NAMMCO

SCIENTIFIC COMMITTEE

REPORT OF THE ELEVENTH MEETING

Greenland Institute of Natural Resources, 25-27 November, 2003

North Atlantic Marine Mammal Commission
Polar Environmental Centre N-9296 Tromsø, Norway
Tel.: +47 77 75 01 80, Fax: +47 77 75 01 81 Email: nammco-sec@nammco.no, Web site: www.nammco.no

REPORT OF THE ELEVENTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

Greenland Institute of Natural Resources, 25-27 November, 2003

REPORT OF THE ELEVENTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

EXECUTIVE SUMMARY

The eleventh meeting of the NAMMCO Scientific Committee was held at the Greenland Institute of Natural Resources in Nuuk.

HARP AND HOODED SEALS

The Scientific Committee used the report of the ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) as a basis for advice on these species. When WGHARP met in Arkhangelsk in September 2003, the stocks of Greenland Sea harp seals, White Sea / Barents Sea harp seals and Greenland Sea hooded seals were assessed. Management agencies had requested advice on "sustainable" yields for the stocks. "Sustainable catch" as used in the yield estimates for seals means the catch that is risk neutral with regard to maintaining the population at its current size within the next 10 year period.

Population assessments performed were based on a new population model that estimates the current total population size using the historical catch data and estimates of pup production. 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.

Harp seals

Distribution and migration

Results of a recent study on the movements of adult harp seals tagged in the Greenland Sea with satellite linked time depth recorders showed that many of the animals migrated to and stayed in the northern parts of the Barents Sea around and to the east of the Svalbard archipelago in the period July-December, to a lesser extent also in April. In January-March their occurrence was confined to the Denmark Strait and the Greenland Sea, where some of the animals stayed during the entire tracking period. While the seals spent much of their time in close association with the pack-ice, occurrence in open waters appeared to be quite common, particularly during summer and early autumn

Preliminary results were presented from a joint Norwegian/Russian study of marine mammal distribution in the Barents Sea, based upon aerial surveys in September and October 2002.The main conclusions were that harp seals were only observed near the ice edge which was north of the major areas of capelin and polar cod (*Boreogadus saida*) distributions. This confirms the findings of preliminary surveys in September 2001 which also concluded that there was no evidence of overlap between harp seals and capelin.

The Greenland Sea stock

Catches over the past 3 years have been only 4-15% of the allocated quota, which was 15,000 animals one year old or older (1+ animals). Parts of, or the whole quota, could be taken as weaned pups assuming 2 pups equalled one 1+ animal.

From 14 March to 6 April 2002 airplane (photographic) and helicopter (visual) surveys were carried out in the Greenland Sea pack-ice to assess the pup production of harp seals using traditional strip transect methodology. The total estimate of pup production was 98,100 (cv 0.20). The stock in 2003 was estimated by modelling to be 349,000 (95% C.I. 319,000-379,000) 1+ animals with a pup production of 68,000 (95% C.I. 62 000-74 000).

Continuation of current catch level will likely result in an increase in population size. A catch of 8,200 1+ animals in 2004 would sustain the population at present level within a 10 year period. Catches twice the sustainable levels will result in the population declining by approximately 20-25% in the next 10 years.

The Barents Sea / White Sea stock

Combined Russian and Norwegian catches over the past 3 years have been 31-39% of the recommended sustainable yields (53,000 1+ seals, where 2.5 pups equalled one 1+ animal).

New airplane surveys of White Sea harp seal pups were conducted in March 2002 and 2003 using traditional strip transect methodology and multiple sensors. Pup production was estimated as 330,000 pups (cv 0.10) in 2002 and preliminarily as 328,000 (cv 0.18) in 2003. Based on Russian surveys in 1998, 2000 and 2002, the stock in 2003 was estimated by modelling to be 1,829,000 (95% C.I. 1,651,000 – 2,006,000) 1+ animals with a pup production of 330,000 (95% C.I. 299,000 – 360,000).

Continuation of current catch level will likely result in an increase in population size. A catch of 45,100 1+ animals, in 2004 would sustain the population at the present level within a 10 year period. If a harvest scenario including both 1+ animals and pups is chosen, one 1+ seal should be balanced by 2.5 pups. Catches twice the sustainable levels will result in the population declining by approximately 20-25% in the next 10 years.

Hooded seals

The Greenland Sea stock

Norwegian catches over the past 3 years have been 27-49% of the given quota (10,300 1+ animals where 1.5 pups equalled one 1+ animal.).

Based on a Norwegian aerial survey in 1997, the stock in 2003 was estimated by modelling 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). Because this estimate is over 6 years old it was decided that any advice provided should be extremely cautious. The Potential Biological Removals (PBR) approach was used to recommend a maximum catch level of 5,600 hooded seals in 2004.

NARWHAL

A successful narwhal survey was conducted in the Qaanaaq area in 2002 using aerial digital photography. However a survey in Melville Bay in August did not result in any sightings of narwhals. The surveys near Uummannaq in November had problems with darkness and wind conditions . Satellite tracking of narwhals in Baffin Bay is ongoing and data from previous satellite tracking studies are presently being analysed. Surveys of narwhal aggregations in Canada, and sample collection for genetic studies, are ongoing in Canada. There are plans for a survey of the narwhal wintering grounds in Disko Bay in March 2004. The Scientific Working Group of the JCNB will meet jointly with the NAMMCO Working Group in February 2004. The main topic of the meeting will be the assessment of narwhal stocks using all available information.

BELUGA

The next survey of belugas on the wintering ground in West Greenland is planned for March 2004. Results from this survey will – assuming successful completion – be available for revising the present advice in the autumn of 2004.

The Scientific Committee has advised on 2 occasions (2000 and 2001) that the West Greenland stock is substantially depleted and that present harvests are several times the sustainable yield, and that harvests must be substantially reduced if the stock is to recover. As yet no system of harvest control has been implemented in Greenland, and catches have not been reduced. The Committee stressed that the delay in reducing the catch to about 100 animals per year will result in further population decline and will further delay the recovery of this stock.

FIN WHALES

The Report of the Working Group on Minke and Fin Whales (Annex 1) from the meeting held in Copenhagen 20-22 November 2003 was considered under this item. The Scientific Committee has carried out fin whale assessments on 2 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.

Given that new information has become available from abundance surveys, satellite tracking programs and reconsideration of historical catch series, in 2002 the NAMMCO Council requested that the Scientific Committee continue with its assessments of fin whale stocks in the areas of interest to NAMMCO countries.

New information

No new genetic information on fin whale stock structure has become available since the last review was conducted in 1998. Stock delineation remains the greatest barrier to the reliable assessment of North Atlantic fin whales, especially at a finer scale. One of 2 fin whales satellite tagged in the Faroes in August 2001 migrated southward as far as 46° N, at the latitude of the Bay of Biscay. This may indicate a stock connection between whales around the Faroes and off the Iberian peninsula, but it would be premature to draw conclusions from the movements of 1 animal.

An improved catch series derived from Faroese and other archival sources is under development. The new figures are somewhat lower for the early part of the 20th century than those in the IWC database.

New estimates of abundance for the EGI and Faroese areas were available from the NASS-2001. In addition a new estimate was available from the Norwegian 1995 shipboard sightings survey, covering the Northeastern Atlantic including the North Sea, the Norwegian Sea, the Greenland Sea and the Barents Sea

Assessments

EGI

Assessment of the EGI fin whales utilised recent estimates of abundance from sighting surveys, and CPUE series for the 1901-1915 and 1962-1987 periods. Two independent assessments were available, one using HITTER/FITTER methodology and the other using a Bayesian approach. However approaches which treat the stock as homogeneous throughout the Central North Atlantic area fail because the population models applied cannot be reconciled with all 3 sources of data (the absolute abundance estimates and the 2 sets of CPUE data). In particular, such models have great difficulty in reflecting the large decline in CPUE observed in the 1901-1915 period.

To address this, two alternative assessment models used a 2 or more substock model approach, where historic catches have been taken from an "inshore" substock only, and there is diffusive mixing between this "inshore" and the "offshore" substock (in the 2-substock model). CPUE data reflect the behaviour of the "inshore" substock only, whereas sightings estimates relate to the combination of all substocks. This age-aggregated models allows both MSYR and the inter-substock mixing rates to be estimated, and provides an acceptable fit to all 3 sources of data. Under such analyses, the resource as a whole is estimated to be close to its pre-exploitation abundance. Projections under constant catch levels suggest that the inshore substock will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales for either assumption concerning the form of density dependence. It is important to note that this result is based upon the assumption that catches are confined to the "inshore" substock, *i.e.* to the grounds from which fin whales have been taken traditionally. If catches were spread more widely, so that the "offshore" substock was also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

Research recommendations provided by the Working Group included splitting the early CPUE series (1901-1915) between eastern and western Icelandic whaling areas. 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. Satellite tracking should be attempted to investigate the movements of fin whales, particularly between the traditional whaling grounds west of Iceland and areas outside.

Faroes

The new information on abundance from NASS-2001 and the updated catch history available for the Faroes did not greatly change the conclusion reached in 2000 (NAMMCO 2001), that the fin whale stock around the Faroes was likely to be heavily depleted under most stock scenarios considered plausible. Under some of these stock scenarios even catches as low as 5 animals per year slow or halt the recovery of the stock, and higher catches result in further depletion in nearly all cases. The uncertainties about stock identity are so great as to preclude carrying out a reliable assessment of the status of fin whales in Faroese waters, and thus the Working Group was not in a position to provide advice on the effects of various catches. It may also 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.

In order to get better information on stock delineation in this area, biopsy sampling for genetic analysis from the Faroes and adjacent areas should be continued. Existing biopsy samples should be analysed as soon as possible. In addition satellite tracking should continue. The revision of catch statistics for Faroese and adjacent whaling operations should be completed, and the feasibility of preparing a CPUE index from Faroese and adjacent whaling operations should be investigated;

Other stocks

The Working Group considered that the availability of abundance estimates from NASS-1995 and the development of abundance estimates from more recent Norwegian surveys for fin whales in the Northeast Atlantic will make the assessment of fin whales in this area feasible. A careful examination and compilation of available data, including catch data, incidental sightings, Discovery tag markings and genetic sampling, is needed before such an assessment is conducted.

Discussion by the Scientific Committee

The Scientific Committee appreciated the recommendations of the Working Group toward an update of the spatially structured models in order to aim for a better reconciliation of the different data sources for EGI fin whales. The Committee furthermore recommended a sensitivity test based on alternative hypotheses, for example changing carrying capacity or inertial dynamics with an additional layer of density dependence that operates on intrinsic life history parameters. It was also noted that the data on trends in the age at sexual maturity for fin whales harvested by Iceland had not been compared to the model runs, and suggested that such comparisons be conducted because they may help to clarify whether the different model hypotheses are likely to reflect the true dynamics of the stock/s.

The Scientific Committee considered that the scheduling of future assessment meetings should be dependent on the completion of additional research and necessary preparatory work, as noted above. The next meeting will concentrate on assessment in the Northeast Atlantic (North and West Norway stocks), and on further development of assessments for the EGI and Faroes areas.

MINKE WHALES

The Scientific Committee carried out an assessment of the Central North Atlantic stock of minke whales in 1998 (NAMMCO 1999). The Committee concluded then that the stock was close to its carrying capacity, and that present removals would not adversely affect the stock. Similar conclusions were reached when the analysis was restricted to the feeding stock in the coastal waters of Iceland, the CIC small area. Since that time, more information has become available on the stock delineation of minke whales in the North Atlantic. New abundance estimates are available for the Central Stock area from NASS-2001, and for the Northeast Atlantic from Norwegian surveys conducted from 1996-2001. Therefore in 2002, the Council of NAMMCO requested that the Scientific Committee complete a new assessment of Central North Atlantic minke whales.

Recent genetic analyses have indicated that animals from the CM Small Area are different from those from the Eastern Medium Area (Annex 1 Fig. 1), and the existence of a separate sub stock in the North Sea. The Working Group concluded that for the purposes of assessment, the existence of a separate Central Stock of minke whales was supported by the available evidence. However there may be sub-structure within this area. While there is no data to support the existence of a separate stock in the CIC Small Area, most catching by Iceland has historically occurred here so it made sense to consider this as a separate area for precautionary sensitivity tests.

No new information on biological parameters had been published since the last review of this stock in 1998 (NAMMCO 1999). However recent work (Olsen 2002) had demonstrated that age estimates based on counting annulae in *tympanic bullae* were not reliable. Therefore any biological parameters that included age as a component (*e.g*. age at maturity, mortality, survival) must now be considered suspect. Other ageing methods, were being developed but had not yet been widely applied. The Working Group nevertheless decided to use the estimates of parameters used in the previous assessment, as they are unlikely to differ greatly from those for the Antarctic minke whale for which valid ageing methods are available. It was also noted that the assessment models used were relatively insensitive to variations in these parameters within a plausible range.

The catch series used in assessments were the same as that used in the 1998 assessment, with the addition of more recent catches by Norway in the CM Small Area and by East Greenland. A “High Catch” case was also developed which included assumed maximum annual levels of both bycatch (5) and unreported catch (10 per annum from 1986-2002) in Icelandic waters.

New abundance estimates available to the Working Group included those from the NASS-2001 and NASS-1987 aerial surveys covering coastal Iceland (CIC small area). A new estimate was also available from the NASS-2001 shipboard survey, considered to be negatively biased because of animals missed on the trackline and diving animals.

Assessment

The results from two independent analytical approaches indicated that the Central Stock of minke whales has not been appreciably impacted by past whaling, having a current abundance of mature females that is at least 85% of the corresponding pre-exploitation level. This result holds regardless of whether the CIC area is treated as an isolated stock, and across a wide range of assumptions concerning past catches, stock boundaries, MSYR values and abundance estimates. Projections over the next 20 years indicate that, under all scenarios considered, a catch of 200 minke whales per year would maintain the mature component of the population above 80% of its pre-exploitation level over that period. Similarly, a catch of 400 per year would maintain the population above 70% of this level. This constitutes precautionary advice, as these results hold even for the most pessimistic combination of the lowest MSYR and current abundance, and the highest extent of past catches considered plausible. The advice applies to either the CIC Small Area (coastal Iceland), or to the Central Stock as a whole.

Questions remain about the stock delineation of minke whales in the Central Area, and further genetic sampling, particularly from Icelandic waters, East and West Greenland, and the Faroes is recommended. Analyses should use the same markers and methodologies as used by Norway so the datasets will be comparable. In addition Further satellite tracking to investigate spatial and temporal distribution in all areas is recommended. The development of valid ageing methods for North Atlantic minkes, using amino acid racemisation in the eye lens or other techniques, is required for the reliable estimation of biological parameters. Use of the number of *corpora albicantia* in females as a proxy for age in estimating biological parameters should be investigated.

WHITE-BEAKED, WHITE-SIDED DOLPHINS AND BOTTLENOSE DOLPHINS

The Council has asked the Scientific Committee to carry out assessments of these species, but to date insufficient information has been available on stock delineation, distribution, abundance and biological parameters to initiate the work. This year a series of working papers from the Faroes reported on research in progress on white sided dolphins, providing information on catches, biological parameters, feeding and genetics. Little progress has been made in analysing samples from white beaked dolphins collected from bycatch in Iceland. A report on the distribution and abundance of dolphins from the 4 aerial surveys carried out around Iceland between 1986 and 2001 is nearly complete, and further information on distribution is available from the NASS ship surveys. As yet no reliable information is available on bycatch of these species in Iceland. Norway will begin a sampling program focussing on white beaked dolphins in 2004, involving biopsy sampling for genetic and fatty acid analyses, and satellite tracking.

The Committee noted that considerable progress has been made in the Faroes in describing the ecology and life history of white sided dolphins, but that some analytical work remains to be completed and sampling will continue. The Committee was informed that satellite tracking will be attempted in the coming years in the Faroes, and that information on white beaked dolphins should be available from Iceland and Norway in about 2 years time. Abundance estimates are lacking in all areas except Icelandic coastal waters, and no information on stock delineation or pod structure is yet available. The SCANS survey planned for 2005/6 and coastal surveys planned for Norway (see below) should provide information on distribution and abundance in some areas. At this point the Scientific Committee considered 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 the above-mentioned studies have been completed, probably by 2007.

GREY SEALS

In 2001 the Scientific Committee noted that the abundance of grey seals around Iceland had decreased from an estimated 12,000 in 1992 to 6,000 in 1998, and that the annual catch of around 500 seals may not be sustainable. In contrast there have been apparent increases in the abundance of grey seals in other areas, including Southwest Norway, the United Kingdom and Canada. Grey seals are harvested or taken incidentally by fisheries and aquaculture operations in the Faroe Islands, Iceland and Norway. Subsequently the Scientific Committee was asked to provide a new assessment of grey seal stocks throughout the North Atlantic.

The Scientific Committee formed a Working Group on Grey Seals, chaired by Kjell Nilssen, which met in Reykjavik in April 2003 (Annex 2). The general terms of reference of the Working Group were:

- to assess the status of greys seals around Iceland, the UK, the Faroes, Norway, the Russian Federation, the Baltic, Canada and other areas;
- survey methods;
- stock delineation (genetics, temporal and geographical distribution);
- recommendations to the NAMMCO Council.

Iceland

The population status of the Icelandic grey seal, which has been investigated in the years of 1982, 1986, 1989, 1990, 1992, 1995, 1998 and 2002 by aerial census of grey seals pups on breeding sites. The Icelandic grey seal population appeared stable between 1982 and 1990, but since then, the pup-production has been declining by about 6% (95% CI 3% to 9%) annually. The abundance of the grey seals around Iceland in the year 2002 was about 5,000 animals. Recently following the decrease in population size, its distribution has contracted and it is now not found off the northeast coast, where some breeding occurred about 10 years ago.

The Working Group noted that it was obvious that harvests had been above sustainable levels for more than 10 years, and that the resulting decline in the population was well documented. While no management objectives have been identified explicitly, it is apparent that the implicit objective has been to reduce the stock to some undeclared level. There is an urgent need to identify clear and explicit limits for the stock and to regulate the level of harvest accordingly. If exploitation is continued at its present rate, it is likely that the population will be reduced to very low levels, and likely extirpated in many areas, within the next 10 years. The Working Group cautioned that, because the stock has been reduced and is still apparently declining, increased survey and monitoring effort will be required in the future. A formal assessment of the effect of present 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.

If aerial surveys are used to monitor the population, a power analysis should be conducted using past data to determine what frequency of surveys is required to reliably monitor trends in the population. A minimum of 3 surveys per site within the breeding season are required. An alternative might be to combine a single aerial count with a ground survey with staging, or to use ground counts on the larger colonies. Harvesting, S/L and bycatch data should be directly included in the population model used to calculate the factor to convert pup counts to 1+ numbers.

Faroes

Based on historical sources, there seems to have been a long tradition for harvesting grey seals in the islands, mainly at breeding grounds. Grey seals in the Faroes mainly breed in caves, which is exceptional for the species. Today, the only take occurs in defence of fish farms. Catch statistics are not available, but from direct contact with fish farmers, the catch in 2001 was estimated to be in the order of 250 to 500 seals, which seems surprisingly high for the population. Present population size is unknown. No tagging experiments have been conducted on Faroese grey seals, but such studies on neighbouring populations have indicated that the annual number of British grey seals migrating into Faroese waters may be significant.

The Working Group expressed concern that the Faroese grey seal population is subject to an apparently high but unknown level of exploitation, and that this exploitation has developed rather recently since the advent of fish farming activities. There is no information on stock identity or abundance on which to base management advice. Nevertheless, the relatively high level of take, combined with the likely small size of the population, suggests that a precautionary approach is warranted.

The Working Group therefore 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. This should include documentation of all used and potential pupping sites, genetic studies, better data on removals and studies on life-history parameters.

Norway

Ship based surveys along the Norwegian coast in 2000-2002, combined with aerial surveys conducted in 1998 in northern parts of Nordland and Troms, show the number of pups born in Norwegian waters is about 1,030, which corresponds to about 4,400-5,500 seals (1+). Total annual catches of grey seals in Norwegian waters ranged from 34-176 animals in 1997-2002, which corresponds to 13%-49% of the scientifically based recommended quotas(which are 5% of the estimated population size), and 11%-35% of the given quotas. There are no catch statistics available prior to 1997. A change in management occurred in 2003 when quotas were at 25% of current population estimate. Also, a bounty of NOK 500 is to be awarded for each grey seal documented killed.

In discussion the Working Group noted that the new quota levels of 25% of the estimated population size would, if taken, certainly result in population reduction. In addition, some proportion of the animals shot are killed but not landed, and there may be a substantial bycatch of seals in the area. No formal analysis of the effect of this level of harvest on the population, including the risk of extinction the sensitivity of the survey program to detect a population decline, has been conducted. While harvests have been considerably below quota levels to date, the possibility that the quotas might be filled should be considered, especially now that a bounty system is in place. Clear management objectives should be developed for this stock.

The vessel-based surveys conducted from 2000-2002 have provided good information on the location and approximate size of breeding colonies along the Norwegian coast. This information can be used to develop a survey design that will provide more reliable estimates of seal abundance in the area. Regular surveys are required to determine trends in the population, and power analysis should be used to determine the survey interval and level of effort required. The possibility of using repeated aerial surveys, at least in areas to the south of Lofoten, should be further explored. Surveys should be co-ordinated with those along the Murman coast in the Russian Federation. In addition a more complete sampling program from the hunt should be established, including the collection of reproductive tracts and genetic samples.

United Kingdom

A 40 year time series of pup production estimates for the majority of the British grey seal colonies is available. The most reliable time series of estimates covers the period from 1984 to 2001. The average annual rate of increase between 1984 and 1999 was 6.3% ±0.26%, but this varied locally and regionally. Recent declines in pup production estimates from the surveys suggest one or more of the demographic parameters may be exhibiting some trend over time as well as year to year variation. The estimate for the total number of females alive just before the 1999 breeding season is 63,000 (95% CI 54,000 to 73,000). The point estimate for females and males is 109,000. These figures refer to seals associated with the annually monitored colonies, which hold over 85% of the British population. The reasons for the rapid population expansion in many areas of Scotland since 1960 are uncertain. There has been little harvest of this population since early in the 20th century. Some culling was carried out in the 1970's and 1980's, and this may have had the unintended effect of forcing females to found new pupping colonies, thus expanding the breeding habitat of the population. In addition, the human occupation of the isolated outer islands has decreased over the past 50 years, allowing the development of breeding colonies on these islands.

Baltic

The Baltic population is severely depleted relative to historical levels, but is recovering after a century of bounty hunting and 3 decades of low fertility rates caused by environmental pollution. However there have been radical changes in the Baltic Sea environment, due to the effects of fishing, depletion of other seal species, environmental pollution and possibly climate change, so there is no reason to expect that carrying capacity would be the same as historical levels. Nevertheless there appears to be room for expansion of this population. The growing population has led to increased interactions with the fishery, and demands have increased for the re-introduction of hunt. A demographic analysis and a risk assessment of the population has been carried out to make recommendations on how to decrease the risk of quasi- extinction (*i.e.* reduction below a threshold level) by overexploitation. Although hunting increases the risk of quasi-extinction, the risk can be significantly reduced by the choice of a cautious hunting regime. The least hazardous regimes allow no hunting below a ‘security level’ in population size. Obviously, to implement such a hunting regime knowledge of the population size and growth rate are required. A hunt exceeding 300 females (less than 600 of both sexes) increases the risk for quasi-extinction substantially.

Russia (Murman Coast)
Grey seals on the Murman coast have been protected since 1958 and are included in the Red Data Book of the USSR and the Russian Federation. Few estimates of the numbers of grey seals inhabiting the Murman coast have been made. Investigations in the early 1960s suggested that about 600 seals inhabited the area at that time. Subsequent studies carried out in 1986 and 1991/92 have indicated that *ca* 850 pups are born in the area, suggesting a population of about 3,500 animals.

Eastern North America - Canada
Northwest Atlantic grey seals form a single stock, but are often considered as two groups, named for the location of the main pupping locales for management purposes. The largest group whelps on Sable Island. The second group, referred to as non-Sable Island or Gulf animals, whelps on the pack ice in the southern Gulf of St. Lawrence, with other smaller groups pupping on small islands in the southern Gulf of St. Lawrence and along the Nova Scotia Eastern Shore. Visual aerial surveys flown during January-February 1996, 1997 and 2000 in the southern Gulf of St Lawrence and along the Eastern Shore show that pup production has declined in this area. However, including Sable Island, the grey seal population has increased from slightly less than 30,000 animals in 1970 to over 260,000 animals in 2000. Currently, there is no commercial harvest for grey seals in Canada. In 2002, the Department of Fisheries and Oceans adopted an Objective Based Fisheries Management approach for seal populations. For "data rich" populations, management objectives ensure that the population size remains above a specific reference point. If harvesting results in a declining population, harvest quotas must be established at a level assuming a much lower risk that the population will continue to decline. If a population continues to decline below a reference limit point set at 30% below the maximum estimated population size, then it is considered that the population has suffered serious harm and harvesting is discontinued. For a population considered data poor, a more conservative approach, such as Potential Biological Removal (PBR), will be adopted.

Eastern North America - USA
Grey seals were historically distributed along the U.S. east coast (from Maine to Connecticut). Native and bounty hunting extirpated the population and they were rarely sighted for most of the 20th century. Seals tagged on Sable Island as pups were observed in New England during the 1980's and 1990's. Breeding began in 1988 and minimum pup production increased from 4 in 1988 to over 800 in 2002. Two additional breeding sites were discovered in Maine in 1994. The grey seals currently found in New England are probably a mixture of Canadian migrants and animals born locally. Continued surveys, historic research, genetic analysis and fieldwork should provide further insight into this recolonisation event and the current status of grey seals in the U.S.

Discussion by the Scientific Committee
The Scientific Committee endorsed the management advice and recommendations for research put forward by the Working Group. Víkingsson informed the Committee that the Marine Research Institute in Iceland had assumed more responsibility for research on grey seals. Surveys will be conducted annually at selected breeding colonies in Iceland. Repeated surveys will be flown and ground surveys will be conducted to assess pup staging. Haug noted that the last portion of the Norwegian coastal survey is being conducted and a complete estimate should be available in 2004. No research on grey seals is presently being conducted in the Faroes.

HUMPBACK WHALES

The Scientific Committee has previously noted that there is evidence of a rapidly increasing abundance of humpback whales around Iceland, and the Council has recommended that the Scientific Committee complete abundance estimates for this species as a high priority. The Scientific Committee was also asked to consider the results of the "Years of the North Atlantic Humpback" (YoNAH) project as it pertains to member countries in providing advice for this species.

A new abundance estimate calculated from the Norwegian NASS-1995 shipboard sightings survey covered the Northeastern Atlantic including the North Sea, the Norwegian Sea, the Greenland Sea and the Barents Sea. The sightings of humpback whales were nearly exclusively made in the Bear Island shelf area, which is known to be an important habitat for humpbacks in summer time. The abundance estimate for the entire survey area was 1,210 (cv 0.255).

The total abundance of humpbacks in the North Atlantic has been estimated at 10,752 (cv 0.068) for the West Indies breeding population only, and 11,570 (95% CI 10,290-13.390) for the entire North Atlantic (Stevick *et al.* 2003). These estimates, which apply to 1992-93, are derived from the YoNAH project, which used mark recapture analysis of photo-id and biopsy data. The estimates from the NASS in 1995 and 2001 are higher, but these apply only to the survey area around Iceland and the Faroes (and Norway in 1995). Because of the low precision of the NASS estimates, there is no significant difference between YoNAH and NASS estimates. However, the YoNAH estimate is said to apply to the entire North Atlantic whereas the NASS estimates apply only to the area around Iceland and the Faroes (and Norway in 1995). Other areas with known concentrations of humpback whales, such as eastern Canada, the Gulf of Maine, and West Greenland, are not included in the NASS estimates. The YoNAH estimate should therefore be considerably larger than the NASS estimates, which apply only to 1 or 2 of potentially 5 feeding areas in the North Atlantic.

The YoNAH estimate for the North Atlantic is negatively biased for at least 2 reasons: animals that do not breed in the West Indies are under-represented; and the area east of Iceland was poorly sampled. This latter area accounted for the bulk of the NASS estimates in 1995 and 2001. Conversely the NASS shipboard estimate from 1995 may be positively biased because of possible double counting, although most other potential biases for the NASS estimates are negative. Nevertheless these biases could not fully account for the apparent difference between the YoNAH and NASS point estimates.

The Scientific Committee concluded that the discrepancy between the NASS and YoNAH estimates suggests that the North Atlantic population of humpback whales is likely considerably larger than estimated in the YoNAH study. Further studies are needed to resolve these differences more fully. In particular, photo-id/biopsy studies need to sample humpback whales in all important habitats around Iceland. It is also recommended that available humpback survey estimates from all feeding aggregations in the North Atlantic should be compiled. For future NASS, consideration should be given to designs suitable for humpback whale feeding aggregations, and to extending the survey coverage.

NORTH ATLANTIC SIGHTINGS SURVEYS

The Working Group on Abundance Estimates met in St Andrews, UK in March 2003. The Working Group was tasked with continuing the evaluation of abundance estimates for target and non-target species, determining if additional analyses are required and recommending estimates for acceptance by the Scientific Committee.

Minke whales

An estimate of the abundance of minke whales form the NASS ship survey around Iceland and the Faroes was presented. This area is exclusive of the aerial survey block around Iceland. The point estimate of 23,955 (cv 0.30) is higher but not significantly so than the estimate from roughly the same area from the 1995 NASS. The distribution of minke whales differed somewhat between the surveys, with many more sightings in the Faroese block in 2001 than in 1995. The distribution of radial, and especially perpendicular distances realised in the survey was highly peaked, possibly due to operational problems on the survey. However the Working Group concluded that the detection function was appropriate for these data, and that the abundance estimate should be comparable to earlier surveys. The Working Group recommended that further efforts be made to use the double platform data to estimate bias due to visible whales missed by observers for this species.

New abundance estimates from the NASS aerial surveys around Iceland carried out in 1987 and 2001 were considered. The new estimates included corrections for previously uncorrected biases. For the 1987 survey the new estimate was 19,320 (cv 0.28) animals for the originally designed strata, while for 2001 it was 43,600 (cv 0.19). Both estimates assume a cueing rate for minke whales of 53 surfacings per hour. Sampling variability in this estimated cueing rate has not been accounted for in the variance of the abundance estimate, which therefore is negatively biased. The estimate from the aerial survey for coastal Iceland in 2001 is more than double that for 1987, however the difference is not significant. The Working Group concluded in 2002, based on line transect analysis of the density of minke whales from the 4 aerial surveys carried out since 1986, that the abundance of minke whales around Iceland has been stable or shown a moderate increase over the period. This conclusion remained unchanged.

Humpback whales

New estimates of humpback whale abundance from the 1995 and 2001 Icelandic and Faroese surveys were considered. These estimates used "spatial analysis", which relates observed density to environmental variables such as location and water depth. The estimate for the 1995 ship survey was higher than that from a conventional analysis, but less precise. The estimate from the 2001 shipboard survey 14,259 (cv 0.50). A calibration factor to make the aerial and shipboard abundance estimates compatible was calculated using data from the areas of overlap between the respective shipboard and aerial surveys. Using this calibration factor, the estimated abundance from the aerial survey was 15,270 in 1995, and 9,920 in 2001. The high variance of these estimates was a disappointment to the Working Group which had hoped the use of spatial covariates would increase the precision of the abundance estimates. The major reason suggested for this was that the main variables determining humpback distribution are probably not location and depth, so that spatial models using these variables alone have limited ability to reduce variance.

In 2002 the Working Group reviewed an analysis of the trend in encounter rate over the course of the 4 Icelandic aerial surveys carried out since 1986 which showed an increase of 11.4% (SE 2.1%) per year over the period in the survey area. This rate of increase is in accordance with that of 11.6% over the period 1970 to 1988 in recorded sightings humpback whales by whalers operating west of Iceland reported by Sigurjónsson and Gunnlaugsson (1990). The total estimates from the spatial analyses of the 1995 and 2001 surveys do not reveal a trend over the period, but they are much higher than estimates from earlier surveys. All available evidence indicates that the abundance of humpback whales around Iceland has increased since 1987.

Other species

New estimates from Icelandic and Faroese NASS shipboard surveys were considered for pilot whales (2001), northern bottlenose whales (1995 and 2001), and blue whales (1995 and 2001). These estimates are negatively biased by animals missed by observers, diving animals and inadequate spatial/temporal coverage (especially for pilot and northern bottlenose whales). For northern bottlenose and blue whales the Working Group considered that these serve as useful first approximations of abundance in the survey area. The Scientific Committee agreed with the conclusion of the Working Group that estimates from the NASS-1995, 1987 and 2001 for pilot whales were likely biased mainly because they did not cover the area occupied by the stock early in the summer. The estimate from NASS-89, which covered areas farther to the south and occurred later in the summer, is still considered the best available for this species. Monitoring of the abundance of this stock is advisable as it is a harvested species, and future surveys should take this into consideration. However it may be possible to derive an abundance index from the other surveys, which covered similar areas at the same time of year, and the Committee recommended that such an index be developed as an interim measure. The SCANS and other coordinated surveys to be conducted in 2005/6 may provide an opportunity to get a new abundance estimate for this species

Future of the NASS
The NASS have been highly successful in providing important information on the distribution and abundance of cetaceans over a broad area of the North Atlantic. This information becomes more valuable every time a survey is completed, as it provides an indication of trends in abundance over meaningful time periods. The Scientific Committee emphasised the importance of these surveys and recommended that they be continued in some form at regular intervals.

Several countries are planning surveys which may offer opportunity for integration into a large-scale survey. Iceland will continue surveys on a 5-6 year rotation, with the next survey tentatively planned for 2006. A new SCANS is being planned for 2005/6, with the offshore portion to be conducted in 2006. The survey will cover the North Sea and adjacent waters, and the North Atlantic EEZ's of all European Union countries. The Faroe Islands is planning a survey of small cetaceans to coincide with the offshore portion of SCANS in 2006. Norway will continue its rotational survey program, but integrate it with other surveys to the extent feasible. Therefore the best opportunity for a future large-scale integrated sightings survey would appear to be in 2006. The Scientific Committee recommended that Iceland, the Faroes, Greenland and Norway make every effort to coordinate their survey activities with other countries into an integrated NASS in 2006. Such co-ordination can occur through this Committee, as has been done in 1995 and 2001.

12. PUBLICATIONS

Five volumes of NAMMCO Scientific Publications have now been published: Vol. 1 *Ringed seals in the North Atlantic*, Vol 2 *Minke whales, harp and hooded seals: Major predators in the North Atlantic ecosystem,* and Vol. 3 *Sealworms in the North Atlantic: Ecology and population dynamics*, Vol. 4 *Belugas in the North Atlantic and the Russian Arctic,* and Vol. 5 *Harbour porpoises in the North Atlantic.* The latter was published late in 2003. The following volumes are planned:

- Vol. 6: North Atlantic Sightings Surveys, ed. Nils Øien and Daniel Pike. To be published early in 2005.
- Vol. 7: Grey Seals in the North Atlantic, ed. Tore Haug and Droplaug Ólafsdóttir. To be published in 2005.
- Vol. 8: Narwhal, ed. Mads Peter Heide-Jørgensen and Øystein Wiig. Planning is tentative, but may be published in 2006 if it goes forward.

The Committee recognised that the production of these volumes involved a significant cost and workload to the Secretariat. Every effort should be made to streamline the publishing process to reduce the workload and the time required to produce the books. It was also recommended that the papers in the volumes be made available on the internet some time after publication. The Secretariat will investigate this possibility.

FUTURE WORK PLANS

The 12th meeting will be held in the Faroes in October at a location and date yet to be determined.

Working Group on the Status of Beluga and Narwhal in the North Atlantic
The Working Group will meet jointly with the Scientific Working Group of the JCNB in February 2004, mainly to deal with narwhal assessments. Dr Øystein Wiig is chairman.

Working Group on Marine Mammal – Fisheries Interactions
The Working Group will meet immediately prior to the Scientific Committee meeting in October 2004 to evaluate new applications of multispecies models and new empirical data on the diet of and consumption by marine mammals. Lars Walløe is chairman.

Satellite Tagging Correspondence Group

The Scientific Committee stressed the necessity for the Satellite Tagging Correspondence Group to complete its task of addressing methodological/technical issues in a timely manner. Chairman Bjarni Mikkelsen anticipated that the Group would begin its work early in 2004.

ELECTION OF OFFICERS

Lars Walløe was elected as Chairman, and Dorete Bloch as Vice Chairman, of the Scientific Committee. The Committee expressed its thanks to Gísli Víkingsson for his able chairmanship over the past 3 years.

OTHER ITEMS

Bycatch

In reviewing the National Progress Reports, it was noted that there were as yet not systematic programs to report bycatch in any member country. There are indications that bycatch of harbour porpoises in Iceland may be substantial, and the extent of bycatch in Norway is completely unknown as no reporting system is in place. The Scientific Committee expressed concern about this matter and noted that all human induced mortality must be accounted for in assessments.

ELEVENTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

Chairman Gísli Víkingsson welcomed the members of the Scientific Committee to their 11th meeting (Appendix 1), held at the Greenland Institute of Natural Resources in Nuuk. He also welcomed the Observer from Japan, Tomio Miyashita. Member Lars Walløe did not attend the meeting.

2. ADOPTION OF AGENDA

The Draft Agenda was accepted without changes (Appendix 2).

3. APPOINTMENT OF RAPPORTEUR

Daniel Pike, Scientific Secretary of NAMMCO, was appointed as Rapporteur.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

4.1 National Progress Reports

National Progress Reports for 2001 from the Faroes, Greenland, Iceland, and Norway were presented to the Committee. In addition a Report was presented from Canada.

It was noted that there were as yet not systematic programs to report bycatch in any member country. There are indications that bycatch of harbour porpoises in Iceland may be substantial, given that over 200 were reported bycaught in 2002 with an unknown but probably low incidence of reporting. Bycatch rate in Norway is completely unknown as no reporting system is in place. The Scientific Committee expressed concern about this matter and noted that all human induced mortality must be accounted for in assessments.

Because of the timing of the Scientific Committee meeting, much of the information on research programs in the reports is nearly one year old when they are received. It was therefore recommended that a new section be added to the Reports to briefly describe research activities being carried out in the current year.

The Observer from Japan, Dr Tomio Miyashita, presented a report on recent Japanese research on cetaceans in the North Pacific. Research is conducted on several species, including minke, Brydes, fin, Baird's beaked and pilot whales, and several species of dolphins and porpoises. In the past year sightings surveys have been conducted in the Sea of Okhotsk and the Sea of Japan, with minke whales and Dall's porpoises as the main target species. Aerial surveys have been conducted in other areas. Other research has included satellite tracking of dolphins, photo ID studies of Brydes whales, and acoustic surveys of sperm whales. The Chairman thanked Dr Miyashita for his interesting presentation and noted the many areas of shared research interest between NAMMCO and Japan.

4.2 Working Group Reports and other documents

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

5. COOPERATION WITH OTHER ORGANISATIONS

5.1. IWC

The 55th meeting of the Scientific Committee of the International Whaling Commission (IWC SC) was held in Berlin from 24 May to 6 June. Daniel Pike attended as observer for the NAMMCO Scientific Committee. Items relevant for the interest for the NAMMCO Scientific Committee that were covered at the meeting are presented below.

The RMP Subcommittee carried out an implementation review of North Atlantic minke whales. Consideration of recent analyses using genetics, fatty acids, trace elements, radioisotopes and organochlorine pollutants led the Subcommittee to conclude that the present stock boundaries of the West Greenland, Central and Northeast Atlantic stocks should be maintained. There was evidence for a distinct North Sea (EN) stock within the Northeast Medium Area. The northern border of the EN small area was moved from 65° N to 62° N based on genetic evidence. There was no evidence for a distinct stock in the EC small area. This small area was therefore eliminated and merged into a new small area designated EW. A western boundary to the EB small area was added at 28° E, based on genetic differences between this area and areas further east.

The Subcommittee reviewed abundance estimates which had become available since the previous review, and their suitability for use in Implementation Simulation Trials (IST) and/or setting catch limits under the RMP. Estimates from Norwegian surveys carried out between 1996-2001 and the Icelandic aerial survey from NASS 2001 were accepted for IST and the RMP. Estimates from Icelandic and Faroese ship surveys from NASS-1995 were accepted while recognising that they are biased because of uncorrected *g(0)*. It was considered that further work was required on the Icelandic ship survey estimate from NASS-2001 to address the significance of the very spiked detection function.

In light of the new information on stock delineation and abundance, the Subcommittee decided that no further IST were necessary at present. It was recognised that if evidence emerges that site specific feeding behaviour is heritable for this stock, a new series of trials incorporating this trait may be required. However the evidence for this is equivocal at present and it was decided this issue could be taken up at the next Implementation Review if necessary.

The IWC SC noted that the need for an abundance estimate for West Greenland minke whales was urgent and recommended that a conventional cue counting survey be carried out off West Greenland in 2003.

A great deal of time was devoted to selecting an RMP variant for North Pacific minke whales. This process has taken more than 10 years. Discussion centred around the relative plausibility of the 4 stock hypotheses considered. In the end no consensus could be reached and all hypotheses were assigned equal plausibility. The Committee could not reach a full consensus on recommending an RMP variant to the Commission, due primarily to the disagreement over stock structure plausibility mentioned above. The Committee therefore gave the Commission a choice of 2 variants.

The Committee also considered the effects of restricting catches to Exclusive Economic Zones (EEZ), in terms of risk to stocks and catch performance. It was concluded that catches could be taken from small areas within an EEZ or straddling an EEZ boundary, but not from small areas outside an EEZ. Therefore, in the case of a management situation with at least some small areas outside an EEZ, restricting catches to within the EEZ would have the effect of reducing catch and reducing risk to the stock.

In June 2002 the Committee held a workshop on modelling cetacean – fishery interactions. In considering the report from the workshop, the Committee agreed that this was an important area of research, but there was disagreement as to whether it was important for the management of whale populations. It was agreed that existing modelling approaches have not developed to the stage where they can be used for quantitative prediction, but that it might be possible to make tentative qualitative predictions if several models predict similar results. The Committee suggested that a possible next step in this area would be to hold a workshop on the functional responses of predators to varying prey abundance.

Iceland presented a proposal for a feasibility study involving the take of 100 minke, 100 fin and 50 sei whales annually for 2 years. The proposal has multiple objectives, but the main ones are feeding ecology for minke whales and estimating biological parameters for fin and sei whales. Criticism of the proposal centred on the "feasibility" nature of the study, the need for lethal sampling to achieve the stated objectives of the program, and the effect of the lethal takes on stocks of fin and sei whales. In this regard NAMMCO assessments of fin and minke whales were presented.

The IWC Scientific Committee is initiating a major project called "Testing of Spatial Structure Models" (TOSSM). This will involve the development of software to generate simulated genetic data, which will be used to test statistical methods for stock discrimination. The software will be made publicly available. Next year the Scientific Committee will consider non-genetic methods of stock delineation, including satellite tracking.

5.2 ICES

Haug reported on recent developments in ICES. The ICES Working Group on Marine Mammal Ecology (WGMME) met 25-29 March 2003 in Hel, Poland, to develop further the response to the European Commission standing request regarding fisheries that have a significant impact on small cetaceans and other marine mammals. Updated information on cetacean populations and on by-catches in gillnets, pelagic trawls and other gear were reviewed, and various ways to avoid by-catches were discussed. WGMME concluded that more information about small cetacean abundance as well as the magnitude of by-catches are required throughout EU (and Norwegian) waters, and that work on new mitigation methods should be given high priority.

WGMME also reviewed the status of populations of Baltic seals (Baltic, Saimaa and Ladoga ringed seals, harbour seals and grey seals) and harbour porpoises. Theses reviews included abundance, distribution, migrations, reproduction, pollutants, health, and interactions with commercial fisheries and iontentional killing. Development of a monitoring programme for Baltic mmarine mammals was discussed.

Another item discussed by WGMME was the Ecological Quality Objectives (EcoQOs) for seal populations in the in the North Sea. One of the EcoQOs adopted in the Bergen Declaration assumes that no seal population in the North Sea shall decline more than 10% in 10 years. The group concluded that management strategies in most countries are appropriate in relation to this. However, the recent changes to Norwegian management of grey and harbour seals in achieving substantial reductions in the populations was a matter of concern for the group. EcoQOs for the bycatch of harbour porpoises (great concern) and for seal breeding sites were also discussed, and preliminary findings from the 2002 seal epizootic event in the North Sea were reviewed. Finally, census techniques for grey and harbour seals were reviewed, and a process to construct a time series of marine mammal abundance, diet, and consumption rates for the North Sea since 1963 was discussed.

After evaluating its history of providing advice on harp and hooded seal harvests in the North Atlantic the Joint ICES/NAFO Working Group of Harp and Hooded Seals (WGHARP) felt the need to re-evaluate its approaches to harvest modelling for the two species. For this reason, a workshop to "Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice" was convened in Woods Hole, Massachusetts, USA on 11-13 February 2003 (ICES 2003). The workshop reviewed and discussed a variety of marine mammal harvest management regimes and different assessment models (including data availability and requirements). Also, the workshop concluded that a management framework for harp and hooded seals needs to be developed which incorporates biological reference points, and it provided WGHARP with some guidelines in this respect. When WGHARP met at SevPINRO, Arkhangelsk, Russia, from 2-6 September 2003 the report from the workshop was evaluated. Furthermore, WGHARP assessed harp seals in the Barents Sea / White Sea and harp and hooded seals in the Greenland Sea, under terms of reference provided by the ICES Advisory Committee of Fishery Management (ACFM), and the process with definition and implementation of biological reference points for the stocks in question was started (See also sections 9.1, 9.2 and 9.9).

The 2003 ICES Annual Science Conference (ASC, at the 91st Statutory Meeting of ICES) was held in Tallinn, Estonia, 24-27 September 2003. Several ICES committees (*e.g.*, Living Resource Committee and Marine Habitat Committee) deal with marine mammal issues. Thus, both present and future theme sessions at the ASC are designed with marine mammals included as an integral part. Relevant sessions at the 2003 ASC were:

- In theme session N ("Size-Dependency in Marine and Freshwater Ecosystems") information presented on diets of cetaceans stranded on the English Channel coast showed that the prey size of common dolphins were smaller than expected and suggested that the common dolphin could be a competitor with many finfish species in the area. The issue of sample size, due to the reliance on strandings and bycatch data, was discussed in the session, and various methods apart from stomach analyses, as well as the comparison of bycatch and stranding results were suggested as possibilities for future comparison.
- Theme session U ("The Scope and Effectiveness of Stock Recovery Plans in Fishery Management") was aimed to review the origin, structure and implementation of recovery plans for a wide range of stocks and locations in order to provide the oportunity to identify their common features and the factors relevant to their success. In many stocks recovery have not been particularly successful, and the causes of failure were discussed and assumed to be a combination of management implementation, coupled with scientific issues such as concerns about the precision of many age-structured stock assessment procedures, and the frequent difficulty of distinguishing between fishing, environment, multispecies interactions and non-fishery factors such as seal predation.
- In theme session V ("Mixed and Multi-Stock Fisheries – Challenges and Tools for Assessments, Prediction and Management") a number of papers dealing with mixed and multi-stock fisheries , including those for whales, were presented. The whale presentation described how IWC had developed the Revised Management Procedure (RMP) through simulation to ensure that management is robust to uncertainty regarding the population dynamics.
- Theme session Y addressed the issue "Reference Point Approaches to Management within the Precautionary Approach", and one of the presentations suggested that it would be possible to identify aspects of predator (birds, mammals) ecology as indicators of healthy ecosystems. It was assumed that the identification of "sensitive" predator species could permit development, from empirical studies, of reference points that would act in a precautionary way to protect the broad community of dependent wildlife.

Future theme sessions relevant to marine mammal issues include, but may not be restricted to: "The Life History, Dynamics and Exploitation of Living Marine Resources: Advances in Knowledge and Methodology" and "Modelling Marine Ecosystems and Their Exploitation" (intended for the 2004 ASC in Vigo, Spain); "Monitoring Techniques and Estimating Abundance of Seals and Whales" and "Mitigation Methods for Reduction of Marine Mammal and Sea Turtle By-Catch in Fisheries" (intended for the 2005 ASC in Aberdeen, Scotland).

Hovelsrud-Broda informed the Committee that efforts to establish a Memorandum of Understanding with ICES to increase cooperation at the scientific level were underway. Given the large area of shared interest between the 2 organisations, the Scientific Committee considered that it would be useful to have such a formal relationship.

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

Neither the NAMMCO nor the Joint Commission Scientific Working Groups have met since the last meeting of the Scientific Committee. Witting, Chairman of the JCNB Scientific Working Group, reported that the next meeting would be held in February 2004, jointly with the NAMMCO Working Group (chairman Øystein Wiig). The resulting Joint Working Group will concentrate on the assessment of narwhal stocks at this meeting (see section 9.4 and 9.5).

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

Grete reported to the Scientific Committee from the Conference on User Knowledge and Scientific Knowledge in Management Decision-Making, held in Iceland in January 2003. More than 120 participants from 11 countries attended the Conference, among them hunters, fishermen, scientists, resource managers and others. The goal of the conference was to find ways to incorporate user knowledge into the management decision-making process in parallel with science, and not as a part of the scientific enterprise. Users (whalers, sealers, fishers etc) hold valuable knowledge that can be better utilised by the managers of the resources. The key topics for the Conference were:

- National and international aspects of resource management, and the structure of the decision-making process at several levels;
- Existing projects that consider user knowledge in management;
- How user knowledge and scientific knowledge is gathered, kept and transmitted;
- The strength and weaknesses of the two types of knowledge;
- An examination of the co-operation between scientists and users with respect to the utilisation of their knowledge; and
- The role and application of user knowledge and scientific knowledge in management decisions.

A number of common themes emerged from the presentations and discussions, including the following:

- There is a need for involvement by the users in both scientific projects and in the management decision-making process. This involvement should be formal and maintained throughout the process starting with the design of the projects;
- There is a need for documenting the availability of user knowledge and its characteristics;
- Continuity and accountability are important to build trust between the parties. The concept of social learning was introduced as a methodology for achieving this;
- A significant investment of time, effort and money is necessary for the process to go forward. There are no simple, short-term solutions;
- All parties must show humility, and recognise the fallibility and limitations of both forms of knowledge;

The Conference drafted a set of recommendations (NAMMCO 2003 p. 73), and the Secretariat presented a set of conclusions to be considered by the Council. At its 12 meeting in March 2003 the NAMMCO Council agreed to move the process forward by 1) publishing the presentations from the Conference along with a review of other management system that have involved user knowledge, and 2) establishing a Working Group under the Management Committee with its terms of reference based on the recommendations and conclusions from the Secretariat.

In discussion it was noted that the incorporation of users knowledge into management decision making was now being treated as a process parallel to the use of scientific advice by the Council. The Scientific Committee will therefore await the conclusions of the new 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 8th meeting in 1998 the Council asked the Scientific Committee to develop a strategy for how to incorporate the knowledge of users in the advice provided by the Scientific Committee. A strategy to utilise Stock Status Reports as a means to incorporate user knowledge was approved by the Scientific Committee at their 7th meeting. Under this system stock status reports would be developed by the Scientific Committee on stocks for which the Committee had provided advice. These documents would be used as the basis of discussion with user groups, and their input would be incorporated. The resulting documents would then reflect the best available scientific and user knowledge about the stock.

At its 9th meeting in 1999 the Council endorsed this proposal. Two stock status reports, on minke and pilot whales, have since been completed, but the process of integrating user knowledge has been delayed pending the outcome of a NAMMCO conference on this topic (see Item 6). Last year the Scientific Committee reiterated the importance of completing these documents, and suggested the idea of contracting out production of the reports should be considered. Pike reported that competing priorities continued to delay production of these reports. However, 3 reports (minke whales, pilot whales and ringed seals) have been placed on the NAMMCO Web Site this year. In addition, a contractor is presently working on the reports for walrus, beluga and fin whales, and these should be ready for review by the Scientific Committee by the end of the year.

8. ROLE OF MARINE MAMMALS IN THE MARINE ECOSYSTEM

8.1 Progress on modelling

Walløe provided a written report on this item. Dr Tore Schweder (Norway) has developed a new scenario model which incorporates harp seals, minke whales and 3 fish species (cod, capelin and herring). Evaluation and further development of this model has just started. This new *Scenario Barents Sea* incorporates improved minke whale and cod predation models. Results from the new combined model will be presented in March in the planned governmental white paper to the Norwegian parliament on marine mammals (*Stortingsmelding om sjøpattedyr*). In addition, work on assessment models for capelin and herring which incorporates predation by harp seals and minke whales is continuing in Norway.

In Iceland work on the *GADGET* model is in progress. Incorporatation marine mammals in the model is planned as a part of the Icelandic Research Program (see 16). The work is planned as a full time job for one year starting early in 2004.

8.2 Other matters

New data on the seasonal migration of seals are accumulating from satellite tags, and more data on prey species of minke whales and other marine mammals are now available or will be available in the near future both in Iceland and Norway from analyses of stomach contents. In addition new information on the diet of dolphins (see Section 9.8) should be available in the coming year from the Faroes and Iceland.

In order not to lose momentum on marine mammal-fisheries interactions the Scientific Committee decided that a new working group meeting should be held in the autumn of 2004, both to discuss progress in the modelling and to review and discuss the new empirical data on diet and consumption. If possible the meeting should be held after the ICES Annual Science Conference, which will have a special session on multi-species modelling (see Section 5.2), so the results from that meeting can be available. A final decision on holding this workshop should be made by the Chairman after consideration of progress in this area.

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

9.1 and 9.2 Harp and hooded seals

The Scientific Committee considered 2 reports from the Joint ICES/NAFO Working Group of Harp and Hooded Seals (WGHARP). After evaluating its history of providing advice on harp and hooded seal harvests in the North Atlantic WGHARP felt the need to re-evaluate its approaches to harvest modelling for the 2 species. For this reason, a workshop to "Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice" was convened in February 2003 (ICES 2003). WGHARP met in September 2003 to evaluate the report from the workshop and to complete assessment work with harp seals in the Barents Sea / White Sea and harp and hooded seals in the Greenland Sea, under terms of reference provided by the ICES Advisory Committee of Fishery Management [ACFM] (ICES 2004).

Workshop to "Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice"

Methods used to assess population status and provide management advice were reviewed and compared. Due to variability in data availability it was concluded that more than one model should be used (one for the Northeast Atlantic, one for the Northwest Atlantic, at least for now) but that the outcome of modelling using the different models on the same data set should be compared. Simulations should be carried out to evaluate sensitivity to the various input parameters (such as age at maturity and late term pregnancy), and the importance of a valid age structure in the Northeast Atlantic model should be evaluated. WGHARP remanded the modelling recommendations to a modelling subgroup for prioritization and intersessional work by correspondence.

Alternative methods used to assess marine mammal status and provide management advice were explored, in particular the suitability of IWC's Revised Management Procedure (RMP) and the US Marine Mammal Protection Act's Potential Biological Removals (PBR). It was concluded that the RMP and PBR approaches are based on different management objectives which probably would not satisfy the ICES/NAFO objectives in most cases (though there may be situations where the PBR approach could be applied to data poor species).

Data requirements were discussed, and the conclusion was that the primary data needs are for:
pup production on regular intervals, reproductive rates, harvest numbers by stage, and age composition of the population and/or harvest. Existing models can get by with limited data but the full suite of data is ultimately needed.

The workshop concluded that WGHARP needs to further discuss the distinction between assessment models and management framework. Also, a management framework for harp and hooded seals needs to be developed which incorporates the biological reference points, and the workshop provided WGHARP with some guidelines and good advise in this respect.

New assessment model
When WGHARP met in Arkhangelsk in September 2003, the stocks of Greenland Sea harp seals, White Sea / Barents Sea harp seals and Greenland Sea hooded seals were assessed. Management agencies had requested advice on "sustainable" yields for the stocks. "Sustainable catch" as used in the yield estimates for seals means the catch that is risk neutral with regard to maintaining the population at its current size within the next 10 year period.

Population assessments performed were based on a new population model that estimates the current total population size using the historical catch data and estimates of pup production. 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.

There are several significant differences between the current model and the one used for the previous assessment (WGHARP meeting in 2000, see ICES 2001). The previous model used only two age classes (pups and 1+ animals), while the new model uses 20 age classes. Work carried out following the previous assessment, including discussions on and recommendations from the workshop mentioned above, indicated that the earlier model was less appropriate than a model with a full age structure. The same population dynamic model was used for all three of the northeast Atlantic populations, but with stock specific values of biological parameters. The inclusion of a full age structure into the model was an improvement from previously used estimation programs. In general the new model gives lower catch options than previous models. This is due to uncertainty in, in some cases also complete lack of, updated relevant data for the assessed stocks.

Harp seals
Distribution and migration
Results of a recent study on the movements of adult harp seals tagged in the Greenland Sea with satellite linked time depth recorders were presented at the WGHARP meeting. Eleven adult harp seals (male and

female) were equipped with satellite transmitters after moulting in the Greenland Sea in 1999. The results showed that many of the animals migrated to and stayed in the northern parts of the Barents Sea around and to the east of the Svalbard archipelago in the period July-December, to a lesser extent also in April. In January-March their occurrence was confined to the Denmark Strait and the Greenland Sea, where some of the animals stayed during the entire tracking period. While the seals spent much of their time in close association with the pack-ice, occurrence in open waters appeared to be quite common, particularly during summer and early autumn. It was noted that there are likely to be interannual differences in migration and therefore, additional deployments are required to determine inter-annual variation. These studies provide exceptionally interesting information, but it must be remembered that they are based on a very small sample (n=11) of adults. Also, movements of other age groups are unknown.

Preliminary results were presented from a joint Norwegian/Russian study of marine mammal distribution in the Barents Sea, based upon aerial surveys in September and October 2002.The main conclusions were that harp seals were only observed near the ice edge which was north of the major areas of capelin and polar cod (*Boreogadus saida*) distributions. In contrast, cetaceans were observed in areas of high capelin abundance. This confirms the findings of preliminary surveys in September 2001 which also concluded that there was no evidence of overlap between harp seals and capelin. Thus, there was no evidence that large numbers of harp seals migrated to areas of capelin abundance at this time of the year.

The Greenland Sea stock

<u>Recent catches</u>

Only Norway took catches of harp seals in the Greenland Sea pack ice from 2001 through 2003. The total catches were 2,992 (including 2,267 pups), 1,232 (1,118 pups) and 2,277 (161 pups) animals in 2001, 2002 and 2003, respectively. Removals were 4-15% of the allocated quotas, which was 15,000 animals one year old or older (1+ animals). Parts of, or the whole quota, could be taken as weaned pups assuming 2 pups equalled one 1+ animal.

<u>Abundance</u>

From 14 March to 6 April 2002 airplane (photographic) and helicopter (visual) surveys were carried out in the Greenland Sea pack-ice to assess the pup production of harp seals using traditional strip transect methodology. The total estimate of pup production was 98,100 with a coefficient of variation for the survey of 20%. This is a minimum estimate as it was not corrected for areas not photographed and for pups born after the survey in one of the three areas surveyed. Based on previous (1983-1991) mark-recapture data and the recent (2002) aerial survey data, the stock in 2003 was estimated by modelling to be 349,000 (95% C.I. 319,000-379,000) 1+ animals with a pup production of 68,000 (95% C.I. 62 000-74 000).

<u>Catch options</u>

Continuation of current catch level will likely result in an increase in population size. ICES identified that a catch of 8,200 1+ animals in 2004 would sustain the population at present level within a 10 year period. If a harvest scenario including both 1+ animals and pups is chosen, one 1+ seal should be balanced by 2 pups. Catches twice the sustainable levels will result in the population declining by approximately 20-25% in the next 10 years.

The Barents Sea / White Sea stock

<u>Recent catches</u>

Combined Russian and Norwegian catches of harp seals in the White and Barents Sea were 44,316 (including 40,555 pups), 36,535 (34,598 pups) and 43,234 (40,279 pups) in 2001, 2002 and 2003, respectively. This is 31-39% of the recommended sustainable yields (53,000 1+ seals, where 2.5 pups equalled one 1+ animal).

Abundance
New airplane surveys of White Sea harp seal pups were conducted in March 2002 and 2003 using traditional strip transect methodology and multiple sensors. In 2002, the pup production was estimated as 330,000 pups (SE = 34,000) from the survey observations. The results from the 2003 surveys are preliminary, but indicate a production of 293,000 pups (SE =53,000) before corrections are made for hunted pups - total pup production in 2003, including a landed catch of 35,000 pups, was 328,000. Based on Russian surveys in 1998, 2000 and 2002, the stock in 2003 was estimated by modelling to be 1,829,000 (95% C.I. 1,651,000 – 2,006,000) 1+ animals with a pup production of 330,000 (95% C.I. 299,000 – 360,000).

Catch options
Continuation of current catch level will likely result in an increase in population size. ICES identified that a catch of 45,100 1+ animals, in 2004 would sustain the population at the present level within a 10 year period. If a harvest scenario including both 1+ animals and pups is chosen, one 1+ seal should be balanced by 2.5 pups. Catches twice the sustainable levels will result in the population declining by approximately 20-25% in the next 10 years.

Hooded seals

The Greenland Sea stock
Recent catches
Catches of Greenland Sea hooded seals during 2001-2003 remained well below the estimated sustainable yields (10,300 1+ animals). Thus, only 27-49% of the given quotas were fulfilled. Total catches (all taken by Norway, Russian sealers did not operate in the Greenland Sea in the period) were 3,820 (including 3 129 pups), 7,191 (6,456 pups) and 5 283 (5,206 pups) animals in 2001, 2002 and 2003, respectively. Parts of, or the whole quota, could be taken as weaned pups assuming 1.5 pups equalled one 1+ animal.

Abundance
Based on a Norwegian aerial survey in 1997, the stock in 2003 was estimated by modelling 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).

Catch options
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 6 years old and there are no estimates of reproductive rates for this stock. Therefore, any advice provided should be extremely cautious. One method of providing advice in such data poor situations is through the use of the Potential Biological Removals (PBR) approach. The Potential Biological Removal (PBR) has been defined as:

$PBR=0.5 \cdot R_{Max} \cdot F_r \cdot N_{Min}$,

where R_{Max} is the maximum rate of increase for the population , F_r is a recovery factor with values between 0.1 and 1 and N_{Min} is the estimated population size using 20th percentile of the log-normal distribution. R_{Max} is set at a default of 0.12 for pinnipeds. It is appropriate to set the recovery factor (F_r) 0.75 given the time since the last survey and uncertainty in parameters used to determine the total abundance. ICES recommended that the PBR approach be used for the Greenland Sea hooded seals, resulting in a recommended maximum catch level of 5,600 hooded seals in 2004.

9.3. Harbour porpoise

9.3.1 Update on progress

Haug reported that feasibility studies into assessing the abundance of harbour porpoise in Norwegian inshore waters have been undertaken in 2000 and 2001. Technical problems with survey design and analysis had arisen and the program is now being reconsidered. It is hoped that the project will be continued but there are no concrete plans in place.

9.3.2 Future work

A second SCANS is tentatively planned for 2005 and 2006. The Faroes is planning to participate in this survey, and other surveys (NASS and Norwegian surveys) may also be planned to coincide. Given that there are presently no abundance estimates for this species for NAMMCO member countries, and that bycatch for this species is unknown but may be significant in some areas (see 4.1), the Scientific Committee recommended that member countries co-operate to the extent possible to maximise the coverage and effectiveness of these surveys.

9.4. Narwhal

9.4.1 Update on progress

A successful narwhal survey was conducted in the Qaanaaq area in 2002 using aerial digital photography. However a survey in Melville Bay in August did not result in any sightings of narwhals. The surveys near Uummannaq in November had problems with darkness and wind conditions . Satellite tracking of narwhals in Baffin Bay is ongoing and data from previous satellite tracking studies are presently being analysed. Surveys of narwhal aggregations in Canada, and sample collection for genetic studies, are ongoing in Canada. There are plans for a survey of the narwhal wintering grounds in Disko Bay in March 2004.

9.4.2 Future work

The Scientific Working Group of the JCNB will meet jointly with the NAMMCO Working Group in February 2004. The main topic of the meeting will be the assessment of narwhal stocks using all available information.

9.5 Beluga

9.5.1 Update on progress

The next survey of belugas on the wintering ground in West Greenland is planned for March 2004. Results from this survey will – assuming successful completion – be available for revising the present advice in the autumn of 2004.

The Scientific Committee has advised on 2 occasions (2000 and 2001) that the West Greenland stock is substantially depleted and that present harvests are several times the sustainable yield, and that harvests must be substantially reduced if the stock is to recover. As yet no system of harvest control has been implemented in Greenland, and catches have not been reduced. The Committee stressed that the delay in reducing the catch to about 100 animals per year will result in further population decline and will further delay the recovery of this stock.

Lydersen informed the Committee that a population genetic study is ongoing using samples from West Greenland, Svalbard and the White Sea. In addition a co-operative project to satellite track belugas in the White Sea will be carried out in 2004 pending funding decisions.

9.5.2 Future work

If the 2004 survey off West Greenland is successful, it should be possible to reconsider this stock for assessment in 2005.

9.6 Fin whales

9.6.1 Update on progress

The Report of the Working Group on Minke and Fin Whales (Annex 1) from the meeting held in Copenhagen 20-22 November 2003 was considered under this item. The Scientific Committee has carried out fin whale assessments on 2 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.

Given that new information has become available from abundance surveys, satellite tracking programs and reconsideration of historical catch series, in 2002 the NAMMCO Council requested that the Scientific Committee continue with its assessments of fin whale stocks in the areas of interest to NAMMCO countries.

Stock structure

In 1999, the NAMMCO Working Group on Fin Whales concluded that there was evidence to indicate the presence of subpopulations with limited gene flow between adjacent subpopulations (NAMMCO 2000). The North Atlantic populations are all different from the Mediterranean Sea population. There is some indication that the western North Atlantic and Iceland areas have populations different from those found off the coasts of Spain and north Norway. Finally, deviations from Hardy-Weinberg genotypic proportions within and between years in the Icelandic samples suggest some sub-structure in this area. Beyond this, there is insufficient evidence to delineate stocks of fin whales in the North Atlantic. No new genetic evidence has come to light since 1998 that would change these conclusions, so stock delineation remains the greatest barrier to the reliable assessment of North Atlantic fin whales, especially at a finer scale.

One of 2 fin whales satellite tagged in the Faroes in August 2001 migrated southward as far as 46° N, at the latitude of the Bay of Biscay. It then moved northeast and reached an area off northwest Ireland, where it stayed within a restricted area for 2 months before contact was lost in November of the same year. While noting that this indicates a possible stock connection between whales around the Faroes and off the Iberian peninsula, the Working Group felt that it would be premature to draw conclusions from the movements of 1 animal.

Biological parameters

Biological parameters for fin whales adopted by the IWC in 1991 (Lockyer and Sigurjónsson 1991) have been used in previous NAMMCO assessments (NAMMCO 2000, 2001). The Working Group agreed that at present there is no new information to change any of these parameters.

Catch data

The catch series available to the Working Group were for the most part the same as those used in previous NAMMCO assessments (NAMMCO 2000, 2001) and were derived from those extracted for the Comprehensive Assessment Meeting on North Atlantic Fin Whales held in 1991 (IWC 1992). A new "Faroese South" area included abundance estimates and catches from the previous "Faroese Medium" area plus Spanish and Portuguese catches, thus capturing the possibility of a link between fin whales caught in the Faroes and areas farther south (see Annex 1 Fig. 3 for area definitions).

Bloch reported on the development of an improved catch series derived from Faroese and other archival sources. The new figures are somewhat lower for the early part of the 20th century than those in the IWC database.

Abundance estimates

Estimates of abundance used in assessments were those accepted by the NAMMCO Scientific Committee from NASS-2001 and earlier surveys, disaggregated by area as appropriate.

A new estimate was available from the Norwegian 1995 shipboard sightings survey. The survey covered the Northeastern Atlantic including the North Sea, the Norwegian Sea, the Greenland Sea and the Barents Sea. Most of the fin whale sightings were made in the Svalbard area, that is, along the continental slope from Bear Island and northwards to the northwest of Spitsbergen. Compared to earlier surveys, the 1995 distribution was more northerly. The abundance estimates based on the combined platform data were considered to give the best estimates of absolute abundance of 5,395 animals (c.v. 0.204) for the survey area.

The Working Group welcomed this new estimate, and urged the timely completion of estimates from the 1996-2001 series of surveys, which is required for future assessments of fin whales in this area.

Assessments

EGI

Assessment of the EGI fin whales utilised recent estimates of abundance from sighting surveys, and CPUE series for the 1901-1915 and 1962-1987 periods. Two independent assessments were available, one using HITTER/FITTER methodology and the other using a Bayesian approach. However approaches which treat the stock as homogeneous throughout the Central North Atlantic area fail because the population models applied cannot be reconciled with all 3 sources of data (the absolute abundance estimates and the 2 sets of CPUE data). In particular, such models have great difficulty in reflecting the large decline in CPUE observed in the 1901-1915 period.

To address this, two alternative assessment models used a 2 or more substock model approach, where historic catches have been taken from an "inshore" substock only, and there is diffusive mixing between this "inshore" and the "offshore" substock (in the 2-substock model). CPUE data reflect the behaviour of the "inshore" substock only, whereas sightings estimates relate to the combination of all substocks. This age-aggregated models allows both MSYR and the inter-substock mixing rates to be estimated, and provides an acceptable fit to all 3 sources of data. Under such analyses, the resource as a whole is estimated to be close to its pre-exploitation abundance. The precise status of the inshore substock differs depending on which of 2 forms of density dependence is assumed for the model, but in either event is estimated to be above MSY level.

Gunnlaugsson extended the 2-substock model by including the existing mark recapture data. Differences had been observed in the rate of recovery of marks applied on the whaling grounds west of Iceland compared to those from East Iceland and East Greenland. In addition there were obvious differences in the mark returns by sex and area. Therefore, the model was sex disaggregated. The model was also expanded from 2 to 4 components for consistency with the marking data. The main results of the analysis are that the higher proportion of females than males in the catch on the grounds is maintained by a higher rate of mixing of females among substock components so that females are more readily replenished, rather than by a heavy selection for larger animals by the whalers. The stochastic runs showed an annual catch of 200 animals over the next two decades from the whaling grounds west of Iceland to be sustainable with high probability.

The Working Group noted that the more complex models involving 2 or more spatial components appeared to 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.

Faroes

As described above, 2 independent analyses were available for Faroese fin whales. These analyses were conducted over a range of assumptions concerning the geographical extent of the resource and the past catches taken from it. The Working Group noted that the results from both modelling efforts were qualitatively and quantitatively very similar. Both indicated that the fin whale stock around the Faroes was heavily depleted under most plausible scenarios about the size and extent of the stock area from which catches were taken. Under some of these stock scenarios even catches as low as 5 animals per year slow or halt the recovery of the stock, and higher catches result in further depletion in nearly all cases. The exception was the "Faroese South" stock area, which linked whales around the Faroes with the relatively large stock off the Iberian peninsula, but the Working Group considered that more evidence was needed before this scenario could form the basis of management advice.

Other

The Working Group considered that the availability of abundance estimates from NASS-1995 and the development of abundance estimates from more recent Norwegian surveys for fin whales in the Northeast Atlantic will make the assessment of fin whales in this area feasible. A careful examination and compilation of available data, including catch data, incidental sightings, Discovery tag markings and genetic sampling, is needed before such an assessment is conducted. In addition the boundary used in this assessment between the Faroe Islands-West-Norway stock and the British-Spain-Portugal stock (as defined in the IWC Schedule) should probably be moved southwards as this does not seem to be in accordance with historical catch distribution or more recent distributional data.

Management recommendations

EGI

Because of the inability of models which treat the EGI fin whale stock as homogeneous to fit all sources of abundance-related data satisfactorily, the Working Group decided to base management advice on the 2-substock model which does fit such data. Projections under constant catch levels suggest that the inshore substock will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales for either assumption concerning the form of density dependence. It is important to note that this result is based upon the assumption that catches are confined to the "inshore" substock, *i.e.* to the grounds from which fin whales have been taken traditionally. If catches were spread more widely, so that the "offshore" substock was also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

Faroes

The new information on abundance from NASS-2001 and the updated catch history available for the Faroes did not greatly change the conclusion reached in 2000 (NAMMCO 2001), that the fin whale stock around the Faroes was likely to be heavily depleted under most stock scenarios considered plausible. The uncertainties about stock identity are so great as to preclude carrying out a reliable assessment of the status of fin whales in Faroese waters, and thus the Working Group was not in a position to provide advice on the effects of various catches. It may also 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.

Research recommendations

The Scientific Committee noted that a stock assessment of the EGI could be completed with the information available whereas the assessment of the Faroes stock could not be completed due to lack of information on stock delineation and for North Norway the main obstacle was the lack of recent abundance estimates (after 1995). In light of this it was recommended that the following research should be initiated for the 3 stock areas.

Faroes

- The revision of catch statistics for Faroese and adjacent whaling operations should be completed;
- The feasibility of preparing a CPUE index from Faroese and adjacent whaling operations should be investigated;
- Biopsy sampling for genetic analysis from the Faroes and adjacent areas should be continued. Existing biopsy samples should be analysed as soon as possible.
- Satellite tracking should continue.

EGI

- The early CPUE series (1901-1915) should be reanalysed and split between eastern and western Icelandic whaling areas. The possibility of using data prior to 1901 should be investigated;
- 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;
- Existing analyses of data on biological parameters from previous commercial and research whaling should be published;
- Satellite tracking should be attempted to investigate the movements of fin whales, particularly between the traditional whaling grounds west of Iceland and areas outside.

Analyses indicate that fin whales are not homogeneously distributed in the conventional EGI stock area with respect to age, sex and behaviour. To facilitate the development of spatially structured models to better represent the overall dynamics, it was recommended that all data (catch, effort, catch-at-age, sightings survey abundance and mark-recapture) be split into 4 subareas as described in the Working Group Report.

<u>North Norway</u>
- Preparation of abundance estimates from the 1996-2001 survey series;
- Compilation and revision of catch statistics;
- Preparation of a CPUE series;
- Collection of additional biopsy samples for genetic analysis, and analysis of existing samples;
- Satellite tracking should continue.

General discussion
The Scientific Committee endorsed the management advice and recommendations for research put forward by the Working Group.

The Scientific Committee appreciated the recommendations of the Working Group toward an update of the spatially structured models in order to aim for a better reconciliation of the different data sources for EGI fin whales. The Committee furthermore recommended a sensitivity test based on alternative hypotheses, for example changing carrying capacity or inertial dynamics with an additional layer of density dependence that operates on intrinsic life history parameters. It was also noted that the data on trends in the age at sexual maturity for fin whales harvested by Iceland had not been compared to the model runs, and suggested that such comparisons be conducted because they may help to clarify whether the different model hypotheses are likely to reflect the true dynamics of the stock/s.

9.6.2 Future work
The Scientific Committee considered that the scheduling of future assessment meetings should be dependent on the completion of additional research and necessary preparatory work, as noted above. The next meeting will concentrate on assessment in the Northeast Atlantic (North and West Norway stocks), and on further development of assessments for the EGI and Faroes areas.

9.7 Minke whales
9.7.1 Update on progress
The Report of the Working Group on Minke and Fin Whales (Annex 1) was considered under this item. The NAMMCO Scientific Committee carried out an assessment of the Central North Atlantic stock of minke whales in 1998 (NAMMCO 1999). The Committee concluded then that the stock was close to its carrying capacity, and that present removals would not adversely affect the stock. Similar conclusions were reached when the analysis was restricted to the feeding stock in the coastal waters of Iceland, the CIC small area. Since that time, more information has become available on the stock delineation of minke whales in the North Atlantic. New abundance estimates are available for the Central Stock area from NASS-2001, and for the Northeast Atlantic from Norwegian surveys conducted from 1996-2001. Therefore in 2002, the Council of NAMMCO requested that the Scientific Committee complete a new assessment of Central North Atlantic minke whales.

Stock structure
The IWC Scientific Working Group on North Atlantic Minke Whales RMP Implementation Review (IWC in press) reviewed an extensive analysis of population structure using samples from Norwegian commercial catches. Over 3000 samples were analyzed using both mitochondrial and microsatellite DNA markers. Both conventional hypothesis testing and the Boundary Rank method, which does not require an *a priori* assignation into stock areas, were used. Both approaches indicated that animals from the CM Small Area were different from those from the Eastern Medium Area (Annex 1 Fig. 1) using mitochondrial markers. Boundary Rank suggested a difference within the CM Small Area, but this difference was not significant using a hypothesis testing approach. Both approaches also indicated the existence of a separate sub stock in the North Sea.

Another recent analysis using mitochondrial and microsatellite DNA sampled from a wider area including East and West Greenland (Andersen *et al.* 2003) also supports the conclusion that animals from the Central Area (East Greenland and CM in this case) are different than those from the Northeast Atlantic and the North Sea.

The Working Group concluded that for the purposes of assessment, the existence of a separate Central Stock of minke whales was supported by the available evidence. However there may be sub-structure within this area. While there is no data to support the existence of a separate stock in the CIC Small Area, most catching by Iceland has historically occurred here so it made sense to consider this as a separate area for precautionary sensitivity tests.

Biological parameters
No new information on biological parameters had been published since the last review of this stock in 1998 (NAMMCO 1999). However recent work (Olsen 2002) had demonstrated that age estimates based on counting annulae in *tympanic bullae* were not reliable. Therefore any biological parameters that included age as a component (*e.g.* age at maturity, mortality, survival) must now be considered suspect. Other ageing methods, especially based on the racemisation of amino acids in the eye lens, were being developed but had not yet been widely applied. The Working Group nevertheless decided to use the estimates of parameters used in the previous assessment, as they are unlikely to differ greatly from those for the Antarctic minke whale for which valid ageing methods are available. It was also noted that the assessment models used were relatively insensitive to variations in these parameters within a plausible range.

Catch data
The catch series used in assessments were the same as that used in the 1998 assessment, with the addition of more recent catches by Norway in the CM Small Area and by East Greenland. A "High Catch" case was also developed which included assumed maximum annual levels of both bycatch (5) and unreported catch (10 per annum from 1986-2002) in Icelandic waters.

Abundance estimates
New abundance estimates available to the Working Group included:

- NASS-2001 and NASS-1987 aerial surveys covering coastal Iceland (CIC small area). The estimate from 1995 is considered biased to an unknown direction and extent and was not used;
- NASS-2001 shipboard survey, considered to be negatively biased because of animals missed on the trackline and diving animals.

Other estimates were the same as those used in previous assessments.

Assessments
Two independent assessments were available for minke whales, one using the HITTER/FITTER program as used in the previous assessment of this stock, and the other using a Bayesian methodology. In the

HITTER runs population trajectories were computed for different assumed levels of productivity rates for the resource (designated by MSY rates – $MSYR^{1+}$) that pass through a given abundance in a recent year. The abundance was set to the inverse variance-weighted average of the available abundance estimates, and the year taken as the average of the years in which the associated surveys took place. Trajectories were computed for $MSYR^{1+}$ values of 1, 2 and 4%, and also projected forward for 20 years under different fixed levels of future catch. Exploratory FITTER analyses, which attempt to estimate the value of MSYR by matching the trends in population trajectories to those of a series of survey results, were also carried out. However the results are not yet regarded as reliable because only a few survey estimates are available to date from which to estimate trend. The Bayesian analysis used available catch series and abundance estimates in an age- and sex-structured model to perform an assessment of Central North Atlantic (C) and CIC minke whales.

The results from both analytical approaches indicated that the Central Stock of minke whales has not been appreciably impacted by past whaling, having a current abundance of mature females that is at least 85% of the corresponding pre-exploitation level. This result holds regardless of whether the CIC area is treated as an isolated stock, and across a wide range of assumptions concerning past catches, stock boundaries, MSYR values and abundance estimates.

Management recommendations
Projections over the next 20 years using HITTER indicate that, under all scenarios considered, a catch of 200 minke whales per year would maintain the mature component of the population above 80% of its pre-exploitation level over that period. Similarly, a catch of 400 per year would maintain the population above 70% of this level. This constitutes precautionary advice, as these results hold even for the most pessimistic combination of the lowest MSYR and current abundance, and the highest extent of past catches considered plausible. The advice applies to either the CIC Small Area (coastal Iceland), or to the Central Stock as a whole.

Research recommendations
- Further genetic sampling, particularly from Icelandic waters, East and West Greenland, and the Faroes. Analyses should use the same markers and methodologies as used by Norway so the datasets will be comparable.
- Development of valid ageing methods for North Atlantic minkes, using amino acid racemisation in the eye lens or other techniques. Use of the number of *corpora albicantia* in females as a proxy for age in estimating biological parameters should be investigated.
- Further satellite tracking to investigate spatial and temporal distribution in all areas.

General discussion
The Scientific Committee endorsed the management advice and research recommendations put forward by the Working Group.

9.7.2 Future work
It was considered that further assessment work was not required until more information on stock delineation, distribution, abundance and biological parameters becomes available.

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

9.8.1 Update on progress
The Council has asked the Scientific Committee to carry out assessments of these species, but to date insufficient information has been available on stock delineation, distribution, abundance and biological parameters to initiate the work. This year a series of working papers from the Faroes reported on research in progress on white sided dolphins (SC/11/16-19).

Sampling has been carried out on 32 pods taken in drive fisheries between 1986 and 2003. Annual catches ranged from 0 to 744 (average 156) between 1872-2003, and the size of pods taken in drive fisheries has averaged 60 (SC/11/16). Catches have been taken throughout the year but peaked between July-November. Males are larger than females (SC/11/18). Animals of all ages up to 27 years were caught, but fewer than expected juveniles (4-8 years) were present in the catches. The sex ratio of 1.3 favoured males. No pregnant females were taken. Sexual maturity appears to occur at age 6-7 in both sexes. A preliminary analysis of stomach contents from 3 pods indicated that the diet was dominated by small pelagic fish, especially blue whiting and Norway pout (SC/11/17). Genetic analyses are underway but have not been completed (SC/11/19).

Ólafsdóttir reported that little progress had been made in analysing samples from white beaked dolphins collected from bycatch in Iceland. A report on the distribution and abundance of dolphins from the 4 aerial surveys carried out around Iceland between 1986 and 2001 is nearly complete, and further information on distribution is available from the NASS ship surveys. As yet no reliable information is available on bycatch of these species in Iceland.

Haug informed the Committee that Norway will begin a sampling program focussing on white beaked dolphins in 2004, involving biopsy sampling for genetic and fatty acid analyses, and satellite tracking.

9.8.2 Future work

Considerable progress has been made in the Faroes in describing the ecology and life history of white sided dolphins. Some analytical work remains to be completed and sampling will continue. The Committee was informed that satellite tracking will be attempted in the coming years in the Faroes, and that information on white beaked dolphins should be available from Iceland and Norway in about 2 years time. Abundance estimates are lacking in all areas except Icelandic coastal waters, and no information on stock delineation or pod structure is yet available. The SCANS survey planned for 2005/6 and coastal surveys planned for Norway (see 9.3) should provide information on distribution and abundance in some areas. At this point the Scientific Committee considered 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 the above-mentioned studies have been completed, probably by 2007.

9.9 Grey seals

9.9.1 Update on progress

In 2001 the Scientific Committee noted that the abundance of grey seals around Iceland had decreased from an estimated 12,000 in 1992 to 6,000 in 1998, and that the annual catch of around 500 seals may not be sustainable. In contrast there have been apparent increases in the abundance of grey seals in other areas, including Southwest Norway, the United Kingdom and Canada. Grey seals are harvested or taken incidentally by fisheries and aquaculture operations in the Faroe Islands, Iceland and Norway. Subsequently the Scientific Committee was asked to provide a new assessment of grey seal stocks throughout the North Atlantic.

The Scientific Committee formed a Working Group on Grey Seals, chaired by Kjell Nilssen, which met in Reykjavik in April 2003 (Annex 2). The general terms of reference of the Working Group were:

- to assess the status of greys seals around Iceland, the UK, the Faroes, Norway, the Russian Federation, the Baltic, Canada and other areas;
- survey methods;
- stock delineation (genetics, temporal and geographical distribution);
- recommendations to the NAMMCO Council.

Iceland

The population status of the Icelandic grey seal, which has been investigated in the years of 1982, 1986, 1989, 1990, 1992, 1995, 1998 and 2002 by aerial census of grey seals pups on breeding sites. The Icelandic grey seal population appeared stable between 1982 and 1990, but since then, the pup-production has been declining by about 6% (95% CI 3% to 9%) annually. The abundance of the grey seals around

Iceland in the year 2002 was about 5,000 animals. In the first census in 1982, the population was estimated at about 9,000 and 1990 it reached a maximum of about 12,000 animals. Grey seals are distributed all around the Icelandic coast. Recently following the decrease in population size, its distribution has contracted and it is now not found off the northeast coast, where some breeding occurred about 10 years ago. There is very little evidence for the Icelandic grey seal stock mixing with other grey seal stocks in the North Atlantic.

The Working Group noted that it was obvious that harvests had been above sustainable levels for more than 10 years, and that the resulting decline in the population was well documented. While no management objectives have been identified explicitly, it is apparent that the implicit objective has been to reduce the stock to some undeclared level. There is an urgent need to identify clear and explicit limits for the stock and to regulate the level of harvest accordingly. If exploitation is continued at its present rate, it is likely that the population will be reduced to very low levels, and likely extirpated in many areas, within the next 10 years. The Working Group cautioned that, because the stock has been reduced and is still apparently declining, increased survey and monitoring effort will be required in the future. Once a limit value for the stock has been identified, surveys may have to be carried out more frequently and with higher effort in order to have an acceptable probability of detecting a further decline in population.

<u>Research recommendations</u>
The Icelandic population is small and declining. Improved and more frequent surveys are urgently required to monitor the trend in the population and ensure that further declines can be detected in time for management action to be taken. Specific recommendations include:

1. If aerial surveys are used, a minimum of 3 surveys per site within the breeding season are required. An alternative might be to combine a single aerial count with a ground survey with staging, or to use ground counts on the larger colonies.
2. A power analysis should be conducted using past data to determine what frequency of surveys is required to reliably monitor trends in the population. If clear management objectives are established for the stock, the power analysis can be used to determine the level of survey effort required to determine if the population has reached a threshold value, with a given degree of certainty.
3. Harvesting, S/L and bycatch data should be directly included in the population model used to calculate the factor to convert pup counts to 1+ numbers.

Management recommendations
The observed decline and continued exploitation of this stock was of great concern. If present trends continue the stock will be reduced to very low levels. The Working Group recommended the immediate establishment of management objectives and conservation reference limits for this stock as an urgent priority. Survey frequency and intensity should be increased to facilitate monitoring of the trend in the population. A formal assessment of the effect of present 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.

Faroes
Based on historical sources, there seems to have been a long tradition for harvesting grey seals in the islands, mainly at breeding grounds. Grey seals in the Faroes mainly breed in caves, which is exceptional for the species. This may explain why biological investigations not have been initiated on grey seals in Faroese waters: as a result biological knowledge is limited and certainly insufficient. No management regime has been implemented. Today, the only take occurs in defence of fish farms. Catch statistics are not available, but from direct contact with fish farmers, the catch in 2001 was estimated to be in the order of 250 to 500 seals, which seems surprisingly high for the population. Present population size is unknown. No tagging experiments have been conducted on Faroese grey seals, but such studies on neighbouring populations have indicated that the annual number of British grey seals migrating into Faroese waters may be significant.

The Working Group expressed concern that the Faroese grey seal population is subject to an apparently high but unknown level of exploitation, and that this exploitation has developed rather recently since the advent of fish farming activities. Unlike the historical harvest, which targeted seals in their breeding caves, salmon farmers take seals in open water. The inaccessibility of some breeding caves therefore no longer provides protection against depletion of the local breeding population. The abundance of breeding and migrant seals in the area is unknown. However it was considered that the number of seals breeding in the Faroes is unlikely to be large because breeding habitat is limited. Therefore, even if the human take includes a large proportion of migrant animals, the local population might still be subject to depletion.

The Working Group therefore 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.

Research recommendations

1. Further basic research is required before surveys are attempted in the Faroes, especially documentation of all used and potential pupping sites. The cave breeding habit of Faroese grey seals will require non-standard survey methods, perhaps including diving and the use of automated camera systems.
2. Genetic studies to investigate the stock identities of grey seals in Faroese waters, and their association with those in adjacent waters, are required. This could be part of the proposed North Atlantic study (see below).
3. Better data on removals is required. This could be achieved by implementing mandatory logbooks for seal hunters; in order to monitor the harvest level.
4. Studies on life-history parameters are required, based on samples from the catch or other sources.

Management recommendations

For this area better information on the level of catch, both direct and as bycatch, is required. There is no information on stock identity or abundance on which to base management advice, and research programs to get this information have been recommended (see above). Nevertheless, the relatively high level of take, combined with the likely small size of the population, suggests that a precautionary approach is warranted.

Norway

Preliminary results from grey seal ship based surveys along the Norwegian coast in 2000-2002, and how these compared with results from 1996-1998, were presented. Most of the grey seal whelping areas from Rogaland county to Finnmark county were investigated. Seal pups were observed from an inflatable boat, after which researchers landed where pups were observed. When possible, pups were caught, tagged, and developmental stage was recorded. In some cases only developmental stage was recorded. Total population estimates were derived from estimates of pups by using a range of multipliers (4.28 and 5.35). When results from aerial surveys conducted in 1998 in northern parts of Nordland and Troms are combined with the estimates from the 2000-2002 study, the number of pups born in Norwegian waters are calculated to be about 1,030, which corresponds to about 4,400-5,500 seals (1+).

Total annual catches of grey seals in Norwegian waters ranged from 34-176 animals in 1997-2002, which corresponds to 13%-49% of the scientifically based recommended quotas(which are 5% of the estimated population size), and 11%-35% of the given quotas. There are no catch statistics available prior to 1997.

In areas with particular conflicts between grey seals and fisheries, Norwegian management authorities have occasionally attempted to use hunting to control population growth and population size by increasing the recommended quotas by 20%-30%. When quotas were set for the 2003 season this approach was taken a large step further in that the quotas in most areas were set at 25% of current population estimate. Also, a bounty of NOK 500 is to be awarded for each grey seal documented killed.

In discussion the Working Group noted that the new quota levels of 25% of the estimated population size would, if taken, certainly result in population reduction. However no formal analysis of the effect of this level of harvest on the population, including the risk of extinction the sensitivity of the survey program to detect a population decline, has been conducted. While harvests have been considerably below quota levels to date, the possibility that the quotas might be filled should be considered, especially now that a bounty system is in place.

It is likely that some proportion of the animals shot are killed but not landed. This proportion of shot but lost (S/L) animals has been observed to be up to 50% in some areas, because many seals sink when they are shot, depending on their condition and the water salinity. As the quotas are based on landed animals, the actual anthropogenic take is likely to be considerably higher than the reported harvest. The Working Group recommended that a study be carried out to determine S/L rates in different areas, seasons and under different conditions.

There is some indication from tag returns that bycatch, particularly of young seals, in bottom set gill nets may be considerable in this area. This source of mortality must also be included in any assessment of the population.

<u>Research recommendations</u>
The vessel-based surveys conducted from 2000-2002 have provided good information on the location and approximate size of breeding colonies along the Norwegian coast. This information can be used to develop a survey design that will provide more reliable estimates of seal abundance in the area.

1. Regular surveys are required to determine trends in the population. Power analysis should be used to determine the survey interval and level of effort required. However, as in the Icelandic case, clear management objectives from the Norwegian authorities would be helpful in specifying the survey requirements.
2. The possibility of using repeated aerial surveys, at least in areas to the south of Lofoten, should be further explored. In northern areas, the lack of light during the breeding season may preclude the use of aerial survey. In these areas ground-based surveys with staging could be used. The possibility of using aerial infrared camera surveys in these areas should be investigated.
3. It will be desirable to co-ordinate surveys efforts in Finnmark with those along the Murman coast in the Russian Federation.
4. A more complete sampling program from the hunt should be established, including the collection of reproductive tracts and genetic samples.

<u>Management recommendations</u>
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. It will be necessary to increase the intensity and frequency of surveys in the area if higher levels of exploitation are realised, in order to have a realistic probability of detecting a decline in the population within a time scale relevant to management.

United Kingdom
British grey seals are monitored using a 2 stage process. Firstly pup production is estimated at most of the major breeding colonies, accounting for approximately 85% of pups born in Britain. Then the total pup production is used to obtain estimates of total grey seal population aged one year and over.

Pup production is determined annually using a series (4 to 7) of aerial photographic surveys, carried out at 10-13 day intervals over 40 primary breeding colonies. A 40 year time series of pup production estimates for the majority of the British grey seal colonies is available. The most reliable time series of estimates covers the period from 1984 to 2001. The average annual rate of increase between 1984 and 1999 was 6.3% ±0.26%. Observed trends in pup production varied locally and regionally. Total pup production for the west coast of Scotland increased more slowly than at colonies in Orkney and on the North Sea coast. All of the increase on the west coast of Scotland was the result of changes at one group of islands: the Monach Isles.

The annual estimates of pup production can be used to update, each year, a trajectory of total population size estimates, with associated levels of uncertainty. Simulation models are used to approximate the likelihood function for all the data combined and hence provide maximum likelihood estimates for the demographic parameters, female population size and other statistics of the population that are not directly observable. The simulation models allow for measurement error and random variation in juvenile survival and recruitment. If these stochastic processes are assumed to be stationary the 95% confidence limits on estimates of female population size over the last 15 years are in the range ±15% to 20%. The estimate for the total number of females alive just before the 1999 breeding season is 63,000 (95% CI 54,000 to 73,000). The point estimate for females and males is 109,000. These figures refer to seals associated with the annually monitored colonies, which hold over 85% of the British population.

Recent declines in pup production estimates from the surveys suggest one or more of the demographic parameters may be exhibiting some trend over time as well as year to year variation. The available data do not provide evidence for this, significant at the 95% level. However, the fact that such trends can have a large effect on the total population size estimate increases the real level of uncertainty beyond that derived under the stationary assumption.

The reasons for the rapid population expansion in many areas of Scotland since 1960 are uncertain. There has been little harvest of this population since early in the 20th century. Some culling was carried out in the 1970's and 1980's, and this may have had the unintended effect of forcing females to found new pupping colonies, thus expanding the breeding habitat of the population. In addition, the human occupation of the isolated outer islands has decreased over the past 50 years, allowing the development of breeding colonies on these islands.

Baltic

This population is recovering after a century of bounty hunting and 3 decades of low fertility rates caused by environmental pollution. The growing population has led to increased interactions with the fishery, and demands have increased for the re-introduction of hunt. A demographic analysis and a risk assessment of the population has been carried out to make recommendations on how to decrease the risk of quasi- extinction (i.e. reduction below a threshold level) by overexploitation. Although hunting increases the risk of quasi-extinction, the risk can be significantly reduced by the choice of a cautious hunting regime. The least hazardous regimes allow no hunting below a 'security level' in population size. Obviously, to implement such a hunting regime knowledge of the population size and growth rate are required. With the current survey methodology, it would take more than 9 years to detect a 5% change in the annual rate of population increase. A hunt exceeding 300 females (less than 600 of both sexes) increases the risk for quasi- extinction substantially. The age and sex composition of killed animals influences the 'cost of the hunt'.

The Baltic population is severely depleted relative to historical levels. The estimate of pre-exploitation population size is based on information from the commercial and bounty harvests, when hunters were required to return a lower jaw to win the bounty. The former population size has been back-calculated based on historical harvests and more recent estimates of absolute population size. At present there seem to be no signs of density dependence in the population. However there have been radical changes in the Baltic Sea environment, due to the effects of fishing, depletion of other seal species, environmental pollution and possibly climate change, so there wais no reason to expect that carrying capacity would be the same as historical levels. Nevertheless there appears to be room for expansion of this population.

Even with annual estimates of abundance a considerable period of time might pass before a negative population trend could be reliably detected. Other triggers for management action, such as local depletion or changes in spatial distribution, might also be developed. However it was noted that the distribution of Baltic grey seals has changed historically and varies quite dramatically from year to year, partially dependent on ice conditions.

Russia (Murman Coast)
Grey seals on the Murman coast have been protected since 1958 and are included in the Red Data Book of the USSR and the Russian Federation. On the Murman coast grey seals are generally confined to two main breeding areas, the western Aynov (Big and Little Aynov Islands and Big Kiy Island) and the eastern "Seven Islands" (pups are born mainly on Big Litskiy and Veshnyak islands) archipelagos. Most grey seal breeding areas on the Murman coast are included in Kandalaksha Nature Reserve.

Few estimates of the numbers of grey seals inhabiting the Murman coast have been made. Investigations in the early 1960s suggested that about 600 seals inhabited the area at that time. Subsequent studies carried out in 1986 and 1991/92 have indicated that *ca* 850 pups are born in the area, suggesting a population of about 3,500 animals.

Eastern North America - Canada
Northwest Atlantic grey seals form a single stock, but are often considered as two groups, named for the location of the main pupping locales for management purposes. The largest group whelps on Sable Island. The second group, referred to as non-Sable Island or Gulf animals, whelps on the pack ice in the southern Gulf of St. Lawrence, with other smaller groups pupping on small islands in the southern Gulf of St. Lawrence and along the Nova Scotia Eastern Shore. Estimates of pup production in this group have been determined using mark-recapture and aerial survey techniques. Aerial surveys use a combination of reconnaissance surveys to detect whelping patches, visual strip transect techniques to estimate the number of animals on the ice, and corrections to the visual estimates for births that occurred after the survey has been flown. Visual aerial surveys flown during January-February 1996, 1997 and 2000 in the southern Gulf of St Lawrence and along the Eastern Shore resulted in pup production estimates of be 11,110 (6,720-14,540), 5,810 (3,480-8,150) and 5,450 (3,860-7,040) in 1996, 1997 and 2000 respectively after correcting for births and including counts of pups on small islands. Incorporating information on pup production, reproduction rates and removals during government sponsored culling and bounty programs into a population model indicates that the Canadian component of the Northwest Atlantic grey seal population has increased from slightly less than 30,000 animals in 1970 to over 260,000 animals in 2000. The Sable Island and Gulf components of the population have followed very different population trajectories over time owing in part to the greater protection afforded Sable animals and higher mortality rates for Gulf animals whelping on the less stable pack ice. At the same time, differences between the two groups in predicted adult mortality rates suggest that some other mechanisms may be involved. The last complete survey of this population was completed in 1997. Given the rapid growth observed this population, and the significant environmental changes that have occurred over the last 6 years, population projections cannot be considered reliable. A new assessment is needed.

Currently, there is no commercial harvest for grey seals in Canada. A few hundred are taken as part of industry interest in market development. In 2002, the Department of Fisheries and Oceans adopted an Objective Based Fisheries Management approach for seal populations. In 2002, the Department of Fisheries and Oceans adopted an Objective Based Fisheries Management approach for seal populations. This scheme adopts two different approaches based on whether seal populations are considered data rich or data poor. A population is considered data rich if recent estimates of catch levels, reproductive rates and estimates of mortality are available. Under a data rich scenario, two precautionary reference points are established at 70% (N_{70}) and 50% (N_{buffer}) of the largest estimated population size. Management objectives ensure that the population size remains above $N_{70.}$ If harvesting results in a declining population, harvest quotas must be established at a level assuming a much lower risk that the population will continue to decline. If a population continues to decline below a Reference limit point set at 30% below the maximum estimated population size, then it is considered that the population has suffered serious harm and harvesting is discontinued. For a population considered data poor, there is still some discussion concerning the exact approach to establish permissible harvests. Current thinking is leaning towards the use of the Potential Biological Removal (PBR) approach developed in the United States. This approach is extremely conservative, but appears to be suitable in situations where recent population dynamics data are limited. Grey seals are currently considered data poor because the last survey was completed more than five years ago. However, a new survey would result in grey seals being considered data rich.

In discussion the Working Group noted that the Objective Based approach used in Canada has the advantage specifying explicit and easily understood rules for management. It was considered that similar approaches could be applied in Iceland and Norway.

The very rapid growth of the population breeding on Sable Island, along with the recent decline in the ice-breeding Gulf population, raises the possibility that seals are emigrating from the Gulf to Sable Island to breed. There is no direct evidence for this, but such an influx would be difficult to detect given the relative sizes of the populations. It appears that space is not a limiting factor at present on Sable Island, and it is not known when or at what level carrying capacity for this group will be reached.

Eastern North America - USA

Grey seals were historically distributed along the U.S. east coast (from Maine to Connecticut). Native and bounty hunting extirpated the population and they were rarely sighted for most of the 20th century. Seals tagged on Sable Island as pups were observed in New England during the 1980’s and 1990’s. Breeding began in 1988 on Muskeget Island (Massachusetts) and minimum pup production there increased from 4 in 1988 to over 800 in 2002. Two breeding sites were discovered in Maine in 1994. These sites have been surveyed during the breeding season from 1994 to –2002. Minimum pup production was approximately 180 in 2002. The previous years’ surveys have not yet been analysed. The grey seals currently found in New England are probably a mixture of Canadian migrants and animals born locally. Continued surveys, historic research, genetic analysis and fieldwork should provide further insight into this recolonisation event and the current status of grey seals in the U.S.

Recommendations for research applying to all stocks

1. More data on stage durations are required for improved input into models for abundance estimation. Stage durations should be estimated at several sites in each country that uses stage durations as model input. The distributions of stage durations, rather than summary statistics for stage durations, should be provided for model input.
1. There should be an ongoing exchange and verification of samples among laboratories conducting age determination for this species.
2. A North Atlantic wide genetic study of grey seal population structure should be initiated. The study should use the same genetic markers, and laboratory and sampling methods should be standardised to the extent feasible. It was considered that such a study could best be done by co-ordinating the existing studies ongoing in range states including the UK, Norway and Canada.
3. Studies to determine struck and lost rates in different seasons and under different hunting conditions should be carried out in the Faroes, Norway and Iceland. Further information on bycatch mortality of grey seals is required from Norway and Iceland.
4. To monitor changes in grey seal populations, anthropogenic mortality should be incorporated explicitly into population models. These sources of mortality include removals due to harvests corrected for animals killed but not recovered (struck and& loss) and bycatch in commercial fisheries.
5. Satellite tracking experiments should be carried out in the Faroe Islands, Iceland and Norway. The studies should be directed towards determining the movements of animals while at sea, and their habitat use through recording of dive profiles. Such studies will have particular relevance to determining possible interactions with fisheries in the area, but also to possible movements of animals between areas. For the Faroe Islands it may help to determine the proportion of animals that are resident in the area.

General discussion

The Scientific Committee endorsed the management advice and recommendations for research put forward by the Working Group. Víkingsson informed the Committee that the Marine Research Institute in Iceland had assumed more responsibility for research on grey seals. Surveys will be conducted annually at selected breeding colonies in Iceland. Repeated surveys will be flown and ground surveys will be conducted to assess pup staging. Haug noted that the last portion of the Norwegian coastal survey is being conducted and a complete estimate should be available in 2004. No research on grey seals is presently being conducted in the Faroes.

9.9.2 Future work

This Working Group was the first dedicated to grey seals over the entire North Atlantic. Members considered the Working Group very worthwhile in terms of exchange of information about research and management programs in other jurisdictions. The Scientific Committee therefore recommended that it meet again at some point to update the status of all stocks, and possibly to conduct detailed assessments of those stocks for which concern has been expressed.

The possibility of dedicating a volume of NAMMCO Scientific Publications to a North Atlantic-wide overview of this species was considered. Several of the working papers could be published in such a volume, and more might be contributed by other authors. Such a volume would be unique and of value. The Scientific Committee therefore nominated Tore Haug and Droplaug Ólafsdóttir to co-ordinate planning for such a volume and report back to the Scientific Committee with a list of potential papers.

9.10 Humpback whales

9.10.1 Update on progress

The Scientific Committee has previously noted that there is evidence of a rapidly increasing abundance of humpback whales around Iceland, and the Council has recommended that the Scientific Committee complete abundance estimates for this species as a high priority. The Scientific Committee was also asked to consider the results of the "Years of the North Atlantic Humpback" (YoNAH) project as it pertains to member countries in providing advice for this species.

Abundance estimates calculated from the Norwegian NASS-1995 shipboard sightings survey were provided to the Committee (SC/11/MF/10). The survey was conducted with 2 independent platforms on each of 11 vessels. The target species was the minke whale and the survey was designed specifically to get a best estimate of abundance for this species. The survey was run in passing mode, that is, without closing on sightings for species identification or group size confirmation. As a result, more than 30% of the sightings of large whales were not identified to species. The survey covered the Northeastern Atlantic including the North Sea, the Norwegian Sea, the Greenland Sea and the Barents Sea. Estimates were based on standard line transect analyses for each of the survey platforms, and the 2 platforms combined. The sightings of humpback whales were nearly exclusively made in the Bear Island shelf area, which is known to be an important habitat for humpbacks in summer time. Compared to earlier surveys, however, the 1995 distribution was much more focused around Bear Island, as both in 1988 and in 1989 most of the humpback whale observations were made in the Norwegian Sea far west off the continental slope. The abundance estimate for the entire survey area was 1,210 (cv 0.255). Abundance estimates from the NASS around Iceland and the Faroes have been completed and are reported under Item 10.

The abundance of humpbacks in the North Atlantic has been estimated at 10,752 (cv 0.068) for the West Indies breeding population only, and 11,570 (95% CI 10,290-13.390) for the entire North Atlantic (Stevick *et al.* 2003). These estimates, which apply to 1992-93, are derived from the YoNAH project, which used mark recapture analysis of photo-id and biopsy data. The estimates from the NASS in 1995 and 2001 are higher, but these apply only to the survey area around Iceland and the Faroes (and Norway in 1995) (NASS-1995: 15,100 (95% CI 6,500 – 35,100); NASS-2001: 14,300 (95% CI 5,700 – 36,000). The broad confidence limits of the NASS estimates are a result of the uncertainty related to sighting surveys of animals having a highly aggregated distribution. Because of this, there is no significant difference between YoNAH and NASS estimates. However, the YoNAH estimate is said to apply to the entire North Atlantic whereas the NASS estimates apply only to the area around Iceland and the Faroes (and Norway in 1995). Other areas with known concentrations of humpback whales, such as eastern Canada, the Gulf of Maine, and West Greenland, are not included in the NASS estimates. The YoNAH estimate should therefore be considerably larger than the NASS estimates, which apply only to 1 or 2 of potentially 5 feeding areas in the North Atlantic.

The YoNAH estimate for the North Atlantic is negatively biased for at least 2 reasons: animals that do not breed in the West Indies are under-represented; and the area east of Iceland was poorly sampled. This latter area accounted for the bulk of the NASS estimates in 1995 and 2001. Conversely the NASS shipboard estimate from 1995 may be positively biased because of possible double counting, although most other potential biases for the NASS estimates are negative. Nevertheless these biases could not fully account for the apparent difference between the YoNAH and NASS point estimates.

The Scientific Committee concluded that the discrepancy between the NASS and YoNAH estimates suggests that the North Atlantic population of humpback whales is likely considerably larger than estimated in the YoNAH study. Further studies are needed to resolve these differences more fully. In particular, photo-id/biopsy studies need to sample humpback whales in all important habitats around Iceland. It is also recommended that available humpback survey estimates from all feeding aggregations in the North Atlantic should be compiled. For future NASS, consideration should be given to designs suitable for humpback whale feeding aggregations, and to extending the survey coverage.

9.10.2 Future work

The Scientific Committee welcomed the new information from the NASS-95 Norwegian survey and recommended that estimates for large whales from the 1996-2001 survey series be completed in a timely manner. Otherwise the Committee will await further requests from the Council on this species.

9.11 Sperm whales

9.11.1 Update on progress

Abundance estimates for sperm whales from the NASS-95 Norwegian shipboard survey were provided to the Committee (SC/11/MF/10, see ***9.10.1*** for a description of the survey). Most sperm whales were sighted in the Norwegian Sea off the continental slope west of northern Norway. A considerable number of sightings were relatively evenly spread out over most of the Norwegian Sea south of about 73˚ N. Two sightings were made far north of Spitsbergen, which is quite unexpected. The 1995 distribution is relatively similar to the 1989 survey distribution, except that more whales were observed in the southern Norwegian Sea in 1995. The 1988 sperm whale survey distribution showed the same pattern in the northern Norwegian Sea, but in that survey the southern part was not covered. The traditional line transect abundance estimate for the entire survey area was 4,319 animals (cv 0.199) with no correction for diving animals, which is likely to be substantial for this species.

9.11.2 Future work

No advice has been requested for this species and no further work was identified.

10. NORTH ATLANTIC SIGHTINGS SURVEYS

10.1 NASS-2001 and earlier surveys

10.1.1 Report of the Working Group on Abundance Estimates

The Working Group on Abundance Estimates met in St Andrews, UK in March 2003. The fourth North Atlantic Sightings Survey was carried out in June/July 2001. The Working Group was tasked with continuing the evaluation of abundance estimates for target and non-target species, determining if additional analyses are required and recommending estimates for acceptance by the Scientific Committee (Annex 3).

Minke whales

An estimate of the abundance of minke whales form the NASS ship survey around Iceland and the Faroes was presented. This area is exclusive of the aerial survey block around Iceland. Double platform data were available and indicated that *g(0)* was less than 1, however an attempt to apply the double platform hazard probability method to these data was not successful due to the distributional properties of the data. The distribution of perpendicular distances showed a steep decline from the trackline and almost no "shoulder", and a long tail extending out to about 3,000 m from the trackline. This made the estimation of effective strip width (esw) problematic as the estimate was not robust to changes in truncation, binning of distance intervals or model choice. The estimated *esw* was narrower than those seen in previous NASS or other similar surveys. The point estimate of 23,955 (cv 0.30) is higher but not significantly so than the estimate from roughly the same area from the 1995 NASS. The distribution of minke whales differed somewhat between the surveys, with many more sightings in the Faroese block in 2001 than in 1995.

The Working Group examined the distributions of sighting angles, radial and perpendicular distances from the ship survey in an effort to determine the source of the highly peaked detection function, but could not conclusively explain the unusual distributions of radial, and especially perpendicular distances realised in the survey. The Working Group concluded that the detection function was appropriate for these data, and that the abundance estimate should be comparable to earlier surveys. The Working Group recommended that further efforts be made to use the double platform data to estimate bias due to visible whales missed by observers for this species.

Borchers provided new abundance estimates from the NASS aerial surveys around Iceland carried out in 1987 and 2001. Estimates for the 1987 survey were previously reported by Hiby *et al.* (1989) and Borchers *et al.* (1997). The former estimate was corrected for bias due to error in measuring radial distance, while the latter, considerably higher estimate was not. However it was not certain whether the difference between the 2 estimates was due to the measurement error bias or to apparent differences in the datasets analysed.

Maximum likelihood estimators of abundance for cue counting surveys with measurement error were developed and their properties were investigated by simulation. Conventional estimators not corrected for measurement errors were found to be insensitive to low levels of measurement error but increasingly biased as measurement error increased. The new estimators were found to be practically unbiased.

For the 1987 survey estimation using this model yielded an abundance estimate of 19,320 (cv 0.28) animals for the originally designed strata. Using analysis options that make the estimate as comparable as possible to the estimates obtained by Hiby *et al*. (1989), yielded an estimate of 10,700, compared to an estimate of about 9,000 obtained by Hiby *et al*. (1989). Estimates obtained using the same methods as were used by Borchers *et al*. (1997) yielded an abundance estimate of 11,100 – compared to the estimate of over 20,000 obtained by them. This indicates that the main source of this discrepancy was differences in the data used in the two analyses, but these differences are not understood.

For the 2001 survey analysis, measurement error had an estimated cv of only 11% for these data. Simulations show that bias due to errors of this magnitude are negligible. One of the primary observers on this survey detected cues at small radial distances with estimated probability of only around 0.25. Correcting estimates accordingly results in an abundance estimate with very high variance. Two approximately unbiased estimators were presented - one using all data and correcting for missed animals at distance zero, the other using only data from the side of the plane with the more efficient observer. Both methods yield abundance estimates of about 43,000 animals. The estimate using only the more effective observer has greater precision (cv 0.19) than the estimate using both observers (cv 0.32). The estimate using data from the more effective observer was considered preferable, as it was more precise and straightforward in calculation than the estimate using both observers. This estimate was therefore recommended for acceptance by the Scientific Committee.

Both estimates assume a cueing rate for minke whales of 53 surfacings per hour. Sampling variability in this estimated cueing rate has not been accounted for in the variance of the abundance estimate, which therefore is negatively biased.

The apparent inconsistencies in the datasets from the 1987 survey analysed by Hiby *et al.* (1989), Borchers *et al.* (1997) and Borchers (SC/11/AE/4) were troubling, however it seems likely that the dataset analysed by Borchers *et al.* (1997) was corrupted in some way, as the results of the other two analyses are consistent. The new estimate by Borchers (SC/11/AE/4) for 1987 was therefore recommended for acceptance by the Scientific Committee.

<u>Trends in abundance</u>
The estimate from the aerial survey for coastal Iceland in 2001 is more than double that for 1987, however the difference is not significant. The Working Group concluded in 2002, based on line transect analysis of the density of minke whales from the 4 aerial surveys carried out since 1986, that the abundance of minke whales around Iceland has been stable or shown a moderate increase over the period. This conclusion remained unchanged.

The results from the NASS series indicate an increase in minke whale abundance to the south of Iceland and around the Faroes from 1995 to 2001. There seems also to have been a decrease in the abundance of minke whales in the Barents Sea, the Norwegian Sea and the North Sea in the same period. These changes in spatial distribution are not statistically significant, but might indicate a shift towards more southern and central Atlantic waters in the Central and Eastern Stocks of minke whales.

Humpback whales
Burt *et al.* (SC/11/AE/7) presented estimates of humpback whale abundance from the 1995 and 2001 Icelandic and Faroese surveys. The data were analysed using the “count” variant of the methodology of Hedley *et al.* (1999). The effort data was divided into small segments, over which covariates were assumed not to vary, and the number of sightings within each segment was estimated. This number formed the response variable and locational variables were used as explanatory variables in a generalised additive model (GAM). A school density surface was obtained by predicting over a grid of the whole survey region and abundance was then estimated by integrating under the surface. Data from these surveys were analysed separately, and results were compared in regions of overlap. The estimated abundance for the region covered by the aerial surveys was 950 (cv 0.37) in 1995 and 3,371 (cv 0.79) in 2001. The estimated abundance of humpback whales from the shipboard surveys was 22,305 (cv 0.59) in 1995 and 14,259 (cv 0.50) in 2001. A calibration factor to make the aerial and shipboard abundance estimates compatible was calculated using data from the areas of overlap between the respective shipboard and aerial surveys. Using this calibration factor, the estimated abundance from the aerial survey was 15,270 in 1995, and 9,920 in 2001.

The high variance of the GAM bootstraps in both the aerial and shipboard surveys was a disappointment to the Working Group which had hoped the use of spatial covariates would increase the precision of the abundance estimates. The major reason suggested for this was that the main variables determining humpback distribution are probably not location and depth, so that spatial models using these variables alone have limited ability to reduce variance. The aerial and shipboard surveys were not integrated into a single spatial model, which would have reduced the variances of the estimates..

<u>Trends in abundance</u>
In 2002 the Working Group reviewed an analysis of the trend in encounter rate over the course of the 4 Icelandic aerial surveys carried out since 1986 which showed an increase of 11.4% (SE 2.1%) per year over the period in the survey area. This rate of increase is in accordance with that of 11.6% over the period 1970 to 1988 in recorded sightings humpback whales by whalers operating west of Iceland reported by Sigurjónsson and Gunnlaugsson (1990). The total estimates from the spatial analyses of the

1995 and 2001 surveys do not reveal a trend over the period, but they are much higher than estimates from earlier surveys. All available evidence indicates that the abundance of humpback whales around Iceland has increased since 1987.

Fin whales

Pike *et al.* (SC/11/AE/8) reported revisions to the estimates of fin whale abundance in the Faroese and Icelandic blocks reported by Gunnlaugsson *et al.* (2002). The new estimates use estimates of *esw* adjusted for the vessel covariate at the stratum level. This should result in somewhat more accurate block estimates, as most blocks were surveyed by only one vessel. In addition a bootstrap estimate of variance was used in the new estimates. The revised total estimate is virtually identical to that reported by Gunnlaugsson *et al.* (2002), however the block estimates differ slightly.

The Working Group noted that the new stratum estimates, while having slightly lower precision than those presented last year, should be more accurate, and recommended their acceptance by the Scientific Committee.

Dolphins

Pike reported that an analysis of *Lagenorhyncus* spp.. dolphin abundance from the Icelandic aerial surveys conducted since 1986 was in progress. The Working Group reiterated its conclusions from previous meetings, that while an analysis of the shipboard dolphin data from the Icelandic 2001 and earlier surveys is feasible, the problems of uncertain species identification, uncertain group size estimation, and possible responsive movement of these species would present significant problems for abundance estimation. As a first step, the data should be closely inspected to determine if further analyses are likely to be useful.

Pilot whales

Pike *et al.* (SC/11/AE/10) provided abundance estimates, uncorrected for availability or perception biases, for pilot whales from the Faroese and Icelandic shipboard components of NASS-2001. The estimate was derived using conventional line transect methods. The total estimate for the Faroese and Icelandic blocks of 65,315 (cv 0.39) is considerably but not significantly lower than estimates for comparable areas from NASS 1987, 1989 and 1995. The estimated *esw* was higher for this survey than for most previous surveys. If it is positively biased then the abundance estimate is negatively biased.

The Working Group noted that pilot whales had not been a target species for the 2001 survey. The estimation of group size and the discrimination of sub-groups are problematic for this species and require specialised methods that were not implemented fully in the 2001 survey. It was also suggested that there were probably differences in operational procedures between vessels. More importantly, there was no coverage in areas to the south of Iceland and the Faroes that are known from previous surveys to have relatively high densities of pilot whales. The Working Group concluded that a survey targeting this species requires a different spatial coverage and special field methods that were not used in 2001. The estimate is therefore not representative of the numbers in the Northeast Atlantic and should not be used for assessment purposes.

Bottlenose whales

Pike *et al.* (SC/11/AE/11) provided abundance estimates for northern bottlenose whales from the shipboard components of NASS 1995 and 2001. There were not enough sightings in the 1995 survey to reasonably estimate the detection function. Therefore sightings from both surveys were combined for the purpose of estimating a single detection function. This was considered reasonable because the same basic field methods, and some of the same vessels and observers were used in both surveys. A separate analysis was also done for the 2001 survey, using only sightings from that survey to estimate the detection function. Double platform data was available for the 2001 survey, and from the Faroese block in 1995, but was not used here for bias correction.

Distribution was similar in the two surveys, however more sightings were made to the northeast of Iceland in 2001 than in 1995. Most sightings were made in the Faroese block in both years. The estimates for the two surveys were almost identical although the 1995 estimate was much less precise. The estimate for 2001 using data from both surveys to estimate the detection function was similar to that using only data from that year. The uncorrected estimates from 1995 (27,900, cv 0.67) and 2001 (28,000, cv 0.22) are significantly higher than the uncorrected estimate from the 1987 survey of 5,800 (cv 0.15) (NAMMCO 1995). These estimates are negatively biased due to whales missed by observers and whales that were diving as the vessels passed. The latter bias is likely severe for this long-diving species. In addition neither survey covered the entire summer range of the species, which extends farther south of Iceland and the Faroes at this time of year.

The Working Group concurred with the authors that bias due to diving animals being missed was likely severe for this species. Bias due to animals on the surface being missed was likely of less significance as this species frequently occurs in groups that are easy to see at short distances. It was suggested that bounds on the bias due to diving whales being missed could be estimated from recent radio tracking experiments on 2 whales off Eastern Canada (Hooker and Baird 1999). Based on these data a correction factor for this bias is unlikely to be greater than 3. However these data may not be applicable as they were collected from only 2 animals and in another part of the Atlantic. The Working Group recommended that telemetry studies be conducted on this species, both to further elucidate migratory patterns and stock structure, and to obtain data on diving to be used for determining correction factors for survey data.

Blue whales

Pike *et al.* (SC/11/AE/12) provided estimates of blue whale abundance from the NASS-1995 and 2001 shipboard surveys around Iceland and the Faroes. An insufficient number of sightings were made in either survey to reliably estimate the detection function, so sightings from the 2 surveys were combined for this purpose. Blue whale sightings were recorded in 4 levels of uncertainty of species identification. For this reason 2 estimates were calculated: a "High" estimate including all classes of sightings, and a "Low" estimate excluding the most uncertain classes of sightings.

Blue whales were concentrated to the west and north of Iceland in both surveys. The difference between the HIGH and LOW estimates was not as great as might be expected given the difference in the number of sightings, primarily because sightings with more uncertain species identification tended to be far from the trackline, and therefore their addition had the effect of increasing the effective strip width. The estimates from both surveys are consistent with a population of between 700 and 1,900 blue whales in the survey area. An area of blue whale concentration off western Iceland near the Snæfellsnes Peninsula has not been covered well particularly in the 2001 survey.

Additional analyses to be carried out

The Working Group provided a list of future work to be carried out to refine abundance estimates from the 2001, 1995 and earlier surveys (see Annex 3 Table 2). The Working Group noted with pleasure that estimates had been completed for target species, and preliminary estimates had been completed for most non-target species for which abundance estimation was feasible.

Structuring integrated analyses from all NASS

Table 1 in Annex X provides a first step towards integrating the results of all NASS by providing estimates by species and survey for comparable areas. However some other issues remain to be addressed to improve comparability between surveys. The analytical methods used in estimating abundance for some species from the 1987 and 1989 Faroese and Icelandic ship surveys differed somewhat from those used for later surveys. Some re-analyses may therefore be required for these surveys using a more standardised analytical approach.

Future of the NASS

The first surveys had the major objective of producing a first description of the distribution and abundance of cetaceans over large areas of the North Atlantic. This objective has been in large part fulfilled. Later Norwegian surveys focussed specifically on providing abundance estimates for minke whales for input into their management program. It is necessary to determine the necessity and objectives of continued large-scale integrated cetacean surveys in the North Atlantic, as the nature of the objectives will determine the optimal form of the survey.

For all countries involved in NASS, the main objective now is to provide abundance estimates for target species for input into harvest management programs. For this purpose periodic estimates of absolute abundance are required, and these estimates should be as unbiased and precise as possible, and with quantified uncertainty. A secondary objective will be to provide information on distribution and abundance for research into ecosystem relations, long-term environmental change and fisheries interactions.

Several countries are planning surveys which may offer opportunity for integration into a large-scale survey. Iceland will continue surveys on a 5-6 year rotation, with the next survey tentatively planned for 2006. A new SCANS is being planned for 2005/6, with the offshore portion to be conducted in 2006. The survey will cover the North Sea and adjacent waters, and the North Atlantic EEZ's of all European Union countries. The Faroe Islands is planning a survey of small cetaceans to coincide with the offshore portion of SCANS in 2006. Norway will continue its rotational survey program, but integrate it with other surveys to the extent feasible. Therefore the best opportunity for a future large-scale integrated sightings survey would appear to be in 2006. The Working Group recommended that contacts be made between the organisations planning these surveys in order to integrate them to the extent possible.

A particular problem is the differing target species of the surveys. Experience with NASS suggests that surveys with large whales as target species do not provide adequate data for small whales and dolphins. The Working Group recommended that survey protocols be modified to make them applicable to multiple species, to the extent feasible given the overall objectives of the surveys.

The Working Group considered the idea of conducting “mosaic” type surveys after the Norwegian model, in which a portion of the total survey area is surveyed annually on a rotational basis. Norway has completed a first 6 year rotation and has had a positive experience with this survey mode. The main advantages are logistical, with annual use of equipment and personnel, rather than a more long-term rotation. This allows more continuity in the use of observers, which in turn results in more experienced observers and better-quality data. The main disadvantage is the loss of synoptic coverage in chosen years, and thus for these years the precision would have been better with a synoptic than with a mosaic design. This would indeed be the case if the whole stock is present in the area covered. If, however, there are shifts in the spatial distribution on a large scale (*e.g.* see 5.iv), the true uncertainty in abundance might be higher than the estimated uncertainty in the synoptic survey. In the long run, a well-designed mosaic of frequent partial surveys might provide a better basis for estimating trends in time and space than do infrequent large-scale surveys. The Working Group recommended that this model be considered for application on an international basis over the entire area covered by NASS.

The NASS have provided important information on the distribution and abundance of cetaceans in the North Atlantic that will be useful for many years to come.

General discussion

The Scientific Committee welcomed the new abundance estimates and accepted those recommended by the Working Group.

The Scientific Committee agreed with the conclusion of the Working Group that estimates from the NASS-1995, 1987 and 2001 for pilot whales were likely biased mainly because they did not cover the area occupied by the stock early in the summer. The estimate from NASS-89, which covered areas farther to the south and occurred later in the summer, is still considered the best available for this species. Monitoring of the abundance of this stock is advisable as it is a harvested species, and future surveys should take this into consideration. However it may be possible to derive an abundance index from the other surveys, which covered similar areas at the same time of year, and the Committee recommended that such an index be developed as an interim measure. The SCANS and other coordinated surveys to be conducted in 2005/6 may provide an opportunity to get a new abundance estimate for this species (see 10.1.3).

10.1.2 Future analytical work

The Committee endorsed the recommendations for further analytical work developed by the Working Group (Annex 3, Table 2). Much of this work will be done in the preparation of the new volume of NAMMCO Scientific Publication on the NASS (see 12.1).

10.1.3 Recommendations for future NASS

The NASS have been highly successful in providing important information on the distribution and abundance of cetaceans over a broad area of the North Atlantic. This information becomes more valuable every time a survey is completed, as it provides an indication of trends in abundance over meaningful time periods. The Scientific Committee emphasised the importance of these surveys and recommended that they be continued in some form at regular intervals.

The Scientific Committee concurred with the Working Group that 2006 will be the best year to hold an international sightings survey, in conjunction with the SCANS. Víkingsson informed the Committee that regular surveys in Icelandic waters were planned, and these could be coordinated with other jurisdictions. The Scientific Committee recommended that Iceland, the Faroes, Greenland and Norway make every effort to coordinate their survey activities with other countries into an integrated NASS in 2006. Such co-ordination can occur through this Committee, as has been done in 1995 and 2001.

10.2 Status of publications from previous NASS surveys

See 12.1.

10.3 Establishment of a sightings survey database

The stratification and coverage in the Faroese and Icelandic ship surveys has varied greatly between surveys. Post-stratification into comparable areas would be facilitated by assembling all NASS data into a standardised database format from which spatially bounded sub-sets could be easily extracted. The DESS program used by the IWC is one example of such a program that could be modified for use with the NASS for storing and extracting data. There would be some cost involved in creating such a database and formatting the data for inclusion in it. However, given the costs and effort that have gone into conducting these surveys, the Working Group considered that this would be a good investment that would facilitate the use of these data. The Working Group on Abundance Estimates therefore recommended that such a database be established for the NASS data.

The Scientific Committee agreed that the use of the DESS system would be advantageous in that the system is designed for this purpose and most of the NASS data have already been entered and verified by the IWC, with the exception of the Faroese NASS-95 and 2001 data. However the establishment and maintenance of such a database would be costly in time, effort and money, and would be largely duplicative of the database already held at the IWC Secretariat. The Scientific Committee therefore recommended that the Secretariat investigate the possibility of reaching an agreement with the IWC for access to these data, with the permission of the data owners. It was also recommended that the data from the 1995 and 2001 surveys be integrated into the database.

11. DATA AND ADMINISTRATION

Nothing was identified for discussion under this item.

12. PUBLICATIONS

12.1 NAMMCO Scientific Publications

Five volumes of NAMMCO Scientific Publications have now been published: Vol. 1 *Ringed seals in the North Atlantic*, Vol 2 *Minke whales, harp and hooded seals: Major predators in the North Atlantic ecosystem,* and Vol. 3 *Sealworms in the North Atlantic: Ecology and population dynamics*, Vol. 4 *Belugas in the North Atlantic and the Russian Arctic,* and Vol. 5 *Harbour porpoises in the North Atlantic.* The latter was published late in 2003.

Pike provided an update on Volume 6 on the North Atlantic Sightings Surveys, to be edited by Dr Nils Øien and Pike. The purpose of the volume will be to publish new estimates from the recent NASS (1995 and 2001) which have not been published elsewhere. In addition the volume will integrate the results by species for all NASS, providing information on the trends in distribution and abundance over the period 1987-2001, and looking into the ecological consequences of these observations. It is expected that papers will be received for peer review in April 2004, making publication likely sometime in 2005.

The Working Group on Grey Seals recommended that the Scientific Committee publish a volume on the status of grey seal stocks in the North Atlantic. In addition to the papers developed for the Working Group meeting, other papers could be invited. Haug and Ólafsdóttir agreed to act as editors for the volume, with the possible assistance of others from outside the Committee. They anticipated that the volume could be ready for publication by 2005.

Heide-Jørgensen informed the Committee that the upcoming assessment meeting on narwhal (see 9.4) will produce a wealth of previously unpublished information for that species. He agreed to investigate the possibility of producing a volume on narwhal, but noted that a long delay in publication might render the volume unattractive to potential authors.

The Committee recognised that the production of these volumes involved a significant cost and workload to the Secretariat. Every effort should be made to streamline the publishing process to reduce the workload and the time required to produce the books. It was also recommended that the papers in the volumes be made available on the internet some time after publication. The Secretariat will investigate this possibility.

12.2 Other publications

Under the Rules of Procedure for the Scientific Committee, working papers prepared for the Scientific Committee cannot be distributed without the permission of the working paper author. While supporting this stipulation, the Scientific Committee considered that working papers could be made more readily available to members, and their existence better known to others. It was recommended that the Secretariat investigate the possibility of maintaining a password-protected web site to provide access to all working papers in electronic form to members. In addition, a list of papers could be provided to others, with contact information for obtaining permission from authors.

13. BUDGET

The Scientific Secretary presented a draft budget for the Scientific Committee for 2003. He noted that the budget allocation of the Scientific Committee was utilised for the most part for funding invited experts to participate in Working Group meetings, and for contracted work. The Scientific Committee approved the budget as presented.

14. FUTURE WORK PLANS

14.1 Scientific Committee

The 12th meeting will be held in the Faroes in October at a location and date yet to be determined.

14.2 Working groups

Working Group on the Status of Beluga and Narwhal in the North Atlantic
The Working Group will meet jointly with the Scientific Working Group of the JCNB in February 2004, mainly to deal with narwhal assessments. Dr Øystein Wiig is chairman.

Working Group on Marine Mammal – Fisheries Interactions
The Working Group will meet immediately prior to the Scientific Committee meeting in October 2004 to evaluate new applications of multispecies models and new empirical data on the diet of and consumption by marine mammals. Lars Walløe is chairman.

Satellite Tagging Correspondence Group
The information from satellite tracking studies has been deemed essential to future assessment efforts. The Scientific Committee therefore stressed the necessity for the Satellite Tagging Correspondence Group to complete its task of addressing methodological/technical issues in a timely manner. Bjarni Mikkelsen is chairman. He anticipated that the Group would begin its work early in 2004.

Other working groups may be required depending on requests received from the Council.

15. ELECTION OF OFFICERS

Lars Walløe was elected as Chairman, and Dorete Bloch as Vice Chairman, of the Scientific Committee. The Committee expressed its thanks to Gísli Víkingsson for his able chairmanship over the past 3 years.

16. ANY OTHER BUSINESS

Research takes of minke whales in Iceland in 2003
In 2003 the Marine Research Institute introduced a 2 year plan involving limited takes of minke, fin and sei whales. This plan was discussed earlier this year by the IWC Scientific Committee and Commission. In August 2003 it was decided to implement research takes of minke whales, and 36 were taken before the program ended at the end of September.

The main objective of the program for minke whales is to collect information on feeding ecology for incorporation into multispecies models. Other objectives include investigations on stock structure, parasites, diseases, biological parameters and pollutants.

Whaling was conducted from 3 vessels with catches distributed around Iceland in proportion to the relative abundance observed from sightings surveys. There was a prevalence of males taken (23) and indications of sex segregation in the catching areas. Animals were dissected and sampled onboard the vessels, and a subsample of animals was examined by veterinarians.

At present it is anticipated that the program will continue in 2004 and 2005, with a total take over the period of 200 minke whales.

Oceanographic sampling using satellite tagged belugas around Svalbard
Lydersen demonstrated how large amounts of oceanographic information could be collected and retrieved in a cost-efficient manner using ice-associated marine mammals as carrier of oceanographic sampling equipment. In addition a vast amount of information regarding the habitat of these animals is concomitantly sampled.

Satellite-linked conductivity-temperature-depth (CTD) loggers purpose built by Sea Mammal Research Unit were deployed on wild, free-ranging white whales to study the oceanographic structure of an Arctic fjord (Storfjorden, Svalbard, Norway). The whales dove to the bottom of the fjord routinely during the study and occupied areas with up to 90% ice-cover. During the initial period of freezing in the fjord, over a period of approximately 2 weeks, 540 CTD profiles were successfully transmitted. The data indicate that Storfjorden has a substantial inflow of warm North Atlantic Water (NAW); this is contrary to conventional wisdom that has suggested that it contains only cold Arctic water.

Free-living ringed seals equipped with satellite-relayed data loggers with incorporated oceanographic-quality temperature sensors were used to collect data from a large sector of the northern Barents Sea during the autumn and early winter. A total of 2,346 temperature profiles were collected over a 4-month period from Norwegian and Russian Arctic waters in areas that were at times 90-100% ice-covered. Temperature distributions at different depths from north-eastern parts of Svalbard, Norway, show warm NAW flowing along the continental slope and gradually cooling at all depths as it flows eastwards. The data suggests that most of the cooling takes place west of 30° E. Vertical temperature profiles from the area between Svalbard and Franz Josef Land, Russia, show how the surface water cools during freeze-up and demonstrates a warm water flow, which is probably NAW, coming in from north through a deep trench west of Franz Josef Land.

17. ACCEPTANCE OF REPORT

The Report was accepted on November 27, 2003. The Scientific Committee expressed their thanks for the fine hospitality shown by the Greenland Institute of Natural Resources and the Home Rule Government.

REFERENCES

Andersen, L.W., Born, E.W., Dietz, R., Haug, T., Øien, N. and Bendixen, C. 2003. Genetic population structure of minke whales Balaenoptera acutorostrata from Greenland, the North East Atlantic and the North Sea probably reflects different ecological regions. Mar. Ecol. Prog. Ser. 247:263-280.

Borchers, D.L., McCracken, M., Gunnlaugsson, Th. and Burt, M.L. 1997. Estimates of minke whale abundance from the 1987 and 1995 NASS aerial surveys. SC/5/AE/2 for the NAMMCO Scientific Committee.

Gunnlaugsson, Th., Víkingsson, G.A., Pike, D.G., Desportes, G., Mikkelsen, B. and Bloch, D. 2002. Fin Whale Abundance in the North Atlantic, Estimated from Icelandic and Faroese NASS-2001 Vessel Surveys. SC/10/AE/8 for the NAMMCO Scientific Committee.

Hedley, S.H., Buckland, S.T. and Borchers, D.L. 1999. Spatial modelling from line transect data. *J. Cetacean Res. Manage.* 1:255-264.

Hiby, L., Ward, A. and Lovell, P. 1989. Analysis of the North Atlantic Sightings Survey 1987: Aerial survey results. *Rep. int. Whal. Commn* 39:447-455.

Hooker, S.K. and Baird, R.W. 1999. Deep-diving behaviour of the northern bottlenose whale (*Hyperoodon ampullatus*). *Proc. R. Soc. Lond.* B 266:671-676.

[ICES] International Council for the Exploration of the Sea. 2001. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, 2-6 October 2000, ICES Headquarters, Copenhagen, Denmark. ICES CM 2001/ACFM 8. 40 pp.

[ICES] International Council for the Exploration of the Sea. 2003. Report of the workshop to develop improved methods for providing harp and hooded seal harvest advice, 11-13 February 2003, Woods Hole, Massachusetts, USA. ICES CM 2003/ACFM 13. 19 pp.

[ICES] International Council for the Exploration of the Sea. 2003. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, 2-6 September 2003, Arkangelsk, Russia. ICES CM 2004/ACFM::06

[ICES] International Council for the Exploration of the Sea. 2004. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, 2-6 September 2003, Arkhangelsk, Russia. ICES CM 2001/ACFM 6. 53 pp.

[IWC] International Whaling Commission. 1992. Report of the comprehensive assessment special meeting on North Atlantic fin whales. *Rep. int. Whal. Commn* 42:595-651.

[IWC] International Whaling Commission. (in press). Report of the Scientific Committee. Annex D. Report of the Sub-committee on the Revised Management Procedure. Appendix 14. Report of the Working Group on North Atlantic Minke Whales RMP *Implementation Review.*

Lockyer, C. and Sigurjónsson, J. 1991. The Icelandic fin whale (*Balaenoptera physalus*): biological parameters and their trends over time. IWC/SC/F91/F8 for the IWC Scientific Committee.

Olsen, E. 2002. Errors in age estimates of North Atlantic minke whales when counting growth zones in *bulla tympanica*. *J. Cetacean Res. Manage.* 4:185-91.

[NAMMCO] North Atlantic Marine Mammal Commission. 1995. Report of the Third Meeting of the Scientific Committee. In: *NAMMCO Annual Report 1995*, NAMMCO, Tromsø, pp.71-126.

[NAMMCO] North Atlantic Marine Mammal Commission. 1999. Report of the Sixth Meeting of the Scientific Committee, Annex 2, Report of the Scientific Committee Working Group on Management Procedures. In: *NAMMCO Annual Report 1998*, NAMMCO, Tromsø, pp. 117-131.

[NAMMCO] North Atlantic Marine Mammal Commission. 2000. Report of the NAMMCO Scientific Working Group on North Atlantic Fin Whales, Annex 2, Report of the Seventh Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 1999*, NAMMCO, Tromsø, Norway, pp. 189-211.

[NAMMCO] North Atlantic Marine Mammal Commission. 2001. Report of the NAMMCO Scientific Working Group on North Atlantic Fin Whales, Annex 4, Report of the Eighth Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 2000*, NAMMCO, Tromsø, Norway, pp. 274-294.

Sigurjónsson, J. and Gunnlaugsson, Th. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. *Rep. int. Whal. Commn* 40:537-551.

Stevick, P.T., Allen, J., Clapham, P.J., Friday, N., Katona, S.K., Larsen, F., Lien, J., Mattila, D.K., Pallsbøll, P.J., Sigurjónsson, J., Smith, T.D., Öien, N. and Hammond, P.S. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. *Mar.Ecol Prog. Ser*. 258:263-273.

Appendix 1

LIST OF PARTICIPANTS

Faroe Islands

Dorete Bloch
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 35 23 20
Fax: +298 35 23 31
Email: doreteb@ngs.fo

Geneviève Desportes
Fjord and Belt Centre
Margrethes Plads 1
DK-5300 Kerteminde, Denmark
Tel.: +45 65 32 57 83
Fax: +45 65 32 42 64
E-mail: genevieve@fjord-baelt.dk

Bjarni Mikkelsen
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 35 23 20
Fax: +298 35 23 31
E-mail: bjarnim@ngs.fo

Greenland

Aqqalu Rosing-Asvid
Greenland Institute of Natural Resources
P.O.Box 570,
DK-3900 Nuuk, Greenland
Tel.: +299 32 10 95
Fax: +299 32 59 57
Email: ARosing-Asvid@zi.ku.dk

Lars Witting
Greenland Institute of Natural Resources
P.O.Box 570,
DK-3900 Nuuk, Greenland
Tel.: +299 32 10 95
Fax: +299 32 59 57
E-mail: larsw@natur.gl

Iceland

Þorvaldur Gunnlaugsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik, Iceland
Tel.: +354 5331363
Fax: +354 5623790
E-mail: thg@halo.is

Droplaug Ólafsdóttir
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik, Iceland
Tel: +354 5520 240
Fax: +354 5623 790
e-mail: droplaug@hafro.is

Gísli A. Víkingsson (Chairman)
Marine Research Institute
P.O. Box 1390
IS-121 Reykjavik, Iceland
Tel.: +354 55 20240
Fax: +354 5 623790
E-mail: gisli@hafro.is

Norway

Tore Haug
Institute of Marine Research,
Sykehusveien 23,
N-9291 Tromsø,
Norway.
Tel: +47 77 60 97 22
Fax: +47 77 60 97 01
Email: toreha@imr.no

Christian Lydersen
Norwegian Polar Institute,
Polarmiljøsenteret,
N-9296 Tromsø, Norway
Tel: +47 77 75 05 23
Fax: +47 77 75 05 01
E-mail: christia@npolar.no

Ex-Officio Members

Grete Hovelsrud-Broda,
General Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø, Norway
Tel: +47 77 75 01 80
Fax: +47 77 75 01 81
E-mail: gretehb@nammco.no

Daniel Pike,
Scientific Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø, Norway
Tel: +47 77 75 01 80
Fax: +47 77 75 01 81
E-mail: daniel.pike@nammco.no

Observer

Dr Tomio Miyashita,
Cetacean Resources Management Section,
National Research Institute of Far Seas Fisheries,
5-7-1 Shimizu-orido, Shizuoka-shi,
424-8633 JAPAN
Tel: +81-543-36-6054
Fax: +81-543-35-9642
E-mail: miyachan@fra.affrc.go.jp

Other

Charlotte Winsnes,
Administrative Co-ordinator,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø, Norway
Tel: +47 77 75 01 80
Fax: +47 77 75 01 81
E-mail: nammco-sec@nammco.no

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**

   8.3 Progress on modelling
   8.4 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 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 Update on progress
      9.4.2 Future work
   9.5 Beluga
      9.5.1 Update on progress
      9.5.2 Future work
   9.6 Fin whales
      9.6.1 Update on progress
      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 Humpback whales
9.10.1 Update on progress
9.10.2 Future work

10. NORTH ATLANTIC SIGHTINGS SURVEYS

10.1 NASS-2001 and earlier surveys
10.1.1 Report of the Working Group on Abundance Estimates
10.1.2 Future analytical work
10.1.3 Recommendations for future NASS
10.2 Status of publications from previous NASS surveys
10.3 Establishment of a sightings survey database

11. DATA AND ADMINISTRATION

12. PUBLICATIONS

12.1 NAMMCO Scientific Publications
12.2 Other publications

13. BUDGET

14. FUTURE WORK PLANS

14.1 Scientific Committee
14.2 Working groups
14.3 Other matters
14.3.1 Provision of advice on sustainable catch to Council

15. ELECTION OF OFFICERS

16. ANY OTHER BUSINESS

16.1 Satellite tagging correspondence group

Appendix 3

LIST OF DOCUMENTS

	Title
SC/11/1	List of Participants
SC/11/2	Provisional Annotated Agenda (Draft)
SC/11/3	List of Documents
SC/11/NPR-F	National Progress Report – Faroe Islands
SC/11/NPR-G	National Progress Report – Greenland
SC/11/NPR-I	National Progress Report – Iceland
SC/11/NPR-N	National Progress Report – Norway
SC/11/NPR-C	National Progress Report – Canada
SC/11/4	Observers Report: 54th Meeting of the IWC Scientific Committee, Shimonoseki, Japan
SC/11/5	ICES/NAFO ”Workshop to Develop Improved Methods for Providing Harp and Hooded Seal Harvest Advice”
SC/11/6	Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals
SC/11/7	Report of the NAMMCO Scientific Committee Working Group on North Atlantic Fin and Minke Whales
SC/11/8	Report of the NAMMCO Scientific Committee Working Group on Grey Seals.
SC/11/9	Report of the NAMMCO Scientific Committee Working Group on Abundance Estimates.
SC/11/10	Status of *NAMMCO Scientific Publications* volume on the NASS.
SC/11/11	Establishment of a sightings survey database
SC/11/13	NAMMCO Scientific Committee Budget 2002.
SC/11/14	Summary of requests by NAMMCO Council to the Scientific Committee, and responses by the Scientific Committee
SC/11/16	Bloch, D. and Mikkelsen, B. Catch history and distribution of White-sided dolphin, *Lagenorhynchus acutus* in the Faroe Islands
SC/11/17	Mikkelsen, B. Feeding ecology of White-sided dolphins, *Lagenorhynchus acutus*, in the Faroe Islands

	Title
SC/11/18	Bloch, D., Mikkelsen, B. and Zachariassen, M. Age and growth parameters of White-sided dolphins, *Lagenorhynchus acutus*, in the Faroe Islands
SC/11/19	Jacobsen, Á., Mikkelsen, B. and Bloch, D. Genetic evidence of stocks of White-sided dolphins, *Lagenorhynchus acutus*, in the Faroe Islands
SC/11/MF/10	Distribution and abundance of large whales in the Northeast Atlantic, 1995.
SC/11/For information	Víkingsson, G.A. and Ólavsdóttir, D. Research takes of minke whales in Icelandic waters during autumn 2003.

ANNEX 1

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON MINKE AND FIN WHALES

Copenhagen, Denmark, 20-22 November 2003

1. OPENING REMARKS

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

Minke and fin whales are likely the two most abundant species of baleen whales in the North Atlantic, and have a long history of exploitation in the area. They are the only species of baleen whales presently being taken in the North Atlantic, by NAMMCO member countries.

The NAMMCO Scientific Committee carried out an assessment of the Central North Atlantic stock of minke whales in 1998 (NAMMCO 1999). The Committee concluded then that the stock was close to its carrying capacity, and that present removals would not adversely affect the stock. Similar conclusions were reached when the analysis was restricted to the feeding stock in the coastal waters of Iceland, the CIC small area. Since that time, more information has become available on the stock delineation of minke whales in the North Atlantic. New abundance estimates are available for the Central Stock area from NASS-2001, and for the Northeast Atlantic from Norwegian surveys conducted from 1996-2001. Therefore in 2002, the Council of NAMMCO requested that the Scientific Committee complete a new assessment of Central North Atlantic minke whales.

The Scientific Committee has carried out fin whale assessments on 2 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.

Since 2000, new abundance estimates from NASS-2001 and the Norwegian survey program have become available. Satellite tagging programs have begun to yield some new information on fin whale movements. In addition, some new information on historical harvests has come to light. In 2002 the NAMMCO Council requested that the Scientific Committee continue with its assessments of fin whale stocks in the areas of interest to NAMMCO countries with existing and new information on abundance and stock delineation as it becomes available. It was emphasised that assessments for the East Greenland-Iceland and Northeast Atlantic stocks should proceed as a high priority for the Scientific Committee.

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.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The documents considered by the Working Group are listed in Appendix 3.

5. MINKE WHALES – CENTRAL NORTH ATLANTIC STOCK

5.1 Stock structure

The IWC Scientific Working Group on North Atlantic Minke Whales RMP Implementation Review (SC/11/MF/4) reviewed an extensive analysis of population structure using samples from Norwegian commercial catches. Over 3000 samples were analyzed using both mitochondrial and microsatellite DNA markers. Both conventional hypothesis testing and the Boundary Rank method, which does not require an *a priori* assignation into stock areas, were used. Boundary Rank analysis used only mitochondrial markers. Both approaches indicated that animals from the CM Small Area were different from those from the Eastern Medium Area (Fig. 1) using mitochondrial markers. Boundary Rank suggested a difference within the CM Small Area, but this difference was not significant using a hypothesis testing approach. Both approaches also indicated the existence of a separate sub stock in the North Sea.

Another recent analysis using mitochondrial and microsatellite DNA sampled from a wider area including East and West Greenland (Andersen *et al.* 2003) also supports the conclusion that animals from the Central Area (East Greenland and CM in this case) are different than those from the Northeast Atlantic and the North Sea.

In discussion the Working Group noted the need for additional samples, especially from around Iceland, the Faroes and Greenland. As mentioned above, there may be substructure within the Central area, but stock delineation on a finer scale will not be possible without additional data from areas other than the Northeast Atlantic and the North Sea. Samples have been collected from all animals taken in the Icelandic Research program in 2003, but have not yet been analysed. Additional samples have been collected from West and East Greenland since 1997, but have not yet been analysed. Only one sample is presently available from the Faroes.

Víkingsson reported on the movements of 3 minke whales tracked using satellite-linked tags in 2001 and 2002 around Iceland. The tags functioned for 16, 66 and 88 days. Movements between August and mid-October were local and the whales remained in inshore waters. One of the whales began moving south after 31 October and had reached 56 N 27 W by 8 November when transmissions ceased. Migration was rapid with the whale covering at least 200 nm in 4 days.

The Working Group noted that, while interesting, this information is based on the movements of only a few whales, and recommended that further tag applications be conducted to describe the spatial and temporal distribution of minke whales. Øien reported that the 2 successful Norwegian applications of satellite tags to minke whales, as well as VHF tag experiments, had shown that the whales there were also rather stationary in the summer and early fall. No tags had lasted long enough to track a migration. Fishermen have reported seeing minke whales in the area in mid-winter, so some whales apparently remain in the area year-round.

The Working Group concluded that for the purposes of assessment, the existence of a separate Central Stock of minke whales was supported by the available evidence. However there may be sub-structure within this area. While there is no data to support the existence of a separate stock in the CIC Small Area, most catching by Iceland has historically occurred here so it made sense to consider this as a separate area for precautionary sensitivity tests.

5.2 Biological parameters

Víkingsson reported that no new information on biological parameters had been published since the last review of this stock in 1998 (NAMMCO 1999). However Øien noted that recent work (Olsen 2002) had demonstrated that age estimates base on counting annulae in tympanic bullae were not reliable. Therefore any biological parameters that included age as a component (*e.g.* age at maturity, mortality, survival) must now be considered suspect. Other ageing methods, especially based on the racemisation of amino acids in the eye lens, were being developed but had not yet been widely applied. It was noted that further development of racemisation is included in the Icelandic research program. Almost all mature female minke whales caught in Norwegian waters are pregnant, so the number of *corpora albicantia* may serve as a proxy for age for estimation of parameters such as natural mortality. Ear plugs have been used for age determination on Icelandic minke whales with some success (Sigurjonsson 1980a, b). The Working Group urged further development of ageing methods for North Atlantic minke whales.

The Working Group nevertheless decided to use the estimates of parameters used in the previous assessment, as they are unlikely to differ greatly from those for the Antarctic minke whale for which valid ageing methods are available. It was also noted that the assessment models used were relatively insensitive to variations in these parameters within a plausible range.

5.3 Catch data

Catch data for the CIC and Central areas were compiled in SC/11/MF/16 (Appendix 4). The catch series were the same as that used in the 1998 assessment, with the addition of more recent catches by Norway in the CM area and by East Greenland. A "High Catch" case was also developed which included assumed maximum annual levels of both bycatch (5) and unreported catch (10 per annum from 1986-2002) in Icelandic waters.

Recent Norwegian catches include reported struck and lost whales. It was noted that past catches do not include struck and lost animals, and it is likely that they were simply not reported. However it was considered unlikely that this would add substantially to the reported take.

5.4 Abundance estimates

The Report of the NAMMCO Scientific Committee Working Group on Abundance Estimates was available as SC/11/MF/11. A new estimate from NASS-2001 and a re-analysis from NASS-1987 of the aerial survey component covering coastal Iceland were available. These estimates were corrected for animals missed along the trackline and for error in measuring distances to sightings, and were considered unbiased. The estimate from the 1995 aerial survey is considered biased to an unknown degree and it was recommended that it not be used in assessments. A new estimate from the NASS-2001 shipboard survey was considered to be negatively biased because of animals missed on the trackline and diving animals. Nevertheless this estimate is comparable with previous ones from the area.

Available abundance estimates, with associated biases, for the CIC and Central areas are shown in Appendix 5. The results from the NASS series indicate an increase in minke whale abundance to the north and west of Iceland and around the Faroes from 1987 to 2001. There seems also to have been a decrease in the abundance of minke whales in the Barents Sea, the Norwegian Sea and the North Sea in the same period. These changes in spatial distribution might indicate a shift towards more southern and central Atlantic waters in the Central and Eastern Stocks of minke whales.

5.5 Assessments

Two independent assessments were available for minke whales. SC/11/MF/5 replicated the methodology used on a previous occasion by the NAMMCO Scientific Committee (NAMMCO 1998), though now updated to take account of further information from abundance surveys as discussed above. This involves applying the HITTER methodology (de la Mare 1989) to compute population trajectories for different assumed levels of productivity rates for the resource (designated by MSY rates – $MSYR^{1+}$) that pass through a given abundance in a recent year. The abundance was set to the inverse variance-weighted average of the available abundance estimates, and the year taken as the average of the years in which the associated surveys took place. Trajectories were computed for $MSYR^{1+}$ values of 1, 2 and 4%, and also projected forward for 20 years under different fixed levels of future catch. Figure 2 provides an example of the results obtained.

Exploratory FITTER analyses, which attempt to estimate the value of MSYR by matching the trends in population trajectories to those of a series of survey results, were also carried out. However the results are not yet regarded as reliable because only a few survey estimates are available to date from which to estimate trend.

The results from HITTER analyses indicated that the Central Stock of minke whales has not been appreciably impacted by past whaling, having a current abundance of mature females that is at least 85% of the corresponding pre-exploitation level. This result holds across a wide range of assumptions concerning past catches, stock boundaries, MSYR values and abundance estimates.

SC/11/MF/7 used the high and low catch series from 1930 (Appendix 4) and the abundance estimates from 1987 and 2001 (Appendix 5) in an age- and sex-structured model to perform a Bayesian assessment of Central North Atlantic (C) and the Central Icelandic Coastal (CIC) minke whales. The model treated the 2 aggregations as isolated populations, it assumed density regulated dynamics, populations in population dynamic equilibrium in 1930, and it projected the populations under the influence of the historical catches. Given the data, the model, and the priors in Table 1, the model estimated the probability by which the IWC management objective for Commercial Whaling[1] (IWC 2000) is met for future catches between zero and 400 individuals per year. It was noted that although priors had been chosen as uniform with the intention that they be uninformative, the effect of constraints imposed by the approach was to adjust the priors to be informative about quantities such as MSYR. The results were rather similar for the four combinations of stock and catch hypothesis. For all hypotheses the historical catches have been low compared with the abundance, with the highest depletion being estimated to 0.94 (CI:0.89-0.97) in 1985, and the highest current depletion being estimated to 0.97 (CI:0.92-0.99). The information in the two abundance estimates was generally insufficient to update the priors to new posterior estimates of the parameters in the model. The exception was the equilibrium pre-exploitation abundance that was estimated to 38,000 (CI:28,000-51,000) individuals for the CIC stock, and 62,000 (CI:41,000-93,000) individuals for the C stock. The probabilities of fulfilling the IWC management objectives for commercial whaling over the next ten years for annual catches of up to 400 individuals were found to be above 0.98 for both the C and the CIC stock hypotheses.

Parameter	s_{ad}	s_{juv}	b_{max}	a_m	**msyr**	**msyl**
Min.	0.80	0.40	0.50	3.00	0.01	0.50
Max.	0.99	0.99	1.00	9.00	0.07	0.70

Table 1. Minimum and maximum values for uniform prior distributions of parameters used in minke whale modelling. s_{ad}- adult survival; s_{juv} – juvenile survival; b_{max} – maximal birth rate; a_m – age of reproductive maturity; msyr – maximum sustainable yield rate; msyl – maximum sustainable yield level.

In discussion the Working Group noted that the results from these two approaches were very similar and that both indicated that the present population in this area was near or very near its pre-exploitation level.

5.6 Management recommendations

Projections over the next 20 years using HITTER (Fig. 2) indicate that, under all scenarios considered, a catch of 200 minke whales per year would maintain the mature component of the population above 80% of its pre-exploitation level over that period. Similarly, a catch of 400 per year would maintain the population above 70% of this level. This constitutes precautionary advice, as these results hold even for the most pessimistic combination of the lowest MSYR and current abundance, and the highest extent of past catches considered plausible. The advice applies to either the CIC Small Area (coastal Iceland), or to the Central Stock as a whole.

[1] As applied in the assessment, these objectives imply that the permitted catch for stocks at or above the MSY level shall not exceed 90% of the MSY. For stocks between the MSY level and 90% of that level, the permitted catch shall not exceed the number of individuals obtained by taking 90% of the MSY and reducing that number by 10% for every 1% by which the stock falls short of the MSY level.

5.7 Research recommendations

- Further genetic sampling, particularly from Icelandic waters, East and West Greenland, and the Faroes. Analyses should use the same markers and methodologies as used by Norway so the datasets will be comparable.
- Development of valid ageing methods for North Atlantic minkes, using amino acid check spelling> racemisation in the eye lens or other techniques. Use of the number of *corpora albicantia* in females as a proxy for age in estimating biological parameters should be investigated.
- Further satellite tagging to investigate spatial and temporal distribution in all areas.

6. FIN WHALES

6.1 Stock structure

In 1999, the NAMMCO Working Group on Fin Whales concluded that there was evidence to indicate the presence of subpopulations with limited gene flow between adjacent subpopulations (NAMMCO 2000). The North Atlantic populations are all different from the Mediterranean Sea population. There is some indication that the western North Atlantic and Iceland areas have populations different from those found off the coasts of Spain and north Norway. Finally, deviations from Hardy-Weinberg genotypic proportions within and between years in the Icelandic samples suggest some sub-structure in this area. Beyond this, there is insufficient evidence to delineate stocks of fin whales in the North Atlantic. No new genetic evidence has come to light since 1998 that would change these conclusions, so stock delineation remains the greatest barrier to the reliable assessment of North Atlantic fin whales, especially at a finer scale. The present Working Group therefore supported the recommendations of previous Working Groups (NAMMCO 2000, 2001) for increased sampling and new genetic analyses for fin whales throughout the North Atlantic.

Some evidence from a tagging experiment conducted in 2001 in the Faroes opens intriguing possibilities for stock relationships of fin whales in the area (SC/11/MF/14). Two applications have been successful, lasting 48 and 116 days. The whale tracked for the shorter period stayed on the Faroese shelf for the entire time. The other whale migrated southward as far as 46° N, at the latitude of the Bay of Biscay. It then moved northeast and reached an area off northwest Ireland, where it stayed within a restricted area for 2 months before contact was lost in November.

While noting that this indicates a possible stock connection between whales around the Faroes and off the Iberian peninsula, the Working Group felt that it would be premature to draw conclusions from the movements of 1 animal. Further tagging work in all areas was encouraged.

Øien presented information on the distribution of fin whales in the Northeast Atlantic based on incidental sightings between 1967 and 2002 (SC/11/MF/18). A total of 986 fin whale sightings have been compiled from research, fishing and coast guard vessels, with the majority from the latter type. Most of the sightings have been made in the summer, but fin whales have been recorded in every month of the year. Sightings are spread throughout the Norwegian survey area, with apparent "hot spots" around Bear Island – Spitzbergen, Jan Mayen and in the eastern Norwegian Sea. These concentration areas are similar to those revealed by dedicated sighting surveys (see **6.4**), but the continuous distribution of fin whale sightings in all areas probably means that there are seasonal or annual shifts in fin whale distribution. There are no gaps in the distribution that may be indicative of stock boundaries.

The Working Group welcomed these data, but noted that their interpretation would be facilitated by some indication of searching effort, particularly vessel tracks, or by presenting the sightings alongside those of other species for which distribution is better known. Without this the apparent distribution of sightings is confounded by the unknown distribution of effort. Bloch noted that similar data on incidental observations exist from the Faroes (Bloch *et al* 2001), and some data previously presented to NAMMCO

(NAMMCO 2001) compiled from whaling logbooks and other sources had shown a continuous presence of fin whales around the Faroes, but with some apparent shifts in seasonal distribution.

6.2 Biological parameters

Biological parameters for fin whales adopted by the IWC in 1991 (Lockyer and Sigurjonsson 1991) have been used in previous NAMMCO assessments (NAMMCO 2000, 2001). The Working Group agreed that at present there is no new information to change any of these parameters. It was noted that much of the information on biological parameters for Icelandic fin whales had not yet been published, and the Working Group urged that this information be published at the earliest opportunity.

6.3 Catch data

The catch series available to the Working Group (Appendix 4) were for the most part the same as those used in previous NAMMCO assessments (NAMMCO 2000, 2001) and were derived from those extracted for the Comprehensive Assessment Meeting on North Atlantic Fin Whales held in 1991 (IWC 1992). A new "Faroese South" area included abundance estimates and catches from the previous "Faroese Medium" area plus Spanish and Portuguese catches, thus capturing the possibility of a link between fin whales caught in the Faroes and areas farther south (see Fig. 3 for area definitions).

Bloch reported on the development of an improved catch series derived from Faroese and other archival sources (SC/11/MF/13). Pre-1920 catches used in previous assessments contained a large proportion of large whales of unknown species, all of which were assumed to be fin whales. However species identity is retrievable from archival sources in most cases. When catch is allocated by species, early catches of fin whales from Faroese land stations are substantially lower than in the previous catch series because species other than fin whales were caught. However only about half of the available material has been consulted to date. The Working Group commended this work and urged that it be completed. It was also considered that the new figures could be used in sensitivity analyses to determine the effect of lower historical catches on the assessments.

6.4 Abundance estimates

The NAMMCO Scientific Committee has accepted estimates of abundance from the NASS-2001 Icelandic and Faroese ship surveys (NAMMCO 2003). These new estimates were included in a compilation of abundance estimates from past surveys presented in Appendix 5. Area divisions used were identical to those used in previous assessments (NAMMCO 2000, 2001) with the addition of the "Faroese South" block (see **6.3,** Fig. 3).

Øien presented abundance estimates calculated from the Norwegian 1995 shipboard sightings survey (SC/11/MF/10). The survey was conducted with 2 independent platforms on each of 11 vessels. The target species was the minke whale and the survey was designed specifically to get a best estimate of abundance for this species and thus involved tracking procedures for minke whale sightings. The survey was run in passing mode, that is, without closing on sightings for species identification or group size confirmation. As a result, more than 30% of the sightings of large whales were not identified to species. The survey covered the Northeastern Atlantic including the North Sea, the Norwegian Sea, the Greenland Sea and the Barents Sea. Estimates were based on standard line transect analyses for each of the survey platforms, and the 2 platforms combined. Most of the fin whale sightings were made in the Svalbard area, that is, along the continental slope from Bear Island and northwards to the northwest of Spitsbergen. Compared to earlier surveys, the 1995 distribution was more northerly; in 1988 fin whales were observed around Jan Mayen and within the Norwegian Sea; in 1989 there were 2 distinct occurrences, one in the northern Norwegian Sea and one in the Norwegian Sea west of northern Norway (Jan Mayen was not surveyed that year). The abundance estimates based on the combined platform data were considered to give the best estimates of absolute abundance of 5,395 animals (c.v. 0.204) for the survey area.

The Working Group welcomed this new estimate, and urged the timely completion of estimates from 1996-2001 series of surveys in the Northeast Atlantic. Completion of these estimates is required for future assessments of fin whales in this area (see **6.7**).

6.5 Assessments

6.5.1 EGI

Assessment of the EGI fin whales differs from that for other fin and minke whale stocks discussed elsewhere in this report because, in addition to recent estimates of abundance from sighting surveys, there are CPUE data available which provide information on trends in abundance over the 1901-1915 and 1962-1987 periods.

However, approaches such as the HITTER or FITTER methodology of SC/11/MF/5, or the Bayesian approach of SC/11/MF/8, both of which treat the stock as homogeneous throughout the Central North Atlantic area, fail because the population model applied cannot be reconciled with all 3 sources of data (the absolute abundance estimates and the 2 sets of CPUE data). In particular, such models have great difficulty in reflecting the large decline in CPUE observed in the 1901-1915 period.

To address this, SC/11/MF/5 considered a 2-substock model approach, where historic catches have been taken from an “inshore” substock only, and there is diffusive mixing between this “inshore” and the “offshore” substock. CPUE data reflect the behaviour of the “inshore” substock only, whereas sightings estimates relate to the combination of both substocks. This age-aggregated model allows both MSYR and the inter-substock mixing rates to be estimated, and provides an acceptable fit to all 3 sources of data. Under such an analysis, the resource as a whole is estimated to be close to its pre-exploitation abundance. The precise status of the inshore substock differs depending on which of 2 forms of density dependence is assumed for the model, but in either event is estimated to be above MSY level.

Gunnlaugsson extended the 2-substock model described above by including the existing mark recapture data in an assessment model described in SC/11/MF/6. Differences had been observed in the rate of recovery of marks applied on the whaling grounds west of Iceland compared to those from East Iceland and East Greenland. In addition there were obvious differences in the mark returns by sex and area. Therefore, the model was sex disaggregated. The model was also expanded from 2 to 4 components for consistency with the marking data. Density response was assumed to occur on the feeding grounds (that is within the component) as in the sensitivity runs of the 2-substock model of SC/11/MF/5. This however makes less difference in this case since the mixing between components is estimated as being considerable, so density changes soon carry over to other components.

The main results of the analysis are that, as predicted by Butterworth and Cunningham (2000), the marking data do constrain the range of the estimated intrinsic growth rate parameter. The higher proportion of females than males in the catch on the grounds is maintained by a higher rate of mixing of females among substock components so that females are more readily replenished, rather than by a heavy selection for larger animals by the whalers. The stochastic runs showed an annual catch of 200 animals over the next two decades from the whaling grounds west of Iceland to be sustainable with high probability.

Satellite telemetry data would be most valuable to clarify how the components in the model relate to abundance by blocks from sighting surveys. The model could be augmented by including age structure and biological parameters. As changes in these would be expected to have occurred during the years with no catch, fresh samples from the grounds would be valuable in this respect.

The Working Group could not draw firm conclusions from these modelling exercises, but noted that the more complex models involving 2 or more spatial components appeared to 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. However further work is needed to clarify the relationships in this area, particularly with regard to area boundaries, sex and age segregation in space and time, and mixing rates. The Working Group provided some recommendations for facilitating this work under **6.**7.

6.5.2 Faroes

The primary assessment conducted of the Faroese fin whales (SC/11/MF/5) was an updated HITTER analysis. The process is identical to that described above (5.5) for Central Atlantic minke whales. These analyses were conducted over a range of assumptions concerning the geographical extent of the resource and the past catches taken from it. Exploratory FITTER analyses were also carried out, but the estimates of MSYR attained were not considered reliable because of the shortness of the time series of abundance estimates available from surveys.

The dominant factor influencing results is the assumption regarding the geographical extent of the stock. At the one extreme, if the stock is restricted to the Faroese EEZ, it is at present highly depleted (only some 10% of the pre-exploitation abundance), and even catches as low as 10 per annum may not be sustainable (see Fig. 4). At the other extreme, for the "Faroese South" stock specification, which includes abundance estimates and past catches as far south as Spain, depletion is much less severe, and for $MSYR^{1+}$ = 4% the resource is estimated to already have recovered to its MSYL.

The model described in SC/11/MF/7 for minke whales (see **5.5)** using priors listed in Table 2 was also used to model the Faroese EEZ, Medium, and Large areas (SC/11/MF/8). For these areas the model could better explain recent increases in abundance estimates than in the EGI case, and it estimated equilibrium abundances of 7,000 (CI: 6,300-8,100) for the EEZ, 9,200 (CI: 8,000-11,000) for the Medium, and 26,000 (CI: 23,000-30,000) for the Large areas (the high catch series). In all these cases the populations have been heavily depleted, with minimum depletion ratios of 0.02 (CI: 0.01-0.04) for the EEZ in 1959, 0.04 (CI: 0.02-0.08) for the medium area in 1958, and 0.09 (CI: 0.05-0.14) in 1963 for the large area with the high catch. Current depletion levels are still low [0.14 (CI:0.09-0.21) for the EEZ, 0.26 (CI: 0.17-0.38) for the medium area, and 0.30 (CI: 0.21-0.43) for the large area with high catch], and this is the reason that the probability of meeting the IWC management objectives for commercial whaling is below 0.04 for all areas even for catches as low as 5 individuals per year. For the Faroese South area, where the equilibrium abundance was estimated to 18,000 (CI: 15,000-21,000), the depletion has been less severe, with a maximal depletion of 0.30 (CI: 0.22-0.37) in 1931, and a current depletion of 0.56 (CI: 0.41-0.72). In this case, annual catches between 5 and 20 whales over the next 10 years result in intermediate probabilities of meeting the IWC management objectives for commercial whaling.

Parameter	s_{ad}	s_{juv}	b_{max}	a_m	**msyr**	**msyl**
Min.	0.93	0.30	0.33	7.00	0.01	0.50
Max.	0.99	0.99	0.50	11.00	0.07	0.70

Table 2. Minimum and maximum values for uniform prior distributions of parameters used in fin whale modelling. s_{ad}- adult survival; s_{juv} – juvenile survival; b_{max} – maximal birth rate; a_m – age of reproductive maturity; msyr – maximum sustainable yield rate; msyl – maximum sustainable yield level.

The Working Group noted that the results from both modelling efforts were qualitatively and quantitatively very similar. Both indicated that the fin whale stock around the Faroes was heavily depleted under most plausible scenarios about the size and extent of the stock area from which catches were taken. Under some of these stock scenarios even catches as low as 5 animals per year slow or halt the recovery of the stock, and higher catches result in further depletion in nearly all cases. The exception was the "Faroese South" stock area, which linked whales around the Faroes with the relatively large stock off the Iberian peninsula, but the Working Group considered that more evidence was needed before this scenario could form the basis for management advice.

6.5.3 Other

The Working Group considered that the availability of abundance estimates from NASS-1995 and the development of abundance estimates from more recent Norwegian surveys for fin whales in the Northeast Atlantic (see 6.4) will make the assessment of fin whales in this area feasible. A careful examination and compilation of available data (specified below) , and further research, is needed before such an assessment is conducted.

Catch data
Catch data are presently available. However, examination of historic Faroese catches indicated that the statistics held by IWC may require revision, involving investigations of the original logbooks, where available, to elucidate problems with species identification and ancillary information. The Working Group recommended that Bloch extend her work on the Faroese data to include Norwegian, Irish and northern British Isles land stations. The catch data includes information on catch position, and therefore can be aggregated by any potential stock division and might provide a basis for valuable CPUE series. This work should be encouraged by NAMMCO .

Other data
Other positional data useful in assessment include incidental sightings and sightings from dedicated surveys, marking with Discovery tags, satellite tagging tracks, biopsy samples and age determinations of some samples. These data should be compiled before assessment proceeds.

Boundaries between present stock divisions
The boundary between the Faroe Islands-West-Norway stock and the British-Spain-Portugal stock should probably be moved southwards. Historically, catches taken by Faroese whalers were sometimes landed at other places, and catches taken by Shetland land stations were sometimes landed at Faroe Islands; furthermore there is no hiatus in catch positions across the present boundary. The recent satellite tagging of a fin whale off the Faroe Islands which migrated southwest in the Atlantic and then returned north again to the grounds west of Ireland makes it possible that the same whales use feeding areas both north and south of the present IWC boundary. The specific placement of this boundary should be based on the distribution of historic catches, distribution from past sighting surveys, and possibly on genetic data if available. The boundary between Faroe Island – West Norway stock and the North Norway stock should be kept since the recent distribution of northern fin whales is associated with the continental slope from Bear Island and northwards to Spitsbergen, so the whales in that area could equally well migrate through the Denmark Strait as through the Norwegian Sea.

6.6 Management recommendations

6.6.1 EGI

Because of the inability of models which treat the EGI fin whale stock as homogeneous to fit all sources of abundance-related data satisfactorily, the Working Group decided to base management advice on the 2-substock model described in SC/11/MF/5, which does fit such data.

Projections under constant catch levels suggest that the inshore substock will maintain its present abundance (which is above MSY level) under an annual catch of about 150 whales for either assumption concerning the form of density dependence (see Fig. 4 for an example of such projections).

It is important to note that this result is based upon the assumption that catches are confined to the “inshore” substock, *i.e.* to the grounds from which fin whales have been taken traditionally. If catches were spread more widely, so that the “offshore” substock was also harvested, the level of overall sustainable annual catch possible would be higher than 150 whales.

6.6.2 Faroes

The new information on abundance from NASS-2001 and the updated catch history available for the Faroes did not greatly change the conclusion reached in 2000 (NAMMCO 2001), that the fin whale stock around the Faroes was likely to be heavily depleted under most stock scenarios considered plausible. The uncertainties about stock identity are so great as to preclude carrying out a reliable assessment of the status of fin whales in Faroese waters, and thus the Working Group was not in a position to provide advice on the effects of various catches. The Working Group therefore reiterated the recommendations made in 2000 (NAMMCO 2001) to carry out a research program (see **6.7**) 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.

6.6.3 Other

The Working Group were not in a position to provide management advice for the North Norway stock area. Once the work identified under 6.5.3 has been done assessments can be carried out for this area.

6.7 Research recommendations

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. Any existing samples from past whaling should be analysed using modern techniques;
- Satellite tagging to determine habitat use and migratory patterns. If possible, a biopsy should be obtained from all tagged animals for genetic analysis and sex determination;
- Noting the application of Bayesian stock assessment methodology, it is important that checks are conducted to ensure that computations have converged numerically.

Faroes

For this area, the detailed research recommendations developed in the previous assessment (NAMMCO 2001) are supported and reiterated.

- The revision of catch statistics for Faroese and adjacent whaling operations should be completed;
- The feasibility of preparing a CPUE index from Faroese and adjacent whaling operations should be investigated;
- Biopsy sampling for genetic analysis from the Faroes and adjacent areas should be continued. Existing biopsy samples should be analysed as soon as possible.
- Satellite tagging should continue once methodological/technical issues are addressed.

EGI

The detailed research recommendations developed during the previous assessment for this area (NAMMCO 2000) are supported and reiterated.

- The early CPUE series (1901-1915) should be reanalysed and split between eastern and western Icelandic whaling areas. The possibility of using data prior to 1901 should be investigated;
- 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;
- Existing analyses of data on biological parameters from previous commercial and research whaling should be published as soon as possible;
- Satellite tagging should be attempted to investigate the movements of fin whales, particularly between the traditional whaling grounds west of Iceland and areas outside.

Analyses presented in SC/11/MF/6 in particular indicate that fin whales are not homogeneously distributed in the conventional EGI stock area with respect to age, sex and behaviour. To facilitate the development of spatially structured models to better represent the overall dynamics, it was recommended that all data (catch, effort, catch-at-age, sightings survey abundance and mark-recapture) be split into 4 subareas. These would be defined as follows: western and eastern sections would be separated by the lines running roughly north and south from Iceland that delineate the B area used in abundance estimation (Fig. 3). The western sector would then be divided by a line drawn from the coast of Iceland to surround the distribution of catch positions until its westernmost point, from which the line continues southward. For the eastern sector, the division line would be conceptual to separate catches to the east of Iceland and those around Jan Mayen without exact specification of geographical location. The separation of abundance estimates for the eastern sector into 2 components for these 2 subareas would be determined by the best fit of a population model to the data. Similar flexibility might need to be exercised for the split of abundance estimates for the western sector.

Other

Research recommendations for the North Norway stock area are identified under 6.5.3.

- Preparation of abundance estimates from the 1996-2001 survey series;
- Compilation and revision of catch statistics;
- Preparation of a CPUE series if possible;
- Collection of additional biopsy samples for genetic analysis, and analysis of existing samples in a timely manner;
- Satellite tagging once methodological/technical problems have been addressed.

7. OTHER BUSINESS

The Working Group considered that the scheduling of future assessment meetings should be dependent on the completion of additional research and necessary preparatory work. For the Norwegian area these preparations are described under **6.5.3**. For the Faroes, additional work is required particularly on stock delineation, as described under **6.7**. Assessment modelling for the EGI area could be usefully extended once the CPUE, abundance estimate and tag return data are disaggregated as described under **6.7**. It was suggested that a 1 day planning/preparatory meeting be held in connection with the NAMMCO Scientific Committee meeting in 2004, to determine what work has been completed and plan for a future assessment meeting, ideally in 2005.

8. ADOPTION OF REPORT

The Report was adopted by the Working Group on 22 November 2003.

REFERENCES

Andersen, L.W., Born, E.W., Dietz, R., Haug, T., Øien, N. and Bendixen, C. 2003. Genetic population structure of minke whales Balaenoptera acutorostrata from Greenland, the North East Atlantic and the North Sea probably reflects different ecological regions. Mar. Ecol. Prog. Ser. 247:263-280.

Borchers, D.L. Analyses of the NASS 1987 and 2001 minke whale cue counting surveys taking account of distance estimation errors. Working Paper SC/11/AE/4 for the NAMMCO Scientific Committee.

Buckland, S.T., Cattanach, K.L. and Lens, S. 1992b. Fin whale abundance in the eastern North Atlantic, estimated from Spanish NASS-89 data. *Rep. int. Whal. Commn* 42: 457-460.

de la Mare, W.K. 1989. Report of the Scientific Committee, Annex L. The model used in the Hitter and Fitter programs (Program:Fitter.SC40). *Rep. int. Whal. Commn*. 39:150-151.

Gunnlaugsson, Th., Pike, D.G, Vikingsson, G.A., Desportes, G. and Mikkelson, B. An estimate of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-2001 shipboard survey. Working Paper SC/11/AE/6 for the NAMMCO Scientific Committee.

[IWC] International Whaling Commission. 2000. International Convention for the Regulation of Whaling, 1946. Schedule. *Ann. Rep. int. Whal. Commn* 49:77-90.

Lockyer, C. and Sigurjónsson, J. 1991. The Icelandic fin whale (*Balaenoptera physalus*): biological parameters and their trends over time. IWC/SC/F91/F8 for the IWC Scientific Committee.

[NAMMCO] North Atlantic Marine Mammal Commission. 1998. Report of the NAMMCO Scientific Working Group on Abundance Estimates, Report of the Fifth Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 1997*, NAMMCO, Tromsø, Norway, pp. 173-202.

[NAMMCO] North Atlantic Marine Mammal Commission. 1999. Report of the Sixth Meeting of the Scientific Committee, Annex 2, Report of the Scientific Committee Working Group on Management Procedures. In: *NAMMCO Annual Report 1998*, NAMMCO, Tromsø, pp. 117-131.

[NAMMCO] North Atlantic Marine Mammal Commission. 2000. Report of the NAMMCO Scientific Working Group on North Atlantic Fin Whales, Annex 2, Report of the Seventh Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 1999*, NAMMCO, Tromsø, Norway, pp. 189-211.

[NAMMCO] North Atlantic Marine Mammal Commission. 2001. Report of the NAMMCO Scientific Working Group on North Atlantic Fin Whales, Annex 4, Report of the Eighth Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 2000*, NAMMCO, Tromsø, Norway, pp. 274-294.

[NAMMCO] North Atlantic Marine Mammal Commission. 2002. Report of the NAMMCO Scientific Working Group on Abundance Estimates, Report of the Ninth Meeting of the NAMMCO Scientific Committee. In: *NAMMCO Annual Report 2001*, NAMMCO, Tromsø, Norway, pp. 249-270.

[NAMMCO] North Atlantic Marine Mammal Commission. 2003 (unpublished). Report of the NAMMCO Scientific Working Group on Abundance Estimates, Report of the 10th Meeting of the NAMMCO Scientific Committee.

Olsen, E. 2002. Errors in age estimates of North Atlantic minke whales when counting growth zones in *bulla tympanica. J. Cetacean Res. Manage.* 4:185-91.

Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. 2003. Fin whale abundance in the North Atlantic, from Icelandic and Faroese NASS-2001 shipboard surveys: Slightly revised estimates. Working Paper SC/11/AE/8 for the NAMMCO Scientific Committee.

Sigurjónsson, J. 1980a. Alderstudier over vaagehval (*Balaenoptera acutorostrata*) i islanske farvann (Studies on age in minke whale in Icelandic waters). Cand. Scient. Thesis. University of Oslo, Norway, 97 pp.

Sigurjónsson, J. 1980b. A preliminary note on ear plugs from Icelandic minke whales. *Rep. Int. Whal. Commn* 30:193-194.

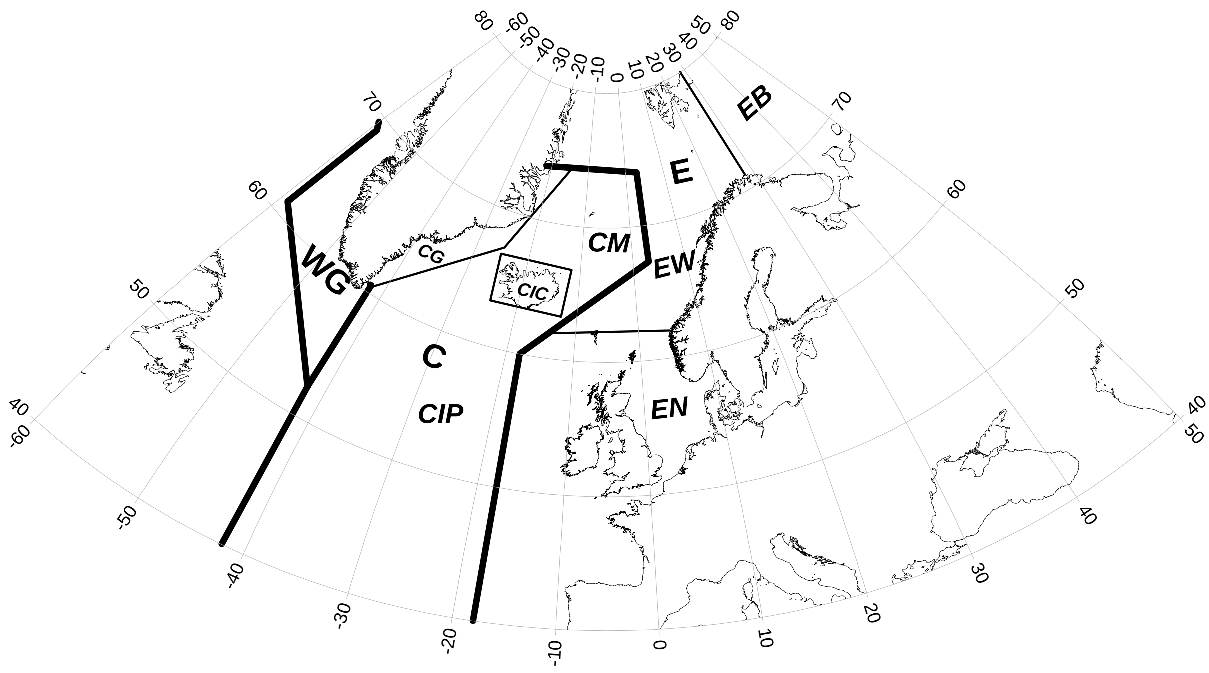

Fig. 1. Minke whale stock areas as defined by the IWC. Thick lines separate medium areas, while thin lines separate small areas. Small area names are given in italics.

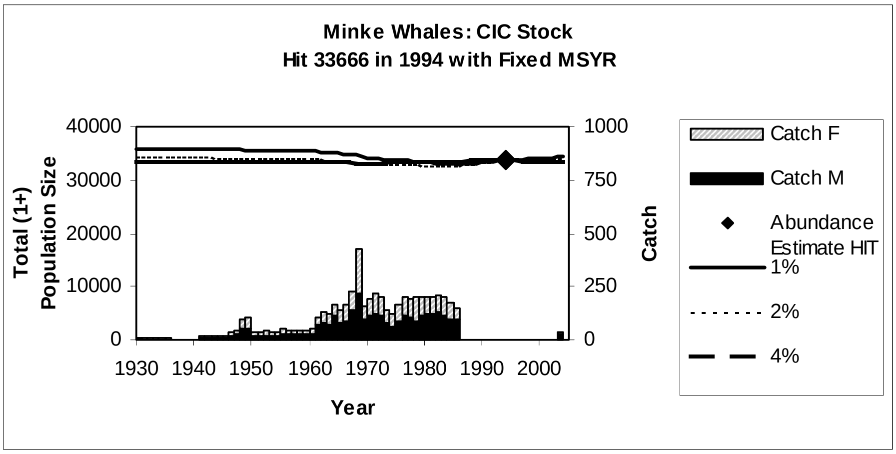

Fig. 2a. Total (1+) population trajectories from 1930 to 2004 in the minke whale CIC stock when assuming a total population size of 33666 in 1994 for $MSYR^{1+}$ values of 1, 2% and 4%. The trajectory corresponding to the lowest MSYR lies highest on the left hand side of this and Fig. 2b. Annual catches are indicated at the bottom of the plot.

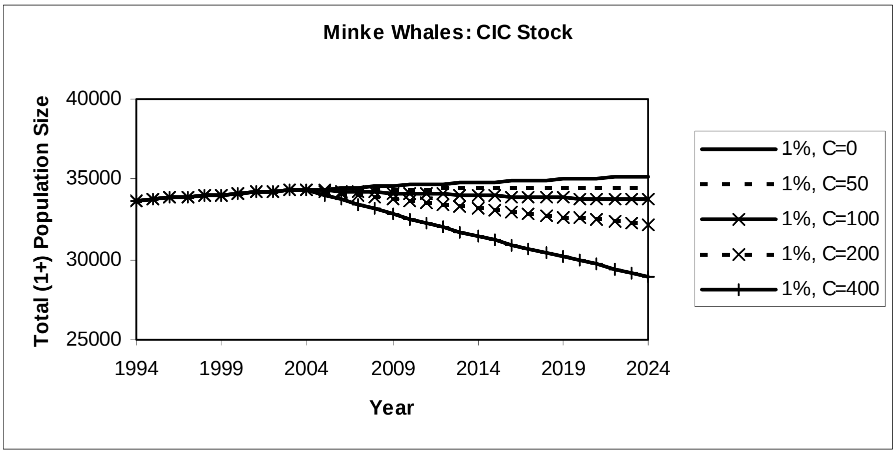

Fig. 2b. Total (1+) population trajectories in the minke whale CIC stock when hitting a best estimate of N^{1+}_{1994} = 33666 for $MSYR^{1+}$ = 1% for future annual catches of 0, 50, 100, 200 and 400 animals. Note that the vertical axis minimum is 25000 animals and not zero.

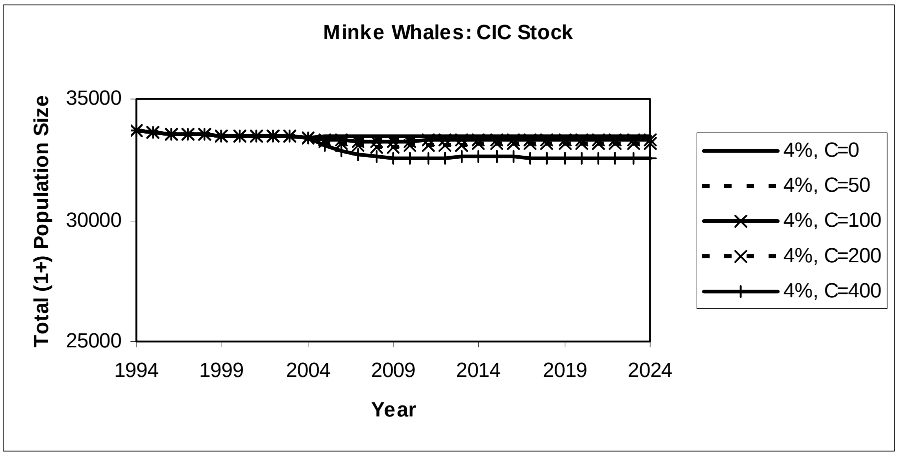

Fig. 2c. Total (1+) population trajectories in the minke whale CIC stock when hitting a best estimate of N^{1+}_{1994} = 33666 for $MSYR^{1+}$ = 4% for future annual catches of 0, 50, 100, 200 and 400 animals. Note that the vertical axis minimum is 25000 animals and not zero.

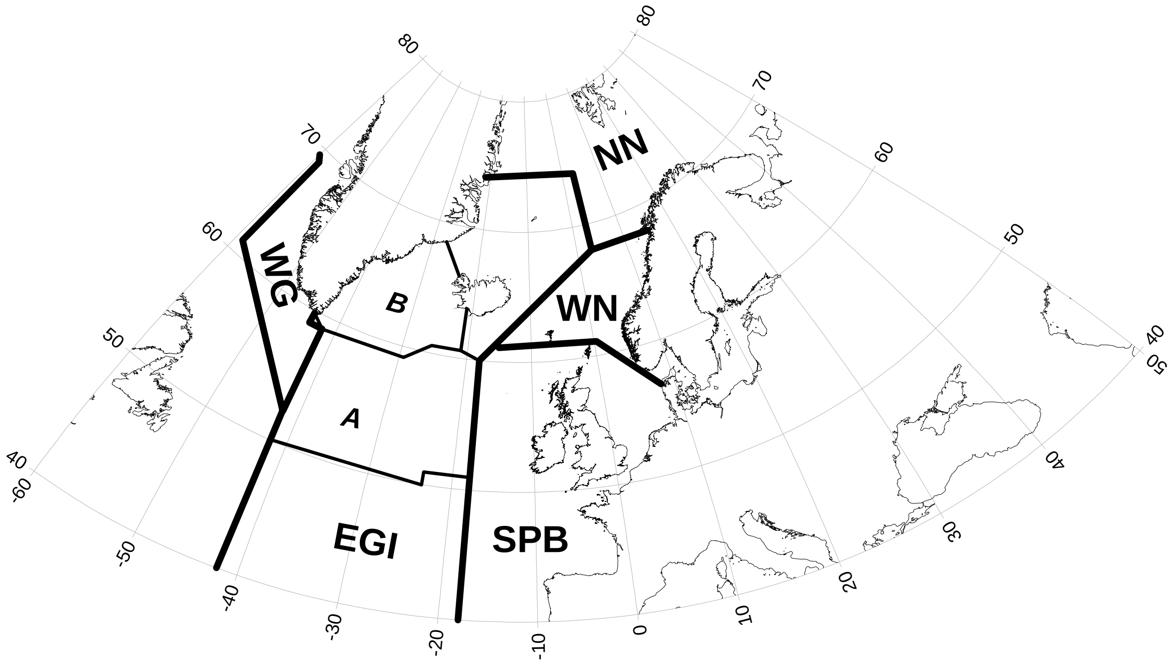

Fig 3a. Fin whale stock areas as defined by the IWC (bold letters), and other areas used in assessments (italics). WG – West Greenland; EGI – East Greenland-Iceland; NN – North Norway; WN – West Norway; SPB – Spain-Portugal-British Isles.

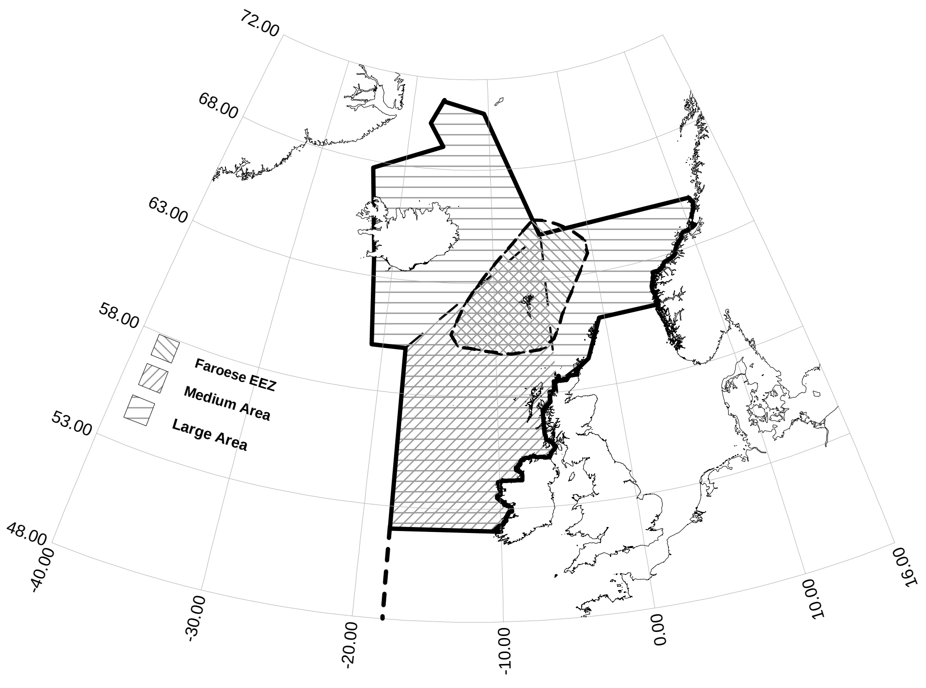

Fig. 3b. Areas used in assessments of Faroese fin whales. The "Faroese South" area includes the Medium Area and continues south to include the remainder of the SPB stock area (see Fig. 3a)

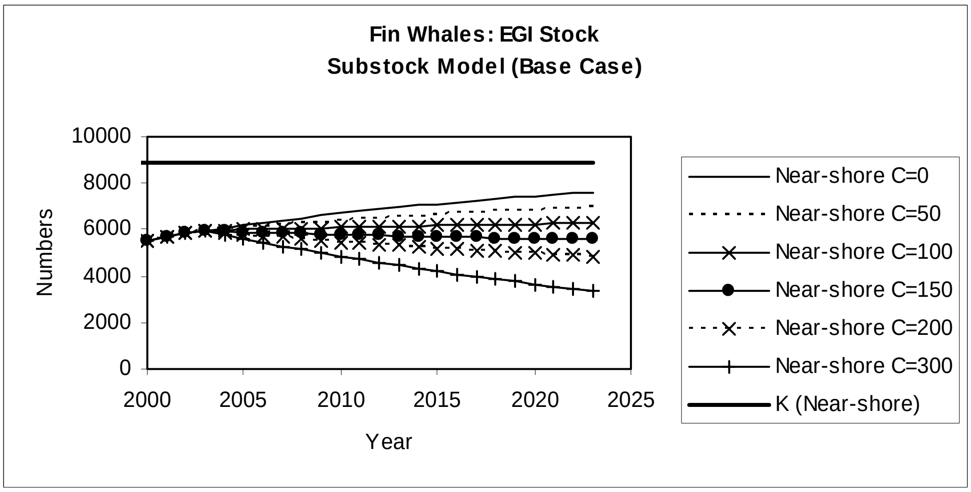

Fig. 4a. Near-shore substock population trajectories of the fin whale EGI stock in terms of the base case (Equations (A.1)) sub-stock model of SC/11/MF/5 for future annual catches of 0, 50, 100, 150, 200 and 300 animals.

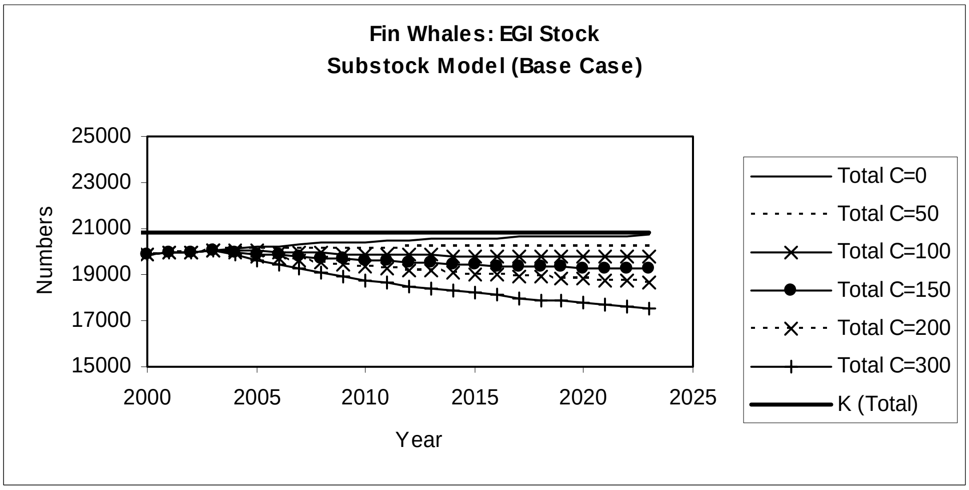

Fig. 4b. Total population trajectories of the fin whale EGI stock in terms of the base case (Equations (A.1)) substock model of SC/11/MF/5 for future annual catches of 0, 50, 100, 150, 200 and 300 animals. Note that the vertical axis minimum is 15000 animals and not zero.

APPENDIX 1

List of Participants

Dr Dorete Bloch
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 35 23 20
Fax: +298 35 23 31
Email: doreteb@ngs.fo

Dr Douglas Butterworth
Dept. of Mathematics and Applied Mathematics,
University of Cape Town
Rondebosch 7701
South Africa
Tel: +27 21 650 2343
Fax: +27 21 650 2334
Email: DLL@maths.uct.ac.za

Dr Carryn Cunningham
Dept. of Mathematics and Applied Mathematics,
University of Cape Town
Rondebosch 7701
South Africa
Tel: +27 31 262 8102
Fax: +27 31 262 8102
Email: c.l.cunningham@telkomsa.net

Dr Anna K. Danielsdottir
Division of Population Genetics,
Marine Research Institute,
c/o Biotechnology House,
Keldnaholt, IS-112 Reykjavik,
Iceland
Tel: +354 5707 221
Fax: +354 5707 210
Email: andan@iti.is

Dr Geneviève Desportes,
Fjord and Belt Centre
Margrethes Plads 1
DL-5300 Kerteminde
Denmark.
Tel: +45 65 32 57 83
Fax: +45 65 32 42 64
Email: genevieve@fjord-baelt.dk

Mr Thorvaldur Gunnlaugsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5331363
Fax: +354 5623790
Email: thg@hafro.is

Dr Grete Hovelsrud-Broda,
General Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Cenntre,
N-9296 Tromsø,
Norway
Tel: +47 77 75 01 78
Fax: +47 77 75 01 81
Email: gretehb@nammco.no

Mr Bjarni Mikkelsen
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 31 85 88
Fax: +298 31 85 89
Email: bjarnim@ngs.fo

Ms Droplaug Ólafsdóttir
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5520 240
Fax: +354 5623 790
Email: droplaug@hafro.is

Mr Daniel Pike
Scientific Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø,
Norway
Tel: +47 77 75 01 77
Fax: +47 77 75 01 81
Email: dan.pike@nammco.no

Dr Hans J. Skaug
Institute of Marine Research
P.O.Box 1870 Nordnes
N-5024 Bergen
Norway
Tel: +47 55 23 84 25
Fax: +47 55 23 86 87
Email: skaug@imr.no

Mr Gísli Víkingsson
Chairman
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5520 240
Fax: +354 5623 790
Email: gisli@hafro.is

Dr Lars Walløe
Department of Physiology
University of Oslo
P.O. Box 1103, Blindern
N-0317 Oslo
Norway
Tel: +47 22 85 12 18
Fax: +47 22 85 12 49
Email: lars.walloe@basalmed.uio.no

Dr Lars Witting
Greenland Nature Research Institute
P.O.Box 570
DK-3900 Nuuk
Greenland
Tel: +299 32 10 95
Fax: +299 32 59 57
Email: larsw@natur.gl

Dr Nils Øien
Institute of Marine Research
P.O.Box 1870 Nordnes
N-5024 Bergen
Norway
Tel: +47 55 23 86 11
Fax: +47 55 23 86 17
Email: nils@imr.no

APPENDIX 2

Agenda

1. OPENING REMARKS

2. ADOPTION OF AGENDA

3. APPOINTMENT OF RAPPORTEUR

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

5. MINKE WHALES – CENTRAL ATLANTIC STOCK

    5.8 Stock structure
    5.9 Biological parameters
    5.10 Catch data
    5.11 Abundance estimates
    5.12 Assessments
    5.13 Management recommendations
    5.14 Research recommendations

6. FIN WHALES

    6.6 Stock structure
    6.7 Biological parameters
    6.8 Catch data
    6.9 Abundance estimates
    6.10 Assessments
        6.7.1 EGI
        6.7.2 Faroes
        6.7.3 Other
    6.8 Management recommendations
        6.8.1 EGI
        6.8.2 Faroes
        6.8.3 Other
    6.9 Research recommendations

7. OTHER BUSINESS

8. ADOPTION OF REPORT

.

APPENDIX 3

List of Documents

Document No.

SC/11/MF/1	List of participants
SC/11/MF/2	Draft agenda
SC/11/MF/3	Draft list of documents
SC/11/MF/4	[IWC] International Whaling Commission. 2003. Report of the Scientific Committee. Annex D. Report of the Sub-committee on the Revised Management Procedure. Appendix 14. Report of the Working Group on North Atlantic Minke Whales RMP *Implementation Review.*
SC/11/MF/5	Cunningham, C.L. and Butterworth, D.S. Updated Assessments of the Central Stock of Minke Whales and the East Greenland-Iceland and Faroese Stocks of Fin Whales in the North Atlantic.
SC/11/MF/6	Gunnlaugsson, Th. Assessment of the East Greenland-Iceland fin whale in a subs-stock model with mixing based on marking data.
SC/11/MF/7	Witting, L. Bayesian assessments of Central Stock minke whales based on density regulated dynamics.
SC/11/MF/8	Witting, L. Bayesian assessments East Greenland-Iceland and Faroese fin whales based on density regulated dynamics.
SC/11/MF/9	Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. Abundance of fin whales southwest of Iceland in 2003, and comparisons with earlier surveys.
SC/11/MF/10	Øien, N. Distribution and abundance of large whales in the Northeast Atlantic, 1995.
SC/11/MF/11	[NAMMCO] North Atlantic Marine Mammal Commission. 2003. Report of the Working Group on Abundance Estimates.
SC/11/MF/13	Bloch, D. and Stefansson. Revised catch data for large whales in the Faroes
SC/11/MF/14	Mikkelsen, B., Bloch, D. and Heide-Jørgensen, M.-P. Preliminary results from satellite tagging of fin whales in the Faroe Islands
SC/11/MF/15	Pike, D.G. Abundance estimates for assessments of North Atlantic minke and fin whales.
SC/11/MF/16	Pike, D.G. Catch statistics for North Atlantic minke and fin whales.
SC/11/MF/17	Allison, C. Comments on SC/11/MF/13: Revised catch data for large whales in the Faroes
SC/11/MF/18	Øien, N. And Hartvedt, S. Distribution of fin whales in the Northeast Atlantic based

.

on incidental sightings, 1967-2002.

SC/11/MF/19 Vikingsson, G. and Heide-Jørgensen, M.P. A note on the movements of minke whales tracked by satellite in Icelandic waters in 2001 and 2002.

.

APPENDIX 4

CATCH STATISTICS FOR NORTH ATLANTIC FIN AND MINKE WHALES

File: EGI Fin
Source: NAMMCO 2000
Notes: None.

YEAR	M	F
1883	2	4
1884	10	12
1885	12	16
1886	10	12
1887	15	16
1888	25	28
1889	54	61
1890	55	61
1891	66	72
1892	90	97
1893	213	232
1894	156	171
1895	208	226
1896	137	149
1897	223	241
1898	155	168
1899	233	254
1900	221	237
1901	260	281
1902	280	304
1903	390	418
1904	251	271
1905	279	300
1906	195	209
1907	316	338
1908	316	339
1909	424	455
1910	270	291
1911	204	219
1912	72	77
1913	52	57
1914	24	26
1915	59	62
1916	21	21
1917	0	0
1918	0	0
1919	0	0
1920	34	34
1921	22	22
1922	20	19
1923	24	24
1924	30	31
1925	29	28

YEAR	M	F
1926	19	20
1927	23	20
1928	36	34
1929	53	56
1930	157	112
1931	1	8
1932	98	96
1933	118	102
1934	59	56
1935	21	23
1936	37	56
1937	165	124
1938	82	77
1939	84	63
1940	0	0
1941	0	0
1942	0	0
1943	0	0
1944	0	0
1945	0	0
1946	13	10
1947	27	22
1948	106	116
1949	123	156
1950	162	172
1951	143	200
1952	99	127
1953	107	111
1954	70	107
1955	120	120
1956	134	165
1957	190	235
1958	143	151
1959	97	81
1960	81	79
1961	65	77
1962	166	139
1963	152	134
1964	114	116
1965	161	136
1966	163	149
1967	111	128
1968	102	101

YEAR	M	F
1969	117	134
1970	153	138
1971	97	111
1972	122	116
1973	135	132
1974	142	143
1975	127	118
1976	132	143
1977	64	80
1978	106	131
1979	127	133
1980	117	120
1981	121	133
1982	96	98
1983	70	74
1984	67	100
1985	73	88
1986	27	49
1987	38	42
1988	31	37
1989	23	45

.

File: EGI Area B Fin
Source: NAMMCO 2000
Notes: Some corrections made to published file.

YEAR	M	F
1883	2	3
1884	8	9
1885	9	12
1886	8	9
1887	11	12
1888	19	21
1889	41	46
1890	41	46
1891	50	54
1892	68	73
1893	169	174
1894	113	124
1895	154	167
1896	97	107
1897	161	174
1898	106	116
1899	162	178
1900	149	161
1901	174	190
1902	183	200
1903	252	273
1904	164	179
1905	182	197
1906	123	134
1907	199	216
1908	201	218
1909	272	296
1910	180	196
1911	133	145
1912	44	47
1913	29	32
1914	7	8
1915	16	18
1916	0	0
1917	0	0
1918	0	0
1919	0	0
1920	0	0
1921	0	0
1922	0	0
1923	0	0
1924	0	0
1925	0	0
1926	0	0
1927	0	0
1928	0	0
1929	37	32

YEAR	M	F
1930	131	79
1931	1	8
1932	98	96
1933	90	80
1934	50	46
1935	12	13
1936	27	45
1937	119	85
1938	55	58
1939	66	43
1940	0	0
1941	0	0
1942	0	0
1943	0	0
1944	0	0
1945	0	0
1946	0	0
1947	0	0
1948	92	103
1949	107	142
1950	97	129
1951	123	189
1952	98	126
1953	101	106
1954	70	107
1955	118	118
1956	116	149
1957	150	198
1958	141	148
1959	97	81
1960	81	79
1961	65	77
1962	165	138
1963	152	131
1964	110	107
1965	156	132
1966	162	148
1967	111	128
1968	101	101
1969	117	134
1970	153	138
1971	97	111
1972	122	116
1973	135	132
1974	142	143
1975	127	118
1976	132	143

YEAR	M	F
1977	64	80
1978	105	131
1979	127	133
1980	117	120
1981	121	133
1982	96	98
1983	70	74
1984	67	100
1985	73	88
1986	27	49
1987	38	42
1988	31	37
1989	23	45

.

File: Faroes EEZ Fin
Source: NAMMCO 2001
Notes: None

Year	M	F
1894	22	22
1895	12	12
1896	30	29
1897	37	37
1898	55	56
1899	69	68
1900	93	93
1901	111	111
1902	145	146
1903	215	214
1904	131	131
1905	147	147
1906	124	124
1907	202	201
1908	193	193
1909	243	243
1910	121	121
1911	106	105
1912	55	55
1913	56	56
1914	59	59
1915	151	151
1916	84	84
1920	136	137
1921	87	87
1922	78	77
1923	96	97
1924	121	124
1925	114	110
1926	77	79
1927	92	79
1928	143	137
1929	65	94
1930	102	131
1933	49	41
1934	34	40
1935	36	39
1936	40	42
1937	73	69
1938	108	75
1939	73	80
1945		
1946	53	39
1947	107	89
1948	112	111
1949	101	121

Year	M	F
1950	211	165
1951	78	78
1952	15	5
1953	43	44
1954	6	11
1955	46	34
1956	22	21
1957	71	70
1958	7	9
1962	5	1
1963	0	3
1964	4	9
1965	5	5
1966	3	1
1968	4	2
1977		
1978	5	2
1979	4	7
1981	2	1
1982	1	2
1983	1	4
1984	2	0

.

File: Faroes Medium Fin
Source: NAMMCO 2001
Notes: None

Year	M	F
1894	22	22
1895	12	12
1896	30	29
1897	37	37
1898	55	56
1899	69	68
1900	93	93
1901	111	111
1902	145	146
1903	215	214
1904	149	150
1905	186	186
1906	134	135
1907	250	249
1908	228	229
1909	383	383
1910	203	204
1911	203	201
1912	119	120
1913	133	132
1914	143	142
1915	151	151
1916	84	84
1920	251	253
1921	87	87
1922	107	104
1923	173	174
1924	196	198
1925	196	192
1926	154	156
1927	169	162
1928	166	166
1929	65	94
1930	102	131
1933	49	41
1934	34	40
1935	36	39
1936	40	42
1937	73	69
1938	108	75
1939	73	80
1946	53	39
1947	107	89
1948	112	111
1949	101	121
1950	229	180
1951	81	88
1952	15	5
1953	43	44
1954	6	11
1955	46	34
1956	22	21
1957	71	70
1958	7	9
1962	5	1
1963	0	3
1964	4	9
1965	5	5
1966	3	1
1968	4	2
1978	5	2
1979	4	7
1981	2	1
1982	1	2
1983	1	4
1984	2	0

.

File: Faroes Large High Fin
Source: NAMMCO 2001
Notes: Some corrections made to published version.

Year	M	F
1883	2	3
1884	8	9
1885	9	12
1886	8	9
1887	11	12
1888	19	21
1889	41	46
1890	41	46
1891	50	54
1892	68	73
1893	160	174
1894	135	146
1895	166	179
1896	127	136
1897	198	211
1898	161	172
1899	231	246
1900	242	254
1901	285	301
1902	328	346
1903	525	545
1904	513	529
1905	554	569
1906	406	418
1907	599	615
1908	593	611
1909	815	839
1910	517	534
1911	467	477
1912	274	278
1913	275	277
1914	264	264
1915	167	169
1916	84	84
1918	302	303
1919	239	238
1920	402	429
1921	105	106
1922	279	275
1923	326	326
1924	508	510
1925	435	435
1926	475	457
1927	421	372
1928	440	407
1929	163	215
1930	146	187
1931	39	30
1932	92	98
1933	278	229
1934	91	115
1935	82	98
1936	112	117
1937	350	304
1938	248	196
1939	207	228
1941	5	1
1942	33	25
1943	67	43
1944	55	57
1945	80	79
1946	260	224
1947	245	236
1948	222	220
1949	196	230
1950	355	305
1951	225	195
1952	169	142
1953	142	160
1954	114	115
1955	111	84
1956	51	61
1957	118	115
1958	28	41
1959	51	47
1960	32	45
1961	62	57
1962	48	27
1963	9	15
1964	7	12
1965	8	7
1966	3	1
1967	1	5
1968	8	6
1969	1	1
1978	5	2
1979	4	7
1981	2	1
1982	1	2
1983	1	4
1984	2	0

.

File: Faroes Large Low Fin
Source: NAMMCO 2001
Notes: Some corrections made to published version
.

Year	M	F
1883	1	1
1884	3	3
1885	3	4
1886	3	3
1887	4	4
1888	6	7
1889	14	15
1890	14	15
1891	17	18
1892	23	24
1893	53	58
1894	60	63
1895	63	68
1896	62	65
1897	91	95
1898	90	95
1899	123	127
1900	143	147
1901	169	174
1902	206	213
1903	357	363
1904	404	410
1905	433	438
1906	324	329
1907	466	471
1908	459	466
1909	634	642
1910	397	403
1911	378	380
1912	245	247
1913	256	256
1914	259	259
1915	156	157
1916	84	84
1918	302	303
1919	239	238
1920	402	429
1921	105	106
1922	279	275
1923	326	326
1924	508	510
1925	435	435
1926	475	457
1927	421	372
1928	440	407
1929	163	215
1930	146	187

1931	39	30
1932	92	98
1933	278	229
1934	91	115
1935	82	98
1936	112	117
1937	350	304
1938	248	196
1939	207	228
1941	5	1
1942	33	25
1943	67	43
1944	55	57
1945	80	79
1946	260	224
1947	245	236
1948	222	220
1949	196	230
1950	355	305
1951	225	195
1952	169	142
1953	142	160
1954	114	115
1955	111	84
1956	51	61
1957	118	115
1958	28	41
1959	51	47
1960	32	45
1961	62	57
1962	48	27
1963	9	15
1964	7	12
1965	8	7
1966	3	1
1967	1	5
1968	8	6
1969	1	1
1978	5	2
1979	4	7
1981	2	1
1982	1	2
1983	1	4
1984	2	0

.

File: Faroes South Fin
Source: NAMMCO 2001, IWC
Notes: Includes Faroes Medium + Spanish/Portuguese catches

YEAR	M	F
1894	22	22
1895	12	12
1896	30	29
1897	37	37
1898	55	56
1899	69	68
1900	93	93
1901	111	111
1902	145	146
1903	215	214
1904	149	150
1905	186	186
1906	134	135
1907	250	249
1908	228	229
1909	383	383
1910	203	204
1911	203	201
1912	119	120
1913	133	132
1914	143	142
1915	151	151
1916	84	84
1917	0	0
1918	0	0
1919	0	0
1920	251	253
1921	248	249
1922	393	389
1923	713	714
1924	805	807
1925	966	955
1926	797	785
1927	351	349
1928	166	166
1929	65	94
1930	102	131
1931	0	0
1932	0	0
1933	49	41
1934	67	73
1935	36	39
1936	40	42
1937	73	69
1938	108	75
1939	73	80
1940	0	0

1941	0	0
1942	0	0
1943	0	0
1944	19	19
1945	18	18
1946	74	60
1947	183	170
1948	178	177
1949	101	121
1950	257	192
1950	246	197
1951	118	113
1952	61	51
1953	57	59
1954	28	33
1955	64	52
1956	25	24
1957	96	95
1958	23	30
1959	26	28
1960	65	59
1961	79	80
1962	29	27
1963	8	14
1964	43	29
1965	87	78
1966	61	50
1967	54	45
1968	64	48
1969	73	43
1970	97	84
1971	58	41
1972	41	56
1973	57	54
1974	65	55
1975	77	60
1976	113	121
1977	129	118
1978	342	293
1979	314	259
1980	113	105
1981	80	69
1982	59	94
1983	63	62
1984	35	69
1985	18	30

.

File: CM Minke
Source: 1930-1996- NAMMCO 1999; Catches post 1996 are compiled from from IWC National Progress Reports for Greenland. Information for Norway was provided by Nils Øien. Catches for Iceland in 2003 were provided by Gisli Vikingsson.
Notes: S/L means struck and lost. For Norway these are animals with unreported sex, probably because they were struck and lost. Bycatch is assumed to be 5 per year in Iceland for a "high catch" case. IUC means illegal unreported catch and is assumed to be 10 per year in Iceland after 1986 for a "high catch" case

Year	M	F	S/L	Bycatch	IUC
1930	5	5		5	0
1931	3	3		5	0
1932	3	3		5	0
1933	3	3		5	0
1934	3	3		5	0
1935	3	3		5	0
1936	1	0		5	0
1937	1	0		5	0
1938	0	0		5	0
1939	0	0		5	0
1940	0	0		5	0
1941	7	7		5	0
1942	7	8		5	0
1943	7	7		5	0
1944	7	7		5	0
1945	7	7		5	0
1946	18	15		5	0
1947	27	18		5	0
1948	56	43		5	0
1949	59	52		5	0
1950	18	15		5	0
1951	20	18		5	0
1952	21	19		5	0
1953	20	18		5	0
1954	20	18		5	0
1955	25	33		5	0
1956	26	21		5	0
1957	25	21		5	0
1958	23	21		5	0
1959	33	28		5	0
1960	37	32		5	0
1961	120	61		5	0
1962	164	125		5	0
1963	114	105		5	0
1964	208	114		5	0
1965	194	206		5	0
1966	181	173		5	0
1967	315	159		5	0
1968	386	350		5	0
1969	171	120		5	0
1970	203	159		5	0
1971	172	131		5	0

.

1972	204	166		5	0
1973	250	127		5	0
1974	143	109		5	0
1975	180	221		5	0
1976	175	110		5	0
1977	107	88		5	0
1978	146	162		5	0
1979	166	118		5	0
1980	198	120		5	0
1981	129	117		5	0
1982	212	109		5	0
1983	164	125		5	0
1984	136	149		5	0
1985	113	123		5	0
1986	6	46		5	10
1987	12	42		5	10
1988	4	1		5	10
1989	1	0		5	10
1990	5	0		5	10
1991	5	2		5	10
1992	8	0		5	10
1993	7	8		5	10
1994	8	38		5	10
1995	6	38		5	10
1996	12	40		5	10
1997	1	29	4	5	10
1998	9	58	0	5	10
1999	10	59	3	5	10
2000	25	41	1	5	10
2001	4	41	3	5	10
2002	6	39	0	5	10
2003	23	13	0	5	0

.

File: CIC Minke
Source: NAMMCO 1999. Catch for Iceland in 2003 was provided by Gisli Vikingsson.
Notes: S/L means struck and lost. Bycatch is assumed to be 5 per year in Iceland for a "high catch" case. IUC means illegal unreported catch and is assumed to be 10 per year in Iceland after 1986 for a "high catch" case.

YEAR	M	F	Bycatch	IUC
1930	5	5	5	0
1931	3	3	5	0
1932	3	3	5	0
1933	3	3	5	0
1934	3	3	5	0
1935	3	3	5	0
1936	1	0	5	0
1937	1	0	5	0
1938	0	0	5	0
1939	0	0	5	0
1940	0	0	5	0
1941	7	7	5	0
1942	7	7	5	0
1943	7	7	5	0
1944	7	7	5	0
1945	7	7	5	0
1946	18	15	5	0
1947	27	18	5	0
1948	56	43	5	0
1949	56	48	5	0
1950	18	15	5	0
1951	20	18	5	0
1952	21	19	5	0
1953	20	18	5	0
1954	20	18	5	0
1955	24	27	5	0
1956	23	21	5	0
1957	24	21	5	0
1958	23	21	5	0
1959	24	21	5	0
1960	30	23	5	0
1961	71	34	5	0
1962	78	50	5	0
1963	69	54	5	0
1964	114	48	5	0
1965	80	62	5	0
1966	87	77	5	0
1967	135	87	5	0
1968	219	206	5	0
1969	93	66	5	0
1970	112	81	5	0
1971	121	98	5	0
1972	115	87	5	0
1973	78	64	5	0
1974	61	63	5	0
1975	89	80	5	0
1976	114	87	5	0
1977	106	88	5	0
1978	85	114	5	0
1979	111	87	5	0
1980	121	81	5	0
1981	119	82	5	0
1982	127	85	5	0
1983	117	87	5	0
1984	100	78	5	0
1985	94	51	5	0
1986	0	0	5	10
1987	0	0	5	10
1988	0	0	5	10
1989	0	0	5	10
1990	0	0	5	10
1991	0	0	5	10
1992	0	0	5	10
1993	0	0	5	10
1994	0	0	5	10
1995	0	0	5	10
1996	0	0	5	10
1997	0	0	5	10
1998	0	0	5	10
1999	0	0	5	10
2000	0	0	5	10
2001	0	0	5	10
2002	0	0	5	10
2003	23	13	5	0

APPENDIX 5

ABUNDANCE ESTIMATES FOR ASSESSMENTS OF NORTH ATLANTIC MINKE AND WHALES

AREA/SPECIES	YEAR	ESTIMATE	CV	BIAS	SOURCE AND COMMENTS

FIN WHALE

.

AREA/SPECIES	YEAR	ESTIMATE	CV	BIAS	SOURCE AND COMMENTS
EGI: entire EGI area	1988	15,614	0.216	1,2	NAMMCO 2000. Variance-weighted average from NASS-87 and NASS-89.
	1995	19,432	0.156	1,2	NAMMCO 1998, SC/11/MF/10
	2001	22,307	0.146	1,2	Pike *et al*. 2003. Re-calculated excluding Faroese block.
EGI "Area B" (Southwest Iceland)	1988	4,586	0.132	1,2	NAMMCO 2000. Variance-weighted average from NASS-87 and NASS-89.
	1995	15,008	0.200	1,2	NAMMCO 2000.
	2001	19,000	0.180	1,2	NAMMCO 2003, Southwest Iceland (blocks A, B, W).
Faroes EEZ	1995	413	0.310	1,2	NAMMCO 2001, but corrected as wrong surface area of Faroese EEZ was used in that estimate. Correct surface area (excluding land) is 79,423 sqr. nm.
	1989	345	0.530	1,2	NAMMCO 2001
	1987	319	0.410	1,2	NAMMCO 2001
	2001	1,612	0.325	1,2	Pike *et al*. 2003. Applied density in Faroese block to EEZ area of 79,423 sqr. nm
Faroese Medium	1987	651	0.410	1,2	NAMMCO 2001
	1989	703	0.530	1,2	NAMMCO 2001
	1995	1,184	0.310	1,2	NAMMCO 2001
	2001	4,617	0.325	1,2,5	Pike *et al*. 2003. Applied density in Faroese block to area of 227,000 sqr. nm.
Faroese large	1987	7,118	0.400	1,2	NAMMCO 2001
	1995	3,603	0.300	1,2	NAMMCO 2001
	2001	6,649	0.224	1,2,4	Pike *et al.* 2003. Including only blocks N, J and Faroes. No estimate available for NSC or southern Iceland.
Faroese South- Includes Faroese medium + remainder of British Isles, Spain and Portugal stock.	1987	5,269	0.100	1,2,4	Buckland *et al*. 1992
	1989	18,038	0.256	1,2,6	Buckland *et al*. 1992
MINKE WHALE					

.

AREA/SPECIES	YEAR	ESTIMATE	CV	BIAS	SOURCE AND COMMENTS
CIC	1987	19,200	0.280	4	NAMMCO 2003, Borchers *et al*. 2003a.
	1995	55,900	0.310	1,3	NAMMCO 1998. **Not recommended for use** (NAMMCO 2002).
	2001	43,600	0.190		NAMMCO 2003, Borchers *et al*. 2003.
Central Stock	1987	25,800	0.212	1,2,4	NAMMCO 2003, Borchers *et al*. 2003. Based on Icelandic and Norwegian ship surveys, and Icelandic aerial survey.
	1995	72,100	0.244	1,2,3	NAMMCO 1998. Based on Icelandic and Norwegian ship surveys, and Icelandic aerial survey. **Aerial survey portion not recommended for use** (NAMMCO 2002).
	2001	63,500	0.158	1,2,4	NAMMCO 2003, Borchers *et al*. 2003, Gunnlaugsson *et al*. 2003. Based on Icelandic ship and aerial surveys.

BIASES

1. Negative, availability
2. Negative, perception
3. Positive, measurement error (cue counts)
4. Negative, coverage
5. Unknown. Density applied to areas not covered in the survey.
6. Positive, coverage

.

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON GREY SEALS

Marine Research Institute, 9-11 April, 2003

1. OPENING REMARKS

Chairman Kjell T. Nilssen welcomed the participants (Appendix 1) to the NAMMCO Scientific Committee Working Group on Grey seals. The Scientific Committee of NAMMCO has previously provided advice on the abundance and stock levels of grey seals in the North Atlantic, with an emphasis on their role in the marine ecosystem and as a source of nematodal infestations in fish (NAMMCO 1997, 1998). However this assessment is now dated, and there have been new developments in some areas that warrant an updated assessment.

In 2001 the Scientific Committee noted that the abundance of grey seals around Iceland had decreased from an estimated 12,000 in 1992 to 6,000 in 1998, and that the annual catch of around 500 seals may not be sustainable. In contrast there have been apparent increases in the abundance of grey seals in other areas, including Southwest Norway, the United Kingdom and Canada. Grey seals are harvested or taken incidentally by fisheries and aquaculture operations in the Faroe Islands, Iceland and Norway. They also have significant direct and indirect interactions with fisheries in these areas. The main task of the Working Group will therefore be to update the status of grey seals in all areas of the North Atlantic.

The general terms of reference of this Working Group are:
- to assess the status of greys seals around Iceland, the UK, the Faroes, Norway, the Russian Federation, the Baltic, Canada and other areas;
- survey methods;
- stock delineation (genetics, temporal and geographical distribution);
- recommendations to the NAMMCO Council.

2. ADOPTION OF AGENDA

The draft agenda (Appendix 2) was accepted without change.

3. APPOINTMENT OF RAPPORTEUR

Daniel Pike, Scientific Secretary of NAMMCO, was appointed as rapporteur for the meeting, with the help from various members of the Working Group.

9. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Documents available to the Working Group are listed in Appendix 3.

5. STATUS OF GREY SEAL STOCKS

5.1 Iceland

Hauksson (SC/11/GS/4) presented information on the population status of the Icelandic grey seal, which has been investigated in the years of 1982, 1986, 1989, 1990, 1992, 1995, 1998 and 2002 by aerial census of grey seals pups on breeding sites. Eight out of a total of 10 surveys have been successful, and have been completed as planned in the months October and November, the main breeding time of the Icelandic grey seal.

The Icelandic grey seal population appeared stable between 1982 and 1990, but since then, the pup-production has been declining by about 6% (95% CI 3% to 9%) annually. The abundance of the grey seals around Iceland in the year 2002 was about 5,000 animals. In the first census in 1982, the population was estimated at about 9,000 and 1990 it reached a maximum of about 12,000 animals.

Grey seals are distributed all around the Icelandic coast. The majority of the population feeds off the west and northwest, with a second area of high density in the southeast coastal waters of Iceland. The breeding distribution of grey seals is somewhat more limited to the southeast and northwest part of the coast. Historically, the distribution of the Icelandic grey seals has changed somewhat. In the last 5 decades grey seals have dispersed from the west coast to the northwest, north and northeastcoasts. Recently following the decrease in population size, its distribution has contracted a little and it is now not found off the northeast coast, where it was breeding about 10 years ago. There is very little evidence for the Icelandic grey seal stock mixing with other grey seal stocks in the North Atlantic.

In discussion the Working Group noted that it was obvious that harvests had been above sustainable levels for more than 10 years, and that the resulting decline in the population was well documented. While no management objectives have been identified explicitly, it is apparent that the implicit objective has been to reduce the stock to some undeclared level. There is an urgent need to identify clear and explicit limits for the stock and to regulate the level of harvest accordingly. If exploitation is continued at its present rate, it is likely that the population will be reduced to very low levels, and likely extirpated in many areas, within the next 10 years. However Hauksson pointed out that the exploitation rate would probably decline as the stock size decreased. Furthermore, Gunnlaugsson noted that the trend predicted above was not based on any modelling of the population, but simply assumed a continued 6% decline per year.

While documented harvests have declined somewhat in recent years, they are still high relative to the size of the stock. In addition, the proportion of animals aged 1 year or older (1+) animals in the catch has increased, which increases the impact of the harvest on the stock. Other sources of human induced mortality include animals shot but lost, and animals killed as bycatch in other fisheries. There are some indications that bycatch may be substantial among young seals, but bycatch has not been adequately documented in Iceland.

The Working Group cautioned that, because the stock has been reduced and is still apparently declining, increased survey and monitoring effort will be required in the future. Once a limit value for the stock has been identified, surveys may have to be carried out more frequently and with higher effort in order to have an acceptable probability of detecting a further decline in population (see Section 6).

It was noted that nature reserves in the southeast, south, west and northwest would likely ensure that the population would not completely vanish there, but there were no nature reserves planned in the north and east of the country. However the efficacy of these protected areas in protecting the population has not been assessed.

The Working Group noted some problems with the estimation of total population size in Icelandic waters. The use of the Leslie Matrix to derive the factor to convert pup counts to estimates of total numbers carries with it the assumption that the population has a stationary age distribution. In addition it is assumed that the age distribution from the hunt is representative of the population. The Working Group considered both assumptions rather unlikely. It was suggested that the model could be improved by explicitly including hunting and other known sources of mortality.

Hauksson and Gunnlaugsson considered that pup counts alone could provide an adequate index of population size on which to base management decisions. The main advantage would be that the assumptions and uncertainties associated with converting pup counts to estimates of total abundance would be avoided. The other members regarded the estimation of total abundance and incorporating known sources of anthropogenic mortality as essential to the setting of risk-averse harvest levels.

Under certain types of catch mortality, pup production could remain relatively constant as the adult population ages, which could lead to a sudden crash in the population as more females die or become reproductively senescent. Monitoring pup numbers alone would give no forewarning under such circumstances.

5.2 United Kingdom

Duck reported on the estimation of grey seal numbers in British waters, as presented in SC/11/GS/5, 13 and 14. British grey seals are monitored using a two stage process. Firstly pup production is estimated at most of the major breeding colonies, accounting for approximately 85% of pups born in Britain. Then the total pup production is used to obtain estimates of total grey seal population aged one year and over.

Pup production is determined annually using a series (4 to 7) of aerial surveys, carried out at 10-13 day intervals over 40 primary breeding colonies. The surveys use a large format aerial camera mounted in a vibration-damped, motion compensating cradle. The photographs can give a resolution of 5-7 mm from a height of 365 m. Counts of pups are made directly from the photographs on a microfiche reader which magnifies the photos by 22 times. Pups are classed as whitecoat, moulted or dead. In the modelling process, the whitecoat and dead totals are combined. Using whitecoat and moulted stages provides sufficient degrees of freedom for the model to estimate various parameters including: total production, 95% CIs, birth start date and mean birth date.

This stochastic modelling of the birth process and the development of pups allows the generation of a 40 year time series of pup production estimates for the majority of the British grey seal colonies (see Fig. 1). The most reliable time series of estimates covers the period from 1984 to 2001. The average annual rate of increase between 1984 and 1999 was 6.3% ±0.26%. Observed trends in pup production varied locally and regionally. Total pup production for the west coast of Scotland increased more slowly than at colonies in Orkney and on the North Sea coast. All of the increase on the west coast of Scotland was the result of changes at one group of islands: the Monach Isles.

Since 1992 pup production at the Monach Isles has been virtually constant and the annual rate of increase in the combined production for all colonies on the west coast of Scotland has declined from 5.6 ± 0.53% to 0.8 ± 0.62%. The rate of increase in pup production for all British colonies declined from 5.8 ± 0.63% before 1992 to 4.5 ± 0.38% from 1992 to 1999.

The Sea Mammal Research Unit (University of St Andrews, Scotland) is in the process of revising the method used to estimate the total grey seal population size. Three alternative approaches are available: a model devised by I.L. Boyd, a second by K. Newman and L Thomas which is under development and a third by L. Hiby which has been used since 1984. The descriptions below relate to this last model.

The annual estimates of pup production can be used to update, each year, a trajectory of total population size estimates, with associated levels of uncertainty. Simulation models are used to approximate the likelihood function for all the data combined and hence provide maximum likelihood estimates for the demographic parameters, female population size and other statistics of the population that are not directly observable.

The simulation models allow for measurement error and random variation in juvenile survival and recruitment. If these stochastic processes are assumed to be stationary the 95% confidence limits on estimates of female population size over the last 15 years are in the range ±15% to 20%. The estimate for the total number of females alive just before the 1999 breeding season is 63,000 (to the nearest 1,000 with 95% confidence limits from 54,000 to 73,000. The point estimate for females and males is 109,000. These figures refer to seals associated with the annually monitored colonies, which hold over 85% of the British population.

.

Recent declines in pup production estimates from the surveys suggest one or more of the demographic parameters may be exhibiting some trend over time as well as year to year variation. The available data do not provide evidence for this, significant at the 95% level. However, the fact that such trends can have a large effect on the total population size estimate increases the real level of uncertainty beyond that derived under the stationary assumption.

In discussion the Working Group noted that this was certainly one of the longest and most precise time series of abundance for any marine mammal, and possibly for any mammal, in existence. The precision and detail in the time series will allow analyses of environmental effects on pup production and other life history parameters. Because data is collected every year, the effects of extreme events such as epizootics can be determined at both the population and breeding colony levels. Given that there is little direct harvest or bycatch from the population, less frequent or partial surveys might be adequate for management purposes. In general the frequency and precision of surveys should be tailored to the objectives of management. However the synoptic and annual nature of the time series make it unique, and serious consideration should be given to its value for the study of marine mammal population dynamics in general before major changes are made to the program.

The reasons for the rapid population expansion in many areas of Scotland since 1960 are uncertain. There has been little harvest of this population since early in the 20th century. Some culling was carried out in the 1970's and 1980's, and this may have had the unintended effect of forcing females to found new pupping colonies, thus expanding the breeding habitat of the population. In addition, the human occupation of the isolated outer islands has decreased over the past 50 years, allowing the development of breeding colonies on these islands.

While there is substantial annual variation in pup production at individual colonies, there is little evidence that females switch between breeding sites. Most females seem to return to the same breeding site year after year. The specific timing of breeding can vary substantially even between nearby sites, so it is necessary to derive the pupping ogive individually for each site. At least 4 surveys at each site are necessary to parameterise the log-normal model used. However this level of effort may not be possible in some other areas.

It was noted that the models used to convert pup counts to estimates of total population size were different between the UK, Canada and Iceland, and these differences are explored further under Item 6.

5.3 Baltic

Harding *et al.* (SC/11/GS/6) reviewed the status of the grey seal in the Baltic Sea. This population is recovering after a century of bounty hunting and three decades of low fertility rates caused by environmental pollution. The growing population has led to increased interactions with the fishery, and demands have increased for the re-introduction of hunt. A demographic analysis and a risk assessment of the population has been carried out to make recommendations on how to decrease the risk of quasi-extinction (i.e. reduction below a threshold level) by overexploitation. Although hunting increases the risk of quasi-extinction, the risk can be significantly reduced by the choice of a cautious hunting regime. The least hazardous regimes allow no hunting below a ‘security level’ in population size. Obviously, to implement such a hunting regime knowledge of the population size and growth rate are required. With the current survey methodology, it would take more than 9 years to detect a 5% change in the annual rate of population increase. A hunt exceeding 300 females (less than 600 of both sexes) increases the risk for quasi-extinction substantially. The age and sex composition of killed animals influences the ‘cost of the hunt’.

.

In discussion the Working Group considered that the risk assessment methodology used in SC/11/GS/6 might be applicable to other grey seal assessments. In particular it could be applied to the Norwegian situation, where takes of up to 25% of the population are planned (see 5.5).

The Baltic population is severely depleted relative to historical levels. The estimate of pre-exploitation population size is based on information from the commercial and bounty harvests, when hunters were required to return a lower jaw to win the bounty. The former population size has been back-calculated based on historical harvests and more recent estimates of absolute population size (Harding and Härkönen 1999). At present there seem to be no signs of density dependence in the population. However there have been radical changes in the Baltic Sea environment, due to the effects of fishing, depletion of other seal species, environmental pollution and possibly climate change, so there is no reason to expect that carrying capacity would be the same as historical levels. Nevertheless there appears to be room for expansion of this population.

Even with annual estimates of abundance a considerable period of time might pass before a negative population trend could be reliably detected. Other triggers for management action, such as local depletion or changes in spatial distribution, might also be developed. However it was noted that the distribution of Baltic grey seals has changed historically and varies quite dramatically from year to year, partially dependent on ice conditions.

5.3 Faroes

Mikkelsen (SC/11/GS/7) reviewed present knowledge of the Faroese grey seal population. Based on historical sources, there seems to have been a long tradition for harvesting grey seals in the islands, mainly at breeding grounds. Grey seals in the Faroes mainly breed in caves, which is exceptional for the species. But it may explain why biological investigations not have been initiated on grey seals in Faroese waters: biological knowledge is limited and certainly insufficient. No management regime has been implemented. Today, the only harvest occurs around fish farms, when seals are interacting with the farms. Logbooks are not mandatory; therefore, hunting statistics are lacking. From direct contact to fish farmers, the annual harvest level is estimated to be in the order of 250 to 500 seals, which seems surprisingly high for the population. Present population size is unknown. No tagging experiments have been conducted on Faroese grey seals, but such studies on neighbouring populations have indicated that the annual number of British grey seals migrating into Faroese waters may be significant. The British and Canadian grey seal populations have been increasing for many years, but this has not been observed in the Faroese grey seal population. The main reason may be the cull of grey seals around the 30 fish farms in operation today. Also, the number of good quality breeding caves may be limited in the Faroes, preventing the population from increasing above the carrying capacity of breeding sites.

In discussion it was noted that the cave breeding habit of Faroese grey seals, while unusual, is not unique to the Faroes, and that cave breeding occurs in the UK as well. It does make counting pups considerably more difficult, and perhaps impossible in some cases. There are no recent observations of Faroese grey seals breeding in caves or anywhere else, but there are historical accounts of people entering caves to hunt breeding grey seals. In addition some whitecoated and weaned pups are observed in the winter, so there is evidence that some breeding does occur in the Faroes.

It was considered likely that the population around the Faroes is a mixture of animals that breed there and possibly form a distinct population, and migrant animals from the UK and possibly other areas. There is direct evidence from satellite tagging experiments and flipper tag returns that UK seals do reach the Faroes, perhaps in considerable numbers. More information will be required to determine the proportion of each component in the grey seals around the Faroes.

The Working Group expressed concern that the Faroese grey seal population is subject to an apparently high but unknown level of exploitation, and that this exploitation has developed rather recently since the advent of fish farming activities. Unlike the historical harvest, which targeted seals in their breeding caves, salmon farmers take seals in open water. The inaccessibility of some breeding caves therefore no longer provides protection against depletion of the local breeding population. The abundance of breeding and migrant seals in the area is unknown. However the number of seals breeding in the Faroes is unlikely to be large because breeding habitat is limited. Therefore, even if the human take includes a large proportion of migrant animals, the local population might still be subject to depletion.

The Working Group therefore 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. The highest priorities will be improved harvest monitoring, sample collection for genetic analysis, and cataloguing of breeding sites (See Section 8.1).

5.5 Norway

Nilssen *et al*. (SC/11/GS/8) summarised preliminary results from grey seal ship based surveys along the Norwegian coast in 2000-2002 (and how these compared with results from 1996-1998), and also provided information about catch regulations and known removals from the population. Most of the grey seal whelping areas from Rogaland county to Finnmark county were investigated. Due to difficult weather conditions the areas north of Vega in Nordland county and Troms county were poorly covered. Seal pups were observed from an inflatable boat, after which researchers landed where pups were observed. When possible, pups were caught, tagged, and developmental stage was recorded. In some cases only developmental stage was recorded. Total population estimates were derived from estimates of pups by using a range of multipliers (4.28 and 5.35).

In Rogaland, pupping occurred only on the Kjør Islands where 28-30 pups were counted each year in the period 2000-2002, which gives an abundance estimate of 128-160 seals (1+). No whelping was observed between the Kjør Islands in Rogaland and Froan in Sør-Trøndelag.

It was estimated that 303 pups were born in the Froan archipelago, which gives an abundance estimate of 1,296-1,620 seals (1+). The pup production was comparable with observations made both in 1993 and 1996.

A total production of 340 pups were estimated in the area of Hortavær in Nord-Trøndelag to Storbraken in Nordland, which gives an estimate of 1,455-1,819 seals (1+). The estimated number of pups born in 2001 was about 24% above results from aerial photographic surveys conducted in the same area in 1998.

In Finnmark, a total of 142 pups were recorded, which corresponds to an abundance estimate range of 608-760 seals (1+). This is an increase of approximately 21% compared with the results from a similar survey conducted in 1998. However, both results are probably underestimates because only one visit was made to each whelping site.

When results from aerial surveys conducted in 1998 in northern parts of Nordland and Troms are combined with the estimates from this study the number of pups born in Norwegian waters are calculated to be about 1,030, which corresponds to about 4,400-5,500 seals (1+).

Total annual catches of grey seals in Norwegian waters ranged from 34-176 animals in 1997-2002, which corresponds to 13%-49% of the scientifically based recommended quotas(which are 5% of the estimated population size), and 11%-35% of the given quotas. There are no catch statistics available prior to 1997.

In areas with particular conflicts between grey seals and fisheries, Norwegian management authorities have occasionally attempted to use hunting to control population growth and population size by increasing the recommended quotas by 20%-30%. When quotas were set for the 2003 season this approach was taken a large step further in that the quotas in most areas were set at 25% of current population estimate. Also, a bounty of NOK 500, is to be awarded for each grey seal documented killed.

In discussion the Working Group noted that the new quota levels of 25% of the estimated population size would, if taken, certainly result in population reduction. However no formal analysis of the effect of this level of harvest on the population, including the risk of extinction the sensitivity of the survey program to detect a population decline, has been conducted. While harvests have been considerably below quota levels to date, the possibility that the quotas might be filled should be evaluated, especially considering that a bounty system is now in place.

It is likely that some proportion of the animals shot are killed but not landed. This proportion of shot but lost (S/L) animals has been observed to be up to 50% in some areas, because many seals sink when they are shot. As the quotas are based on landed animals, the actual anthropogenic take is likely to be considerably higher than the reported harvest. The Working Group recommended that a study be carried out to determine S/L rates in different areas, seasons and under different conditions.

There is some indication from tag returns that bycatch, particularly of young seals, in bottom set gill nets may be considerable in this area. This source of mortality must also be included in any assessment of the population.

Frie informed the Working Group that a research program had been started to look at the population genetics of grey seals in Norwegian waters. Samples have been collected from pups on the breeding sites during surveys, and both mitochondrial and microsatellite DNA analyses will be carried out. Co-operation with other areas, especially the UK and Russia, will be sought to compare samples from these areas. The research program will also include photo-identification at selected breeding sites to look at site fidelity. This could also form the basis for future mark-recapture estimates of abundance, and studies of paternity and mating systems.

5.6 Russia (Murman Coast)

Mishin (SC/11/GS/9) presented information on investigations on grey seals along the Murman coast of the Russian Federation. Grey seals on the Murman coast have been protected since 1958 and are included in the Red Data Book of the USSR and the Russian Federation. On the Murman coast grey seals are generally confined to two main breeding areas, the western Aynov (Big and Little Aynov Islands and Big Kiy Island) and the eastern "Seven Islands" (pups are born mainly on Big Litskiy and Veshnyak islands) archipelagos. Most grey seal breeding areas on the Murman coast are included in Kandalaksha Nature Reserve.

Few estimates of the numbers of grey seals inhabiting the Murman coast have been made. Investigations in the early 1960s suggested that about 600 seals inhabited the area at that time. Subsequent studies carried out in 1986 and 1991/92 have indicated that *ca* 400 pups are born in the area, suggesting a population of about 3,500 animals.

Recent research has been carried out from shore-based sighting stations on the coast, from which sightings of all seals and cetaceans are registered. Grey seals begin to be seen in the area in early April. Numbers sighted peak in June and July, after which sightings slowly decline to the end of the sighting period in September. Additional research on captive grey seals has been carried out at the Murmansk Oceanarium.

Preliminary plans are being made to repeat the vessel-based surveys conducted in 1991/92 on the breeding areas during the pupping season.

In discussion the Working Group noted that the Murmansk breeding colonies were the largest Eastern Atlantic colonies outside of the UK. The seals have been fully protected from exploitation for many years. There is no coastal fishery in the area so bycatch is likely low. It is possible that the population has grown. The Working Group therefore recommended that a new survey be conducted in the area at the earliest opportunity.

5.7 Eastern North America

Canada

Hammill *et al.* (SC/11/GS/10) presented information on the status of Northwest Atlantic grey seals in Canada. Northwest Atlantic grey seals form a single stock, but are often considered as two groups, named for the location of the main pupping locales for management purposes. The largest group whelps on Sable Island, 290 km east of Halifax, Nova Scotia. The second group, referred to as non-Sable Island or Gulf animals, whelps on the pack ice in the southern Gulf of St. Lawrence, with other smaller groups pupping on small islands in the southern Gulf of St. Lawrence and along the Nova Scotia Eastern Shore. Estimates of pup production in this group have been determined using mark-recapture and aerial survey techniques. Aerial surveys use a combination of reconnaissance surveys to detect whelping patches, visual strip transect techniques to estimate the number of animals on the ice, and corrections to the visual estimates for births that occurred after the survey has been flown. Visual aerial surveys flown during January-February 1996, 1997 and 2000 in the southern Gulf of St Lawrence and along the Eastern Shore resulted in pup production estimates of be 11,110 (6,720-14,540), 5,810 (3,480-8,150) and 5,450 (3,860-7,040) in 1996, 1997 and 2000 respectively after correcting for births and including counts of pups on small islands. Incorporating information on pup production, reproduction rates and removals during government sponsored culling and bounty programs into a population model indicates that the Canadian component of the Northwest Atlantic grey seal population has increased from slightly less than 30,000 animals in 1970 to over 260,000 animals in 2000. The Sable Island and Gulf components of the population have followed very different population trajectories over time owing in part to the greater protection afforded Sable animals and higher mortality rates for Gulf animals whelping on the less stable pack ice. At the same time, differences between the two groups in predicted adult mortality rates suggest that some other mechanisms may be involved. The last complete survey of this population was completed in 1997. Given the rapid growth observed this population, and the significant environmental changes that have occurred over the last 6 years, population projections cannot be considered reliable. A new assessment is needed.

Currently, there is no commercial harvest for grey seals in Canada. A few hundred are taken as part of industry interest in market development. In 2002, the Department of Fisheries and Oceans adopted an Objective Based Fisheries Management approach for seal populations. This scheme adopts two different approaches based on whether seal populations are considered data rich or data poor. A population is considered data rich if recent estimates of catch levels, reproductive rates and estimates of mortality are available. Under a data rich scenario, two precautionary reference points are established at 70% (N_{70}) and 50% (N_{buffer}) of the largest estimated population size. Management objectives ensure that the population size remains above $N_{70.}$ If harvesting results in a declining population, harvest quotas must be established at a level assuming a much lower risk that the population will continue to decline. If a population continues to decline below a Reference limit point set at 30% below the maximum estimated population size, then it is considered that the population has suffered serious harm and harvesting is discontinued. For a population considered data poor, there is still some discussion concerning the exact approach to establish permissible harvests. Current thinking is leaning towards the use of the Potential Biological Removal (PBR) approach developed in the United States. This approach is extremely conservative, but appears to be suitable in situations where recent population dynamics data are limited. Grey seals are currently considered data poor because the last survey was completed more than five years ago. However, a new survey would result in grey seals being considered Data Rich.

.

In discussion the Working Group noted that the Objective Based approach used in Canada has the advantage specifying explicit and easily understood rules for management. It was considered that similar approaches could be applied in Iceland and Norway.

The very rapid growth of the population breeding on Sable Island, along with the recent decline in the ice-breeding Gulf population, raises the possibility that seals are emigrating from the Gulf to Sable Island to breed. There is no direct evidence for this, but such an influx would be difficult to detect given the relative sizes of the populations. It appears that space is not a limiting factor at present on Sable Island, and it is not known when or at what level carrying capacity for this group will be reached.

USA

Wood (SC/11/GS/11) presented information on grey seals breeding along the United States East Coast. Grey seals were historically distributed along the U.S. east coast (from Maine to Connecticut). Native and bounty hunting extirpated the population and sightings were rare for most of the 20th century. Seals tagged on Sable Island (Canada)as pups were observed in New England during the 1980's and 1990's. Breeding began in 1988 on Muskeget Island (Massachusetts) and minimum pup production at that site increased from 4 in 1988 to over 800 in 2002. Two breeding sites were discovered in Maine in 1994. These sites have been surveyed during the breeding season from 1994 to 2002. To date, only the 2002 survey photographs have been analysed, resulting in minimum pup production of approximately 180 The grey seals currently found in New England are probably a mixture of Canadian migrants and animals born locally. Continued surveys, historic research, genetic analysis and fieldwork should provide further insight into this recolonisation event and the current status of grey seals in the U.S.

In discussion it was considered that the colonisation of new areas might be by first-time breeders. Juvenile animals have been shown to wander longer distances than mature seals. Studies conducted in the UK indicate that mature animals are for the most part faithful to their breeding sites, and that animals tend to return to the sites at which they were born. However colonisation events offer proof that site fidelity cannot be complete for all animals.

5.8 Summary

A summary of the abundance and trends in abundance of grey seals in all areas considered by the Working Group is presented in Table 1.

6. SURVEY METHODS

Corkeron (SC/11/GS/12) discussed information needs for monitoring the Norwegian grey seal population. Despite decades of monitoring effort, the abundance of grey seals in Norwegian waters remains poorly quantified. Quantitative estimates of trends in abundance are unavailable, although anecdotal information suggests that populations have increased over recent decades. Recently a method for estimating grey seal abundance based on counts of pups allocated into different developmental stage was developed. However, use of this method to quantify seals' abundance requires better data on stage length, the distribution of pupping over time, and life history parameters for Norwegian grey seals than are available at present. This Working Paper demonstrated why these data are required, and discussed issues that need addressing if scientific advice is to inform the management of grey seals in Norwegian waters. These include (i) statistics on the durations of pup "stages"; (ii) fitting a distribution to estimates of pup births over time; and (iii) construction of a Leslie matrix for grey seals to derive an appropriate multiplier for the non-pup population. Design questions included: (i) whether studies should enumerate seal pup abundance or use stratified random surveys to estimate pup abundance; (ii) what the management objectives are for grey seals, which affects where surveys should be conducted, and how often they are required.

.

In discussion the Working Group found that the issues identified had general application to all grey seal monitoring programs. Recommendations for survey programs are detailed under Item 8.1.

Additional investigations

Detailed and valuable information can be obtained from longterm studies of individual animals. Hot iron branding has been used to great effect on Sable Island and UK grey seals, while freeze branding has been used on Swedish harbour seals. In time, information on demographic parameters such as cohort survival, age at first reproduction and age specific fecundity rates can be obtained.

An alternative method for identifying individual grey seals uses their unique pelage characteristics. This has been used to estimate population size in the Baltic and the west North Sea (Hiby and Lovell 1990, Hiby 1994).

7. METHODS FOR STOCK DELINEATION

Genetic analyses, particularly using DNA microsatellites, can be very powerful for this species. It is relatively easy to sample animals on their breeding sites, something that is often difficult with other marine mammal species. Research in the UK has demonstrated that it is possible in some cases to determine the breeding locations of individual animals through genetic analysis. The Working Group considered that genetic techniques could be especially useful in the Faroese case, where the grey seals in the area are almost certainly a mixture of a local breeding population and migratory animals from the UK and elsewhere. The Working Group recommended that a co-ordinated, North Atlantic wide study on the genetic stock structure of grey seals be carried out. The study could be initiated by co-ordinating the activities already ongoing in the UK, Norway, Canada, the Baltic and other areas.

Tagging with satellite-linked transmitters is a very powerful technique for studying various aspects of grey seal ecology. Successful programs have been carried out in the UK and Canada. The transmitters are costly, as are the field programs required to apply the transmitters and the satellite time to download the data. As a result it is often not feasible to apply large numbers of tags. The Working Group considered that satellite tagging programs will have their greatest application in determining where the animals go while at sea. From this it is sometimes possible to infer what they are most likely to be feeding on, although such inferences must be confirmed by other studies. Such studies will have particular importance in determining foraging areas and the possible extent of interactions between grey seals and commercial fisheries.

8. RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT

8.1 Recommendations for future research

Survey Programs

General considerations

2. Enumeration surveys are applicable to small, discrete breeding sites that can be completely covered by plane or by walking with a reasonable amount of effort. Sampling surveys should be considered for larger, more dispersed areas such as ice breeding sites or large islands.
3. While it is generally desirable to cover the entire breeding range of the stock within a single season, this is not an absolute requirement. Partial surveys should be considered when the survey effort and time available will not allow total coverage. A multi-year design should minimise the likelihood that animals will move between breeding areas, by surveying discrete regions if possible.
4. At least 3 and preferably 4 or more surveys within a single season are required for each breeding site to derive the pupping ogive. An alternative is to survey once and simultaneously monitor the age stages of the pups at each site or at least several sites distributed throughout the survey area. It is not adequate to monitor pup staging at a single site and apply the data to other sites.

5. Staging methods should be standardised across regions and stocks.
6. More data on stage durations are required for improved input into models for abundance estimation. Stage durations should be estimated at several sites in each country that uses stage durations as model input. The distributions of stage durations, rather than summary statistics for stage durations, should be provided for model input.

Faroe Islands

Further basic research is required before surveys are attempted in the Faroes. A first step will be to document all used and potential pupping sites. The cave breeding habit of Faroese grey seals will require non-standard survey methods, perhaps including diving and the use of automated camera systems.

Iceland

The Icelandic population is small and declining. Improved and more frequent surveys are urgently required to monitor the trend in the population and ensure that further declines can be detected in time for management action to be taken. Specific recommendations include:

1. If aerial surveys are used, a minimum of 3 surveys per site within the breeding season are required. An alternative might be to combine a single aerial count with a ground survey with staging, or to use ground counts on the larger colonies.
2. A power analysis should be conducted using past data to determine what frequency of surveys is required to reliably monitor trends in the population. If clear management objectives are established for the stock, the power analysis can be used to determine the level of survey effort required to determine if the population has reached a threshold value, with a given degree of certainty.
3. Harvesting, S/L and bycatch data should be directly included in the population model used to calculate the factor to convert pup counts to 1+ numbers.

Norway

The vessel-based surveys conducted from 2000-2002 have provided good information on the location and approximate size of breeding colonies along the Norwegian coast. This information can be used to develop a survey design that will provide more reliable estimates of seal abundance in the area.

5. Regular surveys are required to determine trends in the population. Power analysis should be used to determine the survey interval and level of effort required. However, as in the Icelandic case, clear management objectives from the Norwegian authorities would be helpful in specifying the survey requirements.
6. The possibility of using repeated aerial surveys, at least in areas to the south of Lofoten, should be further explored. In northern areas, the lack of light during the breeding season may preclude the use of aerial survey. In these areas ground-based surveys with staging could be used. The possibility of using aerial infrared camera surveys in these areas should be investigated.
7. It will be desirable to co-ordinate surveys efforts in Finnmark with those along the Murman coast in the Russian Federation. Joint survey efforts should be considered.

Other recommendations for research

General

6. There should be an ongoing exchange and verification of samples among laboratories conducting age determination for this species.
7. Härkönen informed the Working Group of a project comparing 5 methods of preparing and ageing teeth from 4 seal species. New methodologies may allow the estimation of age of maturity from tooth sections. The Working Group recommended that the results of this project be published as soon as possible.
8. A North Atlantic wide genetic study of grey seal population structure should be initiated. The study should use the same genetic markers, and laboratory and sampling methods should be

standardised to the extent feasible. It was considered that such a study could best be done by co-ordinating the existing studies ongoing in range states including the UK, Norway and Canada.

9. Studies to determine struck and lost rates in different seasons and under different hunting conditions should be carried out in the Faroes, Norway and Iceland.
10. Further information on bycatch mortality of grey seals is required from Norway and Iceland.
11. To monitor changes in grey seal populations, anthropogenic mortality should be incorporated explicity into population models. These sources of mortality include removals due to harvests corrected for animals killed but not recovered (struck and loss) and bycatch in commercial fisheries.
12. Satellite tagging experiments should be carried out in the Faroe Islands, Iceland and Norway. The studies should be directed towards determining the movements of animals while at sea, and their habitat use through recording of dive profiles. Such studies will have particular relevance to determining possible interactions with fisheries in the area, but also to possible movements of animals between areas. For the Faroe Islands it may help to determine the proportion of animals that are resident in the area.

Faroes

1. Mapping of used and suspected breeding caves and sites is required.
2. Genetic studies are required to investigate the stock identities of grey seals in Faroese waters, and their association with those in adjacent waters. This could be part of the proposed North Atlantic study (see above).
3. Better data on removals is required. This could be achieved by implementing mandatory logbooks for seal hunters.
4. Studies on life-history parameters are required. This could best be based on samples from the catch.

Iceland

1. A formal analysis of the effect of present 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.

Norway

1. 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.
2. A more complete sampling program from the hunt should be established, including the collection of reproductive tracts and genetic samples.

8.2 Recommendations for management, by area and stock

In general it was considered that the NAMMCO member countries should be in a position to take a leading role in developing and implementing risk-averse conservation and management programs for this species. It was noted in this regard that the NAMMCO Council had recently adopted recommendations of the Scientific Committee concerning the development of clear management objectives, and the information required to develop advice on catch levels. The Working Group therefore recommended that clear management objectives be set for grey seal stocks. The Objective Based Management system used by Canada was considered a good example of such an approach. Once this is done, it will be possible to specify the information needs, in terms of monitoring, survey effort and survey frequency, required to meet the proposed management objectives.

Faroe Islands

For this area better information on the level of catch, both direct and as bycatch, is required. There is no information on stock identity or abundance on which to base management advice, and research programs to get this information have been recommended (see 8.1). Nevertheless, the relatively high level of take, combined with the suggested low size of the population, suggests that a precautionary approach is warranted.

Iceland

The observed decline and continued exploitation of this stock was of great concern. If present trends continue the stock will be reduced to very low levels. The Working Group recommended the immediate establishment of management objectives and conservation reference limits for this stock as an urgent priority. Survey frequency and intensity should be increased to facilitate monitoring of the trend in the population. A formal assessment of the effect of present 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.

Norway

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. It will be necessary to increase the intensity and frequency of surveys in the area if higher levels of exploitation are realised, in order to have a realistic probability of detecting a decline in the population within a time scale relevant to management.

9. OTHER BUSINESS

This Working Group was the first dedicated to grey seals over the entire North Atlantic. Members considered the Working Group very worthwhile in terms of exchange of information about research and management programs in other jurisdictions. The Working Group therefore recommended that it meet again at some point to update the status of all stocks, and possibly to conduct detailed assessments of those stocks for which concern has been expressed.

The possibility of dedicating a volume of NAMMCO Scientific Publications to a North Atlantic-wide overview of this species was considered. Several of the working papers could be published in such a volume, and more might be contributed by other authors. Such a volume would be unique and of value. The Working Group recommended that the Scientific Committee consider the idea of publishing such a volume.

10. ADOPTION OF REPORT

The Report was adopted on 11 April 2003.

REFERENCES

Harding, K. C., and Härkönen, T.J. 1999. Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. *Ambio* 28:619-627

Hiby, L. Lovell, P. 1990 Computer-aided matching of natural markings: a prototype system for grey seals. *Rep. int. Whal. Commn* (Special Issue 12):57-61

Hiby AR 1994 Abundance estimates for grey seals in summer based on photo-identification data. In Grey seals in the North Sea and their interactions with fisheries. In: Hammond, P.S. and Fedak, M.A. (eds) Unpublished report to the Ministry of Agriculture, Fisheries and Food, pp 5-21. Contract MF 0503

[NAMMCO] North Atlantic Marine Mammal Commission. 1997. Report of the Scientific Committee. In: NAMMCO Annual Report 1996, Tromsø, Norway, pp. 97-178.

[NAMMCO] North Atlantic Marine Mammal Commission. 1998. Report of the Scientific Committee. In: NAMMCO Annual Report 1997, Tromsø, Norway, pp. 85-202.

.

Population	Year	Estimate	Trend	Reference	Comments
Baltic	2001	10,250	Increasing	SC/11/GS/6	Based on enumeration of moulting animals. Depleted from historical levels
British	2001	130,000	Increasing	SC/11/GS/14	Based on annual pup surveys of the main breeding colonies
Murman Coast, Russia	1991/92	3,500	Unknown	SC/11/GS/9	
Norway	2000-2002	4,200	Unknown	SC/11/GS/8	Average of range given in paper. Does not include some known colonies in northern Nordland and Troms Counties.
Iceland	2002	5,000	Decreasing	SC/11/GS/4	
Faroes	NA	NA	NA	SC/11/GS/7	No abundance estimate available. Likely a mixture of seals that pup in the Faroes and seals that pup in other areas, especially UK.
Northwest Atlantic: Canada	2,000	260,000	Increasing	SC/11/GS/10	Combined estimate for Gulf of St Lawrence and Sable Island breeding areas. Gulf population has declined since 1996, but the much larger Sable Island population continues to increase.
Northwest Atlantic: USA	2002	NA	Increasing	SC/11/GS/11	Minimum pup production 1,000 at 3 sites in 2002. Colonised since 1988.

Table 1. Status of grey seal stocks in the North Atlantic.

.

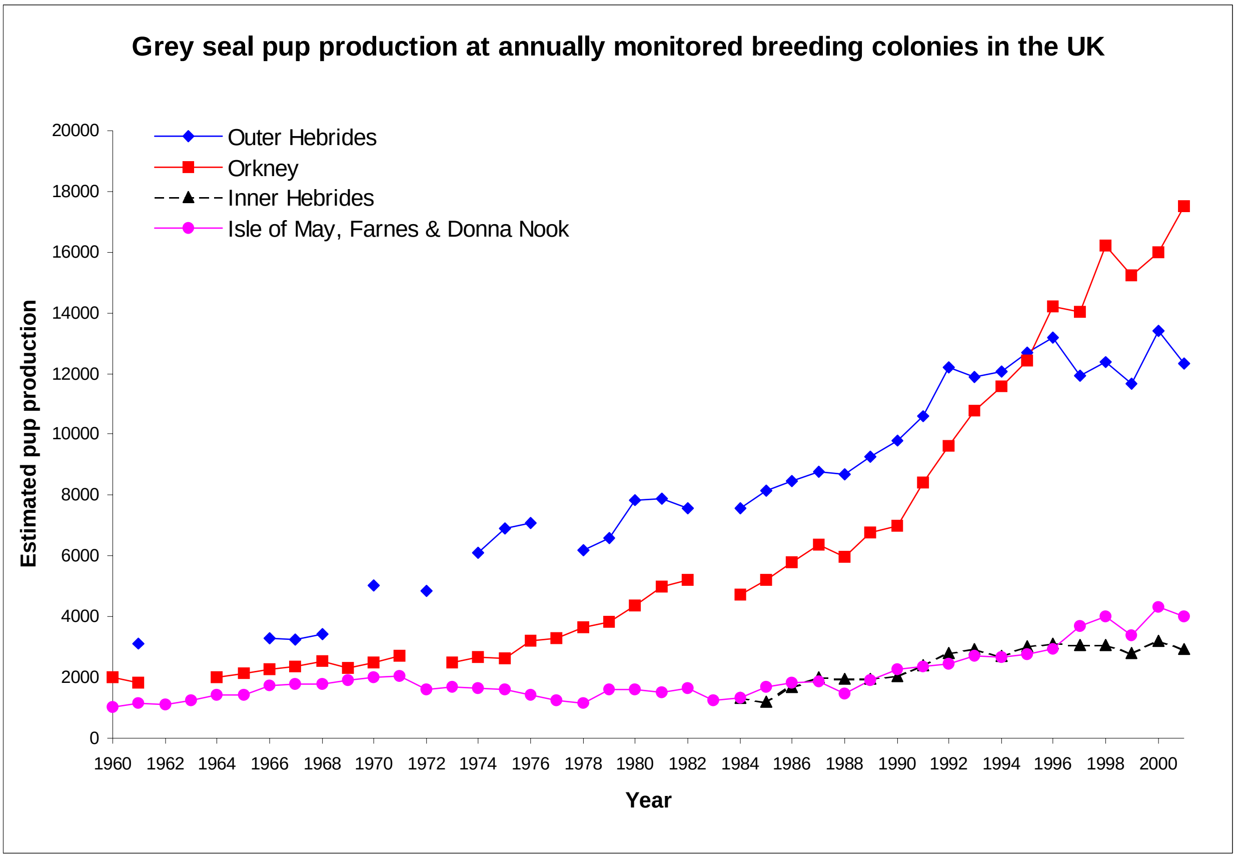

Fig. 1. Grey seal pup production at annually monitored breeding colonies in the UK.

LIST OF PARTICIPANTS

Dr Peter Corkeron
Institute of Marine Research,
Sykehusveien 23,
N-9291 Tromsø,
Norway.
Tel: +47 77 60 97 25
Fax: +47 77 60 97 01
Email: peter.corkeron@imr.no

Dr Callan Duck
Sea Mammal Research Unit
University of St Andrews
St Andrews, Fife
KY16 8LB Scotland
Tel:
Fax:
Email: cdd1@st-and.ac.uk

Ms Anne Kirstine Frie
Institute of Marine Research,
Sykehusveien 23,
N-9291 Tromsø,
Norway.
Tel: +47 77 60 97 29
Fax: +47 77 60 97 01
Email: anne.kristine.frie@imr.no

Mr Þorvaldur Gunnlaugsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5331363
Fax: +354 5623790
Email: thg@hafro.is

Mr Sverrir Daniel Halldorsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5331363
Fax: +354 5623790
Email: dalli@hafro.is

Dr Mike Hammill
Maurice Lamontagne Institute
850 Route de la Mer
P.O. Box 1000
Mont Joli, PQ
Canada G5H 3Z4
Tel:
Fax:
Email: HammillM@dfo-mpo.gc.ca

Dr Tero Härkönen
Swedish Museum of Natural History
Box 50007
S-104 05 Stockholm
Sweden
Tel:
Fax:
Email: tero.karin.h@swipnet.se

Dr Tore Haug,
Institute of Marine Research,
Sykehusveien 23,
N-9291 Tromsø,
Norway.
Tel: +47 77 60 97 22
Fax: +47 77 60 97 01
Email: toreha@imr.no

Mr Erlingur Hauksson
Fornistekkur 14
109 Reykjavik
Iceland
Tel:
Fax:
Email: erlingurhauks@simnet.is

Mr Bjarni Mikkelsen
Natural History Museum,
Futalag 40,
FR-100 Tórshavn,
Faroe Islands
Tel: +298 31 85 88
Fax: +298 31 85 89
Email: bjarnim@ngs.fo

Dr Vasilij Mishin
Murmansk Marine Biological Institute
Vladimirskaya 17
183010 Murmansk
Russia
Tel: 8152 56 12 57
Fax: +47 78910 288
Email: science@mmbi.info

Dr Kjell T. Nilssen
Institute of Marine Research,
Sykehusveien 23,
N-9291 Tromsø,
Norway.
Tel: +47 77 60 97 29
Fax: +47 77 60 97 01
Email: kjell.tormod.nilssen@imr.no

Ms Droplaug Ólafsdóttir
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5520 240
Fax: +354 5623 790
Email: droplaug@hafro.is

Mr Daniel Pike
Scientific Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø,
Norway
Tel: +47 77 75 01 77
Fax: +47 77 75 01 81
Email: dan.pike@nammco.no

Mr Gisli Vikingsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5520 240
Fax: +354 5623 790
Email: gisli@hafro.is

Ms Stephanie Wood
University of Massachusetts, Boston
Biology Department
100 Morrissey Blvd.
Boston, MA 02125
USA
Tel: +1 617-287-6600
Fax: +1 617-287-6650
Email: Stephanie.Wood@umb.edu

.

Appendix 2

AGENDA

1. OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEUR
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
5. STATUS OF GREY SEAL STOCKS
   - 5.1 Iceland
     - *5.1.1 Distribution, migration and stock delineation*
     - *5.1.2 Population sizes and trends*
     - *5.1.3 Exploitation and sustainability of catch*
   - 5.2 United Kingdom
     - *5.2.1 Distribution, migration and stock delineation*
     - *5.2.2 Population sizes and trends*
     - *5.2.3 Exploitation and sustainability of catch*
   - 5.3 Baltic
     - *5.3.1 Distribution, migration and stock delineation*
     - *5.3.2 Population sizes and trends*
     - *5.3.3 Exploitation and sustainability of catch*
   - 5.4 Faroes
     - *5.4.1 Distribution, migration and stock delineation*
     - *5.4.2 Population sizes and trends*
     - *5.4.3 Exploitation and sustainability of catch*
   - 5.5 Norway
     - *5.5.1 Distribution, migration and stock delineation*
     - *5.5.2 Population sizes and trends*
     - *5.5.3 Exploitation and sustainability of catch*
   - 5.6 Russia (Murman Coast)
     - *5.6.1 Distribution, migration and stock delineation*
     - *5.6.2 Population sizes and trends*
     - *5.6.3 Exploitation and sustainability of catch*
   - 5.7 Eastern North America
     - *5.7.1 Distribution, migration and stock delineation*
     - *5.7.2 Population sizes and trends*
     - *5.7.3 Exploitation and sustainability of catch*
6. SURVEY METHODS
7. METHODS FOR STOCK DELINEATION
8. RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT
   - 8.1 Recommendations for future research
   - 8.2 Recommendations for management, by area and stock
9. OTHER BUSINESS
10. ADOPTION OF REPORT

.

Appendix 3

LIST OF DOCUMENTS

Document No.	
SC/11/GS/1	List of participants
SC/11/GS/2	Draft agenda
SC/11/GS/3	Draft list of documents
SC/11/GS/4	Hauksson, E. Distribution, abundance and trends in abundance of grey seals in Icelandic waters, including methods for abundance estimates.
SC/11/GS/5	Duck, C. Pup production in the British grey seal population.
SC/11/GS/6	Harding, K., Härkönen, T. and Helander, B. Status of the Baltic grey seal population, including growth, abundance and ecological risk assessment.
SC/11/GS/7	Mikkelsen, B. Present knowledge of grey seals in Faroese waters.
SC/11/GS/8	Nilssen, K.T., Corkeron, P. and Haug, T. Status of the Norwegian grey seal, *Halichoerus grypus,* population.
SC/11/GS/9	Mishin, V. Grey seal investigations on the Murman coast, Russia, including research plans and needs.
SC/11/GS/10	Hammill, M.O., Gosselin, J.F. and Stenson, G.B. Abundance of Northwest Atlantic grey seals in Canadian waters.
SC/11/GS/11	Wood, S. and Brault, S. Status of the United States grey seal (*Halichoerus grypus*) population, including future research plans.
SC/11/GS/12	Corkeron, P., Nilssen, K.T. and Haug, T. Data requirements for estimating the abundance of Norwegian grey seals, *Halichoerus grypus,* using pup counts.
SC/11/GS/13	Duck, C.D., Hiby, L.R. and Thompson, D. The use of aerial photography to monitor local and regional populations of grey seals, *Halichoerus grypus*
SC/11/GS/14	Hiby, L. and Duck, C. Estimates of the size of the British grey seal *Halichoerus grypus* population and levels of uncertainty.

ANNEX 3

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ABUNDANCE ESTIMATES

University of St Andrews, 19-21 March, 2003

1. OPENING REMARKS

Chairman Nils Øien welcomed all participants to the meeting (see Appendix 1). He reviewed the terms of reference for the Working Group.

The fourth North Atlantic Sightings Survey was carried out in June/July 2001. The survey was planned and co-ordinated by this Working Group under the auspices of the NAMMCO Scientific Committee. The Working Group met in March 2002 and considered survey reports and preliminary abundance estimates from the survey. In addition the Working Group conducted a full evaluation of the survey protocols and methodologies, to be used in the planning of future surveys. The Working Group made recommendations for work to be carried out to complete abundance estimates for several species from the NASS-2001 and earlier surveys.

The present Working Group is therefore tasked with continuing the evaluation of abundance estimates for target and non-target species, determining if additional analyses are required and recommending estimates for acceptance by the Scientific Committee. In addition there will be some discussion of the publication of survey results, and the future of the NASS.

2. ADOPTION OF AGENDA

The Draft Agenda (Appendix 2) was adopted without changes.

3. APPOINTMENT OF RAPPORTEUR

Daniel Pike, Scientific Secretary of NAMMCO, was appointed as Rapporteur for the meeting.

10. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The documents considered by the Working Group are listed in Appendix 3.

5. MINKE WHALES

i. 2001 ship survey

An estimate of the abundance of minke whales form the NASS ship survey around Iceland and the Faroes was presented by Gunnlaugsson *et al*. (SC/11/AE/6). This area is exclusive of the aerial survey block around Iceland. Because of weather and ice related revisions to the survey plan, coverage probability was higher close to the East Greenland ice edge than in other portions of the same blocks. As the area close to the ice edge corresponds to an area of high minke whale density, it was considered that the uneven coverage within the original block structure would likely have resulted in a positively biased estimate. The area was therefore post-stratified to include narrow blocks near the ice edge. Double platform data were available and indicated that *g(0)* was less than 1, however an attempt to apply the double platform hazard probability method to these data was not successful due to the distributional properties of the data. The distribution of perpendicular distances showed a steep decline from the trackline and almost no "shoulder", and a long tail extending out to about 3,000 m from the trackline. This made the estimation of effective strip width (esw) problematic as the estimate was not robust to changes in truncation, binning of distance intervals or model choice. The estimated *esw* was narrower than those seen in previous NASS or other similar surveys.

The point estimate was 23,955 (cv 0.30) for the original strata and almost the same for the post-strata: the estimate using the original strata is therefore preferred. This is higher but not significantly so from the estimate from roughly the same area from the 1995 NASS (Pike *et al.* 2002). The distribution of minke whales differed somewhat between the surveys, with many more sightings in the Faroese block in 2001 than in 1995.

The Working Group examined the distributions of sighting angles, radial and perpendicular distances from the ship survey in an effort to determine the source of the highly peaked detection function. The distribution of radial distances was highly peaked near the vessel, especially for the primary platform. However there was not a great difference between the platforms. It was noted that similar problems were evident in the detection functions of small whales (northern bottlenose, pilot whales) but not of large whales such as fin and blue whales. Conclusive explanations for the unsusual distributions of radial, and especially perpendicular distances were not possible. There were several possible explanations proposed, including:

a. rounding error to favoured distances and angles;
b. distance estimation error caused by estimates being made in different measurement units at different distances;
c. target species being both fin and minke whales, possibly resulting in observers scanning in a way that is incompatible with conventional line transect assumptions;
d. use of both binocular and naked eye searching with no record of which attributed to each sighting, resulting in a mix of both types in the distributions of perpendicular and radial distances.
e. other factors causing heterogeneity in detection probabilities such as weather.

Nevertheless the Working Group concluded that the detection function used by Pike *et al*. (SC/11/AE/6) was appropriate for these data, and that the abundance estimate should be comparable to earlier surveys. The Working Group recommended that further efforts be made to use the double platform data to estimate bias due to visible whales missed by observers for this species.

ii. 2001 and 1987 aerial surveys around Iceland

Borchers (SC/11/AE/4) provided new abundance estimates from the NASS aerial surveys around Iceland carried out in 1987 and 2001. Estimates for the 1987 survey were previously reported by Hiby *et al.* (1989) and Borchers *et al.* (1997). The former estimate was corrected for bias due to error in measuring radial distance, while the latter, considerably higher estimate was not. However it was not certain whether the difference between the 2 estimates was due to the measurement error bias or to apparent differences in the datasets analysed. An estimate for the 2001 survey was previously reported by Pike *et al.* (2002), but this estimate was not corrected for biases due to measurement error or whales missed by observers.

Borchers (SC/11/AE/4) developed maximum likelihood estimators of abundance for cue counting surveys with measurement error and investigated their properties by simulation. Conventional estimators not corrected for measurement errors were found to be insensitive to low levels of measurement error but increasingly biased as measurement error increased. The new estimators were found to be practically unbiased.

For the 1987 survey analysis, measurement error was judged from duplicate detections to be additive with an estimated std. err. of 0.11. However, a model with multiplicative errors was selected on the basis of AIC when fitting to all the survey data. Estimation using this model yielded an abundance estimate of 19,320 (cv 0.28) animals for the originally designed strata. Using analysis options that make the estimate as comparable as possible to the estimates obtained by Hiby *et al*. (1989), yielded an estimate of 10,700, compared to an estimate of about 9,000 obtained by Hiby *et al*. (1989). Estimates obtained using the same methods as were used by Borchers *et al*. (1997) yielded an abundance estimate of 11,100 – compared to the estimate of over 20,000 obtained by them. This indicates that the main source of this discrepancy was differences in the data used in the two analyses, but these differences are not understood.

For the 2001 survey analysis, measurement error had an estimated cv of only 11% for these data. Simulations show that bias due to errors of this magnitude are negligible. One of the primary observers on this survey detected cues at small radial distances with estimated probability of only around 0.25. Correcting estimates accordingly results in an abundance estimate with very high variance. Two approximately unbiased estimators were presented - one using all data and correcting for missed animals at distance zero, the other using only data from the side of the plane with the more efficient observer. Both methods yield abundance estimates of about 43,000 animals. The estimate using only the more effective observer has greater precision (cv 0.19) than the estimate using both observers (cv 0.32).

For 2001, the estimate using data from the more effective observer was considered preferable, as it was more precise and straightforward in calculation than the estimate using both observers. This estimate was therefore recommended for acceptance by the Scientific Committee.

Both estimates assume a cueing rate for minke whales of 53 surfacings per hour. Sampling variablility in this estimated cueing rate has not been accounted for in the variance of the abundance estimate, which therefore is negatively biased. The group discussed whether variability in dive times for given overall surfacing rates would add to the uncertainty in the abundance estimate, but concluded that this is not the case.

The apparent inconsistencies in the datasets from the 1987 survey analysed by Hiby *et al.* (1989), Borchers *et al.* (1997) and Borchers (SC/11/AE/4) were troubling, however it seems likely that the dataset analysed by Borchers *et al.* (1997) was corrupted in some way, as the results of the other two analyses are consistent. The new estimate by Borchers (SC/11/AE/4) for 1987 was therefore recommended for acceptance by the Scientific Committee.

In discussion the Working Group noted that it was not clear whether the measurement error had an additive or multiplicative distribution, and that a more flexible error model, such as the gamma distribution, might be more appropriate. While this was considered unlikely to have much effect on the point or variance estimates, the Working Group recommended that such a model be developed for these data.

Pike *et al.* (SC/11/AE/5) presented a conventional line transect estimate of minke whale density from a shipboard transect through Faxaflói Bay in SW Iceland. This area corresponds to block 1 of the aerial survey and is an area of consistently high minke whale densities. It was therefore of interest to determine if the densities realised by the shipboard survey would correspond with those found from the aerial survey. The transit was conducted under optimal conditions with higher searching effort than was normal on the rest of the survey. Double platform data, while not analysed, indicated that bias due to animals being missed by observers was much lower than during the rest of the survey. The realised density was 1.63 whales nm^{-2} is very similar to estimate for the same block from the aerial survey of 1.74 whales nm^{-2} (cv 0.22) obtained by Borchers (SC/11/AE/4).

The Working Group considered that this provided some independent indication that the estimates obtained in the aerial survey using cue counting were realistic. The shipboard estimates would be expected to be somewhat negatively biased due to diving whales unavailable to the observers, however these biases might be small because of the high survey effort and optimal sighting conditions on this portion of the survey.

iii. Combined estimates

For the 2001 survey there is no overlap between the estimates from the aerial and shipboard components. Combined abundance can therefore be obtained by summation.

iv. Trends in abundance

Abundance estimates for minke whales from all NASS and Norwegian surveys are provided in Table 1.

The estimate from the aerial survey for coastal Iceland in 2001 is more than double that for 1987, however the difference is not significant. The Working Group concluded in 2002, based on line transect analysis of the density of minke whales from the 4 aerial surveys carried out since 1986, that the abundance of minke whales around Iceland has been stable or shown a moderate increase over the period. This conclusion remained unchanged.

The results from the NASS series (Table 1) indicate an increase in minke whale abundance to the south of Iceland and around the Faroes from 1995 to 2001. There seems also to have been a decrease in the abundance of minke whales in the Barents Sea, the Norwegian Sea and the North Sea in the same period. These changes in spatial distribution are not statistically significant, but might indicate a shift towards more southern and central Atlantic waters in the Central and Eastern Stocks of minke whales.

6. HUMPBACK WHALES

Burt *et al.* (SC/11/AE/7) presented estimates of humpback whale abundance from the 1995 and 2001 Icelandic and Faroese aerial and shipboard surveys. The data were analysed using the "count" variant of the methodology of Hedley *et al.* (1999). The effort data was divided into small segments, over which covariates were assumed not to vary, and the number of sightings within each segment was estimated. This number formed the response variable and locational variables were used as explanatory variables in a generalised additive model (GAM). A school density surface was obtained by predicting over a grid of the whole survey region and abundance was then estimated by integrating under the surface. Data from these surveys were analysed separately, and results were compared in regions of overlap. The estimated abundance for the region covered by the aerial surveys was 950 (cv 0.37) in 1995 and 3,371 (cv 0.79) in 2001. The estimated abundance of humpback whales from the shipboard surveys was 22,305 (cv 0.59) in 1995 and 14,259 (cv 0.50) in 2001. A calibration factor to make the aerial and shipboard abundance estimates compatible was calculated using data from the areas of overlap between the respective shipboard and aerial surveys. Using this calibration factor, the estimated abundance from the aerial survey was 15,270 in 1995, and 9,920 in 2001.

Discussion in the Working Group focused on two issues, the high ratio (16.55) of the shipboard survey abundance estimate compared to the aerial survey abundance estimate in 1995 and the high variances associated with the GAM bootstrap estimates. It was concluded that the high shipboard to aerial abundance ratio in 1995 was probably not a feature of the modelling method *per se* as the shipboard abundance estimate for 1995 was similar to the existing abundance estimate calculated with conventional line transect methods, although the GAM point estimates were sensitive to the given degrees of freedom.

The high variance of the GAM bootstraps in both the aerial and shipboard surveys was a disappointment to the Working Group which had hoped the use of spatial covariates would increase the precision of the abundance estimates. The major reason suggested for this was that the main variables determining humpback distribution are probably not location and depth, so that spatial models using these variables alone have limited ability to reduce variance. The Working Group therefore recommended that, as a first step, available maps of oceanographic features such as sea surface temperature and chlorophyll be examined for an apparent relationship to the concurrent distribution of humpback whales in the area. If so, these variables could be off value in the spatial analysis.

The Working Group considered that an integrated spatial analysis of the aerial and shipboard data might provide less biased and more precise estimates of abundance for both 1995 and 2001, and recommended that this be done if more promising potential covariates can be found. In addition, a conventional line transect analysis of the 1995 aerial survey would be useful for comparison to the estimate derived from the spatial analysis.

The Working Group noted that the abundance of humpbacks in the North Atlantic has been estimated at 10,600 (cv 0.067) for 1992-93 using mark-recapture analysis of photo-id (and biopsy) data (Smith *et al.* 1999). Because of the very high cv's of the NASS estimates, there is no significant difference between YoNAH and NASS estimates. However, the YoNAH estimate is for the whole North Atlantic; only a proportion of the population is found around Iceland.

The YoNAH estimate for the North Atlantic is negatively biased for 2 reasons: animals that do not breed in the West Indies are under-represented; and the area east of Iceland was poorly sampled. Nevertheless these biases could not fully account for the difference in the YoNAH and NASS point estimates. Conversely the NASS shipboard estimate from 1995 may be positively biased because of possible double counting.

The Working Group concluded that the discrepancy between the NASS and YoNAH estimates was likely a combination of the above-mentioned biases and the large cv's of the NASS estimates. Further studies are needed to resolve these differences more fully. In particular, photo-id/biopsy studies need to sample humpback whales in all important habitats around Iceland. For future NASS, consideration should be given to designs suitable for humpback whale feeding aggregations.

Combining estimates

As the aerial and shipboard components of the 1995 and 2001 surveys overlapped for this species, the estimates are not additive. Estimates for the aerial and shipboard survey blocks are provided in Table 1.

Trends in abundance

In 2002 the Working Group reviewed an analysis of the trend in encounter rate over the course of the 4 Icelandic aerial surveys carried out since 1986 which showed an increase of 11.4% (SE 2.1%) per year over the period in the survey area. This rate of increase is in accordance with that of 11.6% over the period 1970 to 1988 in recorded sightings humpback whales by whalers operating west of Iceland reported by Sigurjónsson and Gunnlaugsson (1990). The total estimates from the spatial analyses of the 1995 and 2001 surveys do not reveal a trend over the period, but they are much higher than estimates from earlier surveys. All available evidence indicates that the abundance of humpback whales around Iceland has increased since 1987.

7. OTHER SPECIES

i. Fin whales

Pike *et al.* (SC/11/AE/8) reported revisions to the estimates of fin whale abundance in the Faroese and Icelandic blocks reported by Gunnlaugsson *et al.* (2002). The new estimates use estimates of *esw* adjusted for the vessel covariate at the stratum level. This should result in somewhat more accurate block estimates, as most blocks were surveyed by only one vessel. In addition a bootstrap estimate of variance was used in the new estimates. The revised total estimate is virtually identical to that reported by Gunnlaugsson *et al.* (2002), however the block estimates differ slightly. The most notable differences are in the Iceland SW (revised lower) and Faroese (revised higher) blocks. The vessel that surveyed the Iceland SW block (AF2) had a somewhat wider *esw* than the average while the Faroese vessel had a somewhat narrower *esw*.

The Working Group noted that the new stratum estimates, while having slightly lower precision than those presented last year, should be more accurate, and recommended their acceptance by the Scientific Committee.

Øien reported that estimates of large whale abundance from the 1995 and 1996-2001 Norwegian surveys were presently in preparation. Noting that this information would be required for an upcoming assessment of fin whales in the Norwegian and East Greenland-Iceland stock areas by the NAMMCO Scientific Committee, the Working Group recommended the completion of these estimates on a timely basis.

Trends in abundance
Estimates from NASS around Iceland and the Faroes are listed in Table 1.

ii. Dolphins

Pike reported that an analysis of *Lagenorhyncus* spp.. dolphin abundance from the Icelandic aerial surveys conducted since 1986 was in progress.

The Working Group reiterated its conclusions from previous meetings, that while an analysis of the shipboard dolphin data from the Icelandic 2001 and earlier surveys is feasible, the problems of uncertain species identification, uncertain group size estimation, and possible responsive movement of these species would present significant problems for abundance estimation. As a first step, the data should be closely inspected to determine if further analyses are likely to be useful.

Desportes reported that an analysis of the abundance of *Delphinus* sp. from the Faroese area of the NASS-1995 was presently underway. In addition an analysis of the abundance of *Lagenorhyncus* spp. dolphins from the Faroese NASS-2001 block is in progress.The Working Group recommended that these analyses be completed in a timely manner.

iii. Pilot whales

Pike *et al.* (SC/11/AE/10) provided abundance estimates, uncorrected for availability or perception biases, for pilot whales from the Faroese and Icelandic shipboard components of NASS-2001. The estimate was derived using conventional line transect methods. The total estimate for the Faroese and Icelandic blocks of 65,315 (cv 0.39) is considerably but not significantly lower than estimates for comparable areas from NASS 1987, 1989 and 1995. The estimated *esw* was higher for this survey than for most previous surveys. If it is positively biased then the abundance estimate is negatively biased. The authors considered it unlikely that the observed differences in abundance between surveys reflected a real change in the population. Pilot whales are migratory and move into the survey area during the summer months. Some variation between years can be expected, due to differences in the timing of the surveys and/or the advance of the season in a given year. None of the surveys have covered the total summer range of this species.

The Working Group noted that pilot whales had not been a target species for the 2001 survey. The estimation of group size and the discrimination of sub-groups are problematic for this species and require specialised methods that were not implemented fully in the 2001 survey. It was also suggested that there were probably differences in operational procedures between vessels. The Faroese vessel, which encountered generally good weather, was able to close on sightings and count subgroups. The Icelandic vessel surveying Block B to the southwest of Iceland operated in higher sea states, and was not able to identify and record separate subgroups so precisely. Correspondingly, this resulted in a substantially higher estimated mean school size for Block B than for the Faroese block. Probably most importantly, there was no coverage in areas to the south of Iceland and the Faroes that are known from previous surveys to have relatively high densities of pilot whales. The Working Group concluded that a survey targeting this species requires a different spatial coverage and special field methods that were not used in 2001. The estimate is therefore not representative of the numbers in the Northeast Atlantic and should not be used for assessment purposes.

iv. Sperm whales

No new information was available for this species since the last meeting of the Working Group.

v. Bottlenose whales

Pike *et al.* (SC/11/AE/11) provided abundance estimates for northern bottlenose whales from the shipboard components of NASS 1995 and 2001. There were not enough sightings in the 1995 survey to reasonably estimate the detection function. Therefore sightings from both surveys were combined for the purpose of estimating a single detection function. This was considered reasonable because the same basic field methods, and some of the same vessels and observers were used in both surveys. A separate analysis was also done for the 2001 survey, using only sightings from that survey to estimate the detection function. Double platform data was available for the 2001 survey, and from the Faroese block in 1995, but was not used here for bias correction.

Distribution was similar in the two surveys, however more sightings were made to the northeast of Iceland in 2001 than in 1995. Most sightings were made in the Faroese block in both years. The estimates for the two surveys were almost identical although the 1995 estimate was much less precise. The estimate for 2001 using data from both surveys to estimate the detection function was similar to that using only data from that year. These estimates are negatively biased due to whales missed by observers and whales that were diving as the vessels passed. The latter bias is likely severe for this long-diving species. In addition neither survey covered the entire summer range of the species, which extends farther south of Iceland and the Faroes at this time of year.

The Working Group concurred with the authors that bias due to diving animals being missed was likely severe for this species. Bias due to animals on the surface being missed was likely of less significance as this species frequently occurs in groups that are easy to see at short distances. It was suggested that bounds on the bias due to diving whales being missed could be estimated from recent radio tracking experiments on 2 whales off Eastern Canada (Hooker and Baird 1999). Based on these data a correction factor for this bias is unlikely to be greater than 3. However these data may not be applicable as they were collected from only 2 animals and in another part of the Atlantic.

The changes in distribution were of interest but difficult to interpret. The 2001 survey covered this area about 2 weeks earlier than in 1995. This species is known to migrate out of Norwegian and northern Icelandic waters early in the summer, so it is possible that the 1995 survey missed the seasonal peak in the occupation of these areas. It is also possible that environmental changes may have lead to shifts in distribution, but this could not be assessed. The Working Group recommended that telemetry studies be conducted on this species, both to further elucidate migratory patterns and stock structure, and to obtain data on diving to be used for determining correction factors for survey data.

The uncorrected estimates from 1995 and 2001 are significantly higher than the uncorrected estimate from the 1987 survey of 5,800 (cv 0.15) (NAMMCO 1995).

vi. Blue whales

Pike *et al.* (SC/11/AE/12) provided estimates of blue whale abundance from the NASS-1995 and 2001 shipboard surveys around Iceland and the Faroes. An insufficient number of sightings were made in either survey to reliably estimate the detection function, so sightings from the 2 surveys were combined for this purpose. Blue whale sightings were recorded in 4 levels of uncertainty of species identification. For this reason 2 estimates were calculated: a "High" estimate including all classes of sightings, and a "Low" estimate excluding the most uncertain classes of sightings.

Blue whales were concentrated to the west and north of Iceland in both surveys. The difference between the HIGH and LOW estimates was not as great as might be expected given the difference in the number of sightings, primarily because sightings with more uncertain species identification tended to be far from the trackline, and therefore their addition had the effect of increasing the effective strip width. The estimates from both surveys are consistent with a population of between 700 and 1,900 blue whales in the survey area. An area of blue whale concentration off western Iceland near the Snæfellsnes Peninsula has not been covered well particularly in the 2001 survey.

8. ADDITIONAL ANALYSES TO BE CARRIED OUT

Table 2 provides a summary of future work to be carried out to refine abundance estimates from the 2001, 1995 and earlier surveys. The Working Group noted with pleasure that estimates had been completed for target species, and preliminary estimates had been completed for most non-target species for which abundance estimation was feasible.

In addition to the work listed in Table 2, the Working Group recommended that estimates of the abundance of non-target species, particularly fin whales, from the Norwegian surveys be completed as soon as possible. The Working Group also reiterated its previous recommendations with regard to estimating dolphin abundance from NASS shipboard data (see 7.ii.).

9. STRUCTURING INTEGRATED ANALYSES FROM ALL NASS

Tables 1 provides a first step towards integrating the results of all NASS by providing estimates by species and survey for comparable areas. However some other issues remain to be addressed to improve comparability between surveys.

The analytical methods used in estimating abundance for some species from the 1987 and 1989 Faroese and Icelandic ship surveys differed somewhat from those used for later surveys. Some re-analyses may therefore be required for these surveys using a more standardised analytical approach.

The stratification and coverage in the Faroese and Icelandic ship surveys has varied greatly between surveys. Although the groupings used in Table 1 address this to some extent, there is still some variation in the size and extent of the areas. Post-stratification into comparable areas would be facilitated by assembling all NASS data into a standardised database format from which spatially bounded sub-sets could be easily extracted. The DESS program used by the IWC is one example of such a program that could be modified for use with the NASS for storing and extracting data. There would be some cost involved in creating such a database and formatting the data for inclusion in it. However, given the costs and effort that have gone into conducting these surveys, the Working Group considered that this would be a good investment that would facilitate the use of these data. The Working Group therefore recommended that such a database be established for the NASS data.

10. FUTURE OF THE NASS

The first surveys had the major objective of producing a first description of the distribution and abundance of cetaceans over large areas of the North Atlantic. This objective has been in large part fulfilled. Later Norwegian surveys focussed specifically on providing abundance estimates for minke whales for input into their management program. It is necessary to determine the necessity and objectives of continued large-scale integrated cetacean surveys in the North Atlantic, as the nature of the objectives will determine the optimal form of the survey.

For all countries involved in NASS, the main objective now is to provide abundance estimates for target species for input into harvest management programs. For this purpose periodic estimates of absolute abundance are required, and these estimates should be as unbiased and precise as possible, and with quantified uncertainty. A secondary objective will be to provide information on distribution and abundance for research into ecosytem relations, long-term environmental change and fisheries interactions.

Several countries are planning surveys which may offer opportunity for integration into a large-scale survey. Iceland will continue surveys on a 5-6 year rotation, with the next survey tentatively planned for 2006. A new SCANS is being planned for 2005/6, with the offshore portion to be conducted in 2006. The survey will cover the North Sea and adjacent waters, and the North Atlantic EEZ's of all European Union countries. The Faroe Islands is planning a survey of small cetaceans to coincide with the offshore portion of SCANS in 2006. Norway will continue its rotational survey program, but integrate it with other surveys to the extent feasible. Therefore the best opportunity for a future large-scale integrated sightings survey would appear to be in 2006. The Working Group recommended that contacts be made between the organisations planning these surveys in order to integrate them to the extent possible.

A particular problem is the differing target species of the surveys. Experience with NASS suggests that surveys with large whales as target species do not provide adequate data for small whales and dolphins. The Working Group recommended that survey protocols be modified to make them applicable to multiple species, to the extent feasible given the overall objectives of the surveys.

The Working Group considered the idea of conducting "mosaic" type surveys after the Norwegian model, in which a portion of the total survey area is surveyed annually on a rotational basis. Norway has completed a first 6 year rotation and has had a positive experience with this survey mode. The main advantages are logistical, with annual use of equipment and personnel, rather than a more long-term rotation. This allows more continuity in the use of observers, which in turn results in more experienced observers and better-quality data. The main disadvantage is the loss of synoptic coverage in chosen years, and thus for these years the precision would have been better with a synoptic than with a mosaic design. This would indeed be the case if the whole stock is present in the area covered. If, however, there are shifts in the spatial distribution on a large scale (*e.g.* see 5.iv), the true uncertainty in abundance might be higher than the estimated uncertainty in the synoptic survey. In the long run, a well-designed mosaic of frequent partial surveys might provide a better basis for estimating trends in time and space than do infrequent large-scale surveys. The Working Group recommended that this model be considered for application on an international basis over the entire area covered by NASS.

The NASS have provided important information on the distribution and abundance of cetaceans in the North Atlantic that will be useful for many years to come.

11. PUBLICATION OF SURVEY RESULTS

A future volume of NAMMCO Scientific Publications will be a compilation of the results of all NASS conducted to date. The volume, to be edited by Nils Oien and Daniel Pike, is scheduled for publication in late 2004. A list of titles has been prepared and authors have been contacted to begin work on the papers.

12. OTHER BUSINESS

There was no other business.

13. ADOPTION OF REPORT.

The final version of the report was adopted by correspondence on…

REFERENCES

Borchers, D.L. 2003. Analyses of the NASS 1987 and 2001 minke whale cue counting surveys taking account of distance estimation errors. SC/11/AE/4 for the NAMMCO Scientific Committee.

Borchers, D.L. and Burt, M.L. 1997. Sei and fin whale abundance in the North Atlantic, estimated from NASS-95 shipboard survey data. SC/5/AE/1 for the NAMMCO Scientific Committee.

Borchers, D.L., McCracken, M., Gunnlaugsson, Th. and Burt, M.L. 1997. Estimates of minke whale abundance from the 1987 and 1995 NASS aerial surveys. SC/5/AE/2 for the NAMMCO Scientific Committee.

Buckland, S.T., Bloch, D., Cattanach, K.L., Gunnlaugsson, Th. 1993a. Fin whale abundance in the North Atlantic, estimated from Icelandic and Faroese NASS-87 and NASS-89 data. *Rep. int. Whal. Commn* 42:645-651.

Buckland, S.T., Bloch, D., Cattanach, K.L., Gunnlaugsson, Th., Hoydal, K., Lens, S. and Sigurjónsson, J. 1993b. Distribution and abundance of long-finned pilot whales in the North Atlantic, estimated from NASS-87 and NASS-89 data. *Rep. int. Whal. Commn* (Special Issue 14):33-49.

Burt, M.L. and Borchers, D.L. 1997. Pilot whale abundance in the North Atlantic, estimated from NASS-95. SC/5/AE/3 for the NAMMCO Scientific Committee.

Burt, M.L., Hedley, S.L. and Paxton, C.G.M. 2003. Spatial modelling of humpback whales using data from the 1995 and 2001 North Atlantic Sightings Surveys. SC/11/AE/7 for the NAMMCO Scientific Committee.

Gunnlaugsson, Th. and Sigurjónsson, J. 1990. NASS-87: Estimation of whale abundance based on observations made onboard Icelandic and Faroese survey vessels. *Rep. int. Whal. Commn* 40:571-580.

Gunnlaugsson, Th., Pike, D.G, Vikingsson, G.A., Desportes, G. and Mikkelson, B. 2003. An estimate of the abundance of minke whales (*Balaenoptera acutorostrata*) rom the NASS-2001 shipboard survey. SC/11/AE/6 for the NAMMCO Scientific Committee.

Gunnlaugsson, Th., Víkingsson, G.A., Pike, D.G., Desportes, G., Mikkelsen, B. and Bloch, D. 2002. Fin Whale Abundance in the North Atlantic, Estimated from Icelandic and Faroese NASS-2001 Vessel Surveys. SC/10/AE/8 for the NAMMCO Scientific Committee.

Hedley, S.H., Buckland, S.T. and Borchers, D.L. 1999. Spatial modelling from line transect data. *J. Cetacean Res. Manage.* 1:255-264.

Hiby, L., Ward, A. and Lovell, P. 1989. Analysis of the North Atlantic Sightings Survey 1987: Aerial survey results. *Rep. int. Whal. Commn* 39:447-455.

Hooker, S.K. and Baird, R.W. 1999. Deep-diving behaviour of the northern bottlenose whale (*Hyperoodon ampullatus*). *Proc. R. Soc. Lond.* B 266:671-676.

[NAMMCO] North Atlantic Marine Mammal Commission. 1995. Report of the Third Meeting of the Scientific Committee. In: *NAMMCO Annual Report 1995*, NAMMCO, Tromsø, pp.71-126.

Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. 2002a. Preliminary estimates of the abundance of humpback whales (*Megaptera novaengliae*) and Lagenorhyncus spp. dolphins from the NASS-2001 Icelandic aerial survey. SC/10/AE/9 for the NAMMCO Scientific Committee.

Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A. 2002b. A re-calculation of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-95 Icelandic ship survey. SC/10/AE/6 for the NAMMCO Scientific Committee.

Pike, D.G., Gunnlaugsson, Th. and Víkingsson, G.A 2002c. Estimates of humpback whale (*Megaptera novaeangliae*) abundance in the North Atlantic, from NASS-95 shipboard survey data. SC/54/H10 for the IWC Scientific Committee.

Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. 2003. An estimate of the abundance of long finned pilot whales (*Globicephala melas*) from the NASS-2001 ship survey. SC/11/AE/10 for the NAMMCO Scientific Committee.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1996. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. Int. Whal. Commn* 47:453-484.

Sigurjónsson, J. and Gunnlaugsson, Th. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. *Rep. int. Whal. Commn* 40:537-551.

Skaug, H.J, Øien, N., Schweder, T. and Bøthun, G. 2003. Current abundance of minke whales in the northeastern Atlantic; variability in time and space. SC/55/NAM1 for the IWC Scientific Committee.

Smith, T.D., Allen, J., Clapham, P.J., Hammond, P.S., Katona, S., Larsen, F., Lien, J., Mattila, D., Palsbøll, P.J., Sigurjónsson, J., Stevick, P.T. and Øien, N. 1999. An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaengliae*). *Mar. Mam. Sci*. 15:1-32.

Table 1. Trends in whale abundance from the NASS, 1987-2001.

AREA	SPECIES	1987 Estimate	cv	1989 Estimate	cv	1995 Estimate	cv	1996-2000 Estimate	cv	2001 Estimate	cv
Iceland Coastal[2]	**Minke**	19,200[3]	0.28			55,900[4]	0.31			43,600[3]	0.19
	Humpback	Low[5]				1,000[6]	0.37			3,100[7]	0.27
Iceland SW[8]	**Minke**	2,900[9]	0.17[9]	na[10]		4,900[11]	0.27			11,100[12]	0.46
	Fin	3,900[13]	0.19[13]	5,300[13]	0.14[13]	14,300[14]	0.22			19,000[15]	0.18
	Pilot	41,500[16]	0.39[16]	132,800[16]	0.29[16]	72,100[17]	0.37			34,400[18]	0.77
	Humpback	300[19]	0.28[19]	na[10]		900[20]	0.53			2,200[28]	na[28]
Iceland SE, Faroes[21]	**Minke**	2,400[9]	0.25[9]	na[10]		Low[22]				4,100[12]	0.41

[2] From Icelandic aerial surveys.
[3] Borchers (2003). Corrected for g(0) and measurement error biases.
[4] Borchers *et al*. (1997). Estimate may be biased due to measurement error and g(0).
[5] 6 primary sightings
[6] Burt et al. (2003a). Probable negative bias due to g(0).
[7] Pike et al. (2002a). Probable negative bias due to g(0).
[8] Includes the following survey blocks: 1987 – 93+94+95+36; 1989 – 93+94+95+36+26; 1995 - 3+4+7+9; 2001 - A+B+W.
[9] Gunnlaugsson and Sigurjónsson (1990). Calculated from Table 7b using *esw* of 2 x median sighting distance, *esw* = 0.18 nm. CV includes encounter rate variance only.
[10] No estimate has been calculated from these data.
[11] Pike et al. (2002b). Probable negative bias due to g(0).
[12] Gunnlaugsson *et al.* (2003). Probable negative bias due to g(0).
[13] Buckland *et al.* (1993a). Probable negative bias due to g(0). CV positively biased because pooling of estimator components over strata was not taken into account.
[14] Borchers and Burt (1997). Probable negative bias due to g(0). For Iceland NE, does not include estimates for JMC and NVN blocks, which are not yet available.
[15] Gunnlaugsson *et al.* (2002).
[16] Buckland *et al.* (1993b). CV positively biased because pooling of estimator components over strata was not taken into account.
[17] Burt and Borchers (1997). Probable negative bias due to g(0).
[18] Pike *et al.* (2003). Probable negative bias due to g(0).
[19] Gunnlaugsson and Sigurjónsson (1990). Calculated from Table 6 using *esw* of 2 x median sighting distance, *esw* = 0.95 nm. CV does not include variance due to mean pod size estimation.
[20] Pike *et al.* (2002c). Probable negative bias due to g(0). NE does not include JMC and NVN blocks. In 1995 SE area includes eastern blocks of aerial survey area.
[21] Includes the following survey blocks: 1987 – 7+11+14 (no sightings in southern portion of block 8); 1989 – 4, 8, Faroes; 1995 - Faroes; 2001 - E.

AREA	SPECIES	1987 Estimate	cv	1989 Estimate	cv	1995 Estimate	cv	1996-2000 Estimate	cv	2001 Estimate	cv
	Fin	700[13]	0.41[13]	1,500[13]	0.32[13]	1,800[14]	0.31			2,074[15]	0.27
	Pilot	76,500[16]	0.39[16]	132,500[16]	0.36[16]	99,800[17]	0.63			30,900[18]	0.42
	Humpback	0[27]		na[10]		0[27]				200[28]	na[28]
Iceland NE[23]	**Minke**	3,700[9]	0.23[9]	na		12,300[24]	0.27	26,700[25]	0.14	8,800[12]	0.28
	Fin	900[13]	0.34[13]	na		1,600[14]	0.31			4,200[15]	0.32
	Pilot	na[26]		na		0[27]				0[27]	
	Humpback	839[19]	0.23[19]	na		10,903[20]	0.52			na[28]	

[22] 4 primary sightings.
[23] Includes the following survey blocks: 1987 – 8+9 (may need to reduce size of 8 as it extends far to the south); 1989 – not surveyed; 1995 - 5+6+JMC+NVN; 1996-2001 - NE(CM); 2001 - N+J.
[24]Blocks 5+6 from Pike *et al*. (2002b), blocks JMC and NVN from Schweder *et al.* 1997. Probable negative bias due to g(0) for blocks 5+6 (est. 6,100) but not for blocks JMC and NVN.
[25] Corrected for g(0) bias.
[26] 1 sighting.
[27] No sightings.
[28] Burt *et al.* (2003). CV's not given for block estimates. No individual estimate given for NE blocks.

AREA	SPECIES	1987 Estimate	cv	1989 Estimate	cv	1995 Estimate	cv	1996-2000 Estimate	cv	2001 Estimate	cv
Norway EB	Minke			34,700[29]	0.203	56,300[29]	0.136	43,800[30]	0.15		
Norway ES	Minke			13,400[29]	0.192	26,000[29]	0.112	18,200[30]	0.25		
Norway EC	Minke			2,600[29]	0.249	2,500[29]	0.228	600[30]	0.26		
Norway EN	Minke			14,000[29]	0.276	27,400[29]	0.206	17,900[30]	0.25		

[29] Schweder *et al.* (1997). Corrected for g(0).
[30] Skaug *et al.* (2003). Corrected for g(0).

Table 2: Further work to be carried out on abundance estimates from recent NASS.

SURVEY	SPECIES	RECOMMENDED FUTURE WORK	Ref
1987 air	Minke	1. More flexible error model based on gamma distribution.	SC/11/AE/4
1995 air	Minke	1. Redo conventional analysis to determine integrity of the dataset analysed by Borchers (1997). 2. Depending on results, investigate the effect of various levels of measurement error.	SC/5/AE/2
	Dolphins	Estimate unfinished from this and earlier surveys.	
	Humpback	1. Conventional analysis. 2. Determine availability/applicability of other covariates to improve spatial analysis. 3. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
1995 ship	Minke	None.	SC/10/AE/6
	Fin	None.	SC/5/AE/1
	Sei	None.	SC/5/AE/1
	Humpback	None.	SC/9/9
	Humpback	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
	Blue	None.	SC/11/AE/12
	Pilot	None.	SC/5/AE/3
	Bottlenose	None.	SC/11/AE/11
2001 air	Minke	None.	SC/11/AE/4
	Dolphins	1. Use double platform data to correct perception bias.	SC/10/AE/9
	Humpback	None.	SC/10/AE/9
	Humpback (spatial analysis)	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
2001 ship	Minke	1. Use double platform data to correct perception bias.	SC/11/AE/6
	Fin	None.	SC/11/AE/8

SURVEY	SPECIES	RECOMMENDED FUTURE WORK	Ref
	Humpback	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
	Blue	None.	SC/11/AE/12
	Pilot	None.	SC/11/AE/10
	Bottlenose	Use available diving data to place bounds on a correction for availability bias.	SC/11/AE/11
	Sperm	Conduct studies to determine dive times and cueing rate, and use to correct abundance estimate.	SC/10/AE/13

Appendix 1

LIST OF PARTICIPANTS

Dr David Borchers
Research Unit for Wildlife Population Assessment,
Maths Institute, North Haugh,
University of St Andrews,
Fife KY16 9SS Scotland
Tel: +44 1334 463806
Fax: +44 1334 463748
Email: dlb@st-and.ac.uk

Dr Louise Burt
Research Unit for Wildlife Population Assessment,
Maths Institute, North Haugh,
University of St Andrews,
Fife KY16 9SS Scotland
Tel: +44 1334 463806
Fax: +44 1334 463748
Email: louise@mcs.st-and.ac.uk

Dr Genevieve Desportes,
Fjord and Bælt Centre,
Margrethes Plads 1,
DL-5300 Kerteminde,
Denmark.
Tel: +45 65 32 57 83
Fax: +45 65 32 42 64
Email: genevieve@fjord-baelt.dk

Mr Þorvaldur Gunnlaugsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5331363
Fax: +354 5623790
Email: thg@hafro.is

Dr Phil Hammond,
Sea Mammal Research Unit,
University of St Andrews,
St Andrews,
Fife KY16 8LB Scotland
Tel: +44 1334 463222
Fax: +44 1334 462632
Email: psh2@st-and.ac.uk

Dr Sharon Hedley
Research Unit for Wildlife Population Assessment,
Maths Institute, North Haugh,
University of St Andrews,
Fife KY16 9SS Scotland
Tel: +44 1334 463806
Fax: +44 1334 463748
Email: sharon@mcs.st-and.ac.uk

Mr Bjarni Mikkelson
Natural History Museum,
Futalag 40,
FR-100 Tórshavn,
Faroe Islands
Tel: +298 31 85 88
Fax: +298 31 85 89
Email: bjarnim@ngs.fo

Dr Nils Øien
Institute of Marine Research,
P.O.Box 1870 Nordnes,
N-5024 Bergen,
Norway
Tel: +47 55 23 86 11
Fax: +47 55 23 86 17
Email: nils@imr.no

Dr Charles Paxton
Research Unit for Wildlife Population Assessment,
Maths Institute, North Haugh,
University of St Andrews
Fife KY16 9SS Scotland
Tel: +44 1334 463806
Fax: +44 1334 463748
Email: charles@mcs.st-and.ac.uk

Mr Daniel Pike
Scientific Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø,
Norway
Tel: +47 77 75 01 77
Fax: +47 77 75 01 81
Email: dan.pike@nammco.no

Dr Tore Schweder
Department of Economics,
University of Oslo,
P.O. Box 1095, Blindern,
N-0317 Oslo,
Norway
Tel: +47 22 85 51 44
Fax: +47 22 85 50 35
Email: tore.schweder@econ.uio.no

Mr Gísli Víkingsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik,
Iceland
Tel: +354 5520 240
Fax: +354 5623 790
Email: gisli@hafro.is

Appendix 2

AGENDA

1. OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEUR
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
5. MINKE WHALES
   - i. 2001 ship survey
   - ii. 2001 and 1987 aerial surveys around Iceland
   - iii. Combined estimates
   - iv. Trends in abundance
6. HUMPBACK WHALES
   - i. Spatial analysis- 2001 shipboard and aerial surveys
   - ii. Spatial analysis- 1995 shipboard and aerial surveys
   - iii. Trends in abundance
   - iv. Combining estimates
7. OTHER SPECIES
   - i. Fin whales
   - ii. *Lagenorhynchus* dolphins
   - iii. Pilot whales
   - iv. Sperm whales
   - v. Bottlenose whales
   - vi. Blue whales
   - vii. Killer whales
8. ADDITIONAL ANALYSES TO BE CARRIED OUT
9. STRUCTURING INTEGRATED ANALYSES FROM ALL NASS
10. FUTURE OF THE NASS
11. PUBLICATION OF SURVEY RESULTS
12. OTHER BUSINESS
13. ADOPTION OF REPORT.

Appendix 3

LIST OF DOCUMENTS

Document No.	
SC/11/AE/1	List of participants
SC/11/AE/2	Draft agenda
SC/11/AE/3	Draft list of documents
SC/11/AE/4	Borchers, D.L. Analyses of the NASS 1987 and 2001 minke whale cue counting surveys taking account of distance estimation errors.
SC/11/AE/5	Pike, D.G. and Gunnlaugsson, Th. A note on the density of minke whales in Faxaflói Bay, from a NASS-2001 shipboard survey transit.
SC/11/AE/6	Gunnlaugsson, Th., Pike, D.G, Vikingsson, G.A., Desportes, G. and Mikkelson, B. An estimate of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-2001 shipboard survey.
SC/11/AE/7	Burt, M.L., Hedley, S.L. and Paxton, C.G.M. Spatial modelling of humpback whales using data from the 1995 and 2001 North Atlantic Sightings Surveys.
SC/11/AE/8	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. Fin whale abundance in the North Atlantic, from Icelandic and Faroese NASS-2001 shipboard surveys: Slightly revised estimates
SC/11/AE/10	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. An estimate of the abundance of long finned pilot whales (*Globicephala melas*) from the NASS-2001 ship survey.
SC/11/AE/11	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. Surface abundance of northern bottlenose whales (*Hyperoodon ampulatus*) from NASS-1995 and 2001 shipboard surveys.
SC/11/AE/12	Pike, D.G., Víkingsson, G.A. and Gunnlaugsson, Th. Preliminary abundance estimates for blue whales (*Balaenoptera musculus*) in Icelandic and adjacent waters

MEMBERS OF THE NAMMCO SCIENTIFIC COMMITTEE 2003

Faroe Islands

Dorete Bloch
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 35 23 20
Fax: +298 35 23 31
Email: doreteb@ngs.fo

Geneviève Desportes
Fjord and Belt Centre
Margrethes Plads 1
DK-5300 Kerteminde, Denmark
Tel.: +45 65 32 57 83
Fax: +45 65 32 42 64
E-mail: genevieve@fjord-baelt.dk

Mr Bjarni Mikkelsen
Natural History Museum,
Futalag 40,
FO-100 Tórshavn,
Faroe Islands
Tel: +298 31 85 88
Fax: +298 31 85 89
Email: bjarnim@ngs.fo

Greenland

Aqqalu Rosing-Asvid
Greenland Institute of Natural Resources
Dalgas Have 50 B 2. lejl. G
2000 Frederiksberg, Denmark.
Tel.: +45 35 32 12 92
Fax: +45 35 32 21 99
Email: ARosing-Asvid@zi.ku.dk

Lars Witting
Greenland Institute of Natural Resources
P.O.Box 570,
DK-3900 Nuuk, Greenland
Tel.: +299 32 10 95
Fax: +299 32 59 57
E-mail: larsw@natur.gl

Mads Peter Heide-Jørgensen
Greenland Institute of Natural Resources,
c/o National Marine Mammal Laboratory,
National Marine Fisheries Service/NOAA,
7600 Sand Point Way NE,
Seattle, WA 98115 USA
Tel.: +1 206 526 6680
Fax: +1 206 526 6615
Email: mads peter.heide-joergensen@noaa.gov

Iceland

Þorvaldur Gunnlaugsson
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik, Iceland
Tel.: +354 5331363
Fax: +354 5623790
E-mail: thg@halo.is

Droplaug Ólafsdóttir
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavik, Iceland
Tel: +354 5520 240
Fax: +354 5623 790
e-mail: droplaug@hafro.is

Gísli A. Víkingsson (Chairman)
Marine Research Institute
P.O. Box 1390
IS-121 Reykjavik, Iceland
Tel.: +354 55 20240
Fax: +354 5 623790
E-mail: gisli@hafro.is

Norway

Tore Haug
Norwegian Institute of
Fisheries and Aquaculture
N-9291 Tromsø, Norway
Tel.: +47 77 62 92 20
Fax: +47 77 62 91 00
E-mail: toreh@fiskforsk.norut.no

Christian Lydersen
Norwegian Polar Institute
Polarmiljøsenteret
N-9296 Tromsø, Norway
Tel: +47 77 75 05 23
Fax: +47 77 75 05 01
Email: christia@npolar.no

Lars Walløe
Department of Physiology
University of Oslo
P.O. Box 1103, Blindern
N-0317 Oslo
Norway
Tel: +47 22 85 12 18
FAX: +47 22 85 12 49
Email: lars.walloe@basalmed.uio.no

Ex-Officio Members

Grete Hovelsrud-Broda,
General Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø, Norway
Tel: +47 77 75 01 80
Fax: +47 77 75 01 81
E-mail: gretehb@nammco.no

Daniel Pike,
Scientific Secretary,
North Atlantic Marine Mammal Commission,
Polar Environmental Centre,
N-9296 Tromsø, Norway
Tel: +47 77 75 01 80
Fax: +47 77 75 01 81
E-mail: daniel.pike@nammco.no