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SCIENTIFIC COMMITTEE

REPORT OF THE TWELFTH MEETING

Viðareiði, Faroe Islands, 27-29 October, 2004

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Executive summary ii
Report of the Eleventh Meeting of the Scientific Committee 1

Appendix 1 List of participants 26
Appendix 2 Agenda 28
Appendix 3 List of documents 30

ANNEX 1 Marine mammals and fisheries in the North Atlantic: Estimating consumption and modelling interactions 32

ANNEX 2 Report of the fin whale assessment planning meeting 51

Members of the Scientific Committee 2004 54

TWELFTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

EXECUTIVE SUMMARY

The Scientific Committee held their 12th meeting at Viðareiði, the northernmost village in the Faroe Islands, 26 – 29 October 2004. In addition to the regular members, observers from Canada and Japan attended the meeting.

The Scientific Committee was informed that the continuing absence of one of the Norwegian members was due to a lack of funding from the Norwegian government to attend NAMMCO Scientific Committee or Working Group meetings. Noting that this has been and continues to be detrimental to the functioning of the Committee, the Scientific Committee recommended that all members of the Scientific Committee be funded to attend committee meetings, by the government that appointed them.

ROLE OF MARINE MAMMALS IN THE MARINE ECOSYSTEM

At its 8th meeting in Oslo, September 1998, the NAMMCO Council tasked the Scientific Committee with providing advice on the economic consequences of different levels of harvest of marine mammals, especially harp seals and minke whales, in different areas. Working groups established by the Scientific Committee have met on 4 occasions to deal with this and related requests. The Scientific Committee has recognized that the process of developing predictive multi-species models is a long-term one. Therefore the Committee asked the Working Group to to review the progress that has been made in the last 2 years, in 2 specific areas: 1) quantifying the diet and consumption of marine mammals, and 2) the application of multi-species models that include marine mammals to candidate areas of the North Atlantic.

Diet

Preliminary results from the Icelandic research program on feeding ecology of common minke whales in Iceland show that the diet was overwhelmingly piscivorous, with krill dominating the diet in less than 10% of the stomachs. These data indicate that sandeel is by far the most important prey species for the minke whale around Iceland in the autumn and early summer. However the proportion of Atlantic cod and other gadoids in the diet was higher than had been indicated by previous studies, so the possibility for a direct interaction with fisheries still exists.

Recent work on the diet of Barents and Greenland Sea harp and hooded seals show that the diets of both species in this particular habitat were comprised of relatively few prey species. Pelagic amphipods, squid, polar cod, capelin, and sand eels were particularly important, comprising 63-99% of the observed diet biomass in both seal species, irrespective of sampling period. There was some evidence that capelin formed a larger portion of the diet during the fall and winter. However few samples had been taken from open water areas in the late summer, when harp seals might be expected to switch to capelin.

Satellite tagging of harp seals in the Greenland and Barents Seas suggest that substantial parts of the Greenland Sea stock of harp seals may temporarily share feeding grounds with the Barents Sea stock of harp seals. Temporal and spatial aspects of these migrations, as well as the recorded dive depths, overlap with the temporal and spatial distribution of capelin, suggesting that this is an important prey item during parts of the year. It was noted that, due primarily to budgetary restraint, most tagging studies have had insufficient sample size and been of too short duration to adequately determine natural variation in seasonal distribution and migratory behaviour. Nonetheless it was concluded that satellite tracking studies supply important information on the distribution of seals in time and space that may be used to make inferences concerning their diet.

Energy consumption
A new method for estimating urine production and food ingestion of minke whales was discussed. Utilizing allometry of creatinine clearance in relation to body weight and serum and urinary concentrations of creatinine, the average urine volume was predicted to be 214 L per day. From this volume and the known water content of the ingested food the average daily food ingestion was estimated to be about 280 L. This is considerably greater than reported by most workers. In discussion it was pointed out that uncertainty is not incorporated into the prediction of creatinine clearance and thus urine production, and that this uncertainty would likely be substantial given the double-logarithmic relationship used. Hence the prediction of food intake may not in fact be inconsistent with estimates derived from other methods when all sources of uncertainty are incorporated. The Working Group considered that this was a promising new method that should ideally be tested on captive animals.

Recent work on captive seals has provided some direct measurements of the diving metaboloic rate (DMR)in a quasi-natural setting. The resulting mean DMR of both juveniles and adults was 1.7 times the predicted basal metabolic rate of terrestrial mammals of equal size. The Working Group considered that the observed mean of 1.7x BMR for diving animals found in this study was not inconsistent with the rate of 2-3x BMR commonly applied to free living seals to estimate energy consumption.

Multispecies modelling
Recently, a preliminary GADGET model has been set up to model the grey seal population around Iceland as a first GADGET model of marine mammals. Although this GADGET model is still in the early stages of its development, it has shown that some aspects of marine mammal populations can be modelled using the framework provided by the GADGET software. Further work, however, is required before a model that includes the effects of predation by marine mammals on other species is attempted. The Working Group noted that rather little progress had been made in incorporating marine mammals in GADGET-based template models for candidate areas in the North Atlantic, as had been recommended by the NAMMCO Scientific Committee in 2002, presumably because no resources had been allocated for this work. The Working Group again emphasized that progress in this area will not be made unless significant additional resources are dedicated to it.

Scenario C is a model intended for exploring the comparative effects on the catch of cod, herring and capelin of various choices of management regimes for minke whaling and harp sealing, in the Barents Sea. The models for predation are pivotal for the purpose of the study. They have two components: the total food intake of an individual by species and size estimated from energetic considerations, and the relative diet composition given the abundance of the various prey items in the actual area at the time. In addition to modelled prey species, a category of “other food” is included. The abundance of other food is assumed sufficiently abundant to allow the modelled predators to satisfy their energy need regardless of the abundance of the modelled prey species.

Despite the project period soon coming to an end, the model still is inadequate. When harp seals are introduced into the model, the cod is exterminated. The modelled predation of harp seals on cod, in addition to cannibalism and minke whale predation, is simply excessive. The Working Group identified some potential problems with the harp seal diet data used that might have contributed to the unrealistic aspects of the model predictions. Most harp seal stomach samples have been taken from northern areas where cod are uncommon. However a few samples come from coastal northern Norway where the consumption of cod may have been much higher than in other areas. The inclusion of these samples, from outside of the regular distribution area of harp seals, may have positively biased the estimation of the proportion of cod in the diet. Dive profiles obtained from satellite tagged animals indicated that they did not generally dive deep enough to access cod. It was therefore considered unlikely that cod formed an important part of the diet except under exceptional circumstances.

Conclusions

The Working Group made recommendations for research that are detailed in 8.1. In reviewing the amount of multi-species modelling work and associated applications to management decisions that had been conducted world-wide over the past several years, this Working Group noted in 2002 (NAMMCO 2003) a much lower than expected activity in this area. While some progress had been made in further development of the Scenario C model and development of the GADGET platform, it remains the case that the development of multi-species modelling is not proceeding as fast as it should, given the emphasis politicians and management authorities have placed on multi-species (ecosystem) approaches to the management of marine resources. Once again the Working Group emphasized that progress in this area will not be made unless significant additional resources are dedicated to it.

Given this, the Working Group advised that the Chairman should continue to monitor progress in this area, with the possibility of holding another workshop in 2006 if sufficient progress has been made to warrant it, and perhaps also an earlier smaller task group meeting if helpful to maintain momentum.

Discussion by the Scientific Committee
The Scientific Committee supported the recommendations of the Working Group for improving the information base on the diet and energy consumption of harp and hooded seals and minke whales. With respect to multi-species modelling, the Committee, as in 2002, supported the conclusion of the Working Group that progress in this area will not be made in this area unless significant new resources are dedicated. Specifically, the Committee recommended that the Scenario C model be finished and its properties thoroughly tested. The Committee also recommended that the GADGET platform be developed as a model capable of simulating management scenarios, and that the template models including marine mammals be developed as soon as possible.

Witting noted a potential for model selection bias in the ecosystem modelling and encouraged an examination of this potential effect before such models are used to provide management advice.

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

HARP SEALS

In 2004 the Management Committee requested that the Scientific Committee annually discuss the scientific information available on harp and hooded seals and advice on catch quotas for these species given by the ICES/NAFO Working Group on Harp and Hooded Seals. The ICES/NAFO Working Group will be meeting in 2005, after which their advice will become available to the NAMMCO Scientific Committee for consideration. In this regard, the Scientific Committee requested that the Council consider the feasibility of NAMMCO assuming a more formal involvement with ICES and NAFO in the Working Group on Harp and Hooded Seals.

Noting that Canada has instituted a multi-year management plan, the Management Committee requested the Scientific Committee to provide advice on the likely impact on stock size, age composition, and catches in West Greenland and Canada under the conditions of this plan.

In 2002, the Department of Fisheries and Oceans (DFO) adopted an Objective Based Fisheries Management approach for seal populations. Under this approach harp seals are managed with the objective of maintaining the stock size above a reference level of 70% of the maximum observed population size of 5.2 million. Between the reference level and the maximum observed population size the hunt will be managed to facilitate a market based harvest that will maximise return to the sealers. The Total Allowable Catch (TAC) for 2003-2005 is 975,000 for the period, with an annual TAC of up to 350,000 in any 2 years provided the combined TAC is maintained by a reduction in the TAC in the other years.

The DFO has conducted harvest simulations to project the harp seal population forward under the conditions of the Plan. The simulations take account of both the Canadian and Greenlandic harvests. For most scenarios examined, harvest levels exceeded replacement yield and resulted in population decline. Harvests levels at the current average Canadian TAC of 325,000 result in a slow decline up to 2009 and an accelerating decline thereafter. Under this scenario the lower 60% confidence bound reaches the reference level by about 2018. Once such a decline was detected it would trigger management measures estimated to have an 80% chance of halting the decline.

The Scientific Committee accepted the modelling approach used , but noted that Greenlandic harp seal catches had decreased substantially since 2000, and therefore the forecast Greenlandic catch used in the projections may have been too high. In addition the assumed struck and lost rate of 50% used for the Greenlandic hunt may be too high, but there are no data to support a lower level. The effect of using a lower Greenlandic catch in the model would be to increase the length of time before the reference level is reached under most projections.

The TAC levels in the Canadian Management Plan in combination with the Greenlandic harvest exceed the estimated replacement yield and would, if taken, lead to a decline the the size of the stock. It is not known how the proportion of animals that summer in Greenland relates to the size of the overall population. The Scientific Committee could not address this question, but suggested that a modelling approach incorporating historical Greenlandic and Canadian harvest levels and effort and population size might give some indication of the effect of total population size on the numbers summering in Greenland. In addition, the results of the recent abundance survey in Canada will be useful in addressing this question, when they become available. In this regard the Scientific Committee recommended that the ICES/NAFO Working Group should be requested to address the question of how a projected decrease in the total population of Northwest Atlantic harp seals might affect the proportion of animals summering in Greenland.

The Scientific Committee concluded that the likely effect of the harvest levels outlined in the Canadian Management plan was a slight drop in total abundance in the short term (3-5 years), and an accelerating decline if these harvest levels are maintained over a longer period (*ca*. 10 years). However these conclusions may be modified if the Greenlandic harvest is lower than projected. The Committee was not able to directly assess the effect of these measures on the Greenlandic catch, but noted that it was likely that the availability of seals to Greenlandic hunters would decrease as the total population decreased.

HOODED SEALS

The question as to the effects of the Canadian Management Plan on the West Greenland catch (see Harp Seals) was also addressed for this species. Under this plan hooded seals are a "data poor" population as no current estimates of population size are available. The current TAC in Canada is set at 10,000 animals but recent harvests have been very low, as under current regulations the take of bluebacks is prohibited. Currently, therefore, the effect of Canadian management measures on the stock of hooded seals is negligible.

A new population survey for hooded seal is planned for March 2005 as a cooperative effort between Canada, Greenland and Norway. The survey will probably cover all the known pupping areas for the species.

HARBOUR PORPOISE

An analysis of the distribution, abundance and trends in abundance of cetaceans in Icelandic coastal waters from 4 aerial surveys carried out under the NASS program in 1986, 1987, 1995 and 2001 was presented to the Committee. The distribution of harbour porpoise sightings varied greatly between surveys but their occurrence was mainly inshore. Estimates derived from the surveys are likely

severely negatively biased because of animals that were missed by the observers and animals that were underwater when the plane passed over. The relative abundance of harbour porpoises decreased over the period at a rate of -4.9% (CV 0.47), with the negative trend due mainly to the low numbers seen in 2001.

The Scientific Committee agreed that the apparent decline in relative abundance between 1986 and 2001 is cause for concern and should be investigated further. The Scientific Committee noted in this regard that there is likely a substantial level of bycatch for this species in Icelandic fisheries. In order to estimate the sustainability of the ongoing bycatch, better estimates of the present bycatch levels of harbour porpoises are required as well as an estimate of absolute abundance for the area. Aerial surveys will be carried out over the next 2 years as part of the Icelandic Research Program, and the Scientific Committee recommended that the feasibility of modifying these surveys to generate valid estimates of absolute abundance for this species be investigated.

NARWHAL

The aerial survey attempted off West Greenland in March 2004 was not successful due mainly to poor weather conditions. The Scientific Committee emphasized the importance of continuing this survey series to the continued assessment of both West Greenland narwhal and beluga, and therefore strongly recommended that this survey be attempted again in 2005

The Scientific Committee was informed about recent changes in the management regime for narwhal and beluga in West Greenland. The total quota for narwhal is 300, 200 for West Greenland and 100 for Qaanaaq area. The Scientific Committee welcomed this information and recognized that this was a significant step towards the sustainable management of West Greenland narwhal. Nevertheless the Committee recalled its recommendation from 2004 (NAMMCO 2004), that the total removals should be reduced to no more than 135 individuals, and that there should be no narwhal hunting in the Melville Bay area.The Committee once again advised that delay in implementing catch reductions to the recommended levels will result in delay in stock recovery and probably in lower available catches in the medium term.

Noting that the scientific collaboration between JCNB and NAMMCO has been very successful to date, the Scientific Committee recommended that the respective Scientific Working Groups meet jointly to further assessment work in March 2005.

BELUGA

As noted above the West Greenland survey attempted in 2004 was not successful. The Scientific Committee recommended that this survey be attempted again in 2005.

New management measures in Greenland have established a total quota of 320 beluga for West Greenland and the Qanaaq area. The Scientific Committee recognized that this was a significant step in the right direction in the management of this stock. Nevertheless, 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. The Committee once again stressed that the delay in reducing the total removal to about 100 animals per year will result in further population decline and will further delay the recovery of this stock.

FIN WHALES

New abundance estimates for fin, humpback and sperm whales from the Norwegian 1996-2001 shipboard surveys, which covered a large part of the northeast Atlantic through annual partial coverages, were presented. For the total area surveyed through the six-year period 1996-2001, the abundance of fin whales was 10,500 (CV 0.239). The substantial increase over the 1995 estimate can

be explained by the inclusion of an area north of Iceland that was not surveyed in 1995. Analyses of sighting rates in Icelandic NASS and other surveys conducted between 1982 and 2003 showed an increasing trend in abundance for fin and humpback whales while sperm whale sightings showed the reverse trend.

In 2003 the Scientific Committee recommended that the scheduling of future assessment meetings for fin whales be dependent on the progress made in fulfilling recommendations for research. This year the Scientific Committee provided a list of high priority tasks that must be completed before a productive assessment meeting can be held (see 9.6.2). If such a meeting is to be held in Autumn 2005, these tasks should be completed by July 2005.

MINKE WHALES

The Committee was informed that an aerial digital photographic survey had been conducted in West Greenland over 2.5 months in Summer/Fall 2004. The target species were minke and fin whales. Estimates from this survey should be available by June 2005. Progress under the Icelandic Research Program is described in 16.2. In Norway the sightings survey program continued this year with a ship survey in the North Sea.

WHITE-BEAKED, WHITE-SIDED DOLPHINS AND BOTTLENOSE DOLPHINS

Aerial surveys conducted in Icelandic coastal waters between 1986 and 2001 show no significant trend in relative abundance of *Lagenorhynchus* spp. (mainly *L. albirostris* (white-beaked)) dolphins over that period. There were an estimated 31,653 (CV 0.30) dolphins in the survey area in 2001.

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

GREY SEALS

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

The Scientific Committee welcomed the information that Iceland was continuing its survey program for this species as recommended last year. The Committee reiterated its previous recommendations for management of this stock, most notably the immediate establishment of management objectives and conservation reference limits as an urgent priority.

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

HUMPBACK WHALES

In 2004 the Management Committee requested the Scientific Committee to assess the sustainable yield levels for humpback whales, particularly those feeding in West Greenlandic waters. The management objective in this case would be to maintain the stock at a stable level. The Scientific

Committee reviewed the available new information on this species in order to decide how best to respond to this request.

Photo-identification surveys of humpback whales were conducted at West Greenland during 1988–93, with the primary aim of estimating abundance for the West Greenland feeding aggregation. Sequential Petersen capture–recapture estimates between 1988 and 1993 averaged 360 humpbacks (CV =0.07), with no detectable trend over the period. However the power to detect a trend was relatively low for these data.

In considering the request for advice posed by the Council, the Scientific Committee agreed that they could not apply the apparent rate of increase observed for the stock around Iceland to the West Greenland stock as there is no information on a similar trend in abundance from this area. The existing abundance estimate is more than 10 years old and a new estimate may become available from recent surveys off West Greenland. Even so, the uncertainty in the new estimate is likely to be high. Due to the effects of environmental and demographic stochasticity in populations of only a few hundred individuals, the models that the Scientific Committee usually apply to assess sustainability would require modification to be applied to humpback whales in West Greenland. For these reasons the Scientific Committee is unable to recommend sustainable yield levels for this stock at this time, and would be unable to do so without additional information on present abundance.

For areas east of Greenland there is current information on abundance and trends in abundance available, so it would be feasible to estimate sustainable yield levels for these areas. The Scientific Committee could establish a working group to carry out this task, if the Council identifies this as having high priority.

KILLER WHALES

In 2004 the Management Committee requested the Scientific Committee to review the knowledge on the abundance, stock structure, migration and feeding ecology of killer whales in the North Atlantic, and to provide advice on research needs to improve this knowledge. Priority should be given to killer whales in the West Greenland – Eastern Canada area. Several killer whale researchers were consulted prior to the meeting and the prevailing opinion was that there was insufficient information with which to conduct an assessment, particularly for the West Greenland area. The Scientific Committee therefore reviewed the available new information to consider how it could best deal with this request.

In West Greenland there are insufficient data to estimate abundance or trends in abundance of this species. Killer whales appear sporadically and in varying numbers from year to year (NAMMCO 1993). In recent years, incidental reports suggest that sightings have become more frequent, and the catch has increased in the past 2 years. Some of these animals were taken during the winter, a time when sightings were previously very infrequent. This incidental information suggests that the spatial and temporal distribution of killer whales may have changed in recent years off West Greenland, but there are no data to support this suggestion. Given the clumped distribution and sporadic incursions of killer whales in the area, it was considered very unlikely that the aerial surveys conducted in 2004 would provide a useful estimate of abundance for this species.

The Scientific Committee found the question posed by the Council to be ambitious and noted that there was not enough information to support a meaningful assessment at this time, particularly for the West Greenland area. Moreover, the Committee considered it unlikely that such information could be obtained in the near term, even if significant resources for research become available. There is no information on trends in abundance for any area, and limited information on stock identity for killer whales throughout most of the North Atlantic. The Committee recommended some immediate steps that could be taken to improve the available information on this species (see 9.11), and agreed to review progress under this item annually with the view of conducting an assessment when sufficient information becomes available.

WALRUS

In 2004 the Management Committee noted that the Scientific Committee had last provided an assessment of walrus in 1994, and requested the Scientific Committee to provide an updated assessment of walrus, to include stock delineation, abundance, harvest, stock status and priorities for research. The Working Group on Walrus will meet in January 2005 to deal with the request from the Management Committee.

SATELLITE TAGGING CORRESPONDENCE GROUP

In 2002 the Scientific Committee decided to establish an intersessional correspondence group to:

- identify progress in satellite tagging made in NAMMCO member countries and elsewhere;
- explore the technical aspects of satellite tagging, including deployment systems;
- briefly consider what tagging experiments have been done and the rates of success;
- Recommend ways to further the development and success of this technique in NAMMCO member countries.

The Chairman of the Group reported that little progress had been made in 2004. The Scientific Committee considered that the importance of this issue warranted a continued effort to try to resolve the problems in tagging whales, particularly large whales that cannot be captured and handled. Therefore the Committee asked the Chairman to continue his efforts, by broadening the membership of the group to include key experts from member and non-member countries. The idea of holding a workshop should also be considered, but again the participation of researchers and technical experts active in this field must be ensured.

PLANNING FOR FUTURE NASS

In 2003 the Management Committee recommended that member countries continue to co-ordinate cetacean surveys across the North Atlantic, and attempt to broaden the coverage of these surveys through the inclusion of other participants, particularly in the Northwest Atlantic. In 2004 the Scientific Committee agreed that 2006 would be the best year to hold an international sightings survey, in conjunction with a possible SCANS II and other surveys.

The Scientific Secretary reported that he had contacted those responsible for planning the SCANS II survey to discuss the possibility of co-ordinating the offshore portion of that survey with the NASS. The response to this idea was favourable. However, due to lack of funding, the offshore portion of SCANS II has been postponed until 2007, and it is at this point uncertain whether it will be carried out. A research scientist at the Department of Fisheries and Oceans, Canada, was also contacted, and expressed great interest in co-ordinating future surveys off Eastern Canada with the NASS. It was noted that the Icelandic Research Program would likely continue throughout 2006, which would leave researchers there little time to participate in a sightings survey. Also, an international redfish survey, with which the Icelandic NASS successfully shared a survey platform in 2001, may occur again in 2007. Given this information, the Scientific Committee decided that the next NASS should be planned for 2007.

BYCATCH OF MARINE MAMMALS

In 2004 the Management Committee requested the Scientific Committee to carry out an evaluation of the data collection and estimation procedures used in the Icelandic bycatch monitoring program. In 2002 a procedure of monitoring marine mammal bycatch was introduced to the gill net fishery in Iceland. From 4.5-4.8% of the operating fishing reported marine mammal bycach in the fishery log books in 2002 and 2003, recording a total number of 195 and 188 entangled animals for 2002 and 2003 respectively. In October 2004 a questionnaire was presented to the fishermen in order to evaluate the efficiency of the monitoring system and the quality of the bycatch data obtained from the log books. The results from the questionnaire were used to interpret the bycatch data from the log books and estimate the total number of harbour porpoises entangled in the gill net fishery in 2002,

2003 and the first half of 2004. These results were compared to the fishermen's own attempts to estimate the annual bycatch and secondly, to information obtained from gill net research surveys performed in March and April 2003 and 2004. The comparison revealed a considerably lower estimate using the log book reports, indicating a low efficiency of the monitoring system for marine mammal bycatch using the log book reports in the Icelandic gill net fishery.

In discussion the Scientific Committee noted that the estimates of bycatch from the reporting scheme would be negatively biased because of sporadic reporting of bycatch by reporting fishermen, and possibly by deliberate falsification. The uncertainty of the bycatch estimates was not estimated, but it was considered that it should be possible to do so. Given the low return rate of bycatch records, this uncertainty is likely to be very high, especially for species that are rarely taken. The only way to improve the precision of the bycatch estimates would be to increase the response rate of fishermen. Direct independent observation of a subsample of the fishery could provide an unbiased and independent estimate of bycatch. But again, the precision of the estimate would be directly proportional to the fishing effort that could be observed.

The Scientific Committee made a number of recommendations to improve the estimation of bycatch in Icelandic fisheries (see 11.1). The Committee commended the authors for producing the first direct estimation of marine mammal bycatch from a NAMMCO member country, and strongly recommended that other member countries establish bycatch reporting systems for their fisheries.

PUBLICATIONS

Five volumes of *NAMMCO Scientific Publications* have been published to date, the most recent in 2003. Two more or planned: Vol. 6 on the NASS, and Vol. 7 on grey seals.

WORKPLAN

The next meeting of the Scientific Committee will be held in Norway, probably in October 2005.
It is likely that the following working groups will meet in 2005:

- Walrus, January in Copenhagen;
- Narwhal and Beluga, February or March, jointly with the JCNB Scientific Working Group;
- Fin whales, autumn 2005, if progress identified under 9.6.2 is completed.

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

TWELFTH MEETING OF THE NAMMCO SCIENTIFIC COMMITTEE

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

Chairman Lars Walløe welcomed the members of the Scientific Committee to their 12th meeting (Appendix 1), held at Viðareiði, the northernmost village in the Faroe Islands, 26 – 29 October 2004. He also welcomed the Observer from Canada, Patrice Simon, and the Observer from Japan, Tsutomu Tamura. Members Tore Haug and Christian Lydersen (Norway) and Mads Peter Heide-Jørgensen (Greenland) did not attend the meeting.

The Scientific Committee was informed that Lydersen's absence was due to a lack of funding from the Norwegian government to attend NAMMCO Scientific Committee or Working Group meetings. The Scientific Committee noted that this had also been the case for previous members from Norway, leading to the persistent absence of at least one of the Norwegian members from meetings of the Committee. This has been and continues to be detrimental to the functioning of the Committee. The Scientific Committee therefore recommended that all members of the Scientific Committee be funded to attend committee meetings, by the government that appointed them.

2. ADOPTION OF AGENDA

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

3. APPOINTMENT OF RAPPORTEUR

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

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

4.1 National Progress Reports

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

4.2 Working Group Reports

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

5. COOPERATION WITH OTHER ORGANISATIONS

5.1. IWC

The 56th meeting of the Scientific Committee of the International Whaling Commission was held in Sorrento from 29 June to 10 July 2004. Daniel Pike attended as observer for the NAMMCO Scientific Committee.

At the request of Iceland the Committee agreed to begin a "pre-implementation assessment" of North Atlantic fin whales. The primary purpose of such an assessment is to develop a set of plausible stock structure hypotheses to be used in a possible implementation of the RMP. This requires information on abundance, catch, stock structure, whaling operational details (past and future), and rates of mixing and increase. However, as the Committee has given highest priority to the completion of a pre-implementation assessment for North Pacific Brydes whales, the fin whale review will require at least 2 more years to complete. The main focus for next years meeting will be to review information on the stock structure of fin whales.

Some new information on North Atlantic fin whales was presented to the Committee. Gunnlaugsson (2004) and Pike *et al.* (2004) presented information on population modelling and abundance respectively that has already been discussed by the NAMMCO Scientific Committee. Hatch and Clark

(2004) presented an analysis of the acoustic differentiation of fin whales in the North Pacific and North Atlantic, with a comparison with corresponding information from genetic markers. They found that fin whales could be classified to geographic regions by their songs with a high degree of accuracy. There was no significant relationship between acoustic and geographical distance between regional groups. Interestingly, it was found that acoustic distance was negatively correlated with genetic distance, suggesting that more closely related groups of fin whales tend to have more divergent songs.

The IWC Scientific Committee noted that the NAMMCO Scientific Committee was also undertaking an assessment of fin whales, and agreed that the pre-implementation assessment could benefit from co-ordination between the 2 committees. However there was no discussion of how such co-ordination might occur. The NAMMCO Scientific Committee agreed that such co-ordination could be beneficial, and recommended an open exchange of data on genetics, catch, sightings surveys and tag returns, as well as any analyses done. In addition, the NAMMCO Scientific Committee recommended that the option of holding a joint intersessional workshop to develop stock hypotheses be considered, if the issue of stock structure is not fully resolved at the IWC Scientific Committee meeting in May 2005. Such a workshop would ideally occur later in 2005 or early in 2006.

The Committee continued its effort to develop strike limit algorithms (SLA's) for the Greenlandic minke and fin whale hunts. Some new information on stock structure was available (Andersen 2004), which indicated that while West Greenlandic minke whales were genetically different from other groups based on microsatelite DNA, the power of the discrimination was low and individual whales could not be re-assigned to putative stocks with high reliability.

The Committee expressed its disappointment at the continued low sample returns from Greenlandic hunts (12 minke and 1 fin whales in 2003) and urged the Commission to encourage the Greenlandic government to address this situation as an urgent priority.

The most recent abundance estimates for West Greenlandic minke and fin whales are from 1993 and 1987/88 respectively. The Committee has recommended that catches should normally be phased out after 10-14 years without a valid abundance estimate. The Committee therefore advised the Commission that if no estimates become available by next year, it will likely recommend the reduction or cessation of the take of fin whales off West Greenland.

This year the Scientific Committee undertook an in-depth assessment of the Bering-Chukchi-Beaufort (BCB) stock of bowhead whales. Much of the meeting concentrated on the stock structure of this group, which has heretofore been considered a single stock. Assessments indicated that the population has doubled in size since 1978 and may be approaching carrying capacity. The Committee concluded that the present *SLA*, which was developed and tested under a single stock hypothesis, was still appropriate for use in the short term.

New information on Eastern Arctic bowheads, from satellite tagging, genetics and surveys, was presented to but not discussed by the Committee. Satellite tagging studies suggest that only one stock, rather than 2 as previously thought, may summer in the Canadian Eastern Arctic, while genetic studies are equivocal. Recent surveys suggest the population may number in the low thousands, considerably higher than previously thought.

Norway informed the Committee that it intends to develop a revised RMP for baleen whales. The revised procedure will incorporate a revised CLA, and will be tested by the same simulation trails as the current CLA was tested.

The Committee held a short session dealing primarily with a paper published by Roman and Palumbi (2003), which estimated pre-exploitation population sizes for North Atlantic fin, minke and humpback whales based on levels of genetic variability and estimated mutation rate. For fin and humpback whales, the resultant population estimates were *ca* an order of magnitude higher than estimates based

on population modelling. Roman and Palumbi (2003) suggested that inaccurate catch reporting might account for the discrepancy, and suggested that the IWC should consider these estimates when establishing management regimes for whales. The Scientific Committee pointed out several possible technical problems with the genetic estimates, and concluded that they must have considerably more uncertainty than reported. They cannot be assigned to the period immediately prior to whaling, and may apply to a wide period of time before that. Therefore they are of questionable relevance for management. Furthermore it was suggested that historical catch records for fin and humpback whales were reliable and the catches required to reduce populations of the sizes suggested by Roman and Palumbi (2003) simply could not have occurred. The Committee provided recommendations for further research in this area.

The Committee held a "mini-symposium" on the general subject of anthropogenic noise and cetaceans, dealing with the following subject areas: a) the effects of anthropogenic noise on marine animals and the possible synergistic effects between ambient ocean noise levels and other environmental stressors; b) physical acoustics and ambient noise in the ocean; c) audition and the physiology of hearing in cetaceans and the effects of intense sounds on cetacean hearing; and d) whale communication behaviour. It was concluded that military sonar can constitute a direct threat to beaked whales in particular, and that seismic activities and increasing levels of ship noise were cause for serious concern. The Committee made recommendations for further research monitoring, and for measures to protect important cetacean habitats from anthropogenic noise. It was tentatively agreed to hold a workshop on the impacts of seismic exploration at the 2006 meeting.

5.2 ICES

The Joint ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP) last met in 2003 and their report was dealt with by the Scientific Committee last year. Their next meeting will be held in September 2005. Haug reported that the Working Group has dealt with 2 issues by correspondence in the interim.

Referring to the fact that Canada is now giving 3-year-quotas for harp seals with some flexibility to transfer "unharvested" animals over from one year to another, the Norwegian Ministry of Fisheries (NMF) has asked if something similar could be done for the harp and hooded seal populations in the Greenland Sea. After some consideration, WGHARP concluded that it could not provide advice on a quota rollover until more data is available and some modelling and simulations are done. Therefore the issue will be addressed at the next WGHARP meeting

Biological limits of yield reflecting very low risk of collapse must be developed within a Precautionary Approach framework. WGHARP was asked to consider a recent approach on the application of the Precautionary Approach (PA) and conservation reference points to the management of harp and hooded seals, originally developed to fit the harp seal stock in the Northwest Atlantic. After some consideration intersessionally, WGHARP decided to address this issue at their next meeting in 2005.

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

The Scientific Committee noted that the Report from the joint meeting of the JCNB Scientific Working Group (SWG) and the NAMMCO Working Group on the Conservation Status of Narwhal and Beluga had been dealt with intersessionally and presented to the Council in March 2004. Witting reported that the next meeting of the JCNB SWG will be held in March 2005, to further develop assessments for narwhal and to update assessments for beluga. Witting noted that the cooperation between the NAMMCO and JCNB Working Groups had been very productive, and hoped that such cooperation would continue. The Scientific Committee agreed and recommended that the meeting the NAMMCO Working Group meet jointly with the JCNB SWG in March 2005.

The ninth meeting of the JCNB was held in Nuuk, Greenland in May 2004. The JCNB noted the recommendations of the joint NAMMCO/JCNB Scientific Working Group, that West Greenland

narwhals are depleted to approximately one quarter of their historical abundance, and that removals in Qaanaaq and West Greenland, except Melville Bay, should be reduced to no more than 135 narwhals. In Melville Bay, the Joint Working Group recommendation, based on a survey in 2003, was for a cessation of narwhal hunting. The JCNB recommended that removals be reduced substantially in the 2004-2005 season, and thereafter to a level as close as possible to the level recommended by the Joint Working Group.

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

At its 12 meeting in March 2003 the NAMMCO Council agreed to form a Working Group under the Management Committee to deal with the issue of incorporating users' knowledge into the process of management decision making. One of the terms of reference for this group is to "Consider the Scientific Committee's proposal for procedures on how to incorporate user knowledge into the Scientific Committee's deliberations, in light of the results from the 2003 conference". Consequently the incorporation of users knowledge into management decision making is 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 7th meeting in 1999, the Scientific Committee agreed that the Secretariat should proceed with the development of stock status reports summarising the view of the NAMMCO Scientific Committee on the status of stocks/species for which it has provided advice. These Reports will be published on the NAMMCO Web Site or elsewhere as appropriate The Scientific Secretary reported that at present there are 4 reports on the web site: minke whale, long-finned pilot whale, ringed seal and Atlantic walrus. Two more reports (beluga whales and fin whales) are very near completion and should be sent out to the Scientific Committee for review in the next few weeks. The priority reports for completion this year will be for other species which the NAMMCO Scientific Committee has considered: harp seals, hooded seals, grey seals, narwhal, northern bottlenose whales, killer whales and humpback whales. The Scientific Committee noted the progress on this matter and encouraged the completion and publication of more reports in the coming year.

8. ROLE OF MARINE MAMMALS IN THE MARINE ECOSYSTEM

8.1 Report of the Working Group on Marine Mammal – Fisheries Interactions

At its 8th meeting in Oslo, September 1998, the NAMMCO Council tasked the Scientific Committee with providing advice on the economic consequences of different levels of harvest of marine mammals, especially harp seals and minke whales, in different areas.

Working groups established by the Scientific Committee have met on 4 occasions to deal with this and related requests. The third workshop entitled "Marine mammals: From feeding behaviour or stomach contents to annual consumption - What are the main uncertainties?" was held in Tromsø, Norway in September 2001, and concentrated its efforts on consideration of the methodological approaches to the calculation of consumption by marine mammals. This workshop resulted in concrete recommendations to estimate consumption by North Atlantic marine mammals, and a list of research priorities to refine existing estimates. The fourth workshop, "Modelling Marine Mammal – Fisheries Interactions in the North Atlantic", was held in Reykjavik, Iceland in September 2002. This Workshop recommended a general modelling approach involving the use of "minimum realistic" models, and developed specific recommendations for their application to candidate areas of the North Atlantic.

The Scientific Committee has recognized that the process of developing predictive multi-species models is a long-term one. Therefore the Committee asked the Working Group to to review the

progress that has been made in the last two years, in two specific areas: 1) quantifying the diet and consumption of marine mammals, and 2) the application of multi-species models that include marine mammals to candidate areas of the North Atlantic. Their Report is included as Annex 1.

Recent developments in the quantitative description of marine mammal diets
Preliminary observations on minke whale diet around Iceland
Víkingsson reported on the status of an Icelandic research program on feeding ecology of common minke whales in Icelandic waters. The program involves the sampling of a total of 200 minke whales. Sampling was initiated in 2003 when 37 minke whales were taken during August and September under a special permit granted by the government of Iceland, and continued in June 2004 when an additional 25 whales were taken. It is now assumed that the sampling of 200 minke whales will be completed in August 2006. Laboratory analysis of the stomach contents is still underway, and the preliminary results are mostly based on identification of the primary prey species in each stomach as achieved at sea. The diet was overwhelmingly piscivorous, with krill dominating the diet in less than 10% of the stomachs. These preliminary data indicate that sandeel is by far the most important prey species for the minke whale around Iceland in the autumn and early summer. There is presently no fishery for this species in Iceland, which is obviously a key forage species in the marine food web around Iceland. Therefore the minke whale is only a potentially indirect competitor with fisheries for this species. However the proportion of Atlantic cod and other gadoids in the diet was higher than had been indicated by previous studies, so the possibility for a direct interaction with fisheries still exists. It was emphasised that the study is still at a very early stage of sampling so all conclusions of relative importance of different prey species must be viewed with extreme caution.

Recent work on Barents and Greenland Sea harp and hooded seals
To enable an assessment of the ecological role of harp and hooded seals throughout their distributional range of the Nordic Seas, a project was initiated in 1999. The project concentrates on the period July-February (*i.e.*, between moulting and breeding), which is known to be the most intensive feeding period for both harp and hooded seals. Seals were collected in the pack ice belt east of Greenland in September/October 1999 and 2002 (autumn), July/August in 2000 (summer), and February/March in 2001 (winter). Results from analyses of stomach and intestinal contents from captured seals revealed that the diets of both species in this particular habitat were comprised of relatively few prey species. Pelagic amphipods, squid, polar cod, capelin, and sand eels were particularly important. Although their relative contribution to the diet varied both with species and sampling period/area, these 5 prey items constituted 63-99% of the observed diet biomass in both seal species, irrespective of sampling period.

In 2001 and 2002, Norwegian and Russian scientists performed an aerial survey to assess whether there was an overlap in distribution, and thus potential predation, between harp seals and capelin in the Barents Sea. This experiment is now being followed up with ship-based surveys to study pelagic feeding by harp seals in the Barents Sea during summer and autumn. In May/June 2004, a Norwegian survey was conducted, aimed to study the feeding habits of harp seals occurring in the open waters of the Barents Sea. Very few seals were observed along the coast of Finnmark, and no seals were seen in the open, ice-free areas. In the northwestern parts of the Barents Sea, however, very large numbers of seals were observed along the ice edge and 20-30 nautical miles south of this. In these areas, 33 harp seals were shot and sampled (stomachs, intestines, blubber cores). Additionally, samples of faeces were taken from the haul out sites on the ice. Preliminary results from the analyses indicate that krill was the main food item for the seals.

Discussion centred around the seasonality and extent of capelin consumption by harp seals in the Greenland and Barents seas. While the diet seemed to be dominated by *Parathemisto* spp. amhipods and krill in the summer, there was some evidence that capelin formed a larger portion of the diet during the fall and winter. However few samples had been taken from open water areas in the late summer, when harp seals might be expected to switch to capelin. In any event it was obvious that the diet of both harp and hooded seals must be disaggregated both seasonally and spatially for modelling purposes, given the extensive migrations and seasonal variation in diet of these species.

Satellite tagging of harp seals in the Greenland and Barents Seas

Folkow described how data obtained by the remote monitoring of marine mammals may be used in the evaluation of their diet composition, as exemplified by results obtained in 2 studies conducted by scientists from the Department of Arctic Biology, University of Tromsø, on the distribution and diving behaviour of harp seals using satellite-linked dive recorders (SDR). The first study concerns harp seals from the Greenland Sea stock, and describes results obtained from adult females between breeding (late March) and moulting (mid-May) in 1993, and from both female and males (all adults) that were tracked for an average of 244 days after moulting in late May 1999. Tagged animals remained in association with the pack-ice edge for most of the time between breeding and moult. After the moult, however, a majority of the tagged seals migrated into the Barents Sea (in late July) and remained there throughout late summer/early autumn, when harp seals are known to feed intensively and deposit fat reserves. During the course of autumn/winter they returned via the Greenland Sea to the Denmark Strait. The observations suggest that substantial parts of the Greenland Sea stock of harp seals may temporarily share feeding grounds with the Barents Sea stock of harp seals. Temporal and spatial aspects of these migrations, as well as the recorded dive depths, overlap with the temporal and spatial distribution of capelin, suggesting that this is an important prey item during parts of the year.

The second study describes results obtained from SDR-tagged adult harp seals from the Barents Sea stock, both between breeding and moulting and after moulting. The seals displayed a northward migration after the moult and largely foraged in open waters in the northern parts of the Barents Sea during summer and autumn, presumably on a fish-dominated diet. From November and onwards, however, an increasing proportion of time was spent in association with the pack-ice edge which then progressively extended southwards.

In the discussion it was noted that, due primarily to budgetary restraint, most tagging studies have had insufficient sample size and been of too short duration to adequately determine natural variation in seasonal distribution and migratory behaviour. Tagging studies in the Northwest Atlantic have shown that the migratory patterns of hooded seals can vary greatly from year to year. Also, it is known that in some years, harp seals approach the northern Norwegian coast (seal invasions), while in most years they do not. Therefore annual variability would need to be considered to give an accurate description of the seasonal distribution of these animals. Given the variation between individuals observed, many more animals, of all sex and age classes, would have to be followed throughout a full migratory cycle to give a full description of the variability in seasonal distribution.

It was concluded that satellite tracking studies supply important information on the distribution of seals in time and space that may be used to make inferences concerning their diet. This is of particular interest in studies of species such as harp and hooded seals which are not readily accessible for traditional diet composition studies based on collection of stomach/intestinal/faecal samples. Satellite tracking, thus, represents an important and necessary supplement to traditional dietary studies in these species.

Recent developments in the estimation of energy consumption

New studies of relevance for the estimated consumption by marine mammals in Greenland waters was presented and the consumption estimates first presented at the NAMMCO Workshop in 2001 were updated in SC/12/IN/10. Major gaps in knowledge were identified to be: Studies of prey selection: a) Harp seals in offshore waters. b) Hooded seals and narwhales in Baffin Bay (offshore) c) Fin whales along the edge of the southeast Greenland drift ice.The Working Group welcomed this update and noted that Baffin Bay/Davis Strait/Denmark Strait could be a focus of future workshops.

Urine production and food ingestion of minke whales

In August and September 2003 blood and urine samples were obtained from minke whales caught off the coast of Iceland. Both blood and urine samples were obtained, and the animals weight was derived from their length. Na^{+}, K^{+}, Cl^{-}, Mg^{++}, Ca^{++}, creatinine, urea and uric acid were measured in blood and

urine. Utilizing allometry of creatinine clearance in relation to body weight and serum and urinary concentrations of creatinine, the average urine volume was predicted to be 214 L per day. From this volume and the known water content of the ingested food the average daily food ingestion was estimated to be about 280 L. This is considerably greater than reported by most workers.

In the discussion it was pointed out that uncertainty is not incorporated into the prediction of creatinine clearance and thus urine production, and that this uncertainty would likely be substantial given the double-logarithmic relationship used. Hence the prediction of food intake may not in fact be inconsistent with estimates derived from other methods when all sources of uncertainty are incorporated. The Working Group noted that further work is required in order to quantify the water balance in general, and the sea water ingestion in particular. The group considered that this was a promising new method that should ideally be tested on captive animals. Applying this method to Antarctic minke whales, which are nearly stenophagous on krill, may be informative, since the water and electrolyte components of the diet could then easily be estimated.

Recent work on captive seals

Food consumption estimates of marine mammals are mostly based on an assessment of the energy requirements of the animal, which is then translated into the amount of food that is needed in order to cover these requirements. In this context, the daily energy expenditure, or field metabolic rate (FMR), is a key determinant of the total energy requirement. Current estimates of FMR for pinnipeds have been based on metabolic studies of both captive and free-ranging animals, but most of these have not been able to realistically account for energy expenditure during diving. A paper by Sparling and Fedak (2004) describing an approach that could shed more light on the metabolic costs associated with free diving was discussed. In that study, metabolic rates of eight captive grey seals were determined in connection with voluntary diving in a quasi-natural setting (large tank), using open circuit indirect calorimetry based on measurements of oxygen consumption rates. The resulting mean DMR of both juveniles and adults was 1.7 times the predicted basal metabolic rate of terrestrial mammals of equal size. The Working Group considered that the observed mean of 1.7x BMR for diving animals found by Sparling and Fedak (2004) was not inconsistent with the rate of 2-3x BMR commonly applied to free living seals to estimate energy consumption. The Working Group recommended that studies of the type carried out by Sparling and Fedak (2004) on grey seals, should also be carried out on harp and hooded seals.

Recent developments in multispecies modelling

GADGET-based models

GADGET is a flexible and powerful software framework for creating ecosystem models, that was presented at the last Scientific Committee Working Group Modelling meeting (NAMMCO 2003). Since that last meeting GADGET has been extended in a number of ways, including the implementation of a closed life cycle model and the inclusion of information from mark-recapture experiments on tagged sub-populations, including the use of bootstrapping experiments when estimating the migration parameters. Recently, a preliminary GADGET model has been set up to model the grey seal population around Iceland as a first GADGET model of marine mammals. Further work is planned on this model, to include more detail on the dynamics of the pup population, to look at modelling a stock recruit relationship, and to investigate using different growth functions that may be more applicable to marine mammals. Although this GADGET model is still in the early stages of its development, it has shown that some aspects of marine mammal populations can be modelled using the framework provided by the GADGET software. Further work, however, is required before a model that includes the effects of predation by marine mammals on other species is attempted.

The Working Group welcomed this new information, but noted that rather little progress had been made in incorporating marine mammals in GADGET-based template models for candidate areas in the North Atlantic, as had been recommended by the NAMMCO Scientific Committee in 2002, presumably because no resources had been allocated for this work. The Working Group again emphasized that progress in this area will not be made unless significant additional resources are

dedicated to it. Also as noted in 2002, GADGET lacks the scenario aspect where the management process itself is modelled in prognostic simulations. Only when this option is available will it be possible to compare management strategies and their related assessment machinery. The Working Group again recommended that such a facility be developed, noting that this should be fairly straight-forward since it will involve only data transfer to a module, with users to define and code the catch algorithm within that module.

SCENARIO model
Scenario C is a model intended for exploring the comparative effects on the catch of cod, herring and capelin of various choices of management regimes for minke whaling and harp sealing. Cod, capelin, herring, harp seals and minke whales are distributed over age, and over seven areas of the Barents sea, and simulated forwards in monthly time steps. Fishing (catch) mortality is regulated by quotas. Natural mortality is composed of endogenous predation mortality and excess natural mortality. Models for recruitment and mortality are estimated piecewise on available data. The models for predation are pivotal for the purpose of the study. They have two components: the total food intake of an individual by species and size estimated from energetic considerations, and the relative diet composition given the abundance of the various prey items in the actual area at the time. In addition to modelled prey species, a category of "other food" is included. The abundance of other food is assumed sufficiently abundant to allow the modelled predators to satisfy their energy need regardless of the abundance of the modelled prey species.

Despite the project period soon coming to an end, Schweder reported that the model still is inadequate. When harp seals are introduced into the model, the cod is exterminated. This happens with the harp seal stock at the estimated current abundance, and is contrary to what is known of the system. The modelled predation of harp seals on cod, in addition to cannibalism and minke whale predation, is simply excessive. He suggested various causes for this lack of balance. The Working Group identified some potential problems with the harp seal diet data used that might have contributed to the unrealistic aspects of the model predictions. Most harp seal stomach samples have been taken from northern areas where cod are uncommon. However a few samples come from coastal northern Norway where the consumption of cod may have been much higher than in other areas. The inclusion of these samples, from outside of the regular distribution area of harp seals, may have positively biased the estimation of the proportion of cod in the diet. Dive profiles obtained from satellite tagged animals indicated that they did not generally dive deep enough to access cod. It was therefore considered unlikely that cod formed an important part of the diet except under exceptional circumstances. The Working Group also suggested estimating harp seal total abundance using a wide range of mortality, and using the resulting estimates as input to the Scenario model to see if the mortality required to stabilize the model was within a plausible range.

Recommendations for future research
Diet
The Working Group noted that there has been progress on a number of the recommendations for research priorities identified by the WG in their 2001 meeting, and prioritized them explicitly for future action:

1. Distribution of prey species in space and time.
   Progress: Ongoing resource surveys covering main commercial species, such as capelin, cod and herring in all areas. However there continue to be problems in integrating the spatial and temporal scales of resource surveys with our knowledge of predator distribution. Limited information is available on the spatial and temporal distribution of pelagic crustaceans and polar cod, which are extremely important in the harp seal diet.
2. Spatial and temporal distribution of the diet composition of harp and hooded seals;
   Progress: Progress has been made in describing the diet of Barents and Greenland sea harp seals, but important gaps remain, particularly the diet in open water areas in the late summer, autumn and winter.
3. Diet composition of dolphins (white-beaked, white-sided and bottlenose dolphins);

Progress: Some progress has been made in describing the diet of white-sided and bottlenose dolphins around the Faroe Islands, and studies in Iceland are in progress. There has been no progress in other areas.

4. Field metabolic rate of harp and hooded seals;
   Progress: None on harp and hooded seals, but some methodological advances have been made with other phocid species.
5. Temporal changes in energy density of prey species;
   Progress: None
6. Diet of minke whales in Icelandic waters and further west;
   Progress: The Icelandic Research Program is making progress in describing the diet of minke whales in that area.
7. Consumption estimates synthesised within a modelling framework including full uncertainty evaluation;
   Progress: Some progress in Canada but no new estimates from NAMMCO member countries.

The highest priority items identified amongst the above were 2, 6 and 7.

In the immediate future, the Working Group recommended maintaining a focus on modelling the Barents Sea Ecosystem, the area for which the best data is available and where model development is ongoing at present. The Working Group also recommended that although minke whales are an important marine mammal predator in this area, improving the data inputs related to harp seals should be the primary immediate focus. The Working Group therefore recommended that research in the short term should be focused on:

1. Gaining a better understanding of the spatial and temporal distribution of the diet composition of harp seals;
2. Quantifying (with uncertainty) the seasonal abundance and distribution of major prey species of harp seals;
3. Repeating studies on distribution of harp seals in the Barents Sea to determine individual and inter-annual (natural) variation in distribution.

Energy consumption

Little new information specifically relevant to the target species was available to the Working Group. Nevertheless it was considered that existing estimates were probably adequate for modelling purposes at present. It was recommended that experiments should be conducted to determine the diving metabolic rates of harp and hooded seals similar to that of Sparling and Fedak (2004), but, if possible, under more realistic prey availability conditions, such as by using live prey.

Modelling

In general the Working Group reiterated the recommendations for further development of multispecies models made in 2002:

Prey selection

- theoretical and practical work on prey selection models
- development aggregated consumption functions
- migratory and spatial aspects of consumption models

Multi-species modelling

- Further work on the Scenario C Barents Sea model
- Use GADGET as a framework to generate template models for candidate areas in the North Atlantic

With regard to the Scenario C model, the Working Group noted that considerable effort had already gone into developing this model, and recommended that sufficient resources be allocated to finish its development and thoroughly test its properties. Recommendations for the short term included:

- Re-run cod assessment models using a higher value of mortality for young cod and use the results as input for Scenario runs, to determine what levels of mortality would be necessary to achieve compatibility in the model.
- Since pelagic crustaceans and polar cod are important prey to harp seals, the impact of including them explicitly in multispecies models should be explored.
- Investigate the sensitivity of the model to other functional forms of the predation model for harp seals, specifically forms where consumption of particular prey approaches 0 at very low densities of that species.
- Given that the diet information for harp seals is imprecise and probably biased, the sensitivity of the model to changing the proportion of cod in the diet should be explored.

With regard to the GADGET modelling framework, the Working Group noted that further work is required on the existing grey seal model to bring it up to a standard suitable for use as a template model. Once this has happened, work on models that include other marine mammals should be attempted. As in 2002, the Working Group also noted that GADGET lacks the scenario aspect where the management process itself is modelled in prognostic simulations, in a similar manner to that provided by the Scenario Barents Sea model. The inclusion of such a process would allow GADGET to compare management strategies and their related assessment machinery, and developments in the direction should be encouraged.

Workplan

In reviewing the amount of multi-species modelling work and associated applications to management decisions that had been conducted world-wide over the past several years, this Working Group noted in 2002 (NAMMCO 2003) a much lower than expected activity in this area. While some progress had been made in further development of the Scenario C model and development of the GADGET platform, it remains the case that the development of multi-species modelling is not proceeding as fast as it should, given the emphasis politicians and management authorities have placed on multi-species (ecosystem) approaches to the management of marine resources. Once again the Working Group emphasized that progress in this area will not be made unless significant additional resources are dedicated to it.

Given this, the Working Group advised that the Chairman should continue to monitor progress in this area, with the possibility of holding another workshop in 2006 if sufficient progress has been made to warrant it, and perhaps also an earlier smaller task group meeting if helpful to maintain momentum.

Discussion by the Scientific Committee

The Scientific Committee supported the recommendations of the Working Group for improving the information base on the diet and energy consumption of harp and hooded seals and minke whales. With respect to multi-species modelling, the Committee, as in 2002, supported the conclusion of the Working Group that progress in this area will not be made in this area unless significant new resources are dedicated. Specifically, the Committee recommended that the Scenario C model be finished and its properties thoroughly tested. The Committee also recommended that the GADGET platform be developed as a model capable of simulating management scenarios, and that the template models including marine mammals be developed as soon as possible.

Witting noted a potential for model selection bias in the ecosystem modelling and encouraged an examination of this potential effect before such models are used to provide management advice.

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

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

9.1. Harp seals

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

For the Barents/White Sea and Greenland Sea stocks, in addition to the advice on replacement yields, advice should be provided on the levels of harvest that would result in varying degrees of stock reduction over a 10 year period.

Noting that Canada has instituted a multi-year management plan with a 3- year allowable catch of harp seals totalling 975,000 (not including the catch by Greenland), the Management Committee requested the Scientific Committee to provide advice on the likely impact on stock size, age composition, and catches in West Greenland and Canada under the conditions of this plan.

As noted under 5.2, the ICES/NAFO Working Group will be meeting in 2005, after which their advice will become available to the NAMMCO Scientific Committee for consideration. In this regard, the Scientific Committee requested that the Council consider the feasibility of NAMMCO assuming a more formal involvement with ICES and NAFO in the Working Group on Harp and Hooded Seals.

9.1.1 Update on progress

In Norway, studies of age- and sex composition, body condition and feeding ecology were performed on harp seals invading the coast of North Norway in March. In addition, fatty acid profiles and lipid biomarkers from 20 harp seals were used to investigate their foraging ecology in the northeastern Barents Sea. High level of the *Calanus* biomarkers 20:1n9 (mean 14.6 %) and 22:1n11 (mean 6.5%) were recorded together with typical dinoflagellate markers 22:6n3 (mean 6.5%) and C18PUFA (mean 5.5%). Based on analyses of the fatty acid profile by Principal Component Analysis (PCA) the importance of polar cod and the pelagic amphipod *Parathemisto libellula* in harp seal diets was confirmed. The high level of dinoflagellate and *Calanus* biomarkers indicates that harp seal fatty acids originate mainly from these plankton organisms.

A model for a historical assessment of Barents Sea harp seals has been developed. The model has been applied within the context of the ICES WGHARP but needs some further refinements which are scheduled to be completed in 2004.

Final analyses of data from the satellite tagging study of adult Greenland Sea harp seals that was completed in May 2000 have revealed that a large proportion of the tagged seals migrated into the Barents Sea in mid-July, to return in late autumn/winter, thus sharing feeding grounds with the Barents Sea stock of harp seals for a considerable part of the year (4-5 months). Moreover, diving behaviour data show that the seals display both diurnal and seasonal variations in diving depths, with dives being much deeper in winter and at day-time, than in summer and during night-time. Further information is given in Folkow *et al.* (2004).

The Observer for Canada reported that diet studies are continuing and satellite tagging studies are being conducted to determine significant areas and times of co-occurrence between harp and hooded seals and cod, and provide details on the overall habitat use by each species to be used to estimate seal consumption on each cod stock. A new population survey of harp seal was conducted in March 2004 and the estimate from this survey will be considered by WGHARP at their next meeting.

9.1.2 Impact of Canadian management measures

In 2002, the Department of Fisheries and Oceans adopted an Objective Based Fisheries Management approach for seal populations (SC/12/7 and 9). 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, 2 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.

Harp seals are considered a data rich population, and are therefore managed with the objective of maintaining the stock size above the N70 level of 3.85 million. Between N_{max} (5.2 million) and N_{70} the hunt will be managed to facilitate a market based harvest that will maximise return to the sealers. The Total Allowable Catch (TAC) for 2003-2005 is 975,000 for the period, with an annual TAC of up to 350,000 in any 2 years provided the combined TAC is maintained by a reduction in the TAC in the other years.

Document SC/12/8 described harvest simulations carried out as background to the implementation of the Plan. Owing to uncertainty associated with the current estimates of population size, the lower 60% confidence limit served a metric to determine when N_{70} had been reached. Regular and frequent surveys are necessary to reduce the uncertainty surrounding these estimates. Annual harvests ranging from 75,000 to 500,000 over 3 years were examined to determine their impact on the population. The relacement yield for the population is estimated as approximately 255,000 animals. The Greenland harvest was assumed to remain constant at the 2000 level of 108,000, and this was doubled to account for struck and lost animals. For most scenarios examined, harvest levels exceeded replacement yield and resulted in population decline. Harvests levels at the current average Canadian TAC of 325,000 result in a slow decline up to 2009 and an accelerating decline thereafter. Under this scenario the lower 60% confidence bound reaches N_{70} by about 2018. Once such a decline was detected it would trigger management measures estimated to have an 80% chance of halting the decline. It was noted in this respect that the frequency and precision of surveys would affect the performance of the management approach, in that better and more frequent surveys would result in tighter confidence intervals for the forecast population and a lower probability of driving the population below the N_{70} level inadvertantly.

The Scientific Committee accepted the modelling approach used in SC/12/8, but noted that Greenlandic harp seal catches had decreased substantially since 2000, and therefore the forecast Greenlandic catch used in the projections may have been too high. In addition the assumed struck and lost rate of 50% used for the Greenlandic hunt may be too high, but there are no data to support a lower level. The effect of using a lower Greenlandic catch in the model would be to increase the length of time before N_{70} is reached under most projections.

The TAC levels in the Canadian Management Plan in combination with the Greenlandic harvest exceed the estimated replacement yield and would, if taken, lead to a decline the the size of the stock. It is not known how the proportion of animals that summer in Greenland relates to the size of the overall population. Low population levels in the 1970s coincided with very low harvest levels in Greenland, so it is possible that the fraction migrating to Greenland might have been disproportionally affected. Present harvests are substantially lower than they were as recently as 2000, and the decrease apparently coincides with a period of relatively high harvest in Canada. However the West Greenlandic marine ecosystem is very dynamic and there have been changes throughout this period, which might also affect the number of harp seals using the area. The Scientific Committee could therefore not address this question, but suggested that a modelling approach incorporating historical Greenlandic and Canadian harvest levels and effort and population size might give some indication of the effect of total population size on the numbers summering in Greenland. In addition, it was noted that the results of the recent abundance survey in Canada will be useful in addressing this question.

The Scientific Committee concluded that the likely effect of the harvest levels outlined in the Canadian Management plan was a slight drop in total abundance in the short term (3-5 years), and an accelerating decline if these harvest levels are maintained over a longer period (*ca*. 10 years).

However these conclusions may be modified if the Greenlandic harvest is lower than projected. The Committee was not able to directly assess the effect of these measures on the Greenlandic catch, but noted that it was likely that the availability of seals to Greenlandic hunters would likely decrease as the total population decreased. The effect on the age composition was not assessed, but the Committee noted that as the Canadian and Greenlandic harvests were mainly of young of the year animals, the proportion of these animals in the population would decrease under higher levels of harvest.

9.1.3 Future work

The Scientific Committee recommended that the ICES/NAFO Working Group should be requested to address the question of how a projected decrease in the total population of Northwest Atlantic harp seals might affect the proportion of animals summering in Greenland.

9.2. Hooded seals

9.2.1 Update on progress

This year 6 hooded seals were tagged with satellite transmitters in the moulting area for the Northwest Atlantic population off southeast Greenland in a joint project between Greenland and Canada.

Anatomical and physiological studies of hooded seals from the Greenland Sea stock were conducted in connection with a research cruise in the Greenland Sea in spring 2003. Two adult female and 4 newborn hooded seals were used in studies of the vascular arrangement in the front flippers, in connection with ongoing studies of thermoregulatory aspects of diving in this species. Another 8 weanling hooded seals were live captured and brought back to Department of Arctic Biology for later use in studies of the ability of seals to tolerate hypoxia (oxygen shortage) during diving.

9.2.2 Impact of Canadian management measures

The Canadian Management Plan is described under 9.1.1. Under this plan hooded seals are a data poor population as no current estimates of population size are available (see 9.2.3). The current TAC in Canada is set at 10,000 animals but recent harvests have been very low, as under current regulations the take of bluebacks is prohibited. Currently, therefore, the effect of Canadian management measures on the stock of hooded seals is negligible.

9.2.3 Future work

A new population survey for hooded seal is planned for March 2005 as a cooperative effort between Canada, Greenland and Norway. The survey will probably cover all the known pupping areas for the species.

Greenland and Canada will continue their joint program of satellite tagging to determine the migratory patterns for hooded seals in the Northwest Atlantic.

9.3. Harbour porpoise

9.3.1 Update on progress

Working paper SC/12/11 was an analysis of the distribution, abundance and trends in abundance of cetaceans in Icelandic coastal waters from 4 aerial surveys carried out in 1986, 1987, 1995 and 2001. The surveys had nearly identical designs in 3 of the 4 years. The target species was the minke whale but all species encountered were recorded. Sighting rates and line transect densities were used as indices of relative abundance to monitor trends over the period, and abundance estimates corrected for perception biases were calculated for some species from the 2001 survey. The distribution of harbour porpoise sightings varied greatly between surveys but their occurrence was mainly inshore. Few harbour porpoises were sighted in 2001 compared to earlier surveys. Total uncorrected abundance was 4,239 (95% CI 2,724 – 6,599) in 1986 and 5,156 (95% CI 3,027 – 8,739) in 1995, but these estimates are negatively biased, probably severely so, by uncorrected perception and availability biases. The relative abundance of harbour porpoises decreased over the period at a rate of -4.9% (CV 0.47), with the negative trend due mainly to the low numbers seen in 2001.

The Scientific Committee agreed with the conclusions of the authors that the point estimates of abundance were likely heavily negatively biased, and that the evidence for a decline in harbour porpoise in the area was weak. Nevertheless the apparent decline in relative abundance between 1986 and 2001 is cause for concern and should be investigated further. The Scientific Committee noted in this regard that there is likely a substantial level of bycatch for this species in Icelandic fisheries (see 11.1). In order to estimate the sustainability of the ongoing bycatch, better estimates of the present bycatch levels of harbour porpoises are required as well as an estimate of absolute abundance for the area. Aerial surveys will be carried out over the next 2 years as part of the Icelandic Research Program, and the Scientific Committee recommended that the feasibility of modifying these surveys to generate valid estimates of absolute abundance for this species be investigated.

9.3.2 Future work

Bloch indicated that satellite tagging would be attempted for this species in the Faroes if funding could be found. In addition a small number of samples for genetic analysis are available and these will be analyzed soon.

In Iceland, seasonal aerial surveys in coastal waters will continue for the next 2 years, and the protocols of these surveys will be modified to make them more effective for harbour porpoises. Norway has carried out vessel surveys in coastal waters but the status of these was unknown. Norway will be participating in the SCANS II survey to take place in 2005.

9.4. Narwhal

9.4.1 Update on progress

Witting reported that the aerial survey attempted off West Greenland in March 2004 had not been successful due mainly to poor weather conditions. Some ”platform of opportunity” observations of narwhals had been carried out in 2004 from hunters’ and research vessels. Three narwhals had been instrumented with satellite tags in Inglefied Bredning. The tags were of the harpoon type and were applied by Greenlandic hunters using traditional hunting equipment and kayaks. The lifetime of these tags was expected to be short. In addition 8 narwhal were tagged in Admiralty Inlet, Canada. Work continued on refinement of the assessment model for West Greenland narwhal. Recent publications (Laidre and Heide-Jørgensen 2004, Laidre *et al.* 2004) provided new information on the feeding ecology of narwhals in Baffin Bay: this information was considered by the JCNB/NAMMCO Joint Working Group in February 2004 (NAMMCO 2004).

The 3 year survey program for narwhal in Canadian High Arctic and off eastern Baffin Island was completed in 2004, and the results will be discussed at the next meeting of the Joint Working Group. Efforts continue to estimate the loss rates in narwhal hunts, and to allocate catches to putative narwhal stocks.

The Scientific Committee was informed about recent changes in the management regime for narwhal and beluga in West Greenland. The total quota for narwhal is 300, 200 for West Greenland and 100 for Qaanaaq area.

The Scientific Committee welcomed this information and recognized that this was a significant step towards the sustainable management of West Greenland narwhal. Nevertheless the Committee recalled its recommendation from 2004 (NAMMCO 2004), that the total removals should be reduced to no more than 135 individuals. It was also emphasised that this recommendation was given in terms of total annual removal rather than a landed catch. Given the unknown but perhaps substantial loss rates in some areas, limits on landed catch should be lower than this. The Committee also recommended a cessation of narwhal hunting in the Melville Bay area.The Committee once again advised that delay in implementing catch reductions to the recommended levels will result in delay in stock recovery and probably in lower available catches in the medium term.

9.4.2 Future work

Noting that there was some uncertainty as to whether the survey off West Greenland would be attempted again in 2005, the Scientific Committee emphasized the importance of continuing this survey series to the continued assessment of both West Greenland narwhal and beluga. The Committee therefore strongly recommended that this survey be attempted again in 2005.

Witting informed the Committee that the JCNB SWG wished to hold their next meeting in February or March 2005, and expressed the hope that the coordination with the NAMMCO Working Group could be continued. Noting that this collaboration has been very successful to date, the Scientific Committee recommended that the Working Group once again be made a joint one between JCNB and NAMMCO.

9.5 Beluga

9.5.1 Update on progress

As noted under 9.4.1 the West Greenland survey attempted in 2004 was not successful.

New management measures in Greenland (see 9.4.1) have established a total quota of 320 beluga for West Greenland and the Qanaaq area. The Scientific Committee recognized that this was a significant step in the right direction in the management of this stock. Nevertheless, 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. The Committee once again stressed that the delay in reducing the total removal to about 100 animals per year will result in further population decline and will further delay the recovery of this stock. Given what is known about loss rates in beluga hunts, the landed catch should be reduced to a lower level than this.

9.5.2 Future work

As for narwhal (see 9.4.2), the Committee strongly recommended that the West Greenland winter survey be attempted again in 2005.

9.6 Fin whales

9.6.1 Update on progress

Working paper SC/12/20 presented estimates of abundance for fin, humpback and sperm whales from the Norwegian 1996-2001 shipboard surveys which covered a large part of the northeast Atlantic through annual partial coverages. The surveys were conducted with 2 independent observer platforms. The target species of the surveys was the minke whale and the implemented tracking procedures for this species implied that the survey had to be conducted in passing mode so the possibilities for closing on sightings for determining species identity and group sizes were limited. Abundances of large whale species have been calculated based on a combination of the double platform data. For the total area surveyed through the six-year period 1996-2001, the abundance of fin whales was 10,500 (c.v. 0.239. The apparent increase in numbers compared to those based on the synoptic survey in 1995 can be explained by inclusion of the block NVS north of Iceland in the survey coverage.

The Scientific Committee welcomed this new information. It was noted that the estimates are likely negatively biased due to uncorrected perception and availability biases. Also, because the survey was conducted in strictly passing mode, many sightings were classified as unidentified large whales. This would also lead to underestimation of identified species abundances. The precision of the total estimates is likely overestimated, as the "extra variance" due to changes in distribution between survey years was not taken into consideration.

There was overlap in coverage between the NVS block of this survey and some Icelandic blocks of the NASS 1995 and 2001 surveys. Gunnlaugsson and Pike agreed to compare the estimates in the area of overlap and produce a combined estimate if feasible.

Working paper SC/12/21 presented an an analysis of sighting rates in Icelandic NASS and other surveys conducted between 1982 and 2003. The data show high variability for some species but

appear to confirm the observed trend of increase in abundance for fin and humpback whales while sperm whale sightings show the reverse trend. Apparently there has been an increase in sighting efficacy and sighting rates seem to increase almost linearly with the number of observers from 1 to 7.

9.6.2 Future work

In 2003 the Scientific Committee recommended that the scheduling of future assessment meetings for fin whales be dependent on the progress made in fulfilling recommendations for research. As recommended by the Working Group on Minke and Fin whales in 2003, a small Task Group was convened to review the progress that had been made since the last meeting of the Working Group. The Group reviewed the recommendations that had been made in 2003 and noted what progress had been made, and their report is includes as Annex 2.

The Scientific Committee supported the recommendations of the Task Group on some high priority tasks that must be completed before a productive assessment meeting can be held. If such a meeting is to be held in Autumn 2005, these tasks should be completed by July 2005.

Faroes

1. Genetic analyses of existing and additional samples, combined with those from other areas;
2. Completion of revised catch series and development of a CPUE series if feasible;
3. Collection of additional samples for genetic analyses, if possible.

East Greenland - Iceland

1. Spatial disaggregation of abundance, catch, effort and mark-recapture data;
2. Genetic analyses of existing samples combined with those from other areas.

Other (mainly North Norway)

1. Rectification and verification of catch data as described above, and development of a CPUE series. Additional funding is required for both these tasks;
2. Analysis of genetic samples in combination with those from other areas.

The Scientific Committee emphasized that samples from all areas should be combined into a single genetic analysis for the purpose of stock delineation. It was also recommended that the possibility of building a large whale biopsy program into the SCANS-2005 survey be investigated.

9.7 Minke whales

9.7.1 Update on progress

Witting informed the Committee that an aerial digital photographic survey had been conducted in West Greenland over 2.5 months in Summer/Fall 2004. The target species were minke and fin whales. Estimates from this survey should be available by June 2005.

Progress under the Icelandic Research Program is described in 16.2.

In Norway the sightings survey program continued this year with a ship survey in the North Sea.

9.7.2 Future work

To investigate the feasibility of estimating migration rates from genetic data, the IWC Scientific Committee agreed to fund a simulation study to determine what sample sizes and loci numbers would be required to arrive at more definitive conclusions. It is expected that this work will be carried out in the coming year.

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

9.8.1 Update on progress

Abundance and trends of *Lagenorhynchus* spp. (mainly *L. albirostris* (white-beaked)) dolphins in Icelandic coastal waters were reported in SC/12/11 (see 9.3.1). There were an estimated 31,653 (CV

0.30) dolphins in the survey area in 2001, and there was no significant trend in relative abundance between 1986 and 2001.

In the Faroes, sex and total body length have been recorded from nearly all white-sided and bottlenose dolphins caught in 2003-2004. In addition full samples were taken from as many whales as possible in this period. Some biopsy sampling of mainly white-beaked dolphins was carried out during Norwegian sightings surveys in 2003. Analysis of samples from white-beaked dolphins collected from Icelandic bycatch is ongoing.

9.8.2 Future work

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

9.9 Grey seals

9.9.1 Update on progress

Abundance estimation (using pup counts) and sampling of biological material for studies of breeding biology (including tagging of pups), in particular the temporal distribution of births, stock identity and feeding ecology was performed for grey seals in ship borne surveys in Mid and North Norway in October – December 2003.

Grey seal pups were counted repeatedly from an aircraft (3 to 5 times) during the breeding season in the autumn, in selected rookeries in Frameyjar, Breidafiord, W-Iceland and on the South-Coast. The area investigated accounts for about 45% of the estimated Icelandic pup-production. A few grey seal pups were marked with plastic tags in the autumn on Skeiðarársandur, South-Iceland.

The Faroes reported no progress in research or new management measures for this species.

9.9.2 Future work

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

The Scientific Committee welcomed the information that Iceland was continuing its survey program for this species as recommended last year. The Committee reiterated its previous recommendations for management of this stock, most notably the immediate establishment of management objectives and conservation reference limits as an urgent priority. 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.

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

9.10 Humpback whales

9.10.1 Update on progress

In 2004 the Management Committee noted the conclusion of the Scientific Committee that there is evidence from the NASS of a rapidly increasing abundance of humpback whales in the Central North Atlantic, and requested the Scientific Committee to assess the sustainable yield levels for humpback

whales, particularly those feeding in West Greenlandic waters. The management objective in this case would be to maintain the stock at a stable level. The Scientific Committee reviewed the available new information on this species in order to decide how best to respond to this request.

The distribution and abundance of humpback whales in the Northeast Atlantic was described in SC/12/20 (see 9.6.1) For the total area surveyed through the six-year period 1996-2001 the estimate for humpback whales was 4,659 animals (CV 0.391). The majority of the animals were found in the NVS block north of Iceland, which confirms the findings from the Icelandic NASS 1995 and 2001 surveys of a large humpback whale population summering in that area.

The distribution, abundance and trends in abundance of humpback whales in Icelandic coastal waters was described in SC/11/12 based on aerial surveys during 1986 – 2001 (see 9.3.1). Humpback whales increased rapidly at a rate of 10.8% (CV 0.24), with much of the increase occurring off eastern and northeastern Iceland. In 2001 there were an estimated 5,129 (CV 0.462) humpback whales in the survey area.

A similar trend was reported by Gunnlaugsson and Sigurjonsson for the period 1950 – 1984 based on observations by whalers. In SC/12/21 (see 9.6.1) additional support is given for an increasing trend from the NASS vessel surveys 1987 – 2003 and from a comparison of sighting rates in a series of 0-group surveys conducted in late August in the early 1980s and early 1990s.

The Scientific Committee noted that the findings of both these studies supported its conclusion from 2003 with regard to the Years of the North Atlantic Humpback (YoNAH) surveys, 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.

SC/12/14 provided the results of photo-identification surveys of humpback whales conducted at West Greenland during 1988–93, the last 2 years of which were part of the YoNAH research programme, with the primary aim of estimating abundance for the West Greenland feeding aggregation. The area studied stretched from the coast out to the offshore margin of the banks, determined approximately by the 200 m depth contours. Sequential Petersen capture–recapture estimates between 1988 and 1993 averaged 360 humpbacks (CV =0.07), with no detectable trend over the period. However the power to detect a trend was relatively low for these data.

9.10.2 Future work

In considering the request for advice posed by the Council, the Scientific Committee agreed that they could not apply the apparent rate of increase in the stock around Iceland to the West Greenland stock as there is no information on a similar trend in abundance from this area. The existing abundance estimate is more than 10 years old and a new estimate may become available from recent surveys off West Greenland. Even so, the uncertainty in the new estimate is likely to be high. Due to the effects of environmental and demographic stochasticity in populations of only a few hundred individuals, the models that the Scientific Committee usually apply to assess sustainability would require modification to be applied to humpback whales in West Greenland. For these reasons the Scientific Committee is unable to recommend sustainable yield levels for this stock at this time, and would be unable to do so without additional information on present abundance.

For areas east of Greenland there is current information on abundance and trends in abundance available, so it would be feasible to estimate sustainable yield levels for these areas. The Scientific Committee could establish a working group to carry out this task, if the Council identifies this as having high priority.

9.11 Killer whales

9.11.1 Update on progress

In 2004 the Management Committee requested the Scientific Committee to review the knowledge on the abundance, stock structure, migration and feeding ecology of killer whales in the North Atlantic,

and to provide advice on research needs to improve this knowledge. Priority should be given to killer whales in the West Greenland – Eastern Canada area.

Several killer whale researchers were consulted prior to the meeting and the prevailing opinion was that there was insufficient information with which to conduct an assessment, particularly for the West Greenland area. The Scientific Committee therefore reviewed the available new information to consider how it could best deal with this request.

In West Greenland there are insufficient data to estimate abundance or trends in abundance of this species. Killer whales appear sporadically and in varying numbers from year to year (NAMMCO 1993). In recent years, incidental reports suggest that sightings have become more frequent, and the catch has increased in the past 2 years. Some of these animals were taken during the winter, a time when sightings were previously very infrequent. This incidental information suggests that the spatial and temporal distribution of killer whales may have changed in recent years off West Greenland, but there are no data to support this suggestion. Given the clumped distribution and sporadic incursions of killer whales in the area, it was considered very unlikely that the aerial surveys conducted in 2004 would provide a useful estimate of abundance for this species.

Iceland has had a photo-ID program for this species and maintains a catalogue of about 400 photographed animals. No matches have been found between the Icelandic catalogue and a similarly sized catalogue of killer whales off Norway.

Seven killer whales were instrumented with satellite tags in 2000 and 2001 off Norway, and the data are being analyzed to describe movement patterns, home ranges and dive behaviour.

9.11.2 Future work

The Scientific Committee found the question posed by the Council to be ambitious and noted that there was not enough information to support a meaningful assessment at this time, particularly for the West Greenland area. Moreover, the Committee considered it unlikely that such information could be obtained in the near term, even if significant resources for research become available. Abundance estimation for this species is particularly difficult because of their clumped spatial distribution and unpredictable seasonal distribution in some areas. While mark-recapture estimation is applicable to such situations, such a study in West Greenland would be logistically difficult and likely take many years. There is no information on trends in abundance for any area, and limited information on stock identity for killer whales throughout most of the North Atlantic.

The Committee recommended some immediate steps that could be taken to improve the available information on this species:

i. Obtain samples for genetic, life history and ecological studies from all animals harvested in Greenland;
ii. Take biopsy samples from and photos ofkiller whales on an opportunistic basis, especially during sightings surveys;
iii. Compare the existing photo-ID catalogues in Norway and Iceland with available photos from other regions;
iv. Conduct genetic analyses using all new and existing samples for stock delineation.

The Scientific Committee will review progress under this item annually with the view of conducting an assessment when sufficient information becomes available.

9.12 Walrus

9.12.1 Update on progress

In 2004 the Management Committee noted that the Scientific Committee had last provided an assessment of walrus in 1994. Noting that considerable new information has become available since then, the Management committee therefore requested the Scientific Committee to provide an updated

assessment of walrus, to include stock delineation, abundance, harvest, stock status and priorities for research.

In 2003 satellite transmitters were deployed on 10 adult walrus males in the Tusenøyane area, Svalbard, in early August. In addition blubber and blood samples were collected from these animals for studies of pollutants, diets and for a general health assessment.

Samples and ID-photos were collected from walruses from Young Sound – Northeast Greenland as part of an ongoing study that will estimate population numbers in this area.

9.12.2 Future work

Dr Erik Born has agreed to chair a Working Group on Walrus, which will meet in January 2005 to deal with the request from the Management Committee. The Working Group will include members from Norway, Denmark, Greenland, Canada, the Russian Federation and the USA.

9.13 Sperm whales

9.13.1 Update on progress

A description of the distribution and abundance of sperm whales in the Northeast Atlantic was provided in SC/12/20 (see 9.6.1). Sperm whales were concentrated mainly in the Norwegian sea in offshore waters. For the total area surveyed through the six-year period 1996-2001, the abundance of sperm whales 6,375 animals (CV 0.216). It was noted that the estimate is likely to be negatively biased due to availability for this long-diving species. There appears to have been an increase in the abundance of sperm whales in the Norwegian Sea over the course of the NASS and NILS surveys. In contrast the analysis of sighting rates in the Central Atlantic from the NASS and other surveys (SC/12/21- see 9.6.1) showed no trend in the relative abundance of sperm whales in that area. It was noted that historical catch and other data showed that virtually all the sperm whales seen in both areas were males.

9.13.2 Future work

No advice has been requested by the NAMMCO Council for this species. The IWC Scientific Committee is planning for an in-depth assessment of sperm whales, and a research planning meeting is planned for early 2005.

10. NORTH ATLANTIC SIGHTINGS SURVEYS

10.1 NASS-2001 and earlier surveys

Working papers SC/12/11 (see 9.3.1), SC/12/20 (see 9.6.1) and SC/12/21 (see 9.6.1) provided new analyses using data from these surveys. In addition several papers are in various stages of development for the new volume of *NAMMCO Scientific Publication* on the NASS (see 13.1).

10.2 Planning for future NASS

In 2003 the Management Committee recommended that member countries continue to co-ordinate cetacean surveys across the North Atlantic, and attempt to broaden the coverage of these surveys through the inclusion of other participants, particularly in the Northwest Atlantic. In 2004 the Scientific Committee agreed that 2006 would be the best year to hold an international sightings survey, in conjunction with a possible SCANS II and other surveys.

Pike reported that he had contacted those responsible for planning the SCANS II survey to discuss the possibility of co-ordinating the offshore portion of that survey with the NASS. The response to this idea was favourable. However, due to lack of funding, the offshore portion of SCANS II has been postponed until 2007, and it is at this point uncertain whether it will be carried out. A research scientist at the Department of Fisheries and Oceans, Canada, was also contacted, and expressed great interest in co-ordinating future surveys off Eastern Canada with the NASS.

It was noted that the Icelandic Research Program would likely continue throughout 2006, which would leave researchers there little time to participate in a sightings survey. Also, an international redfish survey, with which the Icelandic NASS successfully shared a survey platform in 2001, may occur again in 2007.

Given this information, the Scientific Committee decided that the next NASS should be planned for 2007. Planning will be done by the Working Group on Abundance Estimates and should begin by correspondence immediatly and with a first planning meeting planned for early 2006. It will be important for the Working Group to maintain or establish contact with other potential partners in the survey, including SCANS II, Canada and possibly the USA.

11. BYCATCH OF MARINE MAMMALS

11.1 Estimation of bycatch in Icelandic coastal fisheries

In 2004 the Management Committee requested the Scientific Committee to carry out an evaluation of the data collection and estimation procedures used in the Icelandic bycatch monitoring program. Paper SC/12/16 provided a description of the program and preliminary estimates of bycatch. The Chairman clarified that the Committee should focus on the methods used and the reliability of the bycatch estimates rather than on the significance of the estimates themselves.

In 2002 a procedure of monitoring marine mammal bycatch was introduced to the gill net fishery in Iceland. From 4.5-4.8% of the operating fishing reported marine mammal bycach in the fishery log books in 2002 and 2003, recording a total number of 195 and 188 entangled animls for 2002 and 2003 respectively. In October 2004 a questionnaire was presented to the fishermen in order to evaluate the efficiency of the monitoring system and the quality of the bycatch data obtained from the log books. The results from the questionnaire was used to interpret the bycatch data from the log books and estimate the total number of harbour porpoises entangled in the gill net fishery in 2002, 2003 and the first half of 2004. The results were compared to the fishermen's own attempts to estimate the annual bycatch and secondly, to information obtained from gill net research surveys performed in March and April 2003 and 2004. The comparison revealed a considerably lower estimate using the log book reports, indicating a low efficiency of the monitoring system for marine mammal bycatch using the log book reports in the Icelandic gill net fishery.

In discussion the Scientific Committee noted that it was assumed that those fishermen who reported bycatch in their logbooks, did so for every bycatch event. This assumption is demonstrably false as some fishermen indicated in response to the questionnaire that they reported bycatch only occasionally. This would cause a negative bias of unknown magnitude in the bycatch estimation. However it was recognized that it was probably not feasible at this point to estimate the proportion of bycatch reported by reporting fishermen. This problem could be solved in the future by modifying the logbook forms such that the presence or absence of marine mammal bycatch was consistently reported for every gear cast.

It was also assumed that fishermen did not deliberately falsify their logbook records or answer untruthfully to the questionnaire survey, by reporting that they had no bycatch when in fact they did. It is impossible to estimate the magnitude of this bias, if it exists, in a self-reporting scheme. The most likely effect of such deliberate falsification would be to cause an underestimation of bycatch. The authors of SC/12/16 indicated that most fishermen responded positively to the questionnaire, and they did not think deliberate falsification would be an important problem.

The uncertainty of the bycatch estimates in SC/12/16 was not estimated, but it was considered that it should be possible to do so. Given the low return rate of bycatch records, this uncertainty is likely to be very high, especially for species that are rarely taken. The only way to improve the precision of the bycatch estimates would be to increase the response rate of fishermen. While the bycatch estimates from the experimental gillnet survey program provide an independent check on the estimates from logbooks, the uncertainty in these estimates is likely also to be very high because of the relatively low

amount of effort in the survey fishery. Therefore the gillnet survey will likely have very low power to provide estimates of bycatch with required precision.

Similarly, direct independent observation of a subsample of the fishery could provide an unbiased and independent estimate of bycatch. But again, the precision of the estimate would be directly proportional to the fishing effort that could be observed. It is possible to calculate the amount of observer coverage required to produce estimates of a given precision (Northridge and Thomas 2003), and the Committee recommended that this be done for the Icelandic fishery.

No estimate of bycatch was provided from the lumpfish gillnet fishery, which is known to take marine mammals. It was noted that this fishery is under a different reporting system than other gillnet fisheries, so bycatch estimation would have to be done independently.

The Scientific Committee recommended the following actions to improve the estimation of bycatch in Icelandic fisheries:

i. Logbook reporting forms should be changed such that the presence or absence of bycatch is reported for every gear cast, along with associated effort data;
ii. Full uncertainty should be incorporated into the bycatch estimates from the logbook program and the experimental gillnet survey;
iii. An analysis should be carried out of the level of observer coverage required to achieve an acceptable level of precision in bycatch estimates from the Icelandic gillnet fishery;
iv. Bycatch from the lumpfish gillnet fishery should be estimated.

It was recognized that intentional falsification may produce a negative bias in any self reporting system, but the magnitude of this bias cannot be addressed without an independent estimate of bycatch.

In conclusion, the Scientific Committee commended the authors for producing the first direct estimation of marine mammal bycatch from a NAMMCO member country, and strongly recommended that other member countries establish bycatch reporting systems for their fisheries.

12. DATA AND ADMINISTRATION

There was nothing to report under this item.

13. PUBLICATIONS

13.1 NAMMCO Scientific Publications

Five volumes of *NAMMCO Scientific Publications* have been published to date, the most recent in 2003. Two more or planned: Vol. 6 on the NASS, and Vol. 7 on grey seals. The order of these volumes will depend on which is completed first, as both are expected to be published in 2005. There has also been some discussion about publishing a volume on narwhal, and this will be reconsidered at the next meeting of the Beluga/Narwhal Working Group, probably in 2005.

The planned volume on the NASS is edited by Nils Øien and Daniel Pike. All relevant authors initially confirmed their contribution to the volume, but it has proven difficult to get authors to submit their papers by the required deadlines. Nevertheless the editors expect all papers to be in early in 2005, for an expected publication later in that year.

The grey seal volume is edited by Tore Haug, Mike Hammill and Droplaug Ólafsdóttir. All relevant authors have confirmed their contributions to the volume. The core of the book will be articles reviewing the status of grey seals in various areas (including at least distribution, population sizes and trends (and how these were assessed), and removals (and sustainability of removals, if possible)). The deadline for receipt of articles is January 1 2005, and the book should be completed sometime in 2005.

The idea of publishing a volume on oceanic dolphins (*Lagenorhynchus, Tursiops, Delphinus*) was discussed, but a decision on this was considered premature until the planned assessment has been conducted (see 9.8.2).

13.2 Other publications

The proceedings from the Conference on the Incorporation of Users' Knowledge in Management Decision Making, held in 2003, are expected to be published in book form in 2005.

14. 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.

15. FUTURE WORK PLANS

15.1 Scientific Committee

The next meeting of the Scientific Committee will be held in Norway, probably in October 2005.

15.2 Working groups

It is likely that the following working groups will meet in 2005:

- Walrus, January in Copenhagen;
- Narwhal and Beluga, February or March, jointly with the JCNB Scientific Working Group;
- Fin whales, autumn 2005, if progress identified under 9.6.2 is completed.

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

16. ANY OTHER BUSINESS

16.1 Satellite tagging correspondence group

In 2002 the Scientific Committee decided to establish an intersessional correspondence group to:

- identify progress in satellite tagging made in NAMMCO member countries and elsewhere;
- explore the technical aspects of satellite tagging, including deployment systems;
- briefly consider what tagging experiments have been done and the rates of success;
- Recommend ways to further the development and success of this technique in NAMMCO member countries.

Mikkelsen, chairman of the Group, reported that little progress had been made in 2004. An attempt had been made to put together an overview of past tagging attempts, focussing on the technical details of tag type and attachment, and the relative success of the deployment. However, insufficient information had been provided to warrant a more formal review. Mikkelsen concluded that without the participation of researchers who are active in this area, it will be difficult to make progress on this issue.

The Scientific Committee considered that the importance of this issue warranted a continued effort to try to resolve the problems in tagging whales, particularly large whales that cannot be captured and handled. Therefore the Committee asked Mikkelsen to continue his efforts, by broadening the membership of the group to include key experts from member and non-member countries. The idea of holding a workshop should also be considered, but again the participation of researchers and technical experts active in this field must be ensured.

16.2 Icelandic research program

In 2003 the Marine Research Institute, Reykjavík, in cooperation with a number of other research institutes, introduced a research programme on minke whales in Icelandic waters. The original plan assumed a catch of 100 common minke whales, 100 fin whales and 50 sei whales in each of the 2 years of the programme. The primary objective of the research on minke whales was to increase our

knowledge on the feeding ecology of minke whales in Icelandic waters by studies on diet composition, energetics, seasonal variation in distribution and abundance, consumption of different prey species and multispecies modelling.

In August 2003 the Government of Iceland decided to start implementation of the part of the programme concerning common minke whales by issuing a special permit for the takes of up to 38 animals from 15. August to 30 September 2003 in accordance with the original plan for this period. A total of 37 common minke whales were taken during this period, including one struck and lost animal. In June 2004 a special permit was granted for the takes of a further 25 minke whales. Thus, the sampling has proceeded considerably more slowly than assumed in the original plan, with a total of 62 common minke whales taken during the first whole year of the programme (first 2 summer seasons).

The objectives, methodology, total sample size and spatial and seasonal distribution of the sample remain unchanged from the original proposal and the modifications involve only a reduced rate of sampling. It is now assumed that the sampling of 200 minke whales, originally scheduled to take 2 years, will be completed in August 2006. The proposed catches in 2005 and 2006 are 39 and 100, respectively.

In 2003 there was a dominance of males in the sample (23 males/13 females), while the opposite was true in 2004 (10 males/15 females).

Some very preliminary results from the programme were presented at the NAMMCO workshop on marine mammal fisheries interaction in Oslo (see 8.1).

The status of laboratory work for the different subprojects is given in SC/12/NPR-I. In addition to research directly based on sampling of minke whales, 3 aerial surveys were conducted in Icelandic coastal waters to investigate seasonal distribution and abundance of minke whales in Icelandic waters (SC/12/19) and seven minke whales were instrumented with satellite tags.

No decision has been taken by Icelandic authorities regarding implementation of the part of the programme concerning fin and sei whales.

17. ACCEPTANCE OF REPORT

The Report was accepted on November 29, 2004. The Scientific Committee expressed their thanks to Dorete Bloch for arranging the meeting at such a spectacular location.

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Appendix 2

AGENDA

1. Chairman's welcome and opening remarks
2. Adoption of Agenda
3. Appointment of Rapporteur
4. Review of available documents and reports
4.1 National Progress Reports
4.2 Working Group Reports
4.3 Other reports and documents
5. Cooperation with other organisations
5.1. IWC
5.2 ICES
5.3 Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga
6. Incorporation of the users knowledge in the deliberations of the Scientific Committee.
7. Update on Status of Marine Mammals in the North Atlantic
8. Role of marine mammals in the marine ecosystem
8.2 Report of the Working Group on Marine Mammal – Fisheries Interactions
8.3 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 Impact of Canadian managment measures
9.1.3 Future work
9.2. Hooded seals
9.2.1 Update on progress
9.2.2 Impact of Canadian managment measures
9.2.3 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

9.11 Killer whales
9.11.1 Update on progress
9.11.2 Future work
9.12 Walrus
9.12.1 Update on progress
9.12.2 Future work
9.13 Sperm whale
9.13.1 Update on progress
9.13.2 Future work
10. North Atlantic Sightings Surveys
10.1 NASS-2001 and earlier surveys
10.2 Planning for future NASS
11. Bycatch of marine mammals
11.1 Estimation of bycatch in Icelandic coastal fisheries
11.2 Other
12. Data and administration
13. Publications
13.1 NAMMCO Scientific Publications
13.2 Other publications
14. Budget
15. Future work plans
15.1 Scientific Committee
15.2 Working groups
15.3 Other matters
16. Any other business
16.1 Satellite tagging correspondence group
17. Acceptance of Report

Appendix 3

LIST OF DOCUMENTS

Doc. No.	Title
SC/12/1	List of Participants
SC/12/2	Provisional Annotated Agenda (Draft)
SC/12/3	List of Documents
SC/12/NPR-F	National Progress Report – Faroe Islands
SC/12/NPR-G	National Progress Report – Greenland
SC/12/NPR-I	National Progress Report – Iceland
SC/12/NPR-N	National Progress Report – Norway
SC/12/NPR-C	National Progress Report – Canada
SC/12/4	Observers Report: 54th Meeting of the IWC Scientific Committee, Shimonoseki, Japan
SC/12/5	Update on Status of Marine Mammals in the North Atlantic
SC/12/7	Report of the Working Group on Marine Mammal – Fisheries Interactions
SC/12/7	Atlantic Seal Hunt 2003-2005 Management Plan
SC/12/8	Hammill, M.O. and Stenson, G.B. Harvest simulation for 2003-2006 harp seal management plan.
SC/12/9	Hammill, M.O. and Stenson, G.B. Application of the precautionary approach and conservation reference point to the management of Atlantic seals: a discussion paper.
SC/12/10	Proceedings of the Marine Mammal Peer Review Committee.
SC/12/11	Pike, D.G., Paxton, G.M., Gunnlaugsson, Th. and Víkingsson, G.A. Trends in the distribution and abundance of cetaceans in Icelandic coastal waters from aerial surveys, 1986-2001.
SC/12/12	Report of the NAMMCO Fin Whale Assessment Planning Meeting
SC/12/14	Larsen, F. and Hammond, P.S. Distribution and abundance of West Greenland humpback whales *(Megaptera novaeangliae*). *J. Zool. Lond.* 263:343-358.
SC/12/15	Ólafsdóttir, D. On the bycatch monitoring system in Iceland
SC/12/16	Status of NAMMCO Scientific Publications
SC/12/17	Draft Budget 2004

Doc. No.	Title
SC/12/18	Summary of requests by NAMMCO Council to the Scientific Committee, and responses by the Scientific Committee
SC/12/19	Aerial sightings surveys around Iceland in 2003 and 2004: Preliminary report.
SC/12/20	Øien, N. Distribution and abundance of large whales in the northeast Atlantic, based on data from partial coverages 1996-2001.
SC/12/21	Gunnlaugsson, Th., Víkingsson, G.A. and Pike, D.G. Comparison of sighting rates from NASS and other dedicated cetacean vessel effort around Iceland during 1982 to 2003.

ANNEX 1

MARINE MAMMALS AND FISHERIES IN THE NORTH ATLANTIC: ESTIMATING CONSUMPTION AND MODELLING INTERACTIONS

Oslo, 22-24 October, 2004

1. OPENING REMARKS

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

At its 8th meeting in Oslo, September 1998, the NAMMCO Council tasked the Scientific Committee with providing advice on the following:

i) to identify the most important sources of uncertainty and gaps in knowledge with respect to the economic evaluation of harvesting marine mammals in different areas;
ii) to advise on research required to fill such gaps, both in terms of refinement of ecological and economic models, and collection of basic biological and economic data required as inputs for the models,
iii) to discuss specific areas where the present state of knowledge may allow quantification of the economic aspects of marine mammal-fisheries interaction;
    a) what could be the economic consequences of a total stop in harp seal exploitation, versus different levels of continued sustainable harvest?
    b) what could be the economic consequences of different levels of sustainable harvest vs. no exploitation of minke whales?

Working groups established by the Scientific Committee have met on 4 occasions to deal with this and related requests. It was realised early on that important uncertainties remain in the calculation of consumption by marine mammals, and that such uncertainty was the most important factor hindering the development of models linking consumption with fishery economics. Therefore the Scientific Committee has heretofore concentrated its efforts on consideration of the methodological approaches to the calculation of consumption by marine mammals. These issues were fully reviewed at the third workshop with the title of "Marine mammals: From feeding behaviour or stomach contents to annual consumption - What are the main uncertainties?" held in Tromsø, Norway in September 2001. This workshop resulted in concrete recommendations to estimate consumption by North Atlantic marine mammals, and a list of research priorities to refine existing estimates.

Most recently the Scientific Committee hosted a workshop under the title "Modelling Marine Mammal – Fisheries Interactions in the North Atlantic" in Reykjavik, Iceland in September 2002. This Workshop recommended a general modelling approach involving the use of "minimum realistic" models, and developed specific recommendations for their application to candidate areas of the North Atlantic. However the Workshop emphasized that better data on diet and consumption was needed before marine mammals could be adequately represented in models.

The Scientific Committee has recognized that the process of developing predictive multi-species models is a long-term one. Therefore the Committee would now like to review the progress that has been made in the last two years, in two specific areas: 1) quantifying the diet and consumption of marine mammals, and 2) the application of multi-species models that include marine mammals to candidate areas of the North Atlantic.

2. ADOPTION OF AGENDA

The agenda (Appendix 2) was adopted without changes.

3. APPOINTMENT OF RAPPORTEUR

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

4. REVIEW OF AVAILABLE DOCUMENTS

Documents available to the meeting are listed in Appendix 3.

5. RECENT DEVELOPMENTS IN THE QUANTITATIVE DESCRIPTION OF MARINE MAMMAL DIETS

i. Baleen whales

Preliminary observations on minke whale diet around Iceland

Víkingsson reported on the status of an Icelandic research program on feeding ecology of common minke whales in Icelandic waters (SC/12/IN/4). The program involves the sampling of a total of 200 minke whales. According to the original plan, the sampling was to be completed in 2 years. Sampling was initiated in 2003 when 37 minke whales were taken during August and September under a special permit granted by the government of Iceland, and continued in June 2004 when an additional 25 whales were taken. Thus, the sampling has proceeded considerably more slowly than originally planned. The objectives, methodology, total sample size and spatial and seasonal distribution of the sample remain unchanged from the original proposal. It is now assumed that the sampling of 200 minke whales will be completed in August 2006.

Laboratory analysis of the stomach contents is still underway, and the preliminary results presented here are mostly based on identification of the primary prey species in each stomach as achieved at sea. In addition these results should be viewed with caution as they represent only a small fraction of the overall study, from a selected part of the season (late summer/autumn in 2003 and early summer in 2004). Judging from the limited sampling and very preliminary analyses conducted to date, the following observations can be made:

- The diet was overwhelmingly piscivorous, with krill dominating the diet in only 3% and 8% of the stomachs in 2003 and 2004 respectively.
- Sandeel was the single most important prey type with 70% and 54% prevalence in 2003 and 2004 respectively.
- Cod was dominant in 10% and 11% of the stomachs in 2003 and 2004 respectively, and gadoid-like fish, unidentifiable at sea, were dominant in 7% and 16% of the stomachs.
- The diet composition varied considerably with geographic location. Sandeel dominated the diet in the southern and western areas, while the diet seemed to be more diverse off northern and eastern Iceland.

Discussion

It was noted that several aerial surveys have found that the distribution of minke whales around Iceland is quite predictable in mid-summer, with highest densities found to the west and southeast of Iceland. The seasonal patterns of distribution are being evaluated by carrying out additional surveys in the spring, summer and autumn. With these data it will be possible to estimate consumption by area and season, once diet sampling has been completed for all spatiotemporal combinations.

Preliminary data indicate that sandeel is by far the most important prey species for the minke whale around Iceland. There is presently no fishery for this species in Iceland, which is obviously a key forage species in the marine food web around Iceland. Therefore the minke whale is only a potentially indirect competitor with fisheries due to its consumption of this species. However the proportion of Atlantic cod and other gadoids in the diet was higher than had been indicated by previous studies, so the possibility for a direct interaction with fisheries still exists. Víkingsson emphasized the preliminary nature of these findings, and that further conclusions must await the results of field and laboratory studies to take place over the next 2 years.

Diet and consumption of three baleen whales and their possible interaction with fisheries in the western North Pacific

SC/12/IN/6 presented the results of analyses of the stomach contents of the common minke whale, Bryde's whale and sei whale sampled from May to September 1996-2003. The main prey species of common minke whale consisted of 2 fish species (Japanese anchovy *Engraulis japonicus* and Pacific saury *Cololabis saira*). The main prey species of Bryde's whale consisted of krill (*Euphausia pacifica*) and Japanese anchovy. The main prey species of sei whale consisted of 2 species of copepods (*Neocalanus cristatus*, *N. plumchrus*), krill, Japanese anchovy and Pacific saury). There were seasonal, geographical and yearly changes of prey species in western North Pacific.

The estimated total prey consumptions by weight for common minke, Bryde's and sei whales during the feeding period in the western North Pacific were 912,000 tons, 2,260,000 tons and 8,472,000 tons, respectively. In this region the prey consumptions of economically important Pacific saury, walleye pollock and herring by common minke whales were calculated as 175,000 tons, 177,000 tons and 169,000 tons, respectively. The prey consumption of the economically important chub mackerel by Bryde's whales was calculated as 21,000 tons. The prey consumption of the economically important Pacific saury by sei whales was calculated as 23,000 tons. Based on these results, there is a possibility of direct competition between these whale and the fisheries for these resources in the western North Pacific. To evaluate this competition, more information on accurate abundance in prey species and these whales, and their residence period in the Pacific region, are needed.

Discussion

Discussion by the Working group focussed on the methodological aspects of this study. To estimate consumption the allometric equation developed by Sigurjónsson and Víkingsson (1997) was used. It was noted that one of the assumptions of this method is that the whales consume 80% of their total intake in the summer months. If the whale feeding is spread more evenly throughout the year the method would therefore overestimate consumption in the summer months. However the generalized allometric model was used because no information on energetics is available for Brydes or sei whales, and the existing information on seasonal distribution, while limited, is in rough agreement with the model.

The Working Group noted that there was a need to include all known sources of uncertainty in the estimates of consumption. Sources of uncertainty that had not yet been included were energy use, the proportional description of the diet, and the seasonal variation in the energy content of the prey species, which can be considerable for small pelagic fish.

ii. Seals

Recent work on Barents and Greenland Sea harp and hooded seals

To enable an assessment of the ecological role of harp and hooded seals throughout their distributional range of the Nordic Seas, a project was initiated in 1999 by members of the NAMMCO Scientific Committee. The project concentrates on the period July-February (*i.e.* between moulting and breeding), which is known to be the most intensive feeding period for both harp and hooded seals. To provide data, seals were collected for scientific purposes on expeditions with R/V "Jan Mayen", conducted in the pack ice belt east of Greenland in September/October 1999 and 2002 (autumn), July/August in 2000 (summer), and February/March in 2001 (winter). Results from analyses of stomach and intestinal contents from captured seals revealed that the diet of both species in this particular habitat were comprised of relatively few prey taxa (Haug *et al.* 2004). Pelagic amphipods of the genus *Parathemisto* (probably almost exclusively *P. libellula*), the squid *Gonatus fabricii,* the polar cod *Boreogadus saida,* the capelin *Mallotus villosus*, and sand eels *Ammodytes* spp were particularly important. Although their relative contribution to the diet varied both with species and sampling period/area, these 5 prey items constituted 63-99% of the observed diet biomass in both seal species, irrespective of sampling period.

During sampling in summer (July/August) in 2000 and winter (February/March) in 2001, harp and hooded seals were observed to co-occur in the sampling areas. This facilitated description and comparison of their diets. For hooded seals, *G. fabricii* and capelin were the dominant food items in

winter 2001, but the summer 2000 diet comprised a mixture of this squid and polar cod. *Parathemisto* was most important for the harp seals during summer 2000, whereas in winter 2001 the contribution from krill and capelin were comparable to that of *Parathemisto*. Multivariate analyses revealed significant differences in the intestinal contents of hooded and harp seals, in areas where the 2 species' occurrence showed spatial overlap. Different foraging depths of the 2 seal species may have contributed to the observed differences in diets. Studies of diving behaviour of harp and hooded seals in the Greenland Sea have revealed that both species usually perform more shallow dives during summer than during winter, and that hooded seals dive to deeper waters than harp seals in both periods. Except for the youngest stages, which may occur in the upper water layers during summer, the major hooded seal prey *G. fabricii* has a typical mesopelagic distribution with occurrence mainly at depths greater than 400 m. This is in contrast to the distribution of the major food of harp seals: the observed krill and amphipod species are usually confined to the more upper water layers (< 200m depth).

Based on dorsal blubber cores collected in October 1995, fatty acid profiles and lipid biomarkers from 20 harp seals were used to investigate the foraging ecology of the species and the transfer of energy through the Franz Josef Land – Novaya Zemlya food chain (Falk-Petersen *et al.* 2004). High levels of the *Calanus* fatty acid trophic markers (FATMs) 20:1(n-9) (mean 14.6 %) and 22:1(n-11) (mean 6.5%), together with the typical dinoflagellate FATM 22:6(n-3) (mean 6.5%) and C18PUFA (mean 5.5%), were found in blubber samples. Based on analyses of the fatty acid profiles by principal component analysis, the importance of polar cod and the *Parathemisto libellula* in the diet of harp seals was confirmed. The high levels of 22:6(n-3), C18PUFA and C20 and C22 FATMs indicate that the harp seal lipids mainly originate from dinoflagellates consumed by *Calanus* copepods.

In 2001 and 2002, Norwegian and Russian scientists performed an aerial survey to assess whether there was an overlap in distribution, and thus potential predation, between harp seals and capelin in the Barents Sea. This experiment is now being followed with ship-based surveys to study pelagic feeding by harp seals in the Barents Sea during summer and autumn. In May/June 2004, a Norwegian survey was conducted to study the feeding habits of harp seals occurring in the open waters of the Barents Sea. Very few seals were observed along the coast of Finnmark, and no seals were seen in the open, ice-free areas. In the northwestern parts of the Barents Sea; however, very large numbers of seals were observed along the ice edge and 20-30 nautical miles south of this. In these areas, 33 harp seals were shot and sampled (stomachs, intestines, blubber cores). Additionally, samples of faeces were taken from the haul out sites on the ice. Preliminary results from the analyses indicate that krill was the main food item for the seals.

The project is planned to run over a three-year period (2004-2006), and the next survey to address these questions will take place in June/July 2005. In the Norwegian area (NEZ) a chartered Norwegian coast guard vessel will be used, whereas a Russian vessel will be applied in REZ. The boat-based survey may be supported with aerial reconnaissance surveys performed by a Russian aeroplane.

Discussion

Discussion centred on the seasonality and extent of capelin consumption by harp seals in the Greenland and Barents seas. While the diet seemed to be dominated by *Parathemisto* spp amhipods and krill in the summer, there was some evidence that capelin formed a larger portion of the diet during the autumn and winter. However few samples had been taken from open water areas in the late summer, when harp seals might be expected to switch to capelin. In any event it was obvious that the diet of both harp and hooded seals must be disaggregated both seasonally and spatially for modelling purposes, given the extensive migrations and seasonal variation in diet of these species.

Satellite tagging of harp seals in the Greenland and Barents Seas

Folkow described how data obtained by the remote monitoring of marine mammals may be used in the evaluation of their diet composition, as exemplified by results obtained in 2 studies conducted by representatives of the Department of Arctic Biology, University of Tromsø, on the distribution and

diving behaviour of harp seals using satellite-linked dive recorders (SDR). The first study (Folkow *et al*. 2004) concerns harp seals from the Greenland Sea stock, and describes results obtained from adult females between breeding (late March) and moulting (mid-May) in 1993, and from both female and males (all adults) that were tracked for an average of 244 days after moulting in late May 1999. Tagged animals remained in association with the pack-ice edge for most of the time between breeding and moult. After the moult, however, a majority of the tagged seals (N=7) migrated into the Barents Sea (in late July) and remained there throughout late summer/early autumn, when harp seals are known to feed intensively and deposit fat reserves. During the course of autumn/winter they returned via the Greenland Sea to the Denmark Strait. The observations suggest that substantial parts of the Greenland Sea stock of harp seals may temporarily share feeding grounds with the Barents Sea stock of harp seals. The seals mainly performed shallow dives (<50 m) during summer in the Greenland Sea, while the depth of dives gradually increased throughout autumn and winter. The seals spent a considerable proportion of time in open water in summer and early autumn, while an increasing proportion of time was spent near the pack-ice edge in winter and spring. Temporal and spatial aspects of these migrations, as well as the recorded dive depths, overlap with the temporal and spatial distribution of capelin, suggesting that this is an important prey item during parts of the year.

The second study (in prep.) describes results obtained from SDR-tagged adult harp seals from the Barents Sea stock, both between breeding and moulting and after moulting. The seals displayed a northward migration after the moult and largely foraged in open waters in the northern parts of the Barents Sea during summer and autumn, presumably on a fish-dominated diet. From November and onwards, however, an increasing proportion of time was spent in association with the pack-ice edge which then progressively extended southwards.

Discussion

It was noted that, due primarily to budgetary restraint, most tagging studies have had insufficient sample size and been of too short duration to adequately determine natural variation in seasonal distribution and migratory behaviour. Tagging studies in the Northwest Atlantic have shown that the migratory patterns of hooded seals can vary greatly from year to year. Also, it is known that in some years, harp seals approach the northern Norwegian coast (seal invasions), while in most years they do not. Therefore annual variability would have to be considered to give an accurate description of the seasonal distribution of these animals. It was also noted that sample sizes were in most cases far too low in satellite tagging studies. Given the variation between individuals observed, many more animals, of all sex and age classes, would have to be followed throughout a full migratory cycle to give a full description of the variability in seasonal distribution.

There was some discussion about the ways in which data from satellite tagging experiments could be integrated into multispecies models. The approach used here of disaggregating seal distribution at relatively small spatial and temporal scales and developing a seal "usage surface" was considered a viable way of proceeding, if diet data could be obtained for all or most areas and times. A more complex approach would involve developing models relating seal distribution to prey distribution and environmental variables in a "state space" framework, which, if successful, would enable the prediction of seal distribution from these data. However it was recognized that data on pelagic fish distribution in particular was usually gathered at different spatial and temporal scales, and independently from data on seal distribution, so the 2 data types could not easily be integrated in the same model. It was noted in this regard that there was some effort in Norway to carry out multipurpose cruises to collect several types of data simultaneously, which may make this type of analysis more feasible in the future.

It was concluded that satellite tracking studies supply important information on the distribution of seals in time and space that may be used to make inferences concerning their diet. This is of particular interest in studies of species such as harp and hooded seals which are not readily accessible for traditional diet composition studies based on collection of stomach/intestinal/faecal samples. Satellite tracking thus represents an important and necessary supplement to traditional dietary studies in these species.

There are plans to follow up the successful joint Norwegian-Russian 1996 project (and a similar project during harp seal breeding in 1995) with tagging of harp seals with satellite transmitters in the White Sea. This will contribute to a better understanding of the temporal and spatial distribution of the seals, which is important input data for multi-species modelling. Animals of both sexes and a range of ages are to be tagged. The program is planned to run for 5 years, with 15 tags being deployed every spring (*i.e.* immediately after the moulting period). If funding allows the first deployment of tags will be conducted in 2005.

Quantifying sources of uncertainty in estimating consumption
Working paper SC/12/IN/9 provided a quantitative analysis of the sources of uncertainty in the estimation of consumption of cod by harp seals. The decline in many groundfish stocks in Atlantic Canada has raised concerns about the role of seals in the Northwest Atlantic ecosystem. Estimates of consumption by predators are one piece of information that is required in order to determine the impact predators are having on the recovery of cod stocks. The objective of this paper was to describe the model used to estimate prey consumption by harp seals and to assess the sensitivity of estimate to model parameters. Consumption of Atlantic cod by harp seals in the northern Gulf of St Lawrence (NAFO zone 4RS3Pn) was estimated for the period 1985-2003. Estimates were obtained by combining information on harp seal abundance, energy requirements, diet composition and the distribution of animals. Consumption of Atlantic cod in 2003 was estimated to be in the order of 27,000 (SE = 6,800) tonnes. Current estimates differ from earlier studies by attempting to incorporate variability in population estimates, energy requirements, seal distribution, and diet composition. Sensitivity analysis indicated that the model was most sensitive to changes in population size, the parameters required to estimate energy requirements, the proportion of seals that enter the Gulf and the length of winter residency. Assumptions about the proportion of animals that remain throughout the year in the Arctic or southern waters had little impact on the estimates of cod consumption.

Discussion
While the paper identified several sources of uncertainty that were the most important in modelling consumption, it was noted that the estimation of consumption was sensitive to many of the other factors as well. In this regard it would be important to consider which factors are likely to vary substantially from available estimates. For example, even though the model is sensitive to changes in estimated body mass, this factor is probably well estimated. In contrast there is considerably greater uncertainty in estimates of basal metabolic rate and activity factors. Both the sensitivity of the model and the likely variability of estimated parameters should therefore be considered in developing priorities for data collection to improve consumption estimates. These priorities also need to take account of the relative importance of different factors in quantifying functional relationships (*i.e.*, how consumption estimates vary in response to changes in abundance).

6. RECENT DEVELOPMENTS IN THE ESTIMATION OF ENERGY CONSUMPTION

New studies of relevance for the estimated consumption by marine mammals in Greenland waters were presented and the consumption estimates first presented at the NAMMCO Workshop in 2001 were updated in SC/12/IN/10. Relevant ongoing studies included telemetry studies on adult harp and hooded seals, an aerial survey of marine mammals along the west coast of Greenland and a study of harp seal consumption in coastal areas along west Greenland, and deal with most of the major gaps in our knowledge identified in 2000. Major remaining gaps in knowledge were identified to be: Studies of prey selection: a) Harp seals in offshore waters. b) Hooded seals and narwhals in Baffin Bay (offshore) c) Fin whales along the edge of the southeast Greenland drift ice.

The Working Group welcomed this update and noted that Baffin Bay/Davis Strait/Denmark Strait could be a focus of future workshops.

i. Baleen whales
Urine production and food ingestion of minke whales (SC/12/IN/5)

In August and September 2003 blood and urine samples were obtained from 30 common minke whales caught off the coast of Iceland for scientific purposes. Both blood and urine samples were obtained from 16 of these animals, 4 non-pregnant females and 12 males. The animals' weights were derived from their lengths, which gave a mean weight of 4,571 (SD 1337). Na^+, K^+, Cl^-, Mg^{++}, Ca^{++}, creatinine, urea and uric acid were measured in blood and urine as well as pH and osmolality. Utilizing allometry of creatinine clearance in relation to body weight and serum and urinary concentrations of creatinine, the average urine volume was predicted to be 214 L per day. From this volume and the known water content of the ingested food, the average daily food ingestion was estimated to be about 280 L. This is considerably greater than reported by most workers. Energy calculations suggest considerable heat loss as the metabolic rate is over 3 times that of an equally heavy terrestrial mammal. Concentrations of electrolytes in urine are compatible with the fact that the minke whale is a piscivorous animal and are quite different from those of the krill eating fin whale. The high sodium and magnesium levels in urine suggest some sea water ingestion.

Discussion
The allometric prediction of creatinine clearance in minke whales extends beyond the range of the data used to derive the relationship. Nevertheless it was considered unlikely that cetaceans would vary greatly from the generalized relationship for mammals. More importantly, uncertainty is not incorporated into the prediction of creatinine clearance and thus urine production, and this uncertainty would likely be substantial given the double-logarithmic relationship used. Hence the prediction of food intake may not in fact be inconsistent with estimates derived from other methods when all sources of uncertainty are incorporated.

The Working Group noted that further work is required in order to quantify the water balance in general, and the sea water ingestion in particular. The group considered that this was a promising new method that should ideally be tested on captive animals. Applying this method to Antarctic minke whales, which are nearly stenophagous on krill, may be informative, since the water and electrolyte components of the diet could then easily be estimated. Víkingsson informed the Working Group that measurements of the energy, water and electrolyte composition of the observed components of the minke whale diet were being conducted as part of the Icelandic research program.

ii. Seals

Recent work on captive seals

Food consumption estimates for marine mammals are mostly based on an assessment of the energy requirements of the animal, which are then translated into the amount of food that is needed in order to cover these requirements. In this context, the daily energy expenditure, or field metabolic rate (FMR), is a key determinant of the total energy requirement. Current estimates of FMR for pinnipeds have been based on metabolic studies of both captive and free-ranging animals, but most of these have not been able to realistically account for energy expenditure during diving, which, after all, is what these animals do during a major proportion of their time at sea. This problem is particularly evident in some species (*e.g.*, southern elephant seals (*Mirounga leonina*), hooded seals), which have been demonstrated to dive repeatedly for durations exceeding their calculated aerobic dive limit, strongly suggesting that their diving metabolic rate (DMR) is actually lower than first assumed. A paper by Sparling and Fedak (2004) describing an approach that could shed more light on the metabolic costs associated with free diving was discussed. In that study, metabolic rates of 8 captive grey seals were determined in connection with voluntary diving in a quasi-natural setting (large tank), using open circuit indirect calorimetry based on measurements of oxygen consumption rates. The seals displayed dive durations which realistically mimicked those recorded in free-living grey seals by use of telemetric techniques. The resulting mean DMR of both juveniles and adults was 1.7 times the predicted basal metabolic rate of terrestrial mammals of equal size. Based on these results, a model was developed to allow prediction of DMR from information on dive behaviour of the type routinely collected in telemetry studies of wild seals.

Another paper by Williams *et al*. (2004) was also briefly discussed. It describes how the energy cost of swimming during diving is related to the number of swimming strokes made, as recorded with

accelerometer-linked data loggers that were attached at the base of the tail of freely diving Weddell seals (*Leptonychotes weddellii*). The established relationship could be used to predict locomotor costs of freely diving seals.

Both the approaches described could be employed to produce similar data for harp and hooded seals, which could then be used in conjunction with relevant data collected by use of telemetry from free-ranging animals, in order to obtain more reliable estimates of DMR as well as FMR.

Discussion
The Working Group considered that the observed mean of 1.7x BMR for diving animals found by Sparling and Fedak (2004) was not inconsistent with the rate of 2-3x BMR commonly applied to free living seals to estimate energy consumption. Resting seals were observed to have a higher metabolic rate than diving seals, and it is likely that non-diving, active seals would have still higher metabolic rates. In addition, free living diving seals must actively pursue and capture prey, and thus would probably use more energy than under the experimental conditions used in this study. A valuable next step in this type of study would be to use live prey to increase the effort that the seals must expend to obtain food. Seals have been shown to display reduced core temperature during diving, which would be expected to also reduce their metabolic rate.

The Working Group recommended that studies of the type carried out by Sparling and Fedak (2004) on grey seals, should also be carried out on harp and hooded seals. The Working Group also considered the methodology developed by Williams *et al.* (2004) to be promising and recommended that it should be further tested with captive seals and applied to other species of free ranging seals.

7. RECENT DEVELOPMENTS IN MULTISPECIES MODELLING

i. GADGET-based models

GADGET (the Globally applicable Area Disaggregated General Ecosystem Toolbox) is a flexible and powerful software framework for creating ecosystem models, that was presented at the last Scientific Committee Working Group Modelling meeting (NAMMCO 2003). Since that last meeting GADGET has been extended in a number of ways, including the implementation of a closed life cycle model and the incorporation of information from mark-recapture experiments on tagged sub-populations, together with the use of bootstrapping experiments when estimating the migration parameters (SC/12/IN/7).

Recently, a preliminary GADGET model has been set up to model the grey seal population around Iceland as a first GADGET model for marine mammals. At this early stage in the model development, most of the parameters have been fixed to values obtained outside GADGET, and only the parameters governing the size of the initial population and annual recruitment have been estimated within GADGET. Further work is planned on this model, to include more detail on the dynamics of the pup population, to look at modelling a stock recruit relationship, and to investigate using different growth functions that may be more applicable to marine mammals. Although this GADGET model is still in the early stages of its development, it has shown that some aspects of marine mammal populations can certainly be modelled using the framework provided by the GADGET software. Further work, however, is required before a model that includes the effects of predation by marine mammals on other species is attempted.

Discussion
The Working Group welcomed this new information, but noted that rather little progress had been made in incorporating marine mammals in GADGET-based template models for candidate areas in the North Atlantic, as had been recommended by the NAMMCO Scientific Committee in 2002 (NAMMCO 2003), presumably because no resources had been allocated for this work. The Working Group again emphasized that progress in this area will not be made unless substantial additional resources are dedicated to it.

Also as noted in 2002, GADGET lacks the scenario aspect where the management process itself (*i.e.*, updating parameter estimates given new data before using these updates to compute future catch limits) is modelled in prognostic simulations. Only when this option is available will it be possible to compare management strategies and their related assessment machinery. The Working Group again recommended that such a facility be developed, noting that this should be fairly straight-forward since it will involve only data transfer to a module, with users to define and code the catch algorithm within that module.

Discussion ensued about the advisability and feasibility of "testing" multispecies models. One possibility would be to re-implement in GADGET a model that had already been realized in another form, such as the seal-fishery model for the Benguela ecosystem (Punt and Butterworth 1995). However it was recognised that while this could verify that the functionality of the original model was reproducible in another framework, it would not be a test in any real sense as the predictions of the original model had not been tested in the field. Ecosystems cannot easily be replicated: hence ecosystem models cannot be tested experimentally. Another possibility might be to test model predictions in replicated micro- or mesocosm systems. While such experimental work would be expensive and difficult, it could be conducted by an interdisciplinary team in an international context. Given that multispecies models built using GADGET and other frameworks are likely to be applied to address important management issues, the feasibility of testing such models at some scale should be investigated.

ii. SCENARIO model

Scenario C is a model intended for exploring the comparative effects on the catch of cod, herring and capelin of various choices of management regimes for minke whaling and harp sealing. The model is described in the web document http://www.nr.no/files/sammba/emr/scenario_document.pdf. Cod, capelin, herring, harp seals and minke whales are distributed over age, and over 7 areas of the Barents sea, and simulated forwards in monthly time steps. Fishing (catch) mortality is regulated by quotas. Natural mortality is composed of endogenous predation mortality and excess natural mortality. Models for recruitment and mortality are estimated piecewise on available data in co-operation with the Marine Institute. Work is under way to estimate parameters of natural mortality in excess of mortality caused by modelled predation. This estimation is done by a systems approach by running the model forward from estimated initial conditions and comparing the one step ahead predictions with observed abundances.

In addition to yearly stochasticity in recruitment and abundance internal estimates fed to the management procedures calculating quotas, uncertainty is accounted for by repeating simulation runs for parameters drawn from distributions reflecting estimation uncertainties, and kept fixed for the individual runs.

The models for predation are pivotal for the purpose of the study. They have 2 components: the total food intake of an individual by species and size estimated from energetic considerations, and the relative diet composition given the abundance of the various prey items in the actual area at the time. In addition to modelled prey species, a category of "other food" is included. The abundance of other food is assumed sufficiently abundant to allow the modelled predators to satisfy their energy need regardless of the abundance of the modelled prey species.

Despite the project period soon coming to an end, Schweder reported that the model still is inadequate. When harp seals are introduced into the model, the cod is exterminated. This happens with the harp seal stock at the estimated current abundance, and is contrary to what is known of the system – where fortunately the cod population still is viable. The modelled predation of harp seals on cod, in addition to cannibalism and minke whale predation, is simply excessive. He suggested various causes for this lack of balance, and asked advice regarding the modelled energy needs for harp seals, and also regarding the current abundance estimate of harp seals.

Schweder also asked advice regarding the management strategies for harp seal to explore. He was happy to learn from the group that this question is premature since the model is inadequate.

Discussion
The Working Group identified some potential problems with the harp seal diet data used that might have contributed to the unrealistic aspects of the model predictions. Most harp seal stomach samples have been taken from northern areas (Areas 6 and 7) where cod are uncommon. However a few samples come from coastal northern Norway where the consumption of cod may have been much higher than in other areas. The inclusion of these samples, from outside of the regular distribution area of harp seals, may have positively biased the estimation of the proportion of cod in the diet. It was noted that the distributions of cod and harp seals overlap only for a short time in the spring, and that the seals gained most weight in the summer and autumn when their distribution did not overlap with that of cod. Dive profiles obtained from satellite tagged animals indicated that they did not generally dive deep enough to access cod. It was therefore considered unlikely that cod formed an important part of the diet except under exceptional circumstances. It was recommended that the diet data used in the model be re-examined in this context.

It was suggested that the sensitivity of the model to initial fish abundances should be tested. In particular, the cod assessment data used in the model assume a natural mortality (M) of 0.2 for cod, even though it is generally recognised that M may be much higher than this for the small cod that harp seals might be expected to consume. Assuming a higher mortality for young cod would have the effect of increasing the estimated numbers of small cod that would be available to harp seals. One avenue to pursue might therefore be to conduct sensitivity analyses to determine what level of cod mortality would be sufficient to stabilise the cod population. If this level was beyond the bounds of plausibility, other potential influences must be considered.

In the model the consumption of cod and other prey by harp seals is related to prey abundance by a function that reduces consumption of prey to a low but positive rate when prey abundance is 0. A function that results in a cessation of predation when that prey is absent would be more realistic, and might allow the predicted cod abundance to stabilize. However this would not prevent the initial reduction of cod by seal predation that the model predicts and so would not resolve the immediate difficulty. In addition the population dynamics of both harp seals and minke whales are endogenous in the model in that they are assumed to always obtain their daily rations, regardless of prey abundances. This was considered to be a weak assumption in that both species exhibit strong prey preferences and harp seals have been observed to "invade" the Norwegian coast under conditions of low capelin and polar cod availability. Clearly their population dynamics must be resource dependent to some degree. However it was recognized that at present there were simply no data to support a functional response of predator population dynamics to prey availability.

Projected levels of cod predation by harp seals are of course directly proportional to harp seal abundance. Stenson informed the Working Group that pup counts had been carried out on the White Sea whelping patch almost annually since 1998. These counts have been very consistent in estimating a pup production of around 300,000. Total population estimates are derived from pup production using an assumed level of pup mortality and an assumed range of 1+ mortality, but it was noted that both these parameters had been estimated directly for the population using trend and age structure data, and are entirely consistent with the estimates for other harp seal stocks. The population estimate of around 2 million animals has been thoroughly evaluated by the ICES/NAFO Working Group on Harp and Hooded Seals, and by the NAMMCO Scientific Committee. It was therefore considered unlikely that a positive bias in the abundance estimate for Barents Sea harp seals was contributing to the difficulties with the Scenario model. Nevertheless the Working Group suggested estimating harp seal total abundance using a wider range of 1+ mortality, and using the resulting estimates as input to the Scenario model to see if the 1+ mortality required to stabilize the model was within a plausible range.

iii. Others

The model Bifrost used in the management of capelin was presented by Tjelmeland. Work has been initiated to incorporate predation from harp seal on capelin and problems and possibilities connected to this were pointed out. The predation of herring by minke whales has been included in the model used in managing the Norwegian spring spawning herring stock, SeaStar, on an experimental basis.

The Russian-Norwegian Fishery Commission has initiated work over a 10 year period to evaluate maximum sustainable yield from commercial species in the Barents Sea, taking into account species interactions and influence of the environment. For the first 3 years cod will be the main focus and in the following 7 years multispecies models will be used for a comprehensive evaluation.

In discussion the Working Group noted that the primary focus of this work is to refine medium and long term predictions of fish stock biomass by including predation by marine mammals, which differs somewhat from the objectives of NAMMCO in this area. Nevertheless it was considered that there was an appreciable degree of overlap between these projects and the Scenario C project, and the Working Group urged the developers to closely co-ordinate their efforts in order to optimise the use of scarce resources in this area.

Simulation of minke whale predation (SC/12/IN/11)
Using realistic simulated prey fields (herring, capelin and krill), the behaviour of simulated predators is modified until the resulting simulated diet observations mimic those observed in the field under similar conditions. The modelling framework was first presented to the working group in Reykjavik in 2002. Since then the foraging model has been developed and now includes 4 predator functions: 1. prey encounter function, 2. ingestion rate function, 3. food digestion rate function and 4. patch selection function. A total of 6 parameter vectors and 5 single parameters are included in these functions. An objective function of the least squares type is minimised with respect to the vector containing the switching coefficients of the ingestion rate function. The model is under development, but a future objective of this simulation work will be to run simulations which improve our understanding of how local- and large-scale predator-prey processes are linked.

Discussion
The Working Group considered this to be an ambitious attempt to model the foraging behaviour of a marine predator at a very detailed level, but it was not obvious if or how the model could be directly integrated into multispecies ecosystem models. One benefit may be a better understanding of the implications of applying diet data gathered from small areas to rather large spatial and temporal scales used in most ecosystem models. It was suggested that, once the model is more fully developed, it could be applied to other predator prey systems for which better empirical data are available.

8. RECOMMENDATIONS FOR FUTURE RESEARCH

i. Diet
The Working Group noted that there has been progress on a number of the recommendations for research priorities identified by the WG in their 2001 meeting, and prioritized them explicitly for future action:

1. Distribution of prey species in space and time.
   Progress: Ongoing resource surveys covering main commercial species, such as capelin, cod and herring in all areas. However there continue to be problems in integrating the spatial and temporal scales of resource surveys with our knowledge of predator distribution. Limited information is available on the spatial and temporal distribution of pelagic crustaceans and polar cod, which are extremely important in the harp seal diet.

2. Spatial and temporal distribution of the diet composition of harp and hooded seals;
   Progress: Progress has been made in describing the diet of Barents and Greenland sea harp seals, but important gaps remain, particularly the diet in open water areas in the late summer, autumn and winter.

3. Diet composition of dolphins (white-beaked and white-sided dolphins);
   Progress: Some progress has been made in describing the diet of white-sided dolphins around the Faroe Islands, and studies in Iceland are in progress. There has been no progress in other areas.

4. Field metabolic rate of harp and hooded seals;
   Progress: None on harp and hooded seals, but some methodological advances have been made with other phocid species.

5. Temporal changes in energy density of prey species;
   Progress: None

6. Diet of minke whales in Icelandic waters and further west;
   Progress: The Icelandic Research Program is making progress in describing the diet of minke whales in that area.

7. Consumption estimates synthesised within a modelling framework including full uncertainty evaluation;
   Progress: Some progress in Canada but no new estimates from NAMMCO member countries.

The highest priority items identified amongst the above were 2, 6 and 7.

In the immediate future, the Working Group recommended maintaining a focus on modelling the Barents Sea ecosystem, the area for which the best data are available and where model development is ongoing at present. The Working Group also recommended that although minke whales are an important marine mammal predator in this area, improving the data inputs related to harp seals should be the primary immediate focus. The Working Group therefore recommended that research in the short term should be focused on:

1. Gaining a better understanding of the spatial and temporal distribution of the diet composition of harp seals;
2. Quantifying (with uncertainty) the seasonal abundance and distribution of major prey species of harp seals.
3. Repeating studies on distribution of harp seals in the Barents Sea to determine individual and inter-annual ('natural') variation in distribution;

ii. Energy consumption

Little new information specifically relevant to the target species was available to the Working Group. Nevertheless it was considered that existing estimates were probably adequate for modelling purposes at present. The following specific recommendations were made:

- Conduct experiments to determine the diving metabolic rates of harp and hooded seals similar to that of Sparling and Fedak (2004), but, if possible, under more realistic prey availability conditions, such as by using live prey.
- Apply the methodology developed by Williams *et al.* (2004) to free ranging harp and hooded seals, after validation using captive seals.

iii. Modelling

In general the Working Group reiterated the recommendations for further development of multispecies models made in 2002:

Prey selection

- theoretical and practical work on prey selection models
- development aggregated consumption functions
- migratory and spatial aspects of consumption models

Multi-species modelling

- Further work on the Scenario C Barents Sea model

- Use GADGET as a framework to generate template models for candidate areas in the North Atlantic

With regard to the Scenario C model, the Working Group noted that considerable effort had already gone into developing this model, and recommended that sufficient resources be allocated to finish its development and thoroughly test its properties. Recommendations for the short term included:

- Re-run cod assessment models using a higher value of mortality for young cod and use the results as input for Scenario runs, to determine what levels of mortality would be necessary to achieve compatibility in the model.
- Since pelagic crustaceans and polar cod are important prey to harp seals, the impact of including them explicitly in multispecies models should be explored.
- Investigate the sensitivity of the model to other functional forms of the predation model for harp seals, specifically forms where consumption of particular prey approaches 0 at very low densities of that species.
- Given that the diet information for harp seals is imprecise and probably biased, the sensitivity of the model to changing the proportion of cod in their diet should be explored.

With regard to the GADGET modelling framework, the Working Group noted that further work is required on the existing grey seal model to bring it up to a standard suitable for use as a template model. Once this has happened, work on models that include other marine mammals should be attempted. As in 2002, the Working Group also noted that GADGET lacks the scenario aspect where the management process itself is modelled in prognostic simulations, in a similar manner to that provided by the Scenario Barents Sea model. The inclusion of such a process would allow GADGET to compare management strategies and their related assessment machinery, and developments in the direction should be encouraged.

9. WORKPLAN

In reviewing the amount of multi-species modelling work and associated applications to management decisions that had been conducted world-wide over the past several years, this Working Group noted in 2002 (NAMMCO 2003) a much lower than expected activity in this area. While some progress had been made in further development of the Scenario C model and development of the GADGET platform, it remains the case that the development of multi-species modelling is not proceeding as fast as it should, given the emphasis politicians and management authorities have placed on multi-species (ecosystem) approaches to the management of marine resources. Once again the Working Group emphasised that progress in this area will not be made unless substantial additional resources are dedicated to it.

Given this, the Working Group advised that the Chairman should continue to monitor progress in this area, with the possibility of holding another workshop in 2006 if sufficient progress has been made to warrant it, and perhaps also an earlier smaller task group meeting if helpful to maintain momentum.

10. ADOPTION OF REPORT

The Report was adopted by the Working Group on October 24, 2004.

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APPENDIX 2

Agenda

1. OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEUR
4. REVIEW OF AVAILABLE DOCUMENTS
5. RECENT DEVELOPMENTS IN THE QUANTITATIVE DESCRIPTION OF MARINE MAMMAL DIETS
   i. Baleen whales
   ii. Seals
6. RECENT DEVELOPMENTS IN THE ESTIMATION OF ENERGY CONSUMPTION
   i. Baleen whales
   ii. Seals
7. RECENT DEVELOPMENTS IN MULTISPECIES MODELLING
   i. GADGET-based models
   ii. SCENARIO model
   iii. Others
8. RECOMMENDATIONS FOR FUTURE RESEARCH
   i. Diet
   ii. Energy consumption
   iii. Modelling
9. WORKPLAN
10. ADOPTION OF REPORT

APPENDIX 3

List of Documents

	Agenda	Title
SC/12/IN/1		Draft List of Participants
SC/12/IN/2	2	Draft Agenda
SC/12/IN/3	4	Draft List of Documents
SC/12/IN/4	5	Galan, A. and Víkingsson, G.A. Progress report on the analyses of stomach contents of Icelandic minke whales.
SC/12/IN/5	5, 6	Kjeld, M. and Ólafsson, O. A preliminary report on predicted urine production and food ingestion rate and salt balance of the common minke whale (*Balaenoptera acutorostrata*) off Iceland. IWC SC/56/O11
SC/12/IN/6	5, 6, 7	Tamura, T. Preliminary analyses of prey consumption of three baleen whales and their possible interaction with fisheries in the western North Pacific.
SC/12/IN/7	7	Begley, J. and Howell, D. An overview of GADGET, the Globally applicable Area-Disaggregated General Ecosystem Toolbox
SC/12/IN/8	7	Ólafsdóttir, E.I. and Begley, J. Grey seal in GADGET.
SC/12/IN/9	5, 6	Stenson, G.B. and Hammill, M.O. Quantifying uncertainty in estimates of Atlantic cod (*Gadus morhua*) consumption by harp seals (*Phoca groenlandica*).
SC/12/IN/10	5, 6	Rosing-Asvid, A. Consumption by marine mammals in Greenland waters.
SC/12/IN/11	5, 7	Lindstrøm, U. Simulation of minke whale foraging behaviour with special emphasis on capelin, herring and krill: A model description.
SC/12/IN/12	6	Sparling, C.E. and Fedak, M.A. 2004. Metabolic rates of captive grey seals during voluntary diving. *J. Exp. Biol.* 207:1615-1624.
SC/12/IN/13	5	Haug, T., Nilssen, K.T. and Lindblom, L. 2004. Feeding habits of harp and hooded seals in drift ice waters along the east coast of Greenland in summer and winter. *Polar Res.* 23:35-42.
SC/12/IN/14	5	Falk-Petersen, S., Haug, T., Nilssen, K.T., Wold, A. and Dahl, T.M. 2004. Lipids and trophic linkages in harp seal (*Phoca groenlandica*) from the eastern Barents Sea. *Polar Res.* 23:43-50.

	Agenda	Title
SC/12/IM/15	7	Schweder, T. Scenario C progress report.

ANNEX 2

FIN WHALE ASSESSMENT PLANNING MEETING

Oslo, 25 October, 2004

In 2003 the Scientific Committee recommended that the scheduling of future assessment meetings for fin whales be dependent on the progress made in fulfilling recommendations for research. As recommended by the Working Group on Minke and Fin whales in 2003, a small Task Group (Appendix 1) was convened to review the progress that had been made since the last meeting of the Working Group. The Group reviewed the recommendations that had been made in 2003 and noted what progress had been made.

All stocks

1. *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.*

Iceland is extending genetic analyses on *ca* 600 samples that were collected in the 1980's, mostly from Denmark Strait, to include microsatellite analyses. A few samples from other areas (Norway and Canada) will also be included. Norway has about 30 biopsy samples available that were taken during sightings surveys. It was agreed that these should be added to the Icelandic analysis if feasible. The Faroes has 14 biopsy samples that were taken in 2000/2001, and these have been sent to Per Palsbøll's laboratory for analysis. Víkingsson indicated that they were also coordinating their analyses with Dr Palsbøll.

Øien suggested that historical material may be available from museums, and agreed to look into this.

2. *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;*

No new tagging programs for fin whales have been carried out, mainly because past attempts have had limited success. The technological problems with this methodology must be addressed before large-scale programs can be done.

Faroes

1. *The revision of catch statistics for Faroese and adjacent whaling operations should be completed;*

Dorete Bloch has been working in cooperation with the IWC Secretariat to resolve the inconsistencies in catch data between baleen whaling statistics kept at the IWC office in Cambridge and the material found by the Faroese Museum of Natural History. With funding from the Museum and NAMMCO, the IWC office, different archives in Scotland and England and the Whaling Museum in Sandefjord were visited in 2004 and material copied.
The material contains the baleen whaling taken from the land stations in Ireland, Orkney, the Shetlands, the Faroes, Norway, and the pelagic Norwegian catch. The material is under preparation now and later the Faroese Museum of Natural History and the IWC office will end up with catch record agreed by both institutions.

2. *The feasibility of preparing a CPUE index from Faroese and adjacent whaling operations should be investigated*;

The Task Group recommended that Bloch investigate this after the catch series has been corrected.

3. *Biopsy sampling for genetic analysis from the Faroes and adjacent areas should be continued. Existing biopsy samples should be analysed as soon as possible*.

No samples have been taken in recent years and the Task Group encouraged further biopsy sampling over as wide an area as possible. As noted above the analysis of existing samples is in progress.

4. *Satellite tagging should continue once methodological/technical issues are addressed.*

See above.

East Greenland-Iceland Stock

1. *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;*

No progress has been made on this issue. The Task Group strongly recommended that these analyses should be completed by July 2005.

2. *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.*

There have been no catches.

3. *Additional samples for genetic analysis are required particularly from areas outside the traditional whaling grounds, such as East Greenland and northern and eastern Iceland;*

No new samples are available. The Task Group recommended that the feasibility of conducting biopsy sampling during sighting surveys in these areas be investigated.

4. *Existing analyses of data on biological parameters from previous commercial and research whaling should be published as soon as possible;*

No progress has been made on this recommendation.

5. Satellite tagging should be attempted to investigate the movements of fin whales, particularly between the traditional whaling grounds west of Iceland and areas outside.

See above.

6. *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.*

No progress as yet. Pike agreed to work with Gunnlaugsson on splitting the abundance estimates in this way.

Other (Primarily North Norway)

1. *Preparation of abundance estimates from the 1996-2001 survey series;*

Øien provided a working paper (SC/12/20) that gave estimates for fin, sperm and humpback whales from this survey series. The Task Group recommended that the estimate for fin whales for the areas of overlap with the NASS-2001 survey should be compared and a combined estimate derived if feasible. Pike and Øien agreed to do this in cooperation with Gunnlaugsson.

2. *Revision of catch statistics;*

The 2003 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. Unfortunately no funding was available from Norway to complete this work. The Task Group strongly recommended that this work be funded.

3. *Preparation of a CPUE series if possible;*

Dependent on above.

4 *Collection of additional biopsy samples for genetic analysis, and analysis of existing samples in a timely manner;*

As reported above about 30 samples have been collected during Norwegian surveys. Øien reported that more samples would be collected on an opportunistic basis.

5. *Satellite tagging once methodological/technical problems have been addressed.*

See above.

Critical Items
The Task Group agreed on some high priority tasks that must be completed before a productive assessment meeting can be held. If such a meeting is to be held in Autumn 2005, these tasks should be completed by July 2005.

Faroes
1. Genetic analyses of existing and additional samples, combined with those from other areas;
2. Completion of revised catch series and development of a CPUE series if feasible;
3. Collection of additional samples for genetic analyses, if possible.

EGI
1. Spatial disaggregation of abundance, catch, and mark-recapture data as previously described;
2. Genetic analyses of existing samples combined with those from other areas;

Other (mainly North Norway)
1. Rectification and verification of catch data as described above, and development of a CPUE series. Additional funding is required for both these tasks;
2. Analysis of genetic samples in combination with those from other areas.

APPENDIX 1

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