NAMMCO/5/6 - Annex 2

Report of the *ad hoc* Working Group on Atlantic Walrus

Copenhagen, 31 January - 3 February 1995

Contents

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The *ad hoc* Working Group on the Atlantic walrus met at the Greenland Fisheries Research Institute in Copenhagen from 31 January to 2 February 1995. The Working Group was convened by Erik Born. A list of participants is contained in Appendix 1.

The Working Group referred to the Council's request for advice on the Atlantic walrus (*Odobenus rosmarus rosmarus*), which was as follows:

> "[to]... advise on stock identity for management purposes; to assess abundance in each stock area; to assess long-term effects on stocks by present removals in each stock area; to assess effects of recent environmental changes (i.e. disturbance, pollution), and changes in the food supply" (NAMMCO/2 - *Report*, 64).

The Working Group addressed each of the elements of the request in turn, basing deliberations on all available data on the Atlantic walrus.

1. Stock identity

It was acknowledged from the outset that although Atlantic walruses are generally understood to exist in a number of separate stocks, few studies have been done explicitly addressing questions of genetic relatedness of different groups.

In a preliminary discussion, the Working Group attempted to develop a conceptual model of the distribution and movements of Atlantic walruses, with the following considerations:

a) Walruses breed in winter (February to April) when there is extensive ice coverage. Therefore, stock separation may be driven by discontinuity in the availability of reliable open-water areas in winter. The distribution of polynyas, persistent shore leads, and loose pack ice may dictate to a major extent the opportunities for genetic exchange among walrus groups.

b) Although Atlantic walruses have been characterized as more "sedentary" than the strongly migratory Pacific walruses (Mansfield 1973), they are also known to swim long distances in short periods (Wiig pers. comm.). Several authors (Freuchen 1935, Dunbar 1956, Currie 1968), citing as evidence primarily the observations by walrus hunters and the consistent timing of the arrival and departure of walruses in particular areas, have described migratory routes and schedules involving annual long-distance movements.

c) Aggregations of walruses at traditional haul-out sites on land have often been characterized as "herds", with the implicit assumption that they are social units of some kind. Although the evidence is not as strong for Atlantic walruses as for Pacific walruses, segregation, e.g. all-male groups at some haul-out sites, has been observed in Atlantic walruses during the summer and autumn. Since no mating occurs in summer and autumn, when the terrestrial haul-out sites are occupied, it is possible that animals from different breeding areas share the same haul-out sites.

d) The abandonment of some terrestrial haul-out sites has been observed in Canada, Greenland and Svalbard. Such abandonment may be taken as evidence that the group of animals using the site was either extirpated or driven away by disturbance. It has sometimes not been possible to decide which of these causes was involved.

The Working Group attempted to use the above model in assessing the likely discreteness of groups of walruses in different areas. Two alternative hypotheses were considered, namely:

1. Wintering concentrations represent genetically separate stocks that migrate in summer to areas where walruses from different stocks mingle.
2. Summering concentrations, often involving a complex of traditionally occupied haul-out sites and often separated by large areas where walruses are absent or present only in very low density, represent stocks that are relatively sedentary, with animals moving away from the area only as far as necessary for access to food and open water in winter.

Very little evidence was available to support or refute either of these hypotheses, and it was agreed that both alternatives should be considered in our discussions of stock relations.

The Working Group agreed that it was useful to make a distinction between biological stocks which are genetically isolated, vs. management units, or functional stocks. The latter may include animals from more than one genetic stock, or alternatively be only a subunit of a genetic stock. The basis for defining management stocks may be practical (e.g. for purposes of catch monitoring or allocation, feasibility of designing and executing regular surveys to monitor abundance) or biological/behavioral (e.g. aimed at maintaining the traditional use by walruses of particular feeding, haul-out, or breeding sites).

The stocks proposed in SC/3/13 were reviewed and evaluated by the Working group, as follows (Figure 1, p.15):

1.1 Foxe Basin

Walruses are distributed mainly in the northern half of Foxe Basin where they are present in relatively high density all the year-round. Evidence from morphometric studies in the 1950s indicated that Foxe Basin walruses are larger than those in northern Hudson Bay (Mansfield 1958). No new data are available for northern Hudson Bay, but analyses of new material from Foxe Basin essentially agree with those of Mansfield in the 1950s (Garlich-Miller 1994).

Evidence on walrus distribution and movements, provided both by hunters and by scientists, is consistent with the view that the Foxe Basin group of walruses is largely isolated from other groups to the north (via Fury and Hecla Strait) and south (western Hudson Strait and Southampton Island area).

The Working Group concluded that there was sufficient evidence to regard the Foxe Basin walruses as a separate management unit, and that there is a high probability that it is also a genetic stock.

1.2 Southern and Eastern Hudson Bay

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

There is no basis for evaluating the relationships among the groups of walruses that haul out in summer on shoals and islands in southern and eastern Hudson Bay. It was noted that there is some open water in parts of James Bay and eastern Hudson Bay during winter, so some overwintering by walruses is possible. No direct evidence was available, however, of overwintering by walruses in this region.

The Working Group concluded that there may be reason to regard the southern and eastern Hudson Bay walruses as a separate management unit, but that there is no basis for viewing them as a separate genetic stock.

1. 3 Northern Hudson Bay - Hudson Strait - Northern Labrador - Southeast Baffin Island

Walruses are present all the year round in portions of this area, and they also migrate through Hudson Strait. Their distribution is essentially continuous from the Keewatin coast of northwestern Hudson Bay, throughout the Southampton Island, Coats Island, Foxe Peninsula, and Hudson Strait regions, and from the eastern entrance of Hudson Strait southward along the northern Labrador coast and northward along the southeastern Baffin Island coast. On the other hand, it was noted that densities are particularly high at specific localities, both in winter/spring (e.g. south of Akpatok Island, at the western end of Hudson Strait and in the leads along the north and south shores of Hudson Strait (McLaren and Davis 1982) and summer/autumn (e.g. terrestrial haul-out sites at Southampton and Coats Islands, Lady Franklin Island group, western and northern shores of Foxe Peninsula - MacLaren-Marex 1980, Richard and Campbell 1988, Mansfield and St. Aubin 1991).
In the absence of any direct evidence for stock differentiation (e.g. genetic analyses, tagging, morphometry), the Working Group inferred from the evidence on distribution and movements that the walruses in this area may belong to one genetic stock. It wished to emphasize, however, that considerable risk could be associated with treating them as a single management unit. There is a strong possibility that walrus groups have a high degree of fidelity to geographically separate breeding and haul-out sites. If they do, overhunting or disturbance could prevent the continued use by walruses of some parts of this large area. It was noted that the people living at settlements along the north and south shores of Hudson Strait must make long boat trips to offshore islands for walruses, whereas in the past they were able to catch walruses regularly along shore and at near-shore islands.

1.4 Central West Greenland

Walruses overwinter in two discrete areas over shallow banks off central West Greenland (Born *et al.* 1994). These walruses leave the waters off West Greenland in spring and do not return until autumn. It has been suggested that some of them, particularly those in the southern group, move west to the east coast of Baffin Island. Others may move north to Upernavik and Avanersuaq municipalities. The deep water between the two banks has a very low density of walruses (Born *et al.* 1994; Heide-Jørgensen and Born 1995).

Mitochondrial genetic analyses have shown that the walruses wintering in the southern area off central West Greenland have different haplotypes that could indicate mixing (Cronin *et al.* 1994). However, due to the small sample size, the genetic evidence was judged to be inconclusive for purposes of identifying genetic discreteness.

On the basis of the hiatus in distribution between the two groups of wintering walruses, their differing responses to recent exploitation, and the fact that their status with regard to catches and population trends has been monitored separately (Born *et al* 1994; Heide-Jørgensen and Born 1995), the Working group concluded that these should be treated as separate management units, the southern group designated as the "Sisimiut group" and the northern one as the "Disko group". It was noted that a connection between the Sisimiut group and the southeast Baffin Island etc. group (*1.3* above), is likely.

1.5 North Water (Baffin Bay)

Walruses overwinter off Northwest Greenland and in the eastern Canadian Arctic in what appear to be several discontinuous aggregations (e.g. in the North Water polynya and polynyas in Wellington Channel and Cardigan Strait (Kiliaan and Stirling 1978, Finley and Renaud 1980, Born *et al.* 1995)). Summering grounds for these walruses are primarily in the eastern Canadian Arctic at terrestrial haul-out sites along the coasts of Ellesmere, Devon and Bathurst Islands (Koski and Davis 1979, Riewe 1992). Migrations through Lancaster and Jones Sounds, westward in spring and eastward in autumn, are well documented (e.g. Davis *et al*. 1978). One of ten walruses tagged in August 1993 at Bathurst Island was killed by Inuit off the north coast of Bylot Island in June 1994 (Stewart, unpubl.). Published reports referred to Greenlandic bullets being found in the bodies of walruses taken in the eastern Canadian Arctic (Freuchen 1921, Vibe 1950). Substantial northward migration into the North Water area in spring, along either Greenland or the Baffin Island coast, has not been documented in recent years (Koski 1980, Born *et al.*1994).

MtDNA analyses showed that walruses in the North Water area, hunted during the spring by Inuit in Avanersuaq municipality, are monomorphic (Cronin *et al.* 1994). There is a hiatus in walrus distribution off the northeast coast of Baffin Island (cf. Mansfield 1958, Koski and Davis 1979) that may be a secondary effect of overhunting.

The Working group concluded that the walruses centred in northern Baffin Bay, ranging from Avanersuaq municipality (N.W. Greenland) westward to Peel Sound in the eastern Canadian Arctic, probably comprise a separate genetic stock. Whether they are a genetic stock or not, this group should be considered a separate management unit. As was indicated for the Central West Greenland group, it may prove appropriate to subdivide this group further, for example on the basis of particular haul-out (summering) or overwintering (breeding) sites.

1.6 East Greenland

The walruses present all the year-round in Northeast Greenland are geographically and genetically isolated from those in Northwest Greenland (Cronin *et al.* 1994). Some coastwise movement southward to South Greenland (mainly emigration) is possible. Movement across Fram Strait from East Greenland to Svalbard has been documented (Born and Gjertz 1993), but such movement is considered infrequent.

The Working Group agreed that the East Greenland walruses may be a separategenetic stock and that they should be considered a separate management unit.

1.7 Svalbard - Franz Joseph Land

Recent studies have demonstrated that the walruses in Svalbard and Franz Joseph Land belong to a common population that uses shore haul-out sites in summer and polynyas near both archipelagoes in winter (Gjertz and Wiig 1993). The possibility of a connection between these walruses and those that traditionally hauled out in summer on northern Novaya Zemlya deserves further investigation.

No genetic data are available for these walruses. It was agreed, however, that they should be treated as a separate management unit.

1.8 Kara Sea - Southern Barents Sea - Novaya Zemlya

Walruses definitely overwinter in the Pechora and White seas (e.g. Haug and Nilssen 1995), and there is reason to believe that some movement occurs through the Kara Entrance. The situation of walruses in the Kara Sea is entirely unknown, and any conclusion about their stock affinities would be speculation. For convenience, the Working group agreed to tentatively regard the walruses in the Kara Sea and southern Barents Sea and using Novaya Zemlya as a management stock, pending better information on them.

2. Estimates of walrus abundance

No dedicated walrus surveys that fully address questions of bias have been conducted in any of the areas in the North Atlantic where walruses occur. In some areas, densities obtained from aerial surveys can be used for extrapolation, but no information is available on submergence factors and haul-out patterns that are likely to affect the survey results. In other areas, counts at terrestrial haul-out sites provide information on a segment of the population, but do not correct for animals that were at sea during the survey and, for most areas, do not give complete simultaneous coverage of all haul-out sites that are likely to be used by the walrus stock. Finally, in some areas, figures on abundance are so old or poorly documented that they are no longer considered valid.

2.1 Foxe Basin

The best available information on present abundance of walruses in Foxe Basin are visual systematic strip-transect aerial surveys conducted in August 1988 (Mean 5200 95% CI 900-30500) and in August 1989 (Mean 5500 95% CI 2700-11200) (Cosens et al. 1993). The results of these surveys, which are considered as reference or index points for future surveys, are not corrected for animals that were submerged during the survey. Also, some potential walrus habitats were not surveyed in either year.

2.2 Southern and Eastern Hudson Bay

Virtually nothing is known about historical or current sizes of walrus populations in this area. A group of walruses was counted in October 1978 at the terrestrial haul-out site at Cape Henrietta Maria. The Working Group was not able to assess the number of walruses in southern and eastern Hudson Bay.

2.3 Northern Hudson Bay - Hudson Strait - Northern Labrador - Southeast Baffin Island

Surveys were conducted using different methods in different years in parts of the range of this proposed stock. Aerial surveys in northern Hudson Bay revealed a count of about 2400 walruses in the summers of 1976-77 (Mansfield & St Aubin 1991). Richard (1990) reported sightings of about 1800 walruses from aerial surveys in parts of northern Hudson Bay and western Hudson Strait in 1988. Aerial survey counts of 600-700 were reported for an island off southeast Baffin Island in August 1978 (MacLaren Marex 1980), and Richard and Campbell (1988) estimated a summer population in southeast Baffin Island of about 1000 in the late 1970's, based in part on the count of 600-700 reported by MacLaren Marex (1980). Aerial surveys conducted during March 1981 gave uncorrected estimates of 223 walruses in southwestern Davis Strait and 850 in Hudson Strait (McLaren and Davis 1982).

The various counts and estimates reported above cannot simply be added. The Working Group was unable to produce an estimate for this stock from the data available.

2.4 Central West Greenland

The main wintering grounds have been surveyed from aircraft six times since 1981. The uncorrected abundance estimates indicate that 200-300 walruses are found in these areas during winter. There are recent indications of a decline in walrus abundance in the southern stratum. i.e. in the Sisimiut group (Heide-Jørgensen and Born 1995).

2.5 North Water (Baffin Island)

No complete population estimates are available, but surveys of the North Water in the late winter of 1979 indicated that around 700 walruses were present along the ice edge between Jones Sound and Talbot Inlet (Finley and Renaud 1980). Summer surveys indicate that 500-800 walruses move west into the eastern Canadian Arctic in spring (Davis *et al* 1978).

2.6 East Greenland

The only count covering a large area in East Greenland is from 1984, when two sport kayakers counted some 329 walruses from Nordostrundingen (c. 81°N) to Scoresby Sound (c.70°30'N).

2.7 Svalbard-Franz Joseph Land

An estimate has been made from a count of about 750 male walruses at haul-out sites in Svalbard. To account for an equal number of non-calf females, 750 was multiplied by two and 500 added arbitrarily to derive a rough minimum estimate of total population size of about 2000 for the Svalbard-Franz Joseph Land region (Gjertz and Wiig submitted). The estimation procedure was questioned, as no experiments were conducted to simultaneously estimate sex ratio in the population, and because other male aggregations may have been overlooked.

2.8 Kara Sea - Southern Barents Sea - Novaya Zemlya

No population estimate is available. A total of 138 walruses, including females and calves, were counted in 1994 in the Pechora Sea (Haug and Nilssen 1995). Russian literature suggests that the population numbers a few hundred.

3. Catch statistics and recruitment rates

3.1 Current catches

The most recent catch statistics for each stock were reviewed and summarized (Table 1, p 16). Under-reporting continues to be a problem in all areas and most estimates are subject to reporting errors. Department of Fisheries and Oceans (DFO; Canada) records indicate "data quality" by identifying the percentage by which the reported catch may under or over estimate the true catch (e.g. 50 $\pm$ 50% indicates the estimated harvest was 50 but may have been 25 to 75). For the present status review, data with quality ratings greater than 100% were not used. All catch estimates have been rounded to help reflect their imprecision. There are no recent data for some stocks.

Walruses are killed but not retrieved in all stocks but loss rates have been estimated for only a few hunting situations. They range from 0 to 50% (Freeman 1970; Smith and Taylor 1977) but cannot be broadly applied because they vary with location, season, hunting methods, and hunter skill. Orr *et al.* (1986) concluded that 32% of shot walruses were killed but not retrieved during summer hunts in Foxe Basin. This figure has been used to correct the Foxe Basin reported catch although the proportion of the catch made and the loss rates during the winter hunt are unknown.

Born and Kristensen (1981) recorded the outcome of 34 walrus hunts in the Thule District in the 1980s. They found that 15% of shot walruses were not retrieved. Orphaned calves and severely wounded animals were presumed to have died, making the killed but not retrieved estimate 25%. This figure has been applied to the reported catch for Thule but not to catches in other areas where this stock is hunted.

The loss rate in east Greenland has been estimated at 23% (Born *et al*. 1995). This figure has been applied to the reported and estimated catches there.

3.2 Net recruitment rate

In the absence of data specific to the Atlantic walrus, the Working Group accepted a range of net recruitment rates of 2-5%, indicated from a simulation of a hypothetical population of Pacific walruses (DeMaster 1984).

3.3 Estimates of sustainable removals

Catch statistics and net recruitment rates were used to estimate the probable range of population sizes required to sustain current removals. Two sets of estimates were used - the estimated hunting mortality from Table 1 (p.16) which is adjusted for loss rates where these are available; and a conditional estimate of hunting mortality which assumes a 30% loss rate for stocks lacking specific loss rate estimates. Population sizes are calculated using 2 and 5% net recruitment rates (Table 2, p.17).

4. Anthropogenic effects other than hunting

In Working Paper SC/3/13 information on the anthropogenic effects on walruses other than hunting was summarised and evaluated. The Working Group addressed the questions raised by the Council on potential effects on walruses of recent environmental changes (e.g. disturbance, pollution), and changes in food supply. The Working Group considered the potential effects on walrus populations of the following:

- Disturbance from various types of noise (e.g, that caused by aircraft and shipping, offshore exploration and operational activities, military activity);
- Pollution (e.g. spilled oil, heavy metals, organochlorine compounds, radioactivity, nuclear activity);
- Changes in food availability and interactions with fisheries;

4.1 Disturbance from various types of noise

The Working Group discussed the potential effects on walruses of noise from aircraft, ships and offshore exploration and operational activities.

4.1.1 Aircraft and shipping

Walruses react to the noise of aircraft. Although their reactions are variable, they usually escape into the water when the aircraft gets close. In some cases this can lead to stampeding with the result that calves are crushed to death. The long-term effects of repeated and continued disturbance from aircraft noise, however, cannot be evaluated easily. The Working Group could not rule out the possibility that walruses, like many other species, habituate to noise and other forms of disturbance that are not associated with other types of impact. Cases in which walruses have permanently abandoned uglit (e.g. western and eastern Greenland) have involved factors in addition to noise disturbance, such as hunting and smell of humans, dogs, offal etc., that could have been as, or more, significant.

Walruses also react to noise from boats and ships and they usually exhibit an escape response if the vessel gets too close. However, the degree of responsiveness is highly influenced by the type of noise and its source level, the social and behavioral situation of the walruses, and their previous experience with ship noise, especially whether it was associated with more drastic effects such as hunting. The Working Group did not feel that it was in a position to evaluate whether walruses, like many other species, habituate to noise from ships and boats, nor was the available information sufficient for evaluating the long-term effects of ship and boat traffic on walrus populations.

Because most walrus populations have been subjected to hunting pressure, in many cases intensive and over many years, and because various other human activities have modified walrus habitat through time, it will be very difficult to demonstrate long-term effects, at the population level, caused specifically by exposure to noise.

4.1.2 Offshore exploration and operational activities

Activities associated with oil and gas exploration are now occurring in many areas inhabited by Atlantic walruses. In some areas these activities are large-scale. For example, in the Svalbard area there has been extensive offshore explorations for oil since the early 1980s, and exploratory drilling is presently under way a little south of Bear Island. The feasibility of exploitation on Spitsbergen Bank between Bear Island and the island of Hopen is being evaluated, and exploitation is expected to be initiated before the end of this century. The world's largest field of liquified natural gas, the Stockmann field, is found in the Barents Sea.

In the western Russian Arctic, large oil and gas fields exist in the southern Barents Sea from the White Sea northeast to southern Novaya Zemlya, and along the west coast of Novaya Zemlya. Furthermore, large fields in the Kara Sea stretch eastward to the Yamal Peninsula. Seismic surveys started in 1971, and exploratory drilling in 1981. Several drilling platforms are present along western Novaya Zemlya and in the Kara and Pechora Seas, and oil is now produced on Kolgujev Island. These oil fields overlap with the summer distribution of walruses and therefore large-scale petroleum activities pose a potential threat to walruses in these areas.

At present, there is no exploitation of non-renewable resources in Greenland. Since 1991, however, marine seismic activity related to oil exploration has occurred along the coasts north to 79°N in eastern Greenland and 77°N in western Greenland.

The Working Group was not aware of any offshore petroleum development activity presently occurring in the eastern Canadian Arctic in areas currently occupied by walruses.

In a study of the effects on Pacific walruses of offshore drilling, the animals were found to exhibit only weak short-term behavioral responses to the drilling activities *per se*. They reacted, however, to the ice-breaking activities associated with these operations by moving away for a short time.

The Working Group was not aware of any studies which allowed it to make any conclusions about long-term effects of various exploration and operational activities on walruses.

4.1.3 Military activity

The Working Group was not able to evaluate the extent to which military activity (e.g. rocket launching, explosions) in different areas (e.g. southern Barents Sea) may adversely affect walruses.

4.2 Pollution

4.2.1 Oil spills

The Working Group was not aware of any studies that specifically addressed the direct or indirect effects of oil on walruses.

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

It was the opinion of the Working Group that some features in the ecology of walruses make them more vulnerable to the harmful effects of spilled oil than are many other marine mammals:

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

ii) Walruses tend to inhabit coastal areas and areas of relatively loose pack ice.

Spilled oil is likely to accumulate in such areas. Walruses therefore have a high risk of being fouled not only in the water but also when they haul out on rocks or land.

iii) Because they are benthic feeders, walruses may be more likely to ingest petroleum hydrocarbons than are most other pinnipeds. Benthic invertebrates are known to accumulate petroleum hydrocarbons from food, sediments and the surrounding water. The implications for walruses may be serious since contaminants in their food are certain to build up in their own tissue. In addition, oil contamination may reduce the biomass or productivity of the invertebrate communities that sustain walruses. Walruses would then be forced to seek alternative food or feeding areas. In such a situation, it cannot be assumed that alternative types of food or feeding areas are actually available, however, so such a scenario could prove detrimental to the walruses.

The Working Group was not able to evaluate the effects of a recent major oil spill on land in northwestern Russia. It noted, however, that the massive contamination could eventually reach marine waters and affect walruses in some way, especially the small population in the Pechora Sea region.

4.2.2 Heavy metals and chlorinated hydrocarbons (CHCs)

The Working Group considered the potential effects on walruses of two classes of pollutants that have given particular cause for concern in marine mammals: heavy metals and chlorinated hydrocarbons (CHCs). Few studies, however, have been made of these pollutants in walruses.

The three metals which give greatest cause for concern are mercury (Hg), cadmium (Cd) and lead (Pb). The levels of heavy metals in Pacific walruses have been found to be very high. In certain organs these levels exceeded those considered safe for human consumption. Levels in Atlantic walruses, however, have been found to be less than in Pacific walruses. Certain metals have been found in relatively high concentrations in walruses from Foxe Basin (Cd), southern Hudson Bay (Pb and Hg) and northwest Greenland (Hg).

CHCs are anthropogenic chemicals which accumulate mainly in blubber and are of concern because of their potentially harmful effects on walrus reproduction, the walrus immune and hormone systems, and human health through consumption of contaminated walrus tissue. Walruses have generally low concentrations of CHCs. Especially high concentrations have, however, been found in Eastern Hudson Bay compared to other areas where this has been studied (i.e. other parts of Canada, West Greenland and Alaska). It is speculated that the high concentrations might be related to the significant consumption of ringed seals by these individuals.

The Working Group was concerned about the findings of comparatively high levels of CHCs in some walruses. It was, however, unable to reach a conclusion about what these findings mean to the walruses or to the people who consume them.

4.2.3 Radioactivity and nuclear activity

The Working Group noted that only few studies have been made on radioactive elements in walruses.

In connection with an airplane crash in the Avanersuaq area (Thule area, northwestern Greenland) plutonium was released from nuclear bombs to the surroundings. Analyses of plutonium in sediment, bivalves (including walrus food items) and other benthic organisms collected at the crash site showed values to be elevated from background levels. A study concluded, however, that in this area the plutonium levels in the animals at higher trophic levels such as birds, seals, and walruses were hardly significantly different from the fall-out background. Recent analyses gave the same results.

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

No information is available about the effects on walruses of the nuclear activities in the Novaya Zemlya region and the Working Group could not evaluate the potential effects. Second-hand information, however, from Russian sources indicates that certain walrus haul-out sites in Novaya Zemlya were deserted in the 1960s due to nuclear testing on this island.

4.3 Changes in food availability and interactions with fisheries

The Working Group considered the potential effects on walruses of changes in food supply and direct and indirect effects of interactions with fisheries.

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

The Working Group concluded that although the direct and indirect effects of fisheries on Atlantic walruses are basically unknown, some effects very likely do occur. Fisheries using bottom-draggers have destroyed potential walrus feeding habitat at Svalbard. The noise from fisheries in or near walrus habitat and the disturbance of the sea floor caused by trawling have probably contributed, perhaps synergistically, to the continued depletion of the stock of walruses wintering off central West Greenland.

Intensive fisheries along the coasts of Svalbard and in the Barents Sea also may have prevented walruses from repopulating areas that, from a purely trophic perspective, still appear to be suitable walrus habitat.

5. Recommendations

The Working Group identified many information gaps. They are listed here with possible research approaches. This listing does not preclude the investigation and application of other methods. Items are not listed in any order of priority because priorities will vary according to stock and management objectives.

1. Determine stock identity, especially for international, hunted stocks (e.g. using mtDNA, nuclear DNA, morphometrics, tagging, contaminants, etc.).

2. Determine stock size and/or trend, especially of hunted stocks (e.g. using aerial surveys, haul-out monitoring, biological sampling), as suits management objectives.

3. Evaluate effects of industrial activities including disruption of behaviour and contaminant pathways and effects (e.g. experimentation, feeding habits, physiology).

4. Improve catch statistics and expand to include information on (at least) sex, age, location and loss rates (e.g. biological sampling).

5. Evaluate behaviour related to within-population segregation (e.g. haul-out monitoring, attachment of satellite-linked radio transmitters (PTTs));

6. Assess critical habitat with respect to fisheries interactions and industrial activity (e.g. using PTTs).

6. List of documents

SC/3/6	Report of the 2nd Walrus International Technical and Scientific (WITS) Workshop, 11-15 January 1993, Winnipeg, Manitoba, Canada (eds. R.E.A. Stewart, P.R. Richard & B.E. Stewart)
SC/3/8	T. Haug & K. T. Nilssen, "Observations of Walrus *Odobaenus Rosmarus* in the Southeastern Barents Sea in February 1993".
SC/3/13	E.W. Born, I. Gjertz and R.R. Reeves, Population assessement of Atlantic walrus (*Odobenus rosmarus rosmarus*).
SC/3/16	M.P. Heide-Jørgensen and E.W. Born, Monitoring walrus abundance off West Greenland.

Figure 1. Delineation of possible sub-groups used in review of the status of Atlantic walrus

1. Foxe Basin
2. Southern and Eastern Hudson Bay
3. North Hudson Bay - Hudson Strait - North Labrador - Southeast Baffin Island
4. Central West Greenland
5. North Water (Baffin Bay)
6. East Greenland
7. Svalbard - Franz Joseph Land
8. Kara Sea - South Barents Sea - Novaya Zemlya

Table 1 Estimated removals of Atlantic walrus by stock area

Stock	**Year**	**Reported average annual catch (ref)**	**Year**	**Estim. loss rate (ref)**	**Estim. total removal**	**References & comments**
Foxe Basin	1988/89 to 1992/93	200 (1)	1980s	32% (2)	300	(1) DFO, 1991...94 (2) Orr *et al.* 1986
S. & E. Hudson Bay		35 (3)		nd	35+	(3) Richard & Campbell 1988 (estimates out-dated and of poor reliability)
N. Hudson Bay - Hudson Strait - N. Labrador - S.E. Baffin Island	1988-89 to 1992-93 1972-85	160 (1) 70 (3)		nd	230+	(1) DFO, 1991...94 (3) Richard & Campbell 1988 (estimates out-dated and of poor reliability)
Central West Greenland *- Disko Group* *- Sisimiut Group*	'80-'87 '80-'87	10(5) 40(5)		nd nd	10+ 40+	(5) 10 from Upernavik, Born *et al* 1994
North Water (Baffin Bay)	1988-89 to 1992-93 1970-80 1980-87	20 (1) 250 (4) 10 (5)	1980s	nd 25% (6)	360+	(1) DFO, 1991...94 (4) Born (1987) estimated for Thule only. (5) 10 from Upernavik, Born *et al* 1994 (6) Born & Kristensen 1981
East Greenland	'80 to '87	16 (7) or 20 (8)	1980s	23% (8)	20 to 25	(7) SC/3/13 - reported catch is an underestimate (8) Born - estimated from interviews (SC/3/13)
Svalbard - Franz Joseph Land		protected			+ (9)	(9) Small unreported kill at Franz Joseph Land (SC/3/13). From 1989-93 there were 4 killed during scientific studies
Kara Sea - S. Barents Sea - Novaya Zemlya		protected			+ (9)	(9) Small unreported kill (SC/3/13)

Table 2 Calculations of size of various Atlantic walrus stocks necessary to sustain estimated current removals

Stock	**Reported annual average catch (from Table 1)**	**Required Population assumng NRR* of 0.05**	**Required Population assumng NRR of 0.02**	**Estimated total annual removal (from Table 1)**	**Required population assuming NRR of 0.05**	**Required population assuming NRR of 0.02**	**Abundance Estimate**	**Probable trend [1]**
Foxe Basin	200	4000	10000	300	6000	15000	5500 (95% CI 2700-11200)	stable?
S. & E. Hudson Bay	35	700	1750	50¤	1000	2500	no data	unknown
N.Hudson Bay - Hudson Strait - N. Labrador - S.E. Baffin Isl.	230	4600	11500	330¤	6600	16500	no data	unknown
North Water (Baffin Bay)	280	5600	14000	380¤¤	7600	19000	no data	declining?
Central West Greenland - Disko group - Sisimiut grp.	10 40	200 800	500 2000	15¤ 60¤	300 1200	750 3000	no data	declining
E. Greenland	20	400	1000	25	500	1250	no data	stable/ increasing?
Svalbard-Franz Joseph Land	protected			+			2000	increasing
Kara Sea - S. Barents Sea - Novaya Zemlya	protected			+			no data	increasing?

* NRR = Net Recruitment Rate

1 Derived from full Scientific Committee discussions

¤ where no stock-specific data were available, 30% was used

¤¤ 25% for Thule, 30% for Canada and Upernavik

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Appendix 1

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SC/3/6	Report of the 2nd Walrus International Technical and Scientific (WITS) Workshop, 11-15 January 1993, Winnipeg, Manitoba, Canada (eds. R.E.A. Stewart, P.R. Richard & B.E. Stewart)
SC/3/8	T. Haug & K. T. Nilssen, "Observations of Walrus *Odobaenus Rosmarus* in the Southeastern Barents Sea in February 1993".
SC/3/13	E.W. Born, I. Gjertz and R.R. Reeves, Population assessement of Atlantic walrus (*Odobenus rosmarus rosmarus*).
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