997-2001 harvest records are annual totals reported by community Hunters and Trappers Organizations (HTOs), and are not corrected for hunting losses.
4. South-East Hudson Bay stock is thought to supply walrus hunters in the Nunavut community of Sanikiluaq, and those Nunavik (Northern Quebec) communities adjacent to the Hudson Bay Arc. Harvest information for Sanikiluaq is not available for 2001, whereas Nunavik harvest information is currently only available from Inukjuak in 2001.
5. Hudson Bay-Davis Strait stock is thought to supply walrus hunters from Whale Cove on Hudson Bay, through Hudson Strait to Clyde River on eastern Baffin Island and Killiniq in Nunavik (Northern Quebec). Nunavik harvest information is currently available only for the 1988-1996 and the 2001 reporting years.
6. Foxe Basin stock supplies walrus hunters in the Nunavut communities of Hall Beach, Igloolik, and possibly hunters from Gjoa Haven and Taloyoak.
7. Baffin Bay stock is thought to supply walrus hunters in the Nunavut communities of Arctic Bay, Pond Inlet, Grise Fiord, Resolute Bay, Gjoa Haven, and Taloyoak; the latter two communities are included here but may also be hunting from the Foxe Basin stock.
8. Does not include Nunavik.
9. Includes Nunavik.

South and East Hudson Bay – This stock is thought to supply the Nunavut community of Sanikiluaq. There is some uncertainty about which Nunavik (Northern Quebec) communities it supplies, however it may be reasonable to assign catches of Inukjuak and Umiujaq hunters to this stock. Richard and Campbell (1988) estimated that hunters from Sanikiluaq and Inukjuak

landed a combined average of 13 walrus/year between 1972 and 1985. From 1981/82 to 1987/88, Sanikiluaq hunters averaged 5 walrus/year, however there are no records for Inukjuak and Umiujaq hunts during this interval. Sanikiluaq hunters landed an average of 5 walrus/year between 1988/89 and 1991/92, and Nunavik hunters landed about 6 walrus/year. There are no records for Sanikiluaq walrus hunts between 1992/93 and 1996/97 (DFO 1995 to 1999), but Nunavik hunters landed about 8 walrus/year during this interval. In the 1997-2001 interval, the catch from only two years was reported from Sanikiluaq, yielding an average harvest of 1 walrus/year (Itorcheak, personal communication). Nunavik catches during this interval are known only for 2001, in which Inukjuak hunters landed 8 walrus (Doidge, personal communication).

Hudson Bay-Davis Strait – More than 20 communities in Canada may remove walrus from this stock, from Whale Cove on Hudson Bay, through Hudson Strait, to Clyde River on eastern Baffin Island and Killiniq in northern Quebec. Reported catches for these settlements averaged about 320 walrus/year from 1972 to 1985 (Richard and Campbell 1988). Nunavut communities landed an average of about 215 walrus/year between 1972-85 (Richard and Campbell 1988), about 133 walrus/year between 1988/89 and 1996/97 (DFO 1995, 1996, 1997, 1999), and about 42 walrus/year for 1997/98 to 2001/02 (Itorcheak, personal communication), although the most recent value may increase as the balance of harvest information from 2001 is made available. Nunavik communities landed an average of about 105 walrus/year between 1972-85 (Richard and Campbell 1988), about 65 walrus/year between 1988/89 and 1996/97 (Brooke 1997), and 53 walrus in the 2000/2001 reporting interval (Doidge, personal communication). In central west Greenland, harvests average 60-70 walrus/year., corrected for a 30% loss rate (Born *et al.* 1995). NAMMCO (1995) used 40/year, uncorrected for losses.

Foxe Basin – This stock supplies the communities of Hall Beach and Igloolik. The average reported catch from the Foxe Basin stock was 206 walrus from 1972 to 1985 (Richard and Campbell 1988). Between 1988/89 and 1992/93 an average of 194 walrus were reported landed (DFO 1991, 1993). This is about half of the reported catch for the 1950's (Loughrey 1959) but is thought to be an underestimate (Anderson and Garlich-Miller 1994). Anderson and Garlich-Miller (1994) quoted hunters who estimated the number landed annually at 180-250, and used 215 in their economic calculations. DFO harvest statistics report an average catch of about 148 walrus/year for 1993/94 to 1996/97 (DFO 1995, 1996, 1997, 1999, Itorcheak, personal communication). Although there were no data for Hall Beach in 2 of those years and averages were used, the estimate is similar to that made by hunters (Anderson and Garlich-Miller 1994). Harvests between 1997/98 and 2000/01 increased from 189 to 248 walrus (there are no data for 1999), but only 80 animals were reported in 2001/02. The average harvest for this 5-year period was 181 walrus/year (Itorcheak, personal communication). Orr *et al.* (1986) estimated a loss rate of 32% in this area during summer hunts, but these two communities also hunt walrus in winter when loss rates may be negligible.

Baffin Bay Stock – This stock supplies the communities of Arctic Bay, Pond Inlet, Grise Fiord, Resolute Bay and the outpost camp at Creswell Bay. Reported average catches in these four communities and Creswell Bay were 23 walrus/year from 1972 to 1985 (Richard and Campbell 1988). Between 1988/89 and 1996/97 hunters landed an average of about 21 walrus/year (DFO 1991, 1992a, 1992b, 1993, 1994, 1995, 1996, 1997, 1999, Itorcheak, personal communication). The average reported catch between 1997/98 to 2001/02 was only 8 walrus/year (Itorcheak, personal communication), however information for one community is lacking.

Resource User Perspective

In Coral Harbour, hunters report that walrus are now seen in greater numbers much closer to the community and are seen more frequently throughout the year in the Southampton Island area. In the past the walrus hunt in Coral Harbour was focused on the Coats Island and Walrus Island area during August and September using 2-3 large boats. The walrus hunts for the last ten years have harvested walrus closer to Coral Harbour (within 40-50 kilometres). Currently in Coral Harbour, hunters rarely take even half the allotted quota. Hunters believe that the walrus harvest has been reduced because of a reduction in the demand for walrus meat due to fewer dog teams and not from a decline in the abundance of walrus. However, hunting effort for human need is thought not to have changed dramatically in recent years. Youth are being initiated to the hunt and trained in hunting techniques through local programs.

In Sanikiluaq hunters report that, in the past, there were many walrus near the community and neighboring islands. Now there are very few walrus seen in the open water season near Sanikiluaq, and they are very rarely seen in winter or fall. Walrus hunts are now conducted near the Sleeper Islands during September and there is usually only one hunt a year.

Hunters from Cape Dorset report that over the last thirty years walrus numbers near the community have increased. The majority of the walrus are harvested in Cape Dorset during the late fall and winter from the floe edge by boat in open water areas. In the fall walrus are seen migrating east along the pack ice. It is believed that these animals originate from the south Foxe Basin and North Hudson Bay area. There are walrus at the floe edge throughout the winter. In April/May, the walrus move away to the area of the big islands in Hudson Strait. Hunters believe that walrus distribution and walrus numbers has not changed. The walrus harvest levels vary with the availability of other wildlife. In years of high availability of caribou, walrus hunting effort during the same season is reduced, resulting in lower numbers of walrus harvested.

In the south-east Baffin Island area, walrus are reported to be present in the Frobisher Bay and Cumberland Sound areas all year round. Seasonal movements are affected by ice cover and fast ice edge locations. The hunters have not seen any change in the abundance and distribution of walrus in the Frobisher Bay area. Hunters observe that there are more male walrus on the south shore (Savage Islands area) and more females on the north shore (Loks Land area) of Frobisher Bay. Winter distribution of walrus in Frobisher Bay is along the floe edge on the northeast shore, from Ward Inlet to Countess of Warwick Sound. Iqaluit

hunters have traditionally harvested walrus in the fall by large boat in the Loks Land and Savage Island area with occasional harvests in summer of individual walrus from small boats within Frobisher Bay and during late winter and spring from the floe edge in Frobisher Bay. Harvest levels for Iqaluit have been lower in recent years due to the lack of large boats for hunting walrus in the fall (due to economics, large boats are used to transport more valuable commodities, such as soapstone and other goods), the long distance to the hunting area, and not the lack of walrus.

In northern Foxe Basin, hunters from Igloolik and Hall Beach believe that walrus numbers have not changed in the past twenty-five years. However, due to a reduction of ice in northern Foxe Basin in the last five years, the summer distribution of walrus has changed and summer hunting is being done further off shore than in the past. In the fall walrus move back near shore and there are three islands in western Foxe Basin that continue to have large concentrations of walrus in the fall. Three other islands, that were traditionally used by walrus in the past but were not used for some time, are now being used again by walrus in the fall. The elders refer to two stocks of walrus in northern Foxe Basin; the stocks are distinguished by size, colour and distribution. There have not been any substantial changes in harvesting effort or harvest levels in the past 20 years.

Since the reduction in numbers of dog teams, there has been a significant decline in the demand for walrus meat to feed dogs.

There is a concern in Igloolik and Hall Beach about disease and contaminants in walrus, particularly around areas of Dew Line Sites. Hunters tend to avoid hunting walrus near these sites. There is also concern about the effects of climate change and how it will affect the environment, walrus and other species.

Resource Status

Stock delineation

Four distinct stocks of Atlantic walrus have been identified on the basis of distribution, genetic and lead isotope data: South and East Hudson Bay, Hudson Bay-Davis Strait, Foxe Basin, and Baffin Bay (Stewart 2002). Although evidence for further subdivision of some stocks is tentative and incomplete, the geographic range of some of the currently identified stocks are larger than would be expected for a single stock of such a generally philopatric species, and it is probable that these four stocks are complexes (consist of sub-units that mix little or not at all).

The distribution of walrus in ***South and East Hudson Bay*** (SEHB) was once continuous with western Hudson Strait (Richard and Campbell 1988) and may represent a part of this population. However, walrus distribution is now discontinuous in Northeast Hudson Bay (Richard and Campbell 1988) suggesting a stock in SEHB that is separate from that in Hudson Strait. There has been no noticeable decrease in walrus numbers near Coats Island in Northern Hudson Bay (Richard *et al. in prep.*). However, numbers in Eastern Hudson Bay have declined, suggesting a separation between Northern Hudson Bay and SEHB. Walrus samples from Akulivik and Inukjuak had different lead isotope ratios indicating these two communities, only 250 km apart, hunt two stocks (Outridge and Stewart 1999). The SEHB Bay stock is therefore presumed to include walrus at Inukjuak

and south. The relationships between walrus at James Bay and other stocks are unclear.

The ***Hudson Bay-Davis Strait*** (HBDS) stock ranges from western and northern Hudson Bay through Hudson Strait to Davis Strait (Richard and Campbell 1988). The large geographic extent of this designation suggests in itself that this stock consists of sub-stocks. Distinct management units within this broad geographic range have not yet been identified, but there may be at least three: Northern Hudson Bay, Hudson Strait, and SE Baffin

1) Northern Hudson Bay – Isotopic evidence, distribution and reported movements support the conclusion that the Northern Hudson Bay stock includes walrus from the west end of Hudson Strait to the NW shore of Hudson Bay. There are no isotopic differences between Coral Harbour and a small sample from Repulse Bay (Outridge *et al.* in press). There was some overlap in isotope signatures in samples from Coral Harbour and Akulivik. Hunters report a seasonal movement of walrus, around Coats, Walrus, and Southampton Islands and between Foxe Peninsula and Nottingham and Salisbury Islands (Orr and Rebizant 1987).

2) Hudson Strait – Walrus move through Hudson Strait, east in the spring, west in the fall (Reeves 1978, Davis *et al.* 1980), but also winter in western Hudson Strait (Orr and Rebizant 1987). The relationship between over-wintering and migrating walrus is unknown. Seasonal changes in the distribution of walrus in western Hudson Strait (Orr and Rebizant 1987) suggest local movements but it is unknown if these connect with northern Foxe Basin walrus.

3) South East Baffin Island – Walrus are present around southeast Baffin Island in fall and some may move east to Greenland (Mansfield 1973, Born *et al.* 1995). Walrus are absent from the Sisimiut area (West Greenland) in summer and there is no longer a north and southward migration in and out of the area (Born *et al.* 1995). Sisimiut animals may move west to Baffin Island in the summer but such migrations have not been documented. This stock extends up Baffin's eastern coast, possibly to join the Baffin Bay population, but the evidence is not conclusive (Richard and Campbell 1988). Today there is an apparent break in distribution between the two areas (Mansfield 1967, Riewe 1992).

The ***Foxe Basin*** (FB) stock occupies the northern reaches of Foxe Basin (Mansfield 1959, 1973, Loughrey 1959, DFO 1987). Passage of walrus through Fury and Hecla Strait from Foxe Basin to the Gulf of Boothia is considered unlikely by scientists (Loughrey 1959, Mansfield 1959, Davis *et al.* 1980) and hunters (Garlich-Miller, personal communication). There is some north-south movement in Foxe Basin (Anderson and Garlich-Miller 1994), that may extend to Southampton Island (Freuchen 1935, Davis *et al.* 1980), but the autumn movement of walrus into Foxe Channel may also come from northern Hudson Bay (Orr *et al.* 1986, Richard *et al.* in prep.). There is new evidence based on geochemical signatures in tooth growth layers (Stewart and Outridge, *in review*) that some male walrus landed at Hall Beach have spent part of their lives in the southern reaches of Foxe Basin, around Repulse Bay, or Foxe Peninsula. Evidence from whole tooth samples indicates that walrus landed at Igloolik

are isotopically different than those landed at Hall Beach, although genetic analysis indicates no difference between walrus landed at these two communities. Isotopic differences have not yet been related to the different forms identified by hunters. Walrus in Foxe Basin differ from those in Northern Hudson Bay on the basis of body size and isotope ratios (Garlich-Miller 1994, Garlich-Miller and Stewart 1998, Outridge *et al.* in press). Pregnant walrus are generally not available to hunters from Hall Beach in winter (Kipsigak, personal communication), suggesting segregation based on season, sex, and age. It appears that Foxe Basin has an interbreeding population that separates into groups with different feeding patterns and with different chances of being hunted at different communities.

In Canada, the ***Baffin Bay*** (BB) stock extends west to Bathurst Island, with rare reports from Prince Patrick and Melville Islands and Taloyoak (Harington 1966). Sightings at Bathurst Inlet are thought to be extralimital Pacific walrus (Harington 1966, Stewart and Burt 1995). The distribution of the Baffin Bay stock is now discontinuous with walrus in the southeast Baffin Island and probably includes several management units.

There is tentative evidence of separate stocks within this range. Based on a small sample, both genetic (de March *et al.* 2002) and isotope data (Outridge *et al.* 2002) suggest that Resolute Bay walrus differ from those at Grise Fiord, however tagged animals have moved from Dundas Island to Brooman Point and from Brooman Point to Pond Inlet. There may be a separate Lancaster Sound stock. There is some, but incomplete, overlap in isotope signatures between walrus from Grise Fiord and Thule, suggesting a possible shared stock. There are no data to place walrus from east Ellesmere Island with either Grise Fiord or Thule animals although proximity makes it likely.

Stock Size

There are no complete or modern estimates of numbers for any walrus stock in Nunavut. There are index estimates for some stocks, but the confidence intervals are broad (Cosens *et al.* 1993) and only very large changes in population size would be detectable. Current survey estimates cannot be corrected for submerged animals or haulout dynamics (the portion of the population on land or ice at the time of the survey).

South and East Hudson Bay - In 1978, 310 walrus were counted at the northeast corner of James Bay in summer (Richard and Campbell 1988) where “over 1000" had been counted in 1955 (Reeves 1978). Estimates for the whole area are in the few hundreds (Born *et al.* 1995, Richard and Campbell 1988).

Hudson Bay-Davis Strait –

1) Northern Hudson Bay – Data from the mid-1970s were used to estimate a stock size of 3000-4000 in northern Hudson Bay and western Hudson Strait (Richard and Campbell 1988, Mansfield and St. Aubin 1991). A 1988 survey similar to one conducted in 1977 recorded almost 1400 walrus on Coats Island and 461 on Nottingham Island a day later (Cosens *et al.* 1993). Hunters from Cape Dorset reported 1000 or more walrus on southwest Baffin Island in winter and spring (Orr and Rebizant 1987).

2) Hudson Strait – Aerial surveys provided a late winter estimate of at least 850 walrus in central Hudson

Strait and Ungava Bay (McLaren and Davis 1982). Mansfield (1990) also believed that numbers were low in this area.

3) Southeast Baffin – Richard and Campbell (1988) examined a series of aerial surveys in southeastern and eastern Baffin Island north to Clyde Inlet and concluded that there must be at least 1000 walrus in the area. If walrus in West Greenland form part of the Southeast Baffin management unit identified here, an additional 500 walrus (95% CI: 204-1512) must be added (Born *et al.* 1994) for a total estimated stock size of about 1500.

Foxe Basin – Richard and Campbell (1988) indicated a Foxe Basin population in excess of 3700 based on a count of 2716 in the northern area (Orr *et al.* 1986) and an estimate of over 1000 for west Foxe Peninsula. A systematic aerial survey provided an estimate 5500 (95%CI 2700-11200) in 1989 (Cosens *et al.* 1993). The survey provided only partial coverage of the potential area with walrus and no corrections were made for submerged animals, thus this is likely an under-estimate.

Baffin Bay – Over 1,000 walrus may summer in the Canadian High Arctic based on surveys of haulouts, the ice edge, and open-water transects (Davis *et al.* 1978). 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 walrus known alive (Stewart, unpub.). There are no estimates for the Resolute Bay, east Ellesmere Island, or NE Baffin Island areas. Born *et al.* (1995) summarized counts for this area and guessed the stock size to be 1,700-2,000 animals, perhaps as many as 3,000 walrus.

Stock Trend

Most indicators of trends in stock size are distribution changes, differences in physical condition, and harvest data. Whenever there is a local decrease in numbers, it may be that the animals have moved to another area, but until increases in other parts of the range have been clearly documented, it is prudent to assume numbers have been reduced.

South and East Hudson Bay – Reviews of walrus distribution indicated the range of walrus in eastern Hudson Bay is reduced since the 1800s (Reeves 1978, Richard and Campbell 1988). Hunters in NW Nunavik now hunt further afield and walrus are much less numerous around the Belcher Islands than 50-60 years ago (Arragutainaq, personal communication)

Hudson Bay-Davis Strait –

1) Northern Hudson Bay – Walrus are now rare from James Bay to Whale Cove (Richard and Campbell 1988) and, in general, walrus range in this area, hence probably numbers, has shrunk since historical times (Reeves 1978).

2) Hudson Strait - The distribution of walrus in Hudson Strait has declined and possibly become more fragmented in historical times (Reeves 1978, Richard and Campbell 1988).

3) SE Baffin - Walrus have disappeared from upper Cumberland Sound (Allen 1880, Guinn and Stewart 1988). The range of walrus concentrations in east Baffin Island has declined (Reeves 1978, Richard and Campbell 1988). A haulout near Qikiqtarjuaq was abandoned after a Distant Early

Warning station was built nearby (Reeves 1978). If this population is continuous with walrus in West Greenland, it has also declined there (Born *et al.* 1995).

Foxe Basin – Walrus have disappeared from the west side of Foxe Basin (Brody 1976, Anderson and Garlich-Miller 1994). Many haulouts are abandoned (Mansfield 1966), suggesting declines in numbers or habitat availability, or both. Hunters noted that walrus are returning to some haul out sites, though not on the west coast, and the validity of using changes in distribution to assess abundance remains uncertain.

Baffin Bay – Walrus still occupy most of their former range in the central Arctic archipelago (Davis 1981) but are now rare in the mid-reaches of the eastern Baffin Island (Reeves 1978).

If the Baffin Bay stock is connected to the Disko Bay group in central west Greenland, it may now be much reduced in that part of its range. Large influxes to the Avanersuaq area (Thule district) from the south in spring no longer occur and at least 3 main haulouts in Northwest Greenland have been abandoned (Born *et al.* 1995).

Sustainable Harvest Rate

Estimates of sustainable yield range from 3 to 5% for a population between 59 and 93% of carrying capacity (K) (DeMaster 1984 cited in Born *et al.* 1995). The positions of Canadian stocks with respect to K are unknown.

Estimates of stock size are incomplete for all stocks and can not be used to calculate sustainable removal levels. However, a lower bound for stock size can be established using the minimum counts available for some regions and, in the absence of walrus-specific data, the estimated replacement yield of 2-5% used for cetaceans with similar reproduction patterns. An estimate of 5500 in Foxe Basin permits a sustainable removal of about 110-275. The population estimate is incomplete and the total allowable removal may be higher, but the possibility that different stocks occur in Foxe Basin requires a reassessment for each stock.

For the segment of the Hudson Bay-Davis Strait stock that summers near Coats Island, the sustainable yield would be roughly 30-70 based on partial counts. The relationship of this group to the whole stock is unknown.

Recent counts at haul-outs in Lancaster and Jones Sound of roughly 350, allow a minimum sustainable removal of 14-15. The proportion this group represents of the whole stock is unknown. Adult males are generally not seen on these haulouts.

Sources of Uncertainty

Evidence for stock identity is limited to only a few areas. Genetic markers have been developed (Buchanan *et al.* 1998) and genetics studies are underway (DFO, Greenland Institute of Natural Resources). A new technique using isotopes in the lines in walrus teeth to track the walrus through its life has been developed (Stern *et al.* 1999).

There are no recent population estimates for any stock of walrus in Canada. The estimate for Foxe Basin (5000-5500) is considered an index only. There are about 1400 walrus around Coats and Southampton Islands in early August but the fraction of any northern Hudson Bay management stock or Hudson Bay-Davis Strait genetic stock this represents are unknown. Other estimates, counts, and changes in distribution suggest that walrus numbers have declined in most

areas since the early 1900's but these declines can not be quantified. Resource users indicate that numbers have increased in some communities. There are no data by which to assess recent trends, either increases or decreases.

There are few data on natural mortality, rates of reproduction, age of maturity, or reproductive life span. Most existing data are limited in geographic and temporal scope.

Published harvest statistics are incomplete, and often use averages to estimate harvests. Individual reports are often associated with a wide degree of error (DFO 1991, 1992a, 1992b, 1993, 1994, 1995, 1996, 1997).

There are data on struck-and-loss rates only for a limited number of hunting situations although losses vary with locality, season, habitat, weather, and hunter experience. There are no estimates for mortality among such struck-and-lost walrus in Canada.

There is little information about the relationship of walrus to environmental variables such as ice, their food sources, and other species that they interact with. There is particular concern about the effects of climate change and how it will affect the environment, walrus and other species.

Outlook

There are too few data for any stock to determine if it is increasing, decreasing or stable, or if it is above or below a threshold other than some guessed pre-exploitation level.

Recent surveys of haulouts in the High Arctic suggest that, at least in the Baffin Bay stock, sustainable yield exceeds removals in Canada. This stock may be stable or increasing but total removals in Canada, removals in Greenland, details of stock structure, and the distribution of adult males all remain unknown.

Management Considerations

Walrus are thought to generally use the same areas for haul-out and feeding during their lifetime. Thus the range of their dispersal is restricted. Exchange among groups of walrus is thought to be minimal and walrus hunting should be managed based on local aggregations rather than larger stock units. This reduces the risk of overexploitation inherent in assuming stocks cover large geographic areas.

The uncertainties in stock delineation, stock size and movements, growth rate, harvest levels, and hunt losses necessitate caution in management decisions. Continued efforts to reduce hunting losses, to reduce unreported kills, and to increase understanding about walrus populations are encouraged.

Other Considerations

Chemicals – Examination of walrus tissue indicates that they carry contaminants including lead, mercury, cadmium, nickel, cobalt, copper, strontium, DDT and PCBs. The degree of contamination varies among regions. Lead concentrations in teeth of walrus sampled near Igloolik were stable from pre-industrial times to present, indicating that the lead contamination is at natural levels and not from human causes (Outridge *et al.* 1997). The concentrations of cadmium and some other metals have also declined since pre-industrial times suggesting they are also at natural levels, but nickel, cobalt, copper and strontium increased significantly (Outridge *et al.* 1997).

The effects of chemical contamination on walrus are unknown. Female walrus that have been observed with reproductive anomalies (Garlich-Miller and Stewart 1999) did not have unusual contaminant loads. However, because of their trophic position (they eat mainly bivalves), walrus may have slightly different patterns of contaminant accumulation than other Arctic marine mammals.

Disease – Studies of disease in walrus have shown that walrus in some areas have been exposed to *Brucella*. Exposure to *Brucella* can lead to the disease brucellosis, which has caused reproductive disorders in some mammals. To date, *Brucella* has been detected in walrus from Foxe Basin (Nielsen *et al.* 1996) but walrus samples from Resolute Bay, Grise Fiord or Nunavik did not show signs of these bacteria (Nielsen *et al.* 2001). Female walrus that have been observed with reproductive anomalies (Garlich-Miller and Stewart 1999) did not test positive for *Brucella*.

Infectious diseases can have significant impacts on marine mammal populations by causing large scale die-offs in relatively short periods (Young 1994). Distemper viruses have been responsible for such die-offs among both seals in the northern Atlantic (Harwood 1990) and dolphins off the eastern U.S. coast (Lipscomp *et al.* 1994). There is obviously a potential for widespread mortality within a susceptible wild population and the consequences may be significant when dealing with small, vulnerable and threatened populations. Marine mammals can also transfer infectious diseases to land mammals including man. Trichinosis in humans has been reported in Arctic Canada as a result of consuming infected walrus meat (Forbes 2000).

Walrus have also been widely exposed to phocine distemper or similar virus (Nielsen *et al.* 2000). Walrus testing positive for exposure to this virus were found in Foxe Basin, Grise Fiord, Resolute Bay and Loks Land but not at Nottingham Island. Positive animals showed no signs of disease but detailed postmortems were not done.

Noise – The response of walrus to man-made noise varies. There is evidence of stampedes, with attendant mortality, as well as at least partial habituation to aircraft noise (Born *et al.* 1995). Similarly, some walrus may allow ships to approach quite close and others react to ships 2 km away (Born *et al.* 1995). Noise has been associated with displacement from haulouts for up to 9 h (Salter 1979). Females and calves are most susceptible to disturbance by noise (Salter 1979, Miller 1982). Walrus use elaborate vocal displays during courtship (Stirling *et al.* 1987, Sjare and Stirling 1993, 1996) and are vocal throughout the year (Miller and Boness 1983, Miller 1985) so there is potential for human noise to interfere with walrus communication.

Human presence – There is evidence that the presence of humans and human structures can disturb walrus and displace them from haulouts. When hunted at a haulout, walrus may leave (Mansfield 1966, Smith *et al.* 1979) and eventually abandon a site completely. Presence of a navigation aid on east Coats Island has been implicated in the displacement of walrus there.

Habitat loss – Lost habitat may be physical or biotic. In several areas in Canada, walrus have abandoned traditional haulouts (Brody 1976, Richard and Campbell 1988). Whether

this is a result of a declining population drawing away from marginal habitat or the displacement of walrus from desirable habitat is unknown and testing of these past events is not possible. However, both resources users and scientists (Smith and Taylor 1977) tend to support the displacement hypothesis. Eco-tourism at haulout sites may have similar impacts.

Fisheries may impact walrus populations. Noise from vessels may disturb walrus, and dragging can physically destroy the clam communities upon which walrus depend, even if the fishery is not in direct competition for the prey (Born *et al.* 1995).

For more information:

Contact: Dr. Rob Stewart
Fisheries and Oceans Canada
501 University Crescent
Winnipeg, MB,
R3T 2N6
Tel: 204-983-5023
Fax: 204-984-2403
E-Mail:stewartre@dfo-mpo.gc.ca

References

Allen, J. A. 1880. History of North American pinnipeds. Department of the Interior. U.S. Geological and Geographical Survey of the Territories, Washington. 785 p.

Anderson, L. E., and J. Garlich-Miller. 1994. Economic analysis of the 1992 and 1993 summer walrus hunts in northern Foxe Basin, Northwest Territories. Canadian Technical Report of Fisheries and Aquatic Sciences 2011: iv + 20 p.

Born, E. W., I. Gjertz, and R. R. Reeves. 1995. Population assessment of Atlantic walrus (*Odobenus rosmarus rosmarus* L.). Norsk Polarinstitutt, Oslo, Meddelelser Number. 138, 100p.

Born, E. W., M. P. Heide-Jørgensen, and R. A. Davis. 1994. The Atlantic walrus (*Odobenus rosmarus rosmarus*) in west Greenland. Meddelelser om Grønland Bioscience 40: 33 pp.

Brody, H. 1976. Inuit land use in North Baffin Island and northern Foxe Basin. Pages 152-171 in M. M. R. Freeman (ed.) Inuit land use and occupancy project, Volume 1: Land use and occupancy. Indian and Northern Affairs, Ottawa.

Brooke, L. F. 1997. A report on the 1996 Nunavik beluga and walrus subsistence harvest study. Prepared for Department Fisheries and Oceans under the Aboriginal Fisheries Strategy. Unpaginated.

Buchanan, F. C., L. D. Maiers, T. D. Thue, B. G. E. de March, and R. E. A. Stewart. 1998. Microsatellites from the Atlantic walrus *Odobenus rosmarus rosmarus*. Molecular Ecology 7: 1083-1090.

Cosens, S. E., R. Crawford, B. G. E. deMarch, and T. A. Shortt. 1993. Report of the Arctic Fisheries Scientific Advisory Committee for 1991/92 and 1992/93. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2224: 1-51.

Davis, R. A. 1981. Report of a workshop on Arctic marine mammals. Canadian Technical Report of Fisheries and Aquatic Sciences 1005: iv + 13 p.

Davis, R. A., K. J. Finley, and W. J. Richardson. 1980. The present status and future management of Arctic marine mammals in Canada. Science Advisory Board of the

Northwest Territories, Yellowknife. 91 p.

Davis, R. A., W. R. Koski, and K. J. Finley. 1978. Numbers and distribution of walruses in the central Canadian high Arctic. LGL Report for Polar Gas Project, Toronto. 50 p.

de March, B. G. E., L. D. Maiers, and R. E. A. Stewart. Genetic relationships among Atlantic walrus (*Odobenus rosmarus rosmarus*) in the Foxe Basin and the Resolute Bay-Bathurst Inlet area. Canadian Science Advisory Secretariat Research Document 2002/092.

DFO (Department of Fisheries and Oceans). 1987. Preliminary walrus management plan for northern Quebec. Quebec. (Unpaginated)

DFO. 1991. Annual summary of fish and marine mammal harvest data for the Northwest Territories, 1988-89, Volume 1: v + 59 p.

DFO. 1992a. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 2, 1989-1990: xiv + 61 p.

DFO. 1992b. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 3, 1990-1991: xiv + 67 p.

DFO. 1993. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 4, 1991-1992: xiv + 69 p.

DFO. 1994. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 5, 1992-1993: xvii + 104 p.

DFO. 1995. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 6, 1993-1994: xv + 86 p.

DFO. 1996. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 7, 1994-1995: xiii + 85 p.

DFO. 1997. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 8, 1995-1996: xii + 80 p.

DFO. 1999. Annual summary of fish and marine mammal harvest data for the Northwest Territories, Volume 9, 1996-1997: xii + 72 p.

Fay, F. H., J. J. Burns, S. W. Stoker, and J. S. Grundy. 1994. The struck-and-lost factor in Alaskan walrus harvests, 1952-1972. Arctic 477: 368-373.

Fay, F. H., J. J. Burns, A. A. Kibal'chich, and S. Hills. 1991. Incidence of twin fetuses in walruses (*Odobenus rosmarus* L.). Northwest Naturalist 72: 110-113.

Fisher, K. I. and R. E. A. Stewart. 1997. Summer foods of Atlantic walrus, Odobenus *rosmarus rosmarus*, in northern Foxe Basin, Northwest Territories. Canadian Journal of Zoology 75: 1166-1175.

Forbes, L. B. 2000. The occurrence and ecology of *Trichinella* in marine mammals. Veterinary Parisitology 93: 321-334.

Freuchen, P. 1935. Mammals, Part II. Field notes and personal observations. Report of the 5th Thule Expedition 1921-1924. 2: 68-278.

Garlich-Miller, J. 1994. Growth and reproduction of Atlantic walruses (*Odobenus rosmarus rosmarus*) in Foxe Basin, Northwest Territories, Canada. M.Sc. Thesis, University of Manitoba. 116 p.

Garlich-Miller, J., and R. E. A. Stewart. 1998. Growth and sexual

dimorphism of Atlantic walruses (*Odobenus rosmarus rosmarus*) in Foxe Basin, Northwest Territories, Canada. Marine Mammal Science 14: 803-818.

Garlich-Miller, J., and R. E. A. Stewart. 1999. Reproductive patterns and fetal growth of Atlantic walruses (*Odobenus rosmarus rosmarus*) in Foxe Basin, Northwest Territories, Canada. Marine Mammal Science 15: 179-191.

Guinn, B., and D. B. Stewart. 1988. Marine mammals of central Baffin Island, Northwest Territories. Rep. For Northern Land Use Information Series, Environment Canada and Department of Fisheries and Oceans, Ottawa. 65 p.

Harington, C. R. 1966. Extralimital occurrences of walruses in the Canadian Arctic. Journal of Mammalogy 47: 506-513.

Harwood, J. 1990. The 1998 seal epizootic. Journal of Zoology (London) 222: 349-351.

Lipscomp, T. B., F. Y. Schulman, D. Moffet, and S. Kennedy. 1994. Morbillivirus disease in Atlantic bottlenose dolphins (*Tursiops truncatus*) from the 1987-1988 epizootic. Journal of Wildlife Diseases 30: 567-571.

Loughrey, A. G. 1959. Preliminary investigation of the Atlantic walrus *Odobenus rosmarus rosmarus* (Linneaus). Canadian Wildlife Service Wildlife Management Bulletin (Ser. 1) 14: 1-123.

Mansfield, A. W. 1959. The walrus in the Canadian Arctic. Fisheries Research Board of Canada. Circular 2: 13 p.

Mansfield, A. W. 1966. The walrus in Canada's Arctic. Canadian Geographic Journal 72:88-95.

Mansfield, A. W. 1967. Seals of arctic and eastern Canada. Fisheries Research Board of Canada Bulletin 137 (second edition, revised): 35 p.

Mansfield, A. W. 1973. The Atlantic walrus *Odobenus rosmarus* in Canada and Greenland. IUCN Publications New Series, Supplementary Paper 39:69-79.

Mansfield, A. W. 1990. Marine mammals. Pp. 134-139 in J. A. Percy (ed.) Proceedings of a workshop: Marine ecosystems studies in Hudson Strait, November 9-10, 1989, Montreal, Quebec. Canadian Technical Report of Fisheries and Aquatic Sciences 1770, 175 pp.

Mansfield, A. W. and D. J. St. Aubin. 1991. Distribution and abundance of the Atlantic walrus, *Odobenus rosmarus rosmarus*, in the Southampton Island-Coats Island region of northern Hudson Bay. Canadian Field Naturalist 105: 95-100.

McLaren, P. L. and R. Davis. 1982. Winter distribution of arctic marine mammals in ice-covered waters of eastern North America. Unpublished Report by LGL Ltd. For Petro-Canada Exploration Inc. Calgary, Alberta, 151 pp.

Miller, E. H. 1982. Herd organization and female threat behaviour in Atlantic walruses *Odobenus rosmarus rosmarus* (L.). Mammalia 46: 29-34.

Miller, E. H. 1985. Airborne acoustic communications in the walrus

Odobenus rosmarus. National Geographic Research 1: 124-145.

Miller, E. H. and D. J. Boness. 1983. Summer behaviour of Atlantic walruses *Odobenus rosmarus rosmarus* (L.) at Coats Island, N. W. T. (Canada). Zeitschrift fur Saugetierkunde (International Journal of Mammalian Biology) 48: 298-313.

NAMMCO (North Atlantic Marine Mammal Commission). 1995. Report of the ad hoc working group on the Atlantic walrus. Copenhagen, 31 January - 2 February, 1995. 21 p.

Nielsen, O., K. Nielsen, and R. E. A. Stewart. 1996. Serological evidence of *Brucella* spp exposure in Atlantic walrus (*Odobenus rosmarus rosmarus*) and ringed seals (*Phoca hispida*) of Arctic Canada. Arctic 49: 383-386.

Nielsen, O., R. E. A. Stewart, K. Nielsen, L. Measures, and P. Duignan. 2001. A serological survey of *Brucella* spp antibodies in some marine mammals of North America. Journal of Wildlife Diseases 37: 89-100.

Nielsen, O., R. E. A. Stewart, L. Measures, P. Duignan, and C. House. 2000. A morbillivirus antibody survey of Atlantic walrus (*Odobenus rosmarus*), narwhal (*Monodon monoceros*) and beluga (*Delphinapterus leucas).* Journal of Wildlife Diseases 36:508-517.

Orr, J. R. and T. Rebizant. 1987. A summary of information on the seasonal distribution and abundance of walrus (*Odobenus rosmarus*) in the area of northern Hudson Bay and western Hudson Strait, NWT, as collected from local hunters. Canadian Data Report of Fisheries And Aquatic Sciences 624: iv + 16 p.

Orr, J. R., B. Renooy, and L. Dahlke. 1986. Information from hunts and surveys of walrus (*Odobenus rosmarus*) in northern Foxe Basin, Northwest Territories, 1982-1984. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1899: iv + 24 p.

Outridge, P. M., R. D. Evans, R. Wagemann, and R. E. A. Stewart. 1997. Historical trends of heavy metals and stable lead isotopes in beluga (*Delphinapterus leucas*) and walrus (*Odobenus rosmarus rosmarus*) in the Canadian Arctic. Science of the Total Environment 203: 209-219.

Outridge, P. M. and R. E. A. Stewart. 1999. Stock discrimination of Atlantic walrus (*Odobenus rosmarus rosmarus*) in the eastern Canadian Arctic using lead isotope and element signatures in teeth. Canadian Journal of Fisheries and Aquatic Sciences 56:105-112.

Outridge, P. M., W. J. Davis, R. E. A. Stewart, and E. W. Born. In press. Investigation of Atlantic walrus (*Odobenus rosmarus rosmarus*) stock structure in Canada and Greenland using dental Pb isotope signatures reflecting underlying geology. Arctic.

Reeves, R. R. 1978. Atlantic walrus (*Odobenus rosmarus rosmarus*): a literature survey and status report. U.S. Department of the Interior, Fish and Wildlife Service, Wildlife Research Report 10: 41 p.

Richard, P. R. 1995. Catch of walrus in the eastern Canadian Arctic: 1984-1993. In litt.

Richard, P. R. and R. R. Campbell. 1988. Status of the Atlantic walrus, *Odobenus rosmarus rosmarus*, in Canada. Canadian Field Naturalist 102: 337-350.

Richard, P. R., D. G. Barber, and J. R. Orr. Summer distribution and numbers of walrus in northern Hudson Bay, western Hudson Strait, and Foxe Basin. In prep.

Riewe, R. 1992. Nunavut atlas. Canadian Circumpolar Institute and Tungavik Federation of Nunavut, Edmonton, AB. 259 p.

Salter, R. E. 1979. Site utilization, activity budgets, and disturbance responses of Atlantic walruses during terrestrial haul-out. Canadian Journal of Zoology 57: 1169-1180.

Sjare, B. and I. Stirling. 1993. The vocalizations and breeding behaviour of Atlantic walruses in the central Canadian high Arctic. Pages 85-87 in R. E. A. Stewart, P. R. Richard, and B. E. Stewart (eds.). Report of the 2nd Walrus International Technical and Scientific (WITS) workshop, 11-15 January 1993, Winnipeg, MB, Canada. Canadian Technical Report of Fisheries and Aquatic Sciences 1940: viii + 91 p.

Sjare, B. and I. Stirling. 1996. The breeding behaviour of Atlantic walruses, *Odobenus rosmarus rosmarus,* in the Canadian High Arctic. Canadian Journal of Zoology 74: 897-911.

Smith, T. G., M. H. Hammill, D. W. Doidge, T. Cartier, and G. A. Sleno. 1979. Marine mammal studies in southeastern Baffin Island. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1552.

Smith, T. G. and D. Taylor. 1977. Notes on marine mammal, fox, and polar bear harvests in the Northwest Territories. Fisheries and Marine Service Technical Report 694: vi + 37.

Stern, R. A., P. M. Outridge, W. J. Davis, and R. E. A. Stewart. 1999, Restructuring Pb-isotope exposure histories preserved in walrus teeth annuli using the SHRIMP II ion microprobe. Environmental Science & Technology 33: 1771-1775.

Stewart, B. E. and P. M. Burt. 1994. Extralimital occurrences of beluga, *Delphinapterus leucas* and walrus *Odobenus rosmarus*, in Bathurst Inlet, Northwest Territories. Canadian Field Naturalist 108: 488-490.

Stewart, R. E. A. 2002 Review of Atlantic walrus (*Odobenus rosmarus rosmarus*) in Canada. Canadian Science Advisory Secretariat Research Document 2002/092.

Stewart, R. E. A., P. M. Outridge, and R. A. Stern. In review. Walrus life-history movements reconstructed from lead isotopes in annual layers of teeth. Submitted to Marine Mammal Science.

Stirling, I., W. Calvert, and C. Spencer. 1987. Evidence of stereotyped underwater vocalizations of male Atlantic walruses (*Odobenus rosmarus rosmarus*). Canadian Journal of Zoology 65:2311-2321.

Young, T. P. 1994. Natural die-offs of large mammals: Implications for conservation, Conservation Biology 8: 410-418.

Personal Communication

Ammie Kipsigak, Hall Beach HTO, Hall Beach, Nunavut

Joe Arragutainaq, Sanikiluaq HTO, Sanikiluaq, Nunavut

Ipeelee Itorcheak, DFO Iqaluit, Nunavut.

Joel Garlich-Miller, U.S. Fish and Wildlife Service, Anchorage, Alaska.

Doidge, D. W., Makivik Corporation, Kuujuaq, Quebec.

This report is available:
Stock Assessment Regional Office
c/o RAP Coordinator
Central and Arctic Region
501 University Crescent
Winnipeg, Manitoba R3T 2N6
Tel: (204) 983-5000
Fax: (204) 984-2403
e-mail: RAPCoord-C&A@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

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