ANNEX 3

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON THE STOCK STATUS OF WALRUSES IN THE NORTH ATLANTIC AND ADJACENT SEAS

1 OPENING REMARKS

Chairman Erik Born welcomed the delegates (Section 5.7, p. 379) to the meeting and wished them a pleasant and productive stay in Copenhagen.

NAMMCO has had an interest in the walrus right from its beginning in 1992. One of the first requests for advice given to the Scientific Committee in 1993 was to provide an overall assessment of Atlantic walrus populations, including stock identity, abundance, long-term effects of removals on stocks in each area, and the effects of recent environmental changes (*i.e.* disturbance, pollution) and changes in the food supply. This assessment work eventually led to the compilation of a status report on Atlantic walruses (Born *et al.* 1995, NAMMCO 1995) which identified putative walrus stocks based on available evidence, and provided an assessment on each stock. This report was used by the Scientific Committee as the basis of its management and research recommendations to Council.

Over 10 years have now passed since the first assessment of North Atlantic walruses by NAMMCO. New research has been conducted in the interim, providing information on stock delineation, distribution and abundance, ecology, biological parameters and behaviour. Noting this, in 2004 the NAMMCO Management Committee requested the Scientific Committee to provide an updated assessment of walruses, to include stock delineation, abundance, harvest, stock status, and priorities for research.

It was agreed that the meeting would be chaired by Mads Peter Heide-Jørgensen.

2 ADOPTION OF AGENDA

The Draft Agenda (Appendix 1) was adopted with minor changes.

3 APPOINTMENT OF RAPPORTEURS

Daniel Pike, Scientific Secretary of NAMMCO, was appointed as Rapporteur for the meeting, with the assistance of other members as required.

4 REVIEW OF AVAILABLE DOCUMENTS

Documents available for the meeting are listed in Appendix 2.

5. STOCK STRUCTURE

5.1 Genetic information

There have been no new genetic analyses of Russian samples. Øystein Wiig informed the Working Group that he is attempting to obtain samples from Russia for a joint project between Russia and Norway.

SC/13/WWG/13 presented genetic analyses comparing samples from 70 walruses from Hudson Bay and Hudson Strait (Canada) with previously analysed samples from West Greenland, northwest Greenland, East Greenland, Svalbard, and Franz Josef Land. These analyses indicated (1) the existence of two major complexes of walruses consisting of three sub-populations to the west of Greenland (east Hudson Bay/Hudson Strait, West Greenland, northwest Greenland) and two sub-populations to the east of Greenland (East Greenland and Svalbard-Franz Josef Land); (2) that walruses from the east Hudson Bay/Hudson Strait area are genetically different from West Greenland walruses; (3) that walruses from the east Hudson Bay/Hudson Strait area are more closely related to those wintering in West Greenland than to those occurring nearly all-year round in northwest Greenland (the NOW sub-population); (4) that the walruses in east Hudson Bay/Hudson Strait area seem to function to an unknown extent as a source for the West Greenland walruses; (5) that walruses from the east Hudson Bay/Hudson Strait area probably have been separated from the northwest Greenland walruses for a longer period of time compared to West Greenland walruses; (6) that walruses from East Greenland constitute a separate sub-population with limited connection to the Franz Josef Land- Svalbard sub-population.

The Working Group found these results generally confirmatory of the putative stock structures suggested previously by NAMMCO (1995). They supported the previous conclusion that there is no difference between walruses sampled in Franz Josef Land and Svalbard. However samples from East Greenland were discriminated from both of these areas. They strengthen the suggestion that there is a link between the North Hudson Bay-Hudson Strait-North Labrador-Southeast Baffin Island (HBDS) and West Greenland (WG) stocks, and indicate that the HBDS stock may be a source of immigration to the WG stock. It was noted that only a limited part of the HBDS stock area had been sampled, and that samples from the Southeast Baffin area in particular are urgently needed. There also remains the possibility that there may be sub-structuring within the HBDS and WG stocks.

Some new information on genetic stock delineation of Canadian populations was provided in SC/13/WWG/5. Walruses taken by the Foxe Basin communities of Igloolik and Hall Beach were not distinguishable using mitochondrial DNA and 9 microsatellites. However they could be distinguished from walruses sampled at Resolute, Grise Fiord, and Bathurst Island, indicating a difference between the putative Foxe Basin and North Water (NOW) stocks. Within the NOW stock area, preliminary microsatellite analyses of small sample sizes have indicated a difference between walruses sampled at Grise Fiord and those sampled in Penny Strait, and between West Jones Sound and the Penny Strait area, but not between Western Jones Sound and Resolute Bay. In addition there was no significant difference between walruses sampled at Grise Fiord and Resolute Bay. These results suggest that 1) the

Foxe Basin stock is separate from the NOW stock; and 2) that there is likely substructure within the NOW stock area.

There was some speculation that more complex stock structure may be generated in heavy ice areas, because of the limited size and wide separation of open water areas for overwintering. In this regard the further sub-division of the NOW stock area might be expected.

Chad Jay reported that Pacific walruses are presently considered to be one panmictic stock occupying Alaskan and Russian waters. Genetic analysis is in progress but no results were available as yet.

Conclusions

The Working Group concluded that the genetic analyses presented were generally confirmatory of the putative stock structures previously suggested by NAMMCO (1995), with the exception that HBDS differed from West and northwest Greenland and that there may be further sub-division within the NOW stock area. There is also an indication that HBDS may serve to an unknown extent as a source population for West Greenland.

5.2 Satellite tracking

No satellite tracking studies have been conducted in Russia. Christian Lydersen reported that satellite tagging had been conducted in southeast Svalbard in 2003, and in northern Svalbard in 2004. Some tags have transmitted for more than 1 year. Mainly male walruses are found in the southeast, while animals of both sexes as well as calves occur in the northern area. Some of the animals tagged in the southeast have moved between Svalbard and the Franz Josef Land, while those tagged in the northeast have, to date, remained in that area. This information suggests that while there is mixing between Franz Josef Land and Svalbard, there is sex and age segregation within the Svalbard archipelago and patterns of movement may differ locally. All the animals tagged have been adult males.

Born reported that 19 walruses have been tagged at two locations in East Greenland since 1995. The tags have lasted for a maximum of 199 days. All tagged animals have made only local movements and remained in East Greenland, with some exchange between the two land haulouts in East Greenland, indicating that the same walruses use both sites. The movement patterns of walruses in this area provide no evidence of substructure within the East Greenland stock.

Recent information from satellite tagging in western Jones Sound, Penny Strait and southern Devon Island was presented in SC/13/WWG/5. These tags have endured for a maximum of 3 months. In Western Jones Sound, the animals have remained in the area between August-November and there is no indication that they move out into Baffin Bay to overwinter. Their distribution does not appear to overlap with the hunting area used by Grise Fiord in eastern Jones Sound, suggesting a division between eastern and western Jones Sound. No tagged animals have moved through Hell Gate or Cardigan Strait. These results suggest that western Jones Sound holds a distinct stock of walruses that overwinters in the pack ice around Hell Gate and Cardigan Strait.

Walruses tagged in Penny Strait tended to remain in that area, but tag durations were short and none have endured later than September. One male walrus tagged in this area in 1993 was killed in 1994 near Pond Inlet. Another tagged animal moved to southwest Devon Island. Walruses tagged near southwest Devon Island have remained in that area. Walruses do overwinter in polynyas in Penny Strait area. This information suggests that there may be a separate stock of walruses in the Penny Strait/Lancaster Sound area, but confirmatory data are needed.

Conclusion

Satellite tagging conducted since 1995 has strengthened the conclusion that there is a single stock of walruses occupying the Svalbard and Franz Josef archipelagos, and another off East Greenland. However the new information suggests a sub-division of the NOW stock area, possibly into 3 areas including western Jones Sound and Penny Strait/Lancaster Sound stock areas.

5.3 Tissue signatures (pollutants, trace elements *etc.*)

In Canada and Greenland, lead isotope ratios (^{208}Pb/Pb ^{207}) and trace element profiles have been used as a tool in stock discrimination studies (SC/13/WWG/5, Outridge and Stewart 1999, Outridge *et al.* 2003), under the assumption that concentrations in the teeth represent a cumulative sample from the spatial/temporal environment of the animal, and therefore reflect stock differences. Walruses sampled at Akulivik (HBDS) differed from those sampled at Inukjuak (SEHB) in lead isotope ratios, trace element profiles and also in organochlorine concentrations and profiles in the blubber (Muir *et al.* 1995). Lead isotope ratios of animals taken at Coral harbour differed from those taken to the east at Akulivik. These two communities are within the putative HBDS stock area and therefore the results suggest subdivisions within this area, or possibly a cline of population characters across the area.

Walruses landed at Foxe Basin communities differ from all areas on the basis of lead isotope ratios. Within the area walruses landed at Hall Beach and Igloolik can be differentiated. Even though the communities are less than 150 km apart, their hunting areas generally do not overlap (SC/13/WWG/5). Examination of individual growth layer groups of Hall Beach males indicates that some may make excursions into other areas, but it is not known if they contribute to other populations on these excursions.

Discussion

There was considerable discussion about the applicability of these methodologies to discriminating stock groupings relevant to management. It is apparent that the methods have high discriminatory power even with rather low sample sizes, and where the walruses likely share a common overwintering area, as in Foxe Basin. Some members noted that isotope ratios and trace element signatures may reflect a clinal phenomenon and that the scale of sampling would have a great influence over the number of groupings discriminated. It is not known if a significant difference in isotope ratios between two adjoining areas is of relevance to determining the effects of differential harvesting on these animals. Other members noted that further substructuring of walrus populations was to be expected due to their life history and habitat requirements. Even if 2 groups share an overwintering area and breed as a single population unit, they may occupy different areas in the summer and be susceptible to differential exploitation. Since isotope ratios are a reflection of the migratory patterns of the animals, they are useful in discriminating management stocks. In this view the further splitting of putative walrus stocks is a conservative approach and all relevant evidence, including isotope ratios, should be considered. The Working Group agreed to use this as supplementary evidence.

5.4 Other information

SC/13/WWG/7 and SC/13/WWG/8 presented seasonal distributions of walruses in the Barents, Kara, and Laptev seas from Russian sea ice reconnaissance flights conducted from the 1950's to the 1990's. These observations show no apparent gaps in summer or winter distribution between the northern Barents, Kara, and Laptev Seas. It was considered likely that the animals in the northern Kara Sea were connected to those inhabiting the Franz Josef archipelago and areas farther west. There was a clear separation between these animals and those inhabiting coastal areas south of Novaya Zemlya. There was also an area with many sightings in the southern Laptev Sea extending east to the Novosibirsk Islands, but a clear gap between this area and the Pacific walrus population farther to the east. The authors considered that this distributional evidence suggested the existence of three populations in the area: a Northern population inhabiting the northern Barents, Kara, and Laptev seas, including the Franz Josef islands; a Southern population with a core area in coastal areas south of Novaya Zemlya, and a Laptev population inhabiting the Laptev Sea east to the Novosibirskie Islands.

The Working Group welcomed this information, but noted that additional information, perhaps from genetic, satellite tagging or other studies, would be required before putative stocks could be identified with any certainty.

5.5 Management units

The Working Group considered that while the putative stock units identified in 1995 were in the main supported by new information, some revisions would be required, and these are summarised in Fig. 1 and Table 1. In particular the Working Group agreed to adopt for this assessment the division of the NOW into 3 areas, as suggested by SC/13/WWG/5.

6. BIOLOGICAL PARAMETERS

6.1 Age estimation

Age of walruses is determined by counting growth layer groups in sectioned teeth. There was no new information available to the Working Group on this topic.

6.2 and 6.3 Biological parameters

New information and estimates of biological parameters by region are presented in

Table 2.

7. CATCH STATISTICS

7.1 Reported catch

No recent catches of walruses have been reported from Svalbard or the western Russian Federation, and walrus hunting is prohibited in these areas.

Walrus catches in Greenland from 1946 to 2002 were presented in SC/13/WWG/15 and apportioned to the three putative stocks in Greenland (West Greenland, North Water, and East Greenland). The data were extracted from various sources including the Hunters' Lists of Game (until 1987) and a system for recording hunting statistics (Piniarneq) that was introduced in 1993.

For East Greenland, there are many years with no reports prior to 1993. After the introduction of Piniarneq in 1993, reported catches generally increased and varied greatly, ranging from 1 to 99. By comparison with information on previous catch levels (Born *et al.* 1995, NAMMCO 1995), SC/13/WWG/15 considered some of the higher records in Piniarneq to be implausible. Similarly in West Greenland reported harvests have increased substantially since the introduction of Piniarneq, ranging between 116 and 265 over the period 1993 to 2002. For northwestern Greenland there were few years with valid harvest reports prior to 1993, and reported harvests have not increased since then, ranging from 72 to 265. Validation of catch records is urgently needed and Born speculated that the anomalously high harvest years observed in East and West Greenland since the introduction of Piniarneq might be due to multiple reporting of the same animal by hunters, but could not present data to support this.

Harvest data from the Nunavut Wildlife Harvest Study (NWHS) and a recent compilation for the Committee on the Status of Endangered Wildlife in Canada were reviewed for reported catches in Canada since 1995 (SC/13/WWG/4). All walrus harvest data were plagued by incomplete reporting but data for almost half the annual community totals agreed between sources. When the two estimates did not agree, the larger of the two estimates was used UNLESS the original source expressed serious concerns, in which case "no data" were recorded. Best estimates, likely reliable only to an order of magnitude, are presented for the period 1996-2001.

In discussion the Working Group noted that, even with the advent of new harvest reporting systems in both Canada and Greenland, there was still a high level of uncertainty in the catch reports. Accurate catch reports are crucial for understanding the impact of hunting on the stocks. It was recommended that catch data should be reported fully, including collection, analytical and extrapolation methods, and potential biases. If extrapolations are used, the statistics should include an estimate of uncertainty. Multiple reporting has not been considered an issue with respect to Canadian harvest statistics. It is suspected in Greenland and multiple reporting should be investigated in both areas. The return of a biological sample, preferably a lower jaw, would both validate harvest reports and provide important biological data, and should be considered in any new data collection programs.

7.2 "Struck and lost"

No new information on struck and lost rates has become available from any area. In 1995 this Working Group assumed a loss rate of 30% for stocks lacking specific loss rate information (NAMMCO 1995), and the Working Group saw no reason to change this assumption.

7.3 Catch histories by management units

Estimates of recent average harvests by stock area are presented in Table 3.

8. ABUNDANCE AND TRENDS

8.1 Recent estimates

A coastal ship survey of northern Novaya Zemlya was carried out in August-September 1998, resulting in sightings of about 400 walruses and an estimate of about 600 for the area (SC/13/WWG/7). There are no recent abundance estimates for other areas of the western Russian Federation. SC/13/WWG/7 provided "best guess" estimates of around 3,000 for the Russian part of the Barents sea and the Kara Seas, and 4-5,000 for the Laptev Sea. These estimates could not be divided by stock. The Working Group accepted these estimates for information but noted that they were not of sufficient quality to use in assessments. No recent estimates are available for the Svalbard area.

Based on opportunistic and systematic observations, the East Greenland walrus population was estimated to number *ca* 1,000 (Born *et al.* 1997). The Working Group accepted this estimate for information but noted that it was not of sufficient quality to be used in assessments.

No recent estimates of abundance were provided for West Greenland. The main wintering grounds have been surveyed from aircraft 9 times between 1981 and 1999. Estimates of abundance from 1990 and 1991 surveys using line transect methods were developed by Born *et al.* (1994) and were 458 and 631 respectively (average 545, cv 0.48). SC/13/WWG/6 applied a correction factor of 5 to the estimate of the animals seen in the water, and then added this to the total estimated to be on ice to derive a total estimate of 938 (cv 0.48).

In discussing this estimate the Working Group noted 5 main difficulties: 1) the perpendicular distance functions for animals on the ice and in the water were inappropriately pooled because the functional forms for the two types of sightings are different; 2) the correction factor for diving walruses was not specific for this survey; 3) no variance from the correction factor was included in the estimate, and this is likely to be considerable; 4) there was no correction for perception bias; 5) the two types of sightings are not independent because walruses on ice responded to the 'plane by entering the water. The Working Group could not accept this estimate and recommended that it be re-calculated. It was also recommended that all available surveys from this area should be analysed in a consistent manner.

To enumerate walruses in the North Water, an aerial survey was conducted from 11-19 August 1999 over terrestrial haulouts and along the coasts on eastern Ellesmere Island and in the Jones Sound, south Devon Island and Cornwallis Island – Grinnell Peninsula areas in Canada (SC/13/WWG/6). A total of 452 walruses was counted, of which 73.5% were hauled out. SC/13/WWG/6 used correction factors for those animals seen in the water and those animals seen on land to derive an estimate of about 1,000 walruses for the area. Unsurveyed areas included the southern coasts of Lancaster Sound and Barrow Strait and adjacent areas, and a section of the eastern coast of Ellesmere Island. SC/13/WWG/6 used a "guesstimate" of 500 animals in these areas to produce a total estimate of 1,500 for the NOW area.

The Working Group found that the survey was not presented in sufficient detail for evaluation purposes. Generally it was uncertain whether the correction factors applied for diving and hauled out walruses were appropriate, and it was noted that they were applied without additional variance. The survey was flown under "optimal" conditions and it is not known how environmental conditions affect the proportion of walruses hauled out in this area. In Svalbard, weather appears to have little effect on haulout behaviour of adult males in the summer, but some effects have been noted in Canada and in East Greenland (Salter 1979, Born and Knutsen 1997). The Working Group accepted the estimate for information but noted that it should not be used directly in assessments without further work and documentation.

No new estimates are available from Foxe Basin. Bowhead whale surveys conducted in the area recently are being analysed for walrus distribution and abundance and will form the basis of new abundance estimates.

The Working Group was hindered in its work by the lack of information on the abundance from all areas, and except for the Canadian High Arctic (North Water), there has been no progress in obtaining abundance estimates since 1995. Abundance estimates are an essential component of any assessment, and there can be little progress in establishing sustainable harvest levels and improving conservation measures until this need is addressed.

Available estimates of abundance by stock area are provided in Table 3.

8.2 Trends in abundance by management units

There was no new information on trends in abundance from any area. It was recommended that all surveys in the West Greenland should be analysed in a consistent manner to evaluate trends in abundance or relative abundance.

8.3 Future survey plans

There are no immediate plans to carry out walrus surveys in the Russian Federation.

Lydersen informed the Working Group that an aerial digital photographic survey will be carried out on all known land haulouts in Svalbard in summer 2005. A correction factor derived from satellite tagging data will be used to estimate the total number of walruses using the area.

A survey of West Greenland is presently in the planning stages and should be conducted within 2-3 years. There are no immediate plans to survey the NOW or East Greenland areas.

Stewart informed the Working Group that, in Canada there are plans to use biopsy sampling and DNA analysis to develop mark/recapture estimates for western Jones Sound, the Penny Strait/Lancaster Sound area and Foxe Basin. Data on numbers and distribution of walruses recorded during bowhead surveys in Foxe Basin are being collated in preparation for future population estimates. In addition there have been some counts at Cape Henrietta Maria in James Bay and these will be analysed in the near future. There are no plans for surveys in other areas.

9. ECOLOGY

9.1 Diet and consumption

Indirect measures of the energy consumption rate of two walruses performed by the Doubly Labelled Water technique (DLW) were presented in paper SC/13/WWG/11. These measures of CO_2 production by DLW yielded an estimate of Field Metabolic Rate (FMR) of 328.1 MJ/day for the 1,370 kg walrus and of 365.4 MJ/day for the 1,250 kg walrus. On average this corresponds to 346.8 MJ/day for a 1,300 kg walrus. Considering the average prey composition in the area, when converted to "mussel-equivalents" these FMR values correspond to 67 kg wet-weight per day (5% of total body mass (TBM)) for the 1,370 kg walrus and 75 kg wet-weight per day (6% of TBM) for the 1,250 kg walrus.

To relate this to the availability of food resources in the area (SC/13/WWG/10) the total consumption of bivalve prey by walruses was estimated. Area-use of three adult male walruses equipped with satellite transmitters was measured during the open water season in 1999 and 2001. Overall, the animals spent *ca* 30% of the time in the water in the inshore study area in Young Sound. Information on the total number of walruses using the area (n=60), occupancy in the study area, and estimates obtained from satellite telemetry on the number of daily feeding dives (118-181/24 h at sea), was used to calculate the amount of bivalve food consumed by the walruses during a total of 1,620 "walrus feeding days" inshore. Depending on the number of feeding dives, the estimated consumption by walruses of shell-free (SF) bivalve wet weight (WW) during the open water period ranged between 111 and 171 tons. Based on estimates of mean total body mass (1000 kg) of walruses using the area and daily per capita gross food intake, the corresponding estimate of consumption by walruses is 97 tons SF WW. Daily feeding rates in walruses (*ca* 6% of TBM) indicate that an estimate of total predation of around 100 tons SF WW per year is plausible. According to these parameters walrus predation during the open water season amounts to *ca* 0.8

% of the standing biomass of *Mya sp.* and *Hiatella sp.*, and *ca* 92 % of the annual production of these bivalves.

The Working Group speculated that the rather high feeding and field metabolic rates might be due to walruses depositing blubber from a low-lipid diet. Little information on the seasonality of walrus feeding is available but it was considered that in East Greenland they would have no access to their shallow water feeding areas in the winter.

Lydersen informed the Working Group that a library of fatty acid profiles from prey species from Svalbard and Greenland is being developed and will be compared to fatty acid profiles from walrus blubber from the same areas.

9.2 Impact of global warming

The predicted warming of the Arctic may have a negative effect on walruses. SC/13/WWG/14 offered the alternate hypothesis that Atlantic walruses eventually could benefit from Arctic warming and associated decrease in ice cover.

Historically, walruses lived in areas farther south than their present range. Their present status as Arctic animals is due, in large part, to persecution by man. Atlantic walruses may benefit, at both the individual and the population level, from increased productivity in near-shore waters and from greater access to inshore foraging areas due to Arctic warming. The population size of walruses in most areas of the North Atlantic is probably still far below carrying capacity. Thus, sufficient food resources are assumed to be available as long as all traditional feeding areas will still be available in spite of the lack of ice floes to rest on. A decrease in Arctic sea ice and consequential lengthening of the open-water period could increase the amount of time in which Atlantic walruses have access to the food-rich coastal areas. Walruses are not forced offshore by reduced ice cover but rather may spend more time inshore and thus benefit from the reduction in fast ice and the greater access to shallow-water foraging areas.

It is likely that the hunting pressure on walruses will increase as the amount and duration of ice cover in Arctic regions declines. Apart from humans, the main predators of walruses are polar bears and killer whales. In the absence of sea ice, walruses of all age classes will be forced to use terrestrial haulout sites more frequently and this could expose them to increased predation from polar bears. With less ice to entrap them or obstruct their movements, killer whales may be able to remain for longer periods in walrus areas and this could result in increased walrus mortality. In general then, mortality of walruses from predation might be expected to increase as a result of climatic warming.

The Working Group agreed with the authors of SC/13/WWG/14 that climatic warming was likely a lesser threat to walruses than to other ice breeding pinnipeds, mainly because of their behavioural flexibility in using ice and land haulout sites. Effects on benthic production by reduction in ice cover could not be evaluated by this group. Boreal species (fish and invertebrates) may move into areas presently occupied by walruses and compete with them for food. Ice may be a more important platform for females and calves, providing them with access to feeding areas without travelling long distances from land haulouts. Also there is little direct evidence that walruses can give birth in the water, so females may be dependent on ice for this reason.

It was also noted that the situation is quite different for Pacific walruses, which are dependent on ice as a resting platform in areas where they feed.

The Working Group could not come to any conclusions about the potential effect of global warming on walruses. While walruses could adapt to warmer conditions, perhaps more readily than other Arctic pinnipeds, it was not clear that a warmer climate would be beneficial to them. It was emphasised in this context that the most immediate threat to walrus populations is over-exploitation, not climate change.

9.3 Pollution

Organochlorines

Wiig *et al.* (2000) used samples from 10 adult male walruses from Alaska to investigate the relationship between organochlorine (OC) levels in skin and blubber of individuals. For analyses they selected eleven components that were quantified in the blubber of all individuals. The mean levels in the two types of tissues were significantly different for three of the 11 chemical components. The correlation between the levels in the two types of tissues was significant for all components. In August 1993, skin biopsies were collected from 25 adult male walruses at haulout sites in southeastern Svalbard and from 28 walruses of different sex and age at haulout sites at Franz Josef Land. For all OCs the levels were between five and ten times higher at Svalbard than at Franz Josef Land. A principal component analysis (PCA) detected differences between areas in OC levels and not in patterns. Since the Franz Josef Land samples were mainly taken from females and young individuals, while the Svalbard samples were taken largely from adult males, it is likely that differences in sex and age in the samples may be one of the main causes for the difference in OC levels.

Comparable data for organochlorine levels in skin samples from walruses from other areas are not available. Based on skin biopsy samples, the OC levels presented from Svalbard and Frans Josef Land are high in relation to levels found in walrus blubber in other areas, including northwest Greenland (Born *et al*. 1981), East and northwest Greenland (Muir *et al.* 1999, 2000), eastern Canada (Muir *et al*. 1995) and Alaska (Seagars and Garlich-Miller, in press). The relatively high levels of OCs in walruses from Svalbard and Franz Josef Land may be a combined effect of high pollution level in the environment and seal-eating habits. The study demonstrates that it is possible to use skin biopsies taken by a nondestructive method, to monitor OC levels in walruses.

Heavy metals

Wiig *et al.* (1999) analysed hair samples from adult male walruses collected from anaesthetized individuals at Svalbard for cadmium and total mercury. The mean level of cadmium was 0.860 ± 0.321 µg/g dry weight (dw) (median = 0.811, range = 0.349-1.51 µg/g dw) and the mean level of mercury was 0.235 ± 0.100 µg/g dw (median =

0.251, range = 0.121-0.424 µg/g dw). Levels of cadmium and mercury in hair of walruses from other areas are not known. Both cadmium and mercury levels in hair of walruses from Svalbard are relatively low compared to the levels found in the hair of other marine mammal species. It has been documented from a number of marine species, including marine mammals such as ringed seals and polar bears, that both cadmium and mercury levels at Svalbard are lower than in other areas. It is uncertain to what degree levels in hair reflect levels in internal organs in walruses. In rare and highly endangered species or populations, tissue samples can be difficult to collect. With walruses it is possible to collect hair from anaesthetised individuals or at the haulout sites during moult, to monitor heavy metal levels of the population.

Other

Lydersen informed the Working Group that complete blubber plugs are taken from all walruses immobilised in Svalbard for satellite tagging, and are used for pollutant analyses in ongoing screening studies.

9.4 Other

Disease

In Canada the incidence of antibodies to canine distemper virus (CDV), phocine distemper virus (PDV), canine adenovirus, influenza A and *Brucella* sp., has been examined in walruses (Duignan *et al.* 1994, Nielsen *et al.* 1996, 2000, 2001a, b, Philippa *et al.* 2004), but the implications for walrus health are not clear.

Clinical serum biochemistry analyses have been performed on 26 blood parameters for 13 samples taken from apparently healthy adult male walruses from Svalbard. These data may be useful for future monitoring of health changes in this or other populations (Tryland *et al*. 2003).

Disturbance to land haulouts

It was noted that land haulouts have been abandoned in many areas of Canada, Greenland, Norway and Russia, probably due to hunting and/or disturbance. It is possible that walruses may become more dependent on land haulouts if ice cover is reduced due to global warming. The Working Group expressed concern about the potential disturbance of walruses by increased human activities at or near haulout sites.

Oil and gas exploitation

SC/12/WWG/7 provided some information about oil and gas fields being developed on the continental shelf of the southeastern Barents Sea in the Russian Federation. This is within the area of walrus distribution in these waters. The Working Group cautioned that walruses might be susceptible to disturbance by seismic exploration, shipping, and extraction activities, and to pollution caused by spills and urged that this be assessed in development plans for this area.

10. ASSESSMENT BY STOCK

10.1 Present status

SC/13/WWG/6 combined recent abundance estimates with historical catches and an age- and sex-structured population dynamic model to perform Bayesian assessments of the walrus populations in West Greenland, the North Water in northern Baffin Bay and East Greenland. The model assumed density-regulated dynamics and pre-harvest populations in population-dynamical equilibrium. It projected the populations under the influence of the catches to estimate the historical trajectories and the current population status. It was found that the West Greenland and North Water populations have been heavily exploited during the last century with the current abundance being at best only a few percent of the historical abundance. Apparently these populations are still being exploited above sustainable level. The East Greenland population was heavily exploited after 1889 and during the first half of the 20th Century and was depleted to approximately 50% of pristine population size in 1933. After protective measures were introduced in the 1950s this population has increased to a current level close to the abundance in 1889, and the present exploitation appears to be sustainable.

East Greenland

The Working Group had already agreed that the abundance estimate for East Greenland used in the assessment in SC/13/WWG/6 was not suitable for use in assessment (see 8.1). Rather than using the point estimate, an alternative approach would be to use the count with correction factors as informative priors in the model to scale the count to total abundance. However it was noted that a series of counts would be required before this method could be used to estimate the scaling factor.

There was also great uncertainty about the catch series used in the analysis (see 7.1). The authors of SC/13/WWG/6 replaced the anomalously high catch reports 1993 with average values, and corrections for "struck and lost" and non-reporting were applied. Similarly, there was uncertainty about the life history parameters used in the modelling. However it was recognised that the ranges of the priors used likely captured the true values and that the use of uniform distributions constituted a conservative approach.

The Working Group accepted the conclusion of the authors that the East Greenland walrus population was recovering or recovered after a period of over-exploitation in the early 20th century. However the present size of the stock and its status in relation to its pristine state was uncertain for the reasons noted above.

West Greenland

The Working Group had agreed that the abundance estimate used was not suitable for use in assessment (see 8.1). It was considered that the assessment model could be improved with the use of an index series of relative abundance estimates developed from aerial surveys conducted between 1981 and 1999, scaled to absolute abundance using a correction factor entered as a prior in the model. This could be done using available data and was recommended by the Working Group.

There were also uncertainties about the catch series (see 7.1) and some recent catch reports have been anomalously high. These were however, used in the model. There are also indications that the harvest in West Greenland is supported to an unknown extent by movement of animals from eastern Canada, and a model that incorporated immigration is needed.

In 1995 the Working Group concluded that this stock was depleted and declining, and that a population of 1,000 to 2,500 animals would be required to support the annual harvests, at that time *ca* 50 walruses. It was considered unlikely that present abundance was over 1,000 animals, while reported harvests have increased since 1995. The Working Group noted that it was unlikely that an update of the abundance estimate would change either the overall outcome of the assessment in SC/13/WWG/6 or its agreement with the conclusion reached in 1995. Therefore the Working Group saw no reason to change its previous conclusion that this stock is depleted and declining, and that present harvests are very likely not sustainable.

North Water

The Working Group had already concluded that the former NOW stock should be divided into 3 new stock areas (see 5.5). There is no indication that walruses from Western Jones Sound or Penny Strait/Lancaster Sound support the harvest at Grise Fiord and Qaanaaq municipality. Therefore it was recommended that any future assessments should be carried out with reallocation of the abundance estimate to the new stock areas.

The abundance estimate used here was found by the Working Group to be unsuitable for use in assessment without further analysis and documentation (see 8.1). This is particularly problematic given the new putative stock areas, since most of the abundance estimate in the area of interest was a "guesstimate" due to incomplete survey coverage. It was considered that a new abundance estimate for this area will be required before a meaningful assessment can be undertaken.

The Working Group could not come to any firm conclusions about the present status of this stock.

10.2 Sustainable harvest levels and management recommendations

East Greenland

Because of the uncertainties noted under 10.1, the Working Group could not provide advice on sustainable harvest levels for this population. In 1995 the reported average catches of about 20 animals per year were considered likely to be sustainable, and the new assessment in SC/13/WWG/6, assuming a population size of about 1,000 animals, was in accord with this. But recent reported harvests have been considerably higher than this, so the Working Group expressed concern that continued harvests at the reported levels might not be sustainable, while acknowledging (see 7.1) that for some years, recent (1993-2002) harvest reports are considered to be implausibly high.

West Greenland

Because of the uncertainties noted under 10.1, the Working Group could not provide advice on sustainable harvest levels for this stock. In 1995, the reported average catches of about 50 animals per year was not considered to be sustainable, and the new assessment in SC/13/WWG/6, assuming a population size of about 1,000 animals, was in accord with this. It was agreed that present harvest levels are not sustainable, and that a large reduction in harvest may be required if this stock is to recover. The Working Group recommended that a new assessment of this stock be completed as soon as possible.

North Water (Penny Strait/Lancaster Sound, West Jones Sound and North Water)

Because of the uncertainties noted under 10.1, the Working Group could not provide advice on sustainable harvest levels for these stocks. In 1995 the Working Group concluded that what was then considered to be a single stock could not support the harvest at that time. The Working Group reaffirmed its previous conclusion that there was no indication that these combined stocks are large enough to support the current harvest levels and therefore expressed concern that current harvests are probably not sustainable. The Working Group recommended that a new assessment of these stocks should be completed as soon as possible.

Other areas

For other areas there was insufficient information to allow an assessment at this time.

12. SATELLITE TELEMETRY

An informal workshop was held on the technical aspects of walrus satellite telemetry, but it was agreed that no report would be produced.

13. RECOMMENDATIONS FOR RESEARCH

The Working Group considered that the most urgent priority at present was to complete assessments of the West Greenland and North Water stocks. The following research must be completed before these assessments can be done:

West Greenland

1. Analyse all West Greenland surveys in a consistent manner to obtain a relative abundance index for the area.
2. Complete a stock delineation analysis incorporating all available genetic, satellite tagging and other data to develop putative stock structures for the area and to evaluate the possibility of immigration from Canada supporting the Greenlandic harvest. If possible this analysis should include new samples from eastern Baffin Island.
3. Develop a revised catch series with corrections for "struck and lost", non-reporting, and evaluating the accuracy of recent harvest reports.
4. Develop assessment models incorporating all the above.

North Water

1. Complete a stock delineation analysis incorporating all available genetic, satellite tagging and other data to develop putative stock structures for the area.

2. Provide a documented analysis of the surveys carried out since 1998.
3. Carry out new surveys to estimate abundance in these areas.
4. Develop a revised catch series with corrections for "struck and lost", non-reporting, and evaluating the accuracy of recent harvest reports.
5. Develop assessment models incorporating all the above.

The Working Group recommended that an assessment meeting should be held as soon as the required tasks for at least one of these stocks has been completed. The West Greenland stock was considered of most urgent priority for assessment.

For all areas it was considered that the long term research requirements were:
1. Stock delineation, using genetic, satellite tagging and other methods (all areas);
2. Abundance estimates (all areas and especially exploited populations);
3. Accurate catch series, including corrections for "struck and lost". Specifically the Working Group identified the need for a more reliable catch reporting system for Greenland and Canada;
4. Estimates of biological parameters, especially adult and juvenile mortality and age specific reproductive rates (all exploited areas);
5. The effects of human activities around haulouts should be investigated.
6. The potential effects of global warming should be investigated.

14. OTHER BUSINESS

There was no other business.

15. ADOPTION OF REPORT

The Report was adopted on 14 January 2005. The Chairman thanked all participants for contributing to a productive Working Group and gave special thanks to the meeting rapporteur for his valuable efforts during the Workshop.

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Table 1. New information available since 1995 relevant to the putative stocks identified by NAMMCO (1995).

STOCK	**NEW INFORMATION**
Foxe Basin (FB)	- Distinct from other areas based on isotope ratios, body size and genetics (SC/13/WWG/5) - Indication of subdivision into a northern (Igloolik) and southern (Hall Beach) area in the summer, based on isotope ratios and distribution of kills (SC/13/WWG/5)
S. & E. Hudson Bay (SEHB)	- Distinct from Northern Hudson Bay based on isotope ratios, trace element profiles, and organochlorines (SC/13/WWG/5) - Walruses taken at Inukjuak are different than those taken at Akulivik based on organochlorines and lead isotope ratios (SC/13/WWG/5). - Indicates that boundary with HBDS is likely south of Akulivik.
N. Hudson Bay Hudson Strait - N. Labrador - S.E. Baffin Island (HBDS)	- Distinct from WG based on genetics (SC/13/WWG/13) and lead isotope ratios (SC/13/WWG/5) - Indications for subdivision based on differences in lead isotope ratios between Repulse Bay, Coral Harbour, Akulivik and Loks Land (Frobisher Bay) (SC/13/WWG/5). - Indication that this is a source population for WG (SC/13/WWG/13). - Boundary with SEHB is likely north of Inukjuak (see SEHB).

STOCK	NEW INFORMATION
Central West Greenland (WG) *- Disko Group* *- Sisimiut Group*	- Distinguished from northwest Greenland and HBDS based on genetics (Andersen and Born 2000, SC/13/WWG/13). - No new information to support or refute the idea that the WG sub-population is subdivided into Disko and Sisimiut groups.
North Water (Baffin Bay) (NOW)	- Samples from eastern Jones Sound were distinguished from Foxe Basin, based on isotopic ratios and preliminary genetic data (SC/13/WWG/5). - Samples from Qaanaaq could be distinguished from Sisimiut group and from Hudson Bay- Hudson Strait based on genetics (SC/13/WWG/13, Andersen and Born 2000). - Evidence for subdivision into West Jones Sound, Penny Strait/Lancaster Sound groupings based on satellite tagging (SC/13/WWG/5). - It is unlikely that the harvest in northern Greenland and Grise Fiord is supported to any significant degree by animals from Western Jones Sound or Penny Strait/Lancaster Sound areas, therefore these areas should be treated as separate management stocks.
East Greenland (EG)	- Distinct from all other populations based on genetics (Born *et al.* 2001) and satellite tracking (Born and Knudsen 1992, Acquarone 2004). - No evidence for revision.
Svalbard - Franz Josef Land (SBFJ)	- Distinct from West Greenland, NOW, and East Greenland based on genetics (SC/13/WWG/13, Born *et al.* 2001). - Distinct from all other areas based on satellite tracking (Wiig et al. 1996, Kovacs and Lydersen Pers. Comm.). - Some indication of age and sex segregation within the area. - Continuous distribution to the east may indicate a link with Northern Kara and Laptev Sea walruses (SC/13/WWG/7). - No firm evidence for revision.
Kara Sea - S. Barents Sea - Novaya Zemlya (KBNZ)	- Apparent continuous distribution between Svalbard-Franz Josef Land and the northern Laptev and Kara seas (SC/13/WWG/7). - Gap in distribution between northern and southern areas (SC/13/WWG/7). - No firm evidence for revision.
Laptev Sea (LS)	- Apparent continuous distribution between northern Laptev Sea and northern Kara Sea (SC/13/WWG/7 and 8) - Gap in distribution between northern and southern mainland coastal areas (SC/13/WWG/8) - No firm evidence for revision

Table 2. Selected biological parameters for Atlantic walruses, by sex and putative stock (acronyms as in Table 1). Numbers in parentheses refer to the source of information. Sources: 1) Garlich-Miller and Stewart (1998); 2) Garlich-Miller and Stewart (1999); 3) DFO (2000); 4) Born *et al.* (1995); 5) Mansfield (1959); 6) Fay *et al.* (1991); 7) Born (2001); 8) Knutsen and Born (1994); 9) Chapskii (1936); 10) Born (2003); 11) SC/12/WWG/6; 12) Miller and Boness (1983); 13) Fisher and Stewart (1996)

			Greenland			Canada			
	KBNZ	**SBFJ**	**EG**	**WG**	**NOW**	**FB**	**HBDS**	**SEHB**	**NOW**
Females									
Age at first ovulation (years)	4 (9)		4-10 (7)			5-7 (2)			
Age at first birth (years)					7 (7)				
Age at sexual maturity (years)					6.1 (95% CI: 5.2-7.1) (7)				
Length at sexual maturity (cm)	250 (9)		250 (4?)						
Weight at sexual maturity (kg)			750 (4?)						
Pregnancy rate (overall, mature females)					34.6 % (7)	33% (2) 35%(5)			
Twin births	occur - uncommon (6)								
Mating season (Oestrus)					19 Jan- 25 Jun (7)	Jan-Apr (3)			
Implantation in the uterus					29/6--11/7 or 26/6--5/7 (7)	Jun-Jul (3) 29Jun-3Jul (2) 11May (5)			
Duration of pregnancy (days)					345 [5/7--18/6] (7)	380 (5) 335 (2)			

	KBNZ	SBFJ	Greenland EG	Greenland WG	Greenland NOW	Canada FB	Canada HBDS	Canada SEHB	Canada NOW
Duration of lactation (years)	1/2 to 2 (5) (12) (13)								
Calf birth					20 Jun (7/2--11/11) (7)	May-Jun (3)			
Number of Calves					1				
Calving interval (years)					3 (7)	3 (5)			
Age at reproductive senescence	no current indications of senescence								
Males									
Age at sexual maturity (years)	5-6 (9)				10.9 (95% CI:9.6-12.2; range 7-13) (10)		6-7 (5)		
Age at physical maturity (years)					12-15 (8)				
Season of sexual activity					Nov-Jul (peak eary Jan - Apr) (10)				
Length at physical maturity (cm)					300 (8)				
Weight at physical maturity (kg)					1,100 (8)				
Both sexes									
Longevity									
Average annual mortality (natural)									
Calf length at birth (cm)	100 (9)				112 (110-164) (7)	125 (1) 110 (2)			
Calf weigth at birth (kg)	40 (9)				54.5 (7)				

			Greenland			Canada			
	KBNZ	SBFJ	EG	WG	NOW	FB	HBDS	SEHB	NOW
Calf Survival rate (first year only)	unknown (11)								
Sex differences in the previous three rates									
Juvenile survival rate (>1 yr.)	unknown (11)								
Calf Natural mortality									
Sex ratio at birth	unknown for Atlantic walrus (4) - 1:1 of only 15 fetuses (10) 17 fetuses (2) 14 newborn (2)								
Sex ratio in population	unknown for Atlantic walrus (4)								

Table 3. Average harvest from 1996-2001, and abundance estimates, by putative stock. Sources: (1) NAMMCO (1995); (2) Born *et al.* (1997); (3) Gjertz and Wiig (1995); (4) SC/13/WWG/7.

STOCK	**HARVEST**		**ABUNDANCE**					
	Avg. 1996-2001	**Yrs**	**Year (source)**	**Methods**	**Estimate (error)**	**Bias**	**Correction Factors**	**Reservations/Comments**
Foxe Basin	235	5	1989 (1)	aerial survey	5500 (95%CI 2700-11,200)	neg	none	Partial coverage.
North FB	*137*	5			None			
South FB	*98*	4			None			
South Hudson Bay	10	5			None			
Hudson Bay-Davis Strait	170	5			None			
Northwater	110	5			None			
West Jones Sound	4	1			None			Survey conducted 1999
Penny Strait/Lancaster Sound	8	5			None			Survey conducted 1999
Central West Greenland	158	5			None			Aerial survey data available but should be re-analysed.
Disko group					None			
Sisimiut group					None			

STOCK	HARVEST		ABUNDANCE					
	Avg. 1996-2001	Yrs	Year (source)	Methods	Estimate (error)	Bias	Correction Factors	Reservations/Comments
East Greenland	5	5	1984-1990 (2)	opportun-istic counts	1,000 (na)	?	haulout and dive activity data	Not synoptic, uncertain correction factors. Not of sufficient quality for use in assessment.
Svalbard - Franz Josef Land	0	5	1992/93 (3)	aerial/land counts	2,000 (na)	neg	males only, corrected for missing females and calves	Partial coverage.
Kara Sea - Barents Sea - Novaya Zemlya	0	5	1998 (4)	Ship survey	600 (na)	neg	None.	Partial coverage (northern Novaya Zemlya only). Not of sufficient quality for use in assessment.
Laptev Sea	0	5			None			

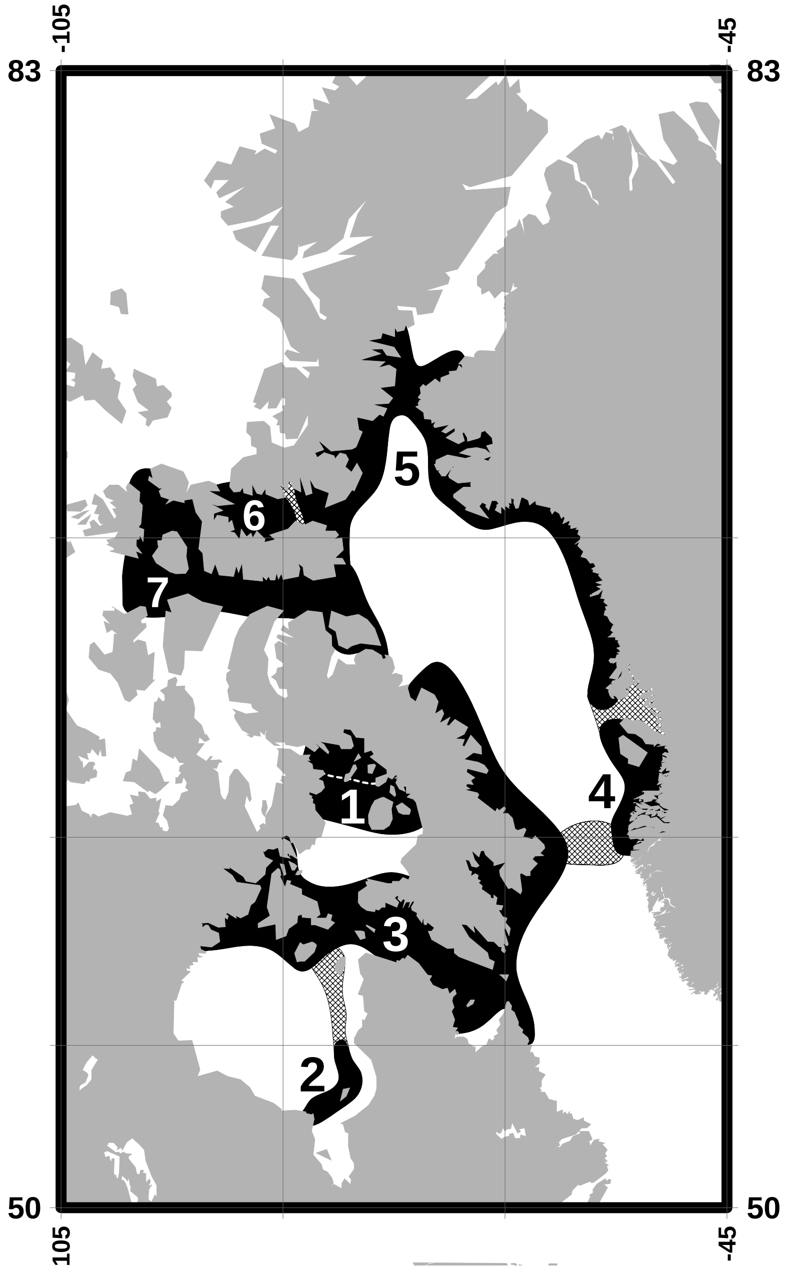

Fig. 1. Delineation of walrus stocks proposed in this report in the western (1a) and eastern (1b) Atlantic and adjacent seas. Boundaries are approximate. Hatching indicates areas of possible stock affiliation.

(1a) 1) Foxe Basin, dashed line divides N. and S. areas; 2) South and East Hudson Bay; 3) N. Hudson Bay- Hudson Strait - N. Labrador - S.E. Baffin Island; 4) Central West Greenland; 5) North Water; 6) West Jones Sound; 7) Penny Strait – Lancaster Sound.

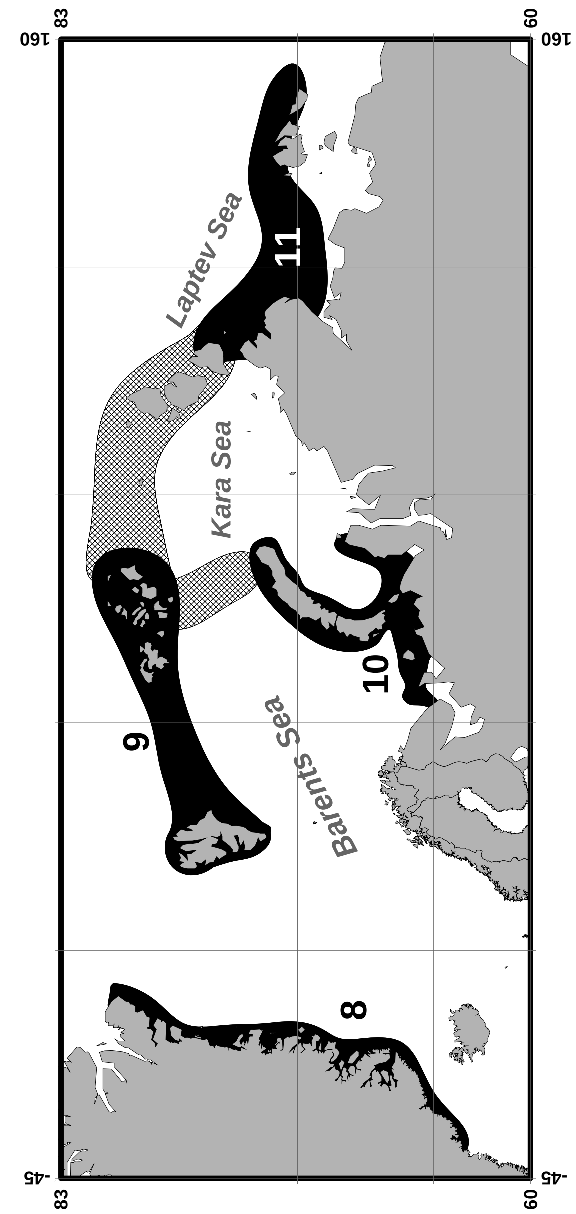

Fig. 1. contd.
(1b) 8) East Greenland; 9) Svalbard – Franz Josef Land; 10) Kara Sea - S. Barents Sea - Novaya Zemlya; 11) Laptev Sea.

Appendix 1

AGENDA

1. OPENING REMARKS
2 ADOPTION OF AGENDA
3 APPOINTMENT OF RAPPORTEURS
4 REVIEW OF AVAILABLE DOCUMENTS
5. STOCK STRUCTURE
    - 5.1 Genetic information
    - 5.2 Satellite tracking
    - 5.3 Tissue signatures (pollutants, trace elements *etc.*)
    - 5.4 Other information
    - 5.5 Management units
6. BIOLOGICAL PARAMETERS
    - 6.1 Age estimation
    - 6.2 Reproductive rates
    - 6.3 Other parameters
7. CATCH STATISTICS
    - 7.1 Reported catch
    - 7.2 “Struck and lost”
    - 7.3 Histories by management units
    - 7.4 Other information
8. ABUNDANCE AND TRENDS
    - 8.1 Recent estimates
    - 8.2 Trends in abundance by management units
    - 8.3 Future survey plans
9. ECOLOGY
    - 9.1 Diet and consumption
    - 9.5 Impact of global warming
    - 9.6 Pollution
    - 9.7 Other
10. ASSESSMENT BY STOCK
    - 10.1 Present status
    - 10.2 Sustainable harvest levels
    - 10.3 Management recommendations
11. SATELLITE TELEMETRY
12. RECOMMENDATIONS FOR RESEARCH
13. OTHER BUSINESS
14. ADOPTION OF REPORT

Appendix 2

LIST OF DOCUMENTS

SC/13/WWG/1	Draft List of Participants.
SC/13/WWG/2	Draft Agenda.
SC/13/WWG/3	Draft List of Documents.
SC/13/WWG/4	Stewart, R.E.A. Canadian walrus harvests.
SC/13/WWG/5	Stewart, R.E.A. Delineation of walrus in Canada.
SC/13/WWG/6	Witting, L. and Born, E. An assessment of Greenland walrus populations.
SC/13/WWG/7	Boltunov A.N., Belikov S.E. Atlantic walruses of the western Russian Arctic.
SC/13/WWG/8	Belikov S.E., Boltunov A.N. Laptev walruses.
SC/13/WWG/9	2003 Walrus Harvest Monitor Project: Annual Summary.
SC/13/WWG/10	Born, E.W. and Acquarone, M. An estimation of walrus (*Odobenus rosmarus*) predation on bivalves in the Young Sound area (NE Greenland).
SC/13/WWG/11	Acquarone, M., Born, E.W. and Speakman, J.R. Direct measures of pinniped field metabolic rate: implications for fisheries models.
SC/13/WWG/12	Acquarone, M. and Born, E.W. Body water and body composition of free-ranging Atlantic walruses *(Odobenus rosmarus rosmarus* L.) studied by isotope dilution.
SC/13/WWG/13	Andersen, L.W., Born, E.W. and Doidge, D.W. A genetic study of population structure in Atlantic walruses: Where do the Canadian walruses fit in?
SC/13/WWG/14	Born, E.W. and Wiig, Ø. Potential effects on Atlantic walrus of warming in the Arctic.
SC/13/WWG/15	Born, E.W. Estimates of the catch of walruses in Greenland (1946-2002).
SC/13/WWG/16	Kovacs, K.M., Lydersen, C. *et al.* Current research on walruses – Svalbard.

Other Documents:

SC/13/WWG/O1	Pacific walrus *(Odobenus rosmarus divergens*): Alaska Stock.
SC/13/WWG/O2	Proceedings of a workshop on the potential application of mark-recapture methods to estimate the size and trend of the Pacific walrus population.
SC/13/WWG/O3	Manly, B.F.J. Report on the Potential for Use of Mark-Recapture Methods to Estimate the Size of the Pacific Walrus Population.
SC/13/WWG/O4	Walrus Harvest Monitoring On Chukotka in 2001.
SC/13/WWG/O5	Atlantic Walrus Stock Status Report, Canada.