NORTH ATLANTIC MARINE MAMMAL COMMISSION

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SCIENTIFIC COMMITTEE

REPORT OF THE THIRTEENTH MEETING

Reine, Norway, 25-27 October, 2005

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EXECUTIVE SUMMARY

The 13th annual meeting of the NAMMCO Scientific Committee was held at Reine i Lofoten, Norway, 25 – 27 October 2005. In addition to Scientific Committee members, observers from Canada, the Russian Federation and the High North Alliance attended the meeting.

HARP AND HOODED SEALS

In 2004 the Management Committee requested that the Scientific Committee annually discuss the scientific information available on harp and hooded seals and advice on catch quotas for these species given by the ICES/NAFO Working Group on Harp and Hooded Seals. The advice by the Scientific Committee on catch quotas should not only be given as advice on replacement yields, but also levels of harvest that would be helpful in light of ecosystem management requirements

In 2005 the Management Committee recommended that the Scientific Committee evaluate how a projected decrease in the total population of Northwest Atlantic harp seals might affect the proportion of animals summering in Greenland. In addition the Management Committee requested the Scientific Committee to specify harvest levels for these 2 (*i.e.* Barents/White Sea and Greenland Sea) harp seal stocks that would result in a population reduction of 20% over a period of 20 years.

The ICES/NAFO Working Group on Harp and Hooded Seals met in September 2005 in St. John’s Newfoundland, Canada. The main tasks of the Working Group were to establish biological limits for Greenland Sea harp seals and White Sea/Barents Sea harp seals, and to provided assessments for each stock.

Biological limits for seal harvest

The Working Group proposed a framework for biological reference points and a corresponding management framework, largely based on the Canadian management system. The framework relates to population numbers with the N_{max} (not exploited) stock size as a key reference point. In accordance with the precautionary approach a distinction is made between data adequate and data poor situations. Data adequate stocks should have a time series of at least five abundance estimates spanning a period of 10-15 years with surveys separated by 2-5 years, and the most recent abundance estimates should be no more than 5 years old. Stocks whose abundance estimates do not meet these and other criteria are considered data poor. Based upon these criteria, the harp and hooded seal stocks should be classified as follows: Greenland Sea harp seal stock - data adequate; White/Barents Sea harp seal stock - data adequate; Northwest Atlantic harp seal stock - data adequate; Northwest Atlantic hooded seal stock - data poor; Greenland Sea hooded seal stock - data poor. For the latter two stocks, new survey results will become available in 2006, after which these stocks may be considered data adequate.

For data adequate stocks, two precautionary and one conservation (limit) reference level are proposed. All reference levels relate to the N_{max} population size. (*e.g.* maximum population size historically observed, N_{max}). The first precautionary reference level could be established at 70% (N_{70}) of $N_{max.}$ When the population is between N_{70} and N_{max}, harvest levels may be decided that may stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. When a population falls below the N_{70} level, conservation objectives are required to allow the population to recover to above the precautionary (N_{70}) reference level. N_{50} is a second precautionary reference point where more strict control rules must be implemented, whereas the N_{lim} reference point is the ultimate limit point at which all harvest must be stopped.

For data poor stocks, it is recommended that only the lower tier (below N_{lim}) be defined. In this case, the four tiers effectively collapse to two (*i.e.*, above and below N_{lim}). Below N_{lim} all harvest must be stopped, and conservative and effective management measures will at all times be required when the stock is below N_{max}.

In the absence of a historical time series which enables estimates of N_{max} it is suggested that populations are kept above the historical minimum populations with high probability. Since present populations are likely above historical minima in all cases, maintaining the populations at or above the present level will thus be in accordance with precautionary management.

Discussion by the Scientific Committee
The Scientific Committee considered that the definition of N_{max} , the maximum population level observed historically, was not clearly specified. In the case of the Northwest Atlantic harp seal stock, the highest abundance estimate is used as a proxy for N_{max}, and this procedure is advised for the Greenland Sea and White/Barents Sea populations. However it was considered that N_{max} should be related to the carrying capacity for the stock. If the maximum observed population size is used, limit levels may be set for a population that is already depleted, and N_{max} will increase over time. It was also not clear how it would be determined that a limit level had been reached, since abundance estimates typically have wide confidence intervals.

The Committee considered that a management framework should be specified with specific reference to goals defined by managers. In this case the framework in a sense pre-defines the management goals. In the case of harp and hooded seals, where management goals may in the future be defined in relation to ecosystem based objectives, more flexibility will be required than is allowed in this framework. For these reasons the Scientific Committee could not advise the adoption of this management framework for harp and hooded seal stocks in the Greenland and White/Barents Seas.

Assessments
A full assessment of hooded seals must await availability of updated abundance estimates (based on surveys conducted in March 2005) and will be performed in 2006. For harp seal stocks options are given for three different catch scenarios: Current catch level; Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population); and two times the maintenance catches.

Greenland Sea harp seal
The stock in 2005 is estimated to be 618,000 (95% C.I. 425,000-845,000) 1+ animals with a pup production of 106,000 (95% C.I. 71,000-141,000). The total catches were 9,895 (including 8,288 pups) in 2004 and 5,808 (4,680 pups) in 2005. Removals were 23-38% of the allocated quotas, which was 15,000 animals one year old or older (1+ animals). Catches have remained significantly less than the quota since 1993. The maintenance catch is 31,000 1+ animals, and twice this catch, taken as 1+ animals, results in a population size 55% that of the present one in 10 years time.

White Sea/Barents Sea harp seal
The adult population in 2005 is estimated to be 2,065,000 (95% C.I. 1,497,000 – 2,633,000) 1+ animals with a pup production of 361,000 (95% C.I. 299,000 – 423,000). No commercial catches were taken from this stock in 2004. The combined catches for 2005 were 22,474 (including 15,420 pups). The maintenance catch is 78,000 1+ animals, and twice this catch, taken as 1+ animals, results in a population size 67% that of the present one in 10 years time.

Northwest Atlantic harp seal.
Since 1996, catches in Canada and Greenland have resulted in average annual removals of about 471,000. Young of the year account for approximately 68% of the current removals. Photographic and visual aerial surveys to determine current pup production of northwest Atlantic harp seals were conducted during March 2004. The northwest Atlantic harp seal population is currently estimated to number ~ 5 .9 million animals (SE=747,000), which is similar to the previous abundance estimate. The sustainable yield estimated from the model presented for the Northwest Atlantic harp seal population is 554,000 animals.

Greenland Sea hooded seal
The 1997 estimate of pup production is the only estimate available for the Greenland Sea hooded seal stock. The single estimate of pup production is over 8 years old and there are no estimates of reproductive rates for this stock. A new aerial and vessel survey of hooded seal pup production in the Greenland Sea pack-ice was conducted in March 2005. The results will be used to estimate the 2005 hooded seal pup production, but will not be available until 2006. Preliminary results suggest, however, that pup production in 2005 may be lower than observed in the previous survey (1997). Due to lack of data it is not possible to provide these options for this stock. Given the poor data available on this stock and indications that pup production may be reduced management of this stock should be extremely cautious.

Northwest Atlantic hooded seals
Canadian catches have been quite low since 1999 (~150 animals per year) with the take in 2004 increasing to around 400 animals. Catches in Greenland have been in the 6,000-7,000 range during 1970-2001, but had declined to around 3,500 in 2002. A hooded seal pup survey was conducted in 2005 in the Gulf, Front, and the Davis Strait. When completed, these results will provide an updated estimate of hooded seal abundance in the Northwest Atlantic by spring 2006.

Discussion by the Scientific Committee
The Committee regretted that the specific requests of the Council pertaining to the fraction of the Northwest Atlantic population migrating to Greenland, and catch levels necessary to reduce the population by 20% over 20 years had apparently not been conveyed to the ICES/NAFO Working Group, as had been recommended last year. The Committee noted that the Working Group would be meeting in 2006, and recommended that these questions be considered at that time. Nevertheless, given the population projections provided above for the Greenland Sea and White/Barents Sea stocks, it is possible to provide some preliminary advice on catches required to reduce the populations by 20%. For the Greenland Sea stock, annual catches of 2x the "maintenance" or equilibrium catch have the effect of reducing the population by 45-55% over 10 years, depending on the proportion of pups taken. Therefore, level of catch required to reduce the population by 20% over 20 years must be considerably less than the 2x maintenance catch. The same holds for the White/Barents Sea stock.

The Scientific Committee supported the recommendations of the Working Group concerning both stocks of hooded seals. Updated abundance estimates are expected in 2006 and at that time better advice on catch levels can be provided.

HARBOUR PORPOISE

In 2004 the Scientific Committee noted that there is likely a substantial level of bycatch of harbour porpoises in Icelandic fisheries. The same is likely true in Norway. The directed catch in Greenland exceeds 2,000 in some years and was reported as 2,320 in 2003. In order to estimate the sustainability of the ongoing bycatch and directed catch in these areas, better estimates of the present bycatch levels of harbour porpoises in Iceland and Norway, as well as estimates of absolute abundance for all areas, are required.

NARWHAL

The following is based on the report from a joint meeting of the NAMMCO Working Group on the Population Status of Narwhal and Beluga in the North Atlantic, and the Canada – Greenland Joint Commission Scientific Working Group was held 13-16 October 2005 in Nuuk, Greenland.

Stock structure
There was little new information available on the stock structure of narwhal. A model of the metapopulation structure of narwhal in Baffin Bay and surrounding areas, based on all available

information, suggests that coastal summering concentrations of narwhals constitute at least four stocks in Canada (Eclipse Sound, Admiralty Inlet, Somerset Island, East Baffin Stocks), two stocks in West Greenland (Inglefield Bredning and Melville Bay), and two shared stocks (Jones sound and Smith sound). For East Greenland, little information on stock structure is available. There are summer aggregations at Scoresbysund, Kangerlussuaq, and Ammassalik that are subject to catches. Narwhal also occur north of Scoresbysund but these are likely not harvested. There is genetic evidence that East Greenland narwhal are distinct from those in West Greenland and Canada. However at present there is no basis for further distinguishing East Greenland stocks beyond observed summer concentrations

Age estimation
Age estimation of toothed whales has traditionally used counting of growth layers in teeth, but this has limitations for narwhals. New results using the alternative method of aspartic acid racemization in eyeballs were presented. About 20% of the whales were older than 50 yrs and there seemed to be a tendency for greater longevity in females than in males. The oldest female was found to be 115 years, the oldest male was 84 years, and age at sexual maturity was estimated to 6-7 yrs for females, and 9 yrs for males. These estimates of sexual maturity are similar to those from other studies.

Catch statistics
Catch statistics for narwhals in Greenland was updated, giving options with various degrees of correction for non-reporting, underreporting and struck and lost. Since 1993 catches have declined in West Greenland especially in Uummannaq where the decline is significant. There has not been a significant sex bias in the catch. There has been an increase in narwhal catches in East Greenland of 8% per year since 1993. The harvest reporting system changed in 1993 and the impacts of this change on the catch statistics are unknown.

In Canada the majority of the communities take a greater proportion of males than females throughout the seasons. Many communities hunt mostly in summer but several communities take a substantial proportion of their catch in spring or autumn. This information was used in allocating the catch to different putative sub-stocks, either local summering sub-stocks or spring or autumn migrating sub-stocks. The average reported landed catch per year from selected communities in the eastern Canadian arctic was 373 for the period between 1996 and 2004. Information on struck and lost is collected in a few communities through a hunter-reporting system, however, there is conflicting information on the lost rate in the narwhal hunts. The JWG therefore recommended the development of a program to collect struck and lost information from direct hunt observation of hunts in Greenland and Canada.

Abundance
Results from the aerial surveys in the Canadian high arctic in August 2002 to 2004 were presented, and estimates accepted by the JWG are provided in Table 1 of Annex 1. The survey estimates have large standard errors due to clumping on certain transects within each stratum. Several areas known to contain narwhal were not surveyed due to weather conditions so the survey cannot provide a complete abundance estimate of the entire summer range in Canada. Some problems with the estimates for east Baffin fiords were identified and these will be addressed intersessionally.

Assessment
A model selection based assessment for West Greenland narwhals was presented, using a density regulated population dynamic model to identify the more likely stock structure hypotheses for West Greenland narwhals. The assessment used the data on abundance, catch history and biological parameters that have been agreed in the past by this committee. Nevertheless there was concern about possible biases in some of the input data, particularly abundance estimates and indices. The models using the stock structures considered most likely by the JWG were examined further. To meet an objective of having a probability of 70% of some stock increase within 5 years, a total annual removal ranging from 15 to 75 narwhals is allowed for the entire area. This strengthens the conclusion reached in 2004, that West Greenland narwhal are heavily depleted and substantial reductions in catch are

required immediately to arrest the decline in numbers. However the JWG could not agree on the quantitative results of the model because of the above noted uncertainties in stock structure and input parameters. The JWG agreed that the recommendation provided in 2004, that the total removal in West Greenland should be reduced to no more than 135 individuals, should be provided again and with greater emphasis. This greater emphasis is due to the fact that all models reviewed by the JWG allowed total annual removals lower than 135.

Given that almost nothing is known about the stock structure and seasonal migrations of East Greenland narwhal, and that the abundance estimate for Scoresbysund is more than 20 years old, a reliable assessment is not possible without new information. Research recommendation to improve this situation are provided in Section 5.7 of Annex 1.

A risk analysis on narwhal hunting in the Canadian High Arctic was presented. The JWG recommended that a different modelling framework be provided for the next meeting, but decided to use the present model to arrive at preliminary conclusions about the status of Canadian summer stocks. Under all but the most pessimistic scenarios of high loss rates combined with low rates of increase, there is a very low risk that the Somerset Island and Eclipse Sound will decline in the next 10 years. For Admiralty Inlet, there is a high probability of stock decline in the next 10 years under these conditions. However it was recognized that the recent estimate for this area may be biased because of the extreme clumping of narwhal. No accepted abundance estimate was available for the East Baffin Fiords, so an assessment could not be provided.

BELUGA

Catch
From 1954 to 1999 total reported catches in West Greenland ranged from 216 to 1874 and they peaked around 1970, and catches have declined at about 2% per year between 1979 and 2004. It was noted that the harvest in 2004 had been very low because of the introduction of the quota system and bad weather in some areas. The average reported landed catch from Canadian communities hunting from the Baffin Bay beluga stock for the period is 42. Reported catches in East Greenland are suspected to be possible misreporting of caught narwhals.

Abundance
An attempt to survey the West Greenland index area in March 2004 was unsuccessful due to inclement weather. The survey will likely be attempted again in 2006.

Assessment update
An updated assessment model for West Greenland beluga, using all available data on catch and abundance, and various combinations of data and parameters as sensitivity tests, was provided. All models estimate similar dynamics, where West Greenland beluga are severely depleted, with median depletion ratios in 2005 varying between 16 and 42 percent of the carrying capacity. Using the model considered most realistic by the JWG, it is predicted that reduction of catches to 100 per year will have an 80% chance of meeting the objective of halting the decline in beluga numbers by 2010. Maintaining higher catches reduces the probability of halting the decline, with the current quota of 220 beluga resulting in a 46% probability of halting the decline. These results are essentially the same as those from previous assessments of the stock.

FIN WHALES

The NAMMCO Working Group on fin whales met in Oslo 20-22 October 2005, and the Report of the meeting is included as Annex 2.

Stock structure

Based on the available genetic and non-genetic evidence, the Working Group did not find reason to change its previous view (NAMMCO 2000a), that most evidence suggests the presence of stocks with limited gene flow between adjacent summering aggregations. However, these summer aggregations could be composed of single and/or mixtures of breeding stocks. Interpretation of these data is limited by the lack of temporal and spatial coverage in the sampling.

Catch

A new analysis of historical catch records for Iceland from 1883 to 1915 split the catch between eastern and western Iceland. Catch position records show that there was very little overlap in the range of the east and west operations, but the operational range expanded with time. Another paper provided a compilation of fin whale catches in the entire North Atlantic, but including Norwegian catches only after 1915. A total of 28,559 fin whales were identified in the catch, leading to an estimate of 30,598 fin whales caught by prorating unidentified catch using the catch composition. Catches of fin whales off northern Norway exceeded 10,000 animals in the period before 1904, but these catches have been adequately documented elsewhere.

Abundance

Regionally stratified abundance estimates for fin whales from North Atlantic Sightings Surveys (NASS) conducted in 1987, 1989, 1995 and 2001 were presented to the Working Group. There has been a substantial increase in the abundance of fin whales in the area west of Iceland since 1987. This corresponds to the area where nearly all fin whaling has been conducted since 1915. Another paper used sightings survey data collected over the period 1988-2004 to calculate relative abundance estimates for fin whales in the Northeast Atlantic. Point estimates of relative abundance in this area ranged between 1,100 and 1,800 whales in 5 surveys, with no significant trend over the period.

Assessment

A new assessment model of the EGI fin whale population was presented, modeled as four subpopulations with movement between the following areas: East Greenland, West Iceland, East Iceland and the Far East. T For the base case assessment scenario, best fits to the data were obtained when the West Iceland and East Iceland are effectively fully mixed with a low level of interchange with East Greenland and virtually no interchange with the Far East region. For the base case and most sensitivity tests, the overall recruited population is increasing and above 80% of pre-exploitation abundance (*K*), and subpopulations in all areas are above 70% of the individual *K* values. Projections for annual catches of 0, 100, and 200 whales indicated that only the last would result in abundance decreases compared to current levels if catches were taken only from the West Iceland area. Based on this assessment model the Working Group found no reason to change its advice provided in 2003, that projections under constant catch levels suggest that West Iceland (termed the "inshore substock" in earlier analyses) will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales. If catches were spread more widely, so that other stock components were also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

The Committee will be holding a special workshop "Catch History, Stock Structure and Abundance of North Atlantic Fin Whales", tentatively scheduled for March 2006 in Reykjavik, Iceland. The Scientific Committee of the IWC has been invited to sent participants to the meeting.

MINKE WHALES

Norway has continued its 6 year rotational sightings survey program, and the blocks north of Iceland and around Jan Mayen were surveyed this year. The Icelandic Research Program continued in 2005 with the take of 39 minke whales in coastal waters. Half the planned total of 200 minke whales have now been sampled. An aerial survey was conducted in May 2005 as part of a series to look at the seasonal distribution of minke whales in the area. In August 2004 satellite tagging was attempted on 9 minke whales. An interim report on the Icelandic Research Program will be produced in 2006. An aerial survey with minke and fin whales as the target species was conducted successfully in West Greenland in September 2005. nke whales is planned, but see 8.1.

DOLPHINS

An analysis of the distribution and abundance of common dolphins from the NASS and other surveys was provided. The estimated abundance in the W Block of the NASS95 Faroese survey was 273,159 (CV = 0.26; 95% CI = 153,392 – 435,104). No sightings were made north of 57º in any year, and encounter rates were highest between 51º and 53º N, with no significant differences in terms of Longitude. Other distributional relationships with depth and sea surface temperature were described. Common dolphins apparently do not occur in the waters of member countries except as occasional visitors.

GREY SEALS

Iceland reported that surveys were carried out in the main pupping areas in 2004, and preliminary results indicate that pup production has declined since 2002. Iceland also noted that, in fulfillment of the recommendation by NAMMCO in 2003 (NAMMCO 2004b), management objectives had been developed for this species. The Scientific Committee reiterated previous recommendations related to the conservation of grey seal stocks in the Faroes, Iceland and Norway.

HARBOUR SEALS

To address a request for a stock assessment brought by the Council in 2005, a Working Group on Harbour Seals has been initiated. The Working Group will meet in fall 2006 to fulfill the request for the entire North Atlantic, but concentrating on areas of interest to NAMMCO member countries.

HUMPBACK WHALES

In 2005 the Management Committee reqested that the the Scientific Committee continue its assessment of humpback whale stocks in the North Atlantic. The Committee decided to postpone the provision of advice for West Greenland until a new abundance estimate is available, probably in 2006. Sufficient information on historical catch, abundance and stock structure is available at present to conduct assessments for the Icelandic and Norwegian stocks. However, given other priorities, the Committee considered it advisable to delay this assessment until after the completion of the NASS-2007 survey, when an additional estimate of abundance should become available.

KILLER WHALES

In 2004 the Scientific Committee provided a list of research required to conduct an assessment of killer whales, particularly in West Greenland, as requested by the Council in 2004. The Committee will review progress under this item annually with the view of conducting an assessment when sufficient information becomes available.

WALRUS

The Working Group on Walrus met in Copenhagen, 11-14 January 2005 under the chairmanship of Mads Peter Heide-Jørgensen. The Report of the Working Group is included as Annex 3.

Stock structure

The Working Group considered evidence from recent genetic, satellite tracking and trace element studies relating to stock discrimination. 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 of Annex X. The new information suggests a sub-division of the North Water

(NOW) stock area, possibly into 3 areas including western Jones Sound and Penny Strait/Lancaster Sound stock areas. Also, differences in trace element profiles suggest that there may be a division between northern and southern Foxe Basin in Canada.

Catch statistics
No recent catches of walruses have been reported from Svalbard or the western Russian Federation, and walrus hunting is prohibited in these areas. By comparison with information on previous catch levels, some recent catches in East and West Greenland appear anomalously high. This might be due to multiple reporting of the same animal by hunters, but there was no data to support this. Reporting from Canada was incomplete and there was some disagreement between the 2 main sources of harvest data. 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. stimates of recent average harvests by stock area are presented in Table 3, Annex 3.

No new information on struck and lost rates has become available from any area. As in 1995, a loss rate of 30% for stocks lacking specific loss rate information was assumed.

Abundance and trends
A survey was cunducted in the NOW area in August 1999, resulting in a total estimate of 1,500 for the NOW area, including corrections for animals seen in the water and on land and for areas not surveyed. The Working Group found that the survey was not presented in sufficient detail for evaluation purposes, accepted the estimate for information but noted that it should not be used directly in assessments without further work and documentation. 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 of Annex 3.

Ecology
Estimates of energy consumption and consumption of bivalve prey for East Greenland walrus suggest that walrus have relatively high metabolic and feeding rates, perhaps because they must deposit blubber from a low-lipid diet, mainly during the summer.

The potential impact of global warming on walrus was discussed, but the Working Group could not come to any firm conclusions on the matter. It was emphasized in this context that the most immediate threat to walrus populations is overexploitation, not climate change. 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.

New oil and gas fields are 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.

Assessment by stock
A formal assessment model was provided only for the West Greenland, NOW and East Greenland populations. However the Working Group agreed that the abundance estimates for the 3 stocks used in the model were not suitable for use in assessment, so the findings of this model could not be accepted at face value.

The Working Group accepted the conclusion that the East Greenland walrus population was recovering or recovered after a period of overexploitation in the early 20th century. However the present size of the stock and its status in relation to its pristine state was uncertain, and advice on sustainable harvest levels for this population could not be provided. In 1995 the reported average catches of about 20 animals per year were considered likely to be sustainable. 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 that for some years, recent (1993-2002) harvest reports are considered to be implausibly high.

In 1995 the Working Group concluded that the West Greenland 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 saw no reason to change this conclusion, but recommended that a new assessment of this stock be completed as soon as possible. This could likely be done using existing data.

The Working Group had already concluded that the former NOW stock should be divided into 3 new stock areas. 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. It was considered that a new abundance estimate for this area will be required before a meaningful assessment can be undertaken. 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.

The situation for West Greenland walrus is especially serious and the preliminary assessment indicates that severe reductions in catch may be required. The Scientific Committee noted that the assessment can be furthered using available data from past surveys of the West Greenland overwintering area, and recommended that these surveys be analyzed as an urgent priority. Once this and other research has been completed, the Working Group should meet again to complete the assessment of the West Greenland and perhaps other stocks. It was anticipated that this could be done as early as 2006 or early in 2007.

NORTH ATLANTIC SIGHTINGS SURVEYS

The next NASS is planned for 2007. Efforts have already been made to coordinate NASS with other surveys to take place in 2007:

- The proposed project "Cetacean Offshore Distribution and Abundance in the European Atlantic" (CODA) that is planned as a follow-up to SCANS-II in 2007. The surveys will cover European Atlantic offshore waters outside the continental shelf area west to the boundary of the EEZ of the UK, Ireland, France, Spain and Portugal. There have been positive discussions with the CODA coordinator about coordination of this survey with NASS-2007, and such coordination is part of the proposal.
- Possible Canadian and US surveys on their eastern seaboards. Again there have positive discussions about coordination with NASS, particularly with the Canadian survey;
- Possible West Greenland survey;
- If an international redfish survey is conducted in the area in 2007, there will be an opportunity to share platforms as was done in 2001 on the Icelandic vessels;
- Ongoing annual surveys by the Russian Federation in the Barents and Norwegian Seas.

The Committee concluded that there is a perhaps unique opportunity to conduct a very wide ranging synoptic cetacean survey, covering areas of the eastern and western Atlantic that have never been covered simultaneously in previous surveys. The Committee strongly recommended that the Council and indidual member countries encourage other jurisdictions to become involved in the NASS project for 2007.

To take advantage of this opportunity, it was decided to establish a steering group, headed by Desportes, to begin planning NASS and its coordination with other surveys. It is anticipated that a planning meeting, involving participation from all relevant jurisdictions, should be held sometime in 2006.

BYCATCH OF MARINE MAMMALS

The Committee was informed that there had been little or no progress since last year in the development of bycatch monitoring programs in NAMMCO member countries. Noting that estimates of all removals, including bycatch, are required for stock assessments, and there is evidence that unreported bycatch occurs in the fisheries of member countries, the Committee strongly recommended that all member countries establish bycatch monitoring systems for their fisheries.

AMENDMENT TO RULES OF PROCEDURE

It has been standard practice for the last several years that NAMMCO funds the attendance of invited experts at Working Group meetings, however this process has not been formalized in the *Rules of Procedure*. To avoid any possibility of confusion, the Committee recommended that the *Rules of Procedure* should be amended such that NAMMCO continues to fund the attendance of invited experts to meetings of NAMMCO Scientific Working Groups, irrespective of their country of origin.

SATELLITE TELEMETRY GROUP

In 2002 the Scientific Committee decided to establish an intersessional correspondence group to explore the technical aspects of satellite tagging, including deployment systems and to recommend ways to further the development and success of this technique in NAMMCO member countries. Attempts had been made to organize a workshop on the technical aspects of tagging large whales, but this had met with little interest from the few research groups involved in this field. These research groups are willing to enter into collaborative projects with others, but do not seem willing to share information on the more technical aspects of tagging in an open forum. The Scientific Committee recognized that the correspondence group could not make progress without the cooperation of key players in the field, and decided that the group would be terminated. The Committee will monitor developments in this field on a regular basis.

FUTURE WORK PLANS

The following working groups will hold meetings meetings during 2006:
- NASS Planning Group, first half of 2006;
- Fin Whale Working Group (with IWC attendance), March in Iceland;
- Harbour Seal Working Group, second half of 2006;
- Walrus Working Group (depending on progress).

Other meetings may be held depending on requests received from the Council.

The next (14th) annual meeting will be held in Iceland at a time and location to be determined.

ELECTION OF OFFICERS

Genevieve Desportes was elected as chair for a 2 year term, to begin after the meeting of NAMMCO Council in March 2006.. It was decided that the vice-chair would be elected by correspondence. The Committee thanked Lars Walløe for his able chairmanship over the past 2 years.

THIRTEENTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

Chairman Lars Walløe welcomed the members of the Scientific Committee to their 13th meeting (Appendix 1), held at Reine i Lofoten, Norway, 24 – 27 October 2005. He also welcomed the Observer from Canada, Patrice Simon, the Observer from the Russian Federation, Dr. Vladimir Zabavnikov, and the Observers from the High North Alliance, Rune Frøvik and Laila Jusnes. Members Tore Haug and Mads Peter Heide-Jørgensen (Greenland) did not attend the meeting.

2. ADOPTION OF AGENDA

The Draft Agenda (Appendix 2) was adopted with minor changes.

3. APPOINTMENT OF RAPPORTEUR

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

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

4.1 National Progress Reports

National Progress Reports for 2004 from the Faroes, Greenland, Iceland, and Norway were presented to the Committee. In addition the Scientific Committee was pleased to receive a progress report from Canada and a presentation given by the Observer for the Russian Federation.

The Committee drew to the attention of the Council that the Report from Greenland was incomplete in that it did not include all research that was conducted in 2004, and did not summarize management measures that were taken in 2004. Noting the importance of these reports, the Committee recommended that complete reports be provided.

4.2 Working Group Reports

Working Group Reports and other documents available to the meeting are listed in Appendix 3.

5. COOPERATION WITH OTHER ORGANISATIONS

5.1. IWC

The 56th meeting of the Scientific Committee of the International Whaling Commission was held in Ulsan, South Korea, 30 May - 10 June 2005. Dr Lars Walløe attended as the Observer for the NAMMCO Scientific Committee.

Last year, the IWC Scientific Committee agreed that there were sufficient data to warrant initiation of the pre-implementation assessment for North Atlantic fin whales. In the meeting this year Iceland presented both non-genetic and genetic data for stock structure. Both the non-genetic data and the genetic divergence of fin whales from different feeding grounds indicate separate breeding units. Apart from that, no firm conclusion was reached, but further work related to identification and refinement of stock structure hypotheses was identified.

Issues to be addressed in completing the pre-implementation assessment for North Atlantic fin whales at the Committee's 2006 meeting were detailed. The IWC Scientific Committee recommended that IWC scientists attend the Workshop proposed by the NAMMCO Scientific Committee (see 9.6.2), given its focus on general scientific issues related to stock structure of fin whales and other nonmanagement related issues such as the development of a final catch series. The Committee agreed that relevant scientists from the NAMMCO Scientific Committee be invited to the 'First Annual Meeting' at which stock structure hypotheses will be discussed further.

The Scientific Committee received an analysis of the results of the photographic aerial strip-transect surveys carried out in 2002 and 2004. Corrections for whales not at the surface were applied to arrive at an estimate of 510 common minke whales, which is significantly smaller than the revised estimate of 6,390 whales in 1993. The corresponding fin whale estimate was 980 whales, which is similar to an estimate of 1,100 (95% CI 520-2,100) whales in 1987-88. The IWC Scientific Committee did not consider these estimates acceptable for a number of reasons related to both the examination of the photographs and the appropriateness of the correction factors applied. The Scientific Committee agreed that, once again, it was in the deeply unfortunate position of being unable to provide satisfactory management advice on safe catch limits. The Scientific Committee recommended (1) a re-examination of the photographs and (2) a cue-counting survey to occur, and agreed that priority should be given to carrying out the survey if insufficient funds were available.

5.2 ICES

The Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) met in September 2005 and their report is dealt with under 9.1 and 9.2.

Pike reported that the NAMMCO Secretariat had attended the ICES Annual Science Conference in September in Aberdeen, Scotland. The Management Committee *Ad Hoc* Working Group on Enhancing Ecosystem Based Management took advantage of the information provided in the theme session "Ecosystem Approach to Fisheries Management: Worked Examples" to hold a meeting to discuss the role of NAMMCO in applying the ecosystem based management approach. In addition 2 other theme sessions were of special interest to the Committee: "Mitigation Methods for Reducing Marine Mammal and Sea Turtle Bycatch" and "Marine Mammals: Monitoring Techniques, Abundance Estimation and Interactions with Fisheries". Pike gave a presentation on trends in humpback and fin whale abundance from the North Atlantic Sightings Surveys (NASS) (SC/13/9) under the latter theme session.

5.3 Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga (JCNB)

The JCNB Scientific Working Group and the NAMMCO Working Group on Narwhal and Beluga met jointly from 13-16 October 2005 and their report is dealt with under 9.4 and 9.5.

5.4 ASCOBANS

Daniel Pike attended the 12th meeting of the ASCOBANS Advisory Committee (AC) as the observer for NAMMCO.

The AC discussed plans for the SCANS-II survey (now completed), and tentative plans to conduct a survey in offshore waters in the same general area, probably in 2007. The Observer for NAMMCO informed the AC about the next (NASS) and the opportunity for coordination of surveys in 2007. The AC was supportive of these efforts.

A draft Recovery Plan for harbour porpoises in the North Sea was considered by the AC. In general the Parties found that the Plan should focus on specific stocks in the North Sea which might be depleted, as there is probably more than one stock in the area. It was also noted that the Plan should be more specific as to threats and possible mitigation actions pertaining to these stocks, and that there was a need for more stakeholder involvement in the Plan. A new version would be ready for the next meeting in 2006.

There was some discussion of the new European Regulations pertaining to bycatch, which will prohibit the use of driftnets in Baltic Sea fisheries by 2008, mandate the use of acoustic deterrent devices (pingers) in some fisheries, and mandate observer coverage in some fisheries.

The agreement establishing ASCOBANS has been amended to cover a larger area, extending west to 15° W and south to 36° N, but not including the area around the Faroes. The new area is contiguous with that of ACCOBAMS to the south. The ratification process is not yet complete but ratification is expected this year. In addition the AC was asked to consider the implications of extending the ASCOBANS agreement to include all cetaceans, not just toothed whales other than sperm whales as at present. This will be dealt with at the next meeting.

6. INCORPORATION OF THE USERS KNOWLEDGE IN THE DELIBERATIONS OF THE SCIENTIFIC COMMITTEE.

As in 2004 the Scientific Committee will await the conclusions of the Management Committee Working Group about what role, if any, the Committee can play in this process.

7. UPDATE ON STATUS OF MARINE MAMMALS IN THE NORTH ATLANTIC

At its 7th meeting in 1999, the Scientific Committee agreed that the Secretariat should proceed with the development of stock status reports summarising the view of the NAMMCO Scientific Committee on the status of stocks/species for which it has provided advice. These Reports will be published on the NAMMCO Web Site or elsewhere as appropriate The Scientific Secretary reported that 2 reports had been added to the web site this year and that at present there are 6 reports on the web site: minke whale, long-finned pilot whale, ringed seal, Atlantic walrus, beluga whale and fin whale. However the NAMMCO web site is in the process of extensive renovation and it is anticipated that simpler information items on marine mammals may be required in addition to the stock status reports.

8. ROLE OF MARINE MAMMALS IN THE MARINE ECOSYSTEM

8.1 Working Group on Marine Mammal – Fisheries Interactions

In 2004 the Committee tasked Walløe with reporting progress in these areas at the 2005 meeting, with the goal of holding a meeting in 2006 to finalize models for the Barents Sea and assess models for other areas, if progress on the identified research and modelling priorities has been sufficient to warrant such a meeting.

Walløe reminded the Committee of the problem with the Scenario C model reported last year, that when harp seals are introduced into the model, the cod are exterminated. This happens with the harp seal stock at the estimated current abundance, and is contrary to what is known of the system. The modelled predation of harp seals on cod, in addition to cannibalism and minke whale predation, is simply excessive. It was considered likely that this was due in part to bias in the harp seal diet data, for which most samples have been collected along the ice edge, where cod are not common, but a few have been taken from coastal Norway and show a relatively large proportion of cod in the diet. Satellite tagging has shown that harp seals spend a large part of the summer and fall in open water in the Barents Sea, but almost no data is available on their diet in this area. Presently efforts are being made to combine satellite tag information on the spatio/temporal distribution of harp seals combined with their diving patterns, with the known distributions of potential prey species, particularly capelin. Also, studies on fatty acid profiles are underway to determine the relative contribution of various prey to the diet. However it is not yet known if these efforts will be successful enough to improve the model.

Víkingsson reported that a person has been hired to integrate marine mammals in GADGET models for Icelandic waters, as had been recommended in 2002. However results are not expected before

2007. The Icelandic Research Program is ongoing and a preliminary report on the diet of minke whales in Icelandic waters will be produced in 2006.

The Observer for the Russian Federation informed the Committee about collaborative studies between PINRO and the Institute of Marine Research in Bergen, involving simultaneous aerial and ship surveys to assess the overlap between the distribution of marine mammal and potential prey species, particularly capelin and polar cod. While earlier surveys had indicated little correlation between the distribution of harp seals and capelin, such a correlation is suspected in 2005. The Committee requested that information on this study be made available at the next meeting.

The Committee tentatively decided to hold a meeting of the Working Group on Marine Mammal – Fisheries Interactions in 2007, depending on progress in modelling for the Barents Sea and Iceland. Again Walløe was asked to monitor progress in these areas.

8.2 Other matters

The Observer for Canada reported that a large amount of information on the distribution of harp and hooded seals from satellite tagging studies, as well as information on their diet in various areas, had been collected in recent years. It was expected that the results of these studies would become available in the next 2-3 years.

9. MARINE MAMMAL STOCKS -STATUS AND ADVICE TO THE COUNCIL

9.1 and 9.2 Harp and hooded seals

9.1.1 Update on progress

In 2004 the Management Committee requested that the Scientific Committee annually discuss the scientific information available on harp and hooded seals and advice on catch quotas for these species given by the ICES/NAFO Working Group on Harp and Hooded Seals. The advice by the Scientific Committee on catch quotas should not only be given as advice on replacement yields, but also levels of harvest that would be helpful in light of ecosystem management requirements

In 2005 the Management Committee recommended that the Scientific Committee evaluate how a projected decrease in the total population of Northwest Atlantic harp seals might affect the proportion of animals summering in Greenland. In addition the Management Committee requested the Scientific Committee to specify harvest levels for these 2 (*i.e.* Barents/White Sea and Greenland Sea) harp seal stocks that would result in a population reduction of 20% over a period of 20 years.

The ICES/NAFO Working Group on Harp and Hooded Seals met in September 2005 in St. John's Newfoundland, Canada. The main tasks of the Working Group were:

- to establish biological limits for Greenland Sea harp seals and White Sea/Barents Sea harp seals;
- assessment of the status of the stocks of harp and hooded seals in the Greenland Sea and harp seals in the White Sea/Barents Sea;
- assessment of the impact on these stocks of three different levels of annual harvest.
- Review the recent assessment of the status of harp seals conducted by Canada;
- Review the results of other ongoing studies on harp and/or hooded seals in the NW Atlantic, in particular any available results from tagging studies using satellite telemetry tracking.

Biological limits for seal harvest

The Working Group proposed a framework for biological reference points and a corresponding management framework, largely based on the Canadian management system. The framework relates to population numbers with the N_{max} (not exploited) stock size as a key reference point. In accordance with the precautionary approach a distinction is made between data adequate and data poor situations. Data adequate stocks should have data available for estimating abundance where a time series of at least five abundance estimates should be available spanning a period of 10-15 years with surveys separated by 2-5 years, the most recent abundance estimates should be prepared from surveys and supporting data (*e.g.*, birth and mortality estimates) that are no more than 5 years old, and the precision of abundance estimates should have a Coefficient of Variation about the estimate of about 30%. Stocks whose abundance estimates do not meet all these criteria are considered data poor.

Based upon these criteria, the harp and hooded seal stocks should be classified as follows: Greenland Sea harp seal stock - data rich; White/Barents Sea harp seal stock - data rich; Northwest Atlantic harp seal stock - data rich; Northwest Atlantic hooded seal stock - data poor; Greenland Sea hooded seal stock - data poor. For the latter two stocks, new survey results will become available in 2006, after which these stocks may be considered data rich.

For data rich stocks, two precautionary and one conservation (limit) reference level are proposed. All reference levels relate to the N_{max} population size. (*e.g.* maximum population size historically observed, N_{max}). The first precautionary reference level could be established at 70% (N_{70}) of $N_{max.}$ When the population is between N_{70} and N_{max}, harvest levels may be decided that may stabilise, reduce or increase the population, so long as the population remains above the N_{70} level. When a population falls below the N_{70} level, conservation objectives are required to allow the population to recover to above the precautionary (N_{70}) reference level. N_{50} is a second precautionary reference point where more strict control rules must be implemented, whereas the N_{lim} reference point is the ultimate limit point at which all harvest must be stopped. In accordance with practices in the Western Atlantic ICES recommends that the limit reference point (N_{lim}) could be either 30% of the historical accurate maximum population estimates or should be set independently using IUCNs vulnerable criteria.

For data poor stocks, it is recommended that only the lower tier (below N_{lim}) be defined. In this case, the four tiers effectively collapse to two (*i.e.*, above and below N_{lim}). Below N_{lim} all harvest must be stopped, and conservative and effective management measures will at all times be required when the stock is below N_{max}.

In the absence of a historical time series which enables estimates of N_{max} it is suggested that a risk avoidance management strategy is implemented. As a precautionary management approach it is therefore suggested that management is implemented such that the populations are above the historical minimum populations with high probability. Recent abundance estimates implies that present populations are above historical minimum with high probability. Maintaining the populations at or above the present level will thus be in accordance with precautionary management.

Assessments

Population assessments were based on a population model that estimates the current total population size. These estimates are then projected into the future to provide a future population size for which statistical uncertainty is provided for each set of catch options. The same population dynamic model was used for both of the Northeast Atlantic harp seal populations but with stock specific population parameters. A full assessment of hooded seals must await availability of updated abundance estimates (based on surveys conducted in March 2005) and will be performed in 2006.

Greenland Sea harp seal

The adult population is at the highest level estimated in the historical time series. Based on previous (1983-1991) mark-recapture data and recent (2002) aerial survey data, the stock in 2005 is estimated to be 618,000 (95% C.I. 425,000-845,000) 1+ animals with a pup production of 106,000 (95% C.I. 71,000-141,000). The total catches were 9,895 (including 8,288 pups) in 2004 and 5,808 (4,680 pups) in 2005. Removals were 23-38% of the allocated quotas, which was 15,000 animals one year old or older (1+ animals). The quota has been implemented such that parts of, or the whole quota, could be taken as weaned pups assuming 2 pups equaled one 1+ animal. Russia has not participated in this hunt since 1994. Catches have remained significantly less than the quota since 1993.

Options are given for three different catch scenarios:

- Current catch level (average of the catches in the period 2001 – 2005);
- Maintenance catches (defined as the fixed annual catches that stabilizes the future 1+ population);
- Two times the maintenance catches.

The catch options are further expanded using different proportions of pups and 1+ animals in the catches.

OPTION #	CATCH LEVEL	PROPORTION OF 1+ IN CATCHES	PUP CATCH	1+ CATCH	D_{1+}		
PRIOR					Lower CI	point	Upper CI
1	Current	25.6% (current level)	3,303	1,138	1.18	1.51	1.83
2	Maintenance	25.6%	36,688	12,624	0.61	1.01	1.41
3	Maintenance	100%	0	31,194	0.66	1.05	1.44
4	2 X maint.	25.6%	73,376	25,248	0.00	0.45	0.97
5	2 X maint.	100%	0	62,388	0.058	0.55	1.03

Table 1. Catch options with corresponding population trend (D_{1+}) for the next 10-year period for harp seals in the Greenland Sea. D_{1+} is the projected ratio of the abundance in 2015 to that in 2005.

White Sea/Barents Sea harp seal

The adult population is at the highest level estimated in the historical time series. Based on Russian surveys in 1998, 2000, 2002 and 2003, the stock in 2005 is estimated to be 2,065,000 (95% C.I. 1,497,000 – 2,633,000) 1+ animals with a pup production of 361,000 (95% C.I. 299,000 – 423,000). No commercial catches were taken from this stock in 2004. The combined catches for 2005 were 22,474 (including 15,420 pups).

OPTION #	CATCH LEVEL	PROPORTION OF 1+ IN CATCHES	PUP CATCH	1+ CATCH	D_{1+}		
PRIOR					Lower CI	Point	Upper CI
1	Current	11.5% (current level)	25,945	3,371	0.91	1.35	1.78
2	Maintenance	11.5%	153,878	19,995	0.57	0.98	1.39
3	Maintenance	100%	0	78,198	0.62	1.04	1.50
4	2 X maint.	11.5%	307,756	39,990	0.12	0.53	0.93
5	2 X maint.	100%	0	156,396	0.24	0.67	1.10

Table 2. Catch options with corresponding population trend (D_{1+}) for the next 10-year period for harp seals in the White/Barents Sea. D_{1+} is the projected ratio of the abundance in 2015 to that in 2005.

Reproductive rates in this stock are lower than those observed in other harp seal stocks. Growth rates have declined and the age of maturity for both males and females has increased since the early 1960s. All these observations may indicate density dependent factors affecting population dynamics of this stock, but this requires further investigations. There are reports that pup mortality rates may vary substantially in the White Sea region, and that in recent years these rates have been very high. For this reason, the 2005 abundance of White Sea harp seals was estimated under the assumption that the ratio between the natural mortality of pups and adults was 5 instead of 3.

Northwest Atlantic harp seal.

The average total removal from 1952 – 1982 was approximately 388,000 (including estimates for struck and lost and bycatch), but declined to 178,000 per year between 1983 and 1995. Since 1996, higher catches in Canada and Greenland resulted in average annual removals of 471,000. Young of the year account for approximately 68% of the current removals.

There is ongoing research involving satellite tracking of harp seal movements. Results of tracking 19 animals released off of NFLD were similar to the observations from 21 deployments in the 1990s. Most animals followed the Labrador coast northward and then dispersed into Baffin Bay, Davis Strait, and west coast of Greenland. A very few animals dispersed eastward to the east coast of Greenland, as in the

1990's deployment. Some double migrations occurred. Similar work is occurring the Gulf of St. Lawrence.

Photographic and visual aerial surveys to determine current pup production of northwest Atlantic harp seals were conducted off Newfoundland and Labrador (the "Front"), and in the Gulf of St. Lawrence during March 2004. Surveys of four whelping concentrations were conducted between 5 and 18 March resulting in estimated pup production of 640,800 (CV=7.3%) at the Front, 89,600 (CV=25.4%) in the northern Gulf, and 261,000 (CV=9.8%) in the southern Gulf (Magdalen Island), for a total of 991,400 (CV=5.9%). Comparison with previous estimates indicates that pup production has not changed since 1999, likely due to the increased hunting of young animals which began in the mid 1990s.

A population model, incorporating uncertainty in reproductive rates, was constructed to examine changes in the size of the Northwest Atlantic harp seal population between 1960 and 2005. The model incorporated information on reproductive rates, reported removals, as well as estimates of non-reported removals and losses through bycatch in other fisheries to determine the population trajectory. The northwest Atlantic harp seal population is currently estimated to number ~ 5 .9 million animals (SE=747,000), which is similar to the previous abundance estimate.

The sustainable yield estimated from the model presented for the Northwest Atlantic harp seal population is 554,000 animals. If it is assumed that the current level and age structure of catches in the Canadian Arctic and Greenland, and as bycatch in commercial fisheries remain the same, this would equate to a landed catch of 325,000 at the Front and Gulf.

Greenland Sea hooded seal

There is not sufficient data to assess the current stock status in an historical perspective. Preliminary results from a pup survey conducted in 2005 suggest that pup production in 2005 may be lower than observed in the previous survey (1997). Based on a Norwegian aerial survey in 1997, the stock in 2003 was estimated to be 120,000 (95% C.I. 65,000-175,000) 1+ animals with a pup production of 29,000 (95% C.I. 17,000-41,000). Total catches (all taken by Norway as Russian sealers did not operate in the Greenland Sea in the period) were 4,881 (including 4,217 pups) in 2004 and 3,752 (3,633 pups) in 2005. This was 87% and 67% of the identified maintenance yields, respectively. The quota was implemented such that parts of, or the whole quota, could be taken as weaned pups assuming 1.5 pups equalled one 1+ animal. Between 1990 and 2000 less than 30% of the quota was taken each year.

The 1997 estimate of pup production is the only estimate available for the Greenland Sea hooded seal stock. The single estimate of pup production is over 8 years old and there are no estimates of reproductive rates for this stock. A new aerial and vessel survey of hooded seal pup production in the Greenland Sea pack-ice was conducted in March 2005. The results will be used to estimate the 2005 hooded seal pup production, but will not be available until 2006. Preliminary results suggest, however, that pup production in 2005 may be lower than observed in the previous survey (1997). Due to lack of data it is not possible to provide these options for this stock. Given the poor data available on this stock and indications that pup production may be reduced management of this stock should be extremely cautious.

Northwest Atlantic hooded seals

Canadian catches have been quite low since 1999 (~150 animals per year) with the take in 2004 increasing to around 400 animals. There is an annual quota of 10,000 age 1+ animals in Canada. Bycatch was very limited due to the species being distributed away from commercial fisheries. Catches in Greenland have been in the 6,000-7,000 range during 1970-2001, but had declined to around 3,500 in 2002.

A hooded seal pup survey was conducted in 2005 in the Gulf, Front, and the Davis Strait. The surveys included visual and photographic estimates at the Front, and visual elsewhere. When completed, these results will provide an updated estimate of hooded seal abundance in the Northwest Atlantic by spring 2006.

Future meeting of the Working Group
It is presently planned that the Working Group will meeting in June 2006, primarily to deal with new information on hooded seals.

Discussion by the Scientific Committee
The Scientific Committee first considered the proposal by the Working Group to establish a management framework for the Greenland Sea and White/Barents Sea populations of harp seals, and the Greenland Sea population of hooded seals, based on biological reference levels. It was considered that the definition of N_{max} , the maximum population level observed historically, was not clearly specified. In the case of the Northwest Atlantic harp seal stock, the highest abundance estimate is used as a proxy for N_{max}, and this procedure is advised for the Greenland Sea and White/Barents Sea populations. However it was considered that N_{max} should be related to the carrying capacity for the stock. If the maximum observed population size is used, limit levels may be set for a population that is already depleted, and N_{max} will increase over time.

Decision rules for determining when limit levels are reached were not clearly specified in the report of the Working Group. Abundance estimates typically have wide confidence intervals, so crossing a specific population threshold can only be specified probabilistically. In the case of the Northwest Atlantic harp seals, the lower 60% confidence limit of the most recent estimate is apparently used as a metric for this.

The Committee considered that a management framework should be specified with specific reference to goals defined by managers. In this case the framework in a sense pre-defines the management goals. In the case of harp and hooded seals, where management goals may in the future be defined in relation to ecosystem based objectives, more flexibility will be required than is allowed in this framework. For these reasons the Scientific Committee could not advise the adoption of this management framework for harp and hooded seal stocks in the Greenland and White/Barents Seas.

The Committee regretted that the specific requests of the Council pertaining to the fraction of the Northwest Atlantic population migrating to Greenland, and catch levels necessary to reduce the population by 20% over 20 years (see above) had apparently not been conveyed to the ICES/NAFO Working Group, as had been recommended last year. The Committee noted that the Working Group would be meeting in 2006, and recommended that these questions be considered at that time.

Nevertheless, given the population projections provided above for the Greenland Sea and White/Barents Sea stocks, it is possible to provide some preliminary advice on catches required to reduce the populations by 20%. For the Greenland Sea stock, annual catches of 2x the ”maintenance” or equilibrium catch have the effect of reducing the population by 45-55% over 10 years, depending on the proportion of pups taken. Therefore, level of catch required to reduce the population by 20% over 20 years must be considerably less than the 2x maintenance catch noted in Table 1. The same holds for the White/Barents Sea stock (Table 2), for which the 2x maintenance catch level reduces the population by 53-67% over 10 years. More detailed advice on this matter will have to await further modelling results.

The Scientific Committee supported the recommendations of the Working Group concerning both stocks of hooded seals. Updated abundance estimates are expected in 2006 and at that time better advice on catch levels can be provided. Until then management should be precautionary, particularly for the Greenland Sea stock, for which preliminary results show that the stock may have declined.

9.1.2 Future work

The Scientific Committee recommended that the ICES/NAFO Working Group should be requested to address the question of how a projected decrease in the total population of Northwest Atlantic harp seals might affect the proportion of animals summering in Greenland. It was also recommended that the Working Group be requested to provide advice on catch levels for the White/Barents and Greenland Sea stocks harp seal stocks that would result in a population reduction of 20% over a period of 20 years.

9.3. Harbour porpoise

9.3.1 Update on progress

The SCANS-II survey was completed in 2005 and will provide estimates of abundance for this species in the North Sea and adjacent areas (see 10).

9.3.2 Future work

In 2004 the Scientific Committee noted that there is likely a substantial level of bycatch of harbour porpoises in Icelandic fisheries. The same is likely true in Norway. The directed catch in Greenland exceeds 2,000 in some years and was reported as 2,320 in 2003. In order to estimate the sustainability of the ongoing bycatch and directed catch in these areas, better estimates of the present bycatch levels of harbour porpoises in Iceland and Norway, as well as estimates of absolute abundance for all areas, are required.

9.4. Narwhal

9.4.1 Report of the Working Group

A joint meeting of the NAMMCO Working Group on the Population Status of Narwhal and Beluga in the North Atlantic, and the Canada – Greenland Joint Commission Scientific Working Group was held 13-16 October 2005 in Nuuk, Greenland. The full Report of the Joint Working Group (JWG) is included as Annex 1.

Stock structure

Four satellite-tracked narwhals had been shown to be stationary in and around Inglefield Bredning through September. Shifts to the west and south were observed for all animals by the end of the month, however no data were collected on migration routes or wintering grounds because the tag attachment duration was less than 20 days for all tags.

The JWG noted the importance of information on the migratory destination narwhals from Inglefield Bredning, but for this purpose the duration of the tags must be doubled or tripled. It was noted that this work had been carried out in cooperation with hunters, who had made an important contribution to the development of the tagging methodology.

No new information was available on stock structure in East Greenland since the NAMMCO Working Group last considered this in 1999 (NAMMCO 2000a). There are summer aggregations at Scoresbysund, Kangerlussuaq, and Ammassalik that are subject to catches. Narwhal also occur north of Scoresbysund but these are likely not harvested. There is genetic evidence that East Greenland narwhal are distinct from those in West Greenland and Canada. However at present there is no basis for further distinguishing East Greenland stocks beyond observed summer concentrations

Management units

An update on the metapopulation structure and hunt allocation of narwhals in Baffin Bay, based on all available information, was presented. The model was similar to that presented at the last meeting, but new evidence on migrations and homing of narwhals from Admiralty had been added. Coastal summering concentrations of narwhals constitute at least four stocks in Canada (Eclipse Sound, Admiralty Inlet, Somerset Island, East Baffin Stocks), two stocks in West Greenland (Inglefield Bredning and Melville Bay), and two shared stocks (Jones sound and Smith sound).

Biological parameters

Age estimation

Age estimation of toothed whales has traditionally used counting of growth layers in teeth, but this has limitations for narwhals. A paper presented results for the age estimation of West Greenland narwhals using the alternative method of aspartic acid racemization. Eyeballs and teeth from 75 narwhals were examined. About 20% of the whales were older than 50 yrs and there seemed to be a tendency for greater longevity in females than in males. The oldest female was found to be 115 years, the oldest male was 84 years, and age at sexual maturity was estimated to 6-7 yrs for females, and 9 yrs for males. These estimates of sexual maturity are similar to those from other studies.

The JWG welcomed this important advance, and it was recommended that the method should be applied to other marine mammals, where ages are available through other methods, and to captive animals of known age, in order to verify the racemization method. It was also recommended that the method be applied to beluga, in order to resolve the question of whether beluga teeth accrue 1 or 2 growth layer groups per year.

Catch statistics

Catch statistics for narwhals in Greenland was updated, with time series being split into hunting grounds and corrected for under-reporting estimated from purchases of mattak, for periods without catch records and from rates of killed and lost whales. Since 1993 catches have declined in West Greenland especially in Uummannaq where the decline is significant.

Sex ratio information for West Greenland is available for some years before 2004, where there seems to have been no apparent sex bias. Since 2004, it has been forbidden to hunt females accompanied by a calf, and this may lead to a bias toward males in the sex ratio as was observed in 2004.

There has been an increase in narwhal catches in East Greenland of 8% per year since 1993. The harvest reporting system changed in 1993 and the impacts of this change on the catch statistics are unknown.

The seasonal distribution and sex ratio of narwhal catches in Baffin region of Nunavut territory, Canada was described using hunter tag information. In many communities, there is more than one season of hunting. Many communities hunt mostly in summer but several communities take a substantial proportion of their catch in spring or autumn. This information was used in allocating the catch to different putative sub-stocks, either local summering sub-stocks or spring or autumn migrating sub-stocks.

The majority of the communities take a greater proportion of males than females throughout the seasons. Underreporting of females may have happened in the past, however, the authors are confident that the present reporting system is working well. In Canada, regulations forbid the harvest of female accompanied of a calf. This, as well as the high monetary value of the tusk, is the likely cause for the male bias in the harvest.

The average reported landed catch per year from selected communities in the eastern Canadian arctic was 373 for the period between 1996 and 2004.

In the communities that are part of the Canadian Community-Based Management program, total hunting mortality should be reported as it is required that hunters report if animals are "wounded and escaped" or "sunk and lost". However, there is conflicting information on the lost rate in the narwhal hunts. While a working paper indicated a somewhat low level of struck and lost in most communities and years, some anecdotal information suggests that higher loss rates are possible. The JWG therefore recommended the development of a program to collect struck and lost information from direct hunt observation of hunts in Greenland and Canada.

Abundance

Recent estimates

There had been a failed attempt to survey narwhals and belugas in West Greenland in March 2004. Due to wind and fog the survey effort proved to be very low with only an insignificant proportion of the total area being covered, preventing the development of an abundance estimate.

A hunter had collected video recordings of narwhal pods in Melville Bay in August 2004 and 2005, with the largest number of observed whales ranging between 107 and 147 narwhals. This confirms that narwhal occur in Melville Bay during the summer. Neither survey effort nor coverage could be estimated from the recordings, and no density estimate could be calculated.

Results from the aerial surveys in the Canadian high arctic in August 2002 to 2004 was presented. Narwhals were surveyed with line transect surveys in Eclipse Sound, Admiralty Inlet, Prince Regent Inlet, Barrow Strait, Gulf of Boothia, and in fiords and bays along the eastern coast of Baffin island. Estimates were corrected for whales that were missed by the observers, and for individuals that were diving when the survey plane flew by. The survey attempt for Admiralty Inlet was unsuccessful due to extreme clumping of the animals off transects in both 2003 and 2004 and the poor weather in 2004. The survey estimates have large standard errors due to clumping on certain transects within each stratum. Several areas known to contain narwhal were not surveyed due to weather conditions so the survey cannot provide a complete abundance estimate of the entire summer range in Canada.

The survey of the east Baffin fiord area was discussed at length. In this survey, a single line was flown up the centre of small fjords with extrapolation of the results to the entire area of the fjord. This resulted in an uneven coverage probability within the fiords, and there were concerns that this may have lead to bias. It was agreed that a sub-committee, co-ordinated by the lead author, should meet by email to try to resolve this issue.

Abundance estimates that have been accepted for use in assessments are presented in Table 1 of Annex 1.

Assessment

Update of West Greenland assessment

A model selection based assessment for West Greenland narwhals was presented, using a density regulated population dynamic model to identify the more likely stock structure hypotheses for West Greenland narwhals. The framework performed Bayesian assessments on 28 of the most likely three, two and one stock hypotheses, and used Akaike weights to determine the relative probabilities of the different models. The analysis discarded 12 of the original hypotheses as being unlikely, and it agreed with other information on the most likely stock structure hypotheses.

There was disagreement within the JWG about the appropriateness of using apparent stock dynamics as a method of selection between stock hypotheses, but this did not preclude the JWG from reaching conclusions about the most likely stock structures in the area and selecting assessment models appropriately.

The assessment used the data on abundance, catch history and biological parameters that have been agreed in the past by this committee. Nevertheless there was concern about possible biases in some of the input data, particularly abundance estimates and indices. For Inglefield Bredning, the 1986 and 2001/2 estimates were produced using different survey methodologies that have not been directly calibrated against one another, and this may influence the trend in the estimates between 1986 and 2001/2.

For Disko Bay, the index surveys conducted in the early 1980's were done by a somewhat different methodology than those done in the 1990's, and it has been recognized by this Committee that, for beluga, the two sets require different treatment. There is no reason to suppose that the situation is different for narwhal, but the assessment applied only a single bias correction factor to all index surveys.

The greatest difficulty in providing advice for West Greenland narwhal is the uncertainty in stock structure. The models using the stock structures considered most likely by the JWG were examined further. A probability of 70% of some stock increase within 5 years was considered an appropriate objective. To meet this objective, depending on the model, a total annual removal ranging from 15 to 75 narwhals is allowed for the entire area. This strengthens the conclusion reached in 2004, that West Greenland narwhal are heavily depleted and substantial reductions in catch are required immediately to arrest the decline in numbers. However the JWG could not agree on the quantitative results of the model because of the above noted uncertainties in stock structure and input parameters. There was no general agreement within the JWG on which model scenarios should be used in a final assessment. However, the JWG agreed that the recommendation provided in 2004, that the total removal in West Greenland should be reduced to no more than 135 individuals, should be provided again and with greater emphasis. This greater emphasis is due to the fact that all models reviewed by the JWG allowed total annual removals lower than 135.

The JWG recognized that new information confirmed that narwhal do occur in Melville Bay, but without an abundance estimate the JWG was unable to recommend a sustainable removal level for this stock.

The JWG recommended the research in Section 5.5.1 of Annex 1 to provide more specific advice on sustainable catches.

<u>Canadian summer stocks</u>
A risk analysis on narwhal hunting in the Canadian High Arctic was presented. A simple population dynamic growth model determined the risk of a decline of 5% and 10% over a period of ten years, assuming a single stock or a metapopulation structure with 4 different sub-stocks (Somerset, Admiralty, Eclipse, East Baffin). Results indicate little or no risk of decline over the time span in all but one case, the Admiralty Inlet sub-stock.

It was considered that including a wider range of some parameters in the analyses would improve the model. Specifically the JWG requested higher struck and lost rates, of up to two times those used initially. This analysis was performed at the meeting. The effect was to increase the probability of a decline at Admiralty Inlet but not substantially so at Eclipse Sound except under the lowest examined rate of population increase.

The model incorporated only recent abundance and catch estimates. The JWG recommended that a model incorporating all abundance estimates considered useable for assessment, with an historical catch series, be developed, as has been done for West Greenland beluga and narwhal. This would show trajectories of stocks over time, providing estimates of stock status and sustainable removal levels.

Until a new modelling framework is developed, the JWG decided to use the present model to arrive at preliminary conclusions about the status of Canadian summer stocks:

<u>Somerset Island</u>
This stock is the largest of the Canadian summer stocks. It is subject to a low level of harvesting in the summer, but may be hunted by several communities in the spring and fall. Even under the most pessimistic scenarios of stock size, hunting loss rates and rate of increase, there is a negligible risk that the stock will decline over the next 10 years. It was concluded that present catch levels are sustainable for this stock.

Admiralty Inlet

Under scenarios of high loss rate and/or low rate of population increase, the model predicts that there is a high probability that this stock will decline in the next 10 years. In addition the survey estimate for 2003 is substantially lower than that for 1984, indicating that there may have been a population decline over that period. However it was recognized that the recent estimate may be biased because of the extreme clumping of narwhal. It was concluded that there is a risk that present catch levels are not sustainable for this stock, and recommended that a new modelling framework as described above be developed to provide estimates of sustainable removals.

Eclipse Sound

Under all but the most pessimistic scenarios of high loss rates combined with low rates of increase, the model indicated that there is a very low risk that this stock will decline in the next 10 years with present catch levels. It was concluded that present catch levels were likely sustainable for this stock, but again recommended that a new modelling framework as described above be developed to provide estimates of sustainable removals.

East Baffin

Because the abundance estimate for this area was not accepted, advice on the sustainability of catch levels in this area could not be provided. It was also noted that there was no information about the seasonal distribution of this stock, so it was not known if it was subject to harvesting outside of the East Baffin area. It was recommended that a new abundance estimate be developed for this area, and that studies be conducted to determine the seasonal distribution of this stock.

East Greenland

Given that almost nothing is known about the stock structure and seasonal migrations of East Greenland narwhal, and that the abundance estimate for Scoresbysund is more than 20 years old, a reliable assessment is not possible without new information. Nevertheless *ad hoc* modelling carried out at the meeting indicated that, under the assumption of an independent stock at Scoresbysund, present local harvest levels are not sustainable given the abundance estimate from 1983. However the validity of these assumptions cannot be assessed without further research. Insufficient information was available to carry out assessments for other areas of East Greenland.

Future research requirements for narwhal are given in Section 5.7 of Annex 1.

Discussion by the Scientific Committee

As in 2004, the Scientific Committee supported the recommenation of the JWG that the total removals of narwhal in West Greenland should be reduced to no more than 135 individuals per year in order to halt the apparent decline in numbers. This should be considered an interim recommendation only. Modelling carried out this year suggests that, under the most likely stock structure scenarios considered, the sustainable harvest may be as low as 15 to 75 animals per year. However it was recognized that there was great uncertainty in these projections, particularly because stock structure was poorly understood, and because there may be biases in the abundance estimates and indices that have not been quantified. The Scientific Committee therefore supported the recommendations for research to improve the advice on sustainable catches for West Greenland narwhal made by the JWG, and noted that much of this research can be completed within 1 to 3 years. The Scientific Committee will continue to monitor this situation closely and will update this advice as new information is provided.

The Scientific Committee was informed that the narwhal quota for West Greenland was 300 in 2004/5, of which 294 were caught, and that the quota has been reduced to 260[1] for 2005/6. While recognizing that this was a significant step towards the sustainable management of West Greenland narwhal, the Committee remained concerned that the total removals were still well above the

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[1] After this meeting the narwhal quota for 2005/2006 was raised by 50 to a total of 310.

recommended level of 135. The Committee once again advised that delay in implementing catch reductions to the recommended levels will result in delay in stock recovery and probably in lower available catches in the medium term.

The Committee noted the conclusion of the JWG that the information was not sufficient to carry out a meaningful assessment of East Greenland narwhal at this time, and supported the recommendations for research that would make an assessment possible.

9.4.2 Future work

It is planned to conduct a survey for narwhal and beluga in the West Greenland overwintering area in March 2006. Noting the difficulties in interpreting the abundance estimates at Inglefield Bredning, Melville Bay and the West Greenland overwintering area, the Scientific Committee emphasized that future surveys should be conducted in a manner such that the results are comparable to past surveys. If new techniques are used, experiments should be conducted to calibrate the new methods against the old. This pertains especially to the surveys of the West Greenland overwintering area, for which a long time series is available.

9.5 Beluga

9.5.1 Report of the Working Group

Catch statistics for belugas in Greenland was updated. From 1954 to 1999 total reported catches ranged from 216 to 1874 and they peaked around 1970, and catches have declined at about 2% per year between 1979 and 2004. It was noted that the harvest in 2004 had been very low because of the introduction of the quota system and bad weather in some areas.

Reported catches in East Greenland are suspected to be possible misreporting of caught narwhals. It was recommended that the occurrence of beluga in East Greenland be investigated, perhaps through a traditional knowledge study, to determine if they do occur there or if the reported harvests are erroneous.

Catch statistics for 1996 to 2004 for Beluga in selected communities in the Eastern Canadian Arctic was presented. The average reported landed catch from communities hunting from the Baffin Bay beluga stock for the period is 42. The JWG noted that, as in the case for narwhal, reporting of struck and lost is variable between years and communities and may be unreliable for some communities.

Abundance

An attempt to survey the West Greenland index area in March 2004 was unsuccessful due to inclement weather. The survey will likely be attempted again in 2006.

Assessment update

<u>West Greenland</u>

Historical catches from 1862 and three time series of abundance estimates were combined with density regulated population models to update the assessments for belugas in West Greenland. Seven model combinations tested for sensitivity of the assessment to variation in the msyr, the presence versus absence of additional variance in abundance estimates, the presence versus absence of an absolute abundance estimate, high versus low catch histories, and the effects of using an age-structured or a discrete population dynamic model. All models estimate similar dynamics, where West Greenland beluga are severely depleted, with median depletion ratios in 2005 varying between 16 and 37 percent of the carrying capacity. The median of the current replacement yield was estimated to lie between 215 and 516 beluga, with the lower 2.5th percentile lying between 51 and 111 beluga. These results are very similar to those from previous assessments.

The JWG considered that the “low MSYR” case provided the most realistic assessment based on available information, with Table 2 providing the probability of halting the decline in beluga numbers in the next 5 years for a range of catch options for this case. Reduction of catches to 100 per year will have an 80% chance of meeting this objective by 2010. Maintaining higher catches reduces the probability of halting the decline, with the current quota of 220 beluga resulting in a 46% probability of halting the decline and a 54% probability of a continued decline.

The JWG also reiterated recommendations made by the NAMMCO Working Group in 2000 (NAMMCO 2001a) pertaining to other measures that would improve the conservation status of beluga in this area.

Canada

Given that the harvest of beluga in high-arctic Canada is very low relative to the summer abundance of beluga in the area (Innes *et al.* 2002), stock assessment for this area was not considered a priority at present. However some proportion of animals summering in Canada migrates to West Greenland and it was considered important to determine where in Canada these animals can be found in the summer, in order to determine if they are harvested also in Canada.

Discussion by the Scientific Committee

The Scientific Committee noted that the conclusions from the new assessment were essentially the same as those conveyed in 2000 and 2001, that a reduction of catches to 100 per year is required to have an 80% chance of meeting the objective of halting the decline in this stock by 2010. Maintaining higher catches reduces the probability of halting the decline, and delay in implementing harvest reductions will increase the risk of continued stock decline. In this regard the Scientific Committee noted that the quota for 2004/5 was 320, of which 91 were caught, and that the quota for 2005/6 was 220.

The Scientific Committee also reiterated the recommendations made in 2000 and again by the JWG this year pertaining to other measures that would improve the conservation status of beluga in this area.

9.5.2 Future work

It is planned to survey the West Greenland overwintering area in March 2006. The recommendations pertaining to this survey under 9.4.2 are reiterated.

9.6 Fin whales

9.6.1 Report of the Working Group on North Atlantic Fin Whales

The NAMMCO Working Group on fin whales met in Oslo 20-22 October 2005, and the Report of the meeting is included as Annex 2. Given that a special workshop primarily on stock structure is planned (see 9.6.3), discussion of this topic was limited, as additional genetic analyses were expected in the near future.

The available data on stock structure of North Atlantic fin whales based on non-genetic methods was summarized. This included a wide range of studies based on discovery marking, morphometry, earplug morphology, photo-identification, acoustics and biological parameters. Although each method is rather inconclusive by itself, collectively they indicate a separation between fin whales summering in the western, central and eastern North Atlantic. There also appears to be a more or less isolated stock in the Mediterranean Sea.

A paper presented results of the genetic variation in 1,018 fin whales sampled at 5 North Atlantic areas; *i.e.* off West Iceland, Norway, Spain, and West Greenland and off the eastern Canadian coast. The data presented were based on genotypes of 9 microsatellite loci. The genetic analyses carried out revealed significant genetic divergence among Icelandic, Norwegian, Spanish, Greenland and Canadian samples. It was concluded that the fin whale samples taken at the feeding grounds of Iceland, Norway, Spain, Greenland and Canada most likely come from separate breeding units. The Working Group recommended that also an analysis of heterogeneity in mitochondrial DNA be carried out.

In summary, the Working Group did not find reason to change its previous view (NAMMCO 2000a), that most evidence suggests the presence of stocks with limited gene flow between adjacent summering aggregations. However, these summer aggregations could be composed of single and/or mixtures of breeding stocks. Interpretation of these data is limited by the lack of temporal and spatial coverage in the sampling.

A new analysis of historical catch records for Iceland was presented. The catch data from the early whaling period 1883 to 1915 are split as requested in 2003 between the Westfjord and east coast regions. Catch position records show that there was very little overlap in the range of the east and west operations, but the operational range expanded with time. The Working Group welcomed this contribution, which will facilitate modeling of fin whale population dynamics.

A paper provided a compilation of fin whale catches in the entire North Atlantic. The time period covered was 1894 to 1984 for all areas except Norway, where the period covered was from 1917 onwards. A total of 28,559 fin whales were identified in the catch, leading to an estimate of 30,598 fin whales caught by prorating unidentified catch using the catch composition. In discussion it was noted that catches of fin whales off northern Norway exceeded 10,000 animals in the period before 1904, but that it was considered that the catches in this period had been adequately documented by Risting (1922) and that there was little to be gained by a recompilation of these data. The Working Group recommended that catches from this period be added to the catch series to make it complete.

Regionally stratified abundance estimates for fin whales from North Atlantic Sightings Surveys (NASS) conducted in 1987, 1989, 1995 and 2001 were presented to the Working Group. Of particular interest were areas considered useful in modelling, namely East Greenland, West Iceland, the remainder of the EGI area and areas outside. The data were re-analysed using a standardized methodology to make the estimates internally consistent. Total abundance estimates for each survey were quite close to previous published and unpublished estimates. There has been a substantial increase in the abundance of fin whales in the area west of Iceland since 1987. This corresponds to the area where nearly all fin whaling has been conducted since 1915. The Working Group welcomed this reanalysis and noted that it fulfilled a request made in 2003. It was concluded that the abundance estimates produced were acceptable for assessment.

A paper used sightings survey data collected over the period 1988-2004 to calculate relative abundance estimates for fin whales in the Northeast Atlantic. Point estimates of relative abundance in this area ranged between 1,100 and 1,800 whales in 5 surveys, with no significant trend over the period. There have been changes in fin whale distribution over the period, with more whales found west of Spitzbergen in later surveys. The abundance estimates are low by comparison with the land station catches in this area, which exceeded 1,000 per year in some years between 1875 and 1904. The stock must therefore be depleted compared with historical abundance levels. The Working Group concluded that the estimates provided would be suitable for use in assessments as an index of relative abundance in this area.

Butterworth reported a new assessment model of the EGI fin whale population, modeled as four subpopulations with movement between the following areas: East Greenland (area 1), West Iceland (area 2), East Iceland (area 3) and the Far East (area 4). The model is sex- and age-structured, and is fitted to CPUE, sightings survey abundance, and mark-recapture data using both maximum likelihood and Bayesian approaches. For the base case assessment scenario, best fits to the data were obtained when the West Iceland and East Iceland are effectively fully mixed with a low level of interchange with East Greenland and virtually no interchange with the Far East region. For the base case and most sensitivity tests, the overall recruited population is increasing and above 80% of pre-exploitation abundance (*K*), and subpopulations in all areas are above 70% of the individual *K* values. Projections for annual catches of 0, 100, and 200 whales indicated that only the last would result in abundance decreases compared to current levels if catches were taken only from the West Iceland area.

It was agreed that the base case model would be updated for the March 2006 meeting to reflect the discussion at this current meeting in the following ways:

1. Using abundance estimates for individual areas in 1988.
2. Use an adjusted set of early CPUE series.
3. Apportion the Norwegian pelagic catches, 1917-1937, to the correct areas.
4. Increase the maximum bound on *r*, the increase in calf production rate at low population sizes.

However, further work is needed to clarify the stock relationships in this area, particularly with regard to area boundaries and mixing rates.

The Working Group found no reason to change its advice provided in 2003 (NAMMCO 2004a), that projections under constant catch levels suggest that West Iceland (termed the "inshore substock" in earlier analyses) will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales. It is important to note that this result is based upon the assumption that catches are confined to West Iceland, *i.e.* to the grounds from which fin whales have been taken traditionally. If catches were spread more widely, so that other stock components were also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

The Working Group is not yet in a position to provide management advice for the North Norway area. Once the identified work has been done assessments can be carried out for this area. However, given the rather low abundance estimates (<2,000) and the high historical harvest in the area, it can be expected that the stock will be found to be depleted relative to past levels.

No new assessments were considered for the West Norway-Faroese area. The Working Group reiterated the advice provided in 2003 (NAMMCO 2004a), that uncertainties about stock identity are so great as to preclude carrying out a reliable assessment of the status of fin whales in Faroese waters.

The Working Group reiterated research recommendations made in previous meetings (NAMMCO 2000b, 2001b, 2004), and identified those most important to refine existing assessment and extend assessments to other areas.

Discussion by the Scientific Committee
The Committee supported the management recommendations for the EGI and Faroese fin whales, and noted that they are unchanged from 2003. The Committee also supported the recommendations for research contained in Section X of Annex X, noting that much of this must be completed for the fin whale workshop in March 2006.

9.6.2 Other information

Trends in the abundance of fin and humpback whales in the Central and Northeast Atlantic were examined in SC/13/9. North Atlantic Sightings Surveys (NASS) were conducted in 1987, 1989, 1995 and 2001. The NASS have covered a very large area of the central and eastern North Atlantic, from East Greenland east to coastal Norway, and from Svalbard south to the Iberian peninsula. The surveys used ships and aircraft as survey platforms. Target species were minke, fin and pilot whales, but all species encountered were registered. Abundance estimates are negatively biased because of whales diving during the passage of the survey platform and whales being missed by observers, but these and other potential biases are likely small for these species. Fin whales occurred in highest densities in Denmark Strait west of Iceland. The abundance of fin whales increased in the survey area over the period, with the greatest increase observed in the waters west of Iceland. There were 29,900 (cv 0.11) fin whales in the area in 2001. The observed trends are consistent with increases in abundance following the cessation of whaling in this area, but the magnitudes of the observed increases, taken at face value, are greater than expected. Other factors, including differential harvesting of sub-stocks, changes in carrying capacity, immigration from other areas, the near extirpation of some other cetacean species, and operational factors in the surveys themselves, may be involved.

SC/13/18 provided a summary of catches of all species of whales taken in the North Atlantic between 1894 and 1984 by Norway, the Faroes, Shetland, the Hebrides and Greenland. The compilation was carried out because discrepancies had been noted between the official records kept by the IWC and archival sources. Primary and secondary sources, including museum, institutional, company and library archives, newspapers and interviews were used to compile the summary. Catches are presented by year, species, location and station, and a crude index of CPUE (catch per boat) is derived.

The Scientific Committee welcomed the information in both papers and noted that they will be useful in future assessments of fin, humpback and other whale species.

9.6.3 Future work

The Committee will be holding a special workshop “Catch History, Stock Structure and Abundance of North Atlantic Fin Whales”, tentatively scheduled for March 2006 in Reykjavik, Iceland. The Scientific Committee of the IWC has been invited to sent participants to the meeting. It is expected that the IWC will wish to use the report from this workshop as input to the ”Pre-implementation Assessment” of fin whales, to be held at their meeting in June 2006. Therefore the Scientific Committee will have to consider the Report from the workshop intersessionally.

Given the available information on catch, abundance and stock structure, the Committee considered that assessment could proceed for the Northeast Atlantic, particularly the North Norway stock, in the near future. The Committee will await the conclusions of the Workshop before proceeding with future assessments.

9.7 Minke whales

9.7.1 Update on progress

No documents pertaining to minke whales were available this year. Norway has continued its 6 year rotational sightings survey program, and the blocks north of Iceland and around Jan Mayen were surveyed this year. Work has continued on the development of an RMP variant specific for Northeast Atlantic minke whales, and the results will be presented to the IWC Scientific Committee this year.

The Icelandic Research Program continued in 2005 with the take of 39 minke whales in coastal waters. Half the planned total of 200 minke whales have now been sampled. An aerial survey was conducted in May 2005 as part of a series to look at the seasonal distribution of minke whales in the area. In August 2004 satellite tagging was attempted on 9 minke whales. Of these 7 tags were successfully implanted, 3 failed immediatly, 2 failed within a few days and 1 transmitted for about 3 weeks. The final tag did not transmit initially but began transmitting in mid-November, by which time the whale was about 500 nm west of Spain. Transmissions endured for a further 3 weeks by which time the whale was west of North Africa. An interim report on the Icelandic Research Program will be produced in 2006.

An aerial survey with minke and fin whales as the target species was conducted successfully in West Greenland in September 2005. Unsuccessful attempts were made to satellite tag minke whales in Disko Bay.

9.7.2 Future work

No further work specifically on minke whales is planned, but see 8.1.

9.8 White-beaked, white-sided dolphins, bottlenose and common dolphins

9.8.1 Update on progress

Norway reported that satellite tagging of white-beaked dolphins had been attempted unsuccessfully this year. In the Faroes the the examination of samples from the catch of primarily white-sided dolphins is ongoing. Sampling of bottlenose dolphins has been very limited because the catch is small. In Iceland work on samples from the bycatch of white-beaked dolphins is continuing.

The data for common dolphins collected during the NASS surveys between 1987 and 2001 was examined in SC/13/19. There were there sufficient data to attempt to estimate abundance only in 1995. The estimated abundance in the W Block of the NASS95 Faroese survey was 273,159 (CV = 0.26; 95% CI = 153,392 – 435,104). This estimate is corrected for animals missed on the trackline (g(0)) and for responsive movement. The data from all surveys were used, together with data from the MICA93 and from the Celtic Block of the SCANS survey, to examine the distribution of common dolphins in the NE Atlantic. No sightings were made north from 57º, and encounter rates were highest between 51º and 53º N, with no significant differences in terms of Longitude. Encounter rates were lower in shallow waters of less than 400m depth, and higher in the 400 – 1,000 m depth range. Group sizes increased with depth. Both encounter rates and group sizes increased steadily with sea surface temperature.

The Scientific Committee noted the lack of overlap between the distributions of common dolphins and especially the *Lagenorhynchus* species. Common dolphins apparently do not occur in the waters of member countries except as occasional visitors.

9.8.2 Future work

The Scientific Committee concluded in 2003 that there was still insufficient information on abundance, stock relationships, life history and feeding ecology to go forward with the requested assessments for these species. This may become feasible once feeding, genetic and life history studies have been completed in Iceland, the Faroes and Norway, and when new abundance estimates become available from the SCANS II, NASS and other sightings surveys. Such an assessment could probably be conducted by 2008 at the earliest.

9.9 Grey seals

9.9.1 Update on progress

Norway and the Faroes reported that no new research had been carried out in 2004. Iceland reported that surveys were carried out in the main pupping areas in 2004, and preliminary results indicate that pup production has declined since 2002. Iceland also noted that, in fulfillment of the recommendation by NAMMCO in 2003 (NAMMCO 2004b), management objectives had been developed for this species.

The Observer for Canada reported that a complete survey of grey seals had been carried out in 2004. The results indicate that the Canadian population is the largest in the world and continues to grow.

9.9.2 Future work

In 2003 the Scientific Committee strongly recommended immediate efforts to obtain better information on the population of Faroese grey seals, and on the nature and impact of the take in the Faroes. Noting that this had not yet begun, the Committee reiterated the recommendations made in 2003.

The Scientific Committee welcomed the information that Iceland was continuing its survey program for this species and had developed management objectives as had been recommended in 2003. Noting that population surveys indicated that the stock continued to decline, the Committee reiterated its previous recommendations for management of this stock,. A formal assessment of the effect of present levels of harvest and bycatch on the population, including the risk of extinction and the sensitivity of the survey program to detect a population decline, should be conducted as soon as possible.

For Norway, the Scientific committee noted as in 2003 that the new quota levels implemented for this area would, if filled, almost certainly lead to a rapid reduction in population in the area. A formal analysis of the effect of the quota levels of harvest on the population, including the risk of extinction and the sensitivity of the survey program to detect a population decline, should be conducted as soon as possible.

9.10 Harbour seals

9.10.1 Update on progress

Lydersen informed the Committee about studies on an isolated stock of harbour seals at Svalbard, involving the live capture and sampling of 365 seals. The population exhibits sexual dimorphism and appears to have a truncated age structure relative to other harbour seal stocks. This information will be considered by the new Working Group (see 9.10.2).

9.10.2 Future work

In 2005 the Management Committee addressed the following request to the Scientific Committee:
Harbour seal abundance has fluctuated in the Northeast Atlantic in recent years due to local outbreaks of viral distemper. Usually these outbreaks have been followed by rapid recoveries, and harbour seal abundance may have increased in many areas. In some areas, harbour seals are harvested and/or taken incidentally by fisheries and aquaculture operations (*e.g.* Greenland, Norway and Iceland). They also have significant direct and indirect interactions with fisheries in many areas. For these reasons, the Scientific Committee is requested to:

- Review and assess the status of harbour seals throughout the North Atlantic;
- Review and evaluate the applied survey methods;
- Assess stock delineation using available data on genetics, spatial and temporal distribution and other sources;
- review available information about harbour seal ecology;
- Identify interactions with fisheries and aquaculture.

Desportes reported that a Working Group on Coastal Seals had been initiated under her chairmanship. The Working Group will meet in fall 2006 to fulfill the request for the entire North Atlantic, but concentrating on areas of interest to NAMMCO member countries. To this end, representation from the Baltic and Wadden seas will be sought from regional management orgainizations for those regions.

9.11 Humpback whales

9.11.1 Update on progress

SC/13/9 provided information on trends in the abundance of humpback whales in the Central and Northeastern Atlantic (see 9.6.2) Humpback whales were most abundant in shelf waters east and west of Iceland. There has been a great increase in the abundance of humpback whales around Iceland, but not in other areas. Aerial surveys conducted in Icelandic coastal waters indicate an annual rate of increase of 15% in this area. There were 14,900 (cv 0.26) humpback whales in the entire survey area in 2001.

Revised catch figures for humpback whales from whaling operations in the North Atlantic were provided in SC/13/18 (see 9.6.2).

An aerial sightings survey of West Greenland was conducted in September 2005, and a number of sightings of large humpback whale groups were made. Estimates from this survey will be available in 2006.

9.11.2 Future work

In 2005 the Management Committee reqested that the the Scientific Committee continue its assessment of humpback whale stocks in the North Atlantic. For West Greenland, the Scientific Committee should assess the long-term effects of annual removals of 0, 2, 5, 10 and 20 whales. For the Northeast Atlantic the Scientific Committee should provide estimates of sustainable yield for the stocks. In all cases the management objective would be to maintain the stocks at a stable level. The

Scientific Committee should identify information gaps that must be filled in order to complete the assessments.

The Committee decided to postpone the provision of advice for West Greenland until a new abundance estimate is available, probably in 2006. However it was noted that the estimate from the 2005 survey may not be directly comparable to earlier estimates, as the survey was conducted later in the year.

Sufficient information on historical catch, abundance and stock structure is available at present to conduct assessments for the Icelandic and Norwegian stocks. However, given other priorities, the Committee considered it advisable to delay this assessment until after the completion of the NASS-2007 survey, when an additional estimate of abundance should become available.

9.12 Killer whales

9.12.1 Update on progress

No new information was tabled on this species.

9.12.2 Future work

In 2004 the Scientific Committee provided a list of research required to conduct an assessment of killer whales, particularly in West Greenland, as requested by the Council in 2004. The Committee will review progress under this item annually with the view of conducting an assessment when sufficient information becomes available.

9.13 Walrus

9.13.1 Report of the Working Group on Walrus

The Working Group on Walrus met in Copenhagen, 11-14 January 2005 under the chairmanship of Mads Peter Heide-Jørgensen. The Working Group had been requested to provide an updated assessment of walruses, to include stock delineation, abundance, harvest, stock status, and priorities for research. The Report of the Working Group is included as Annex 3.

Stock structure

New genetic analyses included samples from various areas in northern Canada, West Greenland, northwest Greenland, East Greenland, Svalbard and Franz Josef Land. No genetic analyses were available from Russia. The Working Group found these results generally confirmatory of the putative stock structures suggested previously by NAMMCO (1995) (see Annex 3 Fig. 1). 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. Animals from Foxe Basin could be distinguished from those from the North Water (NOW) stock area, and some substructuring was found within the NOW area.

Satellite tracking studies have been conducted in Svalbard, East Greenland and Northern Canada, but not in Russia. Results to date have 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.

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 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 communities that were close together and within the same putative stock area, such as Hall Beach and Igloolik, can be differentiated on the basis of these methods. 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.

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.

The Working Group also examined information on the 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. This distributional evidence suggested the existence of 3 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.

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 of Annex X.

Biological parameters
A summary of new information on biological parameters is provided in Table 2, Annex 3.

Catch statistics
No recent catches of walruses have been reported from Svalbard or the western Russian Federation, and walrus hunting is prohibited in these areas. 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, some of the higher records in Piniarneq appear to be implausible. Similarly in West Greenland reported harvests have increased substantially since the introduction of Piniarneq. For northwestern Greenland there were few years with valid harvest reports prior to 1993, and reported harvests have not increased since then. 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 there was no data to support this.

Two sources of harvest data from Canada, 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. All walrus harvest data were plagued by incomplete reporting but data for almost ½ the annual community totals agreed between sources.

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.

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 1995a), and the Working Group saw no reason to change this assumption.

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

Abundance and trends

There are no recent abundance estimates for the western Russian Federation, but some "best guess" estimates were provided. An estimate for East Greenland, based on opportunistic and systematic observations, has been published (Born *et al.* 1997). 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.

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, but as yet estimates have been developed only for the 1990 and 1991 surveys. In discussion the Working Group identified several difficulties with these estimates and recommended that it be re-calculated. It was also recommended that all available surveys from this area should be analyzed in a consistent manner.

A survey was cunducted in the NOW area in August 1999, resulting in a total estimate of 1,500 for the NOW area, including corrections for animals seen in the water and on land and for areas not surveyed. The Working Group found that the survey was not presented in sufficient detail for evaluation purposes, accepted the estimate for information but noted that it should not be used directly in assessments without further work and documentation.

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 of Annex 3.

Ecology

Estimates of energy consumption and consumption of bivalve prey for East Greenland walrus were provided. 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.

The potential impact of global warming on walrus was discussed, but the Working Group could not come to any firm conclusions on the matter. 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 emphasized in this context that the most immediate threat to walrus populations is overexploitation, not climate change.

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.

New oil and gas fields are 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.

Assessment by stock

A formal assessment model was provided only for the West Greenland, NOW and East Greenland populations. The model combined recent abundance estimates with historical catches and an age- and sex-structured population dynamic model to perform Bayesian assessments of the walrus populations. 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 percent 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.

The Working Group had already agreed that the abundance estimate for East Greenland used in the assessment was not suitable for such a use. There was also great uncertainty about the catch series and life history parameters used in the analysis. Similarly, there was uncertainty about the life history parameters used in the modelling. However it was recognized 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 that the East Greenland walrus population was recovering or recovered after a period of overexploitation 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. 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 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 that for some years, recent (1993-2002) harvest reports are considered to be implausibly high.

For West Greenland, the Working Group had agreed that the abundance estimate used was not suitable for use in assessment. 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. 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 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 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.

The Working Group had already concluded that the former NOW stock should be divided into 3 new stock areas. 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. 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. 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.

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 research that must be completed before these assessments can be done is detailed in Annex 3, Section 13.

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.

Discussion by the Scientific Committee

The Committee accepted the conclusions of the Working Group with regard to assessments and recommendations for further research. The situation for West Greenland walrus is especially serious and the preliminary assessment indicates that severe reductions in catch may be required. The Committee noted that the assessment can be furthered using available data from past surveys of the West Greenland overwintering area, and recommended that these surveys be analyzed as an urgent priority. Once this and other research has been completed, the Working Group should meet again to complete the assessment of the West Greenland and perhaps other stocks. It was anticipated that this could be done as early as 2006 or early in 2007.

9.13.2 Other studies

Lydersen reported that a partial survey of land haulouts in Svalbard had been conducted in 2005, but that the survey could not be completed due to adverse ice conditions. It will be attempted again in 2006.

The Observer for the Russian Federation informed the Committee about recent joint surveys of Pacific walrus by the Russian Federation and the USA in the Bering Sea and surrounding areas. The surveys are conducted using aircraft with an infrared scanner, video and digital photography.

9.13.3 Future work

The Working Group could convene again to complete assessments of the West Greenland and perhaps other stocks once essential research has been completed (see 9.13.1). Heide-Jørgensen will be asked to monitor the situation and report to the Committee when an assessment meeting can usefully be held.

9.14 Ringed seal

9.14.1 Update on progress

SC/13/16 detailed an investigation of the haul-out behavior of ringed seals during the spring molting period of 2003 (May-July) in Kongsfjorden, Svalbard, Norway. Multiple regression analyses revealed that time of day and date significantly affected the number of ringed seals hauled out on the ice surface. Other factors influencing the number of seals counted on the ice were air temperature and wind speed. Daily peaks occurred in the early afternoon between 13:00 and 14:00 hrs and the seasonal high (N=385) was registered during the first week in June, after which the number of seals on the ice in the fjord declined. In addition to the visual counts, 24 ringed seals were equipped with VHF transmitters, and the haul-out behavior of individuals was monitored from May through July via an automatic recording station. The seasonal peak of haul-out for the tagged seals preceded the peak seasonal counts by approximately three weeks. This may reflect significant out- and in- flux of seals from and to the area; this possibility warrants further attention because of its implications for assessment studies

SC/13/17 used this information to provide correction factors for an aerial digital photographic survey conducted in the same area. These data were used to create a model that predict the proportion of seals hauled out on any given date, time of day and under various meteorological conditions. Applying this model to the count data from each fjord resulted in an estimate of 7,585 (95% CI 6,332 – 9,085) ringed seals in the surveyed area during the peak molting period. The total estimated number of ringed seals present in the study area at the time of the survey must be regarded as a population index, or at least a minimum estimate for the area, because it does not account for individuals leaving and arriving, which might account for a considerable number of animals. The same situation is likely the case for many other studies reporting aerial census data for ringed seals. To achieve accurate estimates of population sizes from aerial surveys, more extensive knowledge of ringed seal behavior will be required.

SC/13/18 presented updated estimates of growth and population parameters from the same area, for which previous estimates are available from a study done 20 yrs ago. Mean Age at Maturity (MAM) was found to be 4.3 ± 0.3 years for males and 3.5 ± 0.4 years for females. These values are significantly lower than MAM calculated for ringed seals from the same area 20 years ago. The most likely explanation for the reduced MAM is a substantial increase in the polar bear (*Ursus maritimus*) population since its protection in 1973

10. NORTH ATLANTIC SIGHTINGS SURVEYS

10.1 NASS-2001 and earlier surveys

Working paper SC/13/9 (see 9.7 and 9.11) provided an analysis of trends in the abundance of fin and humpback whales from the NASS. Working paper SC/13/19 (see section 9.8.1) presented information on the distribution and abundance of common dolphins from the NASS and other surveys.

10.2 Other surveys

Desportes provided a presentation on the SCANS-II survey conducted in summer 2005. The objective of SCANS II was to estimate small cetacean abundance in European Atlantic waters, allowing the assessment and management of bycatch and other anthropogenic threats, through the development of improved methods for monitoring and a robust management framework, thus defining a clear course of action to allow populations to recover to and maintain favourable conservation status. The project is coordinated by the Sea Mammal Research Unit, University of St Andrews, and financed by EC LIFE-nature programme as well as the eight countries participating.

The core action of the project is a ship based and aerial survey to determine the absolute abundance of small cetacean populations, in shelf waters of the Atlantic margin, the North Sea and adjacent waters (from 62° N to 35° N) which was conducted between June 27 and July 29, 2005. Target species were harbour porpoise, bottlenose dolphin and common dolphin, but line transect data were collected on all species encountered. The aerial surveys was conducted, adopting the 'circle-back' method which allows for estimating g(0) via a probabilistic model. The ship survey was conducted in Buckland and Turnock mode, *i.e.*, adopting passing mode and using two independent observation platforms. This configuration allows the estimation of abundance without the need to assume that either platform sees all cetaceans on the trackline and also accommodates responsive movements.

A substantial effort was made in introducing new techniques and equipment to accommodate the problems usually encountered in line transect surveys, such as accounting for responsive movement of the animals occurring at an unknown distance from the vessels, difficulties in estimating availability bias, lack of accuracy in sighting times, distance and angle data, data transcription errors, amount of data needed to be computed. In addition technical innovations were introduced to automate data collection and to make distance and angle measurements more accurate. However in all cases techniques used in earlier surveys were used simultaneously to maintain comparability. Overall it can be said that the new techniques and equipment performed well.

10.3 Planning for future NASS

Desportes and Pike presented some information on the proposed project "Cetacean Offshore Distribution and Abundance in the European Atlantic" (CODA) that is planned as a follow-up to SCANS-II in 2007. The main purpose of the project is to estimate abundance and map summer distribution of cetaceans in offshore waters of the European Atlantic, in particular dolphins, sperm and beaked whales.The surveys will cover European Atlantic offshore waters outside the continental shelf area covered by the SCANS-II project west to the boundary of the EEZ of the UK, Ireland, France, Spain and Portugal. The northern boundary will be approximately 62° N, and the southern limit will be the boundary of the region covered by the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS). Pike reported that he had already had positive discussions with the CODA coordinator about coordination of this survey with NASS-2007, and that such coordination is part of the proposal.

Pike also reported that he had had discussions with Canadian and American researchers about coordination of NASS with surveys in these areas. Surveys will be conducted on the eastern seaboard of the USA in 2007. At present the Canadian surveys are uncertain, but it is hoped that a coastal aerial survey can be conducted. In addition there is some possibility that the West Greenland coastal aerial survey could be repeated in 2007, although it is presently planned for 2006.

If an international redfish survey is conducted in the area in 2007, there will be an opportunity to share platforms as was done in 2001 on the Icelandic vessels. Opportunities for platform sharing with other surveys planned for 2007 in the area could also be investigated.

The Observer for the Russian Federation informed the Committee about ongoing annual surveys in the Barents and Norwegian Seas. There is some possibility that these surveys could be coordinated with this project.

The Committee concluded that there is a perhaps unique opportunity to conduct a very wide ranging synoptic cetacean survey, covering areas of the eastern and western Atlantic that have never been covered simultaneously in previous surveys. The Committee strongly recommended that the Council and indidual member countries encourage other jurisdictions to become involved in the NASS project for 2007.

To take advantage of this opportunity, it is necessary to begin a planning process immediatly that includes representation from potential participants outside the NAMMCO member countries. It was decided to establish a steering group, headed by Desportes, with the following terms of reference:

1. To begin planning for the NASS-2007 survey, and its coordination with other surveys to be conducted that year, including NILS, CODA and Canadian, American and Russian surveys. To this end a planning meeting, involving participation from all relevant jurisdictions, should be held sometime in 2006;
2. To develop a documented plan for the NASS-2007 and its coordination with other surveys. This plan will be presented to the Council, the IWC, ASCOBANS, potential funding agencies and other interested parties.
3. To seek external funding for the project, if possible.

11. BYCATCH OF MARINE MAMMALS

11.1 Update on progress

Ólafsdóttir reported that the Management Committee Working Group on Bycatch had reviewed the Committee's findings with regard to the Icelandic bycatch monitoring program, and had supported the Committee's recommendations (NAMMCO 2005a, b). These recommendations were in turn supported by the Management Committee and the Council. However there had been little progress in implementing these recommendations this year in Iceland. The Working Group also carried out an evaluation of the potential risk of marine mammal bycatch, by looking at the types of fisheries carried out in member countries and their overlap in time and space with marine mammal distributions. However only the Faroes and Iceland provided information to carry out this evaluation. The Working Group received new terms of reference from the Management Committee, and will now focus on improving the systems for collecting data on bycatch in NAMMCO member countries.

The Icelandic Progress Report indicated that there had been an increase in the reported bycatch in 2004. It is not known if this was due to an increase in bycatch or to more complete reporting as a result of a questionnaire sent out to the fishermen.

The Committee was informed that there had been little or no progress since last year in the development of bycatch monitoring programs in NAMMCO member countries. Noting that estimates of all removals, including bycatch, are required for stock assessments, and there is evidence that unreported bycatch occurs in the fisheries of member countries, the Committee strongly recommended that all member countries establish bycatch monitoring systems for their fisheries.

12. DATA AND ADMINISTRATION

12.1 Amendment to Rules of Procedure

Pike reported that there had been some confusion regarding the responsibility for funding the attendance of invited experts at meetings of working groups of the NAMMCO Scientific Committee. It has been standard practice for the last several years that NAMMCO funds the attendance of invited experts at Working Group meetings.

In 1995, the Scientific Committee "sought guidance from the Council on the question of funding the participation of scientists working within member countries in the work of the Scientific Committee." (NAMMCO 1995b, p. 20). In response "the Council agreed that the general principle should be that scientists appointed by member countries as members of Scientific Committee Working Groups should be funded by member governments, and that funds earmarked for external expertise should be reserved for such use only." (NAMMCO 1995b, p. 20).

This response implies that the Council drew a distinction between invited experts from member and non-member countries. The view of the Council in 1995 was that invited experts from member countries, or at least "scientists appointed by member countries as members of Scientific Working Groups", should be funded by member governments, while those from non-member countries should be funded by NAMMCO. However it should be noted that under the present Rules of Procedure for the Scientific Committee, the Scientific Committee itself "makes proposals to the Council on invitation of external experts or observers" (Section IV.3). It is not the case that member countries appoint members to working groups: this is decided by the Scientific Committee with the support of the Council. Invitations are issued to individuals on the basis of their expert knowledge rather than as national representatives.

To clarify this matter, the Scientific Committee proposed to amend the ROP so that past practice is followed, *i.e.* that NAMMCO continues to fund the attendance of invited experts to meetings of NAMMCO Scientific Working Groups, irrespective of their country of origin. In this way, the Scientific Committee would retain control over who comes to their meetings and help to ensure that the best and most appropriate expert advice is available when required. It was noted that budget of the Scientific Committee has up to now been sufficient to fund the attendance of all invited experts to Working Group meetings. This amendment will be presented to the Council for approval at their next meeting.

13. PUBLICATIONS

13.1 NAMMCO Scientific Publications

Pike reported that there was unfortunately still no publication imminent of the planned volume 6 on the NASS. Several papers were out for peer-review and were expected back by the end of the year, but a few key papers have still not been completed. It is planned to publish this volume in 2006. Ólafsdóttir reported that volume 7 on grey seals was nearing completion, and that only a few papers had not yet been received. The remaining papers were either out for peer-review or already being revised to the final version. Publication is expected in 2006.

The possibility of a volume on fin whales was discussed. It was clear that presently there was a need to wait until more work had been completed, the question will be reconsidered at a later time.

13.2 Other publications

13.2.1. Proceedings from the Conference on the Incorporation of User's Knowledge in Management Decision Making

Charlotte Winsnes reported that editing of the papers presented at this conference in January 2003 was ongoing and the publication would be ready by early 2006.

13.2.2 NAMMCO Website

The Secretariat is planning a renewal of the NAMMCO website. It was tentatively scheduled to open the new site before the end of the year. Members were requested to identify photos or other material that might be suitable for inclusion in the web site.

14. BUDGET

Pike presented the budget for 2005 which detailed the costs of all Scientific Committee activities throughout the year. These costs included specific travel funding provided to experts, meeting costs and work contracts. All costs were within budget, and the draft 2005 budget as presented was approved.

15. FUTURE WORK PLANS

15.1 Scientific Committee
The next (14th) annual meeting will be held in Iceland at a time and location to be determined.

15.2 Working Groups
The following working groups will hold meetings during 2006:
- NASS Planning Group, first half of 2006;
- Fin Whale Working Group (with IWC attendance), March in Iceland;
- Harbour Seal Working Group, second half of 2006;
- Walrus Working Group (depending on progress, see 9.13.3).

Other meetings may be held depending on requests received from the Council.

15.3 Other matters
The Secretariat took note of these scheduled meetings and also noted that there might be additional requests from the Council in 2006. These will be reflected in the preparation of the 2006 budget.

16. SATELLITE TELEMETRY GROUP

In 2002 the Scientific Committee decided to establish an intersessional correspondence group to:
- identify progress in satellite tagging made in NAMMCO member countries and elsewhere;
- explore the technical aspects of satellite tagging, including deployment systems;
- briefly consider what tagging experiments have been done and the rates of success;
- Recommend ways to further the development and success of this technique in NAMMCO member countries.

Mikkelsen presented a summary of the history and current events relating to this group. Attempts had been made to organize a workshop on the technical aspects of tagging large whales, but this had met with little interest from the few research groups involved in this field. These research groups are willing to enter into collaborative projects with others, but do not seem willing to share information on the more technical aspects of tagging in an open forum. The Scientific Committee recognized that the correspondence group could not make progress without the cooperation of key players in the field, and decided that the group would be terminated. The Committee will monitor developments in this field on a regular basis.

17. MEETING CLOSURE

17.1 Election of officers
Genevieve Desportes was elected as chair for a 2 year term, to begin after the next meeting of NAMMCO Council in March 2006. It was decided that the vice-chair would be elected by correspondence. The Committee thanked Walløe for his able chairmanship over the past 2 years.

17.2 Closing remarks
The Committee thanked the Secretariat and the staff of the High North Alliance for arranging the meeting at such a spectacular location, and for arranging contacts with people involved in the whaling industry. The hard work of the Rapporteur was aknowledged with thanks.

17.3 Acceptance of report
The report was accepted on 27 October 2005.

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Appendix 2

AGENDA

1. Chairman's welcome and opening remarks
2. Adoption of Agenda
3. Appointment of Rapporteur
4. Review of available documents and reports
   - 4.1 National Progress Reports
   - 4.2 Working Group Reports
   - 4.3 Other reports and documents
5. Cooperation with other organisations
   - 5.1. IWC
   - 5.2 ICES
   - 5.3 Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga
6. Incorporation of the users knowledge in the deliberations of the Scientific Committee.
7. Update on Status of Marine Mammals in the North Atlantic
8. Role of marine mammals in the marine ecosystem
   - 8.1 Working Group on Marine Mammal – Fisheries Interactions
   - 8.2 Other matters
9. Marine mammal stocks -status and advice to the Council
   - 9.1. Harp seals
     - 9.1.1 Update on progress
     - 9.1.2 New Requests and Future work
   - 9.2. Hooded seals
     - 9.2.1 Update on progress
     - 9.2.2 Future work
   - 9.3. Harbour porpoise
     - 9.3.1 Update on progress
     - 9.3.2 Future work
   - 9.4. Narwhal
     - 9.4.1 Report of the Working Group
     - 9.4.2 Future work
   - 9.5 Beluga
     - 9.5.1 Report of the Working Group
     - 9.5.2 Future work
   - 9.6 Fin whales
     - 9.6.1 Report of the Working Group on North Atlantic Fin Whales
     - 9.6.2 Future work
   - 9.7 Minke whales
     - 9.7.1 Update on progress
     - 9.7.2 Future work
   - 9.8 White-beaked, white-sided dolphins and bottlenose dolphins
     - 9.8.1 Update on progress
     - 9.8.2 Future work
   - 9.9 Grey seals
     - 9.9.1 Update on progress
     - 9.9.2 Future work
   - 9.10 Harbour seals
     - 9.10.1 Update on progress
     - 9.10.2 Future work
   - 9.11 Humpback whales
     - 9.11.1 Update on progress

9.11.2 Future work

9.12 Killer whales

9.12.1 Update on progress

9.12.2 Future work

9.13 Walrus

9.13.1 Report of the Working Group on Walrus

9.13.2 Future work

9.14 Ringed seal

9.14.1 Update on progress

9.14.2 Future work

10. North Atlantic Sightings Surveys

10.1 NASS-2001 and earlier surveys

10.2 Planning for future NASS

11. Bycatch of marine mammals

11.1 Update on progress

11.2 Other

12. Data and administration

12.1 Amendment to Rules of Procedure

13. Publications

13.1 NAMMCO Scientific Publications

13.2 Other publications

14. Budget

15. Future work plans

15.1 Scientific Committee

15.2 Working groups

15.3 Other matters

16. Any other business

16.1 Satellite tagging correspondence group

17. Meeting closure

17.1 Acceptance of report

17.2 Election of officers

17.3 Closing remarks

LIST OF DOCUMENTS

Doc. No.	Title
SC/13/1	List of Participants
SC/13/2	Provisional Annotated Agenda (Draft)
SC/13/3	List of Documents
SC/13/NPR-F	National Progress Report – Faroe Islands
SC/13/NPR-G	National Progress Report – Greenland
SC/13/NPR-I	National Progress Report – Iceland
SC/13/NPR-N	National Progress Report – Norway
SC/13/NPR-C	National Progress Report – Canada
SC/13/4	Observers Report: 55th Meeting of the IWC Scientific Committee, Ulsan, Korea
SC/13/5	Observers Report: ASCOBANS 12th Advisory Committee Meeting, Brest, France.
SC/13/6	ICES/NAFO Working Group on Harp and Hooded Seals- Report 2005.
SC/13/7	Report of the Joint Meeting of the NAMMCO Working Group on the Population Status of Narwhal and Beluga in the North Atlantic, and the Canada – Greenland Joint Commission Scientific Working Group.
SC/13/8	Report of the NAMMCO Working Group on North Atlantic Fin Whales.
SC/13/9	D.G. Pike, Th. Gunnlaugsson, N. Øien, G. Desportes, G.A. Víkingsson, C.G.M. Paxton and D. Bloch. Distribution, abundance and trends in abundance of fin and humpback whales in the North Atlantic
SC/13/10	Report of the Working Group on North Atlantic Walrus.
SC/13/11	Proposed amendment to the Rules of Procedure for the Scientific Committee
SC/13/12	Draft Budget 2004
SC/13/13	Summary of requests by NAMMCO Council to the Scientific Committee, and responses by the Scientific Committee
SC/13/14	Status of *NAMMCO Scientific Publications*

Doc. No.	Title
SC/13/15	Carlens, H., Lydersen, C., Krafft, B.A. and Kovacs, K.M. Spring haul-out behavior of ringed seals (*Pusa hispida*) in Kongsfjorden, Svalbard.
SC/13/16	Krafft, B.A.. Kovacs, K.M., Ergon, T., Andersen, M., Aars, J., Haug, T. and Lydersen, C. Abundance of ringed seals (*Pusa hispida*) in the fjords of Spitsbergen, Svalbard, during the peak molting period.
SC/13/17	Krafft, B.A.. Kovacs, K.M., Haug, T. and Lydersen, C. Growth and population parameters of ringed seals (*Pusa hispida*) from Svalbard, Norway, 2002 - 2004.
SC/13/18	Bloch, D. and Allison, C. 2005. Whale catches in the North Atlantic 1894-1984, taken by Norway, the Faroes, Shetland, the Hebrides, and Ireland. NAMMCO
SC/13/19	Cañadas, A., Donovan, G., Desportes, G., Borchers, D. Distribution and abundance of short-beaked common dolphins (Delphinus delphis) in the central and eastern North Atlantic.

ANNEX 1

JOINT MEETING OF THE

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON THE POPULATION STATUS OF NARWHAL AND BELUGA IN THE NORTH ATLANTIC

AND THE

CANADA/GREENLAND JOINT COMMISSION ON CONSERVATION AND MANAGEMENT OF NARWHAL AND BELUGA SCIENTIFIC WORKING GROUP

Nuuk, Greenland, 13-16 October 2005

1 OPENING REMARKS

Chairmen Lars Witting and Øystein Wiig welcomed the participants (Appendix 1) to the third joint meeting of the Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga (JCNB) Scientific Working Group and the North Atlantic Marine Mammal Commission (NAMMCO) Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic (hereafter referred to as the Joint Working Group or JWG). The chairmen noted that, since the last meeting of the JWG, the JCNB had met once and NAMMCO Council had met twice.

At the ninth meeting of the JCNB, held in May 2004, the Commission agreed to ask the Scientific Working Group to focus on narwhal and complete that assessment and to update the West Greenland beluga assessment using any new information available. In addition the Commission posed the following questions (not in order of priority) to the SWG:

1) The Scientific Working Group should consider ways to resolve the issue of reproductive rate of narwhal.
2) Recent changes have been observed in the distribution of narwhal in Canada. For instance in Pelly Bay, hundreds of narwhal now regularly occur where they seldom occurred in the past. Are there any explanations available for these distributional changes?

The Scientific Working Group was also requested to consider the implications for its own structure and the organization of its work of a possible extension of the Commission's competence to include walrus or other marine mammal species.

NAMMCO Council endorsed the plan of the NAMMCO Scientific Committee to update and finalise the assessment of West Greenland narwhal in 2005 in cooperation with the Scientific Working Group of the JCNB. The Council also requested that the Scientific Committee carry out an assessment of East Greenland narwhal and provide an estimate of sustainable yield for the stock. The management objective in this case is to maintain the stock at a stable level. If the assessment cannot be completed with available information, the Scientific Committee was asked to provide a list of research that would be required to complete the assessment.

The JWG will therefore concentrate on the following tasks:

a. Update and finalize the assessment of West Greenland narwhal.
b. Make progress on assessments of other stocks of narwhal, particularly stocks summering in Canada. This will include provision of advice for the different putative management units.
c. Identify research required to complete an assessment of East Greenland narwhal.
d. Update the available information on the status of West Greenland beluga, taking into account recent harvest levels.
e. Address the specific questions posed by the Commission of the JCNB, above.

In addition the JWG should look at the recent information and if necessary revise previous statements about the extent of sharing of narwhal between Canada and Greenland.

2 ADOPTION OF JOINT AGENDA

The draft Agenda (Appendix 2) was adopted.

3 APPOINTMENT OF RAPPORTEURS

Daniel Pike and Patrice Simon were appointed as rapporteurs for the meeting, with the assistance of other members as required.

4 REVIEW OF AVAILABLE DOCUMENTS

The list of documents (Appendix 3) available for the meeting was reviewed..

5 NARWHALS

5.1 Stock structure

5.1.1 Genetic information

There was no new genetic information available.

5.1.2 Satellite tracking

JWG-2005-12 Laidre, K. and Heide-Jørgensen, M.P. Late summer and early fall movements of narwhals in Inglefield Bredning, Northwest Greenland

A new technique was developed for instrumenting narwhals in Inglefield Bredning, Greenland involving the deployment of satellite tags by hand harpoon from Inuit hunters in kayaks. Four narwhals were tagged in September 2004 and 2005 and movements of each animal were monitored for approximately one month. Tags were thrown into whales from a distance of 2-3 meters and all placed to the left or right of the dorsal ridge. On 6 September 2004, a female narwhal was tagged and positions were received from this animal for 19 days until 24 September. On 12 September 2004 two whales (one adult female and one adult male) were tagged. Positions were received from these two animals until 26 September and 28 September, respectively. Finally, on 30 August 2005 a male narwhal was tagged and positions were received for 20 days until 18 September. All four whales made localized movements in Inglefield Bredning and were generally stationary in the fjord through September. Shifts to the west and south were observed for all animals by the end of the month, however no data were collected on migration routes or wintering grounds because of the limited tag attachment duration. The assumption that only Inglefield Bredning supplies the fall and winter harvests in Greenland at this point should be taken with caution.

Discussion

The JWG noted the importance of the management issue being addressed by this study, the migratory destination of Inglefield Bredning whales and whether or not they contribute to catches further south, and encouraged further work in this area. For this purpose the duration of the tags must be doubled or tripled. It was considered likely that the relatively short transmission-life of the tags was due to attachment failure rather than tag failure, as the battery life of the tags should have been longer than the longest transmission time. Therefore further attempts will be made to refine the attachment system and deployment methods.

It was also noted that this work was being carried out in cooperation with hunters, who had made an important contribution to the development of the tagging methodology.

5.1.3 Management units

JWG-2005-16: Heide-Jørgensen, M.P., Dietz, R. and Laidre, K. Metapopulation structure and hunt allocation of narwhals in Baffin Bay

A model of the metapopulation structure of narwhals in Baffin Bay and adjacent waters is proposed based on a review of recent genetic studies, heavy metals, oroganochlorines, stable isotopes, satellite tracking, hunting statistics and compilations of local knowledge. This model is similar to the model presented at previous meetings but new evidence on migrations and homing of narwhals from Admiralty has been added. The default definition of a stock or management unit should be based on the assumption that disjunct summering aggregations of narwhals are separate stocks with little or no exchange between whales from other summering grounds. Coastal summering concentrations of narwhals in Canada are proposed to constitute at least five separate stocks: Eclipse Sound, Admiralty Inlet, Somerset Island, East Baffin stocks, and Cumberland Sound. Coastal summering concentrations in Greenland constitute at least two separate stocks: Inglefield Bredning and Melville Bay. Stocks that are shared between Canada and Greenland include Jones and Smith sound. In northwest Greenland, whales in Inglefield Bredning likely migrate south to Uummannaq and winter in Disko Bay, although this is the only major aggregation of narwhals that has not been tracked beyond 1 October. Inuit hunting of narwhals will differentially impact the stocks in Canada and Greenland depending on the temporal dispersal of the whales. Therefore, it is important to identify which stocks and aggregations contribute to which hunt in order to assess the sustainability of the hunt. Eighteen major hunting grounds in Canada and Greenland are identified at which several stocks appear to be hunted more than once. Evidence suggests whales from Canadian stocks have a low risk of being harvested in West Greenland. Similarly Greenlandic stocks also have a low risk of being harvested in Canada. The apparent stock delineation may be maintained through a combination of reproductive isolation at the spring mating season and matrilineally inherited site fidelity.

Discussion

The JWG concluded in 2004 that the model for apportioning of catches to putative stocks presented in the previous version of this paper (see Fig. 1) was acceptable based on the available evidence. This general conclusion was unchanged given the rather limited new information available. However the existence of summer stock of narwhal in Cumberland Sound was disputed, given that harvests are relatively low there during the summer and narwhal have not been seen in any significant numbers in extensive surveys of Cumberland Sound. The model presented in JWG/16 is qualitative in nature, using information from all available sources to identify stock units useful for management. The JWG was fully cognizant of the uncertainty of some of these conclusions. It was emphasized that the JWG will remain open to changing its understanding of narwhal stock structure as new information becomes available.

Some of the relationships between summering aggregations of narwhal and wintering areas are based mainly on very low numbers of satellite tracked narwhal. In particular only 2 narwhal from Melville Bay, both males, have been tracked to their wintering area. There was concern that basing stock relationships on such small sample sizes could lead to erroneous conclusions but there was no way to quantify the uncertainty in these conclusions. However in areas where larger numbers of narwhal have been tagged, such as Eclipse Sound, there has been little variance in migratory behaviour, giving greater confidence to conclusions based on small sample sizes. It was also noted that the identification of putative stock units was based on all available evidence, not just that from satellite tracking.

Given the logistical difficulty of deploying satellite tags, and the lack of success in some areas, the idea of using passive tags that would be recovered in the hunt, such as “spaghetti” or Discovery tags, was considered. However it was noted that deploying such tags would likely be no easier than deploying satellite tags and that large numbers would have to be deployed to have a reasonable expectation of a useful number of recoveries. It was considered preferable to maximize the information gain from every tagging opportunity by using tags that actively collect and transmit data. It was also noted that the deployment of passive tags had been tried on beluga in Canada with little success, probably because of tag rejection.

It was emphasized that the mechanism (genetic and/or behavioural) by which independent summer stocks are defined is not relevant to the importance of these stocks as management units and that management advice could be based on these units in either case. There is little evidence to support the contention put forward in JWG-16 that summer stocks of narwhal are in the main reproductively isolated from one another and it was noted in particular that the very low genetic diversity found between narwhal areas does not support this. The observed isolation of summering aggregations from one another could be maintained by maternally directed philopatry, which would not leave a genetic signal if the summer stocks are interbreeding elsewhere. In such a case some separation would be expected in the mitochondrial genetics, as is seen in beluga. That this separation is not seen in narwhal suggests that some mixing is taking place or that there has not been sufficient time since the separation of summering stocks for such differences to develop.

Sharing of stocks between Canada and Greenland

In 2004 the JCNB requested the JWG to look at the recent information and if necessary revise previous statements about the extent of sharing of narwhal between Canada and Greenland. In 2004 the JWG agreed that all available evidence suggests whales from Canadian stocks have a low risk of being harvested in West Greenland and that whales from Greenlandic stocks have a low risk of being harvested in Canada. No new evidence has been presented to change this conclusion. However it was emphasized that this conclusion is preliminary and based on incomplete evidence. The migratory destinations of some summer aggregations in Canada are unknown. These include the East Baffin, Smith Sound, Jones Sound and Parry Island stocks. It is therefore not known if these stocks are at risk of harvest in Greenland. In addition, the lower rate of depletion of the overwintering stock at Disko Bay compared to that of the Inglefield Bredning summer stock suggests that Inglefield Bredning cannot be the sole source of narwhal wintering at Disko Bay, implying that some of the narwhal harvested at Disko Bay must come from stocks summering elsewhere.

The JWG therefore revised its previous statement to conclude that there is a low risk that narwhal summering in the Somerset Island, Admiralty Inlet and Eclipse Sound areas are subject to harvest in Greenland. These groups constitute a large proportion of the total known number of narwhal summering in Canada. The migratory routes and destinations of other Canadian summer stocks, such as the East Baffin, Jones Sound and Parry Island stocks, are unknown and there remains a chance that these stocks are subject to harvest in Greenland, particularly at Uummannaq and Disko Bay during the fall and winter.

Stock structure in East Greenland

No new information has become available on stock structure in East Greenland since the NAMMCO Working Group last considered this in 1999 (NAMMCO 2000). There are summer aggregations at Scoresbysund, Kangerlussuaq, and Ammassalik which are subject to catches. Narwhal also occur north of Scoresbysund but these are likely not harvested. There is genetic evidence that East Greenland narwhal are distinct from those in West Greenland and Canada. However at present there is no basis for further distinguishing East Greenland stocks beyond that of their observed summer distribution.

5.2 Biological parameters

5.2.1 Age estimation

WG-2005-8 Garde, E., Heide-Jørgensen, M. P., Hansen, S. H. and Forchhammer, M. C. Age-specific growth and high longevity in narwhals from West Greenland estimated via aspartic acid racemization.

Age estimation of odontocetes (toothed whales) has traditionally been done by counting of growth layer groups (GLGs) in the teeth or mandible. However, this method has failed to provide reliable results for narwhals and development of a reliable method is needed. Here, we present new results for the age estimation of narwhals using the aspartic acid racemization technique. The technique utilizes the fact that, in metabolically inactive tissues, such as eye lens nuclei and teeth, aspartic acid is converted or racemized from the L-form to the D-form with a constant rate over time. In this study eyeballs and teeth from a total of 75 narwhals taken by Inuit hunters were collected and analyzed. The D/L aspartic acid ratio was measured using High Performance Liquid Chromatography (HPLC). Due to difficulties with the HPLC analysis (aspartic acid peak separation) of the teeth samples, only the results of the eye samples are presented here. Age estimates were successful for all 75 narwhals. The aspartic acid racemization rate (k_{Asp}) was estimated to be 1.045 x 10^{-3} yr^{-1} by regression of D/L ratios to age estimated by length of 15 young narwhals (≤298 cm in length, ≤2.5 years) supplemented with data from 13 fin whales (Nerini 1983) that had been age estimated by counting of earplug laminations. The initial D/L ratio ($(D/L)_0$) was estimated by regression of D/L ratios to estimated age for the 15 young narwhals. The $(D/L)_0$ value was estimated to be 0.02880. About 20% of the whales were older than 50 yrs and there seemed to be a tendency for greater longevity in females than in males. The maximum age obtained was from a 115 year (SE±10 years) old female. The oldest male in the sample was 84 years (SE±9 years). Using the Von Bertalanffy growth model, length at physical maturity was estimated to be 396 (95% CI: 387-404 cm) and 457 cm (95% CI: 443-470 cm) in females and males, respectively. Based on the assumption that cetaceans attain sexual maturity at about 85% of their physical maturity (Laws 1956), length and age at sexual maturity was estimated to be 337 cm and 6-7 yrs for females, respectively, and 388 cm and 9 yrs for males, respectively.

Discussion

The JWG welcomed this important advance in determining the ages of narwhal, for which previously no reliable method was available. It was noted that there were some uncertainties, particularly relating to the lack of studies of known age animals. Such data are mainly available for humans. It was recommended that the method should be applied to other marine mammals, such as some other toothed whales and seals, for which ages are available through other methods, and to captive animals of known age, to verify the reliability of racemization ages. It was also recommended that the method be applied to beluga, in order to resolve the question of whether beluga teeth accrue 1 or 2 growth layer groups per year.

The estimates of age of sexual and physical maturity for male and female narwhal were similar to those from other studies. It was however recommended that the uncertainty in age estimation should be included in the estimation of growth curves.

The JWG found the method very promising and recommended that eyeballs be collected in all future sampling programs for narwhal and beluga. Once sufficient numbers of reliably aged animals have been collected, it should be possible to estimate the survival rate for narwhal stocks, which is an important parameter in stock modelling.

5.2.2 Reproductive rates

In 2004 the JCNB requested that the JWG should consider ways to resolve the issue of the reproductive rate of narwhal. The current scientific view is that narwhal reproduce about every third year. This is based mainly on the observation that roughly 1/3 of mature females in the catch are pregnant. It is also consistent with reproductive rates observed for other toothed whales. Some hunters, based on their own observations, have concluded that narwhal (and beluga) have the capacity to reproduce at a faster rate,

The JWG emphasized that the reproductive rate of one calf every 3 years is an average and does not preclude that some narwhal, at some periods of their lives, may reproduce at faster or slower rates. For example it is entirely possible and likely that younger females may reproduce at a faster rate than older ones: this is observed in other cetacean species.

It was considered that improving the estimate of reproductive rate, or calculating age-specific rates of reproduction, will be difficult. Although a method of ageing narwhal has become available (see 5.2.1), it is not possible to determine the number of pregnancies a female narwhal has had by examination of the reproductive tract, because of the production of accessory *corpora* and resorption of *corpora albicans*. The JWG considered the idea of determining the proportion of females accompanied by calves in aerial photographs, but concluded that this was not feasible because it is often difficult to determine the sex of narwhal from aerial photographs, and because calves are often very difficult to spot. Another possibility is through repeated observations of known individuals, identified through external markings or genetics. In this way individual females could be followed throughout their lives to determine their reproductive output. However, given the large numbers of narwhal in most areas and the lack of readily identifiable external markings, it is likely that a very large sampling effort would be required to achieve this.

While recognizing that the question of the reproductive rates of narwhal and beluga is important, the JWG emphasized that the assessment models that have been developed and used are not very sensitive to changes in the reproductive rate. A wide range of rates of increase are commonly used in these models. In all cases better information on stock structure, abundance and catch history is of far greater importance than a precise estimate of reproductive rate.

5.3 Catch statistics

JWG-2005-6. Heide-Jørgensen, M.P. Reconstructing catch statistics for narwhals in Greenland 1862 to 2005: A preliminary compilation.

Information and statistics including some trade statistics on catches of narwhals in West Greenland since 1862 are reviewed. Detailed statistics split by hunting grounds are missing for most of the years. For the northernmost area, the municipality of Qaanaaq, only sporadic reporting exists. Based on statistics from the most recent three decades a time series is constructed with catches split into hunting grounds and corrected for under-reporting estimated from purchases of mattak (*low option*), for periods without catch records (*medium option*) and from rates of killed and lost (K/L) whales (*high option*). This reveals a time series of somewhat realistic catch levels from 1862 through 2004. Since 1993 catches have declined in West Greenland especially in Uummannaq where the decline is significant. In East Greenland there has been an increase of 8% per year since 1993.

Discussion
There was a discussion on the correction factors used for struck and lost and they were considered appropriate. The correction for underreporting and stuck and lost adds an average of 42% to the harvest statistics for 1954-1998.

Sex ratio is available for some of the years and there is no apparent bias. It is believed that there has been no bias toward males as females also have a high monetary value because of meat/maktak sale.

A new narwhal harvest-monitoring system has been in place since 2004. Information on the date and location of harvest and the sex of harvested animals is collected under this system. Since 2004, it has been forbidden to hunt females accompanied by a calf; this may lead to a bias toward males in the sex ratio as was observed in 2004.

According to the catch statistics provided, there has been an increase in narwhal catches in East Greenland of 8% per year since 1993. The harvest reporting system changed in 1993 and the impacts of this change on the catch statistics are unknown. There should be a better analysis of the reason for this apparent increase in harvest.

JWG-2005-9. Romberg, S. and Richard, P. Seasonal distribution and sex ratio of narwhal catches in Baffin region of Nunavut territory, Canada.

The distribution of seasonal catches and sex ratio of narwhals in the Baffin region of Nunavut Territory, Canada, was studied using hunter tag information archived at the Department of Fisheries and Oceans (DFO) from 1990 to 2004. Histograms of catches by calendar date and a breakdown of catches pre-calendar day 205, between calendar days 205 (roughly floe edge season) and 274 (roughly summer open water season) and post calendar day 274 (later than 30 September) are given to estimate the proportion of animals taken during these periods. The results indicate that, in many communities, there is more than one season of hunting. Many communities hunt mostly in summer but several communities take a substantial proportion of their catch in spring or autumn. These results are used in allocating the catch to different putative sub-stocks, either local summering sub-stocks or spring or autumn migrating sub-stocks. The distribution of catch by sex shows that the majority of the communities take a greater proportion of males than females throughout the seasons.

Discussion
Underreporting of female in catch statistics may have happened in the past, when harvest was recorded under a different reporting system. However, the authors are confident that the present reporting system is working well.

In Canada, regulations forbid the harvest of female accompanied of a calf. This, as well as the high monetary value of the tusk, leads to bias towards males in the sex ratio of the harvest.

Fisheries officers and biologists carry out hunt observation in various communities each year. However, there is no observer program in place to provide consistent hunt observation or to verify information on struck-and-lost.

JWG-2005-10. Romberg. S. Catch Statistics (1996-2004) for narwhal and beluga in selected communities in the eastern Canadian arctic.

Catch statistics for narwhal in Canadian High Arctic region (Nunavut) for the period 1996-2004 are presented. In general, it is believed that the catch reports are accurate as a tag system is in place. Communities receive a specific number of tags and hunters are required to fill in specific information on the catch, report the sex of the animal, and attach a portion of the tag to the tusk when present. The other portion of the tag is returned to DFO which records the information. For communities participating in Community-Based Management, there is the possibility to transfer up to 50% of the annual harvest limit to the following year or to “borrow” up to 15% from the following year’s harvest limit.

Igloolik and Hall Beach have been included however it is not clear on what proportion of narwhals are taken from the Somerset Island s and Northern Hudson Bay stocks.

The average reported landed catch for the period is 373 which does not include Igloolik and Hall Beach.

Struck and lost includes the two categories ‘killed and lost’ and ‘wounded and escaped’.

In the communities which are part of a Community-Based Management program, total hunting mortality is reported. The struck and lost information is based on self-reported data by the hunters. Systems of reporting vary from community to community. In general, hunters are required to report animals that are wounded (wounded and escaped) and animals that have been killed but not retrieved (sunk and lost). Estimates of hunting mortality are calculated based on minima and maxima (min = landed + killed and lost; max = landed + killed and lost + wounded and escaped). Not all wounds result in latent mortality. Many hunting wounds are superficial and heal leaving the scars that are sometimes observed on narwhals. In some cases hunters report scars and whether animals that they have wounded are likely to survive or not.

Discussion:

There was discussion on the variation of the struck and lost rate between years within some communities. There is a need for a more consistent monitoring of struck and lost to provide better information on total removal due to hunting.

There is conflicting information on the lost rate in the narwhal hunts. While the data provided in document JWG-2005-10 indicate a somewhat low level of struck and lost in most communities and years, some anecdotal information suggests that higher loss rates are possible. To address this, and to improve our knowledge on total removal at various hunting sites and using various hunting methods, the JWG recommended the development of a program to collect struck and lost information from direct observation of hunts in Greenland and Canada. This may also assist in improving hunting techniques and efficiency and minimizing hunting losses.

NAMMCO informed the group that it will be holding a workshop on struck and lost in November 2006. The workshop will include participation from hunters, scientists and managers.

5.4 Abundance

5.4.1 Recent estimates

JWG-2005-5. Heide-Jørgensen, M.P. An attempt to survey narwhals and belugas in West Greenland March 2004.

A digital aerial photographic survey for belugas and narwhals was attempted in West Greenland during 19-30 March 2004. The survey aircraft was a twin engine Piper Aztec equipped with two Hasselblad cameras with digital databacks (Phase One) that downloaded images every 3rd second to onboard hard disks together with information on altitude, speed and position. Due to inclement weather with constant wind and/or fog the survey effort proved to be very low with only an insignificant proportion of the total area being covered. The survey was designed to cover the traditional strata used for estimating the winter abundance of belugas in West Greenland. Following advice from the hunters organisation, KNAPK, the survey was extended to cover Vaigat as well as the ofshore parts of Uummannaq. This extension, that was conducted under favorable conditions, did not reveal any observations of whales. However, on the 20 March pods of up to 25 belugas were seen in the northern part of Vaigat where it is known that some belugas winter. No other sightings of belugas or narwhals were made during the survey but one bowhead whale was seen on 18 March outside Ilulissat and prior to the beginning of the survey. Unusual light ice conditions were experienced in West Greenland during spring 2004. The low ice coverage created relatively unstable weather conditions with more wind (average 5.4 m/s) than usually encountered at this time of the year (<3 m/s). The wind over the wide open water fields made it impossible to complete the survey.

Discussion
Although weather often makes it difficult to complete a spring survey in West Greenland waters, the JWG reiterated its recommendation of the previous two meetings that a survey of west Greenland beluga should be conducted. It is planned to conduct a survey in March 2006.

JWG-2005-17. Heide-Jørgensen, M.P., K.L. Laidre and M.J. Simon. Video recordings of narwhal pods in the Melville Bay, northwest Greenland, 2004-2005

Digital aerial photographic surveys of Melville Bay in 2002 resulted in no sightings of whales despite 990 km of transect effort covered resulting 4.558 km^2 digital images. Hunters utilizing the Melville Bay for hunting were not satisfied with the recommendation for a zero catch quota so they proposed to make video recordings of some of the large pods that they frequently encounter in the Melville Bay to demonstrate the occurrence and perhaps numbers of whales in the area. This study reports on the results of hunter-based video recordings of narwhal pods in Melville Bay in August 2004 and 2005. Recordings of narwhal pods were collected on two days in 2004: the 21 and 23 August. On 21 August, 141 whales were estimated to be swimming to the right of the promontory and 34 were estimated to be swimming to the left. Since it is possible that the same whales were recorded on both days the highest minimum count from 21 August is the safest estimate of the minimum number of whales recorded in 2004. In 2005, video recordings were made between 2 - 15 August at Balgoni Islands in central Melville Bay. The largest number of whales was observed on the 12 August where 147 whales were counted from which 35 should be subtracted to account for possible double observations. The achieved number of 112 whales is in the same magnitude as the number from 2004. There are evidently narwhals consistently present in Melville Bay during summer, which is also obvious from the catch statistics. However the low number of narwhals spread over a very large area makes traditional surveys prohibitively expensive and generally unsuccessful.

Discussion
This study confirms that narwhal occur in some numbers in Melville Bay during the summer. Neither survey effort nor coverage could be estimated based on the results presented in this study. The height of the observer can significantly affect detectability, but the height from which each video recording was made was not indicated. For these reasons these results cannot be expanded into an estimate of density. Only a minimum estimate of the numbers seen in the video can be determined.

There is no intention to repeat this study.

JWG-2005-04. Richard, P., Laake, J.L., N. Asselin, and H. Cleator. Baffin Bay narwhal population distribution and numbers: aerial surveys in the Canadian high arctic, 2002-2004.

Narwhals were surveyed in Eclipse Sound, Admiralty Inlet, Prince Regent Inlet, Barrow Strait, Gulf of Boothia, and in fiords and bays along the eastern coast of Baffin island during the month of August of 2002 to 2004 with visual line transect aerial surveys. The visual survey estimates were based on the number of narwhals visible to the observers using systematic line transect methods, corrected for whales that were missed by the observers, and adjusted to account for observations without distance measurements. Using data from narwhals tagged with time-depth recorders, the estimates were further adjusted for individuals that were diving when the survey plane flew by. This correction gave estimates of 20,788 (SE: 24,132) for the Eclipse Sound area in 2002 and 18,733 (SE 6,437) in 2004 , 25,809 (SE: 14,972) for the sum of the Prince Regent and Gulf of Boothia strata in 2002 and 28,346 (SE: 15,015) for that number added to the Barrow Strait strata in 2004, and 14,957 (SE: 6,437) in the east Baffin Island bay stratum in 2003. The estimates from Admiralty Inlet should be considered biased due to extreme clumping of the animals off transects in both 2003 and 2004 and the poor weather conditions in 2004, which halted the survey of southern end of the Inlet. Considering the bias in the Admiralty Inlet survey and the lack of survey in known areas of occupation, such as Peel Sound, Viscount Melville Sound and channels north of Resolute, we conclude that the narwhal population in the Canadian High Arctic is very large. It probably numbers in excess of 70,000 animals, with a large proportion of the animals in the western end of its summer range. It is also probable that over ten thousand narwhals summer in the bays and fiords along the previously un-surveyed East Baffin coastline. Survey estimates had large standard errors due to clumping on certain transects within each stratum. Attempts to reduce the sampling error by stratifying new surveys and increasing survey coverage were successful in the 2004 Eclipse Sound survey but not in the 2004 Admiralty Inlet survey. More dive data is required to refine the availability correction factor used in expanding the surface estimates.

Discussion:
Preliminary results of these aerial surveys were presented at the last JWG meeting in February 2004 and several recommendations to improve the analysis were made (see 2004 JWG report). The JWG noted that some of the recommendations provided in the 2004 meeting were not addressed due to logistical constraints.

The clumped distribution of narwhal and the unexpected high abundance of narwhal in eastern Baffin fiords were problems for the survey design and subsequent analyses.

Several areas known to contain narwhal (Peel Sound, Viscount Melville Sound, channels north of Resolute and east Baffin coastline) were not surveyed due to weather conditions so this survey could not provide a complete abundance estimate of the entire summer range in Canada.

The analysis of the survey data from fiord areas (most of which were at least 2000 meters wide) was discussed at length. In this part of the survey, a single line was flown up the centre of each fiord due to constraints of flying in the fiord environment, with the results extrapolated to the entire area of the fjord. This survey design resulted in uneven coverage probability; not all areas in a fiord had the same probability of being surveyed, possibly causing a bias depending on how the whales are distributed in the fiord. It was agreed that a sub-committee, coordinated by the lead author, would meet by email to try to resolve this issue.

There was some discussion as to the appropriateness of the application of an instantaneous correction for diving whales to a sighting process that is not instantaneous. It was argued that the duration of the chance of seeing a narwhal at the surface is very short such that it might be considered nearly instantaneous, especially for high-density areas where observers are busy with declination measurements. The surface intervals (or rather, the time at depths where they could be detected by an aerial survey crew) for some narwhals have been measured as 2-3 minutes for tagged individuals, but the actual time available to see a whale from a Twin Otter may be less than 3 seconds.

A separate issue is how widely the limitied tag data can be extrapolated. The surface interval used is based on a limited number of tagged narwhal and may not apply to all narwhal in all areas. The JWG agreed that the correction was appropriate given the available data on narwhal diving behaviour, but recommended that more such data be collected.

The serial difference method of variance estimation was suggested in 2004 but results to date have not indicated an improvement using this approach.

In 2004 it was recommended that the criteria for assigning duplicate sightings should be clarified and this recommendation was reiterated.

Although the paper combined the “best” estimates from different areas and years into single estimates, this approach could confound variance estimation (the true variance is likely larger than estimated). In addition the JWG suggested providing a more detailed description of what is defined as “best”.

There were extensive discussions of how to address large groups observed off-transect such as the large groups observed in Admiralty Inlet during the survey. While there was disagreement on this issue, it was decided not to include these sightings in the Admiralty Inlet survey estimate because they were seen off-transect. Other approaches, including adaptive sampling, greater survey effort or changes in stratification, were suggested for future surveys.

Reconnaissance survey in Davis Strait/Baffin Bay

Gosselin presented the preliminary results of an aerial survey conducted in March 2005 of the area from 60° to 65° N to search for the hooded seal whelping patch. The survey was conducted at an altitude of 300 ft and a speed of 200 kts, which is lower and faster than is normal for cetacean surveys. While the target species were seals, observers also noted marine mammals in open water. A total of 55 narwhal were sighted and 1 beluga whale was sighted at the southern end of the area.

5.4.2 Estimates by management units

Abundance estimates that have been accepted for use in assessments by the JWG are presented in Table 1.

5.4.3 Recent changes in distribution in Canada

In 2004 the JCNB was informed that recent changes have been observed in the distribution of narwhal in Canada. For instance in Pelly Bay, hundreds of narwhal now regularly occur where they seldom occurred in the past. The JCNB therefore requested that the JWG look into this matter.

There was no document presented on this topic to the JWG. It was reported that lighter ice conditions had prevailed in this area in recent years, although no quantitative data were presented. It is therefore possible that narwhal are able to penetrate into areas that were not usually available to them previously because of heavier ice cover. The JWG was also informed that narwhal sometimes use the track of an icebreaker to enter the area and that icebreakers began coming to Pelly Bay quite recently. In addition, local people have reported an increased frequency of killer whale sightings in the area, which might also change the distribution of narwhal.

The JWG could not provide any firm explanation as to why more narwhal are coming to this and other areas where previously they were seen infrequently. As a first step to addressing this question, trends in the extent and duration of ice cover in the area should be quantified. These data should be available from satellite and aerial ice reconnaissance. It was also suggested that the use by narwhal of icebreaker tracks should be studied and that the frequency of sightings of killer whales should be monitored.

5.4.4 Future survey plans

It is planned to conduct a narwhal survey in West Greenland in March 2006 .Currently, there are no plans for narwhal surveys in Canadian areas.

5.5 Assessment

5.5.1 Update of West Greenland assessment

JWG-2005-15 Witting, L. A model selection based assessment for West Greenland narwhals with uncertain stock structure.

This paper uses a density regulated population dynamic model in a model selection framework to identify the more likely stock structure hypotheses for West Greenland narwhals. The framework performs Bayesian assessments on 28 of the most likely three, two and one stock hypotheses, and it uses Akaike weights to determine the relative probabilities of the different models, given four time series of abundance data and historical catches from 1862 to 2004. The analysis discards 12 of the original hypotheses as being unlikely, it agrees with other information on the most likely stock structure hypotheses, and it integrates the 16 most likely hypotheses into estimates of sustainable harvest levels.

Discussion

There was disagreement within the JWG about the appropriateness of using apparent stock dynamics as a method of selection between stock hypotheses. One view was that stock identification should be by means independent of the stock dynamics. Harvest history and abundance may be correlated in 2 areas for indirect reasons, for example the economic situation in West Greenland, that have nothing to do with the relatedness of the animals in the 2 areas. Therefore using stock dynamics as a means of assigning probabilities to stock structures could be erroneous because of spurious correlations. Another view held that, given a set of stock hypotheses, it was only reasonable to give greatest weight to those that provided the best fit to the catch and abundance/trend information at hand, unless there was other information that made them unlikely. However it was recognized that this disagreement did not preclude the JWG from itself reaching conclusions about the most likely stock structures in the area and selecting assessment models appropriately.

The models presented in JWG-15 used, as input, the data on abundance, catch history, and biological parameters that have been agreed in the past by this committee. Nevertheless there was concern about possible biases in some of the input data, particularly abundance estimates and indices. For Inglefield Bredning, the 1986 and 2001/2 estimates were produced using different survey methodologies that have not been directly calibrated against one another. There was concern that this might have influenced the apparent negative trend in the estimates between 1986 and 2001/2. The JWG therefore recommended modelling that incorporated only the later surveys and options that considered them as index rather than absolute estimates.

For Disko Bay, the index surveys conducted in the early 1980's were done by a somewhat different methodology than those done in the 1990's and it has been recognized by this Committee that, for beluga, the two sets require different treatment. Specifically, different bias correction factors were used in beluga modelling for the two index sets. There is no reason to suppose that the situation should be different for narwhal, but in the modelling reported in JWG-15 a single bias correction factor was used for all the index surveys. The JWG therefore recommended modelling that incorporated separate bias correction factors for surveys conducted in the 1980's and 1990's.

While past harvesting of narwhal in West Greenland has not been sex-selective, it was expected that the new regulatory structure will lead to a selection for male narwhal. The JWG therefore recommended that the sensitivity of the results to selection for males be examined.

The greatest difficulty in providing advice for sustainable harvest of West Greenland narwhal is the uncertainty in stock structure. The models using the stock structures considered most likely by the JWG were examined further. A probability of 70% of some stock increase within 5 years was considered an appropriate objective. To meet this objective, depending on the model, a total annual removal ranging from 15 to 75 narwhals is allowed for the entire area This strengthens the conclusion reached in 2004, that West Greenland narwhal are heavily depleted and substantial reductions in catch are required immediately to arrest the decline in numbers However the JWG could not agree on the quantitative results of the model presented in JWG-15 because of the above noted uncertainties in stock structure and input parameters. There was no general agreement within the JWG on which model scenarios should be used in a final assessment. However, the JWG agreed that the recommendation provided in 2004, that the total removal in West Greenland should be reduced to no more than 135 individuals, should be provided again and with greater emphasis. This greater emphasis is due to the fact that all models reviewed by the JWG allowed total annual removals lower than 135.

The JWG recognized that the new information presented in JWG-17 confirmed that narwhal do occur in Melville Bay, but without an abundance estimate the JWG was unable to recommend a sustainable removal level for this stock.

The JWG recommends the following research to provide more specific advice on sustainable catches:

1) Modeling:
The model described in JWG 15 should be revised and used with the M|IUD as the base case and M|IU|D, M|I|UD, and M|I|U|D as alternate cases. MSYR will be limited to a range of 0.01 to 0.04, and survey data from Inglefield Bredning should be included as index estimates when combined with harvest data from other areas. As the 1986 estimate for Inglefield Bredning may not be directly comparable with the later estimates, it should be included with a doubling of the CV or excluded from the runs. Also for the survey estimates from Disko Bay, the effect of treating the 1982 and 1981 estimates as a separate index series independent of the earlier estimates (as done for beluga) should be investigated. Trials should also be conducted with pseudo-data sets to determine to what degree the model can identify the true stock structure. Alternate runs could be conducted to determine to what extent new data or independent biological data will improve the performance. These runs should include testing for the existence of an unidentified stock contributing to the harvest at one or more locations, new survey and tagging data and sex ratios in the harvest other than 50:50. (Time frame:1 year)

2) Stock Structure:

a. Reanalysis of existing genetics and contaminants data from harvested samples to account for season of take. (Time frame: 1 year)
b. Satellite tracking from harvest areas beginning with Uummannaq and Inglefield Bredning. (Time frame: 2-5 years)
c. Satellite tracking from areas in northern Canada (East Baffin, Smith Sound, Jones Sound, Kane Basin, Parry Islands) that are poorly known and may contribute to these harvests.

3) Abundance Estimates:

New surveys to extend the current abundance time series and estimate abundance in areas with no distribution or abundance surveys (E. Baffin, Parry Islands, Smith Sound, Jones Sound, Kane Basin). Priorities are a beluga/narwhal survey in Disko Bay and a survey of Melville Bay/ Inglefield Bredning. (Time frame: 2-10 years)

5.5.2 Canadian summer stocks

JWG-2005-11 Richard, P. A risk analysis of narwhal hunting in the Canadian High Arctic.

A simple stochastic dynamic growth model was used to determine the risk of change (-5% and -10%) over a period of ten years. The model runs either assumed no stock structure, a single panmictic stock, or a metapopulation structure with 4 different sub-stocks (Somerset, Admiralty, Eclipse, East Baffin). The structured model runs consider the summer hunting on local sub-stocks and the hunting of these sub-stocks by all communities during migration to or from the wintering areas. Results indicate little or no risk of decline over the time span in all but one case, the Admiralty Inlet sub-stock. The model runs pertaining to the Admiralty Inlet sub-stock assume a population size based on surveys which are considered biased because of extreme clumping of narwhals in the area. Therefore the risk analysis results for this sub-stock are questionable. Finally, risk probabilities are based on a simple model with no density dependent effects. It is conceivable that the decline of a large population will trigger increased productivity and that the real risk is smaller than estimated here.

Discussion

The JWG welcomed this contribution as an important first step in the quantitative assessment of Canadian summering stocks of narwhal.

The range of rates of increase from 1.01 to 1.03 did not include the maximum rate that is likely for narwhal. However the JWG agreed with the author of JWG-11 that this was appropriate given that the relative depletion status of these stocks was unknown, and only stocks that are at or below the maximum sustainable yield level could be expected to exhibit a higher rate of increase. The effect of a higher rate of increase would be to decrease the probability of a stock decline, so in this sense the model is conservative.

The mean loss rates used to estimate total removals were themselves estimated using recent data collected under the Community Based Management system in Canada. However the JWG had already expressed concern that these data may not be reliable and might underestimate true loss rates (see 5.3.1).

For communities taking narwhal in the spring and the fall, the catch may be composed of a mixture of animals from 2 or more summer stocks. In the model it is assumed that the relative proportion of animals from each stock in the catch is proportional to the abundance of each stock. It was considered that, for spring hunts in particular, animals from stocks that summer near to the spring hunting location might be taken in a higher proportion than that of their relative abundance. This was considered especially important for Arctic Bay, for which the spring catch constitutes over half the total.

Given these concerns, it was considered that the model could be improved by including a wider range of some parameters in sensitivity analyses. Specifically the JWG requested that that the following sensitivity analyses be conducted:

i. Higher struck and lost rates, of up to 2x those used initially;
This sensitivity analysis was performed at the meeting. The effect of doubling the loss rate was to increase the probability of a decline at Admiralty Inlet but not substantially so at Eclipse Sound except under the lowest examined rate of population increase.
ii. Higher probability that Admiralty Inlet narwhal are taken at the Arctic Bay ice edge.
There was insufficient time to perform this sensitivity analysis, but it could be expected to result in an increased probability of a decline at Admiralty Inlet.

The model used only recent average catches to project hunting mortality in the future. As yet an historical analysis of Canadian narwhal catches has not been developed, but published figures are available as far back as 1979. In 2004 the JWG concluded that it would be feasible to develop a set of annual removal estimates (*e.g.* low, best, high) for the Canadian Arctic, based on what is presently available in the literature, and it was recommended that the possibility of a longer catch series, spanning at least the time period of the survey estimates, be investigated.

The model incorporated only recent abundance estimates and did not use earlier estimates from Admiralty Inlet and Eclipse Sound from 1984. For Admiralty Inlet, the estimate for 1984 was nearly 3 times that for 2003 although the difference in point estimates is not statistically significant. In contrast the estimate for Eclipse Sound for 1984 was significantly lower than that for 2004.

The JWG therefore recommended that a model incorporating all abundance estimates considered useable for assessment, with an historical catch series, be developed, as has been done for West Greenland beluga and narwhal. Such a model would show the trajectories of the stocks over time and provide estimates of yield that would be useful in assessing stock status and determining sustainable removal levels.

In the interim and until a new modelling framework is developed, the JWG decided to use the model provided in JWG-11 to arrive at some preliminary conclusions about the status of Canadian summer stocks.

Somerset Island
This stock is the largest of the Canadian summer stocks. It is subject to a low level of harvesting in the summer but may be hunted by several communities in the spring and fall. However, even under the most pessimistic scenarios of stock size, hunting loss rates, and rate of increase, there is a negligible chance that the stock will be depleted in the next 10 years. The JWG therefore concluded that present catch levels were sustainable for this stock.

Admiralty Inlet
Under scenarios of high loss rate and/or low rate of population increase, the model predicts that there is a high probability that this stock will decline in the next 10 years. In addition the survey estimate for 2003 is substantially lower than that for 1984, indicating that there may have been a population decline over that period. However it was recognized that the recent estimate may be biased because of the extreme clumping of narwhal in the area. The JWG concluded that there is a risk that present catch levels are not sustainable for this stock and recommended thata new modelling framework as described above be developed to provide estimates of sustainable removals.

Eclipse Sound
Under all but the most pessimistic scenarios of high loss rates combined with low rates of increase, the model indicated that there is a very low risk that this stock will decline in the next 10 years with present catch levels. The JWG therefore concluded that present catch levels were likely sustainable for this stock but, again, recommended that a new modelling framework as described above be developed to provide estimates of sustainable removals.

East Baffin

Because the abundance estimate for this area was not accepted (see 5.4), the JWG could not provide advice on the sustainability of catch levels in this area. It was also noted that there was no information about the seasonal distribution of this stock so it was not known if it was subject to harvesting outside of the East Baffin area. The JWG therefore recommended that a new abundance estimate be developed for this area and that studies be conducted to determine the seasonal distribution of this stock.

5.5.3 East Greenland

The JWG considered that, given that almost nothing is known about the stock structure and seasonal migrations of East Greenland narwhal (see 5.1.4), and that the abundance estimate for Scoresbysund is more than 20 years old, a reliable assessment will not be possible without new information. Nevertheless *ad hoc* modelling carried out at the meeting indicated that, under the assumption of an independent stock at Scoresbysund with a present abundance similar to that in 1983, present harvest levels are not sustainable. However the validity of these assumptions cannot be assessed without further research.

Insufficient information was available to carry out assessments for other areas of East Greenland.

5.6 Ecology

JWG-2005-13: Laidre, K.L. and Heide-Jørgensen, M.P. The behavior of narwhals (*Monodon monoceros*) before, during, and after an attack by killer whales (*Orcinus orca*) in the Eastern Canadian Arctic

On the 19 and 20 of August, 2005 a predation event by killer whales on narwhals was witnessed at Kakiak Point, in Admiralty Inlet, Canada. Approximately 12-15 killer whales (group structure consisted of one adult male, 7-10 adult females and rest were juveniles) were observed attacking narwhals approximately 0.3 - 1 nm off the coast of Kakiak Point. Two explicit attacks were documented on the same day, one occurred at approximately 12 noon and the second occurred at approximately 4 pm. At least 4 narwhals (or 4 independent kill events) occurred over a 6 hour period based on direct counts of observations of oil/blubber slicks at the surface, congregations of fulmars in the center of the slicks, and killer whales moving and diving in the center of oiled areas. When the killer whales entered the vicinity of Kakiak Point, the narwhals were observed to immediately move very close to the coast (<2-3 m). Some narwhals formed tight groups near the shore and lay very still at the surface. One whale was observed to strand itself on a flat gravel beach and violently thrash it tail for >30 seconds. Within hours after the attack, narwhals were observed to resume their pre-attack behavior and distance from the shoreline, and narwhals were no longer observed in extreme proximity to the coast. Narwhals instrumented with satellite tags moved offshore and utilized a wider section of the coastline after the attack. Whether this dispersal is an effect of the killer whale occurrence or a seasonal change in behavior remains unresolved.

5.7 Future research requirements

Research recommendations specific to refining assessments for West Greenland narwhal are listed under 5.5.1.

The JWG supported and reiterated the recommendations from previous meetings. The following were identified as most important at this meeting:

All areas

- Better estimates of struck and loss rates are required from all areas.
- There should be a coordinated effort between Canada and Greenland to collect samples from the catch and from animals of known age, and to conduct analyses to determine the age structure of narwhal stocks using the amino acid racemization technique.
- large-scale effort to obtain dive time data for survey correction, from different areas and seasons;

West Greenland

- The West Greenland index area should be surveyed in 2006 in a manner consistent with previous surveys. If a new survey methodology is used, experiments should be conducted to calibrate the new method with the old.
- Development of a monitoring plan, including survey intervals;
- Stock structure: investigate movements from Inglefield Bredning, Uummannaq and from the wintering grounds.

Canada

- Provide a revised abundance estimate for East Baffin narwhal.
- Conduct a new survey of Admiralty Inlet.
- Develop a longer catch series (at least a series that spans the time period of the survey estimates) incorporating options for high, low and medium catches as has been done for West Greenland.
- Develop assessment models for the next meeting for each stock component, incorporating the catch series (above) and all abundance estimates for each area that have been accepted for use in assessment by this committee (Table 1).
- Provide an abundance estimate from winter surveys in Cumberland Sound.

East Greenland

- Studies of the stock structure of narwhal, through satellite tagging, genetics, contaminants or other means;
- Determination of the seasonal distribution of narwhal, through satellite tagging;
- Abundance surveys for all summer stocks that are harvested;

6 BELUGA

6.1 Stock structure

There was no new information tabled on this subject.

6.2 Recent catch statistics

Greenland

WG-2005-07 Heide-Jørgensen, M.P. Catch statistics for belugas in Greenland 1862 to 2004.

Information and statistics including trade statistics on catches of white whales or belugas in West Greenland since 1862 are presented. The period before 1952 was dominated by large catches south of 66^{o} N that peaked with 1380 reported kills in 1922. Catch levels in the past 5 decades are evaluated on the basis of official catch statistics, trade in mattak (whale skin), sampling of jaws and reports from local residents and other observers. Options are given for corrections of catch statistics based upon auxiliary statistics on trade of mattak, catches in previous decades for areas without reporting and on likely levels of loss rates in different hunting operations. The fractions of the reported catches that are caused by ice entrapments of whales are estimated. During 1954-1999 total reported catches ranged from 216 to 1874 and they peaked around 1970. Correcting for underreporting and killed-but-lost whales increases the catch reports by 42% on average for 1954-1998. If the whales killed in ice entrapments are removed then the corrected catch estimate is on average 28% larger than the reported catches. Catches declined at about 2% per year during 1979-2004. Reported catches in East Greenland are suspected to be erroneous and should perhaps be added to the narwhal catches.

Discussion

It was noted that the harvest in 2004 had been very low because of the introduction of the quota system and bad weather in some areas.

The JWG recommended that the occurrence of beluga in East Greenland be investigated, perhaps through a traditional knowledge study, to determine if they do occur there or if the reported harvests are erroneous.

Canada

JWG-2005-10: Romberg, S. Catch Statistics (1996-2004) for Narwhal and Beluga in Selected Communities in the Eastern Canadian Arctic.

Catch statistics for beluga in Nunavut for the period 1996-2004 are presented. In general it is believed that the reports for beluga are accurate. The Hunters and Trappers Organizations (HTO) for each community are contacted by phone by DFO throughout the hunting season and are asked to report catch statistics. In some cases the HTO requires their hunters to report and in other cases the HTO will give an estimate of hunting that has occurred.

In some communities which are part of a Community-Based Management Program, hunting mortality is required to be reported. Systems of reporting vary from community to community but in general they are required to report animals that are wounded (wounded and escaped) and animals that have been killed but not retrieved (sunk and lost). Estimates of hunting mortality are calculated based as minima and maxima (min = landed + wounded and escaped; max = landed + sunk and lost + wounded and escaped).

The average reported landed catch from communities hunting from the Baffin Bay beluga stock for the period is 42.

Discussion

The JWG noted that, as in the case for narwhal, reporting of struck and lost is variable between years and communities and may be unreliable for some communities. It was recommended that the harvest figures in this compilation be compared to the figures from the Nunavut Wildlife Harvest Study, which examined the period 1996-2001.

6.3 Abundance

6.3.1 Recent and future estimates

West Greenland

JWG-5 described an attempt to survey the West Greenland index area in March 2004, which was not successful due to inclement weather (see 5.4.1). The survey will likely be attempted again in 2006. The JWG noted that a digital photographic survey was attempted, whereas all previous surveys have been visual. The index used to monitor trends abundance since 1982 is based on a visual strip transect, and could not be produced from a photographic survey. The JWG therefore recommended that either a visual survey be conducted, or that experiments be conducted to calibrate the two survey methodologies.

Canada

In 2004 the JWG recommended that the abundance of beluga be estimated from the survey carried out between 2002 and 2004 described in JWG-4 (see 5.4.1). However it was recognized that because the survey did not cover Peel Sound, where beluga are concentrated at this time of year, and did not cover estuaries used by beluga, it could not provide an estimate of abundance for beluga.

6.4 Assessment update

6.4.1 West Greenland

JWG-2005-14 Witting, L. An assessment for West Greenland beluga.

This study combined historical catches from 1862 and 3 time series of abundance estimates with density regulated population models to update the assessments for belugas in West Greenland. Given models and data, the population was projected under the influence of historical catches, to estimate the current status and the probabilities of fulfilling management objectives for different levels of future harvest. Seven model combinations were applied to test for sensitivity of the assessment to i) variation in the prior on the MSYR, ii) the presence versus absence of additional variance in abundance estimates, iii) the presence versus absence of an absolute abundance estimate, iv) high versus low catch histories, and v) the effects of choosing an age-structured or a discrete population dynamic model. All models estimate similar dynamics, where West Greenland beluga are severely depleted, with median depletion ratios in 2005 varying between 16 and 42 percent of the carrying capacity. The median of the current replacement yield was estimated to lie between 248 and 494 beluga, with the lower 2.5th percentile between 40 and 104 beluga.

Discussion
The new assessment produced results that are very similar to those from previous assessments, all of which indicate that the stock is substantially depleted.

The JWG considered that the "low MSYR" case provided the most realistic assessment based on presently available information on the rates of increase of beluga and other odontocetes. The assessment can be updated if new information on rates of increase or other parameters is provided. Table 2 provides the probability of halting the decline in beluga numbers in the next 5 years for a range of catch options for this case. Reduction of catches to 100 per year will have an 80% chance of meeting this objective by 2010. Maintaining higher catches reduces the probability of halting the decline, and delay in implementing harvest reductions will increase the risk of continued stock decline.

The JWG also reiterated recommendations made by the NAMMCO Working Group in 2000 (NAMMCO 2001) pertaining to other measures that would improve the conservation status of beluga in this area.

It was recommended that catch limits be distributed over 3 hunting areas to avoid possible local depletions, as per previous advice (NAMMCO 2001): Northern – N of 72° N; Central – 67.30° to 72° N; Southern - 65° to 67.30° N.

Seasonal Closures
Beluga occurred seasonally in large numbers in Southwest and South Greenland before 1930, and probably disappeared because of overharvesting (JWG-7). Beluga are however occasionally sighted during the summer in S and SW Greenland and other areas of West Greenland. Few beluga are normally caught during these periods, and the occasional stragglers seen at these times should be allowed to establish themselves. The following seasonal closures are recommended:
Northern: June through August
Central: June through October
Southern: May through October.
For the area south of 65° N, it is recommended that no harvesting of beluga be allowed at any time.

6.4.2 Other stocks
Canada
Reported harvests by communities hunting Baffin Bay beluga continue to be low, averaging 42 annually over the last 9 years (see JWG-10, section 6.2). Given that this harvest is very low relative to the summer abundance of beluga in the area (Innes *et al.* 2002), stock assessment in this area is not considered a priority at present. However some proportion of animals summering in Canada migrate to West Greenland and are at risk of harvest there. It was considered important to determine where in Canada these animals can be found in the summer, to determine if they are harvested in Canada.

6.5 Future research requirements
All stocks
- Better estimates of struck and lost rates are required from all areas.

- There should be a coordinated effort between Canada and Greenland to collect samples from the catch and from animals of known age and compare racemization age estimates to tooth layer age estimates.

In 2001 the JWG supported a proposal for a new effort to elucidate the origin of the large number of whales presently being harvested in West Greenland. It was proposed that a two-year field period should be launched to tag a large number of belugas and to track them through the winter. Areas that have not previously been sampled would be given priority and samples for genetic analyses would be taken as well. The results of the tracking will be used to develop a model for the dispersal of the belugas that can be tested by the genetic studies. If possible long-term tag attachments and/or passive tags should be used to find out whether individual animals use the same summer and winter areas repeatedly. The JWG reiterated its support for this proposal and recommended that the research be carried out as a high priority.

West Greenland

- The West Greenland index area should be surveyed in 2006 in a manner consistent with previous surveys. If a new survey methodology is used, experiments should be conducted to calibrate the new method with the old.
- The assessment of West Greenland beluga should be updated once a new abundance estimate has been produced.
- Determine if beluga occur in East Greenland, perhaps through a traditional knowledge study, and attempt to determine if reports of beluga harvest there are correct.

Canada

- Harvest records from DFO should be compared with those from the Nunavut Wildlife Harvest Study.

7. IMPLEMENTATION OF EARLIER ADVICE

On February 12, 2004, Greenland Ministry of Fisheries and Wildlife introduced quotas for narwhal and beluga for the season 1 July 2004 to 30 June 2005. The quotas were set at 300 narwhal and 320 beluga to be divided among municipalities of West Greenland (Table 3). Preliminary catches of beluga reported for the 2004-2005 season were lower than the established quota due to weather conditions. The 2004-2005 narwhal catches had a skewed sex ratio favouring males.

For the hunting season 1 July 2005 to 30 June 2006, the quotas have been established at 260[2] narwhal and 220 beluga, to be divided among the municipalities of West Greenland.

It was noted that the reported catches include whales that are struck and lost. The reporting of catches to management authorities in Greenland is functioning well.

There was a discussion on the management system in place in Canada and Greenland to monitor harvest level and struck and lost animals. There is a need to share information on the reporting system that is in place in Greenland and Canada. This discussion should take place at the JCNB and reported in their proceedings so that there is a better understanding of the reporting system in place in both areas. Information on catches and struck and lost is critical to the assessment of narwhal and beluga.

8. TRADITIONAL KNOWLEDGE

There was no information provided under this item.

9. IMPACT OF HUMAN-MADE NOISE

[2] After the meeting the narwhal quota for 2005/2006 was raised by 50 to a total of 310. See Table 3.

JWG-2005-18: Lawson, J. Overviews: Beluga whale and noise.
Beluga whales have their best hearing sensitivity in the 40-100 KHz frequency range, with poorer hearing at lower and higher frequencies. Natural and man-made noise in the environment has the potential to reduce the probability of detecting biologically relevant signals; this process is termed masking. Beluga whales can detect echolocation signals when they are as little as 1 dB above the level of ambient noise. In studies of ice breaker noise, bubbler noise appeared to be most effective at masking beluga calls, followed by ramming noise, and lastly, ice-cracking noise. Models predicted ice breaker noise would be audible to belugas at distances as great as 35-78 km, cause masking of beluga calls at 14-71 km, and possibly cause temporary changes in hearing sensitivity if belugas stayed within 1-4 km of a large ice breaker for at least 20 minutes. Beluga responses to manmade noise areare highly variable and dependent on a variety of factors which include: local habitat, age, prior experience with the noise, the beluga's activity, resource availability, sound transmission characteristics of the location OR the noise of interest, behavioural state of the whale, and individual variability in beluga behaviour. Reported responses of beluga whales to manmade noise range from the most sensitive reported for any marine mammal to ignoring intentional harassment by boats. Beluga responses include altering their swim direction and speed, changing their dive, surfacing, and respiration patterns, and/or changing their vocalization patterns. There have been few studies of non-auditory physiological effects of exposure to noise in belugas, but several suggest that there are few if any measurable effects.

Discussion
The JWG welcomed this information which addresses a recommendation made in 2001 by JCNB.

10. OTHER BUSINESS

10.1 Implications of the inclusion of other species (*e.g.* walrus) in the work of the SWG
The cooperation between the JCNB SWG and NAMMCO WG has been very productive in providing scientific advice on narwhal and beluga.

The provision of advice on species other than beluga and narwhal from the SWG would be challenging. The addition of other species to this WG would require additional national and external expertise, take more time, may require the SWG to deal with species on a rotational basis or through independent meetings, and may require the establishment of a secretariat to deal with the additional workload.

It was noted that NAMMCO has alreadyworking groups to address issues specific to walrus and other species. Greenland being a member of NAMMCO, already participates in these working groups. Canada could also participate through the Walrus WG. This would avoid duplication of work at the scientific level and the JCNB would obtain its scientific advice through NAMMCO.

An obvious approach would be to carry out scientific activities related to walrus and other marine mammals within the existing NAMMCO structure. Alternatively, scientific advice related to other marine mammals needed by JCNB could be directed to scientists in Canada or Greenland who would examine existing literature or set up the appropriate peer review structure to provide the advice. This however might result in duplication of effort.

11 ADOPTION OF REPORT

A draft version of the Report was adopted at the meeting, and the final version was approved by correspondence. The Chairmen thanked all members for their valuable input, the Greenland Institute of Natural Resources for hosting the meeting, and the hard-working rapporteurs for so ably summarizing the discussions. Noting that Lars Witting and Øystein Wiig would be leaving their posts as chairmen, the members of the JWG thanked them for their efforts over the years.

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Putative stock	Year and ref.	Method	Estimate (cv)	Perception bias	Availability bias	Fully corrected stock size estimate	Reservations
BAFFIN BAY							
Inglefield Bredning Stock surveyed in Inglefield Bredning	1984 a)	Land	4000-8000	-	-	-	Covering ~1/3 of the area
	1985 b)	Line t.	1,091 (0.12)	-	-	-	Late in the season, 27 August -3 September
	1986 b)	Line t.	3,002 (0.25)	0.75 (0.25) *	0.38 (0.06) *	10,533 (0.36)	Perception biased assumed
	2001 b)	Photo	873 (0.35)	0	0.38 (0.06)	2,297 (0.35)	
	2002 b)	Photo	562 (0.24)	0	0.38 (0.06)	1,478 (0.25)	
Central West Greenland or Inglefield Bredning Stock wintering in central West Greenland	1981 c)	Strip	358 (0.31)			Index	
	1982 c)	Strip	440 (0.20)			Index	
	1990 c)	Strip	252 (0.34)			Index	Late in the season: 9-14April
	1991 c)	Strip	273 (0.28)			Index	
	1993 c)	Strip	63 (0.48)			Index	
	1994 c)	Strip	263 (0.36)			Index	
	1998 c)	Strip	213 (0.60)			Index	
	1999 c)	Strip	206 (0.32)			Index	
	1998-99 c)	Line t.	524 (0.51)	0.5 (0.25)	0.35 (0.23)	2,861 (0.61)	
Melville Bay	2002 d)	Photo	-	-	-	Low numbers	
Eclipse Sound	1984 e)	Photo	1,218 (0.59)	0	0.38 (0.06) *	3,205 (0.59)	Partial coverage
Eclipse Sound	2004 i)	Line t.			0.38 (0.25)	18,733 (0.41)	
Admiralty Inlet	1984 f)	Photo	5,556 (0.22)	0	0.38 (0.06) *	14,621 (0.23)	
Admiralty Inlet	2003 i)	Line t.			0.38 (0.25)	5,332 (0.76)	
Somerset Island	1981 f)	Strip	11,142 (0.09)		-	-	Partial coverage
Somerset Island	1996 g)	Line t.			0.38 (0.25)	45,358 (0.35)	Partial coverage
Somerset Island	2002 i)	Line t.			0.38 (0.25)	25,809 (0.58)	Partial coverage
Cumberland Sound	-	-	No data	-	-	-	
Jones Sound	-	-	No data	-	-	-	
Parry Islands	-	-	No data	-	-	-	

Putative stock	Year and ref.	Method	Estimate (cv)	Perception bias	Availability bias	Fully corrected stock size estimate	Reservations
Smith Sound	1978 h)	Total	>1,500	-	-	-	
Mixed stock surveyed in Baffin Bay	1979 h)	Strip	34,363 (0.24)	-	-	-	
EAST GREENLAND							
Scoresby Sund	1983	Line t.	300 (0.31)	0.75 (0.25) *	0.38 (0.06) *	1,053 (0.40)	Late in season, probably neg. bias.
Kangerlussuaq			No data				
Tasiilaq			No data				

Table 1. Estimates and indices of stock sizes of narwhals in Baffin Bay and adjacent waters adopted for by NAMMCO/JCNB Scientific Working Group to be used for stock assessment. * indicate that corrections were applied by the NAMMCO/JCNB Working Group.
a) Born 1986, b) Heide-Jørgensen 2004, c) Heide-Jørgensen and Acquarone 2002, d) Heide-Jørgensen 2003, f) Richard *et al*. 1994, g) Innes *et al*. 2002, h) Koski and Davis 1994, i) NAMMCO/SC/13-JCNB/SWG/2005-JWG/4

CATCH	PROB	CATCH	PROB
0	0	250	0.42
50	0.96	300	0.32
100	0.81	350	0.26
150	0.68	400	0.19
200	0.55		

Table 2. Probability of halting the decline in West Greenland beluga numbers in the next 5 years for a range of catch options for the chosen assessment model (see .6.4.1).

BELUGA			
Municipality	**Quota 04/05**	**Catch 04/05**	**Quota 05/06**
Maniitsoq	7	7	7
Sisimiut	32	18	23
Kangaatsiaq	12	10	10
Aasiaat	3	1	3
Qasigiannguit	9	0	3
Ilulissat	78	14	54
Qeqertarsuaq	15	12	14
Uummannaq	10	8	8
Upernavik	134	19	88
Qaanaaq	20	2	10
Total	**320**	**91**	**220**
NARWHAL			
Kangaatsiaq	5	0	
Aasiaat	23	21	16
Qeqertarsuaq	21	21	16
Uummannaq	88	78	68
Upernavik-Savissivik	63	46	60 + 15
Qaanaaq-Savissivik	100	128	85
Total	**300**	**294**	**260**

Table 3. Quotas and catches of beluga and narwhal in West Greenland, 2004 to 2006. The quota year runs from July 1 to June 30. Qaanaaq including Savissivik, Melville Bay has a five year quota of 100 beluga and 500 narwhal. [NOTE: Since the meeting these quotas have been raised by 50, with the following distribution: 35 to Uummannaq, 5 to Qeqertarsuaq, 5 to Assiaat, 5 to Kangaatsiaq. The total quota for 2005/2006 will be 310.]

APPENDIX 1

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APPENDIX 2

AGENDA

1 OPENING REMARKS
2 ADOPTION OF JOINT AGENDA
3 APPOINTMENT OF RAPPORTEURS
4 REVIEW OF AVAILABLE DOCUMENTS
5 NARWHALS
  5.1 Stock structure
    5.1.1 Genetic information
    5.1.2 Satellite tracking
    5.1.3 Other information
    5.1.4 Management units
  5.2 Biological parameters
    5.2.1 Age estimation
    5.2.2 Reproductive rates
    5.2.3 Other information
  5.3 Catch statistics
    5.3.1 Struck and lost
    5.3.2 Ice entrapments
    5.3.3 Histories by management units
    5.3.4 Other information
  5.4 Abundance
    5.4.1 Recent estimates
    5.4.2 Estimates by management units
    5.4.3 Future survey plans
    5.4.5 Recent changes in distribution in Canada
  5.5 Assessment
    5.5.1 Update of West Greenland assessment
    5.5.2 Canadian summer stocks
    5.5.3 East Greenland
  5.6 Future research requirements

6 BELUGA
  6.1 Stock structure
  6.2 Recent catch statistics
  6.3 Abundance
    6.3.1 Recent and future estimates
  6.4 Assessment update
    6.4.1 West Greenland
    6.4.2 Other stocks
  6.5 Other information
  6.6 Future research requirements
7 IMPLEMENTATION OF EARLIER ADVICE
8 TRADITIONAL KNOWLEDGE
9 IMPACT OF HUMAN-MADE-NOISE
10 OTHER BUSINESS
  10.1 Implications of the inclusion of other species (e.g.walrus) in the work of the SWG.
11 ADOPTION OF REPORT

APPENDIX 3

LIST OF DOCUMENTS

Document No.	
NAMMCO/SC/13-JCNB/SWG/2005-JWG/1	List of participants.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/2	Agenda.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/3	Draft list of documents.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/4	Richard, P. , Laake, J.L., Asselin, N. , and Cleator, H. Baffin Bay narwhal population distribution and numbers: aerial surveys in the Canadian High Arctic, 2002-2004
NAMMCO/SC/13-JCNB/SWG/2005-JWG/5	Heide-Jørgensen, M.P. An attempt to survey narwhals and belugas in West Greenland March 2004
NAMMCO/SC/13-JCNB/SWG/2005-JWG/6	Heide-Jørgensen, M.P. Reconstructing catch statistics for narwhals in Greenland 1862 to 2005**:** A preliminary compilation
NAMMCO/SC/13-JCNB/SWG/2005-JWG/7	Heide-Jørgensen, M.P. Catch statistics for belugas in Greenland 1862 to 2004.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/8	Garde, E., Heide-Jørgensen, M.P., Hansen, S.H. and Forchhammer, M.C. Age-specific growth and high longevity in narwhals (*Monodon monoceros*) from West Greenland estimated via aspartic acid racemization.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/9	Romberg, S. and Richard, P. Seasonal distribution and sex ratio of narwhal catches in the Baffin region of Nunavut Territory, Canada.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/10	Romberg, S. Catch Statistics (1996-2004) for Narwhal and Beluga in Selected Communities in the Eastern Canadian Arctic.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/11	Richard, P. A risk analysis of narwhal hunting in the Canadian High Arctic
NAMMCO/SC/13-JCNB/SWG/2005-JWG/12	Laidre, K. and Heide-Jørgensen, M.P. Late summer and early fall movements of narwhals in Inglefield Bredning, Northwest Greenland

NAMMCO/SC/13-JCNB/SWG/2005-JWG/13	Laidre, K.L. and Heide-Jørgensen, M.P. The behavior of narwhals (*Monodon monoceros*) before, during, and after an attack by killer whales (*Orcinus orca*) in the Eastern Canadian Arctic
NAMMCO/SC/13-JCNB/SWG/2005-JWG/14	Witting, L. An assessment for West Greenland beluga.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/15	Witting, L. A model selection based assessment for West Greenland narwhals with uncertain stock structure.
NAMMCO/SC/13-JCNB/SWG/2005-JWG/16	Heide-Jørgensen, M.P., Dietz, R. and Laidre, K. Metapopulation structure and hunt allocation of narwhals in Baffin Bay
NAMMCO/SC/13-JCNB/SWG/2005-JWG/17	Heide-Jørgensen, M.P. and Laidre, K. Video recordings of narwhal pods in Melville Bay, West Greenland
NAMMCO/SC/13-JCNB/SWG/2005-JWG/18	Lawson, J. Overviews: Beluga whale and noise.

ANNEX 2

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON FIN WHALES

Oslo, 20-22 October 2005

1. OPENING REMARKS

Chairman Lars Walløe welcomed participants (Appendix 1) to the meeting.

The Scientific Committee has carried out fin whale assessments on 3 previous occasions. In 1999, the Committee dealt with the East Greenland-Iceland (EGI) stock. The Committee concluded that catches of up to 200 fin whales per year would be sustainable, but that such catches should be spread over the EGI stock area. In 2000, the Committee considered fin whales around the Faroe Islands, subjected to projected annual catch levels of 5, 10 and 20 whales. This assessment was problematic because there was virtually no information of the stock identity of fin whales around the Faroes. Nevertheless, it was concluded that fin whales in this area are likely substantially depleted, under all scenarios that were examined. In 2003, the Committee revised its previous assessments based on new information from recent NASS and Norwegian surveys. The Committee also identified research to be carried out in order to refine the assessment of the EGI stock area, and continue with assessment of fin whales near the Faroes and in the Northeast Atlantic.

The Chairman noted that the NAMMCO Scientific Committee would be holding a special workshop in collaboration with the IWC Scientific Committee, “Catch History, Stock Structure and Abundance of North Atlantic Fin Whales” in 2006, so discussion of particularly stock structure at the present meeting would be limited, as additional genetic analyses were expected in the near future.

2. ADOPTION OF AGENDA

The draft agenda (Appendix 2) was adopted as written.

3. APPOINTMENT OF RAPPORTEUR

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

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Documents provided for the meeting are listed in Appendix 3.

5. STOCK STRUCTURE

In SC/13/FW/8 the available data on stock structure of North Atlantic fin whales based on non-genetic methods was summarized. This included a wide range of studies based on discovery marking, morphometry, earplug morphology, photo-identification, acoustics and biological parameters. Although each method is rather inconclusive by itself, collectively they indicate a separation between fin whales summering in the western, central and eastern North Atlantic. There also appears to be a more or less isolated stock in the Mediterranean Sea.

The Working Group noted that a single fin whale marked with a Discovery tag in Canada had been recovered in Iceland, indicating that some mixing must occur between these areas. Other evidence, particularly from genetics (see below) indicates that whales summering off eastern Canada are different from those summering off western Iceland. A appreciable proportion of Discovery marks were placed shortly before or after the cessation of whaling in the respective areas. Therefore the chance of recovery of the marks was limited given the relatively low catches and large numbers of fin whales in some areas. The Working Group suggested that it might be useful to undertake an analysis of these data, to determine how many recoveries would be expected under a range of mixing levels. However this would depend on estimates of abundance at the time of marking, which are not available for all areas. These marking data could be usefully included in models where they would set limits to rates of mixing.

Both passive acoustic studies in the North Atlantic and satellite telemetry off West Greenland have indicated that fin whales are present in northern waters in the winter, albeit at lower densities than in the summer. This is contrary to the expected migratory behaviour of most rorquals. The implications of this for stock structure are not clear. It is possible that the animals that remain in the north are non-breeding, but there are no data to support this. It is also uncertain whether all animals migrate in the same way every year, or whether migratory behaviour is more flexible. These questions could be addressed using satellite telemetry, however to date there has been a rather low success rate in using satellite telemetry with fin whales.

Paper SC/13/FW/9 presented results of the genetic variation in 1,018 fin whales sampled at 5 North Atlantic areas; *i.e.* off West Iceland, Norway, Spain, West Greenland and off the eastern Canadian coast. The data presented were based on genotypes of 9 microsatellite loci. Various genetic analyses showed significant genetic heterogeneity among the Icelandic samples, revealing temporal and seasonal differences in the samples from the years 1981-1989. However, the level of genetic differentiation was weak (FST~0.005) and no clear pattern could be detected. The genetic analyses carried out on a macrogeographical scale revealed significant genetic divergence among Icelandic, Norwegian, Spanish, Greenland and Canadian samples (FST~0.008, *P*p<0.05). Greatest difference was observed between the Canadian samples and the other areas (FST~0.022, *P*p<0.05). The authors concluded that the fin whale samples takenlocated at the feeding grounds of Iceland, Norway, Spain, Greenland and Canada most likely come from separate breeding units.

In discussion the Working Group noted that the reason for the low level of genetic heterogeneity among samples from West Iceland is unclear. It has been suggested (Daníelsdóttir *et al.* 1991a, 1991b; Daníelsdóttir 1994) that this may be due to the differential exploitation of "herds", or groups of closely related animals, on the whaling grounds. A similar pattern has been suggested for belugas (Palsbøll *et al.* 2002) and significant genetic heterogeneity among pods has been observed in other toothed whales (Hoelzel *et al.* 1998, Hoelzel and Dover 1991, Richard *et al.* 1996). However almost nothing is known about the social structure of fin whales on the feeding grounds, so this remains conjecture. Other possibilities include spatial segregation of sub-stocks on the feeding grounds, or variations in annual migrations of sub-stocks through the area.

SC/13/FW/9 presented results for microsatellite DNA analyses only. In cases of maternally directed philopatry, where segregation between feeding grounds is maintained by behavioural mechanisms, no differences would be expected in microsatellite DNA between feeding grounds if the whales shared a common breeding ground. Such a pattern is observed with humpback whales, where animals that share a single breeding area migrate to several feeding grounds in the North Atlantic. Therefore an analysis using maternally inherited mitochondrial DNA might reveal a different pattern than that shown by microsatellite DNA. While an analysis using mitochondrial DNA has been conducted for North Atlantic fin whales (Berubé *et al.* 1998), it did not have access to all the samples available for the analysis described in

SC/13/FW/8. Therefore the Working Group recommended that an analysis of heterogeneity in mitochondrial DNA be carried out.

Most genetic and non-genetic methods cannot distinguish between cases where 2 or more stocks mix on a feeding ground,, and cases where a single stock occupies that feeding ground. Samples from fin whale breeding grounds are not available, as the location of the breeding grounds are unknown. Therefore breeding stocks of fin whales have not been characterized genetically or by other methods. The Working Group recommended that available methods (such as the program STRUCTURE) be used to attempt to resolve whether the whales on the feeding grounds came from a single or several stocks, as well as to estimate mixing proportions where appropriate.

The Working Group examined a summary of stock structure hypotheses produced at the 2005 meeting of the IWC Scientific Committee (IWC 2005). It was decided to reorganize the summary in a hierarchical fashion showing first comparisons between IWC stock areas, then between areas within stock areas, and noting what the Working Group considered to be strong and weak evidence for stock separation or mixing. This compilation is shown in AppendixAppendix 4X.

In summary, the Working Group did not find reason to change its previous view (NAMMCO 2000), that most evidence suggests the presence of stocks with limited gene flow between adjacent summering aggregations. However these summer aggregations could be composed of single and/or mixtures of breeding stocks. The North Atlantic summer aggregations are all different from the Mediterranean Sea population. There are also indications of differentiation between Canadian, West Greenland, Icelandic, Norwegian and Spanish feeding grounds. Interpretation of these data is limited by the lack of temporal and spatial coverage in the sampling. On a microgeographic scale there is evidence of a low level of seasonal and annual variation on West Icelandic feeding area, but the implications of this are unclear.

6. BIOLOGICAL PARAMETERS

No new information was tabled on this subject.

7. CATCH DATA

7.1 EGI

SC/13/FW/6 presented a new analysis of historical catch records for Iceland. Catch data (some partial and some incomplete) from original catch reports is presented for just over half the catches from land stations in Iceland during the early whaling period 1883 to 1915, before whaling was banned in Iceland. Some graphical presentation of this data has been given in an earlier paper (Gunnlaugsson *et al.* 1989). The data are split as requested between the Westfjord and east coast regions, but stations operated on the east coast only during the years 1901-1913. Only totals by year for all stations combined can be found complete in the previously published literature. Some totals by station and even species composition have though however published and are used to complement the data where the catch record data are missing. Still some totals by station are missing for the years 1893-1900 where the published totals have to be used, and for the Westfjord operation in the years 1901-1903 when the totals by station for the east coast were subtracted from the published totals to get totals for the West. The total fin whale catch is then prorated from the observed proportion fin whales by year and region. The available sex-determined catch showed a ratio of 52% females and gives no indication offor a changevariation over time or space. Catch position records show that there was very little overlap in the range of the east and west operations, but the operational range expanded with time. Three CPUE series are derived. CPB as used in previous fin whale assessments is total catch of all species per boat by year and region, FPRB90 is fin catch per boat rectified for effort expended catching other species, and CPBM is catch per boat month where the operation time is taken to be from the first to the last whale caught. Operational factors are discussed.

The Working Group welcomed this contribution, which will facilitate modeling of fin whale population dynamics. It was noted that blue and humpback whales were the preferred prey of whalers in the early years, and that they turned to fin whales when stocks of these species had been depleted. Therefore the simple CPB CPUE series may be misleading in that it may reflect declines in species other than fin whales. The Working Group considered that the FPRB90 series was more likely to reflect fin whale densities and recommended that a similar adjustment to the CPBM series be investigated. Years with a very low percentage of fin whales in the catch might best be excluded.

Most catches between about 1917 to about 1937 (see 7.2) were taken by Norwegian pelagic whalers. It was noted that some of this catch may have come from areas other than the traditional whaling grounds off west Iceland, and therefore should be assigned appropriately in modeling. The authors agreed to look into this.

7.2 Norway, the Faroes and other areas

SC/13/FW/10 provided a compilation of whale catches of all species by Norwegian whalers. In this period, Norway carried out 3 types of whaling in the North Atlantic: 1) pelagic whaling, 1917-1937, in an area from Svalbard to Davis Strait; 2) coastal whaling, 1918-1971, starting with *Statens Hvalfangst*; and finally 3) the "Small type whalers", 1938-1986. A total of 143,730 whales were taken by Norway in the period 1917-1986 by all 3 types of whaling. Takes by whaling type were as follows: pelagic whaling 4,314; coastal whaling 14,662; and "Small type whaling" 124,754, of which 647 were larger whales. In coastal whaling 66% of the catch were fin whales, while 71% were fin whales in pelagic whaling. By comparison with a previous treatment of Norwegian whaling published by Jonsgård (1977), this study differs by 3.7%. A measure of CPUE defined as catch per boat month is also provided, but its usefulness is questionable because of operational factors in whaling.

SC/13/FW/11 extended this analysis to cover catches of fin whales in the entire North Atlantic. The time period covered was 1894 to 1984 for all areas except Norway, where the period covered was from 1917 onwards. A total of 28,559 fin whales were identified in the catch, leading to an estimate of 30,598 fin whales caught by prorating unidentified catch using the catch composition. Of the total number of whales caught by land stations and pelagic whaling (excluding small-type whaling), 66% were fin whales. After World War II the proportion of fin whales in the catch declined steeply. The total catch was distributed by area as follows: Norway pelagic 11%, Norway coastal 36%, Faroes 27%, Shetland 17%, the Hebrides 7%, Ireland 2% and Greenland 2%. The sex ratio of the catch has been close to 50% in most areas.

In discussion it was noted that both these compilations excluded Norwegian coastal catches before 1904. Catches of fin whales off northern Norway exceeded 10,000 animals in this period and would therefore double the Norwegian catch reported in SC/13/FW/11. However it was considered that the catches in this period had been adequately documented by Risting (1922) and that there was little to be gained by a recompilation of these data. The Working Group recommended that catches from this period be added to the catch series to make it complete.

Bloch reported that catch positions were in most cases available in the archival material, but that compiling this information would require considerable additional time and effort. The Working Group considered that catch positions were primarily required for the Norwegian pelagic whaling, as these catches would have to be assigned to the appropriate stock areas.

For example some catch by Norwegian pelagic whalers was taken east of Iceland, some in Denmark Strait and some off West Greenland. For shore based and small-type whaling, catch positions may be of less importance for modeling. However, it was noted that some stations reported catches year-round, so catch positions might be of interest for describing seasonal distribution, especially if combined with a CPUE index.

These compilations showed little discrepancy with that of Jonsgård (1977) for Norwegian catches, and it is likely that the Jonsgård (1977) compilation should be preferred for southwest Norway (where the discrepancy was greatest) as it seems that Jonsgård (1977) had access to original archival material that is no longer available.

Similarly to the case for Iceland, derivation of a CPUE index is problematic for the other fin whaling areas. Several species were caught by the whalers and the catch composition changed over time, so the index must be adjusted to compensate for this. The efficiency of whaling might be expected to change over time with as the whalers gained experience and new technology was introduced. Also, as some of the whaling stations operated year round, the CPUE would have to be broken down by season. The simple indices presented in SC/13/FW/11 could be further refined to account for some of these factors, and the Working Group recommended that appropriate CPUE indices be developed for all areas of the North Atlantic.

8. ABUNDANCE ESTIMATES

8.1 EGI

SC/13/FW/4 presented spatially stratified abundance estimates for fin whales from North Atlantic Sightings Surveys (NASS) conducted in 1987, 1989, 1995 and 2001. Of particular interest were areas considered useful in modelling, namely East Greenland, West Iceland, the remainder of the EGI area and areas outside (Fig. 1). These areas were defined as recommended by this Working Group in 2003 (NAMMCO 2004). The data were re-analysed using a standardized methodology to make the estimates internally consistent. As the stratification scheme has been different for each survey, post stratification was used to derive common areas for comparison between surveys. Total abundance estimates for each survey were quite close to previous published and unpublished estimates, except for the 1989 survey for which this estimate was about 15% higher than that of Buckland *et al.* (1993). This is likely due to differences in analytical methods and spatial stratification. There has been a substantial increase in the abundance of fin whales in the area west of Iceland since 1987. This corresponds to the area where nearly all fin whaling has been conducted since 1915. The increases observed in the EGI stock area as a whole are largely due to the increase in the area west of Iceland.

The Working Group welcomed this reanalysis and noted that it fulfilled a request made in 2003. Some concern was expressed about the comparability of the survey series, particularly the 1987 survey. The 1987 survey vessels had lower platform heights and used fewer observers than in later surveys. Also the level of observer experience was generally lower than in later surveys. Sighting rates were lower in 1987 for most (but not all) species than in the other surveys, suggesting that survey efficiency was lower in that year (Gunnlaugsson *et al.* 2006). However Gunnlaugsson *et al.* (2006) concluded that differences in survey efficiency alone could not account for the positive trend observed for fin whales and some other species. It was also noted that the distribution of fin whales off west Iceland had changed over the period, covering a broader area in recent surveys, which again suggested that there had been growth in the population.

It was noted that double platform data had been collected by the Faroese vessel in 1995 and by all vessels in 2001. Therefore perception bias should be estimable for fin whales from these surveys. However an earlier analysis (Gunnlaugsson *et al.* 2002) indicated that perception bias was very low for fin whales in 2001. It was recommended that this be done, but also recognized that the correction could not be applied to earlier surveys.

It was concluded that the abundance estimates produced were acceptable for assessment. The Working Group decided that, as had been done in previous analyses (IWC 1992, NAMMCO 2000, NAMMCO 2004) the estimates from 1987 and 1989 should be combined into a single estimate assigned to the year 1988. This makes the spatial coverage more compatible with later surveys. It was also decided to include components of the 1987 and 1995 Norwegian surveys in estimates for the same reason. Abundance estimates found acceptable for use in modelling by the Working Group are shown in Table 1.

8.2 Norway and Faroes

SC/13/FW/7 used sightings survey data collected over the period 1988-2004 to calculate relative abundance estimates for fin whales in the Northeast Atlantic based on a standard barrel platform with 2 observers which has been used in all the surveys. Analyses of local abundance at the scale of survey blocks seem to be inadequate for trend information, which would require larger areas to be surveyed synoptically. In the case of the fin whale population in the Northeast Atlantic, data collection in a *kernel* area comprising parts of the Norwegian Sea with its slopes and adjacent shelf areas to northern Norway and Spitsbergen, seem to be an appropriate survey area to monitor trends in long-term abundance. Point estimates of relative abundance (not corrected for perception or availability biases) in this area ranged between 1,100 and 1,800 whales in 5 surveys, with no significant trend over the period. There have been changes in fin whale distribution over the period, with more whales found west of Spitzbergen in later surveys.

Although the estimates presented were derived from sightings from a single platform, double platforms had been used in all Norwegian surveys conducted since 1988. Therefore it should be possible to provide an estimate of perception bias for these surveys, and the Working Group recommended that this be done. It was noted that effective strip widths were lower for the Norwegian surveys as compared to the Icelandic and Faroese surveys, and it was considered likely that this resulted from the concentration on minke whales as a target species in the former. Given that forward sighting distances were also presumably less for the Norwegian surveys, it might be expected that availability bias would be greater. However there are no data to test this.

The abundance estimates are low by comparison with the land station catches in this area, which exceeded 1,000 per year in some years between 1875 and 1904. The stock must therefore be depleted compared with historical abundance levels.

The Working Group concluded that the estimates provided would be suitable for use in assessments in this area.

9. ASSESSMENTS

9.1 EGI

SC/13/FW/5 reported a new assessment model of the EGI fin whale population, modeled as four subpopulations with movement between the following areas: East Greenland (area 1), West Iceland (area 2), East Iceland (area 3) and the Far East (area 4) (See Fig. 1). The model is sex- and age-structured, and is fitted to CPUE, sightings survey abundance, and mark-recapture data using both maximum likelihood and Bayesian approaches. Movement parameters are not differentiated by sex since the inclusion of sex-specific movement parameters did not improve the AIC. For the base case assessment scenario, best fits to the data were obtained when the West Iceland and East Iceland are effectively fully mixed with a low level of interchange with East Greenland and virtually no interchange with the Far East region. For the base case and most sensitivity tests, the overall recruited population is increasing and above 80% (base case 88.5%) of pre-exploitation abundance (*K*), and subpopulations in all areas are above 70% (base case > 82%) of the individual *K* values. Projections for annual catches of 0, 100, and 200 whales indicated that only the last would result in abundance decreases compared to current levels. Under catch levels of 200 whales there was less than a 1% probability that any of the 1+, recruited or mature female components of the total EGI population would fall below 60% of pre-exploitation levels within the next 30 years. Selected results are shown in Figs 2-5.

It was noted that the catch data included catches from Norwegian pelagic whalers in the period between 1917 and 1937, and that some of this catch occurred outside of Area 2, to which it was assigned. However it was expected that this misassignment was of low magnitude and would not affect the main conclusions from the model. Possible changes in carrying capacity were not considered in the model,. It was noted in this regard that blue whales apparently occurred in greater abundance in the area in the late 19th century than they do at present, and their low present abundance may have resulted in a carrying capacity for fin whales higher at present than historically.

Some of the predictions of the model did not coincide exactly with our present understanding of fin whales in this area. Firstly, the model predicted a lower rate of mixing between East Greenland and West Iceland, than suggested by Discovery marking (radio tagging also confirms that mixing does occur). Secondly, the model provided a poor fit to the trends in abundance estimates in Area 1 (East Greenland), an area for which sightings surveys have shown a large and significant increase in abundance since 1987 (see Fig. 5). The model predicted little increase in this area. Finally, the model suggested a high rate of mixing between West and East Iceland, whereas the sighting surveys show a gap in summer distribution between East and West Iceland, suggesting a low rate of exchange. There are too few Discovery marks placed off East Iceland to be informative about this exchange rate.

It was suspected that these conflicting results may have been due to an overemphasis on the 2 early CPUE series in the model, because of low associated variances. These series are assumed to be linearly proportional to abundance, but there is considerable uncertainty about this for the reasons noted in 7.1. It was suggested that model runs should be conducted using improved CPUE indices, indices entered with higher levels of variance and alternative assumptions about their relationship to abundance, and without the early indices. However there was insufficient time to do this at the meeting.

Catch positions are available for all phases of Icelandic whaling, and indicate that whaling off western Iceland in the early period was conducted in coastal areas off northwest Iceland, whereas in the later period catches were taken farther offshore to the west. It was suggested that early whaling may have depleted a stock component separate from, or with a low rate of mixing with, the more offshore component targeted by later whaling operations. It was noted in this regard that fin whales presently are not common in coastal areas of Iceland, and occur almost exclusively off the shelf. It was recommended that the catch positions of all phases of Icelandic whaling should be plotted and analyzed, to assist in developing alternative proposals for boundaries between stock components.

It was agreed that the base case model would be updated for the March 2006 meeting to reflect the discussion at this current meeting in the following ways:

5. Using abundance estimates for individual areas in 1988.
6. Use an adjusted set of early CPUE series.
7. Apportion the Norwegian pelagic catches, 1917-1937, to the correct areas.

8. Increase the maximum bound on *r*, the increase in calf production rate at low population sizes, from 0.142 to 0.383.

The Working Group could not draw firm conclusions from this modelling exercise, but noted that the more complex models involving 2 or more spatial components, such as this model and that of Cunningham and Butterworth (2003) (CB model), did fit the historical and modern CPUE and abundance data better than single homogeneous stock models. It is therefore likely that the more complex models will provide a more accurate forecast of the behaviour of the resource under differing catch regimes. The new model provides very similar forecasts to that of the CB and earlier HITTER based models (NAMMCO 2000) for this area. However further work is needed to clarify the stock relationships in this area, particularly with regard to area boundaries and mixing rates.

10. MANAGEMENT RECOMMENDATIONS

10.1 EGI

The Working Group found no reason to change its advice provided in 2003 (NAMMCO 2004), that projections under constant catch levels suggest that West Iceland (termed the "inshore substock" in earlier analyses) will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales. It is important to note that this result is based upon the assumption that catches are confined to West Iceland, *i.e.* to the grounds from which fin whales have been taken traditionally. If catches were spread more widely, so that other stock components were also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

10.2 North Norway

The Working Group is not yet in a position to provide management advice for this area. Once the work identified under 11.2 has been done assessments can be carried out for this area. However, given the rather low abundance estimates (<2,000) and the high historical harvest in the area, it can be expected that the stock will be found to be depleted relative to past levels.

10.3 West Norway-Faroes

No new assessments were considered for this area. The Working Group reiterated the advice provided in 2003 (NAMMCO 2004), that uncertainties about stock identity are so great as to preclude carrying out a reliable assessment of the status of fin whales in Faroese waters. The Working Group therefore reiterated the recommendations made in 2000 (NAMMCO 2001) to carry out a research program to elucidate the stock structure of fin whales in this area, and their relationships to other areas. Once this is done, it may be necessary to obtain clearer guidance on the management objectives for harvesting from what is likely to be a recovering stock before specific advice can be given.

11. RESEARCH RECOMMENDATIONS

The Working Group reiterated research recommendations made in previous meetings (NAMMCO 2000, 2001, 2004), and identified those most important to refine existing assessment and extend assessments to other areas:

All stocks

- Additional genetic sampling in all areas, but particularly in areas from which samples are few or lacking, such as East Greenland, northern and eastern Iceland, the Faroes and Norway (5-10 yrs).
- Laboratory analyses of existing samples from past sampling or catches should be completed by December 2005 so that analyses based on these data can be ready by March

2006. Analyses should be based on modern techniques and include consideration of both nuclear and mitochondrial genetics.
- Use microsatellite analysis to determine if closely related individuals are present on different feeding grounds (March 2006);
- Compile a summary review of past analyses of biological parameters;
- Satellite tagging to determine habitat use and migratory patterns once methodological/technical issues are addressed. If possible, a biopsy should be obtained from all tagged animals for genetic analysis and sex determination (5-10 yrs);

Faroes
- A CPUE index from Faroese and adjacent whaling operations should be developed (March 2006);
- Biopsy sampling for genetic analysis from the Faroes and adjacent areas should be continued (ongoing). Existing biopsy samples should be analysed as soon as possible (December 2005).
- Satellite tagging should continue once methodological/technical issues are addressed (when feasible).

EGI
- Revise the model presented in 9.1 to reflect the recommendations concerning appropriate choices for a base case analysis;
- Refine the CPUE series as recommended in 7.1 (December 2005).
- The catch series should be corrected such that Norwegian pelagic catches are assigned to the proper areas (December 2005);
- Plot all available catch positions from all whaling operations (March 2006);
- Provide an estimate of perception bias for the 2001 abundance survey (March 2006);
- Extend modelling to include neighbouring areas, such as West Greenland, the Faroes and Norway (1-3 yrs);
- Analyze trends in age of maturity and other biological parameters to determine whether changes are compatible in model estimates of trends in population size (March 2006);
- If new catches are taken, samples should be taken if possible both within and outside the traditional whaling grounds. The material should be investigated to get an updated view of age structure and sex distribution on and outside the whaling grounds, and biological parameters such as age at sexual maturity and fecundity.
- Additional samples for genetic analysis are required particularly from areas outside the traditional whaling grounds, such as East Greenland and northern and eastern Iceland (ongoing);
- Satellite tagging should be attempted to investigate the movements of fin whales, particularly between the traditional whaling grounds west of Iceland and areas outside (when feasible).

Norway
- Complete revision of catch statistics, including pre-1904 catches in the series (December 2005);
- Assign catch by pelagic operations to the appropriate stock areas (December 2005);
- Provide estimates of perception bias for all surveys;
- Compile information on incidental sightings, marking with Discovery tags, satellite tagging tracks, biopsy samples and age determinations of some samples (1-3 yrs);
- Prepare CPUE series for coastal and pelagic whaling operations (March 2006);
- Collection of additional biopsy samples for genetic analysis (ongoing), and analysis of existing samples in a timely manner (March 2006);
- Satellite tagging once methodological/technical problems have been addressed (when feasible).

12. OTHER BUSINESS

There was no other business.

13. ADOPTION OF REPORT

A draft version of the Report was adopted at the meeting, and the final version was adopted by correspondence. The Chairman thanked members for their valuable contributions to the meeting, and the members thanked the Chairman for his able leadership. All thanked the Rapporteur for his efforts.

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SURVEY	REGION	DEFINITION	N	CV
1988	EG	1989 A-WEST+1987 B-WEST	5,024	0.228
1988	WI	1989 A-EAST+1987 B-EAST	3,452	0.259
1988	EI+FE	1987 EGI+1987 NOR[1]	6,856	0.427
1988	OUTFE	1987 WN-SPB	675	0.284
1988	EGI-TOT	EG+WI+EI+FE	15,332	0.216
1988	TOT	EG+WI+EI+FE+OUT	16,007	0.205
1995	EG	A-WEST+B-WEST	8,412	0.294
1995	WI	A-EAST+B-EAST	6,800	0.231
1995	EI+FE	EGI	4,145	0.442
1995	EI+FE[2]	EGI+NVN+JMC	5,053	0.368
1995	OUTFE	WN-SPB	1,594	0.285
1995	EGI-TOT	EG+WI+EI+FE	19,357	0.22
1995	EGI-TOT[2]	EG+WI+EI+FE[2]	20,265	0.211
1995	TOTAL	EG+WI+EI+FE	20,951	0.213
1995	TOTAL[2]	EG+WI+EI+FE[2]+OUT	21,859	0.205
2001	EG	A-WEST+B-WEST	11,706	0.195
2001	WI	A-EAST+B-EAST	6,565	0.195
2001	EI+FE	EGI	5,405	0.292
2001	OUTFE	WN-SPB	2,085	0.282
2001	EGI-TOT	EG+WI+EI+FE	23,676	0.133
2001	TOTAL	EG+WI+EI+FE+OUT	25,761	0.125

Table 1. Abundance estimates accepted for use in assessment. Areas are as defined in Fig. 1. [1]Includes Norwegian estimate for Jan Mayen area from 1987 (IWC 1990, p. 141); [2]Includes Norwegian blocks NVN and JMC from 1995 (Øien 2003).

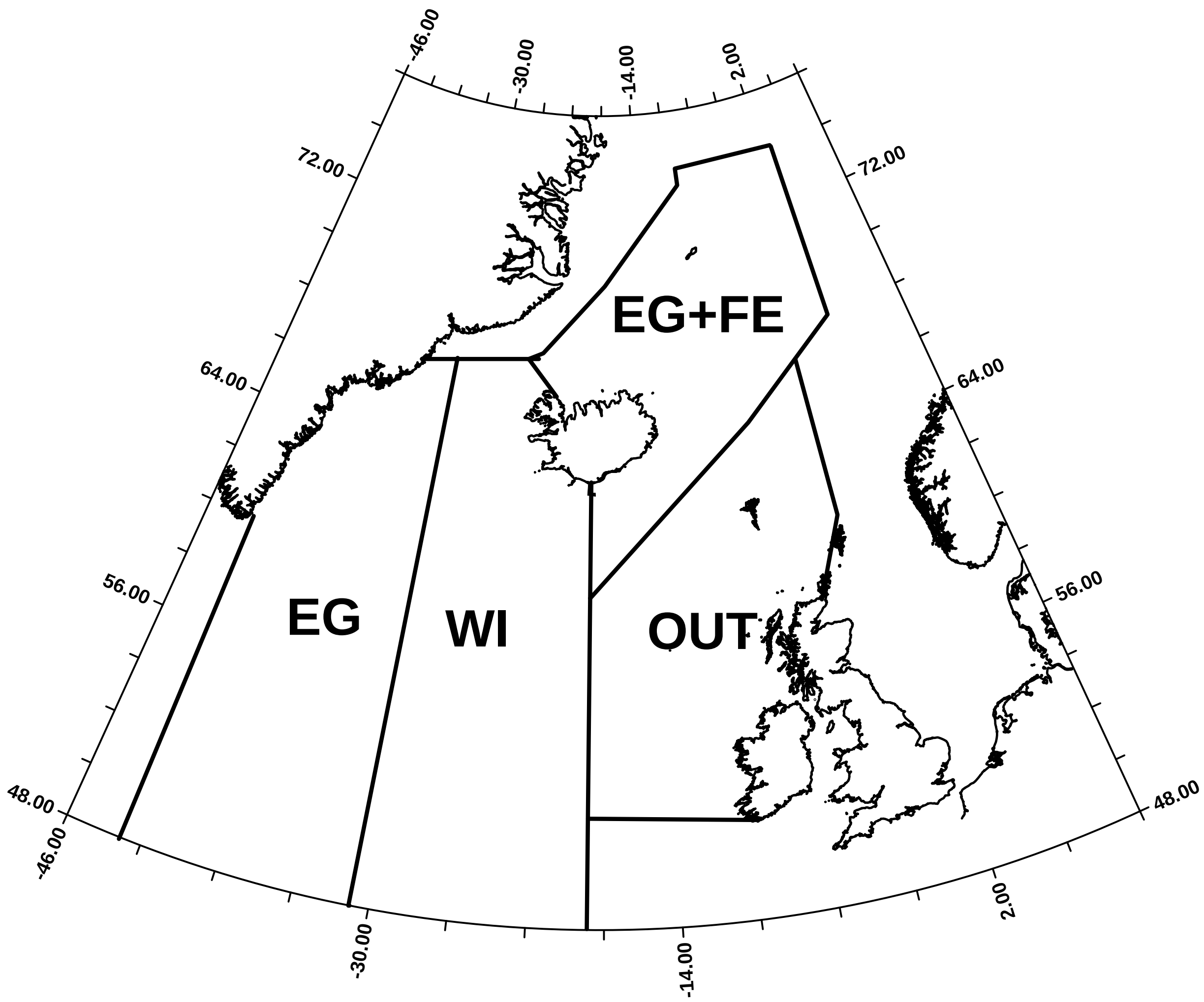

Fig. 1. Approximate boundaries of the subpopulation areas used in the assessment of the EGI stock. EG – East Greenland (area 1); WI – West Iceland (area 2); EI+FE – East Iceland and Far East (areas 3+4); OUT – outside of EGA area (not used).

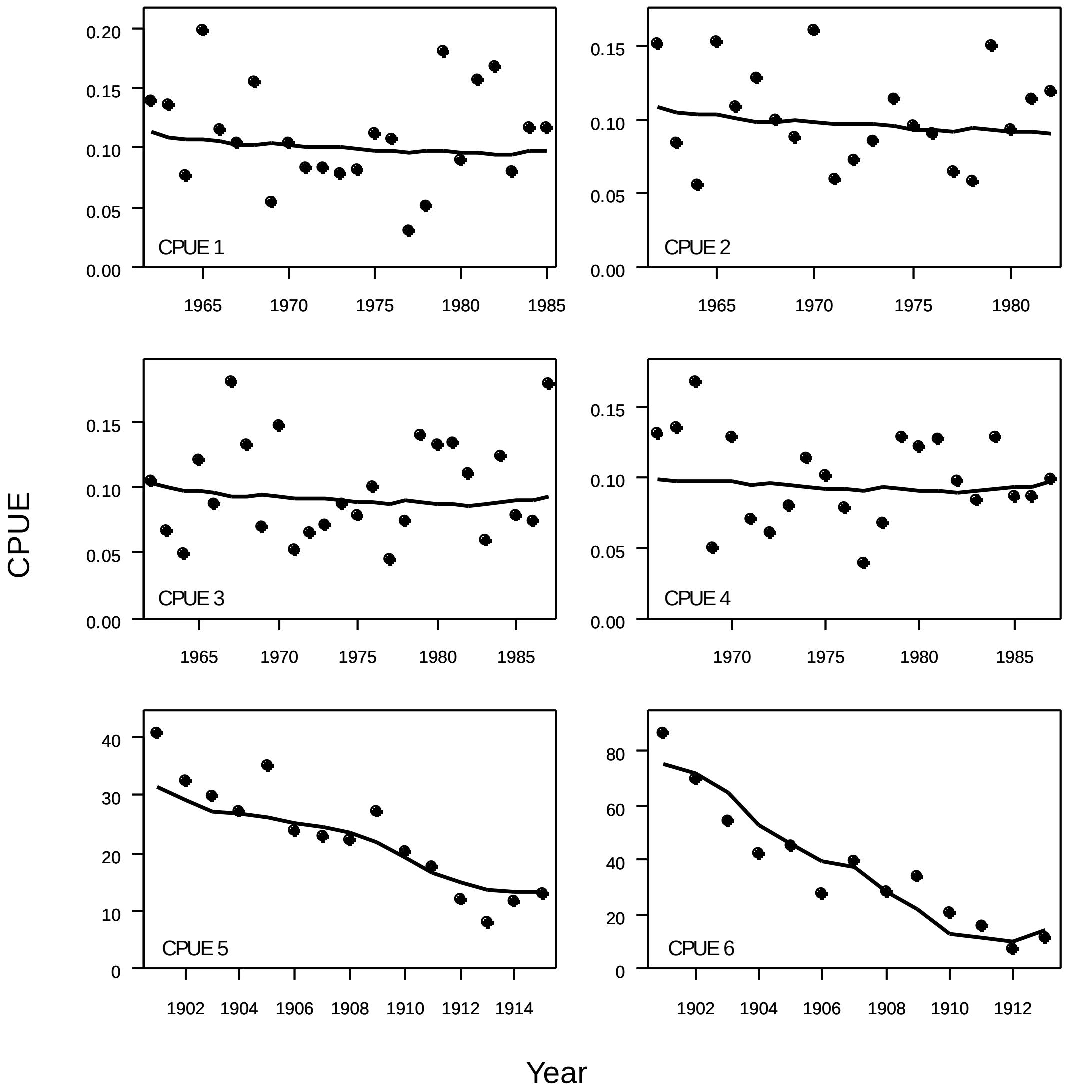

Fig. 2. Base case maximum likelihood fits (lines) to each of the six CPUE series (points).

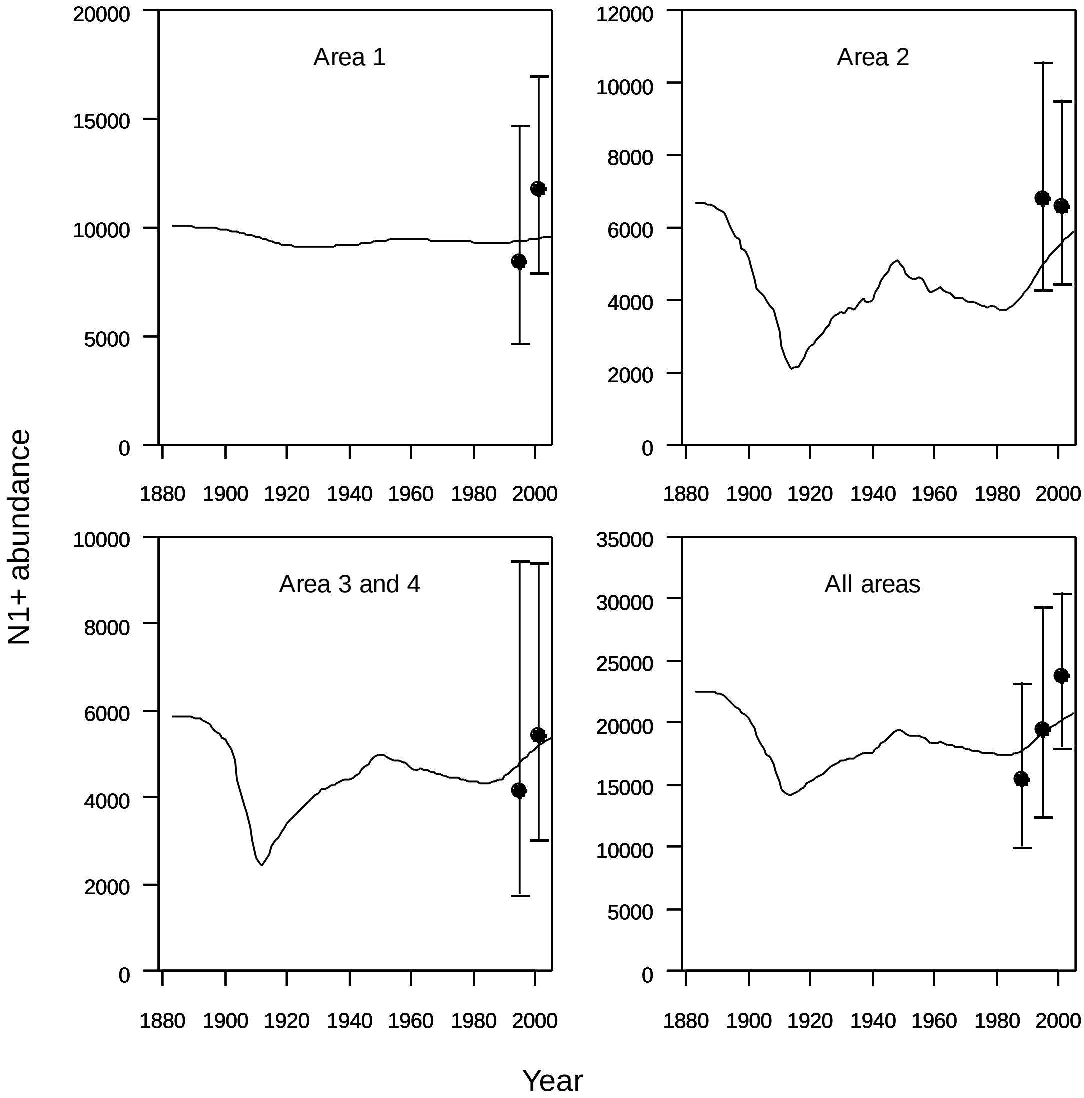

Fig. 3. Base case model fit of 1+ abundance trajectories to sighting survey estimates of abundance for area 1, area 2, area 3+4, and all areas combined. The 95% confidence intervals for the sightings estimates are indicated.

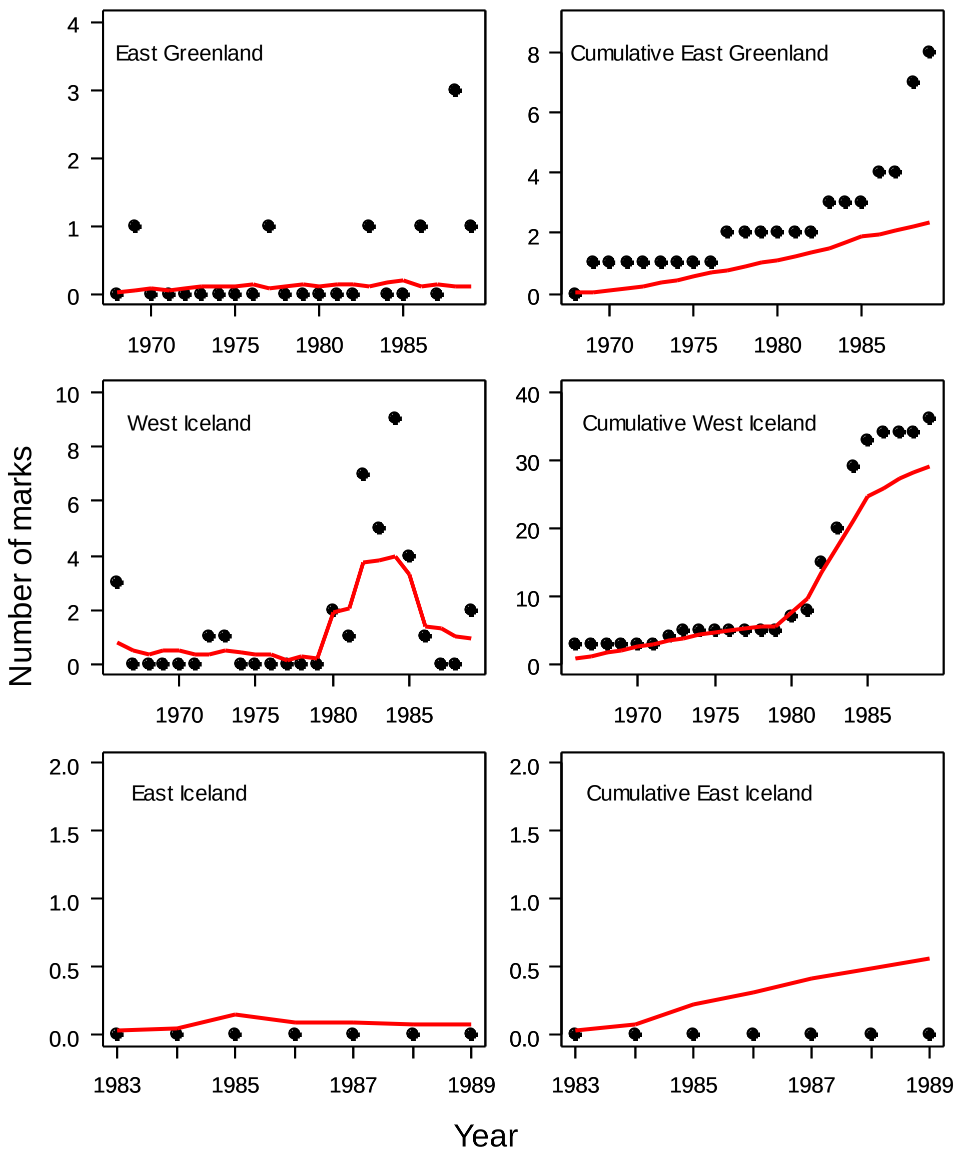

Fig. 4. Fit of the base case model (lines) to the mark-recapture data (points). The left panels represent marks and recaptures; the right panels cumulative marks and recaptures. Areas are those in which the fin whales were marked; all recaptures were in West Iceland. No fin whales marked in East Iceland were recaptured.

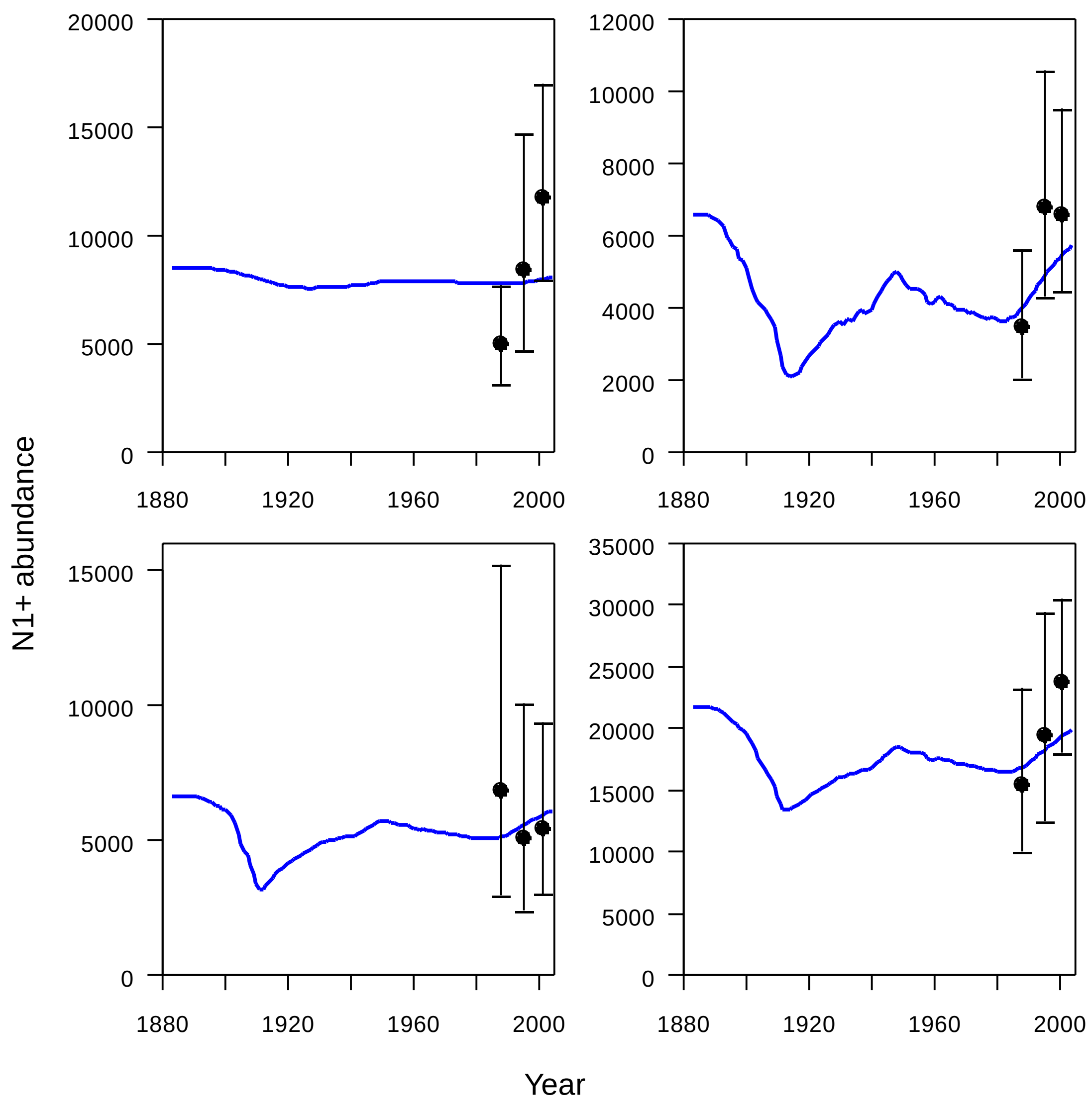

Fig. 5. Model fits when estimates for separate areas are used in "1988" (combined 1987 and 1989 results). Base case model fit of 1+ abundance trajectories to sighting survey estimates of abundance for area 1, area 2, area 3+4, and all areas combined. The 95% confidence intervals for the sightings estimates are indicated.

APPENDIX 1

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APPENDIX 2

Agenda

1. OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEUR
10. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
11. STOCK STRUCTURE
12. BIOLOGICAL PARAMETERS
13. CATCH DATA
    - 7.3 EGI
    - 7.4 North Norway
    - 7.5 West Norway-Faroes
14. ABUNDANCE ESTIMATES
    - 8.3 EGI
    - 8.4 North Norway
    - 8.5 West Norway-Faroes
15. ASSESSMENTS
    - 9.2 EGI
    - 9.3 North Norway
    - 9.4 West Norway-Faroes
    - 9.5 Other
16. MANAGEMENT RECOMMENDATIONS
    - 10.4 EGI
    - 10.5 North Norway
    - 10.6 West Norway-Faroes
    - 10.7 Other
17. RESEARCH RECOMMENDATIONS
18. OTHER BUSINESS
14. ADOPTION OF REPORT

APPENDIX 3

List of Documents

Document

SC/13/FW/1	List of participants
SC/13/FW/2	Draft annotated agenda
SC/13/FW/3	Draft list of documents
SC/13/FW/4	Pike, D.G. and Gunnlaugsson, Th. Regional estimates of density and abundance of fin whales (*Balaenoptera physalus*) from Icelandic and Faroese North Atlantic Sightings Surveys.
SC/13/FW/5	Branch, T.A. and Butterworth, D.S. Assessment of the East Greenland / Iceland fin whale population using a four-substock model.
SC/13/FW/6	Sigurjonsson, J., Konradsson, A. and Gunnlaugsson, Th. Catch series and cpue for the early modern whaling landstations in Iceland.
SC/13/FW/7	Øien, N. et al. Trends in the abundance of fin whales in the Northeast Atlantic
SC/13/FW/8	Víkingsson, G.A. and Gunnlaugsson, Th. Stock structure of fin whales (*Balaenoptera physalus*) in the North Atlantic – indications from non-genetic data.
SC/13/FW/9	A.K. Daníelsdóttir, M.Ö. Stefánsson, B. Thorgilsson, Th.D. Jörundsdóttir, A. Ragnarsdóttir, A. Árnason, Th. Gunnlaugsson, G. A. Víkingsson, D. Ólafsdóttir, M. Bérubé, P.J. Palsbøll, N. Øien, L. Witting And C. Pampoulie. Genetic analysis of North Atlantic fin whales (*Balaenoptera physalus*): Is there more than one breeding unit at the feeding ground west off Iceland?
SC/13/FW/10	Bloch, D. 2005. Norwegian coastal and pelagic whaling, 1917-1986. NAMMCO, report: 1-40.
SC/13/FW/11	Bloch, D. and Allison, C. 2005. The North Atlantic catch of fin whales, 1894-1984, taken by Norway, the Faroes, Shetland, the Hebrides, and Ireland. NAMMCO

Other Documents:

Daníelsdóttir, A.K., Gunnlaugsson, Th., Ólafsdóttir, D. And Víkingsson, G. A. Stock structure hypotheses for North Atlantic fin whales. Report of the 57th Meeting of the IWC Scientific Committee, Annex D, Report of the Subcommittee on the Revised Management Procedure,

Appendix 5.

[NAMMCO] North Atlantic Marine Mammal Commission. 2005. Report of the Fin Whale Assessment Planning Meeting. Report of the Scientific Committee, Annex 2. In: *NAMMCO Annual Report 2004*, NAMMCO, Tromsø, pp. 275-278.

[NAMMCO] North Atlantic Marine Mammal Commission. 2004. Report of the NAMMCO Scientific Committee Working Group on Minke and Fin Whales. Report of the Scientific Committeee, Annex 1. In: *NAMMCO Annual Report 2003*, NAMMCO, Tromsø, pp. 187-229.

APPENDIX 4

Summary of North Atlantic fin whale stock structure information indicating "separation" or "mixing" of whales from the areas compared. "Separate" in this context means that some difference between whales in the two areas has been identified. Note however that such differenceses identified between multiple pairs of areas do not necessarily mean that each area considered contains a different stock; differences could reflect instead differing proportions of two (or more) stocks in the various areas considered. Strong evidence of separation is shown in bold letters.

I IWC Schedule stock areas

Iceland (EGI) v/s Spain (UK Spain and Portugal)		
Separate:	MtDNA	Daníelsdóttir, *et al.,* 1991a
	Allozymes	Árnason & Sigurdsson, 1983; Árnason & Jónsdóttir, 1988; Árnason *et al.,* 1989; 1992; Daníelsdóttir *et al.,* 1991b; 1991c; 1992; Daníelsdóttir, 1994
	Microsatellites	Daníelsdóttir *et al.,* 2005
	Morphometrics	Jover, 1992; Vikingsson, 1992
	Earplug morphology	Lockyer, 1981; 1982
	Heavy metals	Sanpera, 1993; 1996
	Discovery marking Iceland	No returns at Spain
	(Discovery marking Spain)	No returns at Iceland (small numbers)
Iceland (EGI) v/s N-Norway		
Separate:	Allozymes	Daníelsdóttir *et al.,* 1992
	Microsatellites	Daníelsdóttir *et al.,* 2005
	Biological parameters	Haug, 1981
	Depletion pattern	Risting, 1922; Jonsgård, 1966; Sergeant, 1977
	Discovery marking Norway	No returns at W-Iceland. Brown, 1977
Iceland (EGI) v/s W-Norway & Faroes		
Separate	Discovery marking Iceland (few)	No returns in Faroes or Norway
	Discovery marking Norway, Faroes	No returns in Iceland
	(Depletion pattern?)	
	(Genetics/Biol param??)	
Iceland (EGI) v/s Eastern Canada		
Separate:	Allozymes	Daníelsdóttir *et al.,* 1992;
	Microsatellites	Daníelsdóttir *et al.,* 2005
	Depletion pattern	Risting, 1922; Jonsgård, 1966; Sergeant, 1977
	Discovery marking Iceland (few)	No returns at Canada (few catches)

Mixing:	Discovery marking Canada (many)	Only 1 return at W-Iceland
Iceland (EGI) v/s West Greenland		
Separate:	Microsatellites (few Greenl.)	Daníelsdóttir *et al.*, 2005
	Discovery marking Iceland	No returns at W-Greenland (few catches)
	Discovery marking W-Greenl.(few)	No returns at W-Iceland
Iceland (EGI) v/s Mediterranean		
Separate	Microsatellites and mtDNA	Bérubé *et al.*, 1998
	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
Faroes & W-Norway v/s Spain		
Separate	Discovery marking (few at both places)	
Mixing:	Satellite telemetry (1 whale)	NAMMCO, 2003
Faroes & W-Norway v/s N-Norway		
Separate	Discovery marking (few)	
	(Depletion pattern??)	
Faroes & W-Norway v/s Canada	??	
Faroes & W-Norway v/s W-Greenland	**??**	
Faroes & W-Norway v/s Mediterranean		
Separate	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
N-Norway v/s Spain		
Separate	Microsatellites	Daníelsdóttir *et al.*, 2005
	Discovery marking ?	No returns from Spanish catches (catches until 1985)
N-Norway v/s Mediterranean		
Separate	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
N-Norway v/s W-Greenland		
Separate	Discovery marking ??	
	Depletion pattern??	
N-Norway v/s Canada		
Separate	Allozymes	Daníelsdóttir *et al.*, 1992
	Microsatellites	Daníelsdóttir *et al.*, 2005
	Discovery marking ??	
	Depletion pattern??	
W-Greenland v/s Canada		
Separate:	Microsatellites	Daníelsdóttir *et al.*, 2005
W-Greenland v/s Mediterranean		
Separate	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
	Microsatellites and mtDNA**???**	Bérubé *et al.*, 1998
W-Greenland v/s Spain		
Separate:	Microsatellites	Daníelsdóttir *et al.*, 2005

Canada v/s Mediterranean		
Separate	Microsatellites and mtDNA	Bérubé *et al.*, 1998
	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
Canada v/s Spain		
Separate	mtDNA	Bérubé *et al.*, 1998
	Microsatellites	Daníelsdóttir *et al.*, 2005
Spain v/s Mediterranean		
Separate:	Microsatellites and mtDNA	Bérubé *et al.*, 1998
	Organochlorines	Marsili and Focardi, 1996
	Ligurian newborns in summer	Notarbartolo di Sciara *et al.*, 1996
	Accoustics	Clark, 1995; Clark *et al.*, 2002
	Lack of sightings in Gibraltar strait	Duguy *et al.*, 1988
Separate/Mixing	Stable isotope ratios	Guinet *et al.*, 2005
	Satellite telemetry	Guinet *et al.*, 2005
Nova Scotia v/s Labrador-Newfl.		
Separate:	Depletion pattern	Mitchell, 1972; Sergeant, 1977
	Organochlorines	Hobbs *et al.*, 2001
Mixing:	Discovery marking (many)	2 &1 returns
II Within IWC Schedule areas		
W-Iceland v/s E-Iceland		
Separate:		
	Discovery marking E-Iceland (9)	No returns at W-Iceland.
Mixing	Population modelling	Branch & Butterworth 2005
W-Iceland v/s E-Greenland		
Mixing:	Discovery marking E-Greenland	Gunnlaugsson, 2004; Sigurjónsson *et al.*, 1991
	Radio tagging (W-Ice. to E-Greenl.)	Watkins *et al.*, 1984
III Other East-West comparisons		
Bermuda/west Indies v/s Norwegian Sea		
Separate:	Acoustics	Clark, 1995; Clark *et al.*, 2002
Bermuda/west Indies v/s Mediterranean		
Separate:	Acoustics	Clark, 1995; Clark *et al.*, 2002

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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 (Appendix 1) 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 2) 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 3.

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 2 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 2 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 2 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 3 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 3 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 ½ 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 2 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 2 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 analyzed 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 were 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 analyzed 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 analyzed 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 analyzed 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 1370 kg walrus and of 365.4 MJ/day for the 1250 kg walrus. On average this corresponds to 346.8 MJ/day for a 1300 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 1370 kg walrus and 75 kg wet-weight per day (6% of TBM) for the 1250 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 are probably still far below carrying capacity. Thus, sufficient food resources are assumed to be available as long as all traditional feeding areas still will be available in spite of the lack of ice floes to rest on. A decrease in Arctic sea ice and consequent 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 absence of sea ice, walruses of all age classes will be forced to use terrestrial haul-out 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 that 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 emphasized in this context that the most immediate threat to walrus populations is overexploitation, 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 haul out sites in southeastern Svalbard and from 28 walruses of different sex and age at haul out 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) analyzed 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 $\pm$ 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 $\pm$ 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 anaesthetized individuals or at the haul-out 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 immobilized 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 percent 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 recognized 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 overexploitation 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. Analyze 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 our meeting Rapporteur for his valuable efforts during the Workshop.

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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).
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 subpopulation 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)

STOCK	NEW INFORMATION
	- 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 1. New information available since 1995 relevant to the putative stocks identified by NAMMCO (1995).

	KBNZ	SBFJ	Greenland			Canada			
			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)			
Duration of lactation (years)	1/2 to 2 (5) (12) (13)								
Calf birth					20 Jun (7/2--11/11) (7)	May-Jun (3)			
No. Calves					1				
Calving interval (years)					3 (7)	3 (5)			
Age at reproductive senescence	no current indications								
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)					1100 (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)				
Calf Survival rate (first year only)	unknown (11)								
Sex differences in the previous 3									
Juvenile survival rate (>1 yr.)	unknown (11)								

	KBNZ	SBFJ	Greenland			Canada			
			EG	WG	NOW	FB	HBDS	SEHB	NOW
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 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).

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-analyzed.
Disko group					none			
Sisimiut group					none			
East Greenland	5	5	1984-1990 (2)	opportunistic counts	1000 (na)	?	haul out 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	2000 (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			

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.

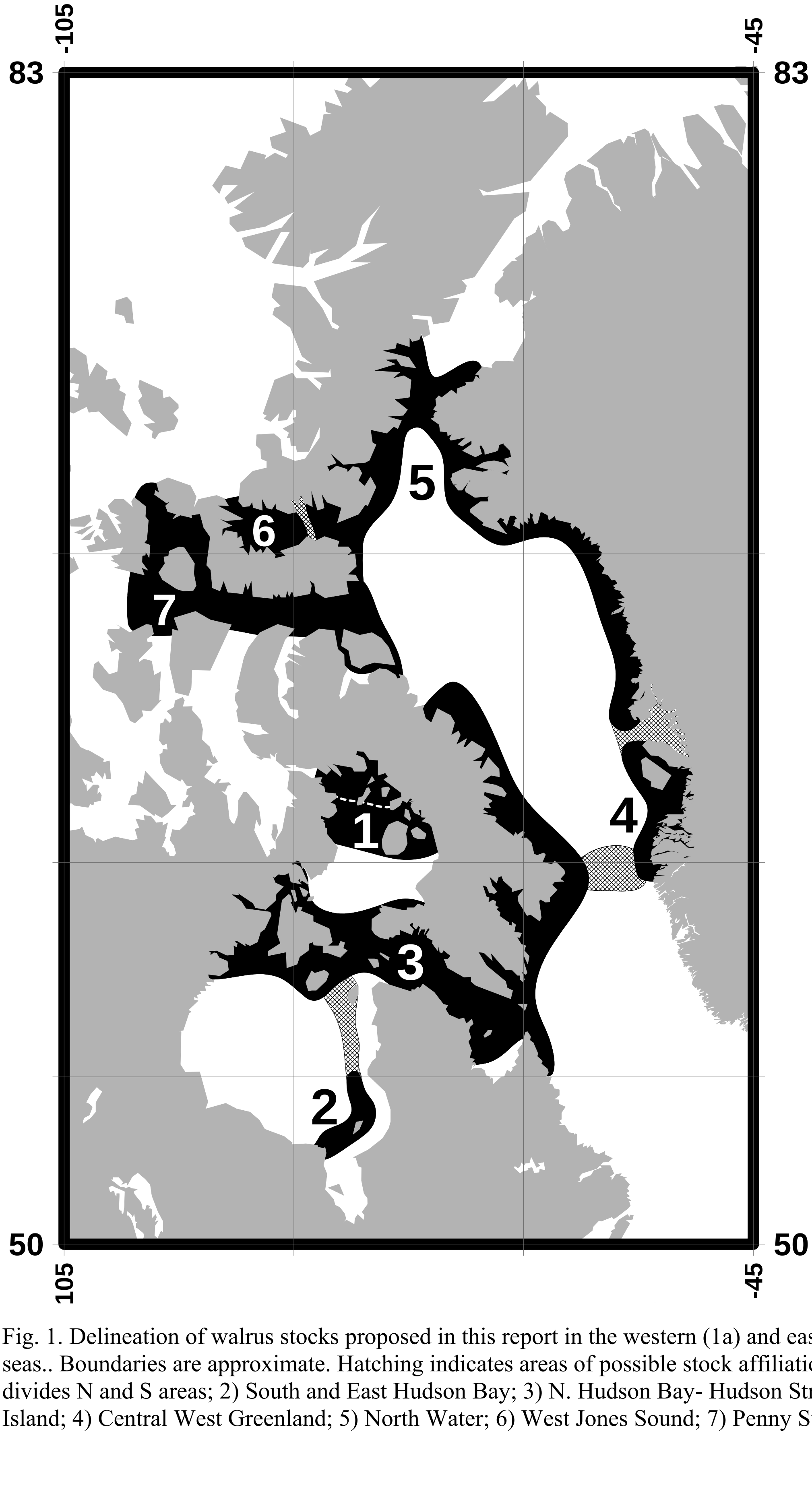

Fig. 1. Delineation of walrus stocks proposed in this report in the western (1a) and eastern (1b) Atlantic and adjacent seas.. Boundaries are approximate. Hatching indicates areas of possible stock affiliation. 1a. 1) Foxe Basin, dashed line divides N and S areas; 2) South and East Hudson Bay; 3) N. 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.

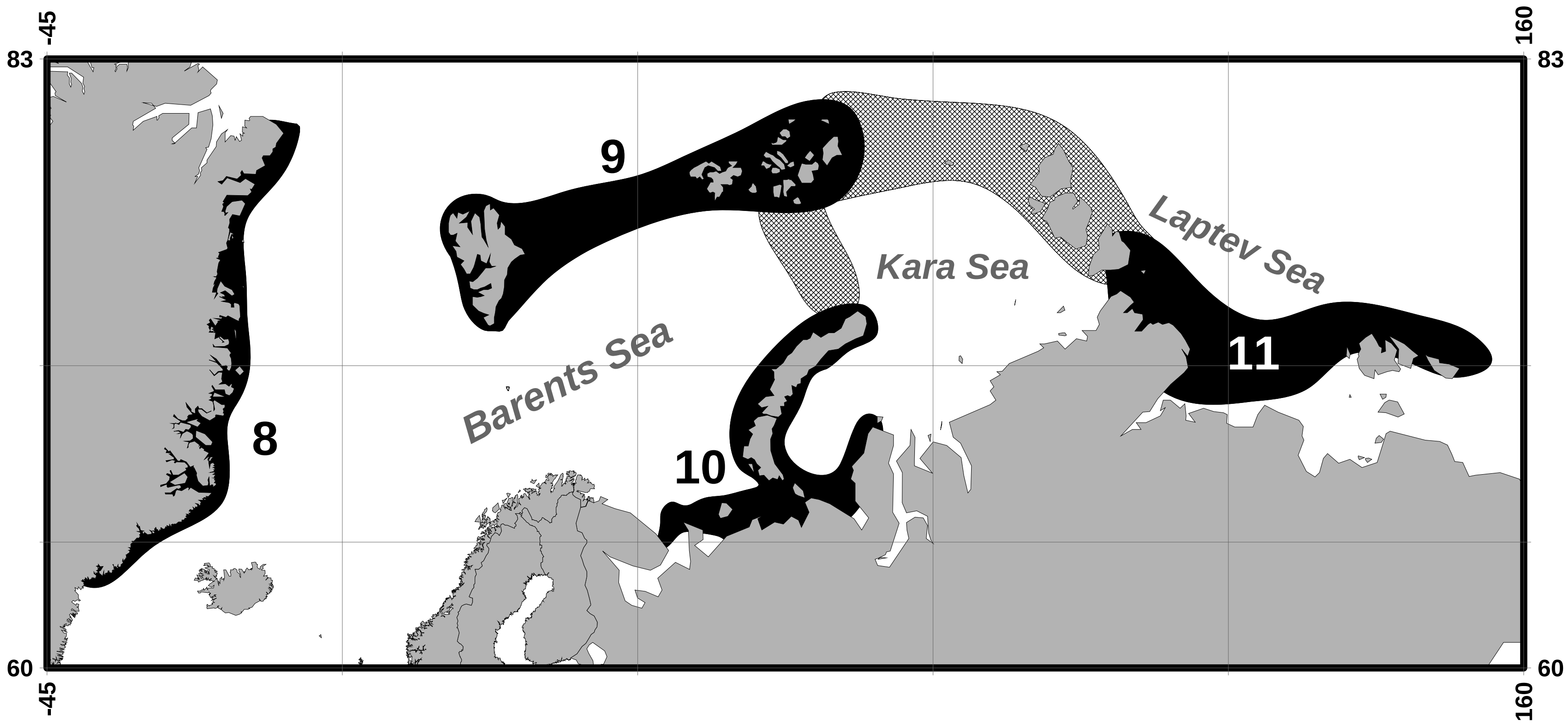

Fig. 1b. (cont'd). 8) East Greenland; 9) Svalbard – Franz Josef Land; 10) Kara Sea - S. Barents Sea - Novaya Zemlya; 11) Laptev Sea.

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APPENDI

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

APPENDI

LIST OF DOCUMENTS

	Title
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

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