TWENTY SIXTH MEETING OF THE COUNCIL

7 – 8 March 2018, Tromsø, Norway

DOCUMENT 08 REPORT OF THE SCIENTIFIC COMMITTEE

Submitted by: Scientific Committee

This document contains

Report of the 24th Scientific Committee meeting, including reports from

- Large Whale Assessment Working Group
- NAMMCO-JCNB Joint Scientific Working Group on Narwhal and Beluga
- By-catch Working Group

Plans WG meetings in 2018.

Action requested:
The Management Committees and Council are asked to review the advice and recommendations given by the Scientific Committee and provide comments and/or endorsement.

REPORT OF THE 24TH SCIENTIFIC COMMITTEE MEETING

13-17 NOVEMBER 2017

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NAMMCO SCIENTIFIC COMMITTEE
24TH MEETING
REYKJAVIK, ICELAND
14-17 NOVEMBER 2017

EXECUTIVE SUMMARY

The 24th meeting of the NAMMCO Scientific Committee was held 14-17 November 2017 at the Marine Research Institute in Reykjavik, Iceland. The Chair, Dr Tore Haug (Institute of Marine Research, Norway) opened the meeting by welcoming the participants.

The Chair noted that all NPRs had been received from member countries, although some were still lacking the catch reporting.

The SC was informed that Council had agreed to request all NPRs to be submitted before 1 March in any year. The SC saw this as beneficial as it will make the reports more relevant for the discussions of the SC meetings.

Reports were available from 3 working groups (WGs; Large Whale Assessment Working Group, NAMMCO-JCNB JWG, and the By-catch WG) for the SC's consideration, and were discussed in detail under the relevant agenda items. The full reports are available in Annex 1-3.

Work Procedures in the SC

The SC was updated on decisions made by Council at NAMMCO-25 on the participation and funding of External Experts, confidentiality of documents, and new requests for advice.

The SC discussed R-1.6.4 (advice on the best methods for collecting struck and loss data) and noted that they responded to this request at the last meeting stating that using observers at the different hunts would be the optimal solution as struck and lost (S&L) rates vary between hunts and species. Council at NAMMCO 25 noted that this would be logistically and financially challenging. The SC further noted that better S&L rate data may not always be the priority parameter for improving assessments, given the difficulty of obtaining such data. However, given the importance of identifying S&L rates for some hunts more than others, it was agreed that one way forward was to direct WGs to indicate when more reliable S&L were a priority for improving the assessment and would make the most significant difference in terms of quota allocation, so the collection of S&L data could be prioritised for these hunts. The WG could then give recommendations on how to better obtain S&L data for the targeted hunts.

The SC also noted the importance of informing hunters that uncertainty of S&L rates could result in lower quota, as precautionary rates are used, whereas reliable observed rates could decrease the uncertainty around population trajectories.

Super-Satellite Tag Proposal

The SC discussed the proposal by Heide-Jørgensen (Greenland) for development of a super-satellite tag. The project which is three fold entails a) the technical development of the tag, b) a programme to study movements and changes in occurrence of common minke whales in the North Atlantic and c) a shared NAMMCO data base of tracking data.

The SC welcomed the proposal and agreed to recommend to Council to prioritise such cooperative projects and asked for approval to work towards such a project. The SC agreed that a small group of SC members (led by Heide-Jørgensen) should either meet in person or via correspondence to discuss the steps to move forward with the proposal. The SC discussed that it might be useful to engage other interested parties in the development of a new "*common minke satellite-tag*", so the cost of the development could be shared.

Working Procedures for Management Advice

Prewitt presented document SC/24/16: "Summary of assessment and working procedures in the SC and associated WGs." The purpose is to render transparent the management advice process, and, where possible

and desirable, streamline the process and make it more consistent between WGs. Alternatively, it would also clearly identify areas where certain WGs have different procedures

The SC agreed that for the purpose of transparency such an overview is important. The aim is not to standardise the rules for how decisions are made, but to have a systematic overview giving the rationale behind specific decisions, and as a result also an historic recording of how decisions are taken for the future.

The SC noted that this was a working document and agreed to give their input to the Secretariat.

SWOT Analysis

As input to the current strategy and capacity building discussion evolving in NAMMCO, SC members were asked to provide a SWOT analysis of the SC (Strengths, Weaknesses, Opportunities and Threats). Members were asked to fill in the distributed template, which will then be collated by the Secretariat.

Cooperation With other Organisations

The SC heard updates on cooperation with the Scientific Committee of the International Whaling Commission (IWC), Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), International Council on the Exploration of the Seas (ICES), the Joint Commission on Narwhal and Beluga (JCNB), and the Arctic Council. Full reports can be found in Appendix 4.

Environmental/Ecosystem Issues

Consumption of resources by marine mammals

Skern-Mauritzen presented the project "Exploring marine mammal consumption relative to fisheries removal in the Nordic and the Barents Seas." The project reviews and summarises the currently available information on diet, abundances, and residence times of marine mammals in the Nordic and the Barents Seas, and follow recently recommended approaches to estimate plausible ranges of total consumption, and also compares marine mammal consumption to removal by fisheries (retrieved from ICES databases). Preliminary results suggest that marine mammal consume around 15 million tons ± 50% of prey per year, predominantly targeting low and mid trophic level species (zooplankton and small pelagic fish). Fisheries remove around 4.3 million tons per year, targeting mid and top trophic levels (small pelagic fish and larger demersal and pelagic fish).

The SC welcomed this joint initiative and noted that there is a lot of NAMMCO participation in this project. Important areas for NAMMCO are covered by this project, and the SC looks forward to seeing the published results.

Foraging studies

Haug reported from a recent study of selection and foraging response of harbour seals in an area (Porsangerfjord, Finnmark, Norway) of changing prey resources (Ramasco et al 2017). The foraging behaviour of seals was investigated by assessing their preference and foraging response to the seasonal dynamics of prey distribution. Small codfish were preferred during autumn, but a response to the presence of pelagic fish was seen when the latter aggregated to overwinter in cold deep waters in the inner parts of the fjord. The formation of ice during late winter, however, provoked a shift in preference for small codfish, due to the sudden inaccessibility of pelagic fish. A strong reversed trend was observed in spring when the ice melted. The results indicate preference for small aggregated fish and the presence of a foraging response to changes in resource distribution.

Furthermore, Haug reported on trophic levels and fatty acids in harp seals compared with common minke whales in the Barents Sea (Haug et al. 2017a). The stable isotopes and fatty acids indicated niche separation between the seals and the whales, and between different age groups of the harp seals. Older seals had fatty acid profiles more equal to common minke whales as compared with younger seals. Furthermore, while the fatty acid profiles suggested that krill was particularly important for the young seals, the profiles from older seals and whales suggested that fish dominated their diets.

Future work

Haug also reported that a high priority part of the planned Joint Norwegian-Russian Research Program on Harp Seal Ecology is to deploy satellite transmitters on harp seals in the White Sea.

By-catch

Desportes presented the report of the By-Catch Working Group (BYCWG) met from 2-4 May 2017 in Copenhagen, Denmark, under the chairmanship of Kimberly Murray, Northeast Fisheries Science Center – NOAA, USA. The Terms of Reference for the meeting were:

1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
2. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
3. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
4. *Review the information from Greenland on reporting of by-catch for the different species.*

By-catch estimate of harbour porpoise, grey and harbour seals

Norway

The WG reviewed the three methods of by-catch estimation, a stratified ratio-based and a model-based approaches, as well as a mark-recapture approach for seals. The WG identified several important issues associated with the three approaches, both with the data acquisition through the coastal reference fleet and the analyses used for extrapolating the observed by-catch rate to the fisheries, which prevented it from endorsing the proposed by-catch estimates. The group recommended methodological improvements to be implemented both in the data collection and the analysis before the by-catch estimates could be endorsed.

The recommendations of the BYCWG are being addressed by current work by IMR in conjunction with the Norwegian Computing Center. There are plans for a student to begin working in early 2018 on revising the estimates, pending funding from Research Council. These estimates are needed for the Harbour Porpoise WG (expected fall 2018) and Coastal Seals WG (expected 2019).

Iceland

The Working Group identified several issues with the analysis, and provided the recommendations for revising the analysis of by-catch estimates to be addressed before it could endorse the estimates, as well as improving the data collection.

In response to some of the recommendations, Iceland has presented an updated working paper addressing most of the technical comments via email to the BYCWG which will be discussed via videoconference in late November.

Faroe Islands

A description of the fleet composition and associated fishing effort, fisheries regulations and logbook system was provided to the WG.

The WG noted that by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidences of by-catch of several species in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch.

The working group recommended therefore that a responsible precautionary approach be taken and that a proper assessment of the by-catch risk in the various fisheries be undertaken, beginning with those of higher concerns like Very High Vertical Opening and generally pelagic pair trawling.

The WG also provided recommendations for by-catch monitoring and observation.

Greenland

Greenland is an atypical case because marine mammals that are caught, either directly or indirectly, are assumed to be reported as direct catch (with large whales being the exception where by-catch is reported as

such). The primary concern is to ensure that any by-catch is included in the total number of removals to be used in population assessments.

The WG reviewed the information provided on the present sources of by-catch reporting and discussed their relative reliability. It provided several recommendations for improvement and identified areas where already existing information should be analysed.

Multispecies approaches to management/Ecosystem Modelling

Prewitt updated the SC on the results of the workshop organised by NAMMCO and held 28 and 29 October in conjunction with the recent SMM conference, "Cetacean distribution and abundance in the North Atlantic". There were two main goals of the Workshop, with the second being the most relevant to this agenda item.

The workshop participants considered that a North Atlantic-wide modelling effort could be of value for a number of reasons. It could help in understanding the large-scale distribution of several species, and why those distributions change over time. It could also be useful in predicting future distribution based on predicted changes in the ocean environment. Habitat modelling may identify areas that are likely to have large numbers of animals but which have not been sampled adequately by surveys.

MareFrame Project

Elvarsson reported that there will be a final meeting for the MAREFRAME project in late 2017.

He further noted that the results of the MAREFRAME project will likely be useful to NAMMCO as models that will serve as building blocks for further development.

The SC **recommended** that a small group be organised to review the report of the Mareframe project and prepare a document for the next SC meeting. This small group will either convene a one-day meeting, or communicate via email correspondence. Elvarsson and Skern-Mauritzen will take the lead on organising this small group, which may need to include additional/external expertise.

Environmental issues

Mary River Project

In **R-1.5.3**, The Council has requested the SC to monitor the development of the Mary River Project. The NAMMCO-JCNB JWG discussed the Mary River Project in detail at its meeting in March 2017. In the report from that meeting, the JWG states:

"The JWG expressed concern regarding development of mining activities and associated ship traffic on the Eclipse Sound narwhal stock. No similar example of such a high level of shipping and development has occurred in a high density narwhal habitat so there is little precedent to inform an assessment of the impacts."

The JWG provided a list of specific concerns for the Mary River Project, and shipping and icebreaking in Baffin Bay overall.

The SC noted that the JWG makes recommendations based on the information that is available on the current plans for the Mary River project at the time of their meetings, however there is often uncertainty around what the plans actually entail, and these plans appear to change often. This makes it difficult to give relevant management advice.

The SC reiterated its previous recommendation that all information on the Mary River project be presented to the JWG. It was suggested that someone from the Fisheries Protection Division in Canada should attend the next NAMMCO-JCNB JWG in 2019.

Non-hunting stressors

In **R-1.5.4**, Council requests the SC to advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.

The SC noted that it is not possible to find a one-size fits all answer to this request, and that, as a start, this request will need to be dealt with on a case by case basis. The SC **recommended** that upcoming/future working groups consider request R-1.5.4, for example by adding non-hunting impacts to their agendas. The SC discussed work that is ongoing, or planned, in future working groups (e.g., NAMMCO-JCNB JWG) that may already address this request.

Climate Change

Haug presented Haug et al. (2017b), a review of possibilities and constraints in future harvest of living resources in a changing northeast Atlantic Arctic Ocean. Northwards shift in the distribution of commercial species of fish and shellfish is observed in the Barents Sea, especially in the summer period, and is related to increased inflow of Atlantic Water and reduced ice cover. This implies a northward extension of boreal species and potential displacement of lipid-rich Arctic zooplankton, altering the distribution of organisms that depend on such prey. Cetaceans and harp seals are likely to follow any further receding of the sea-ice edge, if sufficient food resources become available in the region. Such northward expansions of more boreal marine mammal species are likely to cause competitive pressure on some endemic Arctic species (bowhead whales, white whales, narwhals), as well as putting them at risk of predation and diseases.

SEALS AND WALRUS STOCKS – STATUS AND ADVICE TO THE COUNCIL

Harp Seal

Surveys for pup production are planned for the Greenland and White Seas in March 2018, and a survey of the northwest Atlantic population was conducted in March 2017. The SC **recommended** that the WGHARP meeting be postponed to 2019 to allow for the analysis from the 2017 and 2018 surveys to be completed in time for the meeting.

Hooded Seal

A pup production survey is planned for Greenland Sea hooded seals in March 2018. The results of this survey should be informative, as there should have been sufficient time since this stock of hooded seals were protected in 2007 to potentially see increases in pup production (if hunting was the cause of the decline).

The SC **recommended** that the WGHARP meeting be postponed to 2019 to allow for the analysis from the 2017 and 2018 surveys to be completed in time for the meeting.

Ringed seal

The SC heard updates on a tagging studies which start to show the contours of stock delineations. This suggests that in the near future it will be possible to make management units for ringed seals. Additionally, a genetics study which involves samples from many different areas is ongoing, and will hopefully also inform on stock structure of ringed seals. At SC/23, the SC had r**ecommended** more satellite telemetry and collection of samples for genetics to inform on possible stock structure in Greenland, and across the Arctic. The SC therefore welcomes this new tracking information and looks forward to the genetics results.

The SC decided that more results from the ongoing studies are still needed before a Ringed Seal WG meeting should be convened, and the suggested timing is 2020/2021. It could also be a useful venture to expand the WG to other researchers outside of the NAMMCO countries, in particular Canada.

It was also suggested that this meeting could occur in combination with a Bearded Seal WG, as many of the same researchers would be involved in both meetings.

Grey seal

In preparation for a planned CSWG in 2019, the SC heard updates from Norway, Iceland and the Faroe Islands on the progress of addressing the recommendations from the 2016 CSWG meeting. These updates are included under item 8.4.3.

The SC **welcomed** the work being done on grey seals in Iceland, and the responses to the recommendations by Iceland and Norway.

The SC discussed research plans in the Faroe Islands. It has been 15 years since the SC first expressed concern regarding grey seals in the Faroe Islands. The SC welcomes these new plans for research and **strongly recommends** that this work be given a high priority.

Harbour seal

In preparation for a planned CSWG in 2019, Norway and Iceland provided the SC updates on their responses to the recommendations of the CSWG that occurred in 2016.

The SC **welcomes** the work being done on harbour seals in Iceland, and the responses to the recommendations. A meeting of the CSWG is planned for 2019.

Bearded seal

At SC/23, the SC **recommended** a future working group on bearded seals. The SC recommended that such a working group could be combined with a Ringed Seal Working Group, as many of the same researchers would be involved in both meetings. This combined meeting could be held in 2020.

Walrus

A Walrus Working Group is planned for fall 2018, which will allow for the results of a survey planned for the Qaanaaq area (Baffin Bay stock) in spring 2018 to be available to the meeting, but will also allow for updated catch advice to be given in time for the new quota block (2019-2024).

The SC supported the nomination of Rob Stewart (DFO, retired) as the new Chair of this working group. The SC encouraged the participation of Canadian scientists, as there is a shared stock between Canada and Greenland.

CETACEAN STOCKS – STATUS AND ADVICE TO THE COUNCIL

Fin whale

Iceland

The SC met via videoconference (SC/24/11) on 2nd March 2017 where the results of the LWAWG were presented.

> The SC noted that the IWC's Implementation Review is complete, and these results have been accepted in the IWC SC. The SC endorsed the work of the WG and the recommended that a catch limit of 161 fin whales in the WI area and 48 in EI/F area (based on application of the RMP to the EG+WI+EI/F region) is safe and precautionary, and that this advice should be considered valid for a maximum of 8 years (2018 to 2025).

The SC re-iterated it's management advice from the videoconference meeting and considers R-3.1.7 to be concluded.

Iceland informed the SC that based on this advice, MFRI gave the following advice to the Ministry: For the period 2018-2025, MFRI advises that annual catch of fin whales should be no more than 161 animals from the East-Greenland/West-Iceland management area (EG/WI) and 48 fin whales from the East-Iceland/Faroes management area (EI/G).(https://www.hafogvatn.is/static/extras/images/Langreydur174.pdf)

Humpback whale

Greenland

The SC reiterates its recommendation that the SLAs that are developed in the IWC be used for advice for large whales in Greenland. The SC advises that annual strikes of no more than 25 humpback whales off West Greenland are sustainable from 2019 to 2024.

Common minke whale

Iceland

The SC met via videoconference (SC/24/11) where the results of the LWAWG (which addressed R-3.3.4) were presented. The SC **recommends** that annual catches of common minke whales in the CIC area do not exceed 217 animals during 2018 – 2025. The SC stressed that this is conservative advice because it considers the CIC

as a single stock area, and simulation tests include what is considered an unrealistically low MSYR for this species.

Norway
Interest in whaling in the Jan Mayen (CM) area may increase in coming years because of the higher abundance estimates in this area. Therefore, the SC **recommends** that the work suggested by the LWAWG be completed at a future meeting of the LWAWG.

Beluga
The Joint Meeting of the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic and the Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga Scientific Working Group was held in Copenhagen, Denmark, during 8-11 March 2017. The JWG discussed the life history parameters used in the modelling, stock structure, and hunt removals in Greenland and Canada.

Recommendations
The JWG recommended genetic analysis for stock identity of the summer takes in Greenland. The JWG reiterated its past recommendation that more accurate, and recent, struck and lost data is needed. Struck and lost is likely different for hunting method, season, etc., and the JWG recognizes that it is difficult to collect data on loss rates. However, knowing struck and lost rates is more important in areas where the quotas are small, and these hunts could be prioritised for data collection.

Assessment - West Greenland
An updated assessment for West Greenland beluga (a component of the Eastern High Arctic-Baffin Bay stock) with new catch data and the new priors as agreed by the JWG. The model estimated a decline from 21,180 individuals in 1970 to a minimum of 8,470 in 2004, and it projects an increase to an expected 11,610 individuals in 2023 (assuming post 2016 catches of 225). These results are similar to those of the last assessment, and the JWG agreed to re-iterate the previous advice, which remains valid until 2021.

Reiteration of Past Advice
The SC reiterates the previous advice from 2005 and 2012 about seasonal closures. The following seasonal closures are recommended:

- Northern (Uummannaq, Upernavik and Qaanaaq): June through August
- Central (Disko Bay): June through October
- Southern (South of Kangaatsiaq): May through October.
- For the area south of 65°N, it is recommended that no harvesting of beluga be allowed at any time.

The function of these closures is to protect the few belugas that may remain from historical summer aggregations in Greenland, and to allow for the possibility of reestablishment of the aggregations. The SC noted that the quotas given by the Government of Greenland included catches in these areas.

Narwhal
The JWG reviewed available life history parameters for narwhal and updated this information for use in the modelling. The JWG also discussed stock structure, catch statistics, struck and lost, abundance surveys.

East Greenland
The JWG agreed to recognize the hunting areas in East Greenland, Tasiilaq, Kangerlussuaq and Ittoqqortormiit, as three separate management areas. Maintaining these areas as three stocks is a more precautionary approach and hence is more likely to avoid local depletion.

Based on these assessment, the SC agreed that catches should be reduced to less than 10 narwhals in both Ittoqqortormiit and Kangerlussuaq. In addition, the advice for the southern hunting areas applies only to Kangerlussuaq fjord. The JWG recommended that no catches are taken south of 68°N.

This advice should be updated with new abundance estimates from surveys in 2017. The information that we have on abundance indicates that the harvest may be causing a population decline. This decline was confirmed by the model estimates, independent of the aerial survey results, lending more evidence of a real decline. The

SC recognises that these recommendations include a considerable reduction in catch advice for the communities in east Greenland, however, declines in abundance necessitate these reductions.

The next JWG meeting is planned for March 2019.

Global Review of Monodontids

Prewitt gave a presentation of the results from the GROM meeting. The previous reviews of monodontids (IWC 1992, 1999 and NAMMCO 1999) are about 20 years old, and a large amount of new information has become available since that time, especially on stock identity, movements, abundance, and threats to the populations. Additionally, there are many new stressors that have emerged in the last 20 years, especially related to climate change.

The GROM recognised 22 beluga stocks, and 12 narwhal stocks. In some cases, these are different than the stocks recognised in previous reviews (including the SAMBR), but these stock delineations are the most up-to-date according to the experts at the meeting.

Participants provided "Stock Review" papers prior to the meeting which gave information on abundance, trend, any calculations on sustainability of removals, and habitat concerns. The GROM reviewed these Stock Reviews for each stock and used this information, along with decisions of quality of the data available (e.g. whether the abundance was based on a survey versus expert opinion) and assigned a status of concern -- high, moderate, or low -- relative to the other stocks in that species.

Sei whale

The data from 2007 and 2015 surveys will be explored to assess whether a minimum abundance estimate can be calculated. More information will be discussed at the AEWG meeting in spring 2018.

Bottlenose whale

Mikkelsen informed the SC about a new abundance estimate of bottlenose whales from the Faroese component of the 2007 T-NASS survey that was analysed together with data on deep diving species from the SCANS-II and CODA surveys. The design-based estimate was 19,539 (95% C.I. 9921-38,482; CV 0.36) animals. Sightings were mainly from the Faroese survey block.

Killer whale

The SC **reiterated** its previous concerns regarding the hunt in east Greenland which is unregulated, and from a species with no abundance estimate from this area and unknown stock identity. There is little information available to be able to provide advice on a sustainable removal level.

The SC discussed that it may be difficult to fully validate the catch statistics, however it may be possible to re-create the previous catch histories based on independent observations, for example by contacting scientists that were in Tasiilaq, etc. when these catches occurred.

The last review of killer whales in the North Atlantic was in 1987. The SC recommends that NAMMCO contract a scientist to prepare a working document for the next SC meeting which reviews all available information and current research activities on abundance, stock structure, and movements of killer whales in the North Atlantic.

Pilot whale

Faroe Islands

The SC was pleased to hear that the abundance estimate is ready to be reviewed by the AEWG, and has been submitted for publication. The previous abundance estimate is very old, and an updated estimate is needed.

Satellite tagging of another 3 pods, with 4-8 tags deployed each time, is planned, but has not been possible yet. The SC recommended that the satellite tagging be given a higher priority.

The SC **recommended** that a Pilot Whale working group meeting be held in 2019. The TORs for this meeting would be:

- *full assessment of pilot whales in the North Atlantic*

- *provide advice on the sustainability of catches...with particular emphasis on the Faroese area and East and West Greenland.*

Dolphins
Abundance estimates may be presented at the planned Abundance Estimates Working Group (AEWG).

Faroe Islands
In 2017 catches have been higher again. Not much is known about the abundance of white-sided dolphins in North Atlantic, and therefore there is some concern over taking species where little information is known. The plan is to generate an abundance estimate from the NASS2015 survey.

Harbour porpoise
By-caught harbour porpoises were collected by Norway (IMR) for biological sampling and a food-web model is being developed for the Vestfjord area close to Lofoten to study the role of HP in this area. An abundance estimate is now available from the SCANS-III survey which was extended from 62 to include Vestfjorden, an area of large by-catches. The estimate was 25,000 between Stadt and Vestfjorden. Preliminary investigations using this new abundance estimate suggest that by-catches are within PBR.

As stock structure is an important question in the North Atlantic, the SC encouraged a combined analysis genetics, and encouraged NAMMCO countries to provide samples.

The SC recommended that the HPWG be postponed until 2019 in order to ensure that the results from ongoing analyses are completed in time to be presented to the WG.

The SC noted that it is important to improve the catch history from Greenland for the assessment. There has been a previously reported mismatch between reported and interviews with hunters.

Sperm whale
There were multiple sightings during NASS2015, and it will be investigated whether it is possible to calculate an abundance estimate, in cooperation with Iceland. Sperm whales are a large component of the ecosystem in terms of biomass, SC recommends that an abundance estimate is calculated.

Bowhead whale
The SC heard updates on tagging/biopsies in Norway (Svalbard) and Disko Bay (Greenland), sightings in the Barents Sea and Northeast Water Polynya.

Blue Whales
Norway is preparing an analysis of the presence of blue whales in relation to relevant prey species in the upper 100-150 m. There is an ongoing photo-ID study and NAMMCO countries are encouraged to submit photos. Last year was first year with consistent sightings of blue whales in Disko Bay all summer.

SURVEYS

Abundance Estimates Working Group
The SC recommends using the funds remaining on the NASS budget for completing all the 2007 and 2015/16 analyses as well as conducting a joint analysis of the abundance of common minke whales in Central North Atlantic (NCA). These should be presented to the next Abundance Estimate WG and generate publications to be included in the next NASS volume.

Future Surveys
The next NASS survey should be in 2022-2023. The SC strongly recommends that attempt be made to conduct again a trans-Atlantic coordinated survey and charge the Secretariat to explore what are the present plans and how much flexibility they encompass.

NAMMCO SCIENTIFIC PUBLICATIONS

Volume 10 is still ongoing and should be finalised by the end of 2017 or beginning of 2018.

Volume 11: NASS is underway with Daniel Pike, Rikke Hansen and Geneviève Desportes as editors of the volume. Eighteen papers have been committed, covering both the 2007 and 2015/6 surveys, as well as trend of abundance for a longer period. All feasible design-based abundance estimates which could be generated by the data collected through the TNASS 2007 and NASS 2015/16 surveys would be all both analysed and published. This would represent a considerable progress from the present situation, where analyses from 2007 data are still missing.

FUTURE WORK PLANS

25th Scientific Committee Meeting

2018 will be the 25-jubilee year for the Scientific Committee which had its first meeting in 1993 in Tromsø. Norway which should host the meeting following the usual rotation, offers to host the meeting on one of the Coastal Steamer (Hurtigruten) from Bergen to Tromsø.

Working groups/Symposia/Other meetings

The following WG meetings were recommended for 2018:

- Abundance Estimates WG (Spring 2018)
- By-catch WG (if necessary)
- Walrus WG (Fall 2018)
- Super-satellite tag development meeting (timing TBD)

The following WG meetings were recommended for 2019:

- WGHARP (September, Tromsø)
- Coastal Seal WG
- Pilot Whale WG (Assessment meeting)
- NAMMCO-JCNB JWG (March)
- NAMMCO-JCNB JWG workshop on impact of climate change on management advice
- Harbour porpoise Stock Structure workshop
- Harbour porpoise WG

MEETING CLOSURE

The report was reviewed on 17 Friday, and finalised via correspondence on 1 December 2017. The SC thanked Haug for his efficient chairing of the meeting.

MAIN REPORT

1. CHAIRMAIN'S WELCOME AND OPENING REMARKS

The Chair, Tore Haug (NO), welcomed the participants (Appendix 2) to the meeting. The chair noted the large delegation attendance at the present meeting and welcomed the observers from Canada, Japan and the Russian Federation.

2. ADOPTION OF AGENDA

The agenda (Appendix 1) was adopted with the addition of point 5.6: SWOT-SC and the deletion of point 14.1.

3. APPOINTMENT OF RAPPORTEUR

Prewitt acted as the main rapporteur, with Winsnes and Desportes assisting. Additionally, participants were asked to provide summaries of their interventions.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The SC noted the documents that were available to the meeting (Appendix 3).

4.1 National Progress Reports [SC/24/NPR-F, -G, -I, -N, -C, -J, -R]

The Chair noted that all NPRs had been received from member countries, although some were still lacking the catch reporting.

The SC was informed that Council had agreed to request all NPRs to be submitted before 1 March in any year. The SC saw this as beneficial as it will make the reports more relevant for the discussions of the SC meetings.

Canada
Reference was made to the submitted national progress report from DFO, Canada. In addition, Hammill reported on research activities in Canada. Additional updates on species-specific projects are presented under the relevant items.

Additionally, a multi-disciplinary research camp was established in Tremblay Sound. The research effort involved more than 40 participants from DFO, Parks Canada, the government of Nunavut, Winnipeg Zoo, and universities of Calgary, Windsor, Quebec at Rimouski and Montreal, Pond Inlet, Ocean Wise, and WWF. Satellite transmitters were deployed on 20 narwhal, 31 Greenland sharks, and 2 ringed seals. Physical oceanographic, zooplankton and fish data were also collected.

Japan
Yasunaga informed the Committee on the Japanese research on cetaceans in 2015 (small cetaceans) and 2016/17 (large cetaceans). The information was summarised under three headings: a) biological sampling surveys; b) dedicated sighting surveys; and c) other surveys.

Under a) above, a total of 333 Antarctic minke whales was sampled by the New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) during the austral summer season 2016/17. A total of 37 common minke, 90 sei and 25 Bryde's whales was sampled by the Whale Research Program under Special Permit in the western North Pacific (JARPNII) in 2016. In both cases a substantial number of biological samples and data were collected from each whale taken. Also under a) above, biological sampling was conducted during the commercial catches of small cetaceans in Hakodate, Ayukawa, Abashiri, Taiji and Okinawa, from April 2015 to March 2016.

Under b) above and regarding large cetacean research, dedicated sighting surveys were conducted in Antarctic Area V (2016/17), western North Pacific (summer 2016), northern part of the Sea of Okhotsk (summer 2016) and central North Pacific (summer 2016). The latter was organized by the IWC SC as part of the IWC-Pacific

Ocean Whale and Ecosystem Research (POWER) program. Apart from the sighting activities, photo-ID and biopsy sampling was conducted for several large whale species. Regarding small cetacean, vessel-based sighting surveys were conducted in the Pacific coast of Japan (from July to Sep 2015) and in the East China Sea (from May to June 2015). Two aerial sighting surveys were conducted, one in Kushiro (fall 2015) and the other in the Seto Island Sea (summer 2015).

Under c) above, routine DNA surveys of whale products in the retail market were conducted and the records of stranded and by-caught cetaceans continued in 2016.

Discussion/comments

The SC thanked the observer for presenting the report and noted the impressive activity level both in Antarctica, the western North Pacific and the coastal areas.

It was noted that in Japan, the relevant section of the Fisheries Agency of Japan primarily handles the issue of live strandings, and these information and data are systematically recorded in the ICR database, but collection of stranding information is supported by volunteers.

Yasunaga also presented an outline of the Japanese Research Plan for New Scientific Whale Research Program in the western North Pacific (NEWREP-NP). The NEWREP-NP has two primary objectives: I) contribution to optimizing the establishment of a sustainable catch limit for common minke whales in the coastal waters of Japan; and II) contribution to the RMP/ISTs for North Pacific sei whale. Each primary objective has four secondary objectives. NEWREP-NP has also three ancillary objectives; i) investigation of the influence of environmental changes on whale stocks; ii) examination of the effects of pollutants on whales; and iii) study of distribution, movement and stock structure of large whales with particular emphasis on blue and North Pacific right whales.

The objectives are considered important for the improvement in the conservation and management of whale stocks and the RMP, and for the conservation and management of other living marine resources or the ecosystem of which the whale stocks are an integral part. The objectives are also important for testing of hypothesis not directly related to the management of living resources. Lethal sampling is necessary for several secondary objectives requiring sample/data for age determination, body length and sexual maturity. The lethal sampling is also necessary for some ancillary objectives requiring sample/data on prey composition/consumption, on nutritional condition indices such as blubber thickness, girth, and body weight, and blubber, liver, muscle and plasma.

The species to be taken for Primary Objective I is the western North Pacific common minke whale of the O and J stocks, and the annual samples size is 170 whales. The species to be taken for Primary Objective II is the sei whale of the North Pacific pelagic stock, and the annual sample size is 134. NEWREP-NP is planned for a total period of 12 years with a mid-term review after the first six years. Analyses conducted indicated that there is no negative effect on the stocks of both species. Scientists from the Institute of Cetacean Research will play the leading role in order to pursue the research activities and achieve the research objectives of NEWREP-NP, in collaboration with scientists from other domestic and/or foreign organization. Participation of foreign scientists in the field, laboratory and analytical works is welcomed, and specific protocols were developed to facilitate foreign participation. The research plan for NEWREP-NP was reviewed by the IWC Scientific Committee (SC) through a specialist workshop and by the SC itself. NEWREP-NP started this year after responding several key recommendations on the research plan from the specialist workshop.

Finally, Yasunaga emphasised that Japanese scientists are interested in cooperating with NAMMCO scientists regarding different aspects of this program, in particular satellite tagging.

Discussion

Haug noted that the new programme had taken into account many of the comments made by IWC and he especially drew attention to the incorporation of non-lethal methods.

Russian Federation

The Russian Federation presented a National progress report on marine mammal studies in the North Atlantic area. Main goals including focus on ecosystem role of marine mammals and possible interactions with human-

related impacts were outlined. Results of research in 2016 were discussed for high seas, coastal areas and opportunistic marine mammal studies while fisheries operations. Brief data on survey results including timing, species lists and maps of cruise tracklines as well as some information on ongoing studies was presented.

Discussion

The SC thanked the observer for presenting the report. Haug noted the continuous extensive cooperation between Russian and Norwegian scientists on marine mammals and fisheries.

4.2 Working Group Reports

The following working group (WG) reports were available for the SC's consideration, and were discussed in detail under the relevant agenda items. The full reports are available in Annex 1-3.

- Large Whale Assessment WG [SC/24/11]

SC noted that common minke and fin whales for Iceland had already been addressed intersessionally [SC/24/11], and that these assessments were endorsed by Council (NAMMCO/25). The humpback whale for Greenland remained to be discussed at this meeting.

- NAMMCO-JCNB JWG [SC/24/13]
- By-catch WG [SC/24/12]

4.3 Other reports and documents

- Global Review of Monodontids [SC/24/14]
- SC Intersessional Report [SC/24/11]
- SMM Workshop Report [SC/24/15]

5. WORK PROCEDURES IN THE SC

5.1 Updates from Council: NAMMCO/25

5.1.1 External experts – participation and funding

At its last meeting, the SC had responded to a request for advice from Council related to external experts - definition, participation and funding. Based on this input and also the input from the Committee on Hunting Methods, Council agreed to the following definition and rules:

- To enhance transparency and openness, External Experts should participate in all meetings of committees' subsidiary bodies dealing with non-administrative questions
- External Experts are understood to be any relevant experts who are not a member of the Parent Committee organising the meeting and not involved in the data collection / analysis / interpretation of the work to be discussed, regardless of nationality and institution
- The participation of External Experts may be funded by NAMMCO
- As a rule, each NAMMCO member country is responsible for bringing the information necessary to fulfil the terms of reference of any subsidiary body

Discussion

The SC noted the information and recognised that invited participants that have provided data analysis have sometimes been considered external experts in the past, yet they cannot be considered external experts in the future.

5.1.2. Confidentiality of reports and documents

Council agreed to amend and align the Council and Committees Rules of Procedure (RoPs) with regards to the confidentiality and release of meeting documents. In consequence, the SC RoPs were amended as follows (pertains to RoP SC, IV: 4 and 5):

- 4.) For all meetings of the Committee and subsidiary bodies, the draft agenda, ToRs when relevant, list of participants and the meeting documents that will be published in the Annual Report should be made public and available on the NAMMCO website as soon as they are ready and circulated to the meeting participants.

- 5. a) The Working Groups report their findings in writing to the Scientific Committee according to their terms of reference and within two weeks after the conclusion of their deliberations. Working Group reports are also sent to the Council for information.
- b) The Chairman seeks to have all views expressed on substantive matters during the deliberations of the Working Group made clear in its report.
- c) Working Group reports shall be considered confidential until four weeks (excluding July) after being circulated to the Scientific Committee and the Council. Thereafter they shall be made public and available on the NAMMCO website. Within a week of the report being circulated to the Scientific Committee and the Council, Parties and/or members of the Scientific Committee may ask for a review of the report by the Scientific Committee. In such cases, the Working Group report will remain confidential until it is published together with the report of the Scientific Committee.

Discussion
The SC took note of the above. Desportes noted that the new RoPs seems to function well, allowing one SC WG report to be released immediately (NAMMCO-JCNB Joint WG), while another one had been kept confidential until the SC had reviewed it (By-Catch).

5.1.3 New requests
At NAMMCO 25 Council forwarded the following new requests for advice to the SC:

Walrus
R-2.6.7 *The SC is requested to provide assessments of, and advice on sustainable removals from, all stocks of walrus in Greenland covering the period from 2019 to 2023, with the advice for Qaanaaq starting in 2021.*

Management Procedures
R-1.6.5 *Greenland requests that struck and loss rates are subtracted from future advice on sustainable removals in Greenland, with the advice being given as total allowable landings.*

Environmental Issues – taken under agenda item 7.3
R-1.5.4 *Committed to furthering its ecosystem approach to the management of marine mammals, and recognising the range of anthropogenic pressures facing North Atlantic marine mammals associated with the climate and environmental changes taking place, the Council requests the SC to advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.*

Discussion
SC noted the requests and agreed to discuss the different requests under the respective agenda items.

5.2 Abundance
Attention was drawn to the abundance table developed by the Secretariat which is placed on the website. The SC was reminded of the importance of informing the Secretariat as new abundance estimates become available, so the table could be kept constantly updated.

The table should continue specifying when and which organisation/institution had endorsed the abundance estimates. Also, the SC should discuss which trends of abundance should be indicated in the table, the trend between two surveys or a trend on a longer period.

5.3 Catches
5.3.1 Struck and Lost (R-1.6.4)
R-1.6.4 The SC has recommended that catch statistics include correction for struck and lost animals for different seasons, areas, and catch operations. Council requested the SC and the Committee on Hunting Methods to provide advice on the best methods for collecting the desired struck and loss data. Council noted that this request, although brought up regarding walruses, pertains to all species.

The SC responded to this request at the last meeting stating that using observers at the different hunts would be the optimal solution as struck and lost (S&L) rates vary between hunts and species. Council at NAMMCO 25 noted that this would be logistically and financially challenging.

Discussion
The SC noted the conclusion of Council. It further noted that better S&L rate data may not always be the priority parameter for improving assessments, given the difficulty of obtaining such data. However, given the importance of identifying S&L rates for some hunts more than others, it was agreed that one way forward was to direct WGs to indicate when more reliable S&L were a priority for improving the assessment and would make the most significant difference in terms of quota allocation, so the collection of S&L data could be prioritised for these hunts. The WG could then give recommendations on how to better obtain S&L data for the targeted hunts.

The SC also noted the importance of informing hunters that uncertainty of S&L rates could result in lower quota, as precautionary rates are used, whereas reliable observed rates could decrease the uncertainty around population trajectories.

Presently the catch statistics received by the Secretariat are available on the website under the different species. The SC noted that it might be beneficial to compile these data sets under one easily accessible heading. The Secretariat agreed to undertake this, but keeping the catch database updated implies that Parties send in their catch data as soon as they are validated. This is presently is not the case for Greenland. With reference to last year's presentation by Jessen and Levermann regarding catch data, the Ministry should submit the catch data to NAMMCO. The SC recommended that this issue be directed to/ addressed by the Management Committees.

5.4 Ideas for future meetings/furthering cooperation in SC

5.4.1 Presentation

Hannes Petersen gave a presentation titled "Evolution of the inner ear of whales and relation to sea sickness – how whales avoid getting sea sick as other mammals would." The inner ear transduces mechanical forces of the environment into electrical signals, used by the central nervous system for hearing as well as control of posture, movement and orientation. The vestibular part of the inner ear is of special interest regarding seasickness, as observation shows that if you do not have functional inner ear, you won't become seasick. In a motion rich environment as at sea, both inner ears are equally stimulated, giving the brain the sensation of this extensive movement. At the same time the eyes and proprioception are signalling almost motionless environment. This conflict of sensory information conveyed to the central nervous system for computation, generates efferent autonomic link that is responsible for most of the disturbing symptoms a person feels during motion sickness. Adaptation of the CNS is the immediate response and it takes a seaman 3 – 4 days to develop "sea legs". The most frequent report of those swimming across The Canal is that the most difficult thing about it is not the actual enduring of the swim, but more the burden of seasickness. In the same sense one can argue that aquatic mammals must also suffer from seasickness. Therefore it is of highest interest to investigate the inner ear of whales and try to find out how they have compensated through evolution against sea sickness.
We looked at fin whales inner ears and found out, that the vestibular part of the inner ear, i.e. the semicircular canals as well as utriculus and sacculus which are the main gravity detecting receptors of the inner ear have diminished. This corresponds with the fact that people that find themselves in water, do not detect gravity, even though gravity exists in water, it is more the pressure against the skin that gives information about the depth. These receptors have certainly caused the ancient aquatic mammals to be seasick and therefore the central nervous system has reduced the liability of this information and kept it aside and that is probably the cause of the fact that they have atrophied.

Discussion
The SC thanked Hannes for his very interesting presentation, and Víkingsson for making the arrangements. The presentation was also open to the employees at MFRI, and there was a lively and active question session.

5.4.2 Development of a "super satellite-tag (focused on common minke whales)"

Tracking by satellites has long been recognized as one of the most important and promising techniques available for studies of movements, migrations, behaviour, diving, stock identity and habitat use of cetaceans. Advances have been accomplished by studies of small cetaceans, the techniques are however not well developed for use on large baleen whales that are too big to be captured and handled at sea. SC 23 asked Heide-Jørgensen to develop a project proposal on development of a tag for satellite tracking for cetacean research in

the North Atlantic. The common minke whale is the target species with the reasoning that what works for the common minke whale will work for all other whales.

Hansen presented the proposal (Appendix 4) in the absence of Heide-Jørgensen. The project which is three fold entails a) the technical development of the tag, b) a programme to study movements and changes in occurrence of common minke whales in the North Atlantic and c) a shared NAMMCO data base of tracking data.

In all four NAMMCO countries it would be of great importance to include a reliable, cheap and well-tested satellite tracking system in the toolbox for cetacean studies. It would also be important to develop a NAMMCO program that combine forces to use satellite tracking methods to solve major management issues that cannot be addressed with other techniques. It cannot be expected that research groups outside NAMMCO will focus on developing satellite tracking techniques that will assist in the research and development needed for the on-going NAMMCO assessment process. One example is the seasonal movements and long-term distributional changes of common minke and fin whales, species of importance to all NAMMCO member countries.

The proposal describes how a joint NAMMCO satellite-tracking program could be developed and what would be required to reach a point where the technique can be used as an efficient and reliable field technique. The total cost of all three elements of this project 2,300,000 NOK.

Discussion

SC welcomed the proposal and underlined the importance of developing a tag that functions and that will remain attached for at least a year cycle. SC agreed to recommend to Council to prioritise this kind of project and asked for approval to work towards such a project.

The importance of tag size, distance to animal and attachment area, injection depth and rejection/ retreat time for the tag was discussed. Animal welfare issues related to satellite tagging especially when the tags go deep into the animal was underlined.

The SC agreed with the proposal that the common minke whale was a good target species, because it is a species which has proved difficult to successfully tag, and a tag that works for common minke whales will likely work for larger whales and smaller toothed whale species.

The SC acknowledged that worldwide, many scientists are working on developing satellite tagging systems, but that at the same time the "whale community" was not especially tuned into cooperating and sharing experience when it comes to satellite tagging development.

The SC agreed that a small group of SC members (led by Heide-Jørgensen) should either meet in person or via correspondence to discuss the steps to move forward with the proposal. The SC discussed that it might be useful to engage other interested parties in the development of a new "*common minke satellite-tag*", so the cost of the development could be shared. The SC also discussed preparation of a possible review paper on tagging systems presently in use.

5.4.3 Genetics collaboration

This agenda item was deferred to agenda item 9.11.

5.5 Working procedures for management advice

Prewitt presented document SC/24/16: "Summary of assessment and working procedures in the SC and associated WGs" which gave a preliminary overview of how management advices have been developed in the various WG and SC, which criteria were used and in which forms the advice were forwarded to the managers. The document is to be updated continually, and it should summarise all procedures used in generating management advice in the various working groups of the NAMMCO SC. Examples are: endorsement/rejection of abundance estimates, agreement on data used in modelling (reproductive rates, catch statistics, etc.), guidelines on using "old" data, criteria for management advice (probability of increase, period of time chosen) etc.

Discussion

The purpose is to render transparent the management advice process, and, where possible and desirable, streamline the process and make it more consistent between WGs. Alternatively, it would also clearly identify areas where certain WGs have different procedures

The SC agreed that for the purpose of transparency such an overview is important. The aim is not to standardise the rules for how decisions are made, but to have a systematic overview giving the rationale behind specific decisions, and as a result also an historic recording of how decisions are taken for the future.

The SC noted that this was a working document and agreed to give their input to the Secretariat.

5. 6 SWOT

As input to the current strategy and capacity building discussion evolving in NAMMCO, SC members were asked to provide a SWOT analysis of the SC (Strengths, Weaknesses, Opportunities and Threats). Members were asked to fill in the distributed template, which will then be collated by the Secretariat.

6. COOPERATION WITH OTHER ORGANISATIONS

Full observer reports are available in Appendix 5.

6.1 IWC

Víkingsson reported from the Annual Meeting of the Scientific Committee of the IWC (IWCSC) (SC/67a) held in Bled, Slovenia, during 9-21 May 2017 (Appendix 5).

The RMP Implementation Review process for North Atlantic common minke was completed in 2017 after four years of hard work by the IWCSC. The next review is expected to occur around 2022.

The 2018 IWC Commission meeting will set new block quotas for all aboriginal hunts. IWCSC reiterated its strong intention to complete and recommend Strike Limit Algorithms (SLAs) for all Greenland hunts by the 2018 Scientific Committee meeting. The IWC Commission had endorsed the Humpback SLA in 2014 and the WG-Bowhead SLA in 2016, but the development of SLA‘s for fin and common minke whales has not been finalized. The IWC SC noted that the point estimate of a comparable 2015 survey estimate of fin whales off West Greenland was only one tenth the size of the previous one. The IWC SC had examined this change in abundance, and concluded that considerable additional work is required before final selection of an SLA for West Greenland fin whales. IWC SC developed a work plan aimed at completing the work in order to provide management advice at the 2018 IWCSC meeting. Similarly, the IWC SC developed a workplan to finalize the development of a SLA for the hunt of common minke whales in Greenland and to confirm the agreed SLA for Greenland Bowhead whales.

IWC SC reiterated its management advice for West Greenland regarding Bowhead whales (2/year), common minke whales (164), fin whales (19), humpback whales (10) as well at 12 common minke whales for the East Greenland hunt.

IWC SC has established a working group to address the need for consistency in the way it reviews and categorises abundance estimates. Several new abundance estimates were reviewed at the meeting and added to the official IWC tabulation of accepted abundance estimates and others will be reviewed intersessional.

In response to a request from the IWC Commission the IWC SC started the process to produce advice on the status of cetacean stocks on a broad level (e.g. ocean basin or region) as well as on specific stocks.

Recognising the scope and urgency of the by-catch issue, and recognising that it represents the single greatest threat to cetaceans from human activities globally, the Conservation Committee and the Commission endorsed a number of actions proposed as part of a new By-catch Mitigation Initiative.

The IWC Commission and IWC SC have increasingly taken an interest in the environmental threats to cetaceans. A wealth of new information was submitted to the meeting, including effects of chemical pollution, oil spill impacts, harmful algal blooms, marine debris, diseases, noise, climate change and cumulative impacts.

The Modelling and Assessment of Whale-watching Impacts (MAWI) workshop will be held intersessionally to define the key research questions that are required to understand the potential impacts of whale watching.

Special permits, both in general and on specific SP research projects conducted by Japan (NEWREP-A, JARPN II and NEWREP-NP) were extensively discussed. IWCSC was divided both generally on methods to review SP issues (Annex P) and on the different research projects, including the report from an expert panel.

Discussion
SC noted the report.

6.2 ASCOBANS

Following the decision of NAMMCO 24 to increase its scientific cooperation with organisations dealing with marine mammals, an invitation was conveyed to ASCOBANS MOPs8 for such an increase in cooperation. By the same token, the NAMMCO Scientific Committee, which had recommended that a review and assessment of the status of harbour porpoise stocks in the North Atlantic be conducted in 2018, supported the participation of ASCOBANS and other European Scientists to such an exercise. An invitation was sent by the NAMMCO Secretariat to the Chair of the ASCOBANS AC and the ASCOBANS Secretariats to organise, jointly with the Norwegian Institute for Marine Research, a Review of North Atlantic Harbour Porpoises. At ASCOBANS AC23 in September, Desportes developed further the proposal for such a review at the end of her presentation on NAMMCO's activities. Although ASCOBANS MOP8 had adopted to "*Seek to cooperate closely with …, NAMMCO, … and other relevant organizations."* (MOP8 Work Plan activity 61, Resolution 8.2), ASCOBANS AC23 agreed on declining to cooperate with NAMMCO and IMR on such a review. Parties were, however, invited to send experts or observers to the NAMMCO Working Group on Harbour Porpoises (Action Point 13).

Discussion
The SC noted the refusal of ASCOBANS Advisory Committee to undertake a cooperation which would have been beneficial not the least to the conservation of the harbour porpoise and expressed its disappointment in front of such reaction.

6.3 ICES

Haug reviewed the 2017 activities in ICES which have some relevance to the work in NAMMCO SC. This included work in the ICES Working Group on Marine Mammal Ecology (WGMME), a one-day workshop on predator-prey interactions between grey seals and other marine mammals (WKPIGS) and the Working Group on Bycatch of Protected Species (WGBYC). The ICES Annual Science Conference (ASC) generally include sessions with marine mammals included as an integral part, occasionally also sessions entirely devoted to marine mammals.

Discussion
SC noted the report. It was also noted that the next meeting of the Joint ICES/NAFO/NAMMCO WGHARP will likely be held in Tromsø in 2019. Mike Hammill has agreed to chair the meeting.

6.4 JCNB

Hansen informed the meeting that the report of the November/December 2015 meeting of the JCNB Commission meeting has not been published yet. The presentation of the NAMMCO-JCNB SC meeting in March 2017 was deferred to agenda items 9.4 and 9.5.

Discussion
The SC noted that reports from the JCNB Commission had no "home" so meeting reports seem to be unavailable. Hammill agreed to make enquiries at his end and the Secretariat will contact the Greenland ministry.

6.5 Arctic Council

Tom Barry (Conservation of Arctic Flora and Fauna, CAFF) provided a short overview of the Arctic Marine Biodiversity Monitoring Plan is an agreement amongst Arctic states to compile, harmonize and compare results from existing Arctic marine biodiversity and ecosystem monitoring efforts, across nations and oceans. This consists of six expert networks: sea ice biota, Plankton, Benthos, Marine fishes, Seabirds and Marine

mammals) which have identified key components of the marine ecosystem where changes in their status may indicate greater trends at work and which therefore we monitor and track.

Working with these six expert networks over the last years we collected and compiled all the information we could on these key components of the Arctic's marine ecosystem. For the purposes of reporting and comparison, eight physically and bio-geochemically distinct Arctic Marine Areas (AMAs) were identified. Earlier this year at the May Arctic Council ministerial CAFF released this first integrated report on the state of the Arctic's Marine biodiversity. This report tells us what existing biodiversity monitoring programs are able to say about changes occurring in Arctic marine ecosystems, identifies knowledge gaps and provides key trends and advice for monitoring, directed towards policy and decision makers.

While this is an important report and will feed into how Arctic states address and improve coordination for monitoring across the circumpolar world – perhaps one of its most important outcomes is not so much the key findings or even the advice – but rather the framework the marine plan has put in place to facilitate repeatable reporting and communicating on the status and trends of Arctic marine biodiversity.

Ugarte also presented information on the work of the Marine Mammal Expert Group of the CBMP.

Discussion
The SC thanked Barry and Ugarte for their very interesting presentations and noted especially the increasing cooperation between CAFF and NAMMCO, and the upcoming Arctic Biodiversity Congress (October 2018 in Finland) as a venue for NAMMCO to give input. It was also agreed that upcoming activities on ringed and bearded seals in both the CAFF and the NAMMCO regions were providing good opportunities for the two organisations to cooperate and avoid duplication of efforts.

6.6 Other
No issues were raised under this agenda item.

7. ENVIRONMENTAL/ECOSYSTEM ISSUES
7.1. Marine mammals-fisheries interactions (R-1.1.5, 1.1.8)
7.1.1. Review of active requests

R-1.1.5 (standing): The Council encourages scientific work that leads to a better understanding of interactions between marine mammals and commercially exploited marine resources, and requested the Scientific Committee to periodically review and update available knowledge in this field.

7.1.2. Consumption of resources by marine mammals

Skern-Mauritzen presented the project "Exploring marine mammal consumption relative to fisheries removal in the Nordic and the Barents Seas." The high latitude marine ecosystems of the Nordic (i.e., Iceland Sea, Denmark Strait, Norwegian Sea, Greenland Sea) and the Barents Seas have a high diversity of marine mammals, with 22 species occurring on a regular basis. While the diet and consumption of some species has received much attention, the total consumption of marine mammals has not been estimated. In this work, we review and summarize the currently available information on diet, abundances, and residence times of marine mammals in the Nordic and the Barents Seas, and follow recently recommended approaches to estimate plausible ranges of total consumption using bootstrapping procedures to include uncertainties in input parameters. We also compare marine mammal consumption to removal by fisheries (retrieved from ICES databases). Preliminary results suggest that marine mammal consume around 15 million tons ± 50% of prey per year, predominantly targeting low and mid trophic level species (zooplankton and small pelagic fish). Fisheries remove around 4.3 million tons per year, targeting mid and top trophic levels (small pelagic fish and larger demersal and pelagic fish). Different selectivity by mammals and fisheries reduce the potential for competitive interactions, which can only be assessed using multispecies and ecosystem models.

Discussion
Harp and hooded seals from the northwest Atlantic should be included in this work, as they spend about 6 months out of the year foraging off the coast of East Greenland. The majority of northwest Atlantic hooded seals (total population ca 600,000 hooded seals) and a proportion of the northwest harp seals (total population

ca 7 million harp seals) go to East Greenland. Including these large numbers of seals would likely have an impact on the model.

The SC noted that the total weight of removals by fisheries does not include discards, however unregistered discard is considered to be minimal in Iceland and Norway (less than 10%). Also, the total weight of the fish (e.g., the un-gutted weight) is included in the weight of removals by fisheries.

Some of the expert opinions on abundances, particularly ringed seal in the Barents Sea/Russian waters may be too high, but it was noted that Svalbard is included in the Barents Sea estimate, which accounts for the larger abundance estimates used.

Grey seal research in Canada suggests that the size composition of fish consumed may be underestimated using hard parts in scat. Seals appear to be consuming larger fish off shore, and the hard parts are likely digested and eliminated before the scat sample is collected on land. This may be more of an important issue for grey seals in Canada, where there are many more seals than the coast of Norway.

The SC discussed that it could be informative to investigate the impact of the different metabolic rates in different species using a range of published models, and also the seasonally varying energy density of the prey. Mauritzen informed that the authors of this study have looked at this in detail for specific species, but overall these data gave comparable results, with the body mass dependence of metabolism being included in the analysis. These are interesting results that should be noted in the study.

The ecological impact of the different removals could be presented more clearly if they were expressed in relation to the productivity of the consumed/removed resources.

The SC welcomed this joint initiative and noted that there is a lot of NAMMCO participation in this project. Important areas for NAMMCO are covered by this project, and the SC looks forward to seeing the published results.

Foraging studies

Haug reported from a recent study of a study of selection and foraging response of harbour seals in an area (Porsangerfjord, Finnmark, Norway) of changing prey resources (Ramasco et al 2017). The foraging behaviour of seals was investigated by assessing their preference and foraging response to the seasonal dynamics of prey distribution. The movement and dive patterns of individual seals were tracked with GPS devices. Foraging locations were compared to the availability of potential prey species in the fjord. Results suggested that harbour seals in Porsangerfjord had a preference for small-sized fish (<25 cm). Small codfish were preferred during autumn, but a response to the presence of pelagic fish was seen when the latter aggregated to overwinter in cold deep waters in the inner parts of the fjord. The formation of ice during late winter, however, provoked a shift in preference for small codfish, due to the sudden inaccessibility of pelagic fish. A strong reversed trend was observed in spring when the ice melted. The results indicate preference for small aggregated fish and the presence of a foraging response to changes in resource distribution.

Furthermore, Haug reported on trophic levels and fatty acids in harp seals compared with common minke whales in the Barents Sea (Haug et al 2017a). Trophic levels and possible diet overlap between harp seals and common minke whales in the Barents Sea have been explored using stable isotopes of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) and fatty acid analysis. Blubber and muscle samples from 93 harp seals and 20 common minke whales were collected in the southern Barents Sea in May 2011. The study showed that harp seals were at a higher trophic level than common minke whales during spring. This supported previous diet studies suggesting a more fish-dominant diet for seals, as compared with the whales, during this time of the year. The stable isotopes and fatty acids indicated niche separation between the seals and the whales, and between different age groups of the harp seals. Older seals had fatty acid profiles more equal to common minke whales as compared with younger seals. Furthermore, while the fatty acid profiles suggested that krill was particularly important for the young seals, the profiles from older seals and whales suggested that fish dominated their diets.

Discussion

The scat was analysed for hard parts, mainly otoliths and squid beaks/pens, however results from recent studies have shown that some seals do not eat the head of larger fish, resulting in underestimates of fish consumption.

Future work

Haug also reported that a high priority part of the planned Joint Norwegian-Russian Research Program on Harp Seal Ecology is to deploy satellite transmitters on harp seals in the White Sea. In all the years 2007-2017 it was planned to do this in a joint Russian-Norwegian effort just after the moulting period (in late May), or, alternatively, in late March – early April if ice conditions turns out to be unfavourable in early May. However, either formal problems with permissions, lack of funding or difficult ice conditions prevented tagging of seals. In 2018 a new attempt will be made to obtain funding for and carry out satellite tagging in the White Sea. During the tagging experiment, PINRO will provide the necessary logistics required for helicopter- or boat-based live catch of seals in April-May 2018. IMR, Norway, will, as before, be responsible for the satellite tags, including providing all necessary technical details, as well as for providing experienced personnel and equipment for anaesthetizing seals and tag deployment. For proper planning and budgeting on both institutes, PINRO scientist must obtain the necessary permissions from Russian authorities before December 2017. The permission from Russian authorities is not dependent on the origin of the transmitters, both UK and Russian transmitters can be used. The transmitters cannot collect geographically positioned temperature and salinity data. After the 2018 tagging season future seal tagging will be decided upon following an evaluation of both the tagging methods and the obtained seal movement data set. Due to low pregnancy rates and decline in pup production it will be important to focus on harp seal ecology and demographics in the coming years.

7.1.3. By-catch

Desportes presented the report of the By-Catch Working Group (BYCWG) met from 2-4 May 2017 in Copenhagen, Denmark, under the chairmanship of Kimberly Murray, Northeast Fisheries Science Center – NOAA, USA. The Terms of Reference for the meeting were:

5. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
6. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
7. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
8. *Review the information from Greenland on reporting of by-catch for the different species.*

Norway

The BYCWG received information on the by-catch/entanglement situation with humpback and killer whales in the herring purse seine fishery. It reviewed the revised harbour porpoise and harbour and grey seal estimates developed for the cod and monkfish gillnet fisheries by using by-catch rate collected through the Norwegian coastal reference fleet.

Entanglement of humpback and killer whales

Incidences of humpback and killer whales caught in herring purse seine fisheries have increased. The Fisheries Directorate is working to reduce the risk and the impacts of these incidents, a.o. by limiting the size of vessels allowed to fish inside the fjords and training personal participating in disentanglement operation. The WG commended these efforts.

By-catch estimate of harbour porpoise, grey and harbour seals

The WG reviewed the three methods of by-catch estimation, a stratified ratio-based and a model-based approaches, as well as a mark-recapture approach for seals. The WG identified several important issues associated with the three approaches, both with the data acquisition through the coastal reference fleet and the analyses used for extrapolating the observed by-catch rate to the fisheries, which prevented it from endorsing the proposed by-catch estimates. The group recommended methodological improvements to be implemented both in the data collection and the analysis before the by-catch estimates could be endorsed.

The Scientific Committee **endorsed** the concerns of the WG and the recommendations put forward. The main issues and recommendations are listed below while the complete list is given in Appendix 1 of the WG report.

- The ratio-based approach is more robust to different issues identified (such as zero-data, clustered by-catch events, correlated data) and the WG recommended it should be preferred over for the model-based and mark recapture approaches.

- The total landed weight for all species should be used as a measure of effort, and not only the landed weight of the target species, cod and monkfish, as using only a portion of the catch as a measure of fishing effort may lead to an underestimate of by-catch.
- Other measures of fishery efforts than landings should be explored, as landings do not represent the actual fishing net effort.
- If the same vessels are used in the CRF year after year, they will be correlation in the data samples which will lead to errors in the by-catch estimate and the WG recommended to modify the design of the selection process.
- Some other fisheries are not considered, with particularly the gillnet lumpfish fishery which has a high by-catch rate although it is a small seasonal fishery, and the recreational fishery that also uses gillnets.
- In the mark-recapture approach using tagged animals, the assumption between regarding tag loss and annual mortality rate, emigration and immigration being similar between the two sets of animals (harvested and by-caught) are unlikely to be upheld, also consideration should be given to the implications of different age structures between harvested and by-caught samples. Therefore, the WG recommended to disregard using this method for the estimation of by-catch rates.

Discussion

Norway noted that it would be difficult/costly for Norway to fulfil some of the recommendations, particularly for the CRF. However, the BYCWG pointed out potential problems with the estimates calculated from the CRF, and these biases should be removed if possible, or at the least, the biases should be well-documented.

The recommendations of the BYCWG are being addressed by current work by IMR in conjunction with the Norwegian Computing Center. There are plans for a student to begin working in early 2018 on revising the estimates, pending funding from Research Council. These estimates are needed for the Harbour Porpoise WG (expected 2019) and Coastal Seals WG (expected 2019).

The SC noted that the BYCWG discussed the lack of fishing effort data. IMR is currently working with the Directorate on improving data collection and exploring the additional existing data that may be available.

Iceland

Most of the marine mammal by-catch is assumed to come from the gill net fisheries for cod and lumpfish close to the coast, while it is possible that a smaller number of marine mammals are caught in the pelagic trawls and purse seines targeting capelin, mackerel, herring and blue whiting. Most of the monitoring occurs in the gillnet fisheries, and less information is available from pelagic fisheries.

A new electronic logbook system was implemented in 2010, where it is required for all vessels to report by-catch, but there is little reporting. In some cases in the lumpfish fishery, the by-catch of marine mammals was an order of magnitude (5x) higher when an observer was present compared to what was reflected in the logbook records. As it is the case in other areas as well, logbook records are clearly not a reliable source of by-catch data.

The two main sources of data for estimating by-catch are the records of by-catch from observers from the Directorate of Fisheries on-board commercial fishing vessels targeting lumpfish, and the records from researchers from the Marine and Freshwater Research Institute (MFRI) during an annual research cod gill net survey in April. By-catch was estimated in the two gillnet fisheries (cod and lumpfish), by raising observed by-catch with total fleet effort. An alternative raising approach, using a two-phase gamma-hurdle model, was also explored for the lumpfish fishery in 2016.

The Working Group identified several issues with the analysis, including but not limited to unreliably low uncertainty associated with some of the estimates, a non-randomisation in sampling events, clustered by-catch events, as well as an unrealistically high by-catch estimate for grey seal most likely reflecting a problem in the analysis. Also, the monkfish and Greenland halibut fisheries were not considered. The BYCWG provided the recommendations for revising the analysis of by-catch estimates to be addressed before it could endorse the estimates, as well as improving the data collection.

The Scientific Committee **endorsed** the concerns of the WG and the **recommendations** put forward. The main issues and recommendations are listed below while the complete list is given in the WG report.

Lumpfish Fishery

- Iceland explore different stratification schemes for the ratio estimate, and pool data over the 3-year time frame to report an average annual estimate of by-catch.
- The uncertainty around the estimates be re-evaluated, such as with a bootstrap approach. These revisions should be completed and endorsed by the group prior to the Harbour Porpoise Working Group Assessment meeting in 2018, and the Coastal Seals Working Group Assessment meeting in 2019.
- Fishing trips sampled for estimating by-catch rates be selected as randomly as possible, to ensure observer coverage is representative of various fishing behaviours.
- Observers collect jaws or photos of by-caught seals to improve species identification, and collect skin samples to inform genetic research.

Cod Fishery

- The uncertainty around the estimates be re-evaluated, such as with a bootstrap approach.

Other

- Iceland conduct monitoring of the monkfish and Greenland halibut gillnet fishery, as by-catch has been observed in this type of gear in other areas.

Discussion

In response to some of the recommendations, Iceland has presented an updated working paper addressing most of the technical comments via email to the BYCWG which will be discussed via videoconference in late November.

Faroe Islands

A description of the fleet composition and associated fishing effort, fisheries regulations and logbook system was provided to the WG.

The Fishery Inspection regularly perform independent observation of fishing activities but there is no dedicated marine mammal observer scheme in the Faroes. The reliability of the by-catch reporting has not been assessed, but as elsewhere there is very little reported by-catch in logbooks.

The WG noted that by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidences of by-catch of several species in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch.

The working group recommended therefore that a responsible precautionary approach be taken and that a proper assessment of the by-catch risk in the various fisheries be undertaken, beginning with those of higher concerns like Very High Vertical Opening and generally pelagic pair trawling.

The WG also provided recommendations for by-catch monitoring and observation.

The Scientific Committee **endorsed** the concerns and the recommendations put forward by the WG. It recommended that a data-based assessment of by-catch risk be implemented in a timely manner, starting with analysing the already existing information and the monitoring of the fisheries of most concerns. The main issues and recommendations are listed below while the complete list is given in the WG report.

With regards to by-catch reporting:

The WG recommended adding the selection of local marine mammal species to e-logbook design, so species identification can be easily reported.

- Implement a reporting system for vessels below 15 GMT, as also recommended by the previous BYCWG.

With regards to by-catch observation:

- Review and present to the WG the data already collected by fishery observers on the monkfish fishery during an experimental monitoring of the fishery prior to 2015.
- Improve reporting of by-catch on pelagic pair trawl fisheries by monitoring vessels in the fleet with an electronic monitoring video system (EM) or onboard observers, careful attention being given to where the observer or cameras are placed and to the stage of the haul because of the volume of catch and the multi-vessel nature of the fishery.
- Implement observer coverage in other fleets with potential for by-catch, such as the high vertical opening trawl fleet.
- Include documentation of marine mammal by-catch in the protocol of fisheries observers, as well as other standard characteristics of the fleet (effort, location, month, etc.) to measure by-catch rates.

Discussion of the SC

There has been a meeting within the Ministry where it was agreed that the issue of by-catch should be addressed, however, the recommendations have not been addressed thus far.

Greenland

Greenland is an atypical case because marine mammals that are caught, either directly or indirectly, are assumed to be reported as direct catch (with large whales being the exception where by-catch is reported as such). The primary concern is to ensure that any by-catch is included in the total number of removals to be used in population assessments. It is, however, interesting to be able to distinguish between catch and by-catch, both regarding the certification of fisheries and mitigation (should the total removals not be considered sustainable). As an attempt of improving hunting and bycatch data collection and monitoring, Greenland implemented online reporting in 2013, and is continuing to improve the system.

The WG reviewed the information provided on the present sources of by-catch reporting and discussed their relative reliability. It provided several recommendations for improvement and identified areas where already existing information should be analysed.

The Scientific Committee **endorsed** the recommendations put forward by the WG. The main issues and recommendations are listed below while the complete list, and background reasons are developed in the WG report.

- The marine mammal by-catch reports made in fishery logbooks previous to 2016 have become available and an overview of this information should be analysed and made available for review.
- Summarise and make available the data collected by fisheries inspectors regarding marine mammal by-catch events, in addition to information on the total fisheries effort, the number of trips observed, and the specific focus of the observation/inspection.
- For marine mammal species without regulatory measures (e.g. non-quota small cetaceans such as harbour porpoise, dolphins, pilot and killer whales) and some seals, a reporting system similar to that mandated by the species-specific executive orders (i.e., for large whales, beluga, narwhal and some seals) would be helpful.
- Include in the online reporting system for the hunters some kind of automatic validation, e.g. a pop-up window requesting information on the by-catch and the fishery in which it occurs.
- Greenland perform as soon as feasible the validation of by-catch reporting data from the licensed hunters' online system against those from the buyers to understand levels of by-catch on a routine basis.

General Business

The Scientific Committee noted that the WG recognizes that while it has recommended that marine mammal by-catch reporting is made mandatory in commercial logbook systems for vessels of all sizes, this information is not reliable without validation, which is difficult. While logbook reporting can be useful for qualitative indicators, the most reliable means to obtain information on by-catch is via dedicated monitoring by fisheries observers or electronic monitoring.

The Scientific Committee also noted that the WG discussed interactions between aquaculture and seals, and encouraged the work of the Norwegian Fisheries Directorate to obtain improved data on the numbers of seals

shot at fish farms. It further supported the suggestion of the WG that Norway should look at the numbers of fish mortalities at the fish farms that have been attributed to seals.

The Scientific Committee agreed with the Working Group that a remote electronic monitoring system as developed and used in Denmark for monitoring by-catch and discards, could provide a cheaper alternative to using observers onboard vessels and that this opportunity should be further investigated.

7.2. Multispecies approaches to management/Ecosystem Modelling (R- 1.1.8, 1.2.1, 1.2.2, 1.4.7)

7.2.1. Review of active requests

R-1.1.8 (ongoing): In addressing the standing requests on ecosystem modelling and marine mammal fisheries interaction, the SC is requested to extend the focus to include all areas under NAMMCO jurisdiction. In the light of the distributional shifts seen under T-NASS 2007, the SC should investigate dynamic changes in spatial distribution due to ecosystem changes and functional responses. See also 1.1.6 and 1.4.6.

R-1.2.1 (ongoing): consider whether multispecies models for management purposes can be established for the North Atlantic ecosystems and whether such models could include the marine mammals compartment. If such models and the required data are not available then identify the knowledge lacking for such an enterprise to be beneficial to proper scientific management and suggest scientific projects which would be required for obtaining this knowledge.

R-1.2.2 (standing): In relation to the importance of the further development of multispecies approaches to the management of marine resources, the Scientific Committee was requested to monitor stock levels and trends in stocks of all marine mammals in the North Atlantic.

R-1.4.7 (ongoing): The Scientific Committee is requested to review the results of the MAREFRAME ecosystem management project when these become available. In particular, the results should be reviewed with respect to the ongoing and standing requests on marine mammal interactions (R-1.1.0) and multispecies approaches to management (R-1.2.0).

7.2.2. Updates

SMM Workshop

Prewitt updated the SC on the results of the workshop organised by NAMMCO and held 28 and 29 October in conjunction with the recent SMM conference, "Cetacean distribution and abundance in the North Atlantic". There were two main goals of the Workshop, with the second being the most relevant to this agenda item.

1) To generate a set of North Atlantic wide design-based abundance estimates for 2015/16 for those cetacean species for which sufficient data are available. Species will include common minke, fin, humpback, pilot whales and others that the data support. Estimates will be corrected for biases to the extent possible. The expected outcome is a complete set of estimates, or, more likely, an incomplete set of estimates and an action plan to achieve a complete set in timely fashion.
2) To discuss modelling the spatial and temporal distribution and habitat use of cetaceans in the North Atlantic using data from 2015/16. Discussion will be focussed on the most important and available variables to inform modelling; the merits or otherwise of modelling the entire northern North Atlantic; the challenges of combining multiple datasets from different projects/platforms/methodologies; and the logistics and timelines of moving forward with modelling. The expected outcome is an action plan for moving forward.

There was a wide spectrum of expertise, including aerial and shipboard cetacean surveys in all four NAMMCO countries, but also from Canada, USA, EU (SCANS-III survey) and Ireland. There were also participants with oceanography and spatial/habitat modelling expertise.

After one day of presentations of recent surveys in the North Atlantic, the group discussed the issues relating to combining abundance estimates, and also whether, and how, to move forward with a broad-scale modelling project.

The group considered that a North Atlantic-wide modelling effort could be of value for a number of reasons. It could help in understanding the large-scale distribution of several species, and why those distributions change over time. It could also be useful in predicting future distribution based on predicted changes in the ocean environment. Habitat modelling may identify areas that are likely to have large numbers of animals but which have not been sampled adequately by surveys.

Priority species for modelling include the baleen whales: fin, blue, humpback and common minke. The data holders also agreed in principal to contribute data to such an effort.. Data will be available from most groups within the next year.

To take the project forward a correspondence group was convened under the chairmanship of Hammond to include all interested parties but definitely Hammond, Øien, Palka, Belkin, Víkingsson, Mikkelsen, Rogan, Gilles and Valdimarsson. Hammond noted that it was hoped a Masters student at St Andrews would initiate some preliminary work with some of the 2015 datasets.

MareFrame Project
Elvarsson reported that there will be a final meeting for the MAREFRAME project in late 2017.

He further noted that the results of the MAREFRAME project will likely be useful to NAMMCO as models that will serve as building blocks for further development.

7.2.3. Future work

The SC **recommended** that a small group be organised to review the report of the Mareframe project and prepare a document for the next SC meeting. This small group will either convene a one-day meeting, or communicate via email correspondence. Elvarsson and Skern-Mauritzen will take the lead on organising this small group, which may need to include additional/external expertise.

7.3. Environmental issues (R-1.5.3, R-1.5.4)

7.3.1. Review of active requests

R-1.5.3 The Council requests the SC to monitor the development of the Mary River Project and assess qualitatively or if possible quantitatively the likely impact and consequences on marine mammals in the area.

The NAMMCO-JCNB JWG discussed the Mary River Project in detail at its meeting in March 2017. In the report from that meeting, the JWG states:

"The JWG expressed concern regarding development of mining activities and associated ship traffic on the Eclipse Sound narwhal stock. No similar example of such a high level of shipping and development has occurred in a high density narwhal habitat so there is little precedent to inform an assessment of the impacts. Of particular concern are:

1. Narwhal response to shipping activities is not well understood and may include threshold responses in which the narwhals abandon the disturbance area rather than habituate to the disturbance. In this case an irreversible loss of habitat may occur if the narwhals leave and do not re-inhabit the area even in the absence of shipping activity.
2. Ship strikes, lethal and sub-lethal effects of shipping activity may take significant numbers of narwhals. DFO (2014) estimated as many as 123 narwhal would be in the path of ships each year and be at risk of ship strike. Sub-lethal effects include disruption of feeding and communication, with potential consequences to energetics and reproduction. These impacts may negatively affect the sustainable removal levels of the Eclipse Sound stock which is shared between Greenland and Canada.
3. Risk of an oil or toxic spill in a high latitude area is compounded by the presence of ice and the remoteness from the necessary facilities and personnel for clean-up. It is poorly understood how a high arctic ecosystem would respond to an oil spill, the effects of which are likely detrimental and possibly irreversible.

Shipping/Icebreaking in Baffin Bay

The JWG expressed concern regarding shipping and icebreaking activities in the wintering grounds of narwhal and beluga in Baffin Bay where winter time shipping is unprecedented. Ship noise and icebreaking activities will disturb deep diving narwhal during a critical feeding period and may result in unpredictable response and displacement from preferred habitat of both species. Ice breaking will disrupt the distribution and condition of sea ice which may lead to ice entrapments. The risk from oil spill discussed above applies here as well and the JWG noted that there is no available method for cleaning up an oil spill in ice covered waters. A recent gas leak in Cook Inlet, Alaska has demonstrated the difficulties of responding to such an event.

The JWG also expressed concern that cumulative effects should be considered when new shipping and icebreaking activities are proposed for narwhal and beluga habitat areas."

Discussion of R-1.5.3

The SC noted that the JWG makes recommendations based on the information that is available on the current plans for the Mary River project at the time of their meetings, however there is often uncertainty around what the plans actually entail, and these plans appear to change often. This makes it difficult to give relevant management advice. However, it is clear that increased vessel activity is already taking place in Eclipse Sound (and Baffin Bay). Hunters in Greenland report that narwhals are very skittish to boat activity, and preliminary results from a GINR research project conducted in Scoresby Sound (East Greenland) this summer (2017) indicate that narwhals are actively avoiding vessels and appear to be especially vulnerable to sound.

The SC noted that other species (bowhead whales, ringed seals, walrus, etc.) are also potentially impacted by the Mary River project, not only narwhals and belugas.

The SC reiterated its previous recommendation that all information on the Mary River project be presented to the JWG. It was suggested that someone from the Fisheries Protection Division in Canada should attend the next NAMMCO-JCNB JWG in 2019.

R-1.5.4 (NEW): Committed to furthering its ecosystem approach to the management of marine mammals, and recognising the range of anthropogenic pressures facing North Atlantic marine mammals associated with the climate and environmental changes taking place, the Council requests the SC to advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.

Discussion of R-1.5.4

The SC noted that it is not possible to find a one-size fits all answer to this request, and that, as a start, this request will need to be dealt with on a case by case basis. The SC **recommended** that upcoming/future working groups consider request R-1.5.4, for example by adding non-hunting impacts to their agendas.

There is already some work that has started, or is being planned, in various groups that may address this request. For example, at the NAMMCO-JCNB JWG meeting that was held in March 2017, the JWG discussed holding a "…workshop to address concerns over changes in management advice in response to the non-hunting takes and changes in distribution resulting from development and warming of the arctic. This workshop would take place over 1-2 days and could be joined with the next JWG (in 2019). The workshop will focus on the populations in West Greenland and Canada, but should include experts involved with changes in marine ecosystems and higher trophic animals in relation to climate change in the North Atlantic and Canadian Arctic (polar bears, walrus, etc.)

The Terms of Reference for the workshop will be to:

- Identify specific effects of climate change on belugas and narwhals
  - Request papers on changes in distribution, population dynamics, etc. resulting from climate change in Canada/Greenland waters
  - The focus will be less on the mechanism of the effects, and more on identifying simple predictors and possible consequences

- Identify specific ways that the JWG's advice may be informed by these effects
  - Climate change may affect timing and distribution of hunted populations.

- Climate change may affect population model parameters used for assessment.
- Development in the arctic may result in changes in habitat and carrying capacity as well as increased anthropogenic disturbance which may require changes in assessment models."

Discussion

SC **endorsed** the proposal of the workshop by the JWG.

The Global Review of Monodontids meeting that was held in March 2017 also had a considerable amount of discussion of environmental/habitat concerns for each monodontid stock.

Additionally, Haug informed that IMR (Norway) and PINRO (Russia) will arrange a joint symposium entitled "Influence of ecosystem changes on harvestable resources in high latitudes" in Murmansk, Russia, from 5 to 7 June 2018. The symposium will include theme sessions on: i) oceanography; ii) plankton composition, distribution and abundance; iii) benthic distribution and production; iv) fish communities on the move – food or competitors; and v) top predators.

Skern-Mauritzen also informed the SC about the Ecosystem Overview project in ICES, which "provide a description of the ecosystems, identify the main human pressures, and explain how these affect key ecosystem components" (http://www.ices.dk/community/advisory-process/Pages/Ecosystem-overviews.aspx).

These Ecosystem Overviews provide a qualitative assessment of the cumulative impacts/effects for each ecoregion, including the drivers and stressors, and which process are being impacted. The SC discussed the potential for applying this approach to marine mammal species/stocks to identify key threats, and identify where more quantitative data is needed. The SC **agreed** that this could be a potentially useful approach, however more work needs to be done in the individual working groups.

7.3.2. Updates

Climate Change

Haug presented Haug et al. (2017b), a review of possibilities and constraints in future harvest of living resources in a changing northeast Atlantic Arctic Ocean. Global warming drives changes in oceanographic conditions in the Arctic Ocean and the adjacent continental slopes. This may result in favourable conditions for increased biological production in waters at the northern continental shelves. However, production in the central Arctic Ocean will continue to be limited by the amount of light and by vertical stratification reducing nutrient availability. Upwelling conditions due to topography and inflowing warm and nutrient rich Atlantic Water may result in high production in areas along the shelf breaks. This may particularly influence distribution and abundance of sea mammals, as can be seen from analysis of historical records of hunting. Northwards shift in the distribution of commercial species of fish and shellfish is observed in the Barents Sea, especially in the summer period, and is related to increased inflow of Atlantic Water and reduced ice cover. This implies a northward extension of boreal species and potential displacement of lipid-rich Arctic zooplankton, altering the distribution of organisms that depend on such prey. However, euphausiid stocks expanding northward into the Arctic Ocean may be a valuable food resource as they may benefit from increases in Arctic phytoplankton production and rising water temperatures. Even though no scenario modelling or other prediction analyses have been made, both scientific ecosystem surveys in the northern areas, as well as the fisheries show indications of a recent northern expansion of species such as mackerel, cod, haddock and capelin. These stocks are found as far north as the shelf-break north of Svalbard, and it is assumed that cod and haddock have reached their northernmost limit, whereas species such as capelin have potential to expand their distribution further into the Arctic Ocean. As boreal species migrate northwards for feeding, the question of relocating spawning grounds and egg, larval and juvenile distribution becomes vital for predicting the future. Summer and autumn spawners are found among several species, even if the dominant spawning time is spring. This may indicate a certain probability of expanding spawning grounds to the shelf areas of Svalbard and Franz Josef Land, as the production blooms are later in these areas. Observed settlement of young ages of several species on the northern shelfs of these archipelagos may indicate a certain probability of a northern movement of the full life cycle of some species.

Boreal whale species, such as blue, fin, humpback and common minke whales, are regular seasonal migrants to the Northeast Atlantic side of the Arctic Ocean where they take advantage of the summer peak in

productivity as the sea-ice recedes northward. Furthermore, during the spring to autumn period, most harp seals on the Northeast Atlantic side of the Arctic are found in the central and northern parts of the Barents Sea where sea-ice edge is a platform from which they make foraging trips into open waters. Both migrant cetaceans and harp seals are likely to follow any further receding of the sea-ice edge, if sufficient food resources become available in the region. Such northward expansions of more boreal marine mammal species are likely to cause competitive pressure on some endemic Arctic species (bowhead whales, white whales, narwhals), as well as putting them at risk of predation and diseases.

Discussion
The Ecosystem Surveys do not cover inside the fjords at Svalbard, however it was noted that capelin and other boreal fishes have become common in the fjords.

There appears to be limited potential for the Arctic ocean to overcome stratification. Furthermore, the Arctic ocean north of Alaska is a typical shelf area, while north of Svalbard the Arctic ocean is typically 3-4000 m deep. The two areas are, therefore very different and the effect of increased temperature and receding ice is assumed to be quite different.

8. SEALS AND WALRUS STOCKS – STATUS AND ADVICE TO THE COUNCIL

8.1 Harp Seal

8.1.1 Review of active requests (R-2.1.4, 2.1.10)

R-2.1.4 (standing): update the stock status of North Atlantic harp and hooded seals as new information becomes available.

R-2.1.10 (standing): provide advice on Total Allowable Catches for the management of harp seals and the establishment of a quota system for the common stocks between Norway and the Russian Federation

8.1.2 Update

Surveys
A survey for both harp and hooded seals in the Greenland Sea is planned for March 2018, and an aerial survey is planned for the White Sea at the same time. The results of these surveys will be presented at the next ICES/NAFO/NAMMCO WGHARP meeting.

A harp seal survey to estimate pup production of Northwestern Atlantic harp seals was flown during March 2017. Extensive reconnaissance was completed in the Gulf of St Lawrence (GSL) and off the east coast of Newfoundland (Front). There was very little ice in the GSL. Estimated pup production from visual surveys flown in the southern GSL was approximately 28,000 animals. This estimate was much lower than the roughly 200,000 pups that are normally born in the southern GSL area. Ice was also poor at the Front, compared to traditional conditions, but was suitable for pupping. In 2017, older than expected pups were detected at the Front. Given their age, it was considered that these animals were actually pups produced by females from the GSL, who had moved from the GSL region to the front to have their young. These results will be discussed at the next ICES/NAFO/NAMMCO WGHARP meeting.

Tagging
A tagging study of harp seal pups in the Greenland Sea is ongoing. The tagged pups all went northward along the east Greenland coast and then most turned east to the area around Svalbard, and between Svalbard and Franz Josef Land where most of the seals are now (November 2017). The tags are expected to transmit until May 2018.

Discussion
The breeding patch usually drifts southward after pupping, from 72-73°N to around 69°N. The migration patterns seen in this study appear to be similar to what was seen in adult seals in the 1990s, however the seals are moving further north of Svalbard now, likely due to change in ice conditions.

SC **welcomed** the new information on harp seal migrations and looks forward to the final results. More tagging is also planned in this area next March, including tagging of some adults. The awaited results of this should shed light on whether the migration patterns seen in the 1990s persist in adults as well.

Potential Biological Removal (PBR)
In 2013, the WGHARP examined setting harvest levels for White Sea harp seals using the Potential Biological Removal (PBR) approach. The management objective of PBR is to have a 0.95 probability that the population would recover above or remain above a population level capable of providing Maximum Sustainable Yield. Therefore, harvest levels set using PBR should allow the population to increase above MSY. However, modelling suggested that in spite of a significant decline being observed in the White Sea population, harvest limits set using PBR would likely result in the population declining further. Simulations were completed to try to understand further why PBR would cause the population to decline further. Harp seal pup production in the White Sea dropped by more than 50% in 2003 and has remained low since then. This suggested that there may have been a decline in ecosystem carrying capacity. Model simulations showed that harvest levels estimated using the PBR approach would not meet the management objectives in situations of declines in ecosystem carrying capacity of 40% or more.

Discussion
The SC discussed possible reasons for the 40% reduction in the ecosystem carrying capacity for harp seals and noted that the management objective will not be obtained if PBR is used. The SC agreed that there are presently no clear answers, and that factors like the general degradation in habitat and pollutants travelling downstream may not represent a real change.

The SC emphasised that PBR is a problematic instrument and underlined that the PBR and the PBR approach had originally been designed for managing by-catch takes and not for providing sustainable quota. It is thus questionable if the approach is applicable to other issues. A discussion on the usability of the PBR is needed.

8.1.3 Future Work

The SC **recommended** that the WGHARP meeting be postponed to 2019 to allow for the analysis from the 2017 and 2018 surveys to be completed in time for the meeting.

8.2 Hooded seal

8.2.1 Review of active requests (R-2.1.4 , 2.1.9)

R-2.1.4 (standing): update the stock status of North Atlantic harp and hooded seals as new information becomes available.

R-2.1.9 (ongoing): investigate possible reasons for the apparent decline of Greenland Sea stock of hooded seals; and assess the status of the stock

8.2.2 Update

Abundance
A pup production survey is planned for Greenland Sea hooded seals in March 2018. The results of this survey should be informative, as there should have been sufficient time since this stock of hooded seals were protected in 2007 to potentially see increases in pup production (if hunting was the cause of the decline).

It may be possible to get an abundance estimate of northwest Atlantic hooded seals from photos taken during the 2017 northwest Atlantic harp seal survey, which will be presented to the next meeting of the WGHARP. The previous survey was conducted in 2005, and at that time, this population was estimated to be around 600,000 animals, and increasing.

8.2.3 Future work

The SC **recommended** that the WGHARP meeting be postponed to 2019 to allow for the analysis from the 2017 and 2018 surveys to be completed in time for the meeting.

8.3 Ringed seal

8.3.1 Review of active requests (R-2.3.1, 2.3.2)

R-2.3.1 (ongoing): stock identity, abundance estimate, etc.

R-2.3.2 (ongoing): effects of removals of ringed seals in Greenland

8.3.2 Update

Greenland

A tagging study of ringed seals in Northeast Greenland is ongoing – that study has revealed that the hunt in southeast and probably also in southwest Greenland is supported by ringed seals from northwest Greenland. The seals were tagged in late August and will probably transmit until May 2018.

A study by Yurkowski et al. 2016 was also presented. It compared movements from different tagging studies. It shows that both adult and juvenile ringed seals are mostly resident during the ice free period and that longer ice-free seasons and less inter-annual variability in sea ice phenology generally made ringed seals more resident. The paper also shows the tracks from 6 different tracking studies and they together with other published studies start to show the contours of stock delineations. This suggests that in the near future it will be possible to make management units for ringed seals.

Additionally, a genetics study which involves samples from many different areas is ongoing, and will hopefully also inform on stock structure of ringed seals.

At SC/23, the SC had r**ecommended** more satellite telemetry and collection of samples for genetics to inform on possible stock structure in Greenland, and across the Arctic. The SC therefore welcomes this new tracking information and looks forward to the genetics results.

Svalbard

Lydersen reported from a tracking study of ringed seals and polar bears where biotelemetry devices to ringed seals (n = 60, both sexes) and polar bears (n = 67, all females) before (2002–2004) and after (2010–2013) a sudden decline in sea ice in Svalbard. Following the sea-ice reduction, polar bears spent the same amount of time close to tidal glacier fronts in the spring but less time in these areas during the summer and autumn. However, ringed seals did not alter their association with glacier fronts during summer, leading to a major decrease in spatial overlap values between these species in Svalbard's coastal areas. Polar bears now move greater distances daily and spend more time close to ground-nesting bird colonies, where bear predation can have substantial local effects. These results indicate that sea-ice declines have impacted the degree of spatial overlap and hence the strength of the predator–prey relationship between polar bears and ringed seals, with consequences for the wider Arctic marine and terrestrial ecosystems. Shifts in ecological interactions are likely to become more widespread in many ecosystems as both predators and prey respond to changing environmental conditions induced by global warming, highlighting the importance of multi-species studies.

Lydersen also reported that ringed seals in Svalbard have started to haul-out on shore and in association with harbour seals. Recent intrusions of warm Atlantic Water (with associated prey) have extended deep into the fjords of western Spitsbergen, resulting in deteriorated ice conditions for ringed seals and expanded habitat for harbour seals. Over the last decade, ringed seals have become more and more confined in coastal areas to narrow bands in front of tidal glacier fronts where Arctic conditions still prevail. In one lagoon area, ringed seals are hauling out on intertidal mud flats in close association with harbour seals. Land can likely replace sea-ice for many of the ringed seals haul-out needs. However, for the small dry-cold adapted ringed seal pups that are normally born in snow lairs on the sea ice, terrestrial haul-out is unlikely to be a viable solution because of predation and thermoregulatory stress.

Lydersen also reported that 10 ringed seals were equipped with GPS-CTD-SRDLs as a study of space use in relation to glacier fronts. In addition the annual collection of ringed seal material for the National Tissue Bank continues with 25 animals collected each year.

Canada

Aerial surveys to estimate ringed seal abundance in Eclipse Sound, Milne and Navy Board Inlets were flown in June 2016 and 2017. Infrared red cameras were tested during these surveys to evaluate their effectiveness in detecting animals on the ice.

Discussion
Genetics samples have been collected from ringed seals in Svalbard, and it may be possible to combine these with the analysis of samples from Greenland.

8.3.3 Future work

The previous review of ringed seals occurred in 1996, and although there are still many gaps in knowledge about this species, there has been quite a bit of research since that meeting. At SC/23, the SC discussed a possible Ringed Seal WG meeting, and recommended that possible issues to be discussed by such a WG could be:

1) Stock structure
2) Abundance
3) Effect of polar bears

The SC decided that more results from the ongoing studies are still needed before a Ringed Seal WG meeting should be convened, and the suggested timing is 2020/2021. It could also be a useful venture to expand the WG to other researchers outside of the NAMMCO countries, in particular Canada.

It was also suggested that this meeting could occur in combination with a Bearded Seal WG, as many of the same researchers would be involved in both meetings.

8.4 Grey seal

8.4.1 Review of active requests (R-2.4.2)

R-2.4.2 (ongoing): abundance estimates all areas

As mentioned below, new abundance estimates from Norway and Iceland are expected in the next year.

8.4.2 Coastal Seals WG

In preparation for a planned CSWG in 2019, the SC heard updates from Norway, Iceland and the Faroe Islands on the progress of addressing the recommendations from the 2016 CSWG meeting. These updates are included under item 8.4.3.

Recommendations for Norway from the 2016 CSWG:

- Development of the model to see if it can be modified to account for the observed changes in pup production
- More frequent surveys, particularly in the areas of decline
- Tagging of grey seal pups
- Age-structure of the hunt assumed to be the same as for the by-catch, and this assumption needs to be tested
- Complete the genetics study within this year [2016]
- Reporting of all removals. Currently there is little to no reporting of removals around fish farms and from both commercial gill net fisheries and recreational fisheries

Recommendations for the Norwegian Harbour and Grey Seal Management Plans

- The target population levels for both species should be evaluated as the levels are not based on any biological assessment
- To recommend that the quota is set to 0 when the population is at 70% of the target level instead of 50%
- Management plans should include all sources of mortality, not just the hunt

- A mechanism for consulting IMR on for example seal distribution when fish farms are being built should be required when management plans are revised

Recommendations to Iceland from the CSWG (2016):
Primary

- A Management Plan should be developed including: the frequency of surveys, legislation of seal hunting and re-evaluation of the target population level objective with the new level being based on biological criteria
- A complete survey should be conducted to obtain a full, reliable abundance estimate
- Reporting of all removals (e.g., by-catches, hunted seals, any other removals)

Next steps

- Pup production surveys at least 3 times to make sure that the peak pupping period is covered
  - Iceland should also consider tagging pups for staging
  - Iceland should also investigate whether the peaks in pupping differ in different areas around the country
- Genetics samples should be collected and analysed to explore stock structure

The need for a reporting system for direct catches was underlined to be able to model the status of the population.

Recommendations for the Faroe Islands from the CSWG (2016):

- Develop a monitoring plan that includes regular assessments.
- Based on exiting data analyse population viability (population size necessary to sustain the levels of removals)
- Analyse existing UK telemetry data for possible migration between the UK and the Faroes.
- New research to be undertaken

First Priorities

- Obtain minimum population estimates via haulout counts.
- Obtain reliable and complete reporting of all removals (e.g., all companies operating fish farms need to report).

Secondary Priorities

- Telemetry tagging studies to develop correction factors for the haulout counts and also obtain information on movements and distribution
- Samples should be collected from animals shot at farms (e.g., jaws to obtain information on age, sex, genetics etc.).
- A study using cameras to observe animals going in and out of caves
- Photo-ID study for a mark-recapture based population size

8.4.3 Update

Norway
Updates on recommendations of the CSWG (2016):

- The population model has not yet been updated, but this work planned pending the results of the survey. Norway noted that preliminary results from the surveys indicate that pup production has decreased.
- There are plans to re-survey the areas where substantial decreases have been observed (e.g., Nordland) next year (2018)
- Tagging of grey seal pups has not occurred. There is some indication that tagging may make the seals more vulnerable to by-catch in gill nets.
- The comparison of the age-structure of the hunt and the by-catch has not been addressed.

- Many samples have been collected for the genetics study, and the results have been used to divide the hunting areas into 3 parts.
- With respect to including all removals, including those around fish farms and from both commercial gill net fisheries and recreational fisheries, IMR has been in discussions with the Directorate on possibly implementing such a system.

Updates on recommendations for the Norwegian Harbour and Grey Seal Management Plans

- IMR is in discussions with the management authorities on evaluating the target population levels for both grey and harbour seals, as the levels are not based on any biological assessment
- The recommendation to set the quota to 0 when the population is at 70% of the target level instead of 50% will be implemented into the Management Plans.
- The Management Plans will be amended to include text that requires reporting of all sources of removals, including direct hunt, by-catch, and removals at fish farms.
- IMR is working on implementing a mechanism where they can be consulted on issues such as seal distribution when fish farms are being built, but thus far this has not been implemented.

Other updates from Norway

The survey cycle for grey seals along the Norwegian coast is ongoing and scheduled to be completed this year (2017), with a new estimate planned to be available next year.

In Norway there are ongoing discussions on whether to forbid the shooting of seals around fish farms, and if they are allowed to be removed, to subtract the numbers shot from the from quotas. The SC noted that the total numbers of removals are crucial to model the population.

Iceland

In response to the recommendations from the CSWG (2016), Iceland updated the SC that a new population estimate for the Icelandic grey seal population is underway (2017). As previously recommended by SC, Iceland aims to conduct censuses bi-annually while the population is close to the target level. Further, development of an advisory management plan for the Icelandic grey seal population is ongoing. This includes a re-evaluation of current target population level objective (based on biological criteria), outlining of the frequency of censuses, development of a reporting system for seal hunting and increased effort in by-catch data collection. Iceland also aims to continue to tag during pupping for staging and to investigate geographical differences in timing of pupping.

A national red-list is being developed for Icelandic mammals including pinnipeds and cetaceans.

Discussion

The SC **welcomed** the work being done on grey seals in Iceland, and the response to the recommendations.

Faroe Islands

High numbers of removals of grey seals around fish farms have been reported for a number of years. Previous removal numbers were considered unreliable and incomplete, as they included reporting from only 60% of the fish farms. Recent information from the Ministry indicates that these numbers may be lower, around 100 seals versus the 200+ reported previously.

A survey of the total population of grey seals in the Faroe Islands is planned for summer 2018. The survey is planned to be conducted in late May, with repeated counts in June and July/August. An estimate from this survey would be very valuable, as this would be the first ever abundance estimate of grey seals around the Faroe Islands.

Additionally, there are plans to deploy satellite tags on up to 8 seals during the survey. Data from the satellite tags will be used for information on movements of grey seals around the Faroe Islands, but also for developing correction factors for the survey.

The development of a monitoring plan for grey seals in the Faroe Islands will await the outcome of the 2018 survey.

With regards to the recommendation to analyse existing telemetry data from the UK, Mikkelsen noted that recently presented results from the UK, of around 130 tagged seals, documented only one seal travelling to the Faroe Islands, that stayed only a short period of time . Previous telemetric data from grey seals tagged in the Faroe Islands suggested a local population in the Faroe Islands, which has also been supported by genetic analysis.

The CSWG also recommended that a photo-ID study could be an option for estimating abundance of grey seals in the Faroe Islands, however Mikkelsen reported that this option is likely too time-consuming and likely not achievable compared to a summer counting survey. Additionally, the Faroe Islands informed that the recommendation of the CSWG of deploying underwater cameras to observe the movement of seals in and out of the caves is not a high priority.

Discussion
It has been 15 years since the SC first expressed concern regarding grey seals in the Faroe Islands. The SC welcomes these new plans for research and **strongly recommends** that this work be given a high priority.

Greenland
No grey seals have been seen in Greenland since 2010. There have been recent surveys counting bird colonies and searching for seals, however no seals were seen during these efforts. Additionally, cameras and acoustic recorders in areas where grey seals were previously seen did not detect any grey seals.

Canada
The Canadian grey seal population was assessed in 2016 and the total estimated population is 424,000 animals. Overall, the population continues to increase. Resightings of branded animals marked on Sable Island indicate that adult females have an annual mortality rate of approximately 2%, whereas males have a slightly greater mortality rate of approximately 4%. There have also been changes in juvenile survival rates over the last 20 years. Early estimates of survival rates among animals between weaning and age 4 were approximately 70%, whereas more recent estimates suggest that juvenile survival has declined to approximately 30-35%. Research into life-history characteristics continue. Approximately 4000 animals have been branded over the last three years on Sable Island and in the Gulf of St Lawrence. Satellite transmitters continue to be deployed to study movements and habitat utilization.

Other Updates
Information on by-catch of grey seals in Norway and Iceland was discussed under Item 7.1.3.

8.4.4 Future work

A CSWG is planned for 2019.

8.5 Harbour seal

8.5.1 Review of active requests (R-2.5.2)

R-2.5.2: conduct a formal assessment of the status of harbour seals around Iceland and Norway as soon as feasible

8.5.2 Coastal Seals WG

In preparation for a planned CSWG in 2019, Norway and Iceland provided the SC updates on their responses to the recommendations of the CSWG that occurred in 2016. These are listed below, under updates.

The CSWG in 2016 recommended for Norway:

- Increase the number of vessels in the reference fleet in the areas of high by-catch (especially Nordland that has a long coastline)
- Increase survey effort. Important areas could be identified to be surveyed in between other full-coast surveys.

- Management by county should be re-examined, as these management units do not always follow the population structure of harbour seals, especially Nordland county. This is discussed further under Item 6 (Review of the Norwegian management plan)
- Reporting of all removals. Currently there is little to no reporting of removals around fish farms, or of by-catches in commercial gill net fisheries and recreational fisheries.
- Collect data from by-catches (age, sex, etc.). It would be ideal to collect jaws from bycaught seals which will provide information on age, sex and species. It would be particularly helpful to have samples from the reference fleet.

Recommendations for Iceland from the CSWG (2016):

- An assessment survey of the entire population should be conducted as soon as possible
    - Surveys should then be conducted every 2 years while the population is lower than the target level
- All removals should be reported (e.g., hunting, by-catch, etc.)
- A Management Plan should be developed including outlining the frequency of surveys and legislation of seal hunting
- The target population level objective should be re-evaluated and be based on biological criteria.
- Reproductive rates should be collected
- The effects of disturbance from tourism should continue to be investigated
    - Develop mitigation measures
- The method of catching pups in nets should be investigated. In NAMMCO, killing methods should be immediate. This issue should be referred to the NAMMCO Hunting Committee.

8.5.3 Update

Norway

Update from Norway on the CSWG (2016) recommendations:

- The last survey cycle was from 2011-2015, which resulted in an estimate of 7,644 along the Norwegian coast. The new survey cycle started in the south of Norway in 2016 and is projected to be completed by 2020. Harbour seal surveys along the Norwegian coast are now using drones for photography rather than counts from planes.
- Discussions on increasing the number of vessels in the CRF is being discussed with the Directorate, and it may be able to increase CRF in problematic areas
- Increase survey effort, important areas identified. Not done so far but new survey started has not seen same problems of decrease
- Management units – new genetics data being collected, started in north, some analysis being done, some structuring seen, full results later
- Reporting of removals- discussing with directorate, numbers from fish farms, also accepted by-catch estimate expected.
- Data from by-catches – some older data being analysed, depending on problmes identified. Period of bounty on coastal seals, required to send jaws.

Other updates

It was noted that killer whales on the Norwegian coast have been seen recently taking harbour seals. It is unclear whether this is a new behaviour, or has been occurring previously but just not observed or reported. Norway is investigating whether the level of predation is large enough to warrant inclusion in the population modelling (as natural mortality).

A portion of the genetics data has already been included in a study comparing samples from Norway, Greenland, and Iceland.

Svalbard

Harbour seals in Svalbard may be increasing, and there are plans for tagging studies outside of the breeding area.

Iceland

In Iceland, aerial population censuses have been conducted eleven times since 1980, and have revealed a declining trend in the Icelandic harbour seal population. The newest population estimate from 2016 resulted in an estimated population size of 7,652 animals. The estimated population size was 77% smaller than when first estimated in 1980, and 32% smaller than in 2011, when the latest complete population census was undertaken. The current population is estimated to be 36% below the target population level objective put forward by the Icelandic government. Factors contributing to the observed population decline are poorly understood, but by-catch and direct-hunt are likely population limiting factors.

As previously recommended by SC, Iceland aims to conduct censuses bi-annually while the population is below target level and hence the next harbour seal census is planned in 2018. Further, an advisory management plan for the Icelandic harbour seal population is being considered. This includes a re-evaluation of current target population level objective, outlining of the frequency of censuses, development of a reporting system for seal hunting and increased effort in by-catch data collection.

Discussion
The correction factors used for the surveys were based on correction factors from other countries. There are plans for getting correction factors that are based on Icelandic harbour seals.

MFRI provided advice to the Ministry "that direct hunt should be prevented and that actions must be taken to reduce by-catch of seals in commercial fisheries. MFRI also advices that a hunting management system should be initiated, and that reporting of all seal hunt should be mandatory." (https://www.hafogvatn.is/static/extras/images/Landselur277.pdf).

The SC **welcomes** the work being done on harbour seals in Iceland, and the responses to the recommendations.

8.5.3 Future work

A meeting of the CSWG is planned for 2019.

8.6 Bearded seal

8.6.1 Bearded Seal WG

At SC/23, the SC **recommended** a future working group on bearded seals with the following Terms of Reference:

1) assess the global distribution and possible population delineations
2) evaluate available information on biology including reproduction and feeding habits
3) assess the exploitation and other anthropogenic effects incl. climate changes on bearded seals
4) suggest populations and areas in the North Atlantic where sufficient data are available for assessing the effects of exploitation and reductions in habitats

Possible participants would include: Aqqalu Rosing-Asvid, Mads Peter Heide-Jørgensen, Christian Lydersen, Kit Kovacs, and participants from Russia, Canada, and possibly Alaska.

The SC recommended that such a working group could be combined with a Ringed Seal Working Group, as many of the same researchers would be involved in both meetings. This combined meeting could be held in 2020.

8.6.2 Update

No updated information was presented.

8.7 Walrus

8.7.1 Review of active requests (R-2.6.3, R-2.6.7, R-1.6.4, R-1.6.5)

R-2.6.3 (ongoing): effects of human disturbance, including fishing and shipping activities, in particular scallop fishing, on the distribution, behaviour and conservation status of walrus in West Greenland.

R-2.6.7 (NEW-NAMMCO 25): The SC is requested to provide assessments of, and advice on sustainable removals from, all stocks of walrus in Greenland covering the period from 2019 to 2023, with the advice for Qaanaaq starting in 2021.

R-1.6.4 (ongoing): The SC has recommended that catch statistics include correction for struck but lost animals for different seasons, areas, and catch operations. Council requested the SC and the Committee on Hunting Methods to provide advice on the best methods for collection of the desired statistics on losses.

R-1.6.5 (NEW-NAMMCO 25): Greenland requests that struck and loss rates are subtracted from future advice on sustainable removals in Greenland, with the advice being given as total allowable landings.

8.7.2 Walrus Working Group (2018)

A Walrus Working Group is planned for fall 2018, which will allow for the results of a survey planned for the Qaanaaq area (Baffin Bay stock) in spring 2018 to be available to the meeting, but will also allow for updated catch advice to be given in time for the new quota block (2019-2024).

The SC supported the nomination of Rob Stewart (DFO, retired) as the new Chair of this working group. The SC encouraged the participation of Canadian scientists, as there is a shared stock between Canada and Greenland.

8.7.3 Updates

Greenland

Two surveys were conducted in 2017 in northeast Greenland – a survey in April covered the Northeast water polynya (between 79-82° N) and then an August/September survey covered the coastal areas including old known haulout places and offshore waters (70-82° N). The results are not yet available, but will be presented next year.

A book titled "Walruses and Walrus hunt in West and Northwest Greenland" was published this year. This book contains interviews with walrus hunters in west Greenland that were conducted in 2010. The hunters shared information on the changes to walrus hunting that they have encountered in relation to climate change and the introduction of quotas.

Norway (Svalbard)

Lydersen reported from a genetic study (Andersen et al 2017) that shows that walruses from the Pechora Sea are different from the Svalbard- Franz Josef Land population and should be treated as such. He also reported from a publication (Ølberg et al 2017) describing a new and successful drug combination for anaesthesia of walruses - that hopefully will lead to researchers in other countries using tusks for attachment of telemetric devices again.

Further he reported that Russian colleagues have now deployed all their GPS loggers (N=18) in the Pechora Sea that hopefully will provide novel data on distribution of these animals. Data was collected also this season from many of the 40 GPS loggers that were deployed in Svalbard in 2014 and 2015.

Canada

An aerial survey to count walruses was flown over the Hudson Bay-Davis Strait stock during September 2017. The survey was a combined visual/photographic survey. It involved 3 aircraft that flew the east coast of Baffin Island, the southern shore of Hudson Strait, parts of the northern shore of Hudson Strait and extending to Southampton Island. Analyses are expected to be completed during 2018.

8.7.4 Future Work

As noted above, there is a planned survey in Greenland for the Qaanaaq area in spring 2018, and a Walrus Working Group planned for fall 2018.

9. CETACEAN STOCKS – STATUS AND ADVICE TO THE COUNCIL

9.1 Fin whale

9.1.1 Review of active requests (R-3.1.7, 1.7.11, 1.7.12)

R-1.7.11 (ongoing): develop estimates of abundance and trends as soon as possible

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

R-3.1.7 amended (ongoing): complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. While long-term advice based on the outcome of the RMP *Implementation Reviews (with 0.60 tuning level) is desirable, shorter term, interim advice may be necessary, depending on the progress within the IWC. This work should be completed before the annual meeting of the SC in 2015. Amended at NAMMCO/24: The new amendment replaces the NAMMCO/23 amendment and reads: The SC is requested to complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. A long-term advice based on the new NASS2015 abundance estimate and the available results from the RMP Implementation Reviews (with 0.60 tuning level) is needed in 2016.*

Discussion

The SC considers R-3.1.7 completed.

9.1.2 Update

Iceland

The SC met via videoconference (SC/24/11) on 2nd March 2017 where the results of the LWAWG were presented.

> The SC noted that the IWC's Implementation Review is complete, and these results have been accepted in the IWC SC. The SC **endorsed** the work of the WG and the recommended that a catch limit of 161 fin whales in the WI area and 48 in EI/F area (based on application of the RMP to the EG+WI+EI/F region) is safe and precautionary, and that this advice should be considered valid for a maximum of 8 years (2018 to 2025).

The SC re-iterated it's management advice from the videoconference meeting and considers R-3.1.7 to be concluded.

Iceland informed the SC that based on this advice, MFRI gave the following advice to the Ministry: *For the period 2018-2025, MFRI advises that annual catch of fin whales should be no more than 161 animals from the East-Greenland/West-Iceland management area (EG/WI) and 48 fin whales from the East-Iceland/Faroes management area (EI/G;* https://www.hafogvatn.is/static/extras/images/Langreydur174.pdf)

Iceland has collected several hundred samples between 2006-2015 from commercial catches for information on age, sex, condition, etc., and plans to collect new samples from any future catches. However, there have been no catches in 2016 and 2017. Work is in progress on the analysis of the samples and the data collected.

Norway - Svalbard

Six biopsies were collected for genetics in 2017.

Greenland

Three whales were satellite tagged in west Greenland this year and samples were collected and sent to the University of Potsdam in Germany for genetic analysis.

9.2 Humpback whale

9.2.1 Review of active requests (R-3.2.4, 1.7.12)

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

R-3.2.4-amended (ongoing): conduct a formal assessment following the completion of the T-NASS…In addition the Scientific Committee is requested to investigate the relationship between the humpback whales summering in West Greenland and other areas and incorporate this knowledge into their estimate of sustainable yields of West Greenland humpback whales. ***Amendment (NAMMCO/24):*** *adds the following text: "The SC is further asked to provide advice on future catch levels of humpback whales in West Greenland at different probability levels for a non-declining population evaluated over a 5 year period, similar to the procedure for the advice generated for beluga, narwhal and walrus. The advice should include the latest abundance estimate."*

9.2.2 Large Whale Assessment WG

Following a discussion in the Large Whale Assessment WG, the SC and Council agreed in 2011 that scientific advice on sustainable catches of large whales should be given based on simulation tested and approved management procedures (NAMMCO 2009, 2011). Yet, NAMMCO/24 requested the SC

> *to provide advice on future catch levels of humpback whales in West Greenland at different probability levels for a non-declining population evaluated over a 5-year period, similar to the procedure for the advice generated for beluga, narwhal and walrus. The advice should include the latest abundance estimate (R-3.2.4 Amendment NAMMCO/24).*

The SC **reiterates its recommendation** that the SLAs that are developed in the IWC be used for advice for large whales in Greenland. These SLAs are developed as case specific applications that match the whale stocks and their hunts in Greenland, providing a reasonable balance between exploitation and conservation. The use of these SLAs in NAMMCO will benefit from the work that is carried out in the IWC SC, allowing for an easy application with a minimum of extra work in NAMMCO.

A component of the R-3.2.4 request on West Greenland humpback whales relate to stock structure where "*the Scientific Committee is requested to investigate the relationship between the humpback whales summering in West Greenland and other areas and incorporate this knowledge into their estimate of sustainable yields of West Greenland humpback whales."*

North Atlantic humpback whales, however, have been found to spend the summer in more or less closed geographical aggregations with only a limited exchange of individuals between them. So far there is insufficient information to quantify a potential exchange of individuals, and this is reflected in assessments and trials that have modelled the different aggregations, including West Greenland, as independent units (IWC 2014 SC/65b/Rep04, Witting, 2011).

<u>Abundance</u>

Using a new and improved availability correction, the 2007 estimate of 3,272 (CV= 0.50) humpback whales in West Greenland was recalculated to 2,704 (CV = 0.34).

A fully corrected abundance estimate of 1,321 (CV=0.44, 95% CI: 578-3,022) whales in 2015 was adopted by the Abundance Estimation WG (SC/23/15). The IWC AWMP meeting in December 2016, however, developed a MRDS analysis with an estimated pooled group size of 1.35 (CV=0.09). This gave a fully corrected estimate of 1,008 (CV=0.38, 95% CI: 493-2,062), which is considered to be the best estimate because a very small sample sizes in some strata led to a higher variance in the old estimate.

The SC adopted both of these estimates, and noted that an exchange of individuals between East and West Greenland may explain the difference in the estimates between 2007 and 2015 (a humpback whales that was tagged around Nuuk in 2017 moved to East Greenland during the summer).

<u>SLA advice within NAMMCO</u>

The SLA for humpback whales in West Greenland that was developed in the SC of IWC has been simulated tested and found to provide a safe and precautionary advice. The basis for these tests include that the annual strike limits do not exceed 20 whales from 2013 to 2018, 25 whales from 2019 to 2024, and a linear increase

from 30 to 50 whales over the remaining 88 years of the 100-year simulation period. There is no guarantee that strike limits that are greater than this are sustainable.

Given the agreed abundance estimates for 2007 and 2015, the SLA calculates that strikes up to 25 whales per year are sustainable during the period from 2019 to 2024 (this advice is independent of the actual strikes in 2017 and 2018, as long as these are no larger than 20).

Discussion

The SC **advises** that annual strikes of no more than 25 humpback whales off West Greenland are sustainable from 2019 to 2024.

Comparison with RMP

These strikes can be compared with the allowable takes that are calculated by the CLA of IWC's RMP. The CLA has not been tested for West Greenland humpback whales. However, being developed as a general procedure for a closed population, adequate conservation performance is guaranteed if the CLA is applied to West Greenland humpback whales.

Given annual strikes of ten humpback whales for 2017 and 2018, and the 2007 and 2015 abundance estimates, the CLA calculates total allowable annual takes (from 2019 to 2024) of respectively 13, 14 and 20 whales for tuning levels 0.72, 0.66 and 0.60.

These results are not directly comparable with those of the SLA. The humpback SLA assumes some background by-catch, while by-catch is included in the total allowable removals of the CLA. The actual strike limits of the latter should thus be reduced by a few whales (the by-catch/entanglement numbers for humpback whales in West Greenland were one in 2014, nine in 2015 and three in 2016).

Bayesian assessment

The strikes of the SLA may also be compared with a sustainable catch estimate from a Bayesian assessment. The trials used for the SLA for West Greenland humpback whales are based on a model of density regulated growth for a closed population that is assumed to summer in the waters off West Greenland. A density regulated assessment model for a closed population was developed by Witting (2011), and the model was updated in SC/24/AS/03 with the new abundance estimates for 2007 and 2015 included.

This method is similar in structure to the assessment based advice that is traditionally applied for narwhal, beluga and walrus within NAMMCO, and it estimates that a 70% chance of an increase over the block period from 2019 to 2024 is obtained for a total annual removal of 14 whales. If catches up to 90% of the MSYR are allowed for cases where the population is above the MSYL, the method estimates instead that annual strikes to around 47 whales would ensure a 70% chance of fulfilling the management objective. The latter approach, however, is unable to estimate an upper bound of the carrying capacity, and this implies some uncertainty associated with the last removal estimate.

Future Research

The SC recommends that information be collected on possible movements of individuals between summering areas in the North Atlantic (e.g. satellite tagging, biopsies, photo-ID etc.).

Discussion

The SC **endorsed** the recommendation given by the LWAWG.

9.2.3 Update

Norway

During the sightings survey in the Barents Sea, humpbacks were observed much further north than they have been previously at this time of year. These observations included two large aggregations far north in the Barents Sea. There were also some observations in the southeastern Barents Sea. The leucistic whale was also observed again.

Humpback whales continue to visit northern Norway. During winter 2016/2017 the whales returned to the fjords close to Tromsø, while this year the whales have so far moved slightly further north, off Skjervøy. A group from UiT are conducting research on these animals, including tagging results that show similar movement patterns compared to previous tagging studies in Iceland and Norway.

Iceland
For the past 3 years, whale observers have been present during joint Iceland-Greenland early winter capelin surveys. The objective for having the whale observers on the survey is to estimate the number of humpback and fin whales that are overlapping with the capelin stock, and to calculate estimates of consumption of capelin by humpback and fin whales. This information is then used by fishery managers to calculate quotas according to the harvest control rule (HCR) that aims at leaving with 95% probability at least 150 000 tonnes of mature capelin at the time of spawning in March. In 2015, 7,083 humpbacks and 4,923 fins were estimated to be present on the capelin grounds. Observations during the last 2 years have been similar but insufficient effort was obtained to produce estimates.

Greenland
The Climate Research Center at GINR is satellite tagging and collecting biopsies from humpback whales in Nuuk fjord in west Greenland, and also in east Greenland.

The SC discussed issues relating to sharing of photos to the various organisations that house photo-ID catalogues. Although sharing of photos can be problematic when appropriate acknowledgements are not given by the organisations, the SC encourages researchers to work on collaborative efforts, especially between the NAMMCO countries, but also with organisations outside of NAMMCO. The photo-ID databases are more valuable for looking at broad-scale movements when they cover large areas of the North Atlantic.

9.3 Common minke whale

9.3.1 Review of active requests (R-3.3.4, 1.7.11, 1.7.12)

R-1.7.11 (ongoing): develop estimates of abundance and trends as soon as possible

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

R-3.3.4 amended (ongoing): full assessment, including long-term sustainability of catches, of common minke whales in the Central North Atlantic… assess the short-term (2-5 year) effects of the following total annual catches: 0, 100, 200 and 400. Amended NAMMCO/24: The SC is requested to complete assessments of common minke whales in the North Atlantic and include estimation of sustainable catch levels in the Central North Atlantic.

9.3.2 Update

Iceland
The SC met via videoconference (SC/24/11) where the results of the LWAWG (which addressed R-3.3.4) were presented.

> The projections of the mature female component of the C stock for the next 300 years (see Figure 1) indicate that catches of 400 annually are not sustainable whereas a catch of 300 annually is sustainable in terms of the median trajectory. Noting further that these projections also include annual catches of 50 from the CM sub-area and 12 from the CG subarea, it is reasonable to conclude that an annual catch of about 360 common minke whales is a lower bound for the sustainable catch for the Central North Atlantic. This number is described as a "lower bound" because is corresponds to the "lower bound" MSYR value of 1% in terms of the 1+ population, so that annual sustainable catches would be higher than 360 for the higher value of MSYR that likely applies in practice
>
> The application of the CLA to the CIC sub-area yields a sustainable catch limit for common minke whales of 217 and 139 for tuning levels of 0.60 and 0.72 respectively. These values are compatible with the 360 above as they pertain only to the CIC sub-area within the whole Central North Atlantic region, and also precautionary because the CLA also reflects MSYR values that are perhaps unrealistically low

While the management advice above is precautionary and valid for up to 8 years the WG suggested that once the IWC RMP Implementation Review for North Atlantic common minke whales has been completed (anticipated in May 2017), the results from this should be used as a basis to provide long-term catch limit advice for common minke whales in the Central North Atlantic.

The IWC SC met in Bled, Slovenia in 2017 where the review of the implementation simulation trials was completed. In the trials five management variants where tested:

(1) Sub-areas CIC, CM, CG, CIP, EN, EB, ESW+ESE and EW are Small Areas, with the catch limits for these Small Areas based on catch cascading from the C and E Combination Areas. The catch from the ESW+ESE Small Area is all taken in sub-area ESE. The catch limits set for the CM, CG and CIP Small Areas are not taken (except that the Aboriginal catch is taken from CG);
(2) Sub-areas CIC, CM, CG, CIP, EN and EB+ESW+ESE+EW are Small Areas, with the catch limits for these Small Areas based on catch cascading from the C and E Combination Areas. The catch from the EB+ ESW+ESE +EW Small Area is all taken in sub-area EW. The catch limits set for the CM, CG and CIP Small Areas are not taken (except that the Aboriginal catch is taken from CG);
(3) Sub-areas CIC, CM, CG, CIP, EN, ESW+ESE, and EB+EW are Small Areas, with the catch limits for these Small Areas based on catch cascading from the C and E Combination Areas. The catch from the EB+ EW Small Area is all taken in sub-area EW and the catch from the ESW+ESE Small Area is taken in the ESE sub-area. The catch limits set for the CM, CG and CIP Small Areas are not taken (except that the Aboriginal catch is taken from CG);
(4) As for variant 1, except that sub-areas CIC+CIP+CM are a single Small Area and all of the catches from this Small Area are taken in sub-area CIC. The catch limits set for the CG Small Area are not taken (except that the Aboriginal catch is taken); and
(5) Sub-areas CIP+CIC+CG+CM, EN, EB, ESW+ESE and EW are Small Areas, with the catch limits for the E Small Areas based on catch cascading from the E Combination Area. All the catches from CIP+CIC+CG+CM Small Area are taken in sub-area CIC (after taking the Aboriginal catch from CG) and those for the ESW+ESE Small Area are taken in sub-area ESE.

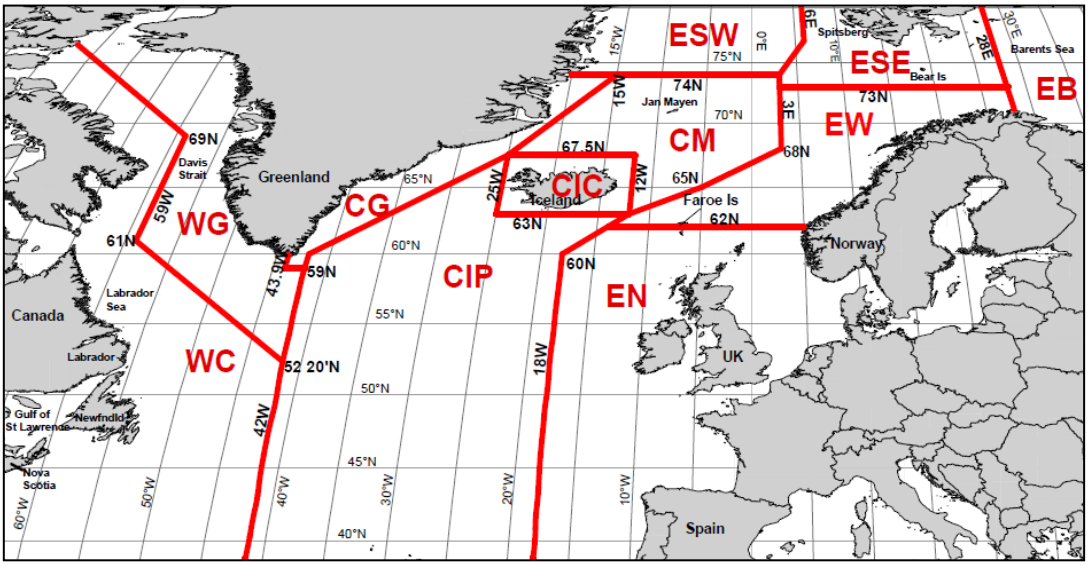

Fig. 1. *Map of the North Atlantic showing the sub-areas defined for the North Atlantic common minke whales*

Based on the results of the Implementation Simulation Trials, variants 1, 3, 4 and 5 are acceptable in terms of conservation performance. Of these variants, variant 5 achieves the best performance in terms of catch.

In January 2017, the LWAWG recommended catch levels in accordance to management variants 1 and 3, while terms of catch levels in the Central Atlantic area are more conservative than variant 5, they were deemed acceptable in the implementation simulation trial. This advice was based on the RMP CLA applied with 0.6 to

abundance and catches in the CIC area, resulting in 217 whales, using the most recent approved abundance estimate from 2015.

In the long term this advice an implementation simulation trial with a 0.6 tuning would formally be required, but in the short to medium term analysis at the 2017 LWAWG suggested that fixed annual catches of 360 common minke whales in the CIC area is safe and precautionary.

In addition the results with respect to acceptability of management variants from the simulation trials are not expected to substantially change with a change in tuning level to 0.6. The SC **recommends** that annual catches of common minke whales in the CIC area do not exceed 217 animals during 2018 – 2025. The SC stressed that this is conservative advice because it considers the CIC as a single stock area, and simulation tests include what is considered an unrealistically low MSYR for this species.

The SC considers **R-3.3.4**, with amendments, to be concluded.

For the next LWAWG meeting the SC may want to consider the following:

1. No management variant has been formally simulation tested that includes catches in the CM area. At the 2017 LWAWG meeting it was noted that Norwegian whalers had expressed interest in taking up to 50 common minke whales in the area in the coming years.
2. The CLA with a tuning level of 0.6 should be formally simulation tested. As noted above, this is not expected to produce substantially different results, but could be conducted in tandem with testing a management variant for the CM area.
3. Catch advice for the CIC area on could be based on the best performing management variant from the IWC simulation trials. This would mean that the combined total catch advice for the Central North Atlantic would be taken in the CIC area. This was not possible for the LWAWG meeting in 2017 as abundance estimates from the CM area were not available and there were still some uncertainty on the final result from the IWC simulation trials.

Norway

Interest in whaling in the Jan Mayen (CM) area may increase in coming years because of the higher abundance estimates in this area. Therefore, the SC **recommends** that the work suggested above (#1) be completed at a future meeting of the LWAWG.

There were many sightings of common minke whales in the recent survey conducted in the Barents Sea, which suggests a more easterly distribution of common minke whales. Unfortunately, permission for the survey to be extended into the southeastern Barents Sea was not granted by Russia.

Muscle samples are collected for genetics analysis from all whales in the hunt, and archived samples exist from 1998 to the present.

Greenland

Three common minke whales were satellite tagged this summer in West Greenland. A random selection of tissue samples from 200 individuals from the catches in 2013-2016 was sent to the University of Potsdam for genetic analysis. Iceland has also sent samples to University of Potdsam for the same analysis.

A new paper has been published on age estimation (Nielsen et al 2017).

9.4 Beluga

9.4.1 Review of active requests (R-3.4.9, 3.4.11, R-3.4.14)

R-3.4.9 (ongoing): provide advice on the effects of human disturbance, including noise and shipping activities, on the distribution, behaviour and conservation status of belugas, particularly in West Greenland; narwhal added at NAMMCO 23

R-3.4.11 (standing): update the assessment of both narwhal and beluga

R-3.4.14 (ongoing): The Council requests the SC to examine the data existing on beluga in East Greenland (sightings, strandings, by-catch and catch) and examine how this material can be used in an assessment process and advice on how this data can be improved.

9.4.2 NAMMCO-JCNB JWG March 2017

The Joint Meeting of the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic and the Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga Scientific Working Group was held in Copenhagen, Denmark, during 8-11 March 2017.

The JWG reviewed new and updated information on life history parameters for belugas. The JWG reviewed the summary table of life history parameters for belugas in Hobbs et al (2015). The JWG reviewed the priors used in past assessment models and discussed whether to use uniform priors or fit alternative distributions (e.g., beta, gamma) that represented our current understanding of the distributions for these priors. The JWG identified four priors that should be updated: 1) adult survival rate (p), 2) first year survival rate ($p0$), 3) birth rate (b), and 4) age at maturity (a_m) or first reproduction. The JWG changed the prior distributions on adult survival (p), the maximum birth rate (b), and the age of the first reproductive event (a_m). In earlier analyses, uniform distributions had been used for the prior distributions of p and a_m, these were changed to symmetric hump-formed beta distributions (a=b=2) that allocated more weight of the centre of the distributions, with the assumed minimum and maximum values of the two parameters being 0.95 and 0.995 for adult survival, and 6 and 14 years for a_m in beluga. The prior on the birth rate was then changed to a single value instead of a distribution in order to reduce the number of parameters to be estimated by the model. This value was set to 0.31 for beluga in West Greenland in accordance with the observed pregnancy rate Heide-Jørgensen and Teilmann (1994).

Stock structure

The JWG were informed of a large biogeographical study of belugas using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks. The JWG encouraged this work, especially to help 1) identify an individual animal to a stock, 2) delineate between stocks, and possibly 3) provide a basis to identify genetic changes in response to climate change, noting that for this type of analysis, gene expression would be used, but would require samples collected to preserve RNA which is logistically challenging for most field conditions.

Hunt removals

Canada

The JWG was presented with the catch statistics from select Nunavut communities for the past five years (2011-2015. The JWG discussed variation and uncertainty in the catch statistics and noted that the catches have not been corrected for struck and lost. The JWG **recommended** that these catches be corrected for struck and lost. There is uncertainty around whether the catches from Kugluktuk are from the Beaufort Sea or Somerset stock. The JWG decided not to include the catches from Kugluktuk in the modelling. The JWG also noted that catches from Kugluktuk were not included in the Beaufort Sea stock assessment. The JWG **recommended** that genetic analysis should be conducted on the catches from this area to clarify the stock identity of these catches. There is some interannual variability in the catches from Igloolik, and it is uncertain whether these catches are from the Somerset Island stock. Canada informed the JWG that explained that seasonality of the hunt explained some allocations and that samples for genetics have been collected and the lab work has been completed, but the results have not been analysed. The JWG **recommended** that the analysis of the existing genetic results be completed. The JWG **recommended** conducting a genetic comparison between Cumberland Sound belugas to the old West Greenland stock, using samples from the Danish Natural History Museum. If genetics indicate a linkage, the JWG further recommended a modelling exercise of these two stocks using historic population size and including catches from the old WG stock from pre-1930.

Greenland

The JWG was presented for catch statistics for 1954-2016. Catches declined during 1979-2016 to levels below 300 whales per year after 2004 (except for 2013 where a catch of 304 whales were reported). All catches are assumed to be taken from the Somerset Island summering stock of belugas and all the catches in West Greenland are presumably taken from the fraction of that stock that winters in West Greenland. The exception is the winter catches in Qaanaaq (approx. 5% of annual catches in Qaanaaq) that likely are taken from the

fraction that winter in the North Water. It is unknown which stock is supplying the summer hunt in Qaaanaq (approx. 15% of annual catches in Qaanaaq). A few confirmed catches (and sightings) of belugas have been recently been reported from East Greenland.

The JWG noted that the catches in Qaanaaq are variable. The JWG has previously recommended that summer catches in this area be prohibited due to the lack of knowledge on the stock identity of these catches. Small numbers of catches in the summer continue to occur. Genetic analysis of catches from Qaanaaq would be informative, however the JWG recognizes that sample collection is logistically challenging from all catches in West Greenland. The JWG **accepted** these catch numbers for use in the assessments. The JWG further noted that the recent catches are below the quota.

Recommendations

The JWG **recommended** genetic analysis for stock identity of the summer takes in Greenland. The JWG reiterated its past **recommendation** that more accurate, and recent, struck and lost data is needed. Struck and lost is likely different for hunting method, season, etc., and the JWG recognizes that it is difficult to collect data on loss rates. However, knowing struck and lost rates is more important in areas where the quotas are small, and these hunts could be prioritised for data collection.

Abundance

No new abundance data was available to the meeting. Canada presented a database of abundance and trends of Canadian Arctic beluga whale and narwhal stocks for long-term monitoring and sustainable harvest management. The database contained 34 records for beluga whale surveys conducted between 1965 and 2015, and 22 records for narwhal surveys conducted between 1975 and 2013. The database is complete to 2015. The database can be updated as future surveys are completed and analysed. This type of database is currently planned for in Greenland, and the JWG **agreed** that it would be helpful for Greenland and Canada to cooperate on creating a consistent database.

Stock assessments and management advice

Canada

The subsistence harvest of Pangnirtung, Nunavut, is directed towards a single stock of belugas in Cumberland Sound, which forms a separate stock among belugas in the Canadian Eastern Arctic. A population model incorporating harvest statistics (1920–2015) was fitted to four aerial survey estimates using Bayesian methods, resulting in a current estimated population of 1,000 (rounded to the nearest 100) animals. The management objective is to achieve a population of 5,000 animals by 2091. This could be expressed as an interim target of 1,235 animals within a decade (2026). At current reported harvest levels of 41 animals, the probability of the population declining over a 10-year period is 1. The probability that the population would increase to the interim target was 0.3, 0.25 and 0.1 for reported harvests of 0, 6, and 25 animals respectively. This paper provides an example of the type of modelling that Canada is conducting. This is for information for the JWG, in case this stock would be included in the future for management advice. The JWG **recommended** genetics analysis for stock identity. The JWG noted that the model was more conservative than the potential biological removal (PBR) calculations with a 0.5 recovery factor, and if the results presented in this paper correctly represented the population, the PBR was not sufficiently conservative to recover the stock.

West Greenland

An updated assessment for West Greenland beluga (a component of the Eastern High Arctic-Baffin Bay stock) with new catch data and the new priors as agreed by the JWG. The model estimated a decline from 21,180 individuals in 1970 to a minimum of 8,470 in 2004, and it projects an increase to an expected 11,610 individuals in 2023 (assuming post 2016 catches of 225). These results are similar to those of the last assessment, and the JWG **agreed** to re-iterate the previous advice, which remains valid until 2021.

Traditional Knowledge

The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

Habitat concerns were discussed under Environmental Concerns (see item 7.3 of this report).

Discussion

Reiteration of Past Advice

The SC **reiterates** the previous advice from 2005 and 2012 about seasonal closures. The following seasonal closures are **recommended**:

- Northern (Uummannaq, Upernavik and Qaanaaq): June through August
- Central (Disko Bay): June through October
- Southern (South of Kangaatsiaq): May through October.
- For the area south of 65°N, it is recommended that no harvesting of beluga be allowed at any time.

The function of these closures is to protect the few belugas that may remain from historical summer aggregations in Greenland, and to allow for the possibility of reestablishment of the aggregations. The SC noted that the quotas given by the Government of Greenland included catches in these areas.

Belugas do not appear to recover when a stock's numbers fall below about 2,000 individuals. The JWG plans to hold a future workshop on small populations.

9.4.3 Global Review of Monodontids

Prewitt gave a presentation of the results from the GROM meeting. The previous reviews of monodontids (IWC 1992, 1999 and NAMMCO 1999) are about 20 years old, and a large amount of new information has become available since that time, especially on stock identity, movements, abundance, and threats to the populations. Additionally, there are many new stressors that have emerged in the last 20 years, especially related to climate change. The Planning Group comprised of the following members: Barry (CAFF), Bjørge (Norway), Ferguson (Canada), Guldborg-Hansen (Greenland), Hobbs (USA), Marcoux (Canada), Prewitt (NAMMCO), Reeves (USMMC), Shpak (Russia), Suydam (USA). There were also 20 participants representing Greenland, Canada, Alaska, Russia, the Government of Nunavut, Nunavut Tunngavik, Inc., the Inuvialuit Settlement Area and the Nunavik Wildlife Management Board.

The GROM recognised 22 beluga stocks, and 12 narwhal stocks. In some cases, these are different than the stocks recognised in previous reviews (including the SAMBR), but these stock delineations are the most up-to-date according to the experts at the meeting. At the recent CBMP meeting in October, it was suggested that that group may consider using these stocks in future reviews/future SAMBR.

Participants provided "Stock Review" papers prior to the meeting which gave information on abundance, trend, any calculations on sustainability of removals, and habitat concerns. The GROM reviewed these Stock Reviews for each stock and used this information, along with decisions of quality of the data available (e.g. whether the abundance was based on a survey versus expert opinion) and assigned a status of concern -- high, moderate, or low -- relative to the other stocks in that species.

Belugas

Out of the 22 beluga stocks, 1 had been previously recognized as Extirpated, 4 were "high" concern (with 1 possibly extirpated), and 2 were "high/moderate" (the participants could not reach consensus). Overall, a similar theme for the "high" concern stocks were that they a) are very small, and b) historically were overharvested. The extirpated stock(s) were likely driven to extinction by overharvest, and overharvest in the past was a major concern for Cook Inlet and St Lawrence, and may still be an issue for Cumberland Sound. Overall, however, hunting has become more regulated in the last 30 years, and the main concern for these small stocks are now mostly the cumulative impacts of multiple stressors.

Very small stocks of other cetacean species do not appear to recover easily, and are at a high risk of extinction. Close monitoring of these stocks is necessary to avoid extirpation of another stock.

Nine of the 22 beluga stocks were classified as "moderate" concern. The common theme for the moderate concern stocks was the lack of information, especially abundance, but also on stock structure and movements. Another common theme for these moderate concern stocks is that they do not have significant levels of harvest – the lack of data would likely have been of greater concern if there was more hunting pressure on these stocks. Additionally, 7 out of these 9 stocks are in Russia, highlighting a geographical region that is a large data gap.

6 of the 22 beluga stocks were given "low" concern levels, which are mostly all fairly large stocks (10-50,000) with reliable data, reliable assessments of the sustainability of removals, and less habitat concerns. The GROM noted that while the Bristol Bay stock is fairly small (about 2,000 belugas), it is a well-studied stock, and the hunting is well-regulated, hence the low level of concern for this stock.

Overall, the pattern that appeared was that there is a cluster of southern stocks with high levels of concern (with the WHB stock being a notable exception). The overall north-south trend in concern may be largely explained by the higher levels and broader range of human activities, and the potentiating effects of climate change.

More information on the narwhals stocks and a discussion of environmental issues for both species is given under item 9.5.3

9.4.4 Update

Canada

Aerial surveys were flown to estimate Cumberland Sound beluga abundance in 2017. The main area of concentration (Clearwater Fiord) was surveyed five times, while the remaining strata in the sound were surveyed twice.

9.4.5 Future work

Norway - Svalbard

A survey planned for 2017 was delayed until 2018 due to ice conditions preventing the survey in 2017.

9.5 Narwhal

9.5.1 Review of active requests (R-3.4.9, 3.4.11)

R-3.4.9 (ongoing): provide advice on the effects of human disturbance, including noise and shipping activities, on the distribution, behaviour and conservation status of belugas, particularly in West Greenland; narwhal added at NAMMCO 23

R-3.4.11 (standing): update the assessment of both narwhal and beluga

9.5.2 NAMMCO-JCNB JWG March 2017

The Joint Meeting of the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic and the Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga Scientific Working Group was held in Copenhagen, Denmark, during 8-11 March 2017.

The JWG reviewed available life history parameters for narwhal. These discussions reviewed recent advances in age estimation and results from samples collected from hunted animals that were informed by these age estimates. The JWG **agreed** to use the life history information to inform the priors and the age structure for the model input. The JWG reviewed the priors used in past assessment models and discussed whether to use uniform priors or fit alternative distributions (e.g., beta, gamma) that represented our current understanding of the distributions for these priors. The JWG identified four priors that should be updated: 1) adult survival rate (p), 2) first year survival rate ($p0$), 3) birth rate (b), and 4) age at maturity (a_m) or first reproduction.

The JWG changed the prior distributions on adult survival (p), the maximum birth rate (b), and the age of the first reproductive event (a_m). In earlier analyses, uniform distributions had been used for the prior distributions of p and a_m, these were changed to symmetric hump-formed beta distributions (a=b=2) that allocated more weight of the centre of the distributions, with the assumed minimum and maximum values of the two parameters being 0.95 and 0.995 for adult survival for narwhal, and 7 and 15 years for a_m in narwhal. The prior on the birth rate was then changed to a single value instead of a distribution in order to reduce the number of parameters to be estimated by the model. This value was set to 0.33 for all narwhal populations to reflect a three-year calving interval.

Stock Structure

The JWG reviewed papers on narwhal biology, including studies on updated life history parameters of narwhals from Greenland and Canada, effect of ice entrapments on the Eclipse Sound narwhal stock, assessment of the winter range of Baffin Bay narwhals, long-term tag retention on narwhals, identification of seasonal foraging areas by examining the spatial distribution of dive data from Canadian populations and the comparison of migration patterns, diving behaviour, site fidelity, travel speed, size of wintering grounds of satellite tracked narwhals from East and West Greenland. Information in these papers were not used to update the assessment and advice at this meeting, but they contribute to the overall knowledge of narwhal biology.

The JWG were informed of a large biogeographical study using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks. A SNP-array (single nucleotide polymorphism) could be developed for the Baffin Bay region as a tool for the joint management of narwhals.

The JWG were informed on the science review of the environmental impact statement addendum for the Baffinland Mary River project.

Catch Statistics and Struck and Lost

Information on catch statistics and struck and lost was presented from both Greenland and Canada.

Greenland presented a time series that provides realistic catch levels from West Greenland during 1862-2016, which was constructed with catches split into hunting grounds and corrected for under-reporting detected from purchases of mattak (low option), for periods without catch records (medium option) and from rates of killed-but-lost whales (high option). Struck and lost rates have been estimated using factors such as community, season, hunting method, direct observations and these estimates are included in the catch history that is used in the assessment model.

Canada presented a reconstructed catch history from 1970-2015 which was constructed with catches from each hunting community that hunt narwhals from the Baffin Bay population. Hunt statistics by community were divided into catch seasons with the average from the following 10-year catch statistics for years with missing catch report. Catches were divided into 6 different hunting regions where different struck and loss corrections by period, type of hunt and community where then assigned.

The JWG noted that ideally there would be monitoring programmes occasionally for struck and lost that could be used to update the values but recognised that there are no plans for this in the near future.

Surveys and Abundance

New abundance estimates based on aerial surveys were presented from the High Arctic Cetacean Survey of narwhals in Baffin Bay, Jones Sound and Smith Sound that was conducted in Canada in August 2013 (Doniol-Valcroze 2015a,b). Density in off shore strata and fjord strata were analyzed independently and the JWG recommended reanalysing the data so high density coastal fjord areas would not be incorporated into, and hence inflate, the large off shore strata. Comparison of photographic data and visual data will be presented at the next JWG meeting. Abundance estimates were corrected for availability bias by using information on the diving behaviour of animals satellite tagged in the area. Fully corrected abundance estimates were 12,664 (cv=0.33) for the Jones Sound stock, 16,360 (cv=0.65) for the Smith Sound stock, 49,768 (cv=0.20) for the Somerset Island stock, 35,043 (cv=0.42) for the Admiralty Inlet stock, 10,489 (cv=0.24) for the Eclipse Sound stock and 17,555 (cv=0.35) for the East Baffin stock. The JWG agreed to provisionally accept the abundance estimates but provided recommendations to investigate the current use of correction factors (satellite tagging and dive cycle) to improve the analysis.

New abundance estimates for narwhals in East Greenland based on aerial surveys were presented and these fully corrected estimates of 288 (cv=0.44) in the Tasiilaq management area and 476 (cv=0.38) for the Scoresby Sound area were accepted by the JWG for use in the assessment. Adding an off shore narwhal component from a survey in 2015 increased the estimate for Tasiilaq management area to 797 (0.69). The JWG noted that no narwhals were seen in south of the Kangerlussuaq fjord.

Re-analysis of survey data from a previous survey in 2008 decreased the abundance estimates from 2008 (1098 (cv=0.63) for the Tasiilaq management area and 1176 (cv=0.29) for the Scoresby Sound area. The JWG accepted these changes for use in the assessment.

The JWG **recommended** that previous surveys from 1983 and 1984 should be re-analysed and discussed at the next JWG meeting. The JWG recommended to conduct an aerial survey in Scoresby Sound in 2017.

The JWG reviewed new studies on the effects of tagging on narwhals (Heide-Jørgensen et al). The JWG noted that recaptured individuals equipped with satellite transmitters showed a low degree of inflammation and that it decreased with increasing thickness of epidermis around the attachment pins. The JWG noted that this information is relevant due to the expressed concerns of satellite tagging from Inuit in Nunavut. The JWG discussed that information provided by satellite tags remains critical in the use of correction factors for aerial surveys and that information from these tags contribute to the knowledge of stock structure, distribution and movement of narwhals.

The JWG reviewed the results of a satellite tagging project in the southern hunting region in Kangerlussuaq Fjord, East Greenland where a single whale was equipped with a satellite tag. The whale moved north and entered the Scoresby Sound hunting region. The movement of the whale demonstrated the connectivity between two areas in East Greenland that are considered two separate management units. The JWG recommended that satellite tagging in Kangerlussuaq Fjord should be continued.

The JWG agreed to recognize the hunting areas in East Greenland, Tasiilaq, Kangerlussuaq and Ittoqqortormiit, as three separate management areas. Maintaining these areas as three stocks is a more precautionary approach and hence is more likely to avoid local depletion.

East Greenland narwhals

Assessment

The JWG updated the assessment of East Greenland narwhal, given the new abundance estimates from 2016, the updated estimates from 2008, the updated age structure, and the new prior distributions that were agreed by the JWG. For both the Ittoqqortormiit and Kangerlussuaq fjords, the assessment estimates an annual production of 1% (90% CI: 0-3%). The decline in abundance that is suggested by the surveys in 2008 and 2016 is supported by the assessment even when the trend information of the abundance data was removed from the assessment. This suggests that the decline is real, and that the current catch levels are unsustainable.

The model estimates a continuous decline in the summer aggregation of Ittoqqortormiit from 1,420 (90% CI:920-2,120) individuals in 1980 to 580 (90% CI:330-980) individuals in 2017, and a somewhat smaller decline in Kangerlussuaq from 1,890 (90% CI:1,260-3,000) individuals in 1980 to 1,140 (90% CI:500-2,560) in 2017. Yet, the latter model is over estimating the abundance to some degree because the uncertainty of the abundance estimates is forcing the lower percentiles of the model against the boundary of extinction. In conclusion, the assessment estimates that total removals of no more than two to five individuals for Ittoqqortormiit, and of more than 10 to 13 individuals for Kangerlussuaq, are required to ensure a 70% chance of increase over the next five-year period.

Based on these assessment, the SC agreed that catches should be reduced to less than 10 narwhals in both Ittoqqortormiit and Kangerlussuaq. In addition, the advice for the southern hunting areas applies only to Kangerlussuaq fjord. The JWG recommended that no catches are taken south of 68°N.

This advice should be updated with new abundance estimates from surveys in 2017. The information that we have on abundance indicates that the harvest may be causing a population decline. This decline was confirmed by the model estimates, independent of the aerial survey results, lending more evidence of a real decline.

Baffin Bay narwhal stocks

The JWG discussed the request from Canada to incorporate PBR into the catch allocation model and that the TJW intends publication of a peer-reviewed paper describing the catch allocation and assessment model which may help address concerns with implementing the model in Canada. The JWG recommends continuing using the catch allocation model for our advice.

Abundance

Canada presented a database of abundance and trends of Canadian Arctic beluga whale and narwhal stocks for long-term monitoring and sustainable harvest management. The database contained 34 records for beluga

whale surveys conducted between 1965 and 2015, and 22 records for narwhal surveys conducted between 1975 and 2013. The database is complete to 2015. The database can be updated as future surveys are completed and analysed. This type of database is currently planned for in Greenland, and the JWG **agreed** that it would be helpful for Greenland and Canada to cooperate on creating a consistent database.

Habitat concerns
The JWG was informed on planned studies of the short-term effects of seismic exploration on narwhals. The recent interest for oil exploration in both East and West Greenland has stressed the importance of conducting studies that assess the environmental impacts of disturbance to marine life in Greenland. Of special concern are the effects of seismic exploration, specifically the effects of the sounds produced by airguns used during seismic surveys. Airgun pulses have high sound amplitudes, which may injure mammalian ears at close ranges and are audible over great distances resulting in disturbance effects far away (e.g., tens of km) from the sound source. Narwhals are considered particularly susceptible to disturbance and are one of the least studied cetaceans when it comes to effects of anthropogenic activities. This study will assess the short-term effects of sound from airgun pulses on narwhals in a closed fjord system in East Greenland to provide an empirical basis for regulation of activities linked to seismic exploration in areas with narwhals.

Based on the few studies we anticipate that narwhals will react vigorously to anthropogenic disturbance. Narwhals dive to depths exceeding 1000 m and airgun sounds may affect their diving behaviour. A sound-mediated disturbance may cause a change in migration path or displacement from a feeding area and could increase the risk of ice entrapment**.** The JWG expressed concern over seismic activities in narwhal habitat. More information on the JWG's concerns regarding habitat of both narwhal and beluga is in Item 13.

Traditional Knowledge
The Aboriginal Traditional Knowledge Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is planning an aboriginal traditional knowledge gathering project for narwhal. Updates on the progress of this project and results will be provided upon availability.

The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

The Canadian HACs used input from local Inuit on locations that should be included in the survey.

Discussion
The SC noted the JWG's statements that ideally there would be monitoring programmes occasionally for struck and lost that could be used to update the values but recognised that there are no plans for this in the near future.

The SC **endorsed** the recommendations of the JWG. The SC recognises that these recommendations include a considerable reduction in catch advice for the communities in east Greenland, however, declines in abundance necessitate these reductions.

9.5.3 Global Review of Monodontids
See item 9.4.3 of this report for an introduction to this meeting.

Narwhal
Two out of the 12 narwhal stocks were given "high" concern: Melville Bay and East Greenland. These are small stocks, with likely overharvest issues, and habitat concerns related to climate change and disturbance from human activities. These stocks should be monitored closely.

Four out of the 12 stocks were "moderate" concern. As with belugas, the concerns were mainly related to the lack of data, but similar again to the belugas, most of these had low numbers of removals, and the level of concern may have been higher if the removals were more substantial. An exception is the Eclipse Sound stock, which does have a higher level of removals – however these are considered sustainable, but this stock has some major concerns over a large mining project in the area (see Item 7.3.1).

Six of the 12 narwhal stocks were of "low" concern. These are mostly large stocks, and the ones that have substantial removals are relatively well studied and regulated (e.g. Somerset Island and Admiralty Inlet).

Overall, narwhal have a more restricted range, as they are only present in the Atlantic sector of hte Arctic, but they are almost as numerous as belugas. The summering grounds tend to be more remote than those of belugas, making them somewhat less susceptible to disturbance currently, but this is likely to change in the future. The primary concerns for narwhals were overharvesting in a few stocks, loss of sea ice (as narwhals are more directly ice-associated than belugas), and increasing human activities/disturbance.

Environmental issues – Belugas and narwhals

The meeting discussed many environmental issues and habitat concerns for belugas and narwhals, and identified the major threats to each stock. With the many effects of climate change, it is critical to continue to monitor, and if at all possible, increase the monitoring of all stocks of both species.

The group also identified the major gaps in data. As mentioned, Russian stocks in general are lacking in all types of data. Abundance was identified as an area with some major data gaps. There were 3 beluga stocks and 2 narwhal stocks where nothing is known about abundance, and many other stocks where the data is more than 5 and 10 years old.

Genetics have been more useful for stock identity in belugas than in narwhals, but there are still some beluga stocks where further genetics information would be helpful. In addition, the meeting heard about some new, possibly promising techniques that are being used now on beluga and narwhal samples, and encouraged the continuation of that work. The results of these studies may have important implications for stock identity, harvest management, etc.

There are also many areas where there is little or no information on movements, distribution, habitat use, etc. These areas were highlighted where future satellite tagging could be prioritised.

Another gap in our knowledge is how monodontids react to disturbance, such as seismic activities, icebreaking, and ship traffic. There are a few old studies (1990) and anecdotal evidence indicating that they are very sensitive to sound (especially narwhals), but more directed studies and concrete information is needed to advise on how human activities will impact these populations.

Health assessments are also lacking and may become more and more important as new species and possible pathogens make their way into the Arctic. Additionally, it would be valuable to continue, and increase, our use of traditional knowledge in monitoring these species. The people who live in the same area, and rely on these species for food and cultural activities have valuable information that should be used as much as possible.

Discussion

The SC noted that, in addition to the report from the meeting, there are plans to publish a peer-reviewed paper on the status of all stocks of belugas and narwhals.

The GROM participants agreed that the presentations and discussions on ongoing research from various stocks were of great value and provided basis for a comprehensive and thorough review. The output from this review will be of valuable input to the SC and JCNB as a reference document in that it compiles updated information on worldwide stocks written by scientists monitoring and/or working with these stocks.

Desportes forwarded the regrets and complaints that the Secretariat had received by NAMMCO and non-NAMMCO participants that Norway did not participate in the review and that the Svalbard stocks were not represented. The SC noted the information.

9.5.4 Update

Greenland

An aerial survey was conducted this summer in Scoresby Sound. The full results are not yet available, but the preliminary data indicates the same pattern of distribution and sightings as seen in 2016.

A survey of the Northeast Water (NEW) polynya was conducted in April for the polynya area (between 79-82°N), and another survey in August/September covered both coastal and offshore areas (70-82°N). There were only 2 observations of single narwhals during the April survey but large numbers of narwhals were seen in the fjords of northeast Greenland in the August survey. These results are preliminary and will be presented at the next SC meeting.

A large study was conducted in Scoresby Sound, east Greenland this summer. The study included deploying satellite tags and acoustic recorders on narwhals at the same time as a research vessel conducting seismic tests was in the area. Preliminary results clearly indicate that narwhals react to boat traffic and seismic activities. The full results will be presented next year.

Norway - Svalbard
An aerial survey of the marginal ice zone north of Svalbard from the Russian border westward estimated over 800 narwhals occupying this area (Vacquié-Garcia et al 2017). The SC noted that this area not recognised as narwhal habitat by the GROM. Many narwhals were observed 200 km deep into marginal ice zone, over deep Arctic Ocean, and there are possibly many narwhals in this area. The narwhals are not likely to be foraging benthically in this area, and are perhaps foraging in the deep scattering layer on mesopelagic fauna. Additionally, passive acoustic monitors located at 79°N detect narwhals year round. This information suggests that narwhal may be present in a continuum from east Greenland to Franz Josef Land.

Canada
A meeting is planned for spring 2018 to discuss stock identity issues around the Eclipse Sound and Admiralty Inlet stocks. Satellite tracking has indicated more movement between these areas than was previously believed.

9.5.5 Future work
The next JWG meeting is planned for March 2019.

9.6 Sei whale
9.6.1 Review of active requests (R-3.5.3 amended, 1.7.12)

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

R-3.5.3 amended (ongoing): assess the status of sei whales in West Greenland waters and the Central North Atlantic and provide minimum estimates of sustainable yield

9.6.2 Update

No new information was presented to the SC.

9.6.3 Future work

The data from 2007 and 2015 surveys will be explored to assess whether a minimum abundance estimate can be calculated. More information will be discussed at the AEWG meeting in spring 2018.

9.7 Bottlenose whale
9.7.1 Update
Mikkelsen informed the SC about a new abundance estimate of bottlenose whales from the Faroese component of the 2007 T-NASS survey that was analysed together with data on deep diving species from the SCANS-II and CODA surveys. The design-based estimate was 19,539 (95% C.I. 9921-38,482; CV 0.36) animals. Sightings were mainly from the Faroese survey block.

There was a presentation by Patrick Miller (SMRU) at the recent SMM conference on satellite tagging of bottlenose whales in the Jan Mayen area, and there is also work being conducted by Peter Kvadsheim (Norwegian Defense Research Establishment) and Lise D. Sivle (IMR). These studies will be discussed by the SC when the papers have been published.

9.8 Killer whale

9.8.1 Review of active requests (R-3.7.2)

R-3.7.2 (ongoing): 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.

9.8.2 Update

Norway

Haug reported on a new paper on killer whales in Norway (Jourdain et al. 2017). Killer whales have been documented preying on either fish or marine mammals in several regions, suggesting that this odontocete species has the ability to specialize on different types of prey. Off Norway, killer whales have been shown to rely on the Atlantic herring as a main prey resource. Infrequent observations have revealed seals as an additional component of their diet, yet the extent of predation on marine mammals has remained largely unknown. Jourdain et al. (2017) present the findings of 29 years of photographic and observational data on seal-feeding killer whale groups identified in Norwegian coastal waters. Four groups have been observed preying and feeding on seals over several years, taking both harbour and grey seals. These stable groups are shown to adopt small group sizes, and were typically observed in near-shore areas and were not encountered on herring wintering grounds. Behavioural and social traits adopted by these groups are similar to those of pinniped-feeding killer whales from other regions.

Results from ongoing tagging studies will be presented when available.

Greenland

Catches

The SC noted that Lennert et al. (2017) contains the reported catches of killer whales from the Government of Greenland, however these numbers have not been fully validated, and preliminary investigations show that up to 50% of these reports are incorrect.

However, it seems clear that catches of killer whales in east Greenland have increased since 2010. Prior to 2010, there were only sporadic catches. Additionally, it appears that groups are taken together, not just single animals, and a large struck and lost rate is likely.

In recent years, there has been a shift in east Greenland from hunting mainly narwhals and common minke whales to hunting more killer whales, pilot whales, and white-beaked dolphins. GINR has applied for funding to conduct an interview study of hunters in Tasiilaq that is primarily focussed on the hunter's recent experiences with distribution of narwhals, but these results will be relevant to understanding the killer whale hunt as well.

Abundance

During the 2015 surveys, no killer whales were seen off West Greenland, and there were only 2 sightings in East Greenland.

Contaminants

The SC noted that results presented in Pedro et al (2017) indicate levels above what has been shown to cause reproductive impairment in other animals. Although we do not know if the results of studies on other animals are relevant to killer whales *per se*, this information does not exist for killer whales, and European studies have been published correlating high levels of contaminants with failure of reproduction (Jepson et al 2016).

Stock Identity and Foraging Ecology

Foote et al (2013) presents information on genetics analysis that indicate that killer whales off Greenland are related to Icelandic and Norwegian killer whales. Stomach samples collected from killer whales caught off east Greenland contained marine mammals.

Discussion

The SC **reiterated** its previous concerns regarding the hunt in east Greenland which is unregulated, and from a species with no abundance estimate from this area and unknown stock identity. There is little information available to be able to provide advice on a sustainable removal level.

A draft executive order exists for small cetaceans that includes more reporting requirements, but this has been in draft form for some time, and there are currently no restrictions on catches of killer whales.

The SC discussed that it may be difficult to fully validate the catch statistics, however it may be possible to re-create the previous catch histories based on independent observations, for example by contacting scientists that were in Tasiilaq, etc. when these catches occurred.

The last review of killer whales in the North Atlantic was in 1987. The SC recommends that NAMMCO contract a scientist to prepare a working document for the next SC meeting which reviews all available information and current research activities on abundance, stock structure, and movements of killer whales in the North Atlantic. Vikingsson and Ugarte should coordinate with the contracted scientist, and the SC encouraged the participation of Canadian scientists to contribute information.

Iceland
Ongoing studies of killer whales in Icelandic waters (Samarra et al 2017a,b) indicate that these whales are associated with the herring. There is some movement between Iceland and Scotland. Stable isotope analysis suggests that some killer whales observed on the herring grounds are herring specialists, but there are also some killer whales that may have mixed diet (both fish and mammals). Additionally, based on photo-ID studies, a few of the same individuals that have been seen preying on marine mammals have also been seen feeding on herring. A killer whale photo-ID catalogue has been published on the MFRI website.

9.8.3 Future work
As described above, the SC **recommended** contracting a scientist to prepare a review paper on the available data/knowledge on killer whales in the North Atlantic.

9.9 Pilot whale
9.9.1 Review of active requests (R-1.7.11, 3.8.6)

R-1.7.11 (ongoing): develop estimates of abundance and trends as soon as possible

R-3.8.6 (ongoing): complete a full assessment of pilot whales in the North Atlantic and provide advice on the sustainability of catches...with particular emphasis on the Faroese area and East and West Greenland. In the short term...provide a general indication of the level of abundance of pilot whales required to sustain an annual catch equivalent to the annual average of the Faroese catch in the years since 1997

The SC noted that the second part of R-3.8.6 has been completed.

9.9.2 Update
Faroe Islands
Mikkelsen informed that a new abundance estimate of pilot whales from the NASS 2015 survey has been completed, and that has been integrated in a trend analysis of pilot whales in North Atlantic, including all sightings surveys since 1987 and partly also the CODA/SCANS surveys. The new estimate is on level with the largest estimate from previous surveys, and no trend was detectable in the estimated abundance of the pilot whale stock over the 28-year period. A manuscript has been submitted for the NAMMCO scientific publication series.

Mikkelsen also informed that collection of biological material from the drive fishery is ongoing. In addition, the Museum continues the tagging effort in order to monitor movements and distributions of pilot whales visiting Faroes. No group was available for tagging in 2017.

Furthermore, Katrin Hoydal, at the Environment Agency, defended her dissertation: “Levels and endocrine disruptive effects of legacy POPs and their metabolites in long-finned pilot whales of the Faroe Islands” in

autumn 2017. This work has been partly in cooperation with the Norwegian University of Science and Technology (NTNU), where she defended her PhD.

Discussion

The SC was pleased to hear that the abundance estimate is ready to be reviewed by the AEWG, and has been submitted for publication. The previous abundance estimate is very old, and an updated estimate is needed.

Samples are being collected to investigate age, diet and life history parameters, and analysis is ongoing. The results will be presented at the planned PWWG. Satellite tagging of another 3 pods, with 4-8 tags deployed each time, is planned, but has not been possible yet. The local sheriff in each of 6 whaling districts oversees the drives and makes the decision on whether a pod should be taken by the hunters or made available for tagging. The SC recommended that the satellite tagging be given a higher priority. The SC further suggested that the Ministry could set up a rotation system so any individual community is not affected by "losing" their whales multiple times.

Greenland

Increasing catches of pilot whales have been reported since 2009 in southeast Greenland, probably due to a reduction of summer sea ice making the animals more accessible to hunters.

Norway

As is usual, there are sporadic sightings along Norwegian coast, especially during summer. These may be becoming more regular.

9.9.3 Future work

9.9.3.1 Pilot Whale WG (2019)

The SC **recommended** that a Pilot Whale working group meeting be held in 2019. The TORs for this meeting would be:

- *full assessment of pilot whales in the North Atlantic*
- *provide advice on the sustainability of catches...with particular emphasis on the Faroese area and East and West Greenland.*

9.10 Dolphins

9.10.1 Review of active requests (R-3.9.6)

R-3.9.6 (ongoing): assessments of dolphin species

9.10.2 Update

Faroe Islands

Mikkelsen informed that during the period 2000-2006, when white-sided dolphins were taken more regularly in Faroe Islands, biological samples were collected, and that the preliminary results on age, diet and life history have been presented to the SC. The results have not yet been published.

After 2006 only a few catches of white-sided dolphins have been taken, but in 2017 catches have been higher again. Not much is known about the abundance of white-sided dolphins in North Atlantic, and therefore there is some concern over taking species where little information is known. The plan is to generate an abundance estimate from the NASS2015 survey.

Norway

During the Barents Sea survey there were many sightings of white-beaked dolphins. White-beaked dolphins are also common around Spitsbergen, as there were many sightings during a survey in August 2017.

Iceland

Analysis for an abundance estimate is in progress, and the data may be combined with a larger area. Additionally, some photo-ID and acoustics research is underway.

Greenland

Increasing catches of white-beaked dolphins have been reported since 2009 in southeast Greenland, probably due to a reduction of summer sea ice making the animals more accessible to hunters. GINR has collected stomach contents samples to investigate feeding ecology.

9.10.3 Future work

Abundance estimates may be presented at the planned AEWG.

9.11 Harbour porpoise

9.11.1 Review of active requests (R-3.10.1)

R-3.10.1 (ongoing): comprehensive assessment of the species throughout its range

9.11.2 Updates

Norway

During 2016 and 2017, 133 by-caught harbour porpoises were collected by IMR for biological sampling. The overall goal of the study is to investigate the role of HP in the coastal ecosystem. The samples so far have been analysed for stomach contents, stable isotopes, fatty acids, and life-history parameters (including age at maturity and reproductive rates). Additional analyses will include genetics to investigate stock identity, pollutants, and health assessments. Finally, a food-web model is being developed for the Vestfjord area close to Lofoten to study the role of HP in this area.

An abundance estimate is now available from the SCANS-III survey which was extended from 62 to include Vestfjorden, an area of large by-catches. The estimate was 25,000 between Stadt and Vestfjorden. Preliminary investigations using this new abundance estimate suggest that by-catches are within PBR.

The sightings of harbour porpoises in the southern parts of the survey area were more offshore than in the previous survey conducted in 2013.

In addition to the SCANS-III survey, experimental surveys were conducted in the fjords in northern Norway. In Verangerfjord there were many sightings of harbour porpoises, whereas in Porsangerfjord there were lower densities, suggesting that harbour porpoise numbers are quite variable between fjords.

The aerial survey north of Stadt did not cover some of the largest fjords, however when some large fjords, such as Trondheimsfjord was covered, there were not many harbour porpoises. This suggests that large fjords may not be as important to harbour porpoises as the general coastal regions.

Iceland

Samples are being collected from by-caught animals by fishermen. 150 samples were collected in 2017, and 20 in 2016. This is an ongoing study for a genetics mark-recapture analysis.

Faroe Islands

It is legal to harvest harbour porpoises, but the numbers appear to be very low. Catch reporting is required to the sheriff, and the sheriff should thereafter report to the Ministry. The SC recommended that if harbour porpoises are taken, scientific samples should be collected.

Greenland

Previous satellite tagging has been presented to the SC. Results from an ongoing genetics study looking into stock structure may be available next year. The SC encouraged these results to be included in larger analysis, and Greenland reported that they can collect more samples each year.

A PhD study on distribution and dive patterns, primarily based on the tagging, is expected in 2018.

General

As stock structure is an important question in the North Atlantic, the SC encouraged a combined analysis genetics, and encouraged NAMMCO countries to provide samples.

9.11.3 By-Catch WG

See item 7.1.3.

9.11.4 HPWG

The SC recommended that the HPWG be postponed until 2019 in order to ensure that the results from ongoing analyses are completed in time to be presented to the WG.

9.11.5 Future work

The SC noted that it is important to improve the catch history from Greenland for the assessment. There has been a previously reported mismatch between reported and interviews with hunters.

9.12 Sperm whale

9.12.1 Update

Norway

There were no sightings in the survey in the Barents Sea.

Faroe Islands/Iceland

There were multiple sightings during NASS2015, and it will be investigated whether it is possible to calculate an abundance estimate, in cooperation with Iceland. Sperm whales are a large component of the ecosystem in terms of biomass, SC recommends that an abundance estimate is calculated.

9.13 Bowhead whale

9.13.1 Review of active requests (R-1.7.12)

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

The SC recommended that R-1.7.12 be removed for bowhead whales because this does not apply to this species.

9.13.2 Updates

Norway

Lydersen presented results from collaborative fieldwork with GINR and Russian colleagues on bowhead whales in the Fram Strait May-June 2017. 16 satellite tags were deployed and 10 biopsies for genetic analyses were collected using a helicopter as the launching platform for both tagging and biopsying. Tracking results so far show that the animals have spread out in the whole distributional area for this stock from south along the east coast of Greenland and into Franz Josef Land, Russia.

There were many open water sightings in the Barents Sea around 79°N 56°E including several groups of bowhead whales.

Greenland

During the winter and August survey of the NEW polynya there were many sightings of bowhead whales. No estimate is available yet, but these may be presented next year. Tagging efforts in Disko Bay are ongoing.

Canada

108 skin biopsy samples and photographs using drones were collected from bowhead whales in Cumberland Sound as part of developing genetic mark-recapture and photo-id catalogues to study abundance and life history characteristics.

9.14 Blue Whales

9.14.1 Update

Norway

Four blue whales were biopsied off Svalbard in 2017 in an ongoing study.

Although no blue whales were seen off the shelf break where they would be expected, during the August survey many were seen north of Svalbard. There have been 4 summer surveys, and Norway is preparing an analysis of the presence of blue whales in relation to relevant prey species in the upper 100-150 m.

Iceland
There is an ongoing photo-ID study and NAMMCO countries are encouraged to submit photos.

Canada
Hammill noted that whales that were previously seen in Canada have not been seen recently, and they are not seeing calves. It would be good to have more cooperation from photo-ID studies in other areas to see if those whales have been seen in other areas.

Greenland
Last year was first year with consistent sightings of blue whales in Disko Bay all summer.

Other
The SC encouraged more cooperation on photo-id studies. A website "Happy whale (https://happywhale.com/home)" posts photos that are available for anyone to use.

Recent satellite tagging in the Azores suggest possible connections between West Africa and northwards. Whales tagged off the Azores have been tracked almost up to Iceland, and whales tagged off Svalbard have been tracked south to Iceland. Also a blue whale matched via photo-ID in Iceland migrated to Mauritania.

10. SURVEYS

R-1.7.11 (ongoing): develop estimates of abundance and trends as soon as possible

R-1.7.12 (ongoing): Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters

Discussion
Abundance estimates and analyses emanating from the 2015/16 NASS surveys have not all been completed and there are still some remaining from the 2007 TNASS survey.

The SC recommend using the funds remaining on the NASS budget for completing all the 2007 and 2015/16 analyses as well as conducting a joint analysis of the abundance of common minke whales in Central North Atlantic (NCA). These should be presented to the next Abundance estimate WG and generate publications to be included in the next NASS volume.

10.1 Abundance Estimates WG (2018)
The Abundance estimate WG planned for Spring 2018 would therefore be postponed for accommodate the time necessary to the proposed new analysis.

Besides reviewing as planned the Norwegian common minke last cycle estimate and the pilot whale 2015 estimate and trends, the WG would therefore also review the

- Icelandic/Faroes shipboard dolphin estimates 2007 and 2015
- Norwegian last two survey cycles all non-common minke species, including large baleen whale, sperm whale, killer whales and dolphins.
- An overall (FR, GL, IS NO) Central North Atlantic common minke whale estimate
- Icelandic/Faroes shipboard sperm whales 2007 and 2015

This would mean that all feasible design-based abundance estimates which could be generated by the data collected through the TNASS 2007 and NASS 2015/16 surveys would all be analysed. This would represent a considerable progress from the present situation, where peer-reviewed publications from the 2007 survey are still missing 10 years after the survey. The Scientific Committee commended and supported this step forward and encourage all to make it possible in the time frame proposed.

10.2 Plans for future surveys

The IWC RMP now required repetition of abundance surveys at 8 years interval. The next NASS survey should therefore be in 2022-2023.

One recommendation emanating from the SCANS survey series for European surveys is an inter-survey interval down from 10 to 6 years. Canada and USA also conduct surveys regularly with variable intervals.

The SC strongly recommends that attempt be made to conduct again a trans-Atlantic coordinated survey and charge the Secretariat to explore what are the present plans and how much flexibility they encompass.

11. NAMMCO SCIENTIFIC PUBLICATIONS

The SC agreed to discuss opening the journal for individual papers accepted outside of themed volumes at its next meeting (SC/25).

11.1 Volume 10: Monodontid age estimation

Volume 10 is still ongoing. Ten papers and 2 workshop reports have been published online, but two remain in progress although one should be out soon. The main author of the last paper is not very active, but the editors have decided to give her a firm deadline for the end of the year otherwise they will take other actions. The volume should therefore be finalised by the end of 2017 or beginning of 2018.

11.2 Volume 11: NASS

Daniel Pike, Rikke Hansen and Geneviève Desportes are editors of the volume. Eighteen papers have been committed, covering both the 2007 and 2015/6 surveys, as well as trend of abundance for a longer period.

Two only, however, have been received by the editors, one is back to the authors for revision after review and the other one is under review.

The papers (4 or 5) resulting from the analysis supported by the NASS budget, see above, should also be included in the volume.

This would mean that all feasible design-based abundance estimates which could be generated by the data collected through the TNASS 2007 and NASS 2015/16 surveys would be all both analysed and published. This would represent a considerable progress from the present situation, where analyses from 2007 data are still missing. The Scientific Committee commended this step forward and encouraged all to make it possible in the time frame proposed.

11.3 Animal Welfare Protocols

Many journals have requirements that authors have followed any institutional and/or national animal welfare protocols. The Scientific Committee agreed that the *NAMMCO Scientific Publications* should also ask the authors to state that the national animal welfare protocols have been followed.

12. FUTURE WORK PLANS

12.1 Scientific Committee

12.1.1 2018 Meeting - *25 year Jubilee*

2018 will be the 25-jubilee year for the Scientific Committee which had its first meeting in 1993 in Tromsø. Norway which should host the meeting following the usual rotation, offers to host the meeting on one of the Coastal Steamer (Hurtigruten) from Bergen to Tromsø, with embarkment on Monday evening and dis-embarkment on Friday midday. The jubilee dinner would be then held in Tromsø.

The total number of delegates and observers is presently estimated to be 22 (FR 1, IS 4, GL 5, NO 4, CAN 2, JP 1, RU 1, SEC 4).

12.1.1.2 Timing

The timing will depend of the availability onboard, considering that the steamers are fully booked from mid-November onwards, likely at the beginning of November. The two weeks proposed presently are 30/10 to 2/11 and 6/11 to 9/11 (see above).

12.2 Working groups/Symposia/Other meetings

12.2.1 2018

Abundance Estimates WG (Spring 2018)

The meeting was delayed to late spring 2018 to accommodate the completion of the 2007 and 2015/16 analysis decided above (point 10.1)

Chair: Daniel Pike, Convenor: Rikke Hansen
Terms of Reference:

1) Icelandic/Faroe Islands pilot whale abundance estimates, 2015 and trends
2) Icelandic/Faroe Islands shipboard dolphin estimates, 2007 and 2015
3) Norwegian common minke analysis from last survey cycle
4) Norwegian last two survey cycles all non-common minke species
5) All (FR, GL, IS NO) Central North Atlantic common minkes
3) Sperm whales 2007 and 2015

External experts should be invited from Canada, USA and the SCANS surveys.

Possible BYCWG
By videoconference or in-person if necessary or sufficient data have become available

Chair: Kimberly Murray (NOAA), Convenor: Geneviève Desportes
Terms of Reference:

- Review the re-analysis by Iceland and Norway
- Review the progress in Faroes and Greenland in analysing already existing data and implementing monitoring recommendations

Likely the same External Experts as at the last WG meeting will be invited to participate.

Walrus WG (Fall 2018, location TBD)

Chair: Rob Stewart (DFO), Convenor: Mads Peter Heide-Jørgensen
Terms of Reference:

- To address R-2.6.7 – *provide assessments of, and advice on sustainable removals from, all stocks of walrus in Greenland covering the period from 2019 to 2023, with the advice for Qaanaaq starting in 2021.*

External experts should be invited from Canada, Alaska and Russia.

Super satellite tag development Planning Meeting (Fall 2018, location TBD)

Chair: Mads Peter Heide-Jørgensen (GINR)
Terms of Reference:

- Develop proposal (with detailed budget) to forward to Council

Other
The harbour porpoise and the harp and hooded seals working group meetings originally planned for 2018 were postponed to 2019, to accommodate respectively the completion of genetic analyses going on in Norway and Iceland and the analysis of the latest surveys by Canada, Norway and Russia.

12.2.2 Preliminary plan for 2019

- WGHARP (September, Tromsø)
- Coastal Seal WG
- Pilot Whale WG (Assessment meeting)
- NAMMCO-JCNB JWG (March)
- NAMMCO-JCNB JWG workshop on impact of climate change on management advice
- Harbour porpoise Stock Structure workshop
- Harbour porpoise WG

12.2.3 Beyond 2019

Back to back meetings of a ringed seal WG (chair Aqqalu Rosing-Asvid) and a bearded seal WG (chair to be determined) were tentatively planned in 2020 or 2021

13. BUDGET

13.1 Spending in 2017

13.2 Budget for 2018

The SC reviewed the present and predicted spending in 2017, and a forecast budget for 2018. The SC noted that the expenses for 2017 were considerably lower than what was predicted. One of the strengths of the NAMMCO SC is that there are funds available, and more efforts should be made to take advantage of the opportunity to fund such items as inviting external experts to the WG meetings, and also contract work (e.g., the proposed killer whale review paper; see item 9.8).

14. ANY OTHER BUSINESS

No additional items were discussed.

15. MEETING CLOSURE

15.1 Acceptance of report

The report was reviewed on 17 Friday, and finalised via correspondence on 1 December 2017.

15.2 Closing remarks

The SC thanked Haug for his efficient chairing of the meeting.

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APPENDIX 1. AGENDA

Paper numbers in [ ].

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** [SC/24/NPR-F, -G, -I, -N, -C, -J, -R]
4.2. **Working Group Reports**
4.2.1. Large Whale Assessment WG [SC/24/11]
4.2.2. NAMMCO-JCNB JWG [SC/24/13]
4.2.3. By-catch WG [SC/24/12]
4.3. **Other reports and documents**
4.3.1. Global Review of Monodontids [SC/24/14]
4.3.2. SC Intersessional Report [SC/24/11]
4.3.3. SMM Workshop Report [SC/24/15]

5. WORK PROCEDURES IN THE SC

5.1. **Updates from Council: NAMMCO/25**
5.1.1. External Experts – participation and funding
5.1.2. Confidentiality of reports and documents
5.1.3. New requests
5.2. **Abundance** [SC/24/05a,b]
5.3. **Catches**
5.3.1. Struck and lost (R-1.6.4)

R-1.6.4 *The SC has recommended that catch statistics include correction for struck but lost animals for different seasons, areas, and catch operations. Council requested the SC and the Committee on Hunting Methods to provide advice on the best methods for collection of the desired statistics on losses. Council noted that this request, although brought up regarding walruses, not only pertains to walrus but to all species.*

5.4. **Ideas for future meetings/furthering cooperation in SC**
5.4.1. Presentation: Hannes Petersen: Evolution of the inner ear of whales and relation to sea sickness – how whales avoid getting sea sick as other mammals would (15 November, 9:00)
5.4.2. Development of a "super-tag" [SC/24/17]
5.4.3. Genetics collaboration
5.5. **Guidelines for development of management advice in NAMMCO** [SC/24/16]
5.6. **SWOT Analysis**

6. COOPERATION WITH OTHER ORGANISATIONS

6.1. **IWC** [SC/24/07]
6.2. **ASCOBANS** [SC/24/06]
6.3. **ICES** [SC/24/08]
6.3.1. Joint ICES/NAFO/NAMMCO WGHARP
6.4. **JCNB**
6.5. **Arctic Council** [SC/24/09]
6.6. **Other**

7. ENVIRONMENTAL / ECOSYSTEM ISSUES

7.1. **Marine mammals-fisheries interactions** (R-1.1.5)
7.1.1. Review of active requests

R-1.1.5 (standing): *The Council encourages scientific work that leads to a better understanding of interactions between marine mammals and commercially exploited marine resources, and requested the Scientific Committee to periodically review and update available knowledge in this field.*

7.1.2. Consumption of resources by marine mammals
7.1.3. By-catch [SC/24/12]

7.2. <u>Multispecies approaches to management/Ecosystem Modelling</u> (R-1.1.8, 1.2.1, 1.2.2, 1.4.7)
7.2.1. Review of active requests

R-1.1.8 (ongoing): *In addressing the standing requests on ecosystem modelling and marine mammal fisheries interaction, the SC is requested to extend the focus to include all areas under NAMMCO jurisdiction. In the light of the distributional shifts seen under T-NASS 2007, the SC should investigate dynamic changes in spatial distribution due to ecosystem changes and functional responses. See also 1.1.6 and 1.4.6.*

R-1.2.1 (ongoing): *consider whether multispecies models for management purposes can be established for the North Atlantic ecosystems and whether such models could include the marine mammals compartment. If such models and the required data are not available then identify the knowledge lacking for such an enterprise to be beneficial to proper scientific management and suggest scientific projects which would be required for obtaining this knowledge.*

R-1.2.2 (standing): *In relation to the importance of the further development of multispecies approaches to the management of marine resources, the Scientific Committee was requested to monitor stock levels and trends in stocks of all marine mammals in the North Atlantic.*

R-1.4.7 (ongoing): *The Scientific Committee is requested to review the results of the MAREFRAME ecosystem management project when these become available. In particular, the results should be reviewed with respect to the ongoing and standing requests on marine mammal interactions (R-1.1.0) and multispecies approaches to management (R-1.2.0).*

7.2.2. Updates
7.2.3. Future work

7.3. <u>Environmental issues</u> (R-1.5.3, R-1.5.4)
7.3.1. Review of active requests

R-1.5.3: *The Council requests the SC to monitor the development of the Mary River Project and assess qualitatively or if possible quantitatively the likely impact and consequences on marine mammals in the area.*

R-1.5.4 (NEW): *Committed to furthering its ecosystem approach to the management of marine mammals, and recognising the range of anthropogenic pressures facing North Atlantic marine mammals associated with the climate and environmental changes taking place, the Council requests the SC to advise on the best process to investigate the effects of non-hunting related anthropogenic stressors on marine mammal populations, including the cumulative impacts of global warming, by-catch, pollution and disturbance.*

7.3.2. Global Review of Monodontids [SC/24/14]
7.3.3. Updates
7.3.4. Future work

8. SEALS AND WALRUS STOCKS - STATUS AND ADVICE TO THE COUNCIL

8.1. <u>Harp Seal</u>
8.1.1. Review of active requests (R-2.1.4, 2.1.10)

R-2.1.4 (standing): *update the stock status of North Atlantic harp and hooded seals as new information becomes available.*

R-2.1.10 (standing): *provide advice on Total Allowable Catches for the management of harp seals and the establishment of a quota system for the common stocks between Norway and the Russian Federation*

8.1.2. Update
8.1.3. Future Work

8.2. <u>Hooded seal</u>
8.2.1. Review of active requests (R-2.1.4 , 2.1.9)

R-2.1.4 (standing): *update the stock status of North Atlantic harp and hooded seals as new information becomes available.*

R-2.1.9 (ongoing): *investigate possible reasons for the apparent decline of Greenland Sea stock of hooded seals; and assess the status of the stock*

8.2.2. Update
8.2.3. Future work

8.3. <u>Ringed seal</u>
8.3.1. Review of active requests (R-2.3.1, 2.3.2)

R-2.3.1 (ongoing): *stock identity, abundance estimate, etc.*

R-2.3.2 (ongoing): *effects of removals of ringed seals in Greenland*

8.3.2. Update
8.3.3. Future work

8.4. <u>Grey seal</u>
8.4.1. Review of active requests (R-2.4.2)

R-2.4.2 (ongoing): *abundance estimates all areas*

8.4.2. Coastal Seals WG (2019)
8.4.3. Update
8.4.4. Future work

8.5. <u>Harbour seal</u>
8.5.1. Review of active requests (R-2.5.2)

R-2.5.2: *conduct a formal assessment of the status of harbour seals around Iceland and Norway as soon as feasible*

8.5.2. Coastal Seals WG (2019)
8.5.3. Update
8.5.4. Future work

8.6. <u>Bearded seal</u>
8.6.1. Bearded Seal WG (2019)
8.6.2. Update
8.6.3. Future work

8.7. <u>Walrus</u>
8.7.1. Review of active requests (R-2.6.3, R-2.6.7, R-1.6.4, R-1.6.5)

R-2.6.3 (ongoing): *effects of human disturbance, including fishing and shipping activities, in particular scallop fishing, on the distribution, behaviour and conservation status of walrus in West Greenland.*

R-2.6.7 (NEW-NAMMCO 25): *The SC is requested to provide assessments of, and advice on sustainable removals from, all stocks of walrus in Greenland covering the period from 2019 to 2023, with the advice for Qaanaaq starting in 2021.*

R-1.6.4 (ongoing): *The SC has recommended that catch statistics include correction for struck but lost animals for different seasons, areas, and catch operations. Council requested the SC and the Committee on Hunting Methods to provide advice on the best methods for collection of the desired statistics on losses.*

R-1.6.5 (NEW-NAMMCO 25): *Greenland requests that struck and loss rates are subtracted from future advice on sustainable removals in Greenland, with the advice being given as total allowable landings.*

8.7.2. Walrus Working Group (2018)
8.7.3. Updates
8.7.4. Future Work

9. CETACEANS STOCKS - STATUS AND ADVICE TO THE COUNCIL

9.1. Fin whale

9.1.1. Review of active requests (R-3.1.7, 1.7.11, 1.7.12)

R-1.7.11 (ongoing): *develop estimates of abundance and trends as soon as possible*

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

R-3.1.7 amended (ongoing): *complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. While long-term advice based on the outcome of the RMP Implementation Reviews (with 0.60 tuning level) is desirable, shorter term, interim advice may be necessary, depending on the progress within the IWC. This work should be completed before the annual meeting of the SC in 2015.* ***Amended at NAMMCO/24:*** *The new amendment replaces the NAMMCO/23 amendment and reads: The SC is requested to complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. A long-term advice based on the new NASS2015 abundance estimate and the available results from the RMP Implementation Reviews (with 0.60 tuning level) is needed in 2016.*

9.1.2. Update
9.1.3. Future work

9.2. Humpback whale

9.2.1. Review of active requests (R-3.2.4, 1.7.12)

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

R-3.2.4-amended (ongoing): *conduct a formal assessment following the completion of the T-NASS…In addition the Scientific Committee is requested to investigate the relationship between the humpback whales summering in West Greenland and other areas and incorporate this knowledge into their estimate of sustainable yields of West Greenland humpback whales.* ***Amendment (NAMMCO/24):*** *adds the following text: "The SC is further asked to provide advice on future catch levels of humpback whales in West Greenland at different probability levels for a non-declining population evaluated over a 5 year period, similar to the procedure for the advice generated for beluga, narwhal and walrus. The advice should include the latest abundance estimate."*

9.2.2. Large Whale Assessment WG [SC/24/11]

9.2.3. Update
9.2.4. Future work

9.3. Common minke whale
9.3.1. Review of active requests (R-3.3.4, 1.7.11, 1.7.12)

R-1.7.11 (ongoing): *develop estimates of abundance and trends as soon as possible*

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

R-3.3.4 amended (ongoing): *full assessment, including long-term sustainability of catches, of common minke whales in the Central North Atlantic… assess the short-term (2-5 year) effects of the following total annual catches: 0, 100, 200 and 400.* ***Amended NAMMCO/24:*** *The SC is requested to complete assessments of common minke whales in the North Atlantic and include estimation of sustainable catch levels in the Central North Atlantic.*

9.3.2. Update
9.3.3. Future work

9.4. Beluga
9.4.1. Review of active requests (R-3.4.9, 3.4.11, R-3.4.14)

R-3.4.9 (ongoing): *provide advice on the effects of human disturbance, including noise and shipping activities, on the distribution, behaviour and conservation status of belugas, particularly in West Greenland; narwhal added at NAMMCO 23*

R-3.4.11 (standing): *update the assessment of both narwhal and beluga*

R-3.4.14 (ongoing): *The Council requests the SC to examine the data existing on beluga in East Greenland (sightings, strandings, by-catch and catch) and examine how this material can be used in an assessment process and advice on how this data can be improved.*

9.4.2. NAMMCO-JCNB JWG March 2017 [SC/24/13]
9.4.3. Global Review of Monodontids [SC/24/14]
9.4.4. Update
9.4.5. Future work

9.5. Narwhal
9.5.1. Review of active requests (R-3.4.9, 3.4.11)

R-3.4.9 (ongoing): *provide advice on the effects of human disturbance, including noise and shipping activities, on the distribution, behaviour and conservation status of belugas, particularly in West Greenland; narwhal added at NAMMCO 23*

R-3.4.11 (standing): *update the assessment of both narwhal and beluga*

9.5.2. NAMMCO-JCNB JWG March 2017 [SC/24/13]
9.5.3. Global Review of Monodontids [SC/24/14]
9.5.4. Update
9.5.5. Future work

9.6. Sei whale
9.6.1. Review of active requests (R-3.5.3 amended, 1.7.12)

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

R-3.5.3 amended (ongoing): *assess the status of sei whales in West Greenland waters and the Central North Atlantic and provide minimum estimates of sustainable yield*

9.6.2. Update
9.6.3. Future work

9.7. <u>Bottlenose whale</u>
9.7.1. Update
9.7.2. Future work

9.8. <u>Killer whale</u>
9.8.1. Review of active requests (R-3.7.2)

R-3.7.2 (ongoing): *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.*

9.8.2. Update
9.8.3. Future work

9.9. <u>Pilot whale</u>
9.9.1. Review of active requests (R-1.7.11, 3.8.6)

R-1.7.11 (ongoing): *develop estimates of abundance and trends as soon as possible*

R-3.8.6 (ongoing): *complete a full assessment of pilot whales in the North Atlantic and provide advice on the sustainability of catches...with particular emphasis on the Faroese area and East and West Greenland. In the short term...provide a general indication of the level of abundance of pilot whales required to sustain an annual catch equivalent to the annual average of the Faroese catch in the years since 1997*

9.9.2. Update
9.9.3. Future work
9.9.3.1. Pilot Whale WG (2019)

9.10. <u>Dolphins</u>
9.10.1. Review of active requests (R-3.9.6)

R-3.9.6 (ongoing): *assessments of dolphin species*

9.10.2. Update
9.10.3. Future work

9.11. <u>Harbour porpoise</u>
9.11.1. Review of active requests (R-3.10.1)

R-3.10.1 (ongoing): *comprehensive assessment of the species throughout its range*

9.11.2. Updates
9.11.3. By-Catch WG [SC/24/12]
9.11.4. HPWG 2018
9.11.5. Future work

9.12. <u>Sperm whale</u>
9.12.1. Update
9.12.2. Future work

9.13. Bowhead whale
9.13.1. Review of active requests (R-1.7.12)

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

9.13.2. Update
9.13.3. Future work

9.14. Blue Whales
9.14.1. Update
9.14.2. Future work

10. SURVEYS (R-1.7.11, 1.7.12)

R-1.7.11 (ongoing): *develop estimates of abundance and trends as soon as possible*

R-1.7.12 (ongoing): *Greenland requests the SC to give information on sustainable yield based on new abundance estimates expected from TNASS2015 for all large baleen whales in West Greenland waters*

10.1. Abundance Estimates WG (2018)
10.2. Plans for future surveys

11. NAMMCO SCIENTIFIC PUBLICATIONS

11.1. Monodontid age estimation
11.2. NASS and Beyond…
11.3. Animal Welfare Protocols

12. FUTURE WORK PLANS

12.1. Scientific Committee
12.1.1. 2018 Meeting
12.1.1.1. *25 year SC Jubilee*
12.1.1.2. *Timing*

12.2. Working groups/Symposia/Other meetings
12.2.1. 2018
12.2.2. 2019

13. BUDGET

13.1. Spending in 2017 [SC/24/10]
13.2. Budget for 2018

14. ANY OTHER BUSINESS

15. MEETING CLOSURE

15.1. Acceptance of report
15.2. Closing remarks

NAMMCO SCIENTIFIC COMMITTEE
24th MEETING

PARTICIPANTS

Geneviève Desportes (Secretariat)
NAMMCO
General Secretary
PO Box 6453
N-9294 Tromsø, Norway
+47 95021228 (mobile)
genevieve@nammco.no

Bjarki Elvarsson (IS)
Marine Research Institute,
PO Box 1390,
IS-121 Reykjavík, Iceland
+ 354 6181681
bjarki.elvarsson@hafogvatn.is

Sandra Granquist (IS)
Icelandic Seal Center and Marine and Freshwater Research Institute
Brekkugata 2, Hvammstangi 530, Iceland
+354 5806348
sandra@veidimal.is

Þorvaldur Gunnlaugsson (IS)
Marine and Freshwater Research Institute
PO Box 1390,
IS-121 Reykjavík, Iceland
+354 5752081 (office)
+354 8236084 (mobile)
thg@hafro.is

Mike Hammill (CA)
Fisheries and Oceans Canada
Maurice Lamontagne Institute
P.O. Box 1000
850 Route de la Mer
Mont-Joli, QC G5H 3Z4
+1 (418) 775-0580
Mike.Hammill@dfo-mpo.gc.ca

Rikke Hansen (GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 3
PO Box 2151
DK-1016 Copenhagen K, Denmark
+45 40295485
rgh@ghsdk.dk

Tore Haug (Chair of SC, NO)
Institute of Marine Research
PO Box 6404
N-9294 Tromsø, Norway
+47 77 60 97 22 (office)
+47 95 28 42 96 (mobile)
tore.haug@imr.no

Christian Lydersen (NO)
Norwegian Polar Institute
Polar Environmental Centre
N-9296 Tromsø, Norway
+47 77 75 05 23 (office)
+47 90 93 07 76 (mobile)
lydersen@npolar.no

Bjarni Mikkelsen (Vice Chair of SC, FO)
Natural History Museum
V. U. Hammersheimbsgøta 20
FO-100 Tórshavn, Faroe Islands
+298 34 05 76 (office)
+298 79 05 76 (mobile)
bjarnim@savn.fo

Jill Prewitt (Secretariat)
NAMMCO
Scientific Secretary
PO Box 6453
N-9294 Tromsø, Norway
+47 95 48 73 48
jill@nammco.no

Aqqalu Rosing-Asvid (GL)
Greenland Institute of Natural Resources
PO Box 570,
DK-3900 Nuuk, Greenland
+299 361247
aqro@natur.gl

Mette Skern-Mauritzen (NO)
(please send info to Jill and jill@nammco.no)

Fernando Ugarte (GL)
Greenland Institute of Natural Resources
PO Box 570,
DK-3900 Nuuk, Greenland
+299 361242
feug@natur.gl

Gísli Víkingsson (IS)
Marine and Freshwater Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
+354 57 52 080 (office)
+354 69 90 475 (mobile)
gisli.vikingsson@hafogvatn.is

Charlotte Winsnes (Secretariat)
NAMMCO
Deputy Secretary
PO Box 6453
N-9294 Tromsø, Norway
+47 91 54 64 30
charlotte@nammco.no

Lars Witting (GL)
Greenland Institute of Natural Resources
PO Box 570,
DK-3900 Nuuk, Greenland
+299 361202
larwi@natur.gl

Genta Yasunaga (JP)
Environmental Chemistry Section
Institute of Cetacean Research
4-5 Toyomi-cho, Chijo-ku
Tokyo I04-0055 Japan
yasunaga@cetacean.jp

Kirill A. Zharikov (RU)
Kirill A. Zharikov
All-Russian Research Institute of Fisheries and Oceanography (VNIRO) Russia 107140 Moscow
V. Krasnosel'skaya, 17
zharikov@vniro.ru

Nils Øien (NO)
Institute of Marine Research
PO Box 1870
Nordnes 5817 Bergen
Norway
+47 55 23 86 11
nils.oien@imr.no

NAMMCO SCIENTIFIC COMMITTEE
24TH MEETING

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SATELLITE TRACKING – A TOOL FOR CETACEAN RESEARCH IN THE NORTH ATLANTIC

By Mads Peter Heide-Jørgensen/NAMMCO SC

Tracking of marine mammals by satellites has long been recognized as one of the most important and promising techniques that are available for studies of movements, migrations, behaviour, diving, stock identity and habitat use of cetaceans. The past two decades has demonstrated an enormous growth in the use of satellite telemetry on whales, but most of the advances in the research community have been accomplished by studies of small cetaceans that can be captured and restrained while they are being instrumented. The techniques are however not well developed for use on large baleen whales that are too big to be captured and handled at sea. A number of studies of bowhead and humpback whales have demonstrated the enormous potential satellite tracking studies have for gaining insight into whale biology, but costs and failure rates of the tracking experiments have been unacceptably high. It is clear that before satellite telemetry can be used as a routine method for monitoring movements of baleen whales it is fundamental to develop new, smaller and more reliable tracking instruments as well as better methods for deploying the tags.

There are many questions that can only be addressed through satellite tracking e.g. where do the North Atlantic baleen whales spend the winter? Are there separate stocks of baleen whales that need to be managed separately? What is the habitat use of the whales and how do they react to oceanographic changes? Satellite tracking of baleen whales can also be used to identify changes in the fish resources (e.g. capelin schools) and provide data on surface time that is crucial for converting survey estimates into total abundance estimates.

Different satellite tracking systems are currently used in the four NAMMCO member countries for studying movements of several species of baleen whales, including minke, fin and blue whales at Svalbard and Norway, minke and humpback whales in Iceland, minke, fin, humpback and bowhead whales in Greenland and fin whales in the Faroe Isles. Lots of effort and funding has been spent on scattered attempts to acquire data on the whales and what is really needed is a joint effort to refine the methods in a way that will eventually benefit the cetacean research in all four countries. Reliable and well-performing satellite transmitter systems are now available for birds, seals, terrestrial mammals and small cetaceans, but refinement of the systems are needed for their use on baleen whales and especially for more cryptic species like minke and fin whales.

In all four NAMMCO member countries it would be of great importance to include a reliable, cheap and well-tested satellite tracking system in the toolbox for cetacean studies. It would also be important to develop a NAMMCO program that combine forces to use satellite tracking methods to solve major management issues that cannot be addressed with other techniques. It cannot be expected that research groups outside NAMMCO will focus on developing satellite tracking techniques that will assist in the research and development needed for the on going NAMMCO assessment process. One example is the seasonal movements and long-term distributional changes of minke and fin whales, species of importance to all NAMMCO member countries.

In this proposal it is described how a joint NAMMCO satellite-tracking program could be developed and what would be required to reach a point where the technique can be used as an efficient and reliable field technique.

Development of a satellite transmitter for remote instrumentation of cetaceans

A major obstacle with tagging large whales is that the instruments need to be deployed at a distance from the whales with the use of an airgun, crossbow or pole system. Currently there are two types of pneumatic guns that can be used for launching satellite transmitters, the ARTS (Air Rocket Transmitter System; Restech, Norway) and the DanInject rifles (Vejle, Denmark). Crossbows are not sufficiently powerful for launching the tags available today and pole systems can only be used for slow moving whales like humpback and bowhead whales.

The main issue with the tag launching system is that the shape and mass of the satellite transmitters works against an optimal ballistic performance. The result is that many deployments are at best of short duration and at worst result in failed instrumentations of the whales.

The way to improve the success rate and duration of the tags is to develop smaller tags with better ballistic performance. This is only technically and commercially feasible if the quantity of tags to be manufactured is

sufficiently large. That is why joint effort and collaboration between all the NAMMCO countries is needed. Programs and effort for whale tagging in the individual NAMMCO countries are too small to generate sufficient commercial incentive for developing an optimal transmitter configuration for large cetaceans.

Here we suggest that a pen like implantable transmitter running on a single AAA cell with a diameter of 10mm is developed. The transmitter will be much smaller than current designs, which will facilitate more reliable deployments. It will be developed in collaboration with Wildlife Computers (Redmond, USA) and it will be designed for launching by the ARTS pneumatic gun that is now widely used for tagging large whales. It is suggested that a basic budget of 1.000.000 NOK is allocated for the development of the prototype transmitter.

Program for studies of movements and changes in occurrence of minke whales in the North Atlantic

The minke whales is the most abundant of the large cetaceans in the North Atlantic, it is hunted by three countries in the North Atlantic and we know nothing or very little about the wintering grounds, migratory routes and changes in distribution in relation to biotic and climatic factors. Other species of large whales, that are easier to study, have been subject to various tracking studies in the North Atlantic (e.g. humpback and blue whales), but despite their ecological and economical importance only sporadic and opportunistic attempts to track minke whales have been conducted.

Here we propose a joint and coordinated effort to study the detailed movements of minke whales in all four NAMMCO countries. Based on the development of a smaller and more efficient satellite transmitter design described above, we propose to purchase a large number of tags that can be allocated to the four NAMMCO countries together with tag launching gear. The launching and tag anchoring parts will be developed and manufactured by the Greenland Institute of Natural Resources based on experience from past systems that GINR has pioneered. It is assumed that the price per tag can be maintained at about 15.000 NOK and in the initial phase of the project 50 tags should be purchased together with four deployment system and Argos CLS (Toulouse, France) satellite fees for a total cost of 1.200.000 NOK.

Shared NAMMCO data base of tracking data

As part of the development of this project NAMMCOs SC will provide a common web based database for exchange of results from the tracking studies of all species. The database will primarily be used for exchange of results from this project among SC members, but it could be expanded to include tracking data from other species and researchers outside NAMMCOs SC.

The database would also serve as a long-term depository of the tracking data. This will ensure that the obtained data will be available for future studies of marine mammal movements in the North Atlantic. It is also increasingly becoming a requirement that data from published studies that are deposited at sites accessible for future generations.

The initial costs for establishing and running the database is estimated at 100.000 NOK.

The total cost of all three element of this project 2.300.000 NOK.

OBSERVER'S REPORTS
6.1 IWC

6.2 ASCOBANS

Observer report from the 23d ASCOBANS Advisory Committee meeting
Le Conquet, France, 5-7 September

Geneviève Desportes

Desportes attended the AC 23 meeting, organized as usual in two sessions: a scientific session and an institutional session. A number of Expert and Working Group reports were presented and discussed. Three focused on harbour porpoise conservation at a regional level in the remit of three regional Action Plans covering the Baltic, the Western Baltic, Belt Sea and Kattegat, and North Sea. Other working groups deal more generally with the threats to small cetaceans - Bycatch, Disturbance, Habitat change and degradation and Management of cumulative impacts. The meeting reviewed new information on threats to small cetaceans and considered steps for mitigating the impacts of human activities on the animals and their habitats.

The Special Species Session was on white-beaked dolphin, a species of interest to NAMMCO, with as background document the Document Inf.3.1.b - White-beaked dolphin review (2016) - Lagenorhynchus albirostris (Cetacea: Delphinidae).

Three other documents of interest to the NAMMCO SC work are:

- Document Inf.4.1.a - Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.
- Document Inf.5.1.1.e - Technical Support Information to the CMS Family Guidelines on Environmental Impact Assessment for Marine Noise Generating Activities.
- Document Inf.6.1.a - Report on Expert Workshop "Unacceptable Interactions" and Bycatch.

The documents are available at http://www.ascobans.org/en/meeting/AC23

Following the decision of NAMMCO 24 to increase its scientific cooperation with organisations dealing with marine mammals, an invitation was conveyed to ASCOBANS MOPs8 for such an increase in cooperation. The NAMMCO Scientific Committee recommended that a review and assessment of the status of harbour porpoise stocks in the North Atlantic be conducted in 2018, and had supported the participation of ASCOBANS and other European Scientists to such an exercise.
The NAMMCO secretariat sent therefore to the Chair of the ASCOBANS AC and the ASCOBANS Secretariats an invitation to organise jointly a North Atlantic Review of Harbour Porpoises (see attached letter from June 2017). The response from the Secretariat was positive and both Secretariats had some exchanges on how to proceed.

At AC 23, Desportes presented a general update on NAMMCO aims, structure and activities, lastly developing the proposal for the joint review of North Atlantic harbour porpoises. Although many scientists present and some delegations were in favour of this cooperation, the AC did not agree on embarking in a specific scientific cooperation with NAMMCO and declined NAMMCO's invitation, although it is stipulated in the Work plan activity 61, adopted by MOPs8 in 2016 (Resolution 8.2):
"61. Seek to cooperate closely with CBD, ECS, HELCOM, ICES, IWC, NAMMCO, OSPAR, UNCLOS, UNEP and other relevant organizations."

An Action Point was however adopted by the AC, which reads:
Action Point 13. - Parties are invited to send experts or observers to the NAMMCO Working Group on Harbour Porpoises.

The official letter of decline was received from the ASCOBANS Secretariat on October 13, 2017 and is attached.

6.3 ICES

REPORT FROM THE 2017 ACTIVITIES IN ICES

Tore Haug
Institute of Marine Research, Tromsø, Norway

ICES WGMME
The ICES Working Group on Marine Mammal Ecology (WGMME) met in St Andrews, UK 6–9 February 2017. It reported on recent information on status of, and threats to, marine mammal populations and briefly reviewed current knowledge of effects of plastics and underwater noise. Direct interactions between seals and fisheries were reviewed and the group also reported on the current status of the ICES / OSPAR seal database(s). The group provided text for five ecosystem overviews (Iceland Sea, Norwegian Sea, Baltic, Azorean ecoregion and the Oceanic Northeast Atlantic ecoregion). Criteria for assessment of abundance trends in offshore cetaceans in the context of the Marine Strategy Framework Directive (MSFD) were reviewed, modifying the proposed indicator (previously based solely on the rate of decline) to make specific reference to baseline values. Linked to this, the group reported on the outcomes of the 2016 SCANS III survey. Given that the three main large-scale surveys of cetaceans in European Atlantic waters have all arisen from individual projects and were separated by intervals of eleven years, there is concern as to the future and utility of these surveys. WGMME recommends that the surveys be co-organised and coordinated by Member States as part of their routine monitoring and that the frequency is increased to once every six years to match the MSFD reporting cycle.

ICES WKPIGS
A one-day Workshop on Predator-prey Interactions between Grey Seals and other marine mammals (WKPIGS) focused on predatory behaviour of grey seals towards other grey seals, harbour seals and harbour porpoises in European waters was convened in Middelfart, Denmark, on 30 April 2017. The workshop aimed to define and harmonise the pathological indicators of grey seal predation events across nations and to collate data on the prevalence and distribution of such events. A further objective was to discuss methods to aid in detection of predation events and potential populationlevel consequences of reported incidences.

The challenge of ascribing grey seal predation as the cause of a mortality event from limited pathological evidence was discussed. In cases where the behaviour has been observed in pinnipeds, a straight-edged wound margin which spirals around the carcass is typical; however, most cases are not directly observed. Inferring grey seal predation as a cause of death from stranding reports, photographs and necropsies occurs by ruling out other potential causes of death and by examining the macroscopic and microscopic pathology. Decision trees have been reported elsewhere and the workshop focused on the challenges of distinguishing grey seal predation from grey seal scavenging and from scavenging by other (terrestrial or avian) predators. New techniques examining the histopathology of wound margins and forensic (DNA) evidence can aid in detection of tearing of warm tissue (indicator of active predation) and in ruling out predators other than grey seals.
Reported cases of grey seal predation events in Europe were collated and summarised. The behaviour has been detected throughout much of the grey seal range, although information is lacking from some key areas. Seasonal trends of predation on pinnipeds peaked during their respective pupping/mating seasons while cases of predation on harbour porpoises peaked in spring months. A total of 737 cases were reported, peaking in 2016.

The implications of these findings for populations of grey seals, harbour seals and harbour porpoises were limited by the challenges of detecting the true prevalence of the behaviour in the grey seal population. The incidence of grey seal predation on other marine mammals steadily increased over the last 10 years although it is not known if this represents a true increase in prevalence, reflects the steady increase in European grey seal numbers over the same period or is due to an increase in effort and reporting. It was noted that if previously high rates of harbour seal mortality due to grey seal predation were sustained, they could potentially account for observed declines in some populations. Coupled with the rise in European grey seal numbers, this could become the most important driver of local harbour seal extinctions in populations already beyond natural recovery.

ICES WGBYC

The ICES Working Group on Bycatch of Protected Species (WGBYC) met at NOAA Fisheries Northeast Fisheries Science Center (NEFSC) in Woods Hole Massachusetts USA, 12–15 June 2017. Highlights from the meeting include:

- Expanding membership, notably protected species (PS) bycatch data from Icelandic fisheries and seabird bycatch experts;
- Review of ongoing bycatch mitigation research projects;
- Site visit/tour of the NEFSC Fisheries Sampling Branch and its staff presentations on interdisciplinary bycatch monitoring programs in the US Northwest Atlantic northeast region;
- Collaborations with other ICES working groups (i.e. WGCATCH and JWGBIRD);
- Positive advancements on WGBYC database development working jointly with the ICES Data Centre;
- Progress on summarizing bycatch for the Baltic Sea and Bay of Biscay/Iberia fisheries overviews.

Similar to previous years, the content of member state (MS) reports (for 2015) continued to vary in both content and format. A total of four species of cetaceans were reported as bycatch from 2015 MS reports (common dolphins, white-beaked dolphin, bottlenose dolphin, and harbour porpoise). Fourteen species of seabirds and five species of seals are also included in the report. WGBYC continues to be challenged by limited availability of accurate total fishing effort from relevant European waters for various gear types. Consequently, there continues to be considerable uncertainty in the representativeness of total fishing effort reported in MS reports submitted to the EC. Thus, WGBYC continues to highlight the inconsistent submission and content of annual reports provided by some MS and the shortcomings to accurately reflect the full magnitude of cetacean bycatch in European fisheries. WGBYC is preparing for the transition away from regular MS reports as the primary source of data on bycatch of cetaceans over to data coming through the ICES regional database as a result of the implementation of new EUMAP.

Five recommendations were included in the 2017 report, some of which were repeated from last year. Key new recommendations pertain to continued maintenance of the WGBYC database and retro-fitting historical data to the revised template format to facilitate historical review. The historical review is intended to serve as a baseline comparison on bycatch of cetaceans from previous monitoring programs to the new EUMap data collection program that requires regional coordination groups to monitor and collect data on PS bycatch events. Additionally, ICES Data Centre intends to issue a formal data call for PS bycatch in 2018 to support WGBYC objectives.

ICES ASC

The 2017 ICES Annual Science Conference (ASC) was held in Fort Lauderdale, USA 18-21 September 2017. The conference included no particular theme session devoterd entirely to marine mammals. Nevertheless, some sessions were designed with marine mammals included as an integral part – of the most relevant sessions were: “Microbes to mammals: metabarcoding of the marine pelagic assemblage” and “From iconic to overlooked species: How (electronic) tags improve our understanding of marine ecosystems and their inhabitants”.

More information is available at the ICES web side www.ices.dk.

6.4 JCNB

The full discussion is in the main report.

6.5 ARCTIC COUNCIL

Observer's Report – Arctic Council

In 2017, NAMMCO attended two meetings of the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) Working Group.

CAFF Board Meeting – 6-7 Sept 2017, Bethel, Alaska

This was the first meeting of the CAFF board under US Chairmanship. The Chair is Cynthia Jacobsen from US Fish and Wildlife. The CAFF members are generally representing ministries and management departments and discusses current activities and future directions of the CAFF.

Prewitt gave a short presentation on the activities in NAMMCO with relevance to CAFF, specifically on Arctic marine mammals. The board member from the Kingdom of Denmark (representing Greenland) noted that there are many experts who work with both CAFF and NAMMCO, and that it would benefit both organisations to have a close cooperation.

CAFF – Circumpolar Biodiversity Monitoring Program (CBMP) – 11-13 October, Anchorage, Alaska

The CBMP group within CAFF is probably the most relevant group within CAFF for NAMMCO. This meeting was a joint meeting between the Marine and Coastal groups. NAMMCO has been active in the Marine group (currently chaired by John Bengston from the US Marine Mammal Laboratory), with Desportes attending a couple of previous meetings, and contributing to the writing of the State of the Arctic Marine Biodiversity Report (SAMBR).

- The SAMBR was the a large project for the CBMP-Marine group, and there were many discussions on how to get a wider circulation of the report, especially to the managers and other people who may be able to influence how this report can be incorporated into management decisions and future monitoring goals. The group realised that all participants must play a part in discussing the report in a wider context, including presenting it to their management. Tom Barry, Executive Secretary of CAFF will attend the NAMMCO SC meeting and give a presentation on the SAMBR.
- The Coastal group is fairly new, and most of their meetings were focused on how to start their monitoring program. A big question for all trophic levels is how the Marine and Coastal groups can work together without duplicating information, and supplementing each other's work. The Coastal group is also focusing heavily on basing their monitoring program on using Traditional Ecological Knowledge (TEK). These discussions will continue as the Coastal group's plans coalesce.
- Prewitt gave a presentation on the Global Review of Monodontids meeting. The participants agreed that the results from this meeting were relevant to the work of the Marine Mammal Expert Group within the CBMP – Marine, and will be incorporated into their future work.

Intersessional SC Meeting
Advice
from the
Large Whale Assessment WG report
2 March 2017, Videoconference

1. OPENING

Chair Haug welcomed the participants to the videoconference meeting. He noted that this intersessional meeting of the SC was necessary because Iceland requires the fin whale advice to be endorsed by the SC before the Council meeting in April 2017. The Central common minke whale advice was also discussed, however it was decided that a complete discussion on the humpback whale section of the report will be postponed until the full SC meeting in November 2017. This decision was for a few reasons, first being that Lars Witting was not available for the intersessional meeting, and also that the WG report did not include information such as population trajectory, catch statistics, etc. This additional information could be brought to the SC meeting in November.

2. PARTICIPANTS

The following participants were present via videoconference: Tore Haug (Chair, Norway), Jill Prewitt (NAMMCO Secretariat), Geneviève Desportes (NAMMCO Secretariat), Nils Øien (Norway), Sandra Granquist (Iceland), Gísli Víkingsson (Iceland), Bjarki Elvarsson (Iceland), Thorvaldur Gunnlaugsson (Iceland), Mads Peter Heide-Jørgensen (Greenland), Rikke Hansen (Greenland), and Bjarni Mikkelsen (Faroe Islands).

3. DOCUMENT AVAILABLE

The only document considered at the meeting was the Large Whale Assessment WG Report from the meeting held 25-27 January 2017 in Copenhagen (Appendix 1).

4. REPORT PLAN

The report from this meeting will be approved by the participants of this Intersessional SC meeting, and then sent to the SC and Council.

5. COMMON MINKE WHALE

Large Whale Assessment WG
Víkingsson presented the report from the working group.

At NAMMCO-24 the following request was made to the SC concerning common minke whales: *The SC is requested to complete assessments of common minke whales in the North Atlantic and include estimation of sustainable catch levels in the Central North Atlantic.*

The most recent advice provided by the SC on sustainable catch levels was in 2015 when the SC concluded that an annual catch limit of 224 common minke whales in in Icelandic coastal waters (CIC sub-area; Fig. 1) was safe and precautionary (NAMMCO 2016). This was interim advice, valid for a maximum of 3 years (2016 – 2018), because of the lengthy time since the last abundance estimate for the CIC sub-area and as a long-term advice was not considered feasible until the IWC RMP *Implementation Review* of North Atlantic common minke whales had been completed.

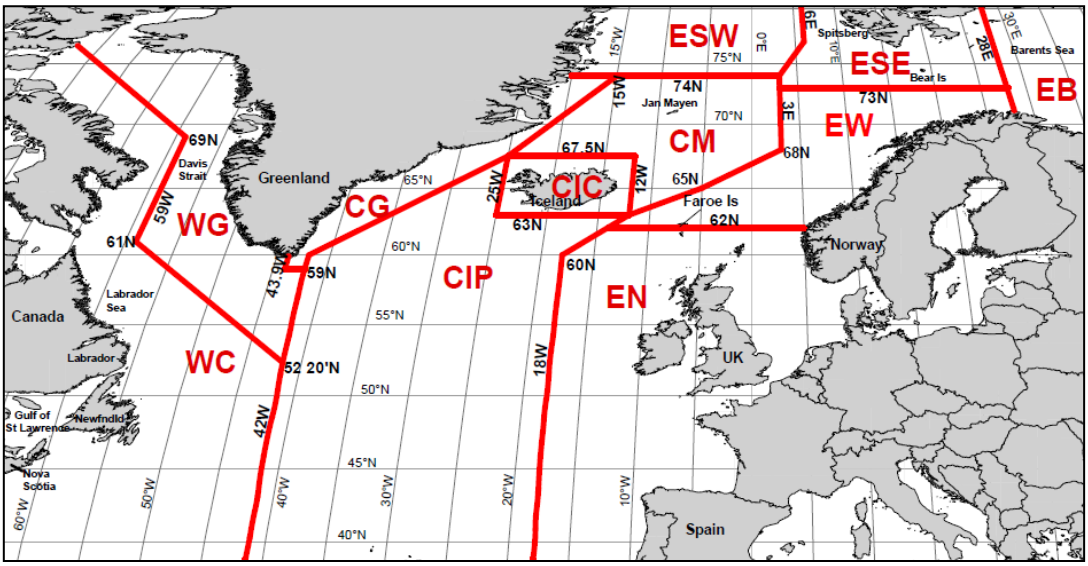

Fig. 1. *Map of the North Atlantic showing the sub-areas defined for the North Atlantic common minke whales*

Unfortunately, the IWC RMP *Implementation Review* could not be completed in 2016 as had been scheduled, and the 2015 aerial survey in CIC was unsuccessful because unusually poor weather conditions which meant that only a very small part of the area could be covered. However, a new abundance estimate from the shipboard part of the 2015 survey has been adopted by the SC (NAMMCO 2016) and results from an aerial survey conducted in 2016 will be finalized in early 2017.

At this time therefore, the NAMMCO-24 request has therefore been addressed below as follows.

a) The IWC SC has near finalized its current *Implementation Review* of the RMP for application to North Atlantic minke whales. The baseline operating models from that exercise as at present have been used as assessments to inform estimation of sustainable catch levels.

b) To relate that estimation of sustainable levels to a simulation tested approach, the RMP's CLA with a tuning level of 0.6 (as applied in Norway to recommend catch levels for its minke whale catch) has been applied to available abundance estimates and historical catch information for the CIC sub-area.

Assessments based on IWC Implementation Review

There are four baseline operating models for the North Atlantic minke whales RMP *Implementation Review*. These cover two MSY rates (1% on the 1+ and 4% on the mature component of the population) and two stock structure hypotheses.

As the main focus was on the Central North Atlantic, results are shown only for the C breeding stock, from which the most of the minke whales found in the Central North Atlantic feeding grounds (sub-areas CG, CIC, CIP and CM) originate. Results given here focus on the 1% MSYR1+ scenarios which constitute "lower bounds", with those for the higher value of MSYR reflecting less depletion and higher sustainable yields (Fig. 2.).

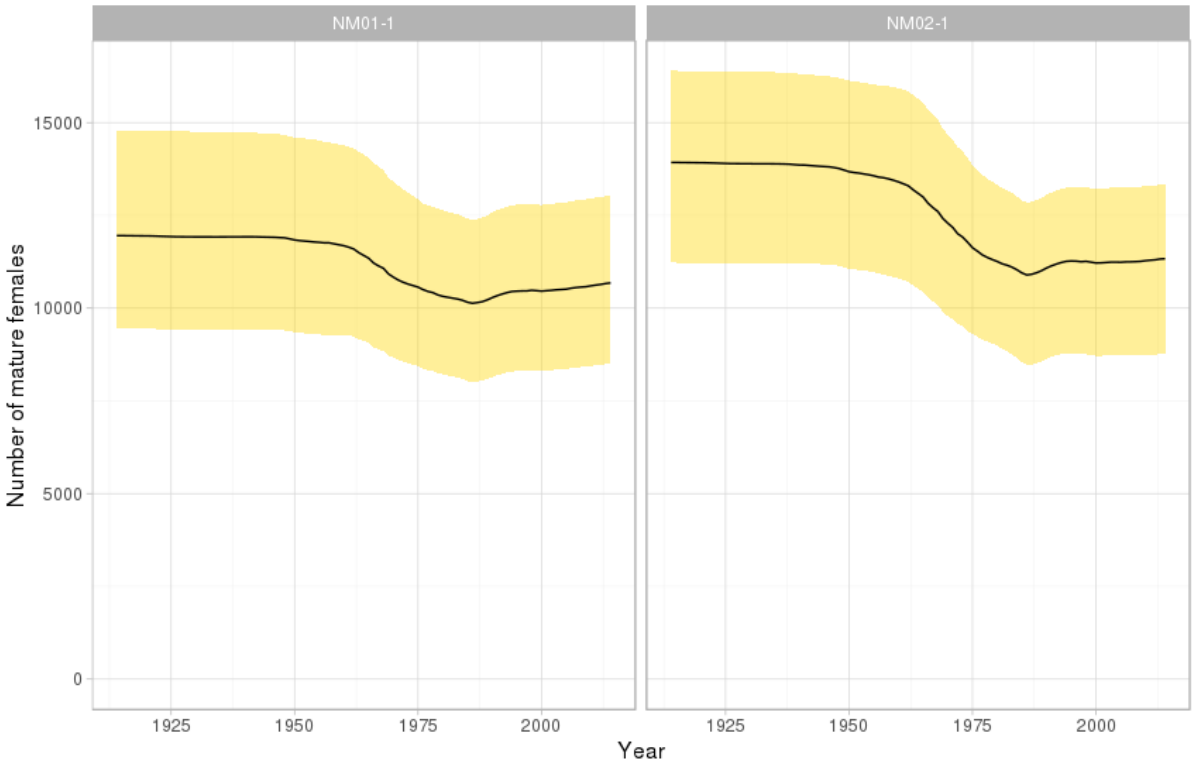

Fig. 2. *North Atlantic common minke whales: conditioning results for the Central Atlantic stock where the panels are split according to two stock structure hypotheses used in IWC implementations simulation trials. The solid black line illustrates the median trajectories and shaded region the 90% interval*

According to historical stock trajectories, the current depletion (relative to the pre-exploitation abundance) is about 80%, i.e. at present this stock is well above its MSY abundance level.

Indications of sustainable catch levels were obtained by projecting forward under various constant catch levels to ascertain whether or not the mature female component of the resource equilibrated above the likely MSY level. To do this, only the constant catch levels in the CIC area were varied. In other areas catches were projected at their recent average levels and with historical averages used for sex ratios with the exceptions that 50 animals were assumed taken in the Jan Mayen area and the interim SLA was used to set catches in the WG sub-area.

Application of the CLA to the CIC area

To calculate the catch limit for minke whales the RMP's CLA with a tuning level of 0.6 (as described in Huseby and Aldrin 2006) was applied. This effectively treats the whales in the CIC sub-area as an isolated stock, and as such has been simulation tested and considered to provide safe and precautionary management by the IWC SC.

Historical catch series and all agreed abundance estimates were used as input data.

The projections of the mature female component of the C stock for the next 300 years (see Figure 3 in Appendix 1.) indicate that catches of 400 annually are not sustainable whereas a catch of 300 annually is sustainable in terms of the median trajectory. Noting further that these projections also include annual catches of 50 from the CM sub-area and 12 from the CG sub-area, it is reasonable to conclude that an annual catch of about 360 minke whales is a lower bound for the sustainable catch for the Central North Atlantic. This number is described as a "lower bound" because is corresponds to the "lower bound" MSYR value of 1% in terms of the 1+ population, so that annual sustainable catches would be higher than 360 for the higher value of MSYR that likely applies in practice

<u>Management Advice</u>

The application of the CLA to the CIC sub-area yields a sustainable catch limit for minke whales of 217 and 139 for tuning levels of 0.60 and 0.72 respectively. These values are compatible with the 360 above as they pertain only to the CIC sub-area within the whole Central North Atlantic region, and also precautionary because the CLA also reflects MSYR values that are perhaps unrealistically low

The WG noted that the generic lower bound for the MSY rate (MSYR) for the 1+ population of 1% as used by the IWC SC for the RMP is likely too low for common minke whales. The WG recommended research to determine a more appropriate lower bound for MSYR for common minke whales, including the collection of data on: ageing and reproductive data.

While the management advice above is precautionary and valid for up to 8 years the WG suggested that once the IWC RMP *Implementation Review* for North Atlantic common minke whales has been completed (anticipated in May 2017), the results from this should be used as a basis to provide long-term catch limit advice for common minke whales in the Central North Atlantic.

Future Research

The WG noted that the generic lower bound for the MSY rate (MSYR) for the 1+ population of 1% as used by the IWC SC for the RMP is likely too low for common minke whales. The WG recommended research to determine a more appropriate lower bound for MSYR for common minke whales, including the collection of data on:

- Ageing (e.g., aspartic acid racemization, ear plugs - although the WG acknowledge there are practical problems with collecting ear plugs from commercial operations)
- Reproductive rate (e.g., age-specific pregnancy rates, age at sexual maturity)

The WG also discussed the possibility of conducting yearly aerial surveys in the Icelandic coastal area. The Assessment WG recommended that Iceland examine past data to see if there is information on changes in distribution over time, as it may be problematic for the reason stated above. The WG recommends two potential options for the coastal Iceland aerial survey:

- Increased effort in an individual year
- Combining results from multiple surveys

Discussion by the SC

Advice

The SC **endorsed** the advice of the WG that an annual catch of about 360 minke whales is a lower bound for the sustainable catch for the Central North Atlantic medium area.

The SC **endorsed** the advice of the WG of catch levels of 217 common minke whales from the CIC sub-area.

The SC discussed that this advice can be updated after the completion of the IWC's *Implementation Review* (expected to be completed in May 2017). The current advice should be updated as new abundance estimates become available, and the advice could be improved with the results from the IWC *Implementation Review*.

The SC will revisit this issue when the results from the IWC *Implementation Review* are available, presumably at the next SC meeting.

Future research

The SC noted that samples have been collected for age, sex and reproductive rate in previous years, but that the existing sample size is too low, and would also need to cover a longer time period. The SC noted that aspartic acid racemization (AAR) aging has also been done in the past, but these were calibrated against previous Japanese ear plug readings on Antarctic minke whales.

Work on age, sex, and reproductive parameter is ongoing in Norway as well. There are old samples that have not yet been analysed, and new sample collection has also begun. The SC also noted that reproductive data are plastic, and therefore old data is not necessarily valid today. These data should be updated routinely as is done with seals.

The catches in Iceland in recent years have been about 30-60 whales per year, with the majority of these being males, therefore it would take many years for Iceland to have a large enough sample size. The catches in Norway have a higher proportion of females, and pooling samples would be beneficial.

The SC **endorsed** the recommendations for collection of age/sex/reproductive data.

Regarding the discussion of the aerial surveys in Iceland, the SC noted that the intent of the previous recommendation for yearly surveys was not to have a "mosaic" design, but rather that the aerial survey is attempted every year until a successful survey is completed. It may be possible to make an arrangement with the flight company to only pay for the good weather hours, and therefore this plan shouldn't increase the costs. The SC also noted that they have discussed this at the previous SC meeting, and **endorsed** this recommendation.

6. FIN WHALE

Vikingsson presented the report from the Large Whale Assessment Working Group meeting.
At NAMMCO-24 the following request was made to the SC concerning fin whales:

The SC is requested to complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. A long-term advice based on the new NASS2015 abundance estimate and the available results from the RMP Implementation Reviews (with 0.60 tuning level) is needed in 2016.

The most recent advice provided by the SC on sustainable catch levels in Icelandic waters was in 2015 when the SC concluded that an annual catch limit of 146 fin whales in the WI sub-area (Fig. 3) was safe and precautionary (NAMMCO 2016). This was an interim advice, valid for a maximum of 2 years (2016 – 2017), because of the lengthy time (8 years) since the last abundance estimate for the sub-areas surrounding Iceland and as long-term advice was not considered feasible until the IWC RMP *Implementation Review* of North Atlantic fin whales had been completed.

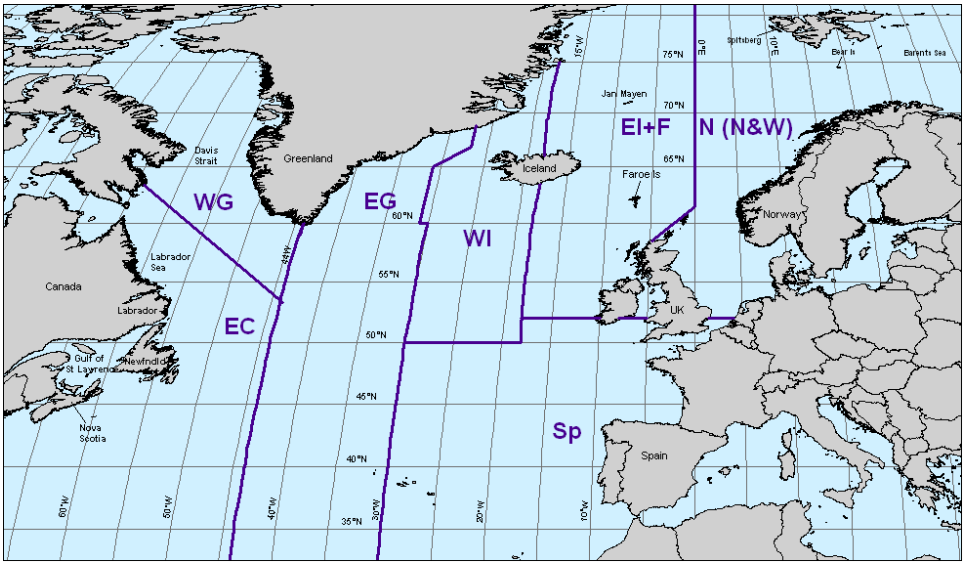

Fig. 3. *Delineation of feeding areas (*Small Areas*) for North Atlantic fin whales*

The assessment of fin whales was completed in 2016 during the RMP *Implementation Review* for the North Atlantic fin whales, the result of which was adopted at the 2016 IWC SC meeting.

Simulation testing of adjusted RMP
In SC/22/AS/07 the full management projections conducted by the IWC SC were rerun based on a 0.60 tuning level for the CLA and compared with equivalent single stock trials with tuning levels of 0.60 and 0.48. The procedure of assigning acceptability follows the procedure used by the IWC.

Seven different management variants were considered (see WG report). Two of these variants had unacceptable conservation performance and were therefore not considered further. Variant 7 was preferred when considering both conservation and catch related performance.

Application of RMP with 0.60 tuning
SC/24/AS/05 presents modelling based on the RMP with a tuning level of 0.60, and provides catch limits for NA fin whales off Iceland and East Greenland. The advice below follows from this analysis, but is effectively the same approach as was used for 2015 NAMMCO fin whale assessment with the survey and catch data updated appropriately. These calculations were based on the recent 2015 estimates of abundance (East Greenland aerial and Iceland/Faroes shipboard surveys).

Management advice
Based on the output from the RMP with a tuning level of 0.60 reported in SC/22/AS/05, the WG recommended that a catch limit of 161 fin whales in the WI area and 48 in EI/F area (based on application of the RMP to the EG+WI+EI/F region) is safe and precautionary, and that this advice should be considered valid for a maximum of 8 years (2018 to 2025).

Further the WG recommended that, when abundance estimates from new surveys become available, these catch limits should be updated in accordance with this variant of the RMP until the IWC's next *Implementation Review* (scheduled to begin around 2022) is completed.

Future research
The WG recommended incorporating samples from a wider geographical area into an existing study on close-kin relationship of whales caught off Iceland and Greenland, e.g. using biopsies.

The WG also recommends gathering information on the annual cycle of fin whales including overall movements and indications of possible breeding areas (e.g. applying satellite telemetry).

The WG also encourages the continued collection of biological samples for age, reproduction, etc. from whales caught off Iceland.

The WG recommends that future work include using existing information to estimate MSY rates with confidence intervals.

Discussion by Intersessional SC
The SC noted that the IWC's *Implementation Review* is complete, and these results have been accepted in the IWC SC.

Advice
The SC **endorsed** the work of the WG and the recommended that a catch limit of 161 fin whales in the WI area and 48 in EI/F area (based on application of the RMP to the EG+WI+EI/F region) is safe and precautionary, and that this advice should be considered valid for a maximum of 8 years (2018 to 2025).

Future Research
The SC commented that additional samples may be available from biopsies collected from Svalbard. IMR reported that there have been no new samples from fin whales in recent years, however there may be additional samples from biopsies collected by the Norwegian Polar Institute. This would be valuable additions to our knowledge of fin whale stock structure.

The Norwegian Polar Institute has also tagged some whales in Svalbard, but the meeting participants did not know how long these tags remained attached.

The SC **endorsed** the recommendations for future research:

- Incorporating samples from a wider geographical area into an existing study on close-kin relationship of whales caught off Iceland and Greenland, e.g. using biopsies.
- Gathering information on the annual cycle of fin whales including overall movements and indications of possible breeding areas (e.g. applying satellite telemetry).
- Continued collection of biological samples for age, reproduction, etc. from whales caught off Iceland.
- Future work should include using existing information to estimate MSY rates with confidence intervals.

7. HUMPBACK WHALE

The humpback whale section will be discussed at the SC-24 meeting in November 2017.

8. SC 24

The next SC meeting will be held 14-17 (Tues-Friday) November 2017 in Iceland. The Icelandic delegation will notify the SC members of the location in due time.

9. CLOSING

Haug commented that with the technical issues, videoconferences are a sub-optimal way to meet, but that despite this, the meeting accomplished its goals. When there are urgent matters, videoconferencing is an option, but it is not desirable to have full meetings this way. He thanked the participants for their efforts to get connected, and their participation in the discussions.

REFERENCES

Huseby, RB, and M Aldrin. 2006. "Updated Documentation of a Fortran 77 Subroutine Implementing the Catch Limit Algorithm-Version January 2006." NR-Note SAMBA/06/06, Norwegian Computing Center.

NAMMCO 2017. Large Whale Assessment Working Group Report. SC/24/AS/Report.

Report
of the
NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ASSESSMENT

Greenland Representation
Copenhagen, Denmark, 25-27 January 2017

1. OPENING REMARKS

Chair Walløe welcomed the participants (Appendix 2) to the meeting, especially the external experts for providing their time and expertise. Walløe then reviewed the requests from Council related to the agenda items, and the goals of the meeting. Walløe also noted that he was unable to attend the meeting on the second day (26 January) however Butterworth had agreed to chair in his absence.

The WG noted that request 1.7.12 is broad, and will not be covered in detail at this meeting. This meeting will focus on humpback whales in Greenland and fin and minke whales off Iceland.

2. ADOPTION OF THE AGENDA

The agenda was adopted without changes (Appendix 1).

3. APPOINTMENT OF RAPPORTEUR

Prewitt was the main rapporteur, with help from other participants as needed.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The WG reviewed the documents that were available to the meeting (Appendix 3).

5. CENTRAL NORTH ATLANTIC COMMON MINKE WHALE STOCK

5.1 Introduction

The most recent advice provided by the SC on sustainable catch levels in Icelandic coastal waters (the CIC sub-area – see Fig. 1) was in 2015 when the SC concluded that an annual catch limit of 224 common minke whales in the CIC sub-area was safe and precautionary (NAMMCO 2016). This was interim advice, valid for a maximum of 3 years (2016 – 2018), because of the lengthy time (six years) since the last abundance estimate for the CIC sub-area and as a long-term advice was not considered feasible until the IWC RMP *Implementation Review* of North Atlantic common minke whales had been completed.

At NAMMCO-24 the following request was made to the SC concerning minke whales:
The SC is requested to complete assessments of common minke whales in the North Atlantic and include estimation of sustainable catch levels in the Central North Atlantic.

Unfortunately the IWC RMP *Implementation Review* could not be completed in 2016 as had been scheduled, and the 2015 aerial survey in CIC was unsuccessful because unusually poor weather conditions meant that only a very small part of the area could be covered. However, a new abundance estimate from the shipboard part of the 2015 survey has been adopted by the SC (NAMMCO 2016) and results from an aerial survey conducted in 2016 will be finalized in early 2017.

At this time therefore, the NAMMCO-24 request has therefore been addressed below as follows.

a) The IWC SC has near finalized its current *Implementation Review* of the RMP for application to North Atlantic minke whales. The baseline operating models from that exercise as at present have been used as assessments to inform estimation of sustainable catch levels.

This report contains the views of the Working Group, and does not necessarily represent the view of the NAMMCO Scientific Committee and/or the Council, which reviewed the report at the 24th meeting.

b) To relate that estimation of sustainable levels to a simulation tested approach, the RMP's CLA with a tuning level of 0.6 (as applied in Norway to recommend catch levels for its minke whale catch) has been applied to available abundance estimates and historical catch information for the CIC sub-area.

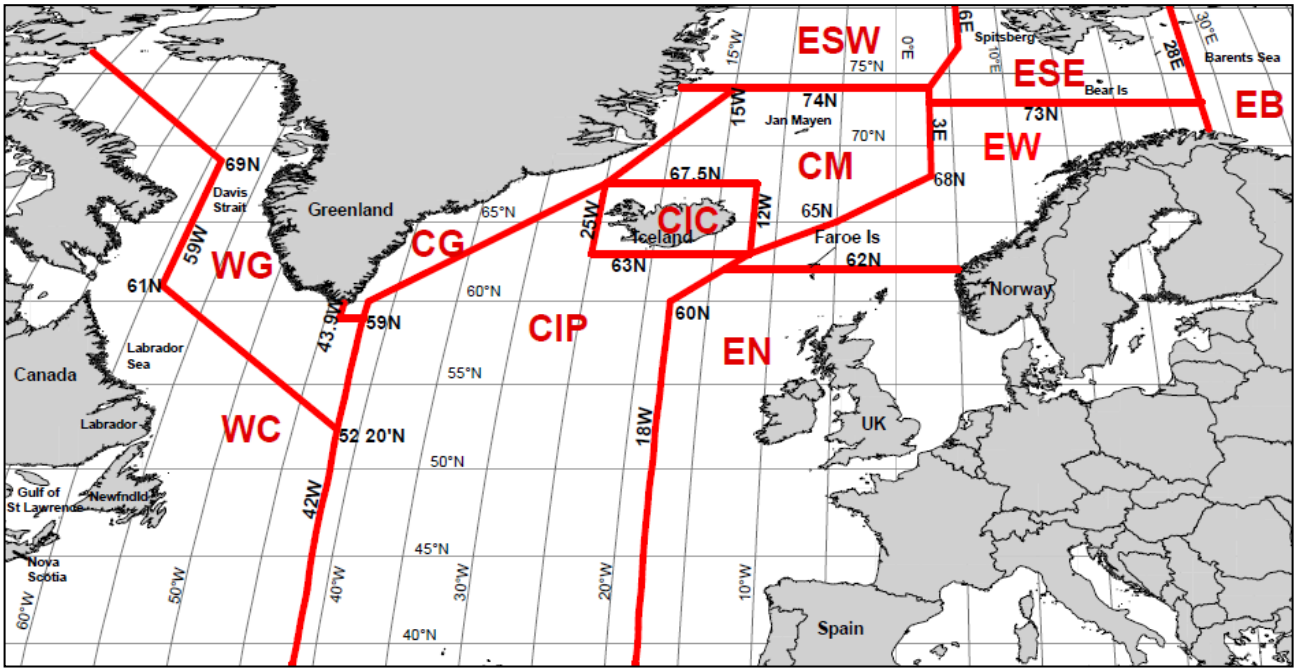

Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic common minke whales

5.2 Analyses

5.2.1 Assessments based on IWC Implementation Review

There are four baseline operating models for the North Atlantic minke whales RMP *Implementation Review*. These cover two MSY rates (1% on the 1+ and 4% on the mature component of the population) and two stock structure hypotheses (one for five and one for four breeding stocks/sub-stocks). The key difference between the two stock structure hypotheses is whether the WC and WG feeding areas are primarily composed of minke whales from one or from two breeding stocks.

Given that the main focus here is on the Central North Atlantic, results are shown only for the C breeding stock, from which the most of the minke whales found in the Central North Atlantic feeding grounds (sub-areas CG, CIC, CIP and CM) originate. Results given here focus on the 1% $MSYR_{1+}$ scenarios which constitute "lower bounds", with those for the higher value of MSYR reflecting less depletion and higher sustainable yields.

Figure 2 shows the corresponding historical trajectories for the mature female component of the C stock, both median and upper and lower 5%-ile estimates, for each of the two stock structure hypotheses. In both cases the current depletion (relative to the pre-exploitation abundance) is about 80%, i.e. at present this stock is well above its MSY abundance level.

Because of the complexity of these models, it is not possible to calculate MSY analytically. In this case therefore, indications of sustainable catch levels were obtained by projecting forward under various constant catch levels to ascertain whether or not the mature female component of the resource equilibrated above the likely MSY level. To do this, only the constant catch levels in the CIC area were varied. In other areas catches were projected at their recent average levels and with historical averages used for the proportion that is female. There were two exceptions to this: the recently zero CM catch was increased to 50 in expectation of a likely Norwegian commercial operation commencing soon in that sub-area, and the interim SLA was used to set catches in the WG sub-area as a constant catch there at the recent average level had a non-trivial probability of extirpating the stock populating that sub-area in the five stock/sub-stock scenario case.

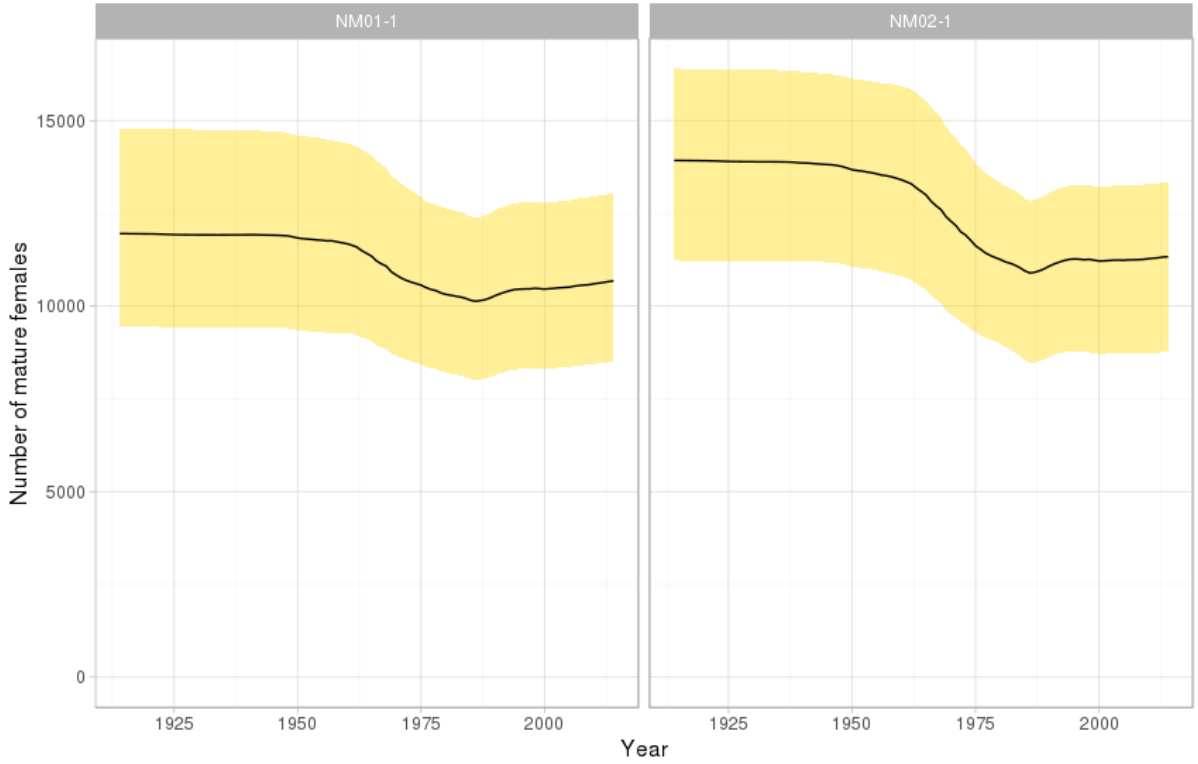

Fig. 2. *North Atlantic common minke whales: conditioning results for the Central Atlantic stock where the panels are split according to two stock structure hypotheses used in IWC implementations simulation trials. The solid black line illustrates the median trajectories and shaded region the 90% interval*

Figure 3 extends the historical mature female trajectories 300 years into the future under constant annual catches of 200, 300 and 400 minke whales to provide insight into sustainable levels of catch.

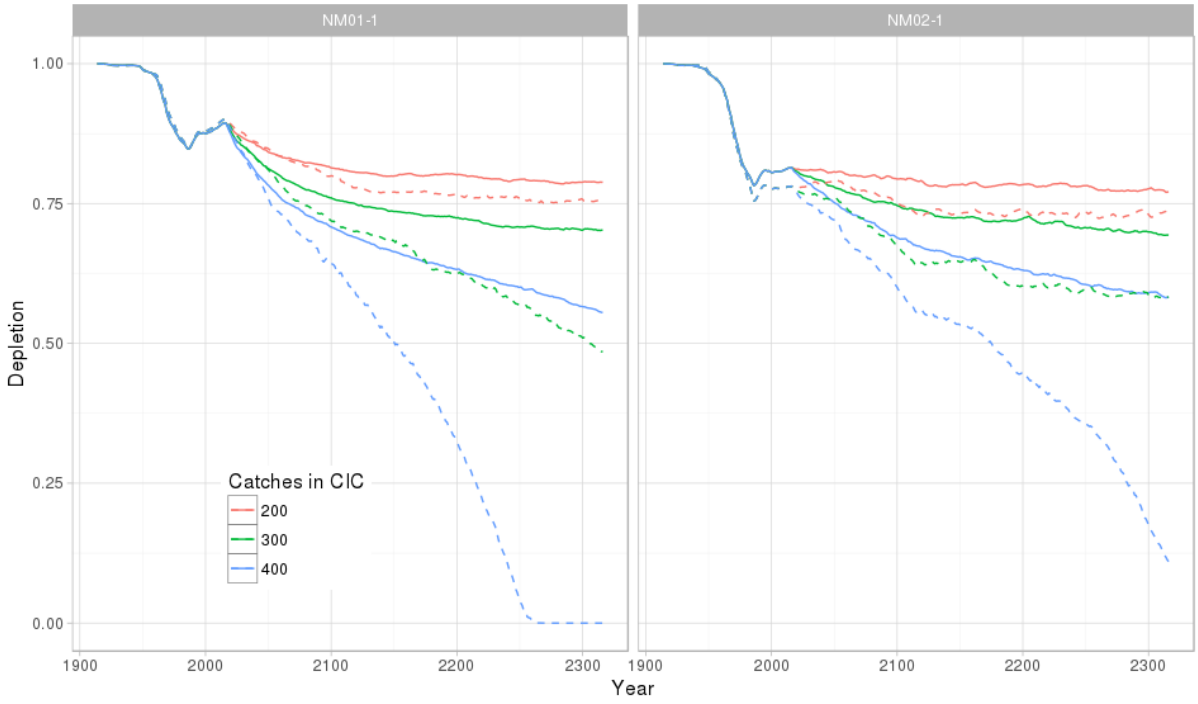

Fig. 3*. North Atlantic common minke whales, predicted depletion trajectories for the Central Atlantic stock to 2315 by catch options (200, 300 and 400 in the CIC area) where the panels are split according to two stock structure hypotheses used in IWC implementations simulation trials. The solid lines illustrates the median trajectories and dashed the lower 5% percentile.*

5.2.2 Application of the CLA to the CIC

To calculate the catch limit for minke whales the RMP's CLA with a tuning level of 0.6 (as described in Huseby and Aldrin 2006) was applied. This effectively treats the whales in the CIC sub-area as an isolated stock, and as such has been simulation tested and considered to provide safe and precautionary management by the IWC SC.

Input data

The historical catch series input to the CLA are illustrated in Fig. 4. Minke whale takes reached a peak during the late 1960's and then generally remained slightly less than 200 whales until the whaling moratorium in 1986. Since 2010 the catch limit has been in the range 200-229 minke whales, while the takes have been considerably less, ranging between 24 and 81 annually since 2008. Abundance estimates for the CIC sub-area are shown in Fig. 5. Recent estimates of minke whale abundance in CIC have been difficult to obtain due to unsuitable weather during the scheduled aerial observation period. However Pike et al. (2016) provided a shipboard estimate of abundance in 2015 which is used here.

5.3 Results

The projections of the mature female component of the C stock under different levels of constant catch in the CIC sub-area that are shown in Figure 3 indicate that catches of 400 annually are not sustainable as the corresponding median mature female trajectory continues downwards to below the likely MSY level (a depletion of about 0.6) even after 300 years. In contrast, a catch of 300 annually is sustainable in terms of the median trajectory, with the lower 5%-ile dropping below the likely MSY level only shortly before the end of that projection period.

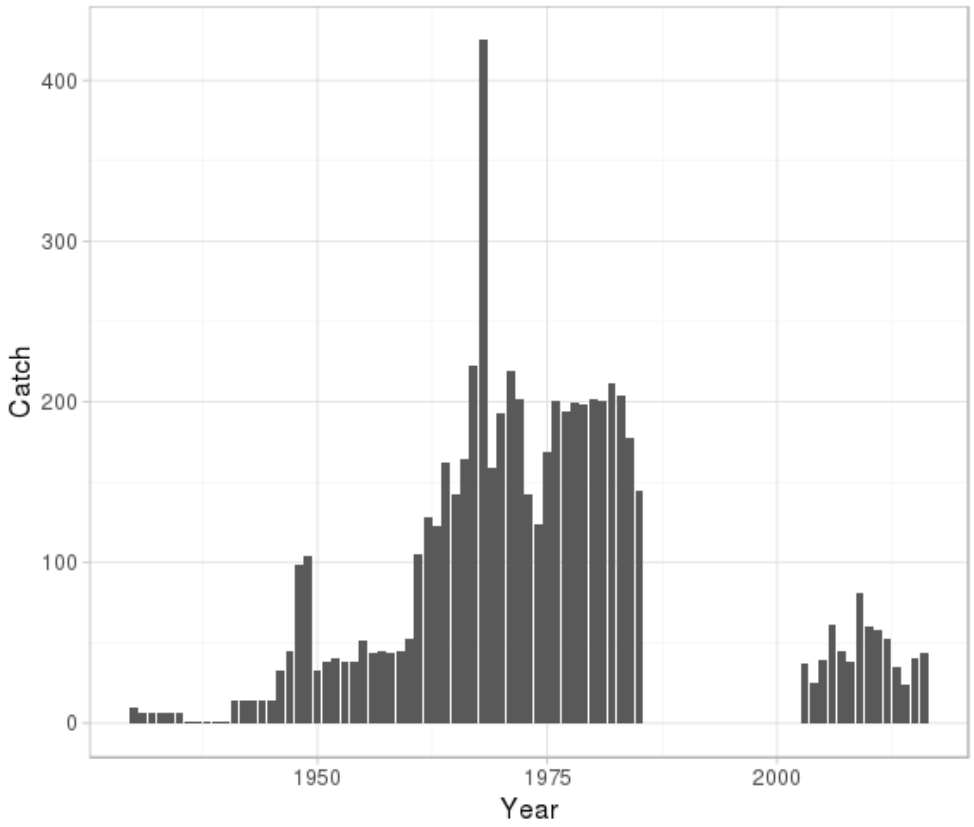

Fig. 4. *Historical catch series from the CIC sub-area*

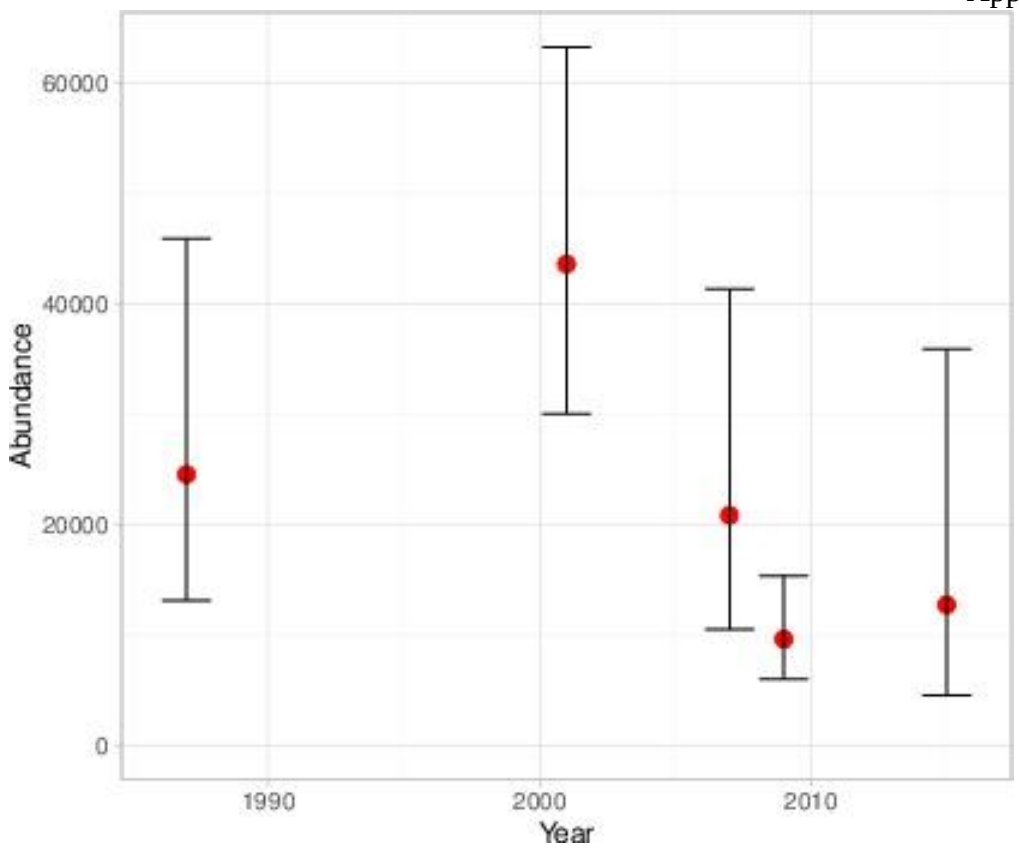

Fig. 5. *Adopted abundance estimates (with 95% confidence intervals) in the CIC sub-area for minke whales. An estimate from the 1995 survey was not adopted and therefore not included in the analysis (NAMMCO 2002).*

Noting further that these projections also include annual catches of 50 from the CM sub-area and 12 from the CG sub-area, it is reasonable to conclude that an annual catch of about 360 minke whales is a lower bound for the sustainable catch for the Central North Atlantic. This number is described as a "lower bound" because is corresponds to the "lower bound" MSYR value of 1% in terms of the 1+ population, so that annual sustainable catches would be higher than 360 for the higher value of MSYR that likely applies in practice (see Section 5.4, Future Research).

The application of the CLA to the CIC sub-area yields a sustainable catch limit for minke whales of 217 and 139 for tuning levels of 0.60 and 0.72 respectively. These values are compatible with the 360 above as they pertain only to the CIC sub-area within the whole Central North Atlantic region, and also precautionary because the CLA also reflects MSYR values that are perhaps unrealistically low (see Section 5.4).

5.4 Future research

The WG noted that the generic lower bound for the MSY rate (MSYR) for the 1^+ population of 1% as used by the IWC SC for the RMP is likely too low for common minke whales. The WG recommended research to determine a more appropriate lower bound for MSYR for common minke whales, including the collection of data on:

- Ageing (e.g., aspartic acid racemization, ear plugs - although the WG acknowledge there are practical problems with collecting ear plugs from commercial operations)
- Reproductive rate (e.g., age-specific pregnancy rates, age at sexual maturity)

Iceland informed the WG that the abundance estimate from the 2016 coastal aerial survey had wide confidence intervals due to low realized effort because of poor weather conditions. At the Abundance Estimates WG in October 2016, the idea of conducting a "mosaic" type survey over time around Iceland was introduced; however there was a concern that this approach may result in an estimate with a variance that is rather high because of large changes in the whale distribution from year to year. The Assessment WG recommended that Iceland examine past data to see if there is information on changes in distribution

over time, as it may be problematic for the reason stated above. The WG recommends two potential options for the coastal Iceland aerial survey:

- Increased effort in an individual year
- Combining results from multiple surveys

Once the IWC RMP *Implementation Review* for North Atlantic common minke whales has been completed (anticipated in May 2017), the results from this should be used as a basis to provide long-term catch limit advice for minke whales in the Central North Atlantic.

6. FIN WHALE

6.1 Introduction

The most recent advice provided by the SC on sustainable catch levels in Icelandic coastal waters (the EG+WI sub-areas – see Fig. 6) was in 2015 when the SC concluded that an annual catch limit of 146 fin whales in the WI sub-area was safe and precautionary (NAMMCO 2016). This was an interim advice, valid for a maximum of 2 years (2016 – 2017), because of the lengthy time (8 years) since the last abundance estimate for the sub-areas surrounding Iceland and as long-term advice was not considered feasible until the IWC RMP *Implementation Review* of North Atlantic fin whales had been completed.

At NAMMCO-24 the following request was made to the SC concerning fin whales:

The SC is requested to complete an assessment of fin whales in the North Atlantic and also to include an estimation of sustainable catch levels in the Central North Atlantic. A long-term advice based on the new NASS2015 abundance estimate and the available results from the RMP Implementation Reviews (with 0.60 tuning level) is needed in 2016.

The assessment of fin whales was completed in 2016 during the RMP *Implementation Review* for the North Atlantic fin whales, the result of which was adopted at the 2016 IWC SC meeting (IWC/SC/66b). In addition to the assessment of the stock, management simulations were conducted based on a CLA with a 0.72 tuning level, the results of which are shown in Annex D of IWC/66/Rep01(2016).

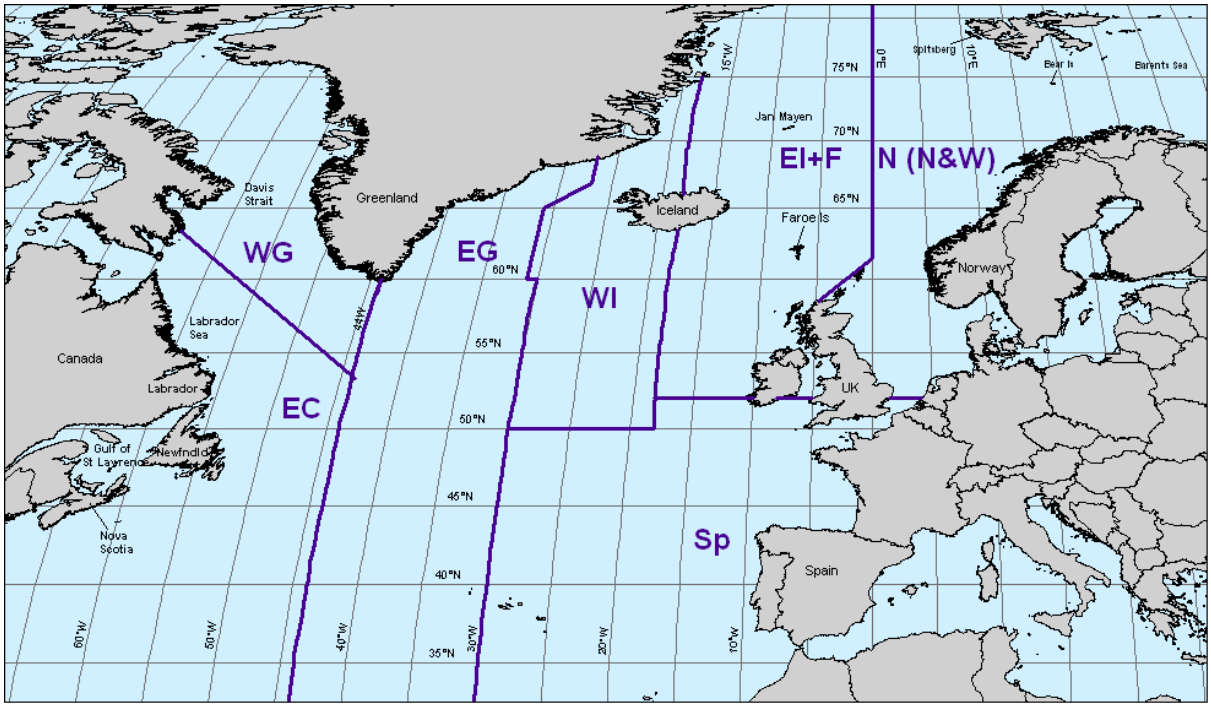

Fig. 6. *Delineation of feeding areas (Small Areas) for North Atlantic fin whales.*

6.2 Analyses

6.2.1 Simulation testing of adjusted RMP

In SC/22/AS/07 the full management projections conducted by the IWC SC were rerun based on a 0.60 tuning level for the CLA and compared with equivalent single stock trials with tuning levels of 0.60and 0.48. The procedure of assigning acceptability follows the procedure used by the IWC, where the performance is acceptable when depletion is above similar values from the equivalent single stock trial based on a tuning level of 0.60 for high plausibility trials. Similarly trials assigned medium plausibility were classified as borderline when above 0.48 and unacceptable otherwise. See Annex D of IWC/66/Rep01(2016) for further details.

The seven management variants considered were as follows (see Fig. 6).

1. Sub-area WI is a *Small Area*.
2. Sub-area (WI+EG) is a *Small Area*; all of the Catch is taken in sub-area WI.
3. Sub-area (WI+EG+EI/F) is a *Small Area*; all of the catch is taken in sub-area WI.
4. Sub-area WI is a *Small Area*; catch limits are set based on survey estimates for sub-area WI north of 60°N (both historical and future surveys).
5. Sub-areas WI and EG are taken to be *Small Areas* and sub-area WI+EG is taken to be a *Combination Area*; the catch limits set for the EG *Small Area* are not taken.
6. Sub-areas WI, EI/F and EG are taken to be *Small Areas* and sub-area WI+EI/F+EG is taken to be a *Combination Area*; the catch limits set for the EG and EI/F *Small Areas* are not taken.
7. Sub-areas WI+EG and EI/F are taken to be *Small Areas* and sub-area WI+EI/F+EG is taken to be a *Combination Area*; the catch limits set for the WI+EG *Small Area* are taken in sub-area WI; the catch limit for sub-area EI/F is taken there.

The results from these trials were consistent with what was previously reported in Annex D of IWC/66/Rep01(2016). Management variants 1, 4, 5 and 6 all had acceptable conservation performance on all management trials, albeit the catch related performance was substantially worse than that for variants 2, 3 and 7. The conservation performance of variants 2 and 3 was in general not considered acceptable given the large number of trials whose performance did not meet acceptability thresholds. Although Variant 7 had unacceptable performance of two medium plausibility trials, the levels of unacceptability were deemed marginal so that performance overall was considered "acceptable".

6.2.2 Application of RMP with 0.60 tuning

Elvarsson presented SC/24/AS/05 which is based on the RMP with a tuning level of 0.60, and provides catch limits for NA fin whales off Iceland and East Greenland. The advice below follows from this analysis, but is effectively the same approach as was used for 2015 NAMMCO fin whale assessment with the survey and catch data updated appropriately. These calculations were based on the recent 2015 estimates of abundance. The new 2015 estimates were as agreed at the last AEWG meeting (SC/23/15). This includes the aerial survey estimate from coastal East Greenland uncorrected for diving whales and the Icelandic and Faroese shipboard survey estimates. The areas farther north and south have been surveyed by Norway and SCANS-III/OBSERVE, respectively, but no estimates have been reported yet, so these areas receive zero abundance in this analysis.

6.3 Recommendations

Based on the output from the RMP with a tuning level of 0.60 reported in SC/22/AS/05, the WG recommended that a catch limit of 161 fin whales in the WI area and 48 in EI/F area (based on application of the RMP to the EG+WI+EI/F region) is safe and precautionary, and that this advice should be considered valid for a maximum of 8 years (2018 to 2025).

Comparable catch limits are 99 and 29 for WI and EI/F respectively when the RMP is applied with a tuning level of 0.72. Further the WG recommended that, when abundance estimates from new surveys become available, these catch limits should be updated in accordance with this variant of the RMP until the IWC's next *Implementation Review* (scheduled to begin around 2022) is completed.

6.4 Future research

There is ongoing work on close-kin relationships from samples of whales caught off Iceland and Greenland to continue to better clarify stock structure. It would be informative to collect samples from a wider geographical area, if possible. Biopsies could be an option for collecting samples from areas where fin whales are not being caught. The WG also recommends gathering information on the annual cycle of fin whales including overall movements and indications of possible breeding areas. Satellite tagging would be helpful, but the WG recognizes that this would require tags that stay attached for multiple months, which has rarely been achieved in the past.

The WG also encourages the continued collection of biological samples for age, reproduction, etc. from whales caught off Iceland.

The WG recommends that future work include using existing information to estimate MSY rates with confidence intervals. Use of a range of population models, including ones that drop the assumption of starting at pre-exploitation equilibrium, may assist in this regard.

7. HUMPBACK WHALE

7.1 Introduction

The Large Whale Assessment WG meeting on 5-7 October 2015 provided advice on sustainable yields of West Greenland humpback whales. Based on the work of that WG, the SC endorsed the advice of ten strikes per year based on the IWC SC's humpback SLA, and noted that a higher number may also be sustainable (because the SLA calculations were based on a maximum of the ten annual strikes that had been requested by Greenland to the IWC). Greenland nevertheless also wished to receive advice related to the level of use which would be sustainable. Arising from this NAMMCO/24 includes the following request made to the SC:

> *to provide advice on future catch levels of humpback whales in West Greenland at different probability levels for a non-declining population evaluated over a 5-year period, similar to the procedure for the advice generated for beluga, narwhal and walrus. The advice should include the latest abundance estimate* ***(R-3.2.4 Amendment NAMMCO/24).***

Following a discussion in the Large Whale Assessment WG and the SC, the NAMMCO Council agreed that scientific advice on sustainable catches of large whales should be given based on simulation tested and approved management procedures (NAMMCO 2009, 2011). This WG (on Assessment) recommends that the SLAs that are developed in the IWC be used for Greenland. These SLAs are developed as case specific applications that match the whale stocks and their hunts in Greenland, providing a reasonable balance between exploitation and conservation. Use of these SLAs in NAMMCO will also benefit from the scientific work that is carried out in the IWC SC, allowing for an easy application with a minimum of extra work in NAMMCO.

7.2 Analyses

7.2.1 Stock Structure

A component of the **R-3.2.4** request on West Greenland humpback whales relate to stock structure where "*the Scientific Committee is requested to investigate the relationship between the humpback whales summering in West Greenland and other areas and incorporate this knowledge into their estimate of sustainable yields of West Greenland humpback whales."*

North Atlantic humpback whales, however, have been found to spend the summer in more or less closed geographical aggregations with only a limited exchange of individuals between them. So far there is insufficient information to quantify a potential exchange of individuals, and this is reflected in assessments and trials that have modelled the different aggregations, including West Greenland, as independent units (IWC 2014 SC/65b/Rep04, Witting, 2011).

7.2.2 Abundance

Heide-Jørgensen and Laidre (2015) presented an updated availability correction factor for humpback whales off West Greenland, and used this to generate a revised estimate of abundance from the aerial survey in 2007. Thirty-one Satellite Linked Time Depth Recorders (SLTDRs - three different models)

were deployed on humpback whales off West Greenland in May and July 2009-10. The SLTDRs recorded the proportion of a 6 hour period that the whales spent at or above 2m depth (defined here as time at the surface); 2m is considered to be the maximum depth at which humpback whales are reliably detected from the air on visual aerial surveys off West Greenland. Eighteen transmitters provided data on the surfacing time and the drift of the pressure transducer. Transmitters on six whales met the data filtering criteria and had low drift in depth data, from which the average proportion of time at the surface was estimated as 0.335 (CV = 0.10). Whales are available to be seen by observers for a period of time (i.e. availability is not an instantaneous process), so surface time needs to be adjusted to provide an unbiased correction factor for availability bias (see Laake et al. 1997).

For the 2007 survey, the time in view of detected humpback whales was an average of 3.21 seconds. Using the method of Laake et al. (1997), the data on surface time and time in view were used to estimate an availability correction of 0.368 (CV = 0.10), an increase over the estimated surface time of 10%. Using this new availability correction factor, the 2007 abundance estimate of 3,272 (CV= 0.50) was recalculated as 2,704 (CV = 0.34). The previous estimate had used an availability correction factor based on surface time defined as 0-4m, based on data from four humpback whales instrumented on Fyllas Bank, West Greenland in June 2006. The WG agreed the application of the new availability correction factor and the revised estimate of abundance for 2007.

For the 2015 aerial survey (SC/23/15), the at-surface abundance estimates for humpback whales were corrected for perception bias with point independence mark-recapture distance sampling (MRDS) models, in which it is assumed that only detections on the trackline were independent between the two teams of observers on the aircraft. Separate detection functions were fitted for the mark-recapture data and the distance sampling data. Conditional detection functions for the mark-recapture data were developed where heterogeneity was modelled with covariates (perpendicular distance to sightings, Beaufort, group size and observer); the best model selected based on AIC included perpendicular distance and observer. The estimated perception probability on the trackline, *p(0)*, was 0.99 resulting in very small adjustments to abundance from the strip census analysis.

The fully corrected abundance estimate, adopted by the AEWG (SC/23/15), was 1,321 humpback whales (CV=0.44, 95% CI: 578-3,022) off West Greenland. Group size was estimated per stratum and then combined to generate an overall expected group size of 1.53 (CV=0.16). At the IWC AWMP meeting in December 2016, an MRDS analysis with an estimated global (pooled) group size of 1.35 (CV=0.09) was developed. This gave a fully corrected abundance estimate of 1,008 (CV=0.38, 95% CI: 493-2,062) off West Greenland. The WG agreed that the estimate of 1,008 (CV=0.38) based on global group size was the best estimate because very small sample sizes in some strata led to higher variance in the estimate with strata-based group size.

7.2.3 SLAs within NAMMCO

The West Greenland humpback whale SLA developed in the IWC Scientific Committee has been simulated tested and found to provide safe and precautionary advice. The basis for these tests include that strike limits not exceed future values specified by the vector [20,25,30-50], where the first number applies from 2013 to 2018, the second number from 2019 to 2024, and the last two numbers define a linear increase over the remaining 88 years of the 100 year simulation period. There is no guarantee that strike limits greater than this are sustainable.

The output from this SLA with input of the abundance estimates above of 2,704 (cv: 0.34) humpback whales in 2007 and 1,008 (cv: 0.38) in 2015 for the block period that runs from 2019 to 2024 is 25 strikes per year. This calculation can be performed now as the SLA does not use the catch history, and the result is thus independent of the strikes in 2017 and 2018.

7.2.4 Comparison with RMP

The IWC's CLA has not been tested directly on the trials for West Greenland humpback whales. However the CLA was developed as a general procedure with adequate conservation performance when applied to a closed population. As the West Greenland humpback trials deal with a summer aggregation that is modelled as a closed population, adequate conservation performance is guaranteed if the CLA is applied for West Greenland humpback whales.

Given future annual strikes of ten humpback whales for 2017 and 2018, and the 2007 and 2015 abundance estimates, the CLA calculates total annual allowable takes starting in 2019 of respectively 13, 14 and 20 whales for CLA tuning levels 0.72, 0.66 and 0.60.

These results are, however, not directly comparable with the SLA. The humpback SLA was tested including some background by-catch, while by-catch has to be included in the total allowable removals under the CLA. The actual strike limits of the latter would thus be reduced by a few whales (the by-catch/entanglement numbers for humpback whales in West Greenland were one in 2014, nine in 2015 and three in 2016).

It is of interest to note that given the 2007 and 2015 abundance estimates, a potential advice for the block period from 2025 to 2031 (disregarding potential phase-out) would remain basically the same for the CLA. However, the 25 for the SLA would increase to 30 because of the increase in the strike limit envelopes (applying the SLA for 2025 to 2031 with the 2007 and 2015 abundance estimates generates advice of 30 strikes per year).

7.2.5 Bayesian assessment

It is of interest to compare SLA based advice with a sustainable catch estimate from a Bayesian assessment. The trials used for the SLA for West Greenland humpback whales are based on a model of density regulated growth for a closed population that is assumed to summer in the waters off West Greenland. A density regulated assessment model for a closed population was developed by Witting (2011), and the model is updated in SC/24/AS/03 with the abundance estimate for 2015 included.

This method is similar to that used to provide assessment based advice that is traditionally applied for narwhal, beluga and walrus within NAMMCO, and it estimates that a 70% chance of an increase over the block period from 2019 to 2024 is obtained for a total annual removal of 14 whales (the 70% chance of an increase resembles the NAMMCO recommendation for beluga, narwhal and walrus). If catches up to 90% of the MSYR are allowed for cases where the population is above the MSYL, it is estimated that annual strikes to around 47 whales would ensure a 70% chance of fulfilling the management objective. However this assessment approach is unable to estimate an upper bound of the carrying capacity, and there is therefore some uncertainty associated with this last strike limit estimate.

7.3 Recommendations

Based on the simulation tested humpback SLA, the WG recommended that annual strikes of no more than 25 humpback whales off West Greenland are sustainable for 2019 to 2024 and allow for an increase if the population is depleted. This result is shown to be robust by the fact that two additional approaches (the IWC CLA and an assessment method) produce similar results. Both results are in fact slightly less, but that might be expected because the CLA reduces catch limits heavily is populations are depleted even if they are recovering, and the assessment method may struggle to secure a high recovery level because many of its results correspond to a population already well above MSYL.

7.4 Future Research

Regarding **R-3.2.4**, (*investigate the relationship between the humpback whales summering in West Greenland and other areas and incorporate this knowledge into their estimate of sustainable yields of West Greenland humpback whales*), and also to clarify our knowledge North Atlantic stock structure, the WG recommended that information be collected on possible movements of individuals between summering areas (e.g. satellite tagging, biopsies, photo-ID etc.).

8. FUTURE WORK

8.1 Minke whales

Once the IWC RMP *Implementation Review* for North Atlantic common minke whales has been completed (anticipated in May 2017), the results from this should be used as a basis to provide long-term catch limit advice for minke whales in the Central North Atlantic.

8.2 General

Regarding **R-1.7.12** (*sustainable yield…for all large baleen whales in West Greenland waters*), this request will be addressed after the adoption of the finalized SLAs for fin and common minke whales in the IWC SC, expected to be completed in 2018. The bowhead whale SLA has been finalized and could be used as a basis for advice, similar to what has been done in this meeting for the humpback whale.

The WG noted that little research has been conducted for many years on sei, sperm and blue whales in the North Atlantic. It could be valuable from a conservation perspective to undertake an assessment of blue whales in the North Atlantic.

9. OTHER BUSINESS

The WG thanked Cherry Allison from the IWC Secretariat for her valuable assistance during this meeting and the Greenland Representation for providing excellent facilities. The WG also thanked Walløe and Butterworth for a well-run and successful meeting.

10. ADOPTION OF THE REPORT

The content of the report was adopted by the WG at the close of the meeting on 27 January 2017, and in final editorial form by correspondence on 1 February 2017.

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AGENDA

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ASSESSMENT

Greenland Representation
Copenhagen, Denmark, 25-27 January 2017

Chair
Lars Walløe

1. Opening remarks
2. Adoption of the agenda
3. Appointment of rapporteur
4. Review of available documents and reports
5. Central North Atlantic common minke whale stock
   - 5.1 Stock structure
   - 5.2 Biological parameters
   - 5.3 Catch data
   - 5.4 Abundance estimates
   - 5.5 Assessments
   - 5.6 Recommendation for future research
6. Fin whale
   - 6.1 Stock structure
   - 6.2 Biological parameters
   - 6.3 Catch data
   - 6.4 Abundance estimates
   - 6.5 Assessments
   - 6.6 Recommendation for future research
7. Humpback whale
   - 7.1 Stock structure
   - 7.2 Biological parameters
   - 7.3 Catch data
   - 7.4 Abundance estimates
   - 7.5 Assessments
   - 7.6 Recommendation for future research
8. Next NAMMCO SC WG on Assessment - Preparation
9. Other business
10. Adoption of the report

NAMMCO Scientific Committee
Working Group on
Assessment

25-27 January 2017, Copenhagen, Denmark

List of Participants

Doug S. Butterworh (Invited Expert)
University of Cape Town
Rondebosch 7701, South Africa
Email: Doug.Butterworth@uct.ac.za
Phone: +27 (21) 650 2343

Bjarki Elvarsson (Iceland)
Marine Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
Email: bjarki.elvarsson@gmail.com
Phone: + 354 6181681

Thorvaldur Gunnlaugsson (Iceland)
Marine Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
Email: thg@hafro.is
Phone: +354 5752081

Phil Hammond (Invited Expert)
Bute Building
University of St Andrews
St Andrews, Fife
KY16 9TS, UK
Email: psh2@st-andrews.ac.uk
Phone: +44 01334 463222

Rikke Hansen (Greenland)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 3
PO Box 2151
DK-1016 Copenhagen K, Denmark
Tel: +45 40295485
rgh@ghsdk.dk

Jill Prewitt (Scientific Secretary)
NAMMCO
PO Box 6453
N-9294 Tromsø, Norway
Email: jill@nammco.no
Phone: +47 77687373

Gisli A. Víkingsson (Iceland)
Marine Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
Email: gisli@hafro.is
Phone: +354 5752080

Lars Walløe (Working Group Chair)
University of Oslo
PO Box 1103 Blindern
N-0317 Oslo, Norway
Email: lars.walloe@medisin.uio.no
Phone: +47 22851218

Lars Witting (Greenland)
Greenland Institute of Natural Resources
PO Box 570
DK-3900 Nuuk
Greenland
Email: lawi@natur.gl
Phone: +299 361202

Nils Øien (Norway)
Institute of Marine Research
PO Box 1870
Nordnes 5817 Bergen, Norway
Email: nils.oien@imr.no
Phone: +47 55 23 86 11

NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ASSESSMENT

Greenland Representation
Copenhagen, Denmark, 25-27 January 2017

List of Documents

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Report of the

NAMMCO-JCNB
Joint Scientific Working Group
***on* Narwhal and Beluga**

8-11 March 2017
Copenhagen, Denmark

EXECUTIVE SUMMARY

A Joint Meeting of the NAMMCO Scientific Committee Working Group on the Population Status of Narwhal and Beluga in the North Atlantic and the Canada/Greenland Joint Commission on Conservation and Management of Narwhal and Beluga Scientific Working Group was held in Copenhagen, Denmark, during 8-11 March 2015. The group reviewed new information on the biology of narwhals and belugas, and updated the assessments and catch advice based on new information. To accommodate some invited participants and for the efficiency of the meeting the JWG decided to discuss narwhals and belugas together for some topics, and that organization is reflected in the meeting report and this summary.

Life History Parameters
The JWG reviewed new and updated information on life history parameters for belugas and narwhals.

Belugas
The JWG reviewed the summary table of life history parameters for belugas in Hobbs et al (2015). These discussions informed the JWG's decisions made on the values to be used in the population modelling (see Item 2.3).

Narwhals
The JWG reviewed available life history parameters for narwhal. These discussions reviewed recent advances in age estimation and results from samples collected from hunted animals that were informed by these age estimates.

The JWG noted that beluga and narwhal racemization rates for aspartic acid in the eye lens appear to be different, and the cause of this is unknown. However, the narwhal results from two different labs using two different methods were similar, lending confidence that these reflect the accurate ages.

The JWG **agreed** to use the life history information to inform the priors and the age structure for the model input.

Review of the population models
The JWG reviewed the priors used in past assessment models and discussed whether to use uniform priors or fit alternative distributions (e.g., beta, gamma) that represented our current understanding of the distributions for these priors. The JWG identified four priors that should be updated: 1) adult survival rate (p), 2) first year survival rate ($p0$), 3) birth rate (b), and 4) age at maturity (a_m) or first reproduction.

The JWG changed the prior distributions on adult survival (p), the maximum birth rate (b), and the age of the first reproductive event (a_m). In earlier analyses, uniform distributions had been used for the prior distributions of p and a_m, these were changed to symmetric hump-formed beta distributions (a=b=2) that allocated more weight of the centre of the distributions, with the assumed minimum and maximum values of the two parameters being 0.95 and 0.995 for adult survival for both beluga and narwhal, and 6 and 14 years for a_m in beluga, and 7 and 15 years for a_m in narwhal.

This report contains the views of the Working Group, and does not necessarily represent the view of the NAMMCO Scientific Committee and/or the Council, which reviewed the report at the 24th meeting.

The prior on the birth rate was then changed to a single value instead of a distribution in order to reduce the number of parameters to be estimated by the model. This value was set to 0.31 for beluga in West Greenland in accordance with the observed pregnancy rate Heide-Jørgensen and Teilmann (1994), and it was set to 0.33 for all narwhal populations to reflect a three-year calving interval.

Belugas

Stock structure

The JWG were informed of a large biogeographical study of belugas using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks.

The JWG encouraged this work, especially to help 1) identify an individual animal to a stock, 2) delineate between stocks, and possibly 3) provide a basis to identify genetic changes in response to climate change, noting that for this type of analysis, gene expression would be used, but would require samples collected to preserve RNA which is logistically challenging for most field conditions.

Hunt removals

Canada

Ferguson presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/12 that included the catch statistics from select Nunavut communities for the past five years (2011-2015; Table 1, Appendix 4). Catch reporting for the 2016-2017 harvest year was incomplete. The JWG discussed variation and uncertainty in the catch statistics.

The JWG noted that the catches have not been corrected for struck and lost. The JWG **recommended** that these catches be corrected for struck and lost.

There is uncertainty around whether the catches from Kugluktuk are from the Beaufort Sea or Somerset stock. The JWG decided not to include the catches from Kugluktuk in the modelling. The JWG also noted that catches from Kugluktuk were not included in the Beaufort Sea stock assessment. The JWG **recommended** that genetic analysis should be conducted on the catches from this area to clarify the stock identity of these catches.

There is some interannual variability in the catches from Igloolik, and it is uncertain whether these catches are from the Somerset Island stock. Canada informed the JWG that explained that seasonality of the hunt explained some allocations and that samples for genetics have been collected and the lab work has been completed, but the results have not been analysed. The JWG **recommended** that the analysis of the existing genetic results be completed.

The JWG **recommended** conducting a genetic comparison between Cumberland Sound belugas to the old West Greenland stock, using samples from the Danish Natural History Museum. If genetics indicate a linkage, the JWG further recommended a modelling exercise of these two stocks using historic population size and including catches from the old WG stock from pre-1930.

Greenland

Garde presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/06 (See Tables 2 and 3, Appendix 4). Catches declined during 1979-2016 to levels below 300 whales per year after 2004 (except for 2013 where a catch of 304 whales were reported). All catches are assumed to be taken from the Somerset Island summering stock of belugas and all the catches in West Greenland are presumably taken from the fraction of that stock that winters in West Greenland. The exception is the winter catches in Qaanaaq (approx. 5% of annual catches in Qaanaaq) that likely are taken from the fraction that winter in the North Water. It is unknown which stock is supplying the summer hunt in Qaaanaq (approx. 15% of annual catches in Qaanaaq). A few confirmed catches (and sightings) of belugas have been recently been reported from East Greenland.

The JWG noted that the catches in Qaanaaq are variable. The JWG has previously recommended that summer catches in this area be prohibited due to the lack of knowledge on the stock identity of these

catches. Small numbers of catches in the summer continue to occur. Genetic analysis of catches from Qaanaaq would be informative, however the JWG recognizes that sample collection is logistically challenging from all catches in West Greenland.

The JWG **accepted** these catch numbers for use in the assessments. The JWG further noted that the recent catches are below the quota. This is likely because with the recent ice conditions, as belugas have been observed (during aerial surveys) further from the coast, and are therefore it has become more difficult for the hunters in small boats to access the belugas. Additionally, a new cod fishery may be taking away some incentive to take marine mammals, although the price for maktak remains high in Greenland.

Recommendations

The JWG **recommended** genetic analysis for stock identity of the summer takes in Greenland.

The JWG reiterated its past **recommendation** that more accurate, and recent, struck and lost data is needed. Struck and lost is likely different for hunting method, season, etc., and the JWG recognizes that it is difficult to collect data on loss rates. However, knowing struck and lost rates is more important in areas where the quotas are small, and these hunts could be prioritised for data collection.

Abundance

No new abundance data was available to the meeting. Canada presented a database of abundance and trends of Canadian Arctic beluga whale and narwhal stocks for long-term monitoring and sustainable harvest management. The database contained 34 records for beluga whale surveys conducted between 1965 and 2015, and 22 records for narwhal surveys conducted between 1975 and 2013. The database is complete to 2015. The database can be updated as future surveys are completed and analysed. This type of database is currently planned for in Greenland, and the JWG **agreed** that it would be helpful for Greenland and Canada to cooperate on creating a consistent database.

Allocation of shared stocks

Belugas taken in West Greenland are believed to be from the Somerset Island stock.

Stock assessments and management advice

Canada

The subsistence harvest of Pangnirtung, Nunavut, is directed towards a single stock of belugas in Cumberland Sound, which forms a separate stock among belugas in the Canadian Eastern Arctic. A population model incorporating harvest statistics (1920–2015) was fitted to four aerial survey estimates using Bayesian methods, resulting in a current estimated population of 1,000 (rounded to the nearest 100) animals. The management objective is to achieve a population of 5,000 animals by 2091. This could be expressed as an interim target of 1,235 animals within a decade (2026). At current reported harvest levels of 41 animals, the probability of the population declining over a 10-year period is 1. The probability that the population would increase to the interim target was 0.3, 0.25 and 0.1 for reported harvests of 0, 6, and 25 animals respectively.

This paper provides an example of the type of modelling that Canada is conducting. This is for information for the JWG, in case this stock would be included in the future for management advice. The JWG **recommended** genetics analysis for stock identity.

The JWG noted that the were more conservative than the potential biological removal (PBR) calculations with a 0.5 recovery factor, and if the results presented in this paper correctly represented the population, the PBR was not sufficiently conservative to recover the stock.

Another survey is planned for this area during summer 2017.

West Greenland Assessment

An updated assessment for West Greenland beluga with new catch data and the new priors as agreed by the JWG. The model estimated a decline from 21,180 individuals in 1970 to a minimum of 8,470 in

2004, and it projects an increase to an expected 11,610 individuals in 2023 (assuming post 2016 catches of 225). These results are similar to those of the last assessment, and the JWG **agreed** to re-iterate the previous advice, which remains valid until 2021.

Traditional Knowledge

The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

Narwhal

Stock Structure

The JWG reviewed papers on narwhal biology, including studies on updated life history parameters of narwhals from Greenland and Canada, effect of ice entrapments on the Eclipse Sound narwhal stock, assessment of the winter range of Baffin Bay narwhals, long-term tag retention on narwhals, identification of seasonal foraging areas by examining the spatial distribution of dive data from Canadian populations and the comparison of migration patterns, diving behavior, site fidelity, travel speed, size of wintering grounds of satellite tracked narwhals from East and West Greenland.

Information in these papers were not used to update the assessment and advice at this meeting, but they contribute to the overall knowledge of narwhal biology.

The JWG were informed of a large biogeographical study using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks. A SNP-array (single nucleotide polymorphism) could be developed for the Baffin Bay region as a tool for the joint management of narwhals.

The JWG were informed on the science review of the environmental impact statement addendum for the Baffinland Mary River project.

Catch Statistics and Struck and Lost

Information on catch statistics and struck and lost was presented from both Greenland and Canada.

Greenland presented a time series that provides realistic catch levels from West Greenland during 1862-2016, which was constructed with catches split into hunting grounds and corrected for under-reporting detected from purchases of mattak (low option), for periods without catch records (medium option) and from rates of killed-but-lost whales (high option). Struck and lost rates have been estimated using factors such as community, season, hunting method, direct observations and these estimates are included in the catch history that is used in the assessment model.

Canada presented a reconstructed catch history from 1970-2015 which was constructed with catches from each hunting community that hunt narwhals from the Baffin Bay population. Hunt statistics by community were divided into catch seasons with the average from the following 10-year catch statistics for years with missing catch report. Catches were divided into 6 different hunting regions where different struck and loss corrections by period, type of hunt and community where then assigned.

The JWG noted that ideally there would be monitoring programmes occasionally for struck and lost that could be used to update the values but recognised that there are no plans for this in the near future.

Surveys and Abundance

New abundance estimates based on aerial surveys were presented from the High Arctic Cetacean Survey of narwhals in Baffin Bay, Jones Sound and Smith Sound that was conducted in Canada in August 2013 (Doniol-Valcroze 2015a,b). Density in off shore strata and fjord strata were analyzed independently and the JWG recommended reanalyzing the data so high density coastal fjord areas would not be incorporated into, and hence inflate, the large off shore strata. Comparison of photographic data and visual data will be presented at the next JWG meeting. Abundance estimates were corrected for availability bias by using information on the diving behavior of animals satellite tagged in the area.

Fully corrected abundance estimates were 12,664 (cv=0.33) for the Jones Sound stock, 16,360 (cv=0.65) for the Smith Sound stock, 49,768 (cv=0.20) for the Somerset Island stock, 35,043 (cv=0.42) for the Admiralty Inlet stock, 10,489 (cv=0.24) for the Eclipse Sound stock and 17,555 (cv=0.35) for the East Baffin stock. The JWG agreed to provisionally accept the abundance estimates but provided recommendations to investigate the current use of correction factors (satellite tagging and dive cycle) to improve the analysis.

New abundance estimates for narwhals in East Greenland based on aerial surveys were presented and these fully corrected estimates of 288 (cv=0.44) in the Tasiilaq management area and 476 (cv=0.38) for the Scoresby Sound area were accepted by the JWG for use in the assessment. Adding an off shore narwhal component from a survey in 2015 increased the estimate for Tasiilaq management area to 797 (0.69). The JWG noted that no narwhals were seen in south of the Kangerlussuaq fjord.
Re-analysis of survey data from a previous survey in 2008 decreased the abundance estimates from 2008 (1098 (cv=0.63) for the Tasiilaq management area and 1176 (cv=0.29) for the Scoresby Sound area. The JWG accepted these changes for use in the assessment.

The JWG recommended that previous surveys from 1983 and 1984 should be re-analyzed and discussed at the next JWG meeting.

The JWG reviewed new studies on the effects of tagging on narwhals (Heide-Jørgensen et al). The JWG noted that recaptured individuals equipped with satellite transmitters showed a low degree of inflammation and that it decreased with increasing thickness of epidermis around the attachment pins. The JWG noted that this information is relevant due to the expressed concerns of satellite tagging from Inuit in Nunavut. The JWG discussed that information provided by satellite tags remains critical in the use of correction factors for aerial surveys and that information from these tags contribute to the knowledge of stock structure, distribution and movement of narwhals.

The JWG reviewed the results of a satellite tagging project in the southern hunting region in Kangerlussuaq Fjord, East Greenland where a single whale was equipped with a satellite tag. The whale moved north and entered the Scoresby Sound hunting region. The movement of the whale demonstrated the connectivity between two areas in East Greenland that are considered two separate management units. The JWG recommended that satellite tagging in Kangerlussuaq Fjord should be continued.
The JWG agreed to recognize the hunting areas in East Greenland, Tasiilaq, Kangerlussuaq and Ittoqqortormiit, as three separate management areas. Maintaining these areas as three stocks is a more precautionary approach and hence is more likely to avoid local depletion.

Assessment - East Greenland
The updated assessment suggests a lower catch than the previous advice for both the Tasiilaq and Ittoqqortormiit area. The JWG recommends this lower quota. The JWG also recommends recognizing three management areas for East Greenland (Tasiilaq, Kangerlussuaq and Ittoqqortormiit). The JWG noted that the stock structure in East Greenland is unclear and that more information is needed. The JWG noted that the distribution of narwhals may be changing due to environmental changes and the JWG recommends more information on distribution and movements.

Management advice
The JWG agreed that catches should be reduced to less than 10 narwhals in both Kangerlussuaq and Ittoqqortormiit management areas. The JWG recommends that no catches are taken south of 68°N. The JWG noted that the harvest may be causing a population decline. This decline was confirmed by the model estimates, independent of the aerial surveys results, lending more evidence of a real decline.

Recommendations
- Re-evaluation of the Larsen et al (1994) survey
- Aerial survey in Scoresby Sound in 2017
- Stock identity of the Scoresby Sound winter hunt

Baffin Bay narwhal stocks
The JWG discussed the request from Canada to incorporate PBR into the catch allocation model and that the TJW intends publication of a peer-reviewed paper describing the catch allocation and assessment model which may help address concerns with implementing the model in Canada. The JWG recommends continuing using the catch allocation model for our advice.

Habitat concerns
The JWG was informed on planned studies of the short-term effects of seismic exploration on narwhals. The recent interest for oil exploration in both East and West Greenland has stressed the importance of conducting studies that assess the environmental impacts of disturbance to marine life in Greenland. Of special concern are the effects of seismic exploration, specifically the effects of the sounds produced by airguns used during seismic surveys. Airgun pulses have high sound amplitudes, which may injure mammalian ears at close ranges and are audible over great distances resulting in disturbance effects far away (e.g., tens of km) from the sound source. Narwhals are considered particularly susceptible to disturbance and are one of the least studied cetaceans when it comes to effects of anthropogenic activities. This study will assess the short-term effects of sound from airgun pulses on narwhals in a closed fjord system in East Greenland to provide an empirical basis for regulation of activities linked to seismic exploration in areas with narwhals

Based on the few studies we anticipate that narwhals will react vigorously to anthropogenic disturbance. Narwhals dive to depths exceeding 1000 m and airgun sounds may affect their diving behaviour. A sound-mediated disturbance may cause a change in migration path or displacement from a feeding area and could increase the risk of ice entrapment**.** The JWG expressed concern over seismic activities in narwhal habitat. More information on the JWG's concerns regarding habitat of both narwhal and beluga is in Item 13.

Traditional Knowledge
The Aboriginal Traditional Knowledge Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is planning an aboriginal traditional knowledge gathering project for narwhal. Updates on the progress of this project and results will be provided upon availability.

The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

The Canadian HACs (see Item 11) used input from local Inuit on locations that should be included in the survey.

<u>Habitat Concerns for both narwhals and belugas</u>
Baffinland Mary River Mine
The JWG expressed concern regarding development of mining activities and associated ship traffic on the Eclipse Sound narwhal stock. No similar example of such a high level of shipping and development has occurred in a high density narwhal habitat so there is little precedent to inform an assessment of the impacts. Of particular concern are:

4. Narwhal response to shipping activities is not well understood and may include threshold responses in which the narwhals abandon the disturbance area rather than habituate to the disturbance. In this case an irreversible loss of habitat may occur if the narwhals leave and do not re-inhabit the area even in the absence of shipping activity.
5. Ship strikes, lethal and sub-lethal effects of shipping activity may take significant numbers of narwhals. DFO (2014) estimated as many as 123 narwhal would be in the path of ships each year and be at risk of ship strike. Sub-lethal effects include disruption of feeding and

communication, with potential consequences to energetics and reproduction. These impacts may negatively affect the sustainable removal levels of the Eclipse Sound stock which is shared between Greenland and Canada.

6. Risk of an oil or toxic spill in a high latitude area is compounded by the presence of ice and the remoteness from the necessary facilities and personnel for cleanup. It is poorly understood how a high arctic ecosystem would respond to an oil spill, the effects of which are likely detrimental and possibly irreversible.

Shipping/Icebreaking in Baffin Bay

The JWG expressed concern regarding shipping and icebreaking activities in the wintering grounds of narwhal and beluga in Baffin Bay where winter time shipping is unprecedented. Ship noise and icebreaking activities will disturb deep diving narwhal during a critical feeding period and may result in unpredictable response and displacement from preferred habitat of both species. Ice breaking will disrupt the distribution and condition of sea ice which may lead to ice entrapments. The risk from oil spill discussed above applies here as well and the JWG noted that there is no available method for cleaning up an oil spill in ice covered waters. A recent gas leak in Cook Inlet, Alaska has demonstrated the difficulties of responding to such an event.

The JWG also expressed concern that cumulative effects should be considered when new shipping and icebreaking activities are proposed for narwhal and beluga habitat areas.

Climate change impact on management advice

Workshop

Various aspects of climate change may be impacting certain populations of belugas and narwhals. One example is the lack of sightings of narwhals in the southern areas in East Greenland, which may indicate a shift in distribution and/or loss of range. The JWG recommends a workshop to address concerns over changes in management advice in response to the non-hunting takes and changes in distribution resulting from development and warming of the arctic. This workshop would take place over 1-2 days and could be joined with the next JWG (in 2019). The workshop will focus on the populations in West Greenland and Canada, but should include experts involved with changes in marine ecosystems and higher trophic animals in relation to climate change in the North Atlantic and Canadian Arctic (polar bears, walrus, etc.)

The Terms of Reference for the workshop will be to:

- Identify specific effects of climate change on belugas and narwhals
  - Request papers on changes in distribution, population dynamics, etc. resulting from climate change in Canada/Greenland waters
  - The focus will be less on the mechanism of the effects, and more on identifying simple predictors and possible consequences

- Identify specific ways that the JWG's advice may be informed by these effects
  - Climate change may affect timing and distribution of hunted populations.
  - Climate change may affect population model parameters used for assessment.
  - Development in the arctic may result in changes in habitat and carrying capacity as well as increased anthropogenic disturbance which may require changes in assessment models.

Other Business

Discussion/workshop on small populations

The JWG discussed the observations that small beluga populations appear to not recover once their abundance is below around 2000 individuals. Possible issues are limited mate selection, loss of "cultural" knowledge within the population or loss of habitat from a contraction of range. Modelling exercises could shed light on the causes of the lack of recovery, identifying other issues which should

be examined for these small populations when even 0 catches do not result in recovery. This could be a one day workshop for a future JWG meeting.

Focus of the meeting
The participants noted that work procedures of the JWG should be discussed at a future meeting, of particular concern was the proportion of time given to reviewing general beluga and narwhal science and discussion and review of management advice. The concern being that the management advice is late on the agenda and may not be getting the time and consideration necessary.

Rapporteur
Rapporteuring has been done by NAMMCO although it is a joint working group of NAMMCO and JCNB. The JWG suggested that a second rapporteur be provided by the JCNB so that duties are shared between the two organizations in future meetings.

Review of Report
A draft version of the report was reviewed during the meeting, and the final version of the report was accepted via correspondence on 20 April 2017.

Next Meeting
The JWG agreed that the next meeting should be held in March 2019 and will be hosted by Canada.

NAMMCO-JCNB
Joint Scientific Working Group
***on* Narwhal and Beluga**

8-11 March 2017
Copenhagen, Denmark

Main Report

1. OPENING REMARKS

Chair Hobbs opened the meeting and welcomed the participants (Appendix 1).

1.1. Adoption of Joint Agenda

The agenda (Appendix 2) was adopted without changes, but the order that the points were taken were rearranged during the meeting due to availability of the relevant participants. These rearrangements were accepted by the JWG.

1.2. Appointment of Rapporteurs

Prewitt acted as rapporteur, with help from participants as needed.

1.3. Review of Available Documents

Hobbs reviewed the documents that were available to the meeting (Appendix 3).

2. LIFE HISTORY PARAMETERS

The JWG reviewed new and updated information on life history parameters for belugas and narwhals.

2.1 Belugas

The JWG reviewed the summary table of life history parameters for belugas in Hobbs et al (2015). These discussions informed the JWG's decisions made on the values to be used in the population modelling (see Item 2.3).

For birth rates, it was noted the values in Hobbs et al (2015) were often based on the number of females seen with calves, and that the high numbers should be treated with caution because of possible sexual segregation of the population, and low numbers also should have caution because of possible lower detection of calves. Despite the caveats, this table provided a range of values that are in the literature to inform the JWG decisions.

2.2 Narwhals

Age estimation

Matthews presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/11 which provided age estimates for narwhal using embedded tusks and aspartic acid racemization (AAR).

There has been long-standing difficulty in generating accurate age estimates of narwhal (*Monodon monoceros*). Recently, the ratio of the D to L-isomer of aspartic acid in eye lens nuclei has been used to estimate cetacean ages. L-aspartic acid converts to D-aspartic acid at a constant rate over time (racemization), and age can be estimated from the D/L ratio of metabolically inert tissue when the initial aspartic acid D/L ratio and racemization rate are known. We collected paired eye lens and embedded tusk samples from 20 narwhals to calibrate a species-specific aspartic acid racemization (AAR) rate for narwhals. Ages were estimated from counts of annual growth layer groups (GLGs) in dentine of embedded tusks, while aspartic acid D/L ratios in eye lens nuclei were measured using HPLC-MS/MS. Occlusion of the embedded tusk root by acellular cementum, which prevented dentine deposition beyond that point, limited absolute age estimates to tusks aged ≤ 14 years (n = 7). Linear regression of aspartic acid D/L ratios against the estimated age of these seven whales showed estimated age to be a

significant predictor of aspartic acid D/L ratios, with a slope and intercept of 0.00211 and 0.0688, respectively. This relationship corresponds well to that previously determined using eye lens nuclei and erupted tusks of older narwhals (0.00229x + 0.0580, respectively). Similar results from this study, which included much younger animals, extends the age range over which aspartic acid racemization rates in narwhals have been determined, and indicates AAR can be reliably used to generate age narwhal age estimates.

Discussion
The beluga and narwhal racemization rates appear to be different, and the cause of this is unknown.

The narwhal results from two different labs using two different methods were similar, lending confidence that these reflect the accurate ages.

Life History Parameters
Garde presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/16 which provided updated life history parameters for narwhals.

Biological information and samples from narwhals (n=57) were collected during field operations in Scoresby Sound (Hjørnedal), East Greenland, in the years 2011 – 2016 and in Melville Bay, West Greenland, in 2012. Eyes from 22 narwhals were available for age estimation using the AAR technique. Two tusks were collected for age estimation by counting of growth layer groups and AAR. Information on reproductive status, measures of body mass, body length, tusk length, circumference and heart mass were also collected and stomach content analysed. Asymptotic body mass and body length was estimated to be 1428 ± 69 kg and 457 ± 13,2 cm for males from East Greenland, respectively. Male narwhals from West Greenland have an asymptotic body mass of 1645 ± 55 kg and are thus heavier as adults compared to males from East Greenland. It is estimated that female narwhals become sexually mature at an age of 8 ± 1,60 – 10 ± 1,65 yrs, a body length of ~340 cm and a body mass from 550 kg – 610 kg. First parturition occurs at 9 ± 1,63 – 11 ± 1,68 yrs. Male narwhals become sexual mature at ages between 12 ± 1,70 – 16 ± 1,84 yrs, body lengths from 350 – 400 cm, and body masses between >700 kg – <870 kg. Pregnancy rate for East Greenland narwhals was estimated to be between 0.29 – 0.31 and for West Greenland 0.36. Tusk mass (kg) versus age (yrs) show a linear relationship. The longest living narwhal of 107,7 ± 8,8 yrs were recorded – previous record was 101 yrs.

Discussion
The difference in weight between males in West Greenland and East Greenland should be examined to see if season of collection could explain these differences.

The JWG **agreed** to use the life history information to inform the priors and the age structure for the model input.

2.3 Review of the population model

As background information to the discussion of the population modelling used by this JWG for belugas, Hobbs presented the population model for Cook Inlet belugas (Hobbs et al 2015). Ditlevesen presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/09 which provided examples of different options for distributions that could be used for prior distributions in a Bayesian analysis. Witting reviewed the population model for beluga that has been used in this JWG.

Discussion of priors used for the Bayesian assessment model
The JWG reviewed the priors used in past assessment models and discussed whether to use uniform priors or fit alternative distributions (e.g., beta, gamma) that represented our current understanding of the distributions for these priors. The JWG noted that priors that were too broad could introduce bias by allowing the model to use parameters that were outside the range of biological observations. Priors that were too narrow would limit the range of outcomes on which the advice is based and may make it less conservative. The JWG identified four priors that should be updated: 1) adult survival rate (p), 2) first year survival rate ($p0$), 3) birth rate (b), and 4) age at maturity (a_m) or first reproduction. The JWG

discussed the *p0* and *b* which multiply together to determine the number of belugas at age 1 in the model. This suggested that the model could be simplified somewhat by fixing the *b* at observed values for populations where this information was available and allowing the *p0* to vary.

Priors
Based on discussions the JWG decided to change the prior distributions on adult survival (*p*), the maximum birth rate (*b*), and the age of the first reproductive event (a_m). In earlier analyses, uniform distributions had been used for the prior distributions of *p* and a_m, these were changed to symmetric hump-formed beta distributions (a=b=2) that allocated more weight of the centre of the distributions, with the assumed minimum and maximum values of the two parameters being 0.95 and 0.995 for adult survival for both beluga and narwhal, and 6 and 14 years for a_m in beluga, and 7 and 15 years for a_m in narwhal.

The prior on the birth rate was then changed to a single value instead of a distribution in order to reduce the number of parameters to be estimated by the model. This value was set to 0.31 for beluga in West Greenland in accordance with the observed pregnancy rate Heide-Jørgensen and Teilmann (1994), and it was set to 0.33 for all narwhal populations to reflect a three-year calving interval.

3. Stock structure beluga

Eline Lorenzen and Mikkel Skovrind from University of Copenhagen presented information on a large biogeographic study of narwhal and beluga, using whole-genome sequencing to elucidate the genetic differentiation among geographic regions and stocks, which has so far not been possible with population genetic data in the form of microsatellites and mitochondrial control region data. These high-resolution data will hopefully uncover biogeographically informative genomic regions in the form of SNPs (single nucleotide polymorphisms). By combining these in a custom-designed SNP-array for each species, it will be possible to provide a cost-effective and relatively easy way to discern narwhal and beluga stocks, which could potentially be run in any lab with suitable equipment. If there is an interest in such a genetic tool for the joint management of narwhal and beluga stocks in Canada and Greenland, Lorenzen and Skrovind will prioritize developing a SNP-array for the region.

Lorenzen and Skovrind informed the JWG that they are also collecting samples for analysing the microbiome from the whales (swabs from the digestive and respiratory tracts) to look at possible differences between the stocks.

Discussion
The JWG identified a few areas that could be prioritized

- Include the samples collected during the tagging in major summer aggregation areas of western Hudson Bay to provide stock id for catches in this area that are not available from hunting areas.
- Summer catches in West Greenland (see Recommendations under Item 4).
- Comparison between Cumberland Sound and the extinct West Greenland stock using old WG beluga samples in the museum

The JWG encouraged this work, especially to help 1) identify an individual animal to a stock, 2) delineate between stocks, and possibly 3) identify genetic changes in response to climate change. Lorenzen noted that genomic analysis will not be able to identify changes within the last 50 years. For this type of analysis, gene expression could be used, but would require samples collected to preserve RNA which is logistically challenging for most field conditions.

3. Hunt removals beluga

Canada

Ferguson presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/12 that included the catch statistics from select Nunavut communities for the past five years (2011-2015; Table 1, Appendix 4). Catch reporting for the 2016-2017 harvest year was incomplete.

In Baffin Bay the harvest remains relatively low, likely because hunters in Nunavut prefer narwhal. There is no quota for beluga but Hunters and Trappers Organizations do provide catch statistics. Igloolik reported a relatively large take in 2011-2012, but no reports were available for recent years.

Discussion
The JWG noted that the catches have not been corrected for struck and lost. The JWG **recommended** that these catches be corrected for struck and lost.

In Table 1 (Appendix 4), "NR" means that a report was not received, not a zero catch.

There is uncertainty around whether the catches from Kugluktuk are from the Beaufort Sea or Somerset stock. The JWG decided not to include the catches from Kugluktuk in the modelling. The JWG also noted that catches from Kugluktuk were not included in the Beaufort Sea stock assessment. The JWG **recommended** that genetic analysis should be conducted on the catches from this area to clarify the stock identity of these catches.

There is some interannual variability in the catches from Igloolik, and it is uncertain whether these catches are from the Somerset Island stock. Canada informed the JWG that catches in Igloolik, and nearby Hall Beach, occur in August and September if the belugas come close to the villages, which is variable from year to year, thus explaining the variability. There are also belugas in Foxe Basin throughout the summer. Catches in this area are taken mostly in the summer and fall, with rare catches in winter and spring. Samples for genetics have been collected and the lab work has been completed, but the results have not been analysed. The JWG **recommended** that the analysis of the existing genetic results be completed.

The JWG decided to continue to leave Pangnirtung out of the modelling until there is evidence that it is a shared stock between Canada and Greenland. Movements of tagged animals indicate that the belugas remain in Cumberland Sound, suggesting that it is not currently a shared stock. When this stock was larger, there is a possibility that it could have been a shared stock (possibly related to the now-extirpated West Greenland stock), and if the stock abundance were to increase in the future, it could become a shared stock. The JWG noted that there have been a few catches in south Greenland. The JWG **recommended** conducting a genetic comparison between Cumberland Sound belugas to the old West Greenland stock, using samples from the Danish Natural History Museum. If genetics indicate a linkage, the JWG further recommended a modelling exercise of the historic population size, including catches from the old WG stock from pre-1930.

Greenland
Garde presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/06 (See Tables 2 and 3, Appendix 4). Catches declined during 1979-2016 to levels below 300 whales per year after 2004 (except for 2013 where a catch of 304 whales were reported). All catches are assumed to be taken from the Somerset Island summering stock of belugas and all the catches in West Greenland are presumably taken from the fraction of that stock that winters in West Greenland. The exception is the winter catches in Qaanaaq (approx. 5% of annual catches in Qaanaaq) that likely are taken from the fraction that winter in the North Water. It is unknown which stock is supplying the summer hunt in Qaaanaq (approx. 15% of annual catches in Qaanaaq). A few confirmed catches (and sightings) of belugas have been recently been reported from East Greenland.

Discussion
The JWG noted that the catches in Qaanaaq are variable. This is an opportunistic hunt that takes advantage of belugas passing near the village, which does not occur regularly.

The JWG has previously recommended that summer catches in this area be prohibited due to the lack of knowledge on the stock identity of these catches. Small numbers of catches in the summer continue to occur. Genetic analysis of catches from Qaanaaq would be informative, however the JWG recognizes that sample collection is logistically challenging from all catches in West Greenland.

Previous studies have accounted for past underreporting, and it is not believed that underreporting is a significant problem with the more recent catch reporting. Greenland has implemented a special form that hunters must complete with various information (e.g., hunting method, length, etc.) that is used to track removals during the hunting season in relation to the quota within the year.

Belugas taken from to ice entrapments are not included in the quotas, and are considered to be utilizing animals that would have been lost from the population due to natural mortality.

The JWG **accepted** these catch numbers for use in the assessments. They noted the improved reporting system in Greenland, and the attempts to account for each take. The JWG further noted that the recent catches are below the quota. This is likely because with the recent ice conditions, as belugas have been observed (during aerial surveys) further from the coast, and are therefore it has become more difficult for the hunters in small boats to access the belugas. Additionally, a new cod fishery may be taking away some incentive to take marine mammals, although the price for maktak remains high in Greenland.

Recommendations
The JWG **recommended** genetic analysis for stock identity of the summer takes in Greenland.

The JWG reiterated its past **recommendation** that more accurate, and recent, struck and lost data is needed. Struck and lost is likely different for hunting method, season, etc., and the JWG recognizes that it is difficult to collect data on loss rates. However, knowing struck and lost rates is more important in areas where the quotas are small, and these hunts could be prioritised for data collection.

2. Abundance- Belugas

No new abundance data was available to the meeting. Ferguson presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/10, where information from the literature was summarized on abundance and trends of Canadian Arctic beluga whale and narwhal stocks for long-term monitoring and sustainable harvest management. Metadata in the database includes area studied, time frame, survey type, uncorrected and corrected (if available) abundance estimate, measures of variability around the point estimate (confidence intervals, coefficient of variation), types of corrections for availability and perception bias, trends in abundance estimates, and limitations and sources of uncertainty. The database contained 34 records for beluga whale surveys conducted between 1965 and 2015, and 22 records for narwhal surveys conducted between 1975 and 2013. The database is complete to 2015. The database can be updated as future surveys are completed and analysed.

Discussion by JWG
The JWG noted this work, and discussed that a possible next step is to create a database of the survey data, including sightings, effort, sea state, etc. For older surveys in Canada, some of this information is not available. This type of database is currently planned for in Greenland, and the JWG **agreed** that it would be helpful for Greenland and Canada to cooperate on creating a consistent database.

3. Allocation of shared beluga stocks

Belugas taken in West Greenland are believed to be from the Somerset Island stock.

4. Stock assessments and management advice belugas

Matthews presented Marcoux and Hammill (2016). The subsistence harvest of Pangnirtung, Nunavut, is directed towards a single stock of belugas in Cumberland Sound, which forms a separate stock among belugas in the Canadian Eastern Arctic. A population model incorporating updated information on harvest statistics (1920–2015) was fitted to four aerial survey estimates using Bayesian methods, resulting in a current estimated population of 1,000 (rounded to the nearest 100) animals. The

management objective is to achieve a population of 5,000 animals by 2091. This could be expressed as an interim target of 1,235 animals within a decade (2026). At current reported harvest levels of 41 animals, the probability of the population declining over a 10-year period is 1. The probability that the population would increase to the interim target was 0.3, 0.25 and 0.1 for reported harvests of 0, 6, and 25 animals respectively.

Discussion
This paper provides an example of the type of modelling that Canada is conducting. This is for information for the JWG, in case this stock would be included in the future for management advice. The JWG **recommended** genetics analysis for stock identity.

The JWG noted that the results presented in Marcoux and Hammill (2016) were more conservative than the potential biological removal (PBR) calculations with a 0.5 recovery factor, and if the results presented in this paper correctly represented the population, the PBR was not sufficiently conservative to recover the stock.

Another survey is planned for this area during summer 2017.

Assessment of West Greenland belugas
NAMMCO/SC/24-JCNB/SWG/2017-JWG/13 updated the assessment for West Greenland beluga with new catch data and the new priors as agreed by the JWG. The model estimated a decline from 21,180 (90% CI:15,370-29,620) individuals in 1970 to a minimum of 8,470 (90% CI:6,016-11,890) in 2004, and it projects an increase to an expected 11,610 (90% CI :6,320-19,520) individuals in 2023 (assuming post 2016 catches of 225). These results are similar to those of the last assessment, with a total annual removal of 310 individuals from 2017 to 2022 ensuring a 70% chance of an increase in the population over the period.

Discussion
The JWG noted that the changes in the priors (see Item 2.3) did not have a strong influence on the assessment.

This is an updated analysis, and the JWG **agreed** to re-iterate the previous advice, which remains valid until 2021.

5. Habitat Concerns belugas
See discussions for habitat concerns for both belugas and narwhals in Item 13.

6. Traditional Knowledge belugas
The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Information is collected on land and marine use by the community, fisheries resources and habitat, fish species, bird species, community infrastructure, marine mammals, aquatic plants, shellfish harvesting, etc. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

7. Stock structure narwhal
7.1. Genetics
Lorenzen and Skovrind informed the JWG on their project(s) involving genetics in beluga and narwhal. See Item 3 for information on this project.

Discussion
The JWG is interested in being able to assign an individual animal (e.g. hunted) to a specific stock.

The JWG noted that for stock identity, Lorenzen would need to know the date of kill/sample collection, specifically prioritizing summer samples (defined as the last week of July, first 3 weeks of August).

7.2 Tagging and Movements
The JWG discussed Heide-Jørgensen et al (2017) "Long-term tag retention on two species of small cetaceans":

Abstract:
The effects of tagging on small cetaceans are difficult to assess due to logistical difficulties in recapturing the whales. In this study two narwhals, *Monodon monoceros*, and five harbor porpoises, *Phocoena phocoena*, were recaptured between 297 and 767 days after instrumentation with satellite transmitters. The transmitters were mounted by pins that were pushed through the fins of the porpoises or the backs of the narwhals. Overall body condition seemed unaffected by the instrumentations. Macroscopical examination revealed that umbilicalization of the tissue surrounding the pins was almost complete. On one of the narwhals the reepithelialization created a closed tunnel where the pins were isolated from the subdermal tissue, however the reepithelialization was incomplete around the middle of the pin and a low-grade inflammation increased with decreasing thickness of epidermis. The inflammation consisted of mononuclear cells, mainly lymphocytes. With increasing inflammation the number of neutrophils and macrophages increased. In the lymphoid follicular hyperplasia macrophages and a few neutrophils were found, in one case accompanied by Splendore-Hoeppli material with radiating eosinophilic clubs and Gram-positive cocci. Immunohistochemical staining of the cocci for *Staphylococcus aureus* was positive. The observations from the recaptured cetaceans suggest that the instrumentations caused only temporary and low-grade inflammatory responses.

Discussion
This information is relevant to our discussions of tagging for investigations of movements of individual whales.

Hobbs indicated that the US is planning a workshop in fall 2017 to review impacts of current tag attachments on cetaceans and to discuss design improvements.

The satellite tagging of narwhal and beluga remains a sensitive issue in Nunavut and Inuit have expressed concerns about invasive methods. Efforts to minimize the impacts of satellite tags on individuals is ongoing including the adoption of new technologies. The information provided from these devices remains critical in the use of correction factors that contribute to the generation of abundance estimates from aerial surveys. The information from these tags also contributes to the knowledge of stock structure, distribution and movement of narwhals.

East Greenland movements
Heide-Jørgensen presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/05, and also discussed relevant results in Heide-Jørgensen et al (2015) as background information.

One adult female narwhal (345cm) was tagged in Kangerlussuaq in East Greenland on 24 August 2016. The purpose was to investigate the stock identity of narwhals in fjord systems in East Greenland and especially those that are supplying the hunt in Tasiilaq and Ittoqqortormiit.

The narwhal was tagged with a Wildlife Computers SPOT6 backpack transmitter that was duty cycled to transmit every day.

The whale remained inside the Kangerlussuaq fjord system until it departed from the fjord on 6 October. It took a north-going coastal course along the Blosseville Coast where it visited almost every inlet and bay until it reached Kap Brewster on 21 October at the entrance to Scoresby Sound. It moved as far east as Føn Fjord (5 November) as far north as Bjørne Øerne (28 November). It spent most of its time in Gåse Fjord and it departed from Scoresby Sound (passing Kap Brewster) on 9 December. It spent the winter (through 24 February) on the East Greenland shelf area off the Blosseville Coast.

The movements of the whale demonstrated the connectivity between two areas in East Greenland that are considered separate management stocks. Narwhals in Kangerlussuaq are only hunted by hunters from Tasiilaq and hunters from Scoresby Sound never venture that far south along the uninhabited Blosseville Coast. The whale nevertheless spent November in Scoresby Sound in areas where narwhals are hunted although infrequently that late in the year.

After the relatively late departure from Scoresby Sound in December the whale stayed in the same areas where narwhals tagged in Scoresby Sound have remained in winter (Heide-Jørgensen et al. 2015).

More tagging of narwhals in Kangerlussuaq is needed to determine if the timing of their fall visits to Scoresby Sound coincides with the hunting season for narwhals in that area.

Discussion

Narwhals in East Greenland are hunted in Tasiilaq, Kangerlussuaq, and Ittoqqortormiit. Previously, the animals hunted in Kangerlussuaq have been assigned to the Tasiilaq quota. However, the only animal tagged in Kangerlussuaq moved north to Scoresby Sound. The JWG **agreed** to recognize these hunting areas as three separate management areas (Tasiilaq, Kangerlussuaq and Ittoqqortormiit). Maintaining these areas as three stocks is a more precautionary approach as it is more likely to avoid local depletion.

The JWG also discussed the possible connection between the East Greenland and Svalbard stocks. Of 29 animals tagged in Greenland, none went to Svalbard. There are sightings of narwhals in the Greenland Sea between East Greenland and Svalbard, but the JWG considered that there could be two populations that are not connected – a coastal population in East Greenland and a coastal Svalbard population.

Greenland informed the JWG that a survey will be flown in northern East Greenland (Northeast Water Polynya) in spring 2017. There will also be another survey in summer 2017 in south East Greenland.

8. Hunt removals narwhal

Canada

Ferguson presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/08, a reconstructed catch history from 1970-2015 (See Table 4, Appendix 4).

Abstract

Catch statistics from 1970-2015 for 13 Canadian communities that hunt narwhals from the Baffin Bay population are reviewed. Detailed statistics by community are missing from some of the communities, particularly before quotas were implemented in 1977. In these cases, an average value calculated from reported hunts in the following 10 years is used as approximation. Many catches were reported with date of kill which allowed a separation of hunt statistics across seasons. Catches were then divided into seasons for all years. When date of kill was not reported, as with total catch, we averaged catches over the next 10 years to estimate catch by season. Finally, catches were attributed to 6 different hunting regions in Canada, including Grise Fiord, Central Canadian Arctic, Arctic Bay, Pond Inlet, Baffin Island Central, and Baffin Island South and assigned different struck and loss corrections by period (1979-1989, 1990-2004, and 2005-2015), and when possible by type of hunt (open water, ice edge/crack), and community. The results can be used for data modelling purposes and thereby provide more reliable estimates of sustainable hunt management advise.

Discussion

The JWG noted that 10 years is a long time for using an average to fill in the missing data, but for this older data it has little influence on the results of the modelling.

Self-reporting rates from hunters were similar to rates reported by observers, suggesting that hunter self-reporting may be sufficient.

The JWG thanked Canada, especially Watt, for providing this work which fulfils the request from the last meeting (see NAMMCO 2016). The JWG **agreed** to use these catch numbers for the analysis.

Greenland
Garde presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/07, in which information and statistics including some trade statistics on catches of narwhals (*Monodon monoceros*) in Greenland since 1862 are reviewed (See Tables 5 and 6, Appendix 4). Since 1993 catches have declined in West Greenland especially in Uummannaq and Disko Bay where the decline is significant. In East Greenland there has been an increase of 5% per year since 1993.

Discussion
The JWG **agreed** to use these catch numbers from West and East Greenland in the model. The East Greenland information provided updated catches since 2010 and were corrected for struck and lost (30%, based on direct observations).

9. Habitat Concerns narwhal

Ferguson presented Richard et al (2013). Published tracking studies of narwhals have delimited two winter home ranges in Baffin Bay and Davis Strait for the Baffin Bay population of narwhals. One centres in northern Davis Strait and southern Baffin Bay, the "southern narwhal over-wintering area", which is in large part within Canadian waters, and contains Canadian narwhal summering stocks from Admiralty Inlet and Eclipse Sound, and the Greenland narwhal stock from Melville Bay. New tracking data from narwhals tagged in Admiralty Inlet suggest that the narwhals that summer there use the southern wintering area annually. Animals in the southern wintering area forage at depths over 1,000 m and it appears that a large part of their diet is Greenland halibut. The second wintering area referred to as the "northern narwhal over-wintering area" is largely inside Greenlandic waters of central Baffin Bay and is used by narwhals from the Somerset Island summering stock. The Division 0A Narwhal Overwintering and Coldwater Coral Protection Zone (fishing closure) includes an area of particularly high Ecological or Biological Significance and requires the provisions to protect and manage fishing activities in such areas.

Discussion
The JWG **recommended** maintaining the closure in this area.

Ferguson presented Watt et al. 2017:

> Abstract: In Canada, narwhals (*Monodon monoceros* L., 1758) are divided into the Baffin Bay (BB) and northern Hudson Bay (NHB) populations. Satellite tracking of 21 narwhals from BB and NHB provided information on their diving behaviour and was used to identify foraging regions. Previous research from hunted narwhals indicated that narwhals in both populations depend on benthic prey to meet their dietary needs. To evaluate home ranges and define areas important for benthic foraging, we conducted kernel density analysis on narwhal locations and focused on areas where deep diving occurs, as a proxy for foraging, in the winter, spring, and migratory periods. These analyses revealed important areas for foraging for BB narwhals on the summer grounds in Eclipse Sound, and the winter grounds in Davis Strait, as well as on the migratory pathway between regions. Similarly, important areas were identified for the NHB narwhal population in northwestern Hudson Bay in summer, in NHB and Hudson Strait on the migration, and to the east of the entrance to Hudson Strait in the winter. This, along with an analysis of the absolute dive depths, provides information on seasons and regions important for foraging, which is particularly relevant with increasing industrial activities in the Arctic.

Discussion
The "deep dives" described in this paper are deep relative to the bottom. The JWG noted that the depth measurements are not very precise, thus it is uncertain whether the deep dives actually made contact with the bottom, or were mid-water foraging dives.

Satellite tracks show that narwhals remain close to shore in summer, and are not diving frequently. Tracking of both killer whales and narwhals suggest that narwhals are remaining near shore to avoid the killer whales.

Plans for research in Eclipse Sound
Matthews presented updated information on recent research in Eclipse Sound.

An aerial survey of the Eclipse Sound and Admiralty Inlet narwhal stocks was conducted in August 2016 to update estimates obtained from surveys conducted in 2013. Photographic surveys were flown along pre-determined transect lines over nine days between August 7-21, including repeats of Tremblay Sound (n=7), Milne Inlet & Koluktoo Bay (n=4), and Eclipse Sound (n=3). Unfortunately, Admiralty Inlet was only partially surveyed once (August 13) due to poor sea state conditions which persisted throughout the survey period. Photos are currently being analysed, with a goal of producing abundance estimates from four replicate surveys (August 9, 10, 15, and 21) of the Eclipse Sound beluga summering range. Count data from Admiralty Inlet will not be used to estimate stock abundance due to incomplete coverage of the area.

A satellite telemetry study of Eclipse Sound narwhals was also conducted during August 2016 to provide information on 1) stock discreteness, 2) migratory pathways, winter range, feeding and diving habits, and 3) changes in behaviour in the presence of marine vessels and other industrial activity. A field camp was established in Tremblay Sound from Aug 11-31. To capture narwhals for tag deployment and sample collection, 50-m mesh nets were set perpendicular to the shore and were monitored at all times. Captured narwhals were brought to shore, where they were restrained and equipped with a satellite transmitter attached onto their dorsal ridge. Blood, morphometric measures, and other biological samples (e.g. blubber) were taken before the whale was released. Six narwhals were captured, including a juvenile that was not tagged. The five tagged whales included three females (one with a tusk) and two males. Two of the tags stopped transmitting early after deployment (one whale was shot by a hunter a few days after tagging), and one tag stopped transmitting while in the Eclipse Sound area. Two of the tags continued transmitting as the whales moved along the known migration route to wintering grounds in Baffin Bay, and stopped transmitted on November 10 and 17, respectively.

Trace elements were measured in skin samples of 188 narwhals from five Canadian summer stocks of the Baffin Bay narwhal population (Admiralty Inlet, n = 49; East Baffin Island, n = 16; Eclipse Sound, n = 63; Jones Sound, n = 45; Somerset Island, n = 15). Trace elements can be useful for stock delineation because the concentrations of trace elements in the marine ecosystem are related to underlying geology (e.g. lead [Pb] and strontium [Sr]), which can lead to regional differences in baseline marine food web trace element concentrations that are ultimately reflected in animal tissues. Additionally, trace element concentrations can reflect certain dietary preferences (e.g. cadmium [Cd] is elevated in marine mammals feeding largely on cephalopods; Bustamente et al. 2004; Lahaye et al. 2005). Preliminary principle components and discriminant analyses of the 31 trace elements measured in the narwhal skin samples show separation among the Baffin Bay narwhal stocks.

Discussion
The updated abundance estimate for Eclipse Sound are expected in a CSAS document in fall 2017, and will be available at the next JWG meeting.

General discussion on habitat concerns
Heide-Jørgensen updated the JWG on planned studies of the short-term effects of seismic exploration on narwhals. The recent interest for oil exploration in both East and West Greenland has stressed the importance of conducting studies that assess the environmental impacts of disturbance to marine life in Greenland. Of special concern are the effects of seismic exploration, specifically the effects of the sounds produced by airguns used during seismic surveys. Airgun pulses have high sound amplitudes, which may injure mammalian ears at close ranges. These high amplitudes also mean that the pulses will generally be audible over great distances and can therefore result in disturbance effects far away (e.g.,

tens of km) from the sound source. Even though all marine mammals can be considered vulnerable to some extent to sounds from airgun pulses, narwhals are considered particularly susceptible to disturbance. Narwhals are also one of the least studied cetaceans when it comes to effects of anthropogenic activities. This includes in particular short-term reactions to airgun pulses, which might lead to longer-term effects on populations. In this study it is planned to assess the short-term effects of sound from airgun pulses on narwhals in a closed fjord system in East Greenland, to acquire knowledge about narwhal movements in response to airgun pulses that can be applied to disturbance scenarios in both East and West Greenland as well as in offshore areas and to provide an empirical basis for regulation of activities linked to seismic exploration in areas with narwhals

The current lack of information on narwhals makes it impossible to predict the type and level of disturbance that airgun sounds would cause in areas with high densities of narwhals. Based on the few studies we anticipate that narwhals will react vigorously to anthropogenic disturbance. Narwhals dive to depths exceeding 1000 m and airgun sounds may affect their diving behaviour. A sound-mediated disturbance may cause a change in migration path or displacement from a feeding area. If a displacement occurs when they are in areas with heavy ice coverage or an area about to freeze over, then they could get trapped in ice.

Discussion

The JWG expressed concern over seismic activities in narwhal habitat. More information on the JWG's concerns regarding habitat of both narwhal and beluga is in Item 13.

10. Traditional Knowledge Narwhal

The Aboriginal Traditional Knowledge Subcommittee of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is planning an aboriginal traditional knowledge gathering project for narwhal. Updates on the progress of this project and results will be provided upon availability.

The Government of Nunavut's Department of Environment completed a Nunavut Coastal Resource Inventory (NCRI) in Pond Inlet in 2016. Information is collected on land and marine use by the community, fisheries resources and habitat, fish species, bird species, community infrastructure, marine mammals, aquatic plants, shellfish harvesting, etc. Local Inuit knowledge, both spatial and anecdotal, collected on narwhal and beluga in this area may be relevant for the JWG and will be compiled and presented for the next meeting.

The Canadian HACs (see Item 11) used input from local Inuit on locations that should be included in the survey.

11. Abundance

Correction factors

Riisanger-Pedersen presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/17 which deals with developing depth correction factors for aerial surveys. One of the technical challenges to using line transect aerial surveys is the development of an appropriate depth correction factor, which represent proportion of time that the animals are visible for the observers. To estimate this six narwhals were instrumented with time-depth recorders. Five animals carried an Acousonde and one carried a SPLASH tag from Wildlife Computers. Sensor inertia, causing parts of the dive profiles to be displaced, were corrected for each single dive using the compensation setting in the software program MTdive.

Discussion

The issues with the instrument not recording the surface correctly may be due to a delay in the sensor resulting from a change in the water temperature as the tag approaches the surface so that a short period of time is required for the sensor to reach the ambient temperature at the surface.

The JWG discussed that the method of choosing where to start and end applying the compensation could introduce bias in the proportion of time at the surface. Although this bias may be small, the effects of adjusting the method of compensation should be examined. One possibility for examining when to

start the compensation is to use the Acousonde sound recording to verify when the animal is actually surfacing. This would be labour intensive, so a first step would be to test a subsample of the data.

The JWG discussed whether there could be variation in the error between instruments, e.g., are they consistently wrong. The JWG recommended that this be investigated further.

Tervo presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/19. Thirty-two harbour porpoises were instrumented with satellite linked time depth recorders (TDR) in Western Greenland off Maniitsoq in 2013-2014. Four of them were retrieved in 2016 and three of them had sufficient data allowing comparisons between the transmitted time-at-depth (TAD) data and the archival TDR data. Comparisons between temporal resolution, time at surface (at depths >= -2) and time at different depth categories between the two datasets were made. Only daytime data between 07:00:00 and 18:59:59 were used. The transmitted TAD data had 159 (39 %) fewer transmission days compared to the raw TDR data. Time spent at surface was underestimated by the TAD datasets for all the three individuals (in average 6.1 ± sd 1.7 hours/12 hours and 4.5 ± sd 2.4 hours/12 hours, respectively). The trends in both datasets and for all individuals were comparable with a decreasing tendency in time spent at the surface with progressing season, however it is possible that some of the change observed is the result of progressive instrument failure. For time spent at depth, in average all depth bins apart from bin 2, were underestimated by the TAD data.

The reasons for the discrepancies in the two datasets are unknown. Time spent at surface is an important component in the correction factor used in the analysis of abundance data from surveys. Using TAD data alone for calculating availability will result in an underestimation and can thus lead to an overestimation of abundance.

Discussion

The JWG discussed what the mechanism is behind the decline in the data. There is likely an issue with the programming. One possibility is the compression algorithm is losing some of the data at uplink.

There may also be issues with the sensor, possibly due to accumulation of "crud" or corrosion on the sensor. These issues may not be a problem for larger, slow moving species, but for quick, fast moving species, it is possible that they are not at depth for a long enough time for the sensors to detect the surfacing.

The JWG **agreed** that SLTDR data should be used with caution when developing correction factors. The TDR data appears to be more trustworthy than the TAD data. Alternatively the experimental results presented could be used to develop a correction for the TAD data.

Angle measurements during aerial surveys

Hansen presented information on a new device for measuring angles during aerial surveys, the Geometer. Aerial surveys employing distance sampling techniques are widely used in estimating the abundance of marine mammals and other wildlife. Distances are estimated using the declination angle from the observer to the sighting, which is either estimated by the observer or measured using an analogue forestry inclinometer. Angle estimation is imprecise and inaccurate, while using analogue inclinometers is cumbersome, slow and requires manual transcription of recorded data. A new device, called a geometer, was therefore developed in Iceland for the NASS 2015 survey. The geometer is a handheld, USB-connected device that measures pitch, roll and yaw and records these measurements with date and time when the user depresses a button. The observer simply aims the device at the sighting using a red-dot rifle sight, and depresses the button to record these data to a computer. The associated software also facilitates the recording of GPS data, voice and video. Up to four or more geometers can be recorded simultaneously on a single computer. The major advantages of the geometer over other measurement devices are: 1) ease of use, reducing observer training time and enabling faster measurements in high-density areas; 2) no recording or transcription error; 3) accurate timing of observations, improving the precision of distance measurements and duplicate identification; and 4) elimination of time-consuming data transcription. Extensive testing has shown that angle measurements

are at least as accurate and precise as those taken by other methods, with no calibration drift over time. To date geometers have been employed successfully in two aerial surveys in Iceland and one in Greenland.

Discussion
The JWG noted that this device adds great precision to angle measurements critical to distance sampling analysis.

Database of Abundance Surveys in Canada
Ferguson presented paper NAMMCO/SC/24-JCNB/SWG/2017-JWG/10 which gave information on a database of abundance surveys belugas and narwhals in Canada. See Item 5 for more information.

East Greenland survey
Hansen presented NAMMCO/SC/24-JCNB/SWG/2017-JWG/18. A visual aerial survey of narwhals was conducted in fjords and bays along the coast of East Greenland in August 2016. A total of 66 unique sightings of narwhal groups were recorded in 9 strata, with more than half of the sightings occurring in the Scoresby Sound region, primarily in the tributary of Nordvestfjord.

The uncorrected individual abundance estimate was 237 (CV=0.318, 95% CI= 128-437) narwhals. A new availability correction factor was developed based on archival instruments deployed on six narwhals in Scoresby Sound in 2013-16. The average surface time from the whales that provided data was 0.31 (SE=0.064, cv=0.08) during daylight hours. The fully corrected individual abundance estimate was 765 (CV 0.33; 95% CI: 409–1430). The disaggregated estimates for the Tasiilaq management area was 288 (CV=0.44, 95%CI 125-663) and 476 (CV=0.38, 95%CI 232-977) narwhals for the Scoresby Sound area.

A survey in 2015 covered areas off the coast of East Greenland and including the estimate from that survey increases the abundance estimates to 1268 (0.48; 95% CI: 519–3098). Adding the offshore estimate to the Tasiilaq management area gave 797 (0.69, 95%CI 236-2686) narwhals in that area alone. Recalculation of the 2008-survey with corrected transect lengths, new stratum areas and the new availability correction factor gave an estimate of 2274 (cv=0.53, 95%CI 862-6002) narwhals in 2008. The disaggregated estimates for the Tasiilaq management area was 1098 (0.63, 95%CI 351-3437) and 1176 (0.29, 95%CI 661-2094) narwhals for the Scoresby Sound area in 2008.

Discussion
The correction factor presented in NAMMCO/SC/24-JCNB/SWG/2017-JWG/17 was applied to the data from this survey. Only one of the fjords in this area is muddy, so these data were not corrected for different detectability in murky water.

The northeast part of Scoresby Sound was not covered because both the satellite tracks and the 2008 survey have not shown that narwhals use this area.

The 2016 survey had the same number of sightings as the 2008 survey, however the distribution was different. The most important difference between the surveys was the expected group size. The use of the geometer (see NAMMCO/SC/24-JCNB/SWG/2017-JWG/O20) might have changed the estimates of group size because the observers had more time during the sightings, and therefore "clumped" the groups less.

During the 2016 survey, no narwhals were seen in the southern areas, whereas during the 2008 survey there were 3 sightings of narwhals.

2008 re-analysis
The changes in the transect lines (km instead of nm) and strata both decrease the abundance estimate. The re-analysis also included the application of the new availability correction factor. The biggest issue

is the availability of 0-2m, as there is uncertainty in the depth at which narwhal can be seen. The JWG noted that the re-analysis halved the abundance estimate.

The JWG **accepted** these changes to the 2008 analysis and agreed to use the new numbers in the assessment. However, the JWG recognizes that there may be further analysis that could be done with the availability correction factor in the future (review of depth of visibility, detection depth).

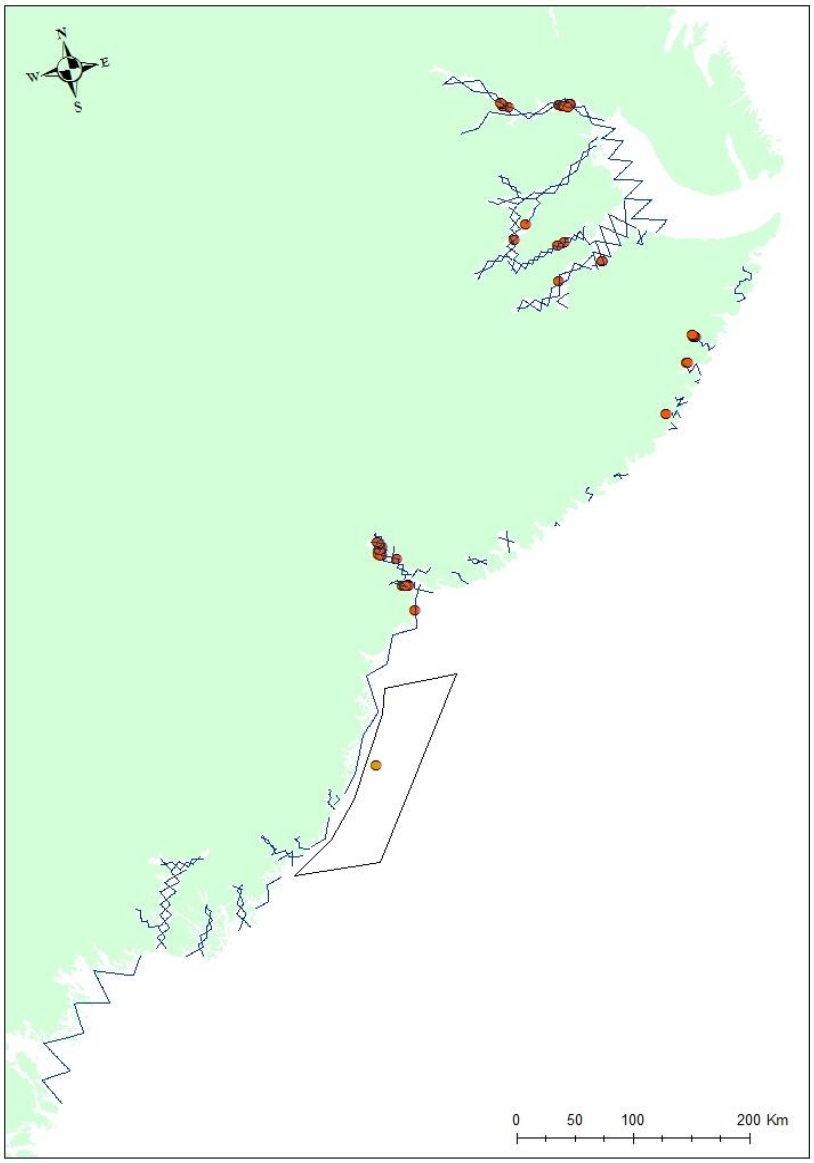

Figure 1. Transect lines in ss<3 and sightings of narwhals. The offshore strata is from 2015.

2016 estimate

The 2016 survey included an added "offshore" strata. There could be an "offshore" component of the population, or an influx from the northern area. The JWG **agreed** to the addition of the offshore strata, as these animals could be part of that population.

The JWG **agreed** to use these estimates in the assessment, while recognizing that continued analysis may refine the results. While continued analysis is not likely to change the results drastically, possible areas of future analysis include looking at the truncation, correction factors, etc.

The JWG noted that this area has been/is being heavily impacted by climate change. There have been many observations of new species (dolphins, humpback whales, killer whales), and it is looking less like narwhal habitat. The ecosystem changes in this area are having uncertain impacts.

Canadian High Arctic Cetacean Survey
Doniol-Valcroze presented (via Skype) information on the 2013 High Arctic Cetacean Survey (HACS) of narwhal stocks in Baffin Bay, Jones Sound and Smith Sound (Doniol-Valcroze et al 2015a,b; DFO 2015; Pike and Doniol-Valcroze 2015).

DFO conducted the High Arctic Cetacean Survey (HACS) in August 2013 to estimate abundance of all four Canadian Baffin Bay narwhal summer stocks as well as putative stocks in Jones Sound and Smith Sound. This is the first survey to count all of the narwhal stocks in the Canadian High Arctic during one summer (Fig. 2).

Narwhal abundance was estimated using a double-platform aerial survey. Three aircraft were used simultaneously to cover the vast survey area within a short time frame. Each stock range was divided in several strata, based on geographic boundaries as well as observed densities of narwhals from past surveys. Distance sampling methods were used to estimate detection probability away from the track line. Mark-recapture methods were used on the sighting data from two observers on each side of the aircraft to correct for the proportion of narwhals missed by visual observers (i.e., perception bias).

Duplicate sightings (NAMMCO/SC/24-JCNB/SWG/2017-JWG/O06)
One of the key assumptions of distance sampling is that all animals on line are detected by observers. Double-platform methods have been developed to address situations of incomplete detection at the track line, but they require the identification of sightings seen by both observers. However, there is no means to independently and unequivocally determine whether or not a given pair of sightings is in fact a duplicate pair, or to select the most likely duplicate among a set of candidate sightings observed in close proximity. Most previous studies have used ad-hoc methods and arbitrary thresholds. Here, we develop a data-driven approach to identify single and duplicate sightings made during the 2013 High Arctic Cetacean Survey (HACS). We make use of four covariates to compare sightings made by front and rear observers: difference in time of sighting, difference in declination angle, difference in group size and difference in species identity. To estimate the relative weights of these covariates, we compared two datasets in a logistic regression framework: a set of sighting pairs that contain both duplicates and non-duplicates and a similar dataset known to contain no true duplicates (the observations made at the same time but on the other side of the plane). This allowed us to determine which combinations of factors were most successful at discriminating duplicates and to rate each candidate pair within the same-side data with an index of dissimilarity. Candidates with the lowest scores were identified as duplicates using two different methods and a range of threshold values for each covariate. Depending on the procedure used, 19% to 30% of narwhal sightings in the HACS dataset were seen by both observers, whereas 36% to 50% of bowhead whale sightings were seen by both observers. However, the aggregated nature of the sightings and particularly the relatively high proportion of missing primary data such as declination and group size made the identification of duplicates uncertain in many cases.

Density in Fjords (NAMMCO/SC/24-JCNB/SWG/2017-JWG/O05)
Previous studies have shown that narwhals spend time inside narrow inlets and fjords on their summer distribution range. Thus, any surveying effort must include these areas to provide a credible abundance estimate. Estimating abundance in fjords, however, creates logistical and statistical difficulties because of their narrow complex shapes and high cliffs, preventing the use of conventional distance sampling based on systematic transects. To address these issues, we used a two-stage cluster sampling design in which fjords designated as primary sampling units were selected in a way that maintained equal probability and systematic coverage. Within each fjord, we estimated density and abundance of narwhals using spatial density modelling. Density surface models do not require track lines to be designed according to a formal survey sampling scheme, and accommodates both non-random and

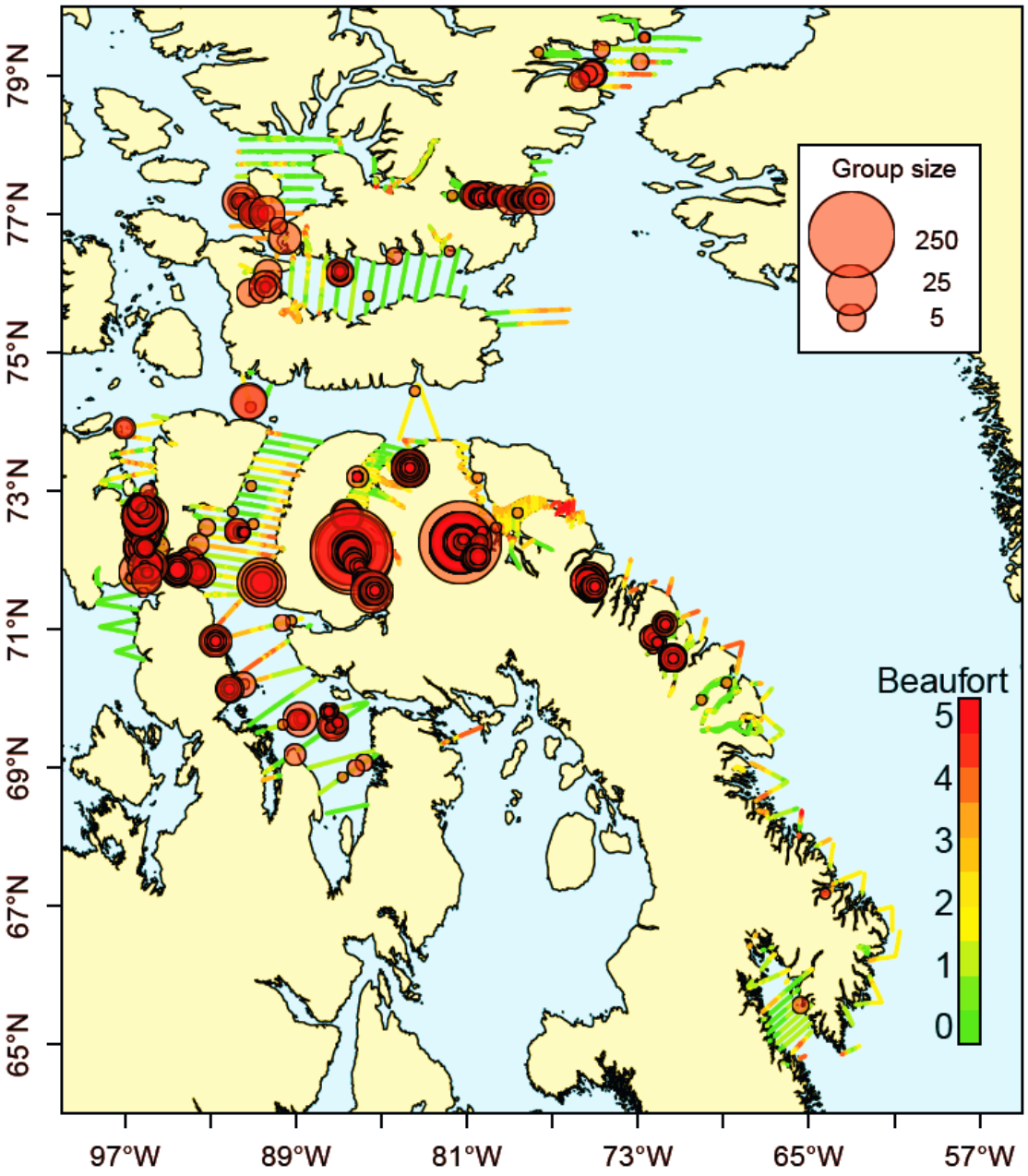

Figure 2. Unique sightings of narwhal groups made during the 2013 High Arctic Cetacean Survey (red circles). Lines represent realized effort with color scale showing Beaufort conditions.

unequal coverage. Moreover, the resulting variance of the abundance estimate incorporates both the variance from the detection function and that of the spatial model. Because no observations were made in West Ellesmere fjords, no abundance estimate was produced. Sightings of narwhals in the other fjords during HACS were highly variable. After expanding the abundance estimates to unsurveyed fjords, total (surface) abundance estimates were 45 for Jones Sound fjords (CV 94%), 1,916 (CV 45%) for Smith Sound fjords, 143 (CV 85%) for Admiralty Inlet fjords, 1,135 (CV 19%) for Eclipse Sound fjords, and 3,799 (CV 35%) for east Baffin Island fjords. Abundance estimates for the fjord strata will be added to other strata estimated via conventional distance sampling.

Discussion

The JWG discussed whether the density modelling could have been used for the entire area, rather than the traditional distance sampling. Density modelling is a new approach and there was some reluctance to use it for the entire survey. Rather, it was seen as a solution for the challenge of the fjords, not for use in the whole area.

The selection of which fjords to survey was done randomly, however certain fjords are known to be very important areas to survey. For the HACS, Makinson Inlet happened to be selected randomly, but if it had not been, this likely would have been problematic since it was the highest density strata (Fig. 3). One possibility would be to sub-stratify. Post-stratification was not seen as an option because there was limited previous knowledge of narwhal distributions in this area, and there was hesitation in making any assumptions.

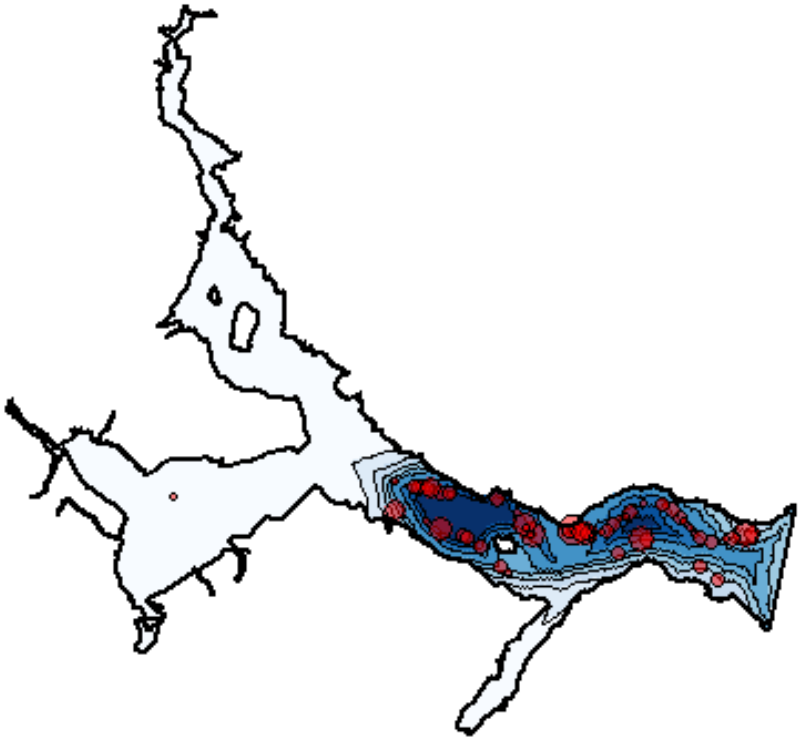

Figure 3. Spatial density surface of narwhal abundance in Mackinson Inlet (Smith Sound fjords stratum). Red line: track of aircraft. Red circles: sightings of narwhal groups. Darker shading indicates higher predicted density.

The JWG discussed the definition of the fjord strata, and that the strata as defined are potentially inflating the estimate. The JWG suggested creating a “near-shore” strata.

The comparison of the photographic data and the visual data has not been finalized, but preliminary results indicate close agreement in the estimates. The results of this comparison will be presented at the next JWG meeting.

Abundance estimates
Doniol-Valcroze et al (2015) contains the abundance estimates from the HACS.

Abundance estimates were obtained for each stock by combining standard Mark-Recapture Distance-Sampling estimates for off-shore strata and density spatial modelling estimates for fjord strata. Estimates were corrected for availability bias (narwhals that are not available for detection because they are submerged when the plane passes overhead) using a new analysis of satellite-linked time depth recorders transmitting information on the diving behaviour of narwhals in August.

Fully corrected abundance estimates were 12,694 (Coefficient of Variation [CV] 33%) for the Jones Sound stock, 16,360 (CV 65%) for the Smith Sound stock, 49,768 (CV 20%) for the Somerset Island stock, 35,043 (CV 42%) for the Admiralty Inlet stock, 10,489 (CV 24%) for the Eclipse Sound stock, and 17,555 (35%) for the East Baffin Island stock. Sources of uncertainty arise from the high level of clustering observed, particularly in Admiralty Inlet, Eclipse Sound and East Baffin Island, as well as the difficulty in identifying duplicate sightings between observers in large aggregations.

Discussion
The time in view was developed using 3 tags that classified dives starting at 8m, and these likely should not be used for the development of the correction factor. There is a need for data on the dive cycle. This will impact both the photographic and visual surveys.

The group size defined by observers can differ among observers for the same group and is likely influenced by the density of whales.

The JWG noted a similar problem in the HACS as the previously discussed 2016 survey in East Greenland, with the drop in the 0-100 meter bin of the detection function. This is likely not due to movement away from aircraft as the animals may have time to dive, but probably not enough time to swim away from trackline. Rather, the detection function is probably because it is difficult to see directly below the plane, and it is not always possible to look in every direction. Additionally, the speed of the sightings going by the plane at close distances means that there is less time for the observers to see the whales. Another possibility is the HACS was also a bowhead whale survey, and the observers may have been looking further from the plane to be able to detect bowhead whales. The HACS analysis accounted for this issue by using gamma curves fitted to the detection function, which better captures how observers see sightings.

The previously discussed problems with using SLTDRs for developing correction factors affects these results as well.

The JWG **agreed** to provisionally accept the HACS results, but provided recommendations to improve the analysis.

Recommendations:
- Investigate the issues surrounding the devices used to develop correction factors
    - Availability based on SLTDR
    - Time in view based on 8m dives
- Create a "near-shore" strata in Smith Sound. In the current analysis, the stratification of the fjords was too restricted, and the JWG recommended post-stratification to account for this. This would alleviate the issue of extrapolating high densities observed in coastal waters near the entrance of fjords to the large "offshore" strata.

12. Stock assessments and management advice narwhal

1983-84 Abundance estimate
The JWG discussed Larsen et al (1994) which discussed an aerial survey conducted in Scoresby Sound for narwhals in 1983 and 1984. The results of this survey have not been previously used in the assessments because it was a simple line-transect survey with no correction factors applied. The uncorrected numbers in Scoresby Sound fluctuated between ca 100-300. If corrected for perception and availability, the estimate is around 1000, which provides some agreement with the modelling of past abundance. The JWG **recommended** that the re-scaling of this estimate should be discussed fully at the next meeting.

East Greenland
NAMMCO/SC/24-JCNB/SWG/2017-JWG/14 examined the ability of the age structure from the East Greenland hunt (NAMMCO/SC/24-JCNB/SWG/2017-JWG/16) to update the estimates of annual survival and population dynamics growth. It showed that the assessment model is updating primarily the population dynamic growth rate, with an estimated annual production of 2% (90% CI:0-4%). A strong updating of the survival rate is dependent on a constrained growth rate. Given an assumed growth rate of zero, the model would update the survival rate. The associated estimate, however, is only 0.95 (90% CV:0.94-0.95), while the estimate from the more realistic model where the growth rate is estimated, is 0.97 (90% CI:0.96-0.99). This may explain why some earlier estimates of annual survival in beluga and narwhal from age structured data are lower than expected.

NAMMCO/SC/24-JCNB/SWG/2017-JWG/15 updated the assessment of East Greenland narwhal, given the new abundance estimates from 2016, the updated estimates from 2008, the updated age structure, and the new prior distributions that were agreed by the JWG. For both the Ittoqqortormiit and Kangerlussuaq fjords, the assessment estimates an annual production of 1% (90% CI: 0-3%). The decline in abundance that is suggested by the surveys in 2008 and 2016 is supported by the assessment even when the trend information of the abundance data was removed from the assessment. This suggests that the decline is real, and that the current catch levels are unsustainable.

The model estimates a continuous decline in the summer aggregation of Ittoqqortormiit from 1,420 (90% CI:920-2,120) individuals in 1980 to 580 (90% CI:330-980) individuals in 2017, and a somewhat smaller decline in Kangerlussuaq from 1,890 (90% CI:1,260-3,000) individuals in 1980 to 1,140 (90% CI:500-2,560) in 2017. Yet, the latter model is over estimating the abundance to some degree because the uncertainty of the abundance estimates is forcing the lower percentiles of the model against the boundary of extinction. In conclusion, the assessment estimates that total removals of no more than two to five individuals for Ittoqqortormiit, and of more than 10 to 13 individuals for Kangerlussuaq, are required to ensure a 70% chance of increase over the next five-year period.

Discussion
As discussed under Item 7.2, the JWG **agreed** to recognize three management areas for East Greenland (Tasiilaq, Kangerlussuaq, and Ittoqqortormiit). However, the JWG noted that the stock structure in East Greenland is very unclear, and it is possible that it could be many small populations. It is possible that animals from further north are supplying the hunt in Scoresby Sound. The JWG noted that more information is needed on the stock structure of East Greenland narwhals.

During the 2016 survey, there were less calves than were expected to be seen, and this should be explored further for the 2008 survey. Additionally, there no sightings of narwhals south of Kangerlussuaq. Although there are a lot of uncertainties with this population, the JWG is certain that there are not many narwhals. The distribution may be changing due to environmental changes, and the JWG recommends obtaining more information on distribution and movements (e.g. satellite tagging).

Management advice
Based on the assessment, the JWG agreed that catches should be reduced to less than 10 narwhals in both Ittoqqortormiit and Kangerlussuaq. In addition, the advice for the southern hunting areas applies only to Kangerlussuaq fjord. The JWG recommended that no catches are taken south of 68°N.

The catch advice will be updated with new abundance estimates from surveys in 2017. The information that we have on abundance (including the re-analysis of the 2008 survey which halved the abundance estimate) indicates that the harvest may be causing a population decline. This decline was confirmed by the model estimates, independent of the aerial survey results, lending more evidence of a real decline.

Recommendations

- Re-evaluation of the Larsen et al (1994) survey
- Aerial survey in Scoresby Sound rather than the Tasiilaq area (2017) (continue with the planned NE Greenland survey)
- Stock identity of the Scoresby Sound winter harvest

Assessment on Baffin Bay narwhal stocks

Canadian review of catch allocation model

Previously, there was a request from Canada to incorporate PBR into the catch allocation model for data poor populations. The JWG noted that if Canada wants to use PBR and Greenland does not, this may cause conflicts. The risk based assessment model is more conservative in data poor populations or populations that are declining, thus the PBR assessment may allow a larger removal than the risk model. For shared stocks if Canada used the PBR and Greenland used the risk model result then allowable takes from that population in Canada would be reduced by the quota in Greenland and where there was significant difference between the two methods, the quota in Greenland might exceed the PBR for the population leaving no takes for Canada. The JWG briefly discussed two options for implementing this request: 1) Using the risk based assessment results for data rich populations and for data poor populations using PBR when it was less than the risk based result. As noted above this would require some agreement between managers in Greenland and Canada to insure equitable distribution of takes. 2) Modify the risk based assessment model to meet the assumptions and criteria of the PBR assessment model; this would require a major overhaul of the assessment model and it would no longer be a Bayesian risk based assessment. The JWG intends publication of a peer-reviewed paper describing the JWG's catch allocation and assessment model, which may help address concerns with implementation of the model in Canada.

The JWG **recommends** continuing to use the catch allocation model for our advice.

13. Habitat Concerns for both narwhals and belugas

Baffinland Mary River Mine

The JWG expressed concern regarding development of mining activities and associated ship traffic on the Eclipse Sound narwhal stock. No similar example of such a high level of shipping and development has occurred in a high density narwhal habitat so there is little precedent to inform an assessment of the impacts. Of particular concern are:

7. Narwhal response to shipping activities is not well understood and may include threshold responses in which the narwhals abandon the disturbance area rather than habituate to the disturbance. In this case an irreversible loss of habitat may occur if the narwhals leave and do not re-inhabit the area even in the absence of shipping activity.
8. Ship strikes, lethal and sub-lethal effects of shipping activity may take significant numbers of narwhals. DFO (2014) estimated as many as 123 narwhal would be in the path of ships each year and be at risk of ship strike. Sub-lethal effects include disruption of feeding and communication, with potential consequences to energetics and reproduction. These impacts may negatively affect the sustainable removal levels of the Eclipse Sound stock which is shared between Greenland and Canada.
9. Risk of an oil or toxic spill in a high latitude area is compounded by the presence of ice and the remoteness from the necessary facilities and personnel for cleanup. It is poorly understood

how a high arctic ecosystem would respond to an oil spill, the effects of which are likely detrimental and possibly irreversible.

Shipping/Icebreaking in Baffin Bay

The JWG expressed concern regarding shipping and icebreaking activities in the wintering grounds of narwhal and beluga in Baffin Bay where winter time shipping is unprecedented. Ship noise and icebreaking activities will disturb deep diving narwhal during a critical feeding period and may result in unpredictable response and displacement from preferred habitat of both species. Ice breaking will disrupt the distribution and condition of sea ice which may lead to ice entrapments. The risk from oil spill discussed above applies here as well and the JWG noted that there is no available method for cleaning up an oil spill in ice covered waters. A recent gas leak in Cook Inlet, Alaska has demonstrated the difficulties of responding to such an event.

The JWG also expressed concern that cumulative effects should be considered when new shipping and icebreaking activities are proposed for narwhal and beluga habitat areas.

13.1. Climate change impact on management advice

Workshop

Various aspects of climate change may be impacting certain populations of belugas and narwhals. One example is the lack of sightings of narwhals in the southern areas in East Greenland, which may indicate a shift in distribution and/or loss of range. The JWG recommends a workshop to address concerns over changes in management advice in response to the non-hunting takes and changes in distribution resulting from development and warming of the arctic. This workshop would take place over 1-2 days and could be joined with the next JWG (in 2019). The workshop will focus on the populations in West Greenland and Canada, but should include experts involved with changes in marine ecosystems and higher trophic animals in relation to climate change in the North Atlantic and Canadian Arctic (polar bears, walrus, etc.)

The Terms of Reference for the workshop will be to:

- Identify specific effects of climate change on belugas and narwhals
  - Request papers on changes in distribution, population dynamics, etc. resulting from climate change in Canada/Greenland waters
  - The focus will be less on the mechanism of the effects, and more on identifying simple predictors and possible consequences

- Identify specific ways that the JWG's advice may be informed by these effects
  - Climate change may affect timing and distribution of hunted populations.
  - Climate change may affect population model parameters used for assessment.
  - Development in the arctic may result in changes in habitat and carrying capacity as well as increased anthropogenic disturbance which may require changes in assessment models.

14. Other Business

Discussion/workshop on small populations

The JWG discussed the observations that small beluga populations appear to not recover once their abundance is below around 2000 individuals. Possible issues are limited mate selection, loss of "cultural" knowledge within the population or loss of habitat from a contraction of range. Modelling exercises could shed light on the causes of the lack of recovery, identifying other issues which should be examined for these small populations when even 0 catches do not result in recovery. This could be a one day workshop for a future JWG meeting.

Focus of the meeting

The participants noted that work procedures of the JWG should be discussed at a future meeting, of particular concern was the proportion of time given to reviewing general beluga and narwhal science and discussion and review of management advice. The concern being that the management advice is late on the agenda and may not be getting the time and consideration necessary.

Rapporteur
Rapporteuring has been done by NAMMCO although it is a joint working group of NAMMCO and JCNB. The JWG suggested that a second rapporteur be provided by the JCNB so that duties are shared between the two organizations in future meetings.

15. Review of Report
A draft version of the report was reviewed during the meeting, and the final version of the report was accepted via correspondence on 20 April 2017.

16. Closing

The JWG agreed that the next meeting should be held in March 2019 and will be hosted by Canada.

Hobbs thanked the participants for their hard work and discussions.

The meeting was closed at 17:30 on 11 March 2017.

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List of Participants

Susanne Ditlevsen (Invited by NAMMCO)
Department of Mathematical Sciences
University of Copenhagen
susanne@math.ku.dk

Thomas Doniol-Valcroze (Teleconference part of 10 March, CA)
Institut Maurice-Lamontagne
Fisheries and Oceans Canada
Mont-Joli, Québec G5H 3Z4, Canada
Thomas.Doniol-Valcroze@dfo-mpo.gc.ca

Steve Ferguson (CA)
Fisheries and Oceans Canada
Freshwater Institute
501 University Crescent
Winnipeg, MB, R3T 2N6, Canada
Steve.Ferguson@dfo-mpo.gc.ca

Eva Garde (GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 2
DK-1401 Copenhagen K
evaga@mail.ghsdk.dk

Maha Ghazal (Gov. of Nunavut)
Fisheries and Sealing Division
Department of Environment, Government of Nunavut
PO Box 613
Pangnirtung, NU X0A0R0
mghazal@gov.nu.ca

Rikke Guldborg Hansen (JCNB Chair, GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 2
DK-1401 Copenhagen K
rgh@ghsdk.dk

Mads Peter Heide-Jørgensen (GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 2
DK-1401 Copenhagen K
mhj@ghsdk.dk

Roderick Hobbs (NAMMCO Chair; USA)
Marine Mammal Laboratory
Alaska Fisheries Science Center
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, WA, 98155-6349, USA
E-mail: Rod.Hobbs@noaa.gov

David Lee (NTI)
Nunavut Tunngavik Limited
Department of Wildlife and Environment
dlee@tunngavik.com

Eline Lorenzen (Invited by NAMMCO)
Natural History Museum of Denmark
Øster Voldgade 5-7, 1350 København K
elinelorenzen@snm.ku.dk

Cory Matthews (CA)
Fisheries and Oceans Canada
Freshwater Institute
501 University Crescent
Winnipeg, MB, R3T 2N6, Canada
Cory.Matthews@dfo-mpo.gc.ca

Christian Riisager Pedersen (GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 2
riisager-pedersen@hotmail.com

Jill Prewitt (NAMMCO)
North Atlantic Marine Mammal Commission
PO Box 6453
N-9294 Tromsø, Norway
jill@nammco.no

Olga Shpak (Invited by NAMMCO)
Severtsov Institute of Ecology and Evolution
ovshpak@gmail.com

Mikkel Skrovind (Invited by NAMMCO)
Natural History Museum of Denmark
Øster Voldgade 5-7, 1350 København K
mikkelskovrind@gmail.com

Outi Tervo (GL)
Greenland Institute of Natural Resources
c/o Greenland Representation
Strandgade 91, 2
DK-1401 Copenhagen K
outi@mail.ghsdk.dk

Lars Witting (GL)
Greenland Institute of Natural Resources
P.O.Box 570
DK-3900 Nuuk Greenland
lawi@natur.gl

AGENDA

Wednesday 8 March

1. Opening Remarks
   1.1. Adoption of Joint Agenda
   1.2. Appointment of Rapporteurs
   1.3. Review of Available Documents

2. Review of population model
   2.1. Review of life history priors for beluga
   2.2. Review of life history priors for narwhal

Thursday 9 March

3. Stock structure beluga
4. Hunt removals beluga
5. Abundance belugas
6. Allocation of shared beluga stocks
7. Stock assessments and management advice belugas
8. Implementation of earlier advice on belugas
9. Habitat Concerns belugas
10. Traditional Knowledge belugas

Friday 10 March

11. Stock structure narwhal
    11.1. Genetics
12. Hunt removals narwhal
13. Habitat Concerns narwhal
14. Traditional Knowledge narwhal
15. Abundance w/ teleconference to Tomas after 1pm

Saturday 11 March

16. Stock assessments and management advice narwhal
17. Implementation of earlier advice on narwhals
18. Other business
    18.1. Climate change impact on management advice (workshop?)
19. Review of Report
20. Closing

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03	Document List	
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05	Heide Jørgensen. The East Greenland Connection: movement of a narwhal from Kangerlussuaq to Scoresby Sound	11
06rev	Heide-Jørgensen and Garde. Catch statistics for belugas in Greenland 1862 to 2016	4
07	Heide-Jørgensen and Garde et al. Reconstructing catch statistics for narwhals in Greenland 1862 to 2016	12
08	Watt and Hall. Catch Statistics for Narwhal in Canada from 1970-2015	12
08a	Catch tables (data for paper 08 Watt and Hall)	
08b	Copy of narwhal...(data for paper 08 Watt and Hall)	
08c	Kill dates by community... (data for paper 08 Watt and Hall)	
08d	Narwhal struck and lost (data for paper 08 Watt and Hall)	
09	Ditlevesen. Priors for Analysis of Belugas	2.1
10	Higdon & Ferguson. Database of aerial surveys and abundance estimates for beluga whales (*Delphinapterus leucas*) and narwhals (*Monodon monoceros*) in the Canadian Arctic	5, 15
11rev	Stewart B. Age estimates of narwhal (*Monodon monoceros*) derived from growth-layer groups (GLGs) in the dentine of embedded tusks–Developmental constraints and best practices.	2.2
12	Young & Ferguson. Canadian beluga harvest from Baffin Bay.	4
13	Witting, L. Assessment of West Greenland beluga – 2017	7
14	Witting. L. Age structure in East Greenland	16
15	Witting. L. Narwhals East Greenland	16
16	Garde and Heide-Jørgensen. Update on life history parameters of narwhals (*Monodon monoceros*) from East and West Greenland	2
17	Riisager-Pedersen et al. East Greenland narwhal depth correction factor for aerial surveys	15
18	Hansen et al. Abundance of narwhals at the hunting areas in East Greenland in 2008 and 2016	15
19	Tervo et al. Comparing satellite transmitted and archival depth data – TAD versus TDR	11

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O15	Heide-Jørgensen and Laidre 2015. Surfacing time, availability bias and abundance of humpback whales in West Greenland	15
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O18	Heide-Jørgensen et al. The predictable narwhal: satellite tracking shows behavioural similarities between isolated subpopulations	
O19	Heide-Jørgensen et al. (2016) Rebuilding beluga stocks in West Greenland.	
O20	Geometer status update	
O21	CSAS 2013/024	
O22	NAMMCO/24/MC/8 Disturbance Symposium Report	
O23	Larsen et al 1994. Line-transect estimation of abundance of narwhals (*Monodon monoceros*) in Scoresby Sund and adjacent waters	

Catch Tables

Table 1. Landed catches of beluga whales *(Delphinapterus leucas)* reported by select Nunavut communities for the past five years (2011-2015). Catch reporting for the 2016-2017 harvest year will be complete by 31 March 2017.

			Landed Catches by Harvest Year [o]				
Beluga Population	Community	Quota [¥]	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Baffin Bay	Arctic Bay	NRQ	0	2	0	0	0
	Clyde River	NRQ	0	0	0	n.r.	1
	Gjoa Haven	NRQ	10	4	5	n.r.	10
	Grise Fiord	NRQ	0	n.r.	0	3	3
	Hall Beach	NRQ	8	n.r.	0	19	7
	Igloolik	NRQ	42	n.r.	0	n.r.	n.r.
	Kugaaruk	NRQ	0	0	0	1	0
	Kugluktuk	NRQ	21	0	0	n.r.	0
	Pond Inlet	NRQ	0	0	0	n.r.	0
	Qikiqtarjuaq	NRQ	0	n.r.	n.r.	n.r.	0
	Resolute Bay	NRQ	4	6	76	8	4
	Taloyoak	NRQ	0	0	n.r.	n.r.	3
	Total						
			Landed Catches by Harvest Year				
Cumberland Sound	Community	Quota [1]	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
	Pangnirtung	41	42	41	41	41	18 [§]
	Total						

[¥] NRQ = No Regulatory Quota
[o] n.r. = no record received
[§] The large amount of ice present in Cumberland Sound during the summer of 2015 limited the beluga harvest in Pangnirtung.

Table 2. Catches of belugas in three areas in West Greenland with three options for corrections of catch numbers. 'North' includes Qaanaaq, Upernavik and Uummannaq, 'Central' includes Disko Bay with the municipalities Kangaatsiaq, Aasiaat, Qasigiannguit, Ilulissat and Qeqertarsuaq, and 'South' includes Sisimiut, Maniitsoq, Nuuk and Paamiut. Last column show the catches with ice entrapments subtracted from the Central area. For 1954-1974 a *low* and a *medium option* correct for lack of catch reports from Qaanaaq. For 1975-1985 a correction factor for unreported catches is applied to Upernavik (*low option*) and to all areas (*medium option*). For 1986-1992 a *low* and a *medium option* correct for lack of catch reports from Qaanaaq and Sisimiut. For 1993-2016 the high option was applied to catches in the North (10%), Central (30%) and South (30%).

	NORTH			CENTRAL			SOUTH			TOTAL			TOTAL WITHOUT ICE ENTRAPMENTS		
YEAR	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
1954	95	186	205	1774	1774	2306	23	23	30	1892	1983	2541	118	209	767
1955	31	122	134	275	275	358	12	12	16	318	409	507	318	409	507
1956	35	126	139	373	373	485	34	34	44	442	533	668	442	533	668
1957	35	126	139	391	391	508	95	95	124	521	612	770	521	612	770
1958	25	116	128	182	182	237	36	36	47	243	334	411	243	334	411
1959	42	133	146	243	243	316	42	42	55	327	418	517	277	368	467
1960	37	128	141	179	179	233	18	18	23	234	325	397	234	325	397
1961	53	53	58	219	219	285	73	73	95	345	345	438	345	345	438
1962	101	101	111	186	186	242	42	42	55	329	329	408	329	329	408
1963	105	105	116	93	93	121	31	31	40	229	229	277	229	229	277
1964	135	135	149	166	166	216	30	30	39	331	331	403	331	331	403
1965	223	223	245	214	214	278	51	51	66	488	488	590	488	488	590
1966	131	222	244	398	398	517	50	50	65	579	670	827	579	670	827
1967	118	209	230	369	369	480	127	127	165	614	705	875	564	655	825
1968	180	271	298	1013	1013	1317	84	84	109	1277	1368	1724	1043	1134	1490
1969	165	256	282	661	661	859	170	170	221	996	1087	1362	996	1087	1362
1970	357	357	393	1133	1133	1473	34	34	44	1524	1524	1910	474	474	860
1971	243	243	267	328	328	426	168	168	218	739	739	912	739	739	912
1972	336	427	470	362	362	471	161	161	209	859	950	1150	859	950	1150
1973	313	404	444	581	581	755	191	191	248	1085	1176	1448	1085	1176	1448
1974	231	231	254	512	512	666	170	170	221	913	913	1141	913	913	1141

	NORTH			CENTRAL			SOUTH			TOTAL			TOTAL WITHOUT ICE ENTRAPMENTS		
YEAR	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
1975	254	270	297	268	331	430	167	206	268	689	807	995	689	807	995
1976	157	172	189	953	1177	1530	120	148	192	1230	1497	1912	844	1259	191
1977	395	419	461	379	468	608	121	149	194	895	1036	1263	895	1036	1263
1978	192	207	228	452	558	725	99	122	159	743	887	1112	743	887	1112
1979	356	367	404	379	468	608	65	80	104	800	915	1116	800	915	1116
1980	366	396	436	412	509	662	155	191	248	933	1096	1346	933	1096	1346
1981	594	635	699	340	420	546	163	201	261	1097	1256	1506	1097	1256	1506
1982	550	584	642	313	386	502	108	133	173	971	1103	1317	871	1003	1217
1983	360	377	415	194	240	312	102	126	164	656	743	891	656	742	888
1984	447	456	502	352	435	566	42	52	68	841	943	1135	621	723	915
1985	428	474	521	177	219	285	50	62	81	655	755	887	655	755	887
1986	520	623	685	114	114	148	48	96	125	682	833	958	682	833	958
1987	579	682	750	29	29	38	60	108	140	668	819	928	668	819	928
1988	141	244	268	125	125	163	46	94	122	312	463	553	187	338	428
1989	445	548	603	30	30	39	86	134	174	561	712	816	561	712	816
1990	356	356	392	684	684	889	69	117	152	1109	1157	1433	609	657	933
1991	450	450	495	100	100	130	46	94	122	596	644	747	596	644	747
1992	677	780	858	26	26	34	46	94	122	749	900	1014	749	900	1014
1993	473	473	520	191	191	248	118	118	153	782	782	922	782	782	922
1994	231	231	254	239	239	311	148	148	192	618	618	757	618	618	757
1995	296	296	326	301	301	391	187	187	243	784	784	960	784	784	960
1996	114	114	125	244	244	317	183	183	238	541	541	681	541	541	681
1997	208	208	229	228	228	296	120	120	156	556	556	681	556	556	681
1998	275	275	303	304	304	395	135	135	176	714	714	873	714	714	873
1999	250	250	275	184	184	239	58	58	75	492	492	590	492	492	590
2000	332	332	365	202	202	263	78	78	101	612	612	729	612	612	729
2001	161	161	177	207	207	269	87	87	113	455	455	559	455	455	559

	NORTH			CENTRAL			SOUTH			TOTAL			TOTAL WITHOUT ICE ENTRAPMENTS		
YEAR	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
2002	246	246	271	149	149	194	35	35	46	430	430	510	430	430	510
2003	189	189	208	149	149	194	74	74	96	412	412	498	412	412	498
2004	24	24	26	96	96	125	73	73	95	193	193	246	193	193	246
2005	42	42	46	102	102	133	40	40	52	184	184	231	184	184	231
2006	53	53	58	49	49	64	35	35	46	137	137	168	137	137	168
2007	29	29	32	59	59	77	28	28	36	116	116	145	116	116	145
2008	217	217	239	58	58	75	12	12	16	287	287	330	287	287	330
2009	165	165	182	53	53	69	27	27	35	245	245	286	245	245	286
2010	121	121	133	60	60	78	7	7	9	188	188	220	188	188	220
2011	75	75	83	67	67	87	8	8	9	150	150	179	150	150	179
2012	148	148	163	58	58	75	5	5	7	211	211	245	211	211	245
2013	212	212	233	52	52	68	40	40	52	304	304	353	304	304	353
2014	176	176	194	71	71	92	24	24	31	271	271	317	271	271	317
2015	36	36	40	73	73	95	16	16	21	125	125	156	125	125	156
2016	95	95	105	79	79	103	29	29	38	203	203	246	203	203	246

Table 3. Catches of belugas in East Greenland. Data from 1955-1990 from Dietz et al. (1994) and data from 1993-2016 from Piniarneq.

Year	Ittoqqortormiit	Tasiilaq	All
1955			
1956	1	2	3
1957			
1958			
1959	2	3	5
1960	0	1	1
1961			
1962	0	1	1
1963	0	1	1
1964			
1965	5	0	5
1966	1	0	1
1967			
1968			
1969	2	0	2
1970	0	1	1
1971	0	1	1
1972	0	18	18
1973	1	2	3
1974	1	7	8
1975			
1976	0	1	1
1977	0	1	1
1978			
1979			
1980			
1981			
1982			
1983			
1984	15	0	15
1985			
1986	0	15	15
1987			
1988			
1989			
1990			
1991			
1992			
1993	0	8	8
1994	0	0	0
1995	0	0	0
1996	0	0	0
1997	0	1	1
1998	0	0	0
1999	0	0	0
2000	1	3	4
2001	0	1	1
2002	0	0	0
2003	0	12	12

Year	Ittoqqortormiit	Tasiilaq	All
2004	0	0	0
2005	0	1	1
2006	0	0	0
2007	0	1	1
2008	0	0	0
2009	0	0	0
2010	0	0	0
2011	0	0	2
2012	2	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0

Table 4. Seasonal harvest of narwhals multiplied by a struck and loss factor for each hunting region in Canada. AB = Arctic Bay, GF = Grise Fiord, PI = Pond Inlet, CCA = Central Canadian Arctic (includes the communities of Kugaaruk, Hall Beach, Igloolik, Gjoa Haven, Resolute Bay, Creswell Bay, and Taloyoak), BIC = Baffin Island Central (includes the communities of Clyde River and Qikiqtarjuaq), and BIS = Baffin Island Sound (includes the communities of Pangnirtung and Iqaluit). Superscript F = fall, Sp = spring, S = summer, and W = winter.

Year	AB_F	AB_{Sp}	AB_S	GF_F	GF_{Sp}	GF_S	PI_F	PI_{Sp}	PI_S	CCA_F	CCA_{Sp}	CCA_S	CCA_W	BIC_F	BIC_{Sp}	BIC_S	BIS_F	BIS_{Sp}	BIS_S
1970	21	112	22	34	11	37	30	145	75	18	4	30	0	30	7	12	1	8	2
1971	21	112	23	17	6	19	30	141	74	21	4	32	0	43	10	20	3	26	4
1972	23	121	26	5	2	7	8	44	22	20	4	35	0	28	6	14	4	27	5
1973	33	183	37	12	3	18	60	264	136	30	4	62	0	11	3	6	0	0	1
1974	10	66	12	3	2	6	29	139	63	18	3	32	0	56	13	26	4	34	5
1975	30	220	35	3	2	6	25	107	46	19	6	36	0	17	4	12	4	34	4
1976	22	147	27	5	4	9	40	171	78	17	7	33	0	18	5	12	2	16	2
1977	19	23	22	0	0	0	34	144	69	36	0	13	0	111	0	14	0	6	0
1978	12	83	16	0	0	0	48	198	100	5	5	14	0	29	6	15	1	3	0
1979	8	42	6	19	0	2	0	118	97	15	0	4	0	23	25	6	3	23	27
1980	18	160	0	0	0	0	34	121	66	1	1	44	0	75	14	50	0	40	0
1981	20	113	34	0	0	0	29	101	58	86	0	20	0	77	15	52	23	53	8
1982	19	99	31	0	0	45	0	188	52	0	4	73	0	103	0	9	27	56	11
1983	14	141	18	2	0	3	78	81	71	29	0	64	0	36	38	42	0	4	2
1984	0	164	5	0	2	2	8	94	8	0	0	0	0	66	15	60	0	68	0
1985	0	183	0	2	7	6	62	141	27	8	11	18	0	5	8	78	0	36	2
1986	29	87	45	0	2	2	31	113	83	5	4	10	0	11	2	7	26	22	8
1987	7	22	11	0	2	2	17	57	44	6	4	11	0	65	9	35	0	0	0
1988	24	75	39	1	6	6	16	55	49	8	4	12	0	56	17	44	2	1	0
1989	27	86	46	1	4	4	25	74	74	11	7	21	0	74	15	47	34	28	9
1990	16	39	28	3	9	12	14	32	39	8	4	17	0	61	8	35	2	3	1
1991	26	65	49	3	10	13	21	46	55	15	4	18	0	66	10	40	5	3	2
1992	29	56	41	0	1	1	19	48	54	7	3	23	0	53	8	38	3	2	1
1993	22	46	36	1	5	6	15	38	43	10	5	30	0	65	9	43	15	12	5
1994	25	54	42	3	6	7	21	44	47	12	4	28	0	58	8	36	21	16	6
1995	16	33	9	2	5	5	0	90	0	12	3	26	0	61	8	34	4	3	1

Year	AB_F	AB_{Sp}	AB_S	GF_F	GF_{Sp}	GF_S	PI_F	PI_{Sp}	PI_S	CCA_F	CCA_{Sp}	CCA_S	CCA_W	BIC_F	BIC_{Sp}	BIC_S	BIS_F	BIS_{Sp}	BIS_S
1996	20	59	43	0	0	1	26	40	57	7	1	13	0	28	3	14	14	8	3
1997	13	40	29	0	0	1	21	28	43	12	2	21	0	57	5	26	1	1	0
1998	18	54	41	2	4	7	2	21	106	17	4	47	0	57	5	29	2	2	1
1999	16	49	45	2	8	11	39	17	106	8	3	12	0	79	1	29	25	14	4
2000	23	66	64	2	8	11	58	69	79	12	2	38	0	153	18	79	0	9	44
2001	24	67	71	3	12	16	21	27	32	37	6	54	0	108	13	53	14	11	1
2002	63	22	11	0	3	0	0	48	29	21	0	37	0	73	0	98	30	9	0
2003	15	60	84	0	0	10	10	32	40	2	4	32	0	105	12	73	1	36	0
2004	21	81	50	9	0	3	39	27	14	59	0	13	0	94	34	71	21	12	0
2005	1	83	93	0	1	0	20	26	25	26	0	43	0	133	14	10	6	0	0
2006	3	170	3	0	0	26	20	25	56	73	1	73	0	111	5	45	1	0	0
2007	5	90	72	0	4	21	32	8	35	12	0	44	0	120	10	31	0	4	1
2008	35	65	78	5	0	23	9	16	58	8	0	45	0	65	2	52	22	0	4
2009	1	23	150	0	5	1	21	24	6	46	3	22	0	93	9	25	40	10	0
2010	32	51	89	0	10	16	37	20	15	14	2	48	0	76	17	77	20	14	1
2011	26	38	112	2	14	10	3	45	81	4	8	51	0	125	7	23	4	2	0
2012	100	4	65	0	2	17	23	25	63	23	0	47	0	98	9	31	10	0	1
2013	4	43	167	4	5	0	58	30	82	23	1	33	0	143	11	9	18	3	1
2014	81	63	46	9	1	0	59	33	63	32	0	45	0	140	16	22	11	1	0
2015	165	20	107	0	0	9	94	28	97	38	0	43	2	111	0	52	0	0	0

Table 5. Construction of time series of catches of narwhals from 1862 through 2014 by provisional stock divisions. Catches during 1877-1886 and 1889-1891 were created as the average of five years before and two years after the period. Catches between 1894 and 1902 were set to the average of five years before and after the period. The period 1935-1948 was constructed as linear extrapolations of the catches before and after the period. Catches for the period for 1949-1954 and 1959-1960 were calculated as the average of the catches for the period 1955 to 1958 (minus ice entrapments). Catches for Inglefield Bredning was arbitrarily set to 25 whales per year for 1862 to 1899 and to 50 for 1900 to 1934. From 1935 to 1960 catches were increased linearly from 50 to 134 in Inglefield Bredning. For 1959 to 1974 catches were distributed between Upernavik, Uummannaq and Disko Bay in proportion to the relative change in catch levels before and after that period.
After 1983 catches in Savissivik in Qaanaaq municipality are allocated to the Upernavik-Melville Bay stock together with catches from Upernavik municipality. From 1993-2010 catches in Siorapaluk are subtracted from the catches in Inglefield Bredning as they are assumed to be from the Smith Sound stock, however in 2011 this practice was changed to allocate any catches from Qaanaaq with location data north of Siorapaluk to the Smith Sound. Catches from all areas south of Disko Bay are assumed to come from the Disko Bay stock. Ice entrapments are subtracted from catches. Values for years with no catch reporting are constructed as the average of three years before and after the missing year. In the *low option* catches from Inglefield Bredning and Melville Bay are corrected for underreportings needed to sustain the purchases of mattak. Before 1950 all catches under the high option are corrected for a loss rate of 5%. After 1950 catches in Inglefield Bredning and Smith Sound are under the *high option* corrected for a loss rate of 5%, catches in Melville Bay are corrected for losses of 15% and catches in Uummannaq and Disko Bay and corrected for a 30% loss rate. The quality of the data is assessed based on the amount of corrections needed where LQ=low quality, MQ=moderate quality, R=reliable and P=preliminary.

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1862	LQ				25	25	26	29	29	30	4	4	4	45	45	47
1863	LQ				25	25	26	24	24	25	12	12	13	43	43	45
1864	LQ				25	25	26	42	42	44	30	30	32	70	70	74
1865	LQ				25	25	26	16	16	17	30	30	32	35	35	37
1866	LQ				25	25	26	32	32	34	20	20	21	72	72	76
1867	LQ				25	25	26	38	38	40	22	22	23	96	96	101
1868	LQ				25	25	26	17	17	18	11	11	12	55	55	58
1869	LQ				25	25	26	46	46	48	37	37	39	136	136	143
1870	LQ				25	25	26	23	23	24	80	80	84	106	106	111
1871	LQ				25	25	26	32	32	34	35	35	37	102	102	107
1872	LQ				25	25	26	22	22	23	46	46	48	103	103	108
1873	LQ				25	25	26	29	29	30	21	21	22	88	88	92
1874	LQ				25	25	26	32	32	34	13	13	14	106	106	111
1875	LQ				25	25	26	22	22	23	17	17	18	73	73	77

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1876	LQ				25	25	26	24	24	25	23	23	24	80	80	84
1877	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1878	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1879	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1880	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1881	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1882	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1883	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1884	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1885	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1886	LQ				25	25	26	28	28	29	28	28	29	98	98	103
1887	LQ				25	25	26	32	32	34	38	38	40	117	117	123
1888	LQ				25	25	26	32	32	34	38	38	40	117	117	123
1889	LQ				25	25	26	29	29	30	35	35	37	105	105	110
1890	LQ				25	25	26	29	29	30	35	35	37	105	105	110
1891	LQ				25	25	26	29	29	30	35	35	37	105	105	110
1892	LQ				25	25	26	31	31	33	42	42	44	102	102	107
1893	LQ				25	25	26	31	31	33	42	42	44	102	102	107
1894	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1895	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1896	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1897	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1898	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1899	LQ				25	25	26	31	31	33	36	36	38	87	87	91
1900	LQ				50	50	53	31	31	33	36	36	38	87	87	91
1901	LQ				50	50	53	31	31	33	36	36	38	87	87	91
1902	LQ				50	50	53	31	31	33	36	36	38	87	87	91
1903	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1904	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1905	LQ				50	50	53	33	33	35	35	35	37	70	70	74

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1906	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1907	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1908	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1909	LQ				50	50	53	33	33	35	35	35	37	70	70	74
1910	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1911	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1912	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1913	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1914	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1915	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1916	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1917	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1918	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1919	LQ				50	50	53	50	50	53	62	62	65	112	112	118
1920	LQ				50	50	53	46	46	48	42	42	44	74	74	78
1921	LQ				50	50	53	46	46	48	42	42	44	74	74	78
1922	LQ				50	50	53	46	46	48	42	42	44	74	74	78
1923	LQ				50	50	53	46	46	48	42	42	44	74	74	78
1924	LQ				50	50	53	46	46	48	42	42	44	74	74	78
1925	LQ				50	50	53	43	43	45	55	55	58	58	58	61
1926	LQ				50	50	53	43	43	45	55	55	58	58	58	61
1927	LQ				50	50	53	43	43	45	55	55	58	58	58	61
1928	LQ				50	50	53	43	43	45	55	55	58	58	58	61
1929	LQ				50	50	53	43	43	45	55	55	58	58	58	61
1930	LQ				50	50	53	43	43	45	53	53	56	87	87	91
1931	LQ				50	50	53	43	43	45	53	53	56	87	87	91
1932	LQ				50	50	53	43	43	45	53	53	56	87	87	91
1933	LQ				50	50	53	43	43	45	53	53	56	87	87	91
1934	LQ				50	50	53	43	43	45	53	53	56	87	87	91
1935	LQ				53	53	56	42	42	44	50	50	53	83	83	87
1936	LQ				56	56	59	41	41	43	48	48	50	78	78	82

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1937	LQ				59	59	62	40	40	42	45	45	47	74	74	78
1938	LQ				62	62	65	39	39	41	42	42	44	70	70	74
1939	LQ				66	66	69	38	38	40	39	39	41	65	65	68
1940	LQ				69	69	72	37	37	39	37	37	39	61	61	64
1941	LQ				72	72	76	36	36	38	34	34	36	57	57	60
1942	LQ				75	75	79	36	36	38	31	31	33	52	52	55
1943	LQ				78	78	82	35	35	37	28	28	29	48	48	50
1944	LQ				81	81	85	34	34	36	26	26	27	44	44	46
1945	LQ				84	84	88	33	33	35	23	23	24	39	39	41
1946	LQ				87	87	91	32	32	34	20	20	21	35	35	37
1947	LQ				90	90	95	31	31	33	17	17	18	31	31	33
1948	LQ				94	94	99	30	30	32	15	15	16	26	26	27
1949	LQ				97	97	102	29	29	30	12	12	13	22	22	23
1950	LQ				100	100	105	29	29	30	12	12	13	22	22	23
1951	LQ				103	103	108	29	29	33	12	12	16	22	22	29
1952	LQ				106	106	111	29	29	33	12	12	16	22	22	29
1953	LQ				109	109	114	29	29	33	12	12	16	22	22	29
1954	LQ				112	112	118	29	29	33	12	12	16	22	22	29
1955	LQ				115	115	121	23	23	26	2	2	3	14	14	18
1956	LQ				118	118	124	15	15	17	32	32	42	21	21	27
1957	LQ				122	122	128	55	55	63	11	11	14	8	8	10
1958	LQ				125	125	131	24	24	28	3	3	4	46	46	60
1959	LQ				128	128	134	25	25	29	11	11	14	21	21	27
1960	LQ				131	131	138	24	24	28	12	12	16	24	24	31
1961	MQ				134	134	141	29	29	33	15	15	20	26	26	34
1962	MQ				182	182	191	12	12	14	7	7	9	12	12	16
1963	MQ				275	275	289	16	16	18	10	10	13	16	16	21
1964	MQ				275	275	289	16	16	18	11	11	14	18	18	23
1965	LQ				210	210	220	35	35	40	25	25	33	40	40	52
1966	LQ				203	203	213	36	36	41	28	28	36	47	47	61
1967	LQ				196	196	206	33	33	38	28	28	36	50	50	65

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1968	LQ				189	189	198	50	50	58	46	46	60	83	83	108
1969	LQ				182	182	191	37	37	43	37	37	48	82	82	107
1970	LQ				175	175	184	61	61	70	66	66	86	99	99	129
1971	LQ				168	168	176	39	39	45	46	46	60	103	103	134
1972	LQ				161	161	169	21	21	24	27	27	35	60	60	78
1973	LQ				154	154	162	46	46	53	64	64	83	92	92	120
1974	LQ				147	147	155	30	30	35	47	47	61	64	64	83
1975	LQ				140	140	147	54	54	62	11	11	14	51	51	66
1976	LQ				133	133	140	22	22	25	27	27	35	57	57	74
1977	LQ				126	126	133	62	62	71	113	113	147	31	31	40
1978	MQ				110	110	116	56	56	64	183	183	238	263	263	342
1979	MQ				120	120	126	22	22	25	132	132	172	103	103	134
1980	MQ				130	130	137	61	61	70	146	146	190	125	125	163
1981	MQ				160	160	168	83	83	95	140	140	182	268	268	348
1982	MQ				164	164	172	59	59	68	162	162	211	76	76	99
1983	MQ				135	135	142	72	72	83	164	164	213	68	68	88
1984	MQ				274	274	288	80	80	92	210	210	273	67	67	87
1985	MQ				115	115	121	34	34	39	39	39	51	68	68	88
1986	LQ				165	165	173	81	81	93	97	97	126	59	156	203
1987	LQ				155	155	163	145	145	167	334	334	434	26	156	203
1988	LQ				145	145	153	*85*	85	98	226	226	294	*35*	156	203
1989	LQ				136	136	142	37	37	43	288	288	374	7	156	203
1990	LQ				126	126	132	127	127	146	1019	1019	1325	11	156	203
1991	LQ				116	116	122	90	90	104	223	223	290	40	156	203
1992	LQ				106	106	111	37	37	43	288	288	374	7	156	203
1993	R	4	4	4	104	104	109	102	102	117	301	301	391	103	103	134
1994	R	2	2	2	90	90	95	150	150	173	297	297	386	156	156	203
1995	R	0	0	0	88	88	92	113	113	130	159	159	207	125	125	163
1996	R	0	0	0	37	37	39	77	77	89	405	405	527	172	172	224
1997	R	4	4	4	54	54	57	98	98	113	381	381	495	209	209	272
1998	R	3	3	3	68	68	71	128	128	147	344	344	447	227	227	295

Stock	Quali-ty of data	Smith Sound			Inglefield Bredning			Melville Bay			Uummannaq			Disko Bay and south		
Year		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
1999	R	17	17	18	87	87	91	130	130	150	253	253	329	258	258	335
2000	R	20	20	21	85	85	89	154	154	177	106	106	138	196	196	255
2001	R	30	30	32	98	98	103	172	172	198	95	95	124	140	140	182
2002	R	23	23	24	58	58	61	177	177	204	180	180	234	125	125	163
2003	R	35	35	37	66	66	69	158	158	182	174	174	226	121	121	157
2004	R	52	52	55	111	111	117	68	68	78	67	67	87	76	76	99
2005	R	52	52	55	79	79	83	77	77	89	161	161	209	39	39	51
2006	R	19 [a)]	19	20	55 [a)]	55	58	80 [b)]	80	92	72 [c)]	72	94	56 [c)]	56	73
2007	R	0 [d)]	0	0	134 [d)]	134	141	107[e)]	107	123	67 [c)]	67	87	66[c)]	66	86
2008	R	7	7	7	122	122	140	92	92	120	87	87	113	47	47	61
2009	R	6	6	6	84	84	97	136	136	177	91	91	118	89	89	116
2010	R	9	9	10	99	99	114	40	40	52	42	42	55	45	45	59
2011	R	2	2	2	53	53	56	79	79	91	77	77	100	40	40	52
2012	R	3	3	3	128	128	134	83	83	96	42	42	55	55	55	72
2013	R	0	0	0	83	83	87	71	71	82	78	78	101	51	51	66
2014	R	0	0	0	102	102	107	113	113	130	69	69	90	50	50	65
2015	R	0	0	0	75	75	79	71	71	86	42	42	73	29	29	38
2016	P	0	0	0	81	81	85	91	91	105	120	120	189	56	56	73

a) Based on *special reports*
b) Based on *special reports* from Savissivik and *Piniarneq* from Upernavik
c) Based on *Piniarneq – special reports* too low.
d) Catches from Siorapaluk all assumed to be from Inglefield Bredning
e) Incl. five catches reported from Savissivik (*special reports*)

Table 6. Catches of narwhals in East Greenland. Data from 1955-1990 from Dietz et al. (1994) and data from 1993-2016 from Piniarneq. There was one ice entrapment in Tasiilaq in February 2008 that involved about 37 narwhals.

Year	Ittoqqortormiit	Tasiilaq	All
1955	18	6	24
1956	10		10
1957	9	5	14
1958	28	1	29
1959	17	9	26
1960	54	2	56
1961	12	4	16
1962		3	3
1963	8	21	29
1964	8		8
1965			0
1966	2	67	69
1967		20	20
1968		30	30
1969	6	17	23
1970	6	47	53
1971	5	33	38
1972	1	25	26
1973	4	18	22
1974	2	40	42
1975	2	2	4
1976	1	8	9
1977	5	14	19
1978	1	1	2
1979	10	20	30
1980	10	49	59
1981	15	128	143
1982	25	84	109
1983	43	12	55
1984	50		50
1985	28	21	49
1986		63	63
1987		19	19
1988	40	11	51
1989	70	19	89
1990	70	88	158
1991			
1992			
1993	9	16	25
1994	17	20	37
1995	34	35	69
1996	8	39	47
1997	9	42	51
1998	21	26	47
1999	19	99	118
2000	11	28	39
2001	52	70	122
2002	54	55	109
2003	6	87	93

Year	Ittoqqortormiit	Tasiilaq	All
2004	39	96	135
2005	50	68	118
2006	93	29	122
2007	39	40	79
2008	37 *	39	76
2009	12	0	12
2010	20	10	30
2011	30	15	45
2012	31	17	48
2013	47	19	66
2014	63	18	81
2015	74	20	94
2016	38	15	53

*All taken in ice entrapment in Sermilik

Report

of the

NAMMCO Scientific Committee
Working Group on By-catch

2 - 4 May 2017, Faroes Representation
Copenhagen, Denmark

This report contains the views of the Working Group, and does not necessarily represent the view of the NAMMCO Scientific Committee and/or the Council, which reviewed the report at the 24th meeting.

This report was retained until after the Scientific Committee (SC) on the request of Council. The comments of the SC on this report are found in section 7.1.3 of the 24th SC meeting report.

EXECUTIVE SUMMARY

The By-Catch Working Group (BYCWG) met from 2-4 May 2017 in Copenhagen, Denmark, under the chairmanship of Kimberly Murray. The Terms of Reference for the meeting were:

9. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
10. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
11. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
12. *Review the information from Greenland on reporting of by-catch for the different species.*

The BYCWG also discussed that the goals of the meeting were not to assess the sustainability of the estimates as the sustainability is reviewed by the species-specific working groups that are doing the population assessments. The BYCWG should provide advice on whether the by-catch estimates are reliable and complete enough to be used in these population assessments.

Norway

The BYCWG reviewed the by-catch situation with humpback and killer whales in herring purse seine fishery, and updated harbour porpoise and harbour and grey seal estimates from the gillnet fisheries.

Humpback and Killer Whales

In recent years, as herring have entered fjords in high densities and both fishermen and whales are following the herring, incidences of humpback and killer whales caught in herring purse seine fisheries have increased. The Fisheries Directorate is working to reduce the risk of these incidents with a recommendation to limit the size of vessels allowed to fish inside the fjords, and recommendations for handling these incidents, including training fishermen, inspectors, and the Coast Guard for disentanglement and release of whales from the seine. The WG encouraged Norway to continue these efforts and also **recommended** investigating technical solutions to avoid the situation, such as night vision equipment to detect whales inside the seine, etc.

Harbour Porpoise

The WG reviewed the various methods of by-catch estimation of harbour porpoises in Norway. The WG **recommended** that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group suggests revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Harbour Porpoise Working Group Assessment in late 2018.

Grey and Harbour Seals

The WG reviewed the various methods of by-catch estimation of grey and harbour seals in Norway. The WG recommended that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group recommended the revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Coastal Seals Working Group Assessment in 2019.

The WG recommends that in the mark-recapture estimation approach, analysts consider the implications of different age structures between the tagged, harvested sample and the by-catch sample.

Other gillnet fisheries

The WG noted that in Norway the small mesh fisheries for mackerel and herring are not monitored, although small mesh is not known to catch harbour porpoises in Norway. This is also a quite small fishery. The gillnet lumpfish fishery has a high by-catch rate, but it is a small seasonal fishery. There is also a recreational fishery that uses gillnets.

Iceland

By-catch of marine mammals, seabirds and elasmobranchs in Icelandic waters has not been systematically investigated until very recently. Based on a study by Pálsson et al. 2015 and literature from other regions, most of the marine mammal by-catch is expected to come from the gill net fisheries for cod and lumpfish close to the coast, while it is possible that a smaller number of marine mammals are caught in the pelagic trawls and purse seines targeting capelin, mackerel, herring and blue whiting.

Most of the monitoring occurs in gillnet gear, where most of the by-catch is assumed. Less information is available from pelagic fishing gears. Fisheries observers cover all gear types (~1% coverage in all fisheries) but the sampling is not focused on documenting marine mammal by-catch. A new electronic logbook system was implemented in 2010, and since then logbook records of by-catch have diminished for unknown reasons. By-catch is not being reported on the e-logbooks, even though it is required for all vessels where possible. It has been shown that in some cases in the lumpfish fishery, the by-catch of marine mammals was an order of magnitude (5x) higher when an observer was present compared to what was reflected in the logbook records, so logbook records are clearly not a reliable source of data.

Data and Analysis

The two main sources of data used in this summary were records of by-catch from observers from the Directorate of Fisheries on-board commercial fishing vessels targeting lumpfish, and records from researchers from the Marine and Freshwater Research Institute (MFRI) during an annual research cod gill net survey. By-catch was estimated in the two gillnet fisheries (cod and lumpfish), by raising observed by-catch with total fleet effort. An alternative raising approach, using a two phase gamma-hurdle model, was also explored for the lumpfish fishery in 2016.

Recommendations

The BYCWG provided recommendations on the analysis of by-catch estimates (see item 7.3 in the main report) and recommended that these be addressed before the estimates are used by the Harbour Porpoise Working Group and Coastal Seals Working Group.

Faroe Islands

A description of fisheries in Faroese waters, fisheries regulations, the logbook system, fleet composition and fishing effort by fleet categories was provided to the WG.

There is little independent observation of fishing activities and no dedicated marine mammal observer scheme in the Faroes. The reliability of the by-catch reporting has not been assessed, but as elsewhere there is very little reported by-catch in logbooks.

The WG noted that reliable by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidence of by-catch in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch. A responsible precautionary approach requires initiating a proper assessment of the by-catch risk in the various fisheries, beginning with those of higher concerns.

The WG provided recommendations for by-catch monitoring and observation (see discussion items 8.1 and 8.2 in main report).

Greenland

The WG reviewed information on the existing knowledge about marine mammal by-catch in Greenland and gave the following recommendations:

1. The WG suggested that for marine mammal species without regulatory measures (e.g. non-quota small cetaceans such as harbour porpoise, dolphins, pilot and killer whales) and some

seals, a reporting system similar to that mandated by the species-specific executive orders (i.e., for large whales, beluga, narwhal and some seals) would be helpful.

2. The WG recommends that Greenland include in the online reporting system for the hunters some kind of automatic validation, e.g. a pop-up window requesting information on the by-catch and the fishery in which it occurs.

3. The marine mammal by-catch reports made in fishery logbooks previous to 2016 have become available in the electronic fisheries database maintained by the Greenlandic Fishery License Control Authority in the Ministry of Fisheries and Hunting. The WG recommends that an overview of this information be made available to WG for review.

4. The WG recommends that Greenland perform as soon as feasible the validation of by-catch reporting data from the licensed hunters' online system against those from the buyers to understand levels of by-catch on a routine basis. This will help evaluate the new reporting system and will give an indication of the reliability of the overall reporting system.

5. The WG recommends that data collected by fisheries inspectors be summarized and made available. As the reporting of marine mammal by-catch is included in the protocols of fisheries inspectors, a report of the characteristics of any marine mammal by-catch events, in addition to information on the total fisheries effort, the number of trips observed, and the specific focus of the observation/inspection (fully monitored over the whole trip or just boarded to check gear type) would be helpful.

The WG also provided recommendations for improving the information in the background document SC/24/BYC/14 (see item 9.2 in the main report) and discussed mitigation measures in Greenland (item 10).

General Business

The WG recognizes that while it has recommended that marine mammal by-catch reporting is made mandatory in commercial logbook systems for vessels of all sizes, this information is not reliable without validation, which is difficult. While logbook reporting can be useful for qualitative indicators, the most reliable means to obtain information on by-catch is via dedicated monitoring by fisheries observers or electronic monitoring.

The WG briefly discussed interactions between aquaculture and seals, and encouraged the work of the Norwegian Fisheries Directorate to obtain improved data on the numbers of seals shot at fish farms. The WG also suggested that Norway should look at the numbers of fish mortalities at the fish farms that have been attributed to seals.

The WG also discussed electronic monitoring of by-catch, including a presentation on a system developed in Denmark which could provide a cheaper alternative to observers onboard vessels.

Next Meeting

At the next BYCWG meeting, all countries should:

- Provide information on all fisheries and gear types operating in the country, with levels of effort in each, and whether they are monitored for marine mammal by-catch. NAMMCO will provide a table of requested fields for countries to populate.
- Provide any information on observed trips, following a format provided by NAMMCO as above.
- Providing any new by-catch estimate(s) for review.

Each country should also report on progress with the recommendations made at this meeting.

MAIN REPORT

1. CHAIRMANS WELCOME AND OPENING REMARKS

Kimberly Murray, the chair of the meeting, welcomed the participants (Appendix 3). The participants introduced themselves and gave a brief background on their experience with by-catch issues.

2. TERMS OF REFERENCE

Murray reviewed the terms of reference for this meeting, which were:

13. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
14. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
15. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
16. *Review the information from Greenland on reporting of by-catch for the different species.*

The WG also discussed that the goals of the BYCWG were not to assess the sustainability of the estimates as the sustainability is reviewed by the species-specific working groups that are doing the population assessments. The BYCWG should provide advice on whether the by-catch estimates are reliable and complete enough to be used in these population assessments.

3. ADOPTION OF AGENDA

The agenda (Appendix 2) was adopted without changes.

4. APPOINTMENT OF RAPPORTEURS

Prewitt acted as primary rapporteur, with help from Desportes, Murray and other participants where needed.

5. REVIEW OF AVAILABLE DOCUMENTS AND DATA

The documents available to the meeting are listed in Appendix 4.

6. NORWAY

6.1. Fisheries Overview

Rolf Harald Jensen gave a presentation on the work of the Surveillance Unit of the Fisheries Directorate in Norway, which ensures that the fisheries are carried out in accordance with regulations and in responsible methods. The unit consists of 21 inspectors, 2 advisers and 1 manager of service in the administrative staff in Tromsø. In 2016, there were 180 inspected fishing vessels, with 2400 stations/fishing operations (hauls) controlled. The inspector's main duties are to collect length and weight measurements of the fish to consider the need to close or open fishing grounds, however they also report observed incidences of marine mammal by-catch.

Fishermen are required to report marine mammal by-catch, however it is not likely that they are reporting all incidents.

In recent years, as herring have entered Norwegian fjords in high densities and both fishermen and whales are following the herring, incidences of humpback and killer whales caught in herring purse seine fisheries have increased. When the whales are detected inside the seine, and before the fish are dead, it may be possible to release the whales. However, if the herring have died, it is illegal for the

fishermen to open the seine (the dead herring are considered discards/slippage which is forbidden). Additionally, this fishery takes place primarily in the dark (24hrs darkness November to January), and there are cases where entrapped whales are not detected until it is too late.

There has been a recommendation from the Fisheries Directorate that no vessels over 21m be allowed to fish inside the fjords, in an attempt to reduce the risk of by-caught whales. The Fisheries Directorate is also working with the Coast Guard and the fishermen to develop recommendations for handling these incidents, including training fishermen, inspectors, and the Coast Guard for disentanglement and release of whales from the seine.

Discussion

The WG encouraged Norway to continue with their plans on training in disentanglement and release (with David Mattila), and also **recommended** investigating technical solutions to avoid the situation, such as night vision equipment to detect whales inside the seine, etc.

The WG discussed whether this issue may also be occurring in the purse seine fisheries outside the fjords, where they would not be observed as easily by inspectors, Coast Guard, or other people (whalewatchers, etc.). It is possible that this could be happening, but it could also be less of a risk because the fish, fishermen, and whales have more room to move around outside of the fjords.

There have also been incidents of humpback whales in the capelin purse seine fishery in the Barents Sea.

6.2. By-catch Data and Analysis

Harbour porpoise

Bjørge presented a summary of paper SC/24/BYC/08. Data from a monitored segment (18 vessels) of the fleet of about 6,000 small (less than 15m) vessels operating gillnets in the coastal zone were used to estimate the by-catch rate, and landings statistics of the target species for the whole fleet using same gear types were used to extrapolate to the entire fisheries. The previously published estimated annual by-catch of about 6,900 harbour porpoises for the period 2006-2008 (Bjørge et al. 2013) was based on incorrect landings statistics of the target species provided by the Directorate of Fisheries. The by-catch for the entire period 2006-2014 is estimated by two methods: ratio-based approaches and model-based approaches. In the ratio-based approaches, the data were stratified according to five different stratification schemes, by month, by area, by region, and by each possible combination of area × month and region × month. The stratified ratio-based by-catch estimates ranged from 2,211 (CV 0.16) to 3,218 (CV 0.17) porpoises. In the model-based approaches, generalized additive models (GAMs) were used to estimate the by-catch rate and to extrapolate to entire fisheries. Poisson and negative binominal distributions and their zero-inflated counterparts were compared. The Poisson distribution performed best, and the best model based on Akaike's Information Criterion adjusted for small samples, AICc, yielded an annual by-catch of 2,317 (CV 0.10) porpoises.

Discussion

The document used for the main WG discussion on harbour porpoise (and seal) by-catch rates was SC/24/BYC/Info07, rather than SC/24/BYC/08, because SC/24/BYC/Info07 was completed after SC/24/BYC/08, and provided the most recent set of results from the different estimation techniques used.

Data

The WG discussed the possibility of using fishery effort instead of landings data as a measure of effort. The landings fluctuate from year to year and fishermen may increase their net length if fish are scarce. Although SC/24/BYC/Info07 showed that the relationship between landings and effort was good, the WG **recommended** that other measures of effort should be explored. This exploration should include cooperation between IMR and the Fisheries Directorate on identifying what data are available (e.g. number of trips, soak length, net size, etc.). It would be helpful for the Directorate to clarify to data requestors what data fields are available for by-catch analyses.

Jensen also informed the WG that fishermen must report to the Coast Guard when a net is deployed and when it is pulled, and the location (including start and end) of the net, which could be used to calculate the length of the net. These data would enable much more detailed by-catch estimation.

If landed weight is used, ideally the by-catch rates should be extrapolated using total landings for all species, not only the target species (e.g., monkfish or cod), as it is the gear that is in the water that poses risk of porpoise by-catch. Using a portion of the catch as a measure of fishing effort underestimates the possible marine mammal by-catch. A suggestion was made to estimate by-catch for gillnet "gear", ideally separated into large and small mesh groups, rather than for "cod" and "monkfish" fisheries (see Technical Comments, Appendix 1).

Coastal Reference Fleet

All vessels in the Coastal Reference Fleet (CRF) are less than 15m, but catch statistics used in the by-catch extrapolation may include all vessel sizes. The WG **recommended** that this should be clarified.

The WG discussed that it would be good to look into whether the same vessels are used in the CRF year after year. There is almost certainly bias in the CRF data if the vessels are not switched out on a regular basis. Moan also acknowledges in SC/24/BYC/Info07 that these kinds of repeated samples cause correlations in the data samples, which could lead to errors in the analysis. One solution to this problem might be to change the design of the reference fleet selection process, such that any one vessel cannot participate 2 consecutive years.

The CRF fishes mainly in the coastal zone. It could be interesting to stratify by inshore/offshore if the data are available.

Estimation Approaches

SC/24/BYC/Info07 reported by-catch rates estimated using a model-based approach and a ratio-estimator approach. The WG agreed that between the 2 approaches, the ratio-estimator approach was preferred, though revisions were required before the ratio-estimator results could be endorsed by the group (see Technical Comments, Appendix 1). The ratio-estimator approach was preferred because some of the GAM models used to estimate by-catch provided a poor fit to the data, and this may have been due to a variety of factors that could not be clearly identified. For instance, poor fits may be due to the model selection process, the high-degree of zeros in the data, the clustered nature of the sampling events, correlated data, etc. The group felt that the ratio-estimator approach was more robust to these kinds of issues compared to the model-based approach.

Other gillnet fisheries

The small mesh fisheries for mackerel and herring are not monitored, although small mesh is not known to catch harbour porpoises in Norway. This is also a quite small fishery.

The gillnet lumpfish fishery has a high by-catch rate, but it is a small seasonal fishery.

There is also a recreational fishery that uses gillnets. The landings are reported if the catch is sold, but if they are not selling it the recreational fishermen do not need to report. No license is required, however there is a maximum length and number of nets that can be deployed (210m of net can be set at a time). The soak time limit is the same as for the commercial fisheries: gillnets for cod, haddock and saithe have a limit of one day; Greenland halibut, blue ling, ling and redfish must be pulled every second day; and monkfish every third day. There is also likely some level of illegal fishing, which is of course difficult to monitor.

By-catch of seals in Norway

Bjørge presented document SC/24/BYC/Info07 which reported by-catch rates of seals using a model-based approach and a ratio-estimator approach. A third approach was presented in SC/24/BYC/08, whereby seal by-catch was estimated via mark-recapture techniques. For the period 1997-2014 Norway

has statistics on the number of grey and harbour seals harvested from the populations, as well as information on number of seals tagged, number of tags recovered from the hunt and number of tags recovered from fishery by-catches. These data provided an opportunity to estimate the total number of seals taken as by-catch, assuming equal ratios of animals in the total harvest to the tagged harvest, and total by-catch to the tagged by-catch.

Discussion

The working group noted that while hunters may take a wide range of age groups, most by-caught seals are juveniles, so assumptions regarding tag loss and annual mortality rate, emigration and immigration being similar between the two sets of animals are unlikely to be upheld.

For hunted animals, the data may not reflect the full age structure of the hunt. Hunters are only required to report number of seals hunted and the sex (i.e., not length or some other data that could be used for aging). For some years, the lower jaw was collected which would be able to provide information on age.

In addition, the authors acknowledge that some of the by-caught seals that were identified as grey seals may have been incorrect. Issues with these assumptions were discussed at the Coastal Seals Working Group meeting (NAMMCO 2016).

Given these issues, and the existence of more detailed estimates of by-catch from sampling the CRF, the WG agreed that the mark-recapture method was not the preferred approach. However, if these data were to be used for other purposes it would be important to consider the implications of the different age structures between the harvested and by-caught animals, and how this might affect the probability of recovering a tag.

For instance, in the calculations of by-catch estimates for seals, the total harvest should be replaced by total juvenile harvest. Only juveniles were tagged and almost all the recoveries were within the first year, so all ages should not be lumped. The WG **recommended** separating out the seals less than 1 yr, or investigating other ways to separate out the differing probabilities of tag recovery based on age.

6.3 Recommendations

Harbour Porpoise

1. The WG **recommended** that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches for reasons mentioned above; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group suggests revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Harbour Porpoise Working Group Assessment in late 2018.

Grey and Harbour Seals

1. The WG recommended that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches for reasons mentioned above; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group recommended the revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Coastal Seals Working Group Assessment in 2019.

2. The WG recommended that in the mark-recapture estimation approach, analysts consider the implications of different age structures between the tagged, harvested sample and the by-catch sample.

7. ICELAND

7.1. Fisheries Overview

Guðjón Sigurdsson presented information on by-catch in Iceland, which summarized SC/24/BYC/10.

The major fisheries in Icelandic waters can be divided into pelagic and demersal fisheries. The pelagic fishery targets capelin, herring and mackerel with pelagic trawl and purse seines. The demersal fishery targets various species of ground fish (gadoids and redfish), flatfish and crustaceans with long line, demersal seine, bottom trawl and gill nets.

7.2 Monitoring

By-catch of marine mammals, seabirds and elasmobranchs in Icelandic waters has not been systematically investigated until very recently. Based on a study by Pálsson et al. 2015 and literature from other regions, most of the marine mammal by-catch is expected to come from the gill net fisheries for cod and lumpfish close to the coast, while it is possible that a smaller number of marine mammals are caught in the pelagic trawls and purse seines targeting capelin, mackerel, herring and blue whiting.

Most of the monitoring occurs in gillnet gear, where most of the by-catch is assumed. Less information is available from pelagic fishing gears. Observers cover all gear types (~1% coverage in all fisheries) but the sampling is not focused on documenting marine mammal by-catch. Observers are not always in a position to document marine mammal by-catch in all fisheries. For instance, in the pelagic pair trawl fishery, observers are below deck to monitor the catch, and not in a position to see if a marine mammal is caught. Since 2014 this has improved with stricter guidelines regarding marine mammal by-catch and supervision of the observers, but prior to that data were not reliable for reporting of marine mammal by-catch.

A new electronic logbook system was implemented in 2010, and since then logbook records of by-catch have diminished for unknown reasons. By-catch is not being reported on the e-logbooks, even though it is required for all vessels where possible. Smaller vessels that cannot use the e-log system have to report catch and by-catch in paper based logbooks. It has been shown that in some cases in the lumpfish fishery, the by-catch of marine mammals was an order of magnitude (5x) higher when an observer was present compared to what was reflected in the logbook records, so logbook records are clearly not a reliable source of data.

7.3 Data and Analysis

The two main sources of data used in this summary were records of by-catch from observers from the Directorate of Fisheries on-board commercial fishing vessels targeting lumpfish, and records from researchers from the Marine and Freshwater Research Institute (MFRI) during an annual research cod gill net survey. By-catch was estimated in the two gillnet fisheries (cod and lumpfish), by raising observed by-catch with total fleet effort. In the case of the cod gillnets, observed by-catch in the survey was first raised by effort (nets pulled x soak days) in April, to get an estimate of by-catch by the fleet in April. This estimate for April was then raised for other months by effort but then adjusted for seasonal variation in marine mammal abundance. For lumpfish nets, observed by-catch was raised by overall effort of the fishing fleet in terms of nets pulled and the number of soakdays. An alternative raising approach, using a two phase gamma-hurdle model, was also explored for the lumpfish fishery in 2016. In this approach, the likelihood of a by-catch event occurring was estimated using a binomial generalized linear model, and then the magnitude of the event using a gamma GLM.

By-catch estimates from 2014-2016 using the standard raising method are given in Table 1, and from the lumpfish fishery in 2016 using the gamma hurdle model are given in Table 2.

The extremely high estimates of grey seal by-catch in the lumpfish fishery are due to three observed events, where 17, 16 and 12 grey seals were caught. Outside of those three events only one grey seal was observed among 57 observed hauls. Based on the latest population estimate of grey seals in Iceland, the estimated by-catch amount represents close to 60% of the total population. This estimate is therefore inaccurate and requires further analysis. Possible solutions would be to add spatial stratification to the estimate, as those three events took place in the same general area and might not be representative for the entire fleet. In addition, data could be pooled over the 3 years to report an average annual estimate, which will reduce the overall effect of those extreme by-catch events.

Even with the grey seal estimate removed, authors saw an increase in marine mammal by-catch from the estimates done in 2014 and 2015, mostly due to a 4-fold increase in harbour porpoise by-catch. As fishing effort has been stable, it could be an indicator of an increase in the local density of harbour porpoises between years, or a sporadic event which might become evident with further sampling.

Discussion

The WG noted that the most important factor in by-catch estimation is confidence in the data inputs. Iceland informed the WG that they have very high confidence in the cod gillnet data, and high confidence in the lumpfish fishery data. There is a potential bias in the lumpfish data, as some of the observer trips are targeted to observe boats that have reported little or no cod catch in relation to other boats in the area. This has been addressed with the Directorate of Fisheries, and they will mark those trips as "non-random" starting in 2017 which will allow for an analysis of this potential bias.

The WG noted that in general all the standard deviations of the estimates seemed surprisingly low, and it was **recommended** that uncertainty be re-evaluated with other means, perhaps a bootstrapping approach (see R2 below).

Cod Fishery

This fishery is further offshore and in deeper waters than the lumpfish fishery, and consequently harbour porpoises are by-caught more often than seals (harbour and grey) in cod gillnets in Iceland. In 2016, 35 harbour porpoises were recorded in 3948 net days (at 100 nets fished/day, this is ~40 days). When comparing coverage with the same metric, the capture rate in cod gillnets was about 10 times the capture rate in lumpfish nets.

There was an increase in harbour porpoise by-catch in cod gillnets in 2016. The rate is four times higher compared to 2015 (with the same amount of observer effort), suggesting that harbour porpoise density on the fishing grounds might be changing.

It was suggested that Iceland examine trends in commercial effort in the cod fishery over time, because the change in the by-catch estimate (the 2015 estimate went from 553 to 2,618 in 2016) might be influenced by increases in commercial fishing effort, in addition to higher by-catch rates.

The estimated harbour porpoise by-catch in 2016 was ~2-9% of the abundance estimate of 43,179, however this abundance estimate was considered to be a minimum estimate because it was based on an incomplete aerial survey. The WG noted that large ecosystem changes have been observed in the Icelandic ecosystem between 2015 and 2016, which could have affected the abundance and distribution of porpoises. A new estimate based on next of kin genetic analysis is ongoing.

The WG noted that as a way to check if the high by-catch rates would be expected, rates could be evaluated relative to a density per area. Density values are available in Gilles et al (2011). The density estimate in area 1 (where high observed by-catch rates occurred) is low (0.15 in July), despite the high by-catch rates in that area. However, the density values are based on a harbour porpoise survey conducted in July, while the high by-catch rates are based on a study conducted in April, and the densities of harbour porpoises may change seasonally.

Banana pingers were tested in 2017 to try to reduce porpoise bycatch in the cod gillnet survey. There was no difference in the observed by-catch in a paired trial, with three porpoises caught in 70 observed hauls of 840 nets with banana pingers and four in 70 observed hauls of 840 nets without any pingers.

Table 1. Estimated numbers of marine mammal bycatch by species and fishing gear type in Icelandic waters in 2014-2016 from the standard raising methods. Standard deviation of the estimate is shown in the brackets.

Species	Cod gill nets			Lumpfish nets			Other gear			Total		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
Harbour porpoise	551 (30)	553 (48)	2618 (77)	139 (61)	215 (75)	374 (153)	0 (0)	0 (0)	0 (0)	690	768	2992
Harbour seal	0 (0)	46 (0.7)	0 (0)	232 (116)	1,288 (1335)	624 (356)	0 (0)	86 (3.3)	0 (0)	232	1,420	624
Gray seal	0 (0)	0 (0)	0 (0)	162 (118)	1,216 (1824)	2870 (9820)	0 (0)	0	0 (0)	162	1,216	2,870
Harp seal	92 (1.5)	212 (7.7)	144 (7.0)	23 (7.5)	72 (61)	187 (42)	0 (0)	0 (0)	0 (0)	115	284	331
Ringed seal	38 (1.0)	0 (0)	0 (0)	46 (7.5)	143 (31)	0 (0)	0 (0)	0 (0)	0 (0)	84	143	0
Hooded seal	0 (0)	46 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0	46	0
Bearded seal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	124 (23)	0 (0)	0 (0)	0 (0)	0	0	124
Total	681	857	2,762	602	2,934	4179	0	86	0	1,283	3,877	6,941

Table 2. Estimated numbers of marine mammal bycatch by species in the lumpfish fishery in 2016 using the gamma-hurdle model. Mean estimate is shown, as well as the 95% CI in brackets.

Species	Lumpfish nets
Harbour porpoise	259 (84 – 473)
Harbour seal	2171 (511 – 4156)
Gray seal	1881 (622-3798)
Harp seal	134 (35-229)
Ringed seal	0
Hooded seal	0
Bearded seal	146 (13-310)
Total	4591 (2076-7445)

Lumpfish Fishery
Seals (grey and harbour) are the main marine mammal by-catch in the lumpfish fishery, as this fishery occurs in shallow water close to haul out sites. Estimates of by-catch in the lumpfish fishery rely on observers who sample a portion of the gillnet fleet. Observer coverage in the lumpfish fishery was 1.7%. However, data from the lumpfish fishery were not always drawn from a random sample of vessels, because some observations have been directed at vessels with lower reported cod catches than other boats fishing in the same area. Starting in 2017, this potential bias can be better quantified, because the observations are coded depending on why the vessel has been selected for monitoring.

Grey seals
Out of 57 trips, 46 grey seals were by-caught, which led to a by-catch ratio estimate of 2,870 (SD=9,820). The grey seal population in Iceland in 2012 was 4200 (95% CI: 3400 – 5000) seals, which is an annual decrease of 5% (90% CI: 4%-6%) between 2005 and 2012 (Hauksson et al. 2014). A new abundance estimate is expected from a survey planned for summer 2017. The WG noted that this by-catch estimate is 57-84% of the 2012 abundance estimate, and it is likely biased high. As the group recommended revisions to the by-catch estimate analysis, these comparisons to abundance are subject to change.

As seen in other areas (Norway, UK, US), most of the by-caught seals are young of the year.

Three trips took the majority of seals (i.e 17 seals in 1 trip) and are likely skewing the estimates, because very high by-catch rates are being applied to the entire fishery. The estimate could be improved by spatially stratifying the data to focus on the region which contained most of the observed by-catch. Additionally, it is possible that young harp seals are being misidentified as grey seals, so improved species identification is recommended.

Estimates from the gamma hurdle model estimate were considerably lower (1,881, CI=622-3798) than the ratio estimate, but a preferred approach was not selected. The WG did not have the gamma hurdle model details to evaluate the differences or recommend a preferred approach.

Harbour Seals
The current abundance estimate for harbour seals in Iceland is 7652 animals, which indicates a decrease of 32% since the last estimate in 2011 (Þorbjörnsson et al 2017). The harbour seal by-catch estimate is 6-12% of this abundance estimate. As above, the group recommended revisions to the by-catch estimate analysis so these comparisons to abundance are subject to change.

Recommendations

Lumpfish Fishery
R1. The WG **recommended** that Iceland explore different stratification schemes for the ratio estimate, and pool data over the 3-year time frame to report an average annual estimate of by-catch.

R2. The group also **recommended** that the uncertainty around the estimates be re-evaluated, such as with a bootstrap approach. These revisions should be completed and endorsed by the group prior to the Harbour Porpoise Working Group Assessment meeting in 2018, and the Coastal Seals Working Group Assessment meeting in 2019.

R3. The WG **recommended** that fishing trips sampled for estimating by-catch rates be selected as randomly as possible, to ensure observer coverage is representative of various fishing behaviours.

R4. The WG **recommends** that for seals, observers collect jaws or photos to improve species identification, and to collect skin samples to inform genetic research.

Cod Fishery
R5. The WG **recommended** that the uncertainty around the estimates be re-evaluated, such as with a bootstrap approach. These revisions should be completed and endorsed by the group prior to the Harbour Porpoise Working Group Assessment meeting in 2018, and the Coastal Seals Working Group Assessment meeting in 2019.

Other
R6. The WG **recommended** that Iceland conduct monitoring of the monkfish and Greenland halibut gillnet fishery, as by-catch has been observed in this type of gear in other areas.

8. FAROE ISLANDS

8.1 Fleet description and Fisheries Regulations

Mikkelsen presented SC/24/BYC/13 which provided a description of fisheries in Faroese waters, fisheries regulations, the logbook system, fleet composition and fishing effort by fleet categories.

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese vessels, fishing primarily for cod, haddock and saithe. The pelagic/midwater fisheries, which targets blue whiting, herring and mackerel, are conducted by Faroese and foreign fishing vessels, licensed through bilateral and multilateral fisheries agreements. All vessels over 15 tonnes are equipped with satellite tracking devices

The fishery within the Faroese exclusive economic zone is regulated by individual transferable effort quotas in days within fleet groups. The individual transferable effort quotas (number of fishing days) applies primarily to four main fleet categories: trawlers <400 HP, longliners >110 HK, longliners and trawlers <110 GRT and boats <15 GRT. The single trawlers >400 HP do not have effort limitations, but they are not allowed to fish within the 12 nm limit, and are also, together with trawlers <400 HK, regulated by area closures. Also, their catch of cod and haddock is limited by maximum by-catch allocations. The single trawlers <400 HP are given special licenses to fish inside 12 nm with a by-catch allocation of 25% cod and 12% haddock. In addition, they are obliged to use sorting grids in their trawls. One fishing day by longliners <110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners <110 GRT could therefore double their numbers of days by converting to jigging. Technical measures such as area closures during the spawning periods, to protect juveniles and young fish and mesh size regulations, are also in effect.

The fishery for greater silver smelt (*Argentina silus*) in Faroese waters is a bottom/semi-pelagic fishery, performed with very high vertical opening (VHVO) trawls of about 100 m x100 m. This fishery is regulated by quota and number of operating vessels (6 vessels working in pairs). The fishery occurs in the summer months (April - September) at depths between 300 - 700 meters.

The gillnetters target Greenland halibut and monkfish with set gillnets. They operate in deep waters off the Faroe Plateau, Faroe Bank, Bill Bailey's Bank, Lousy Bank and the Faroe-Iceland Ridge. This fishery is regulated by the number of licensed vessels (8 vessels) and technical measures like depth and gear specifications. The minimum depth for set gillnets targeting Greenland halibut is 500 meters, while in the monkfish fishery gillnets must be set deeper than 380 meters.

The Faroese pelagic fisheries are conducted by purse seiners and larger purse seiners also equipped for pelagic trawling. The pelagic fishery by Russian vessels is conducted by large factory trawlers, while other countries use purse seiners and factory trawlers, operating as pair trawlers. The fishery for blue whiting has exhibited a more than ten-fold increase since 2011 and is by far the most important fishery in terms of landings (over 230000 tons in 2015), followed by mackerel and herring.

The dominant fishing equipment for recreational fishing is hand line with baited hooks. A limited effort using longlines (halibut) and gillnets (herring) does occur in nearshore waters. There are no restrictions in gears or landings imposed on the recreational fishery.

8.2 By-catch information

By-catch reporting

Also based on SC/24/BYC/13, Mikkelsen reported that electronic logbooks, with on-line access and delivery (e-logbooks) to the Faroese Fisheries Inspection (www.vorn.fo), were introduced for the Faroese fleet larger than 15 GRT in the fishing year 2012/13, when also by-catch registration of marine mammals became mandatory.

By-catch registration is a dedicated column in the logbook, where fishermen register or are prompted to set "null" for no by-catch before being able to close the registration form Information on the species of bycaught whales and seals is not given, because the option is not available in the e-logbook, however the information can be added under comments.

The by-catch numbers registered in the e-logbooks are 2 whales in 2012/13, 2013/14 and 2014/15, respectively, and 5 whales in 2015/16. For some by-caught whales, the species has been given, and in these cases this has been either pilot whales or killer whales. Almost all by-catches originate in the pelagic/midwater fisheries for mackerel.

Table 3. From NAMMCO/SC/24/BYC/13, Landings (tonnes) of the main fisheries in Faroese waters – colours indicate fisheries with potential for bycatch of marine mammals (blue=gillnets, purple=high vertical opening trawl, green=pelagic trawl).

Fisheries in Faroese waters										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cod	12851,2	12359,2	10819	9724,1	12506,5	11731,9	7287,7	5209,7	6529,3	7103,3
Haddock	15457,8	11291,9	6763,2	4474,1	4514,4	3195,5	2353,1	2624,6	2499,1	2660,7
Tusk	2386,9	2031,6	2556,6	2243,9	3323,7	2872,2	3232,2	1274,8	1522	1124,5
Ling	3430,7	3006,4	3341,4	3237	4518,4	4060,9	5010,7	3513,5	5065,6	3795,1
Blue ling	1690,2	1600,9	926,1	853,5	1413,4	1294,9	1062,7	540,7	799,8	578,6
Saithe	59884,2	54961,4	50966,0	52579,5	39713,5	26842,6	31968,8	23660,2	21391,0	22666,4
Greenland halibut	900,8	1586,8	2103,9	2311,9	1165,1	1738,1	2241,1	2739,9	2904,4	3007,1
Redfish	3464,5	3031,4	1455,1	1468,7	1650,5	913,7	677,8	786,1	591,2	785
Monkfish	4334,1	3401,7	1869	1779,5	2015,3	1901,2	1079,2	454,8	590,8	543,6
Greater silver smelt	12270	13437	19248,8	19740,3	19189,5	18711,7	12265,6	14195,7	12018,8	14093,9
Salmon	0	0	0	0	0	0	0	0	0	0
Blue whiting	161939	145889,4	105167,8	24261,8	26964,1	14435	40594,4	83761	173810	231502
Norway pout	0	0	0	0	2,5	49,6	1751,2	586,1	1098,4	0
Herring	24559	10925	4256,7	4181,4	11891,3	56487,6	43005	110791,8	37448,5	37829
Horse mackerel	0	12,4	9,5	0	199,5	8,7	0,1	0	15,1	4,5
Mackerel	0	201,3	120,7	4990,7	66072,2	122047,4	107115,7	142735,1	95301	71148
Total	303168,4	263736,4	209603,8	131846,4	195139,9	266291	259645,3	392874	361585	396841,7

Discussion for 8.1 and 8.2

There is little independent observation of fishing activities and no dedicated marine mammal observer scheme in the Faroes. The reporting of by-catch in logbooks has become mandatory but only for vessels larger than 15 GRT. The reliability of the by-catch reporting has not been assessed, but as elsewhere there is very little reported by-catch in logbooks (11 whales in the period 2012-2016).

The information provided in SC/24/BYC/13 was supplemented by the information provided at the previous meeting of the WG (SC/23/13) and compared with information from other fisheries in an attempt to identify possible risk.

Pelagic and semi-pelagic fleet

Pilot, minke, and killer whales have been reported as by-catch in the Faroe Islands. Within one incident, a pod of 5 killer whales was by-caught in one trawl. VHVO trawlers have caught marine mammals in other regions in the North Atlantic. For example, in Spain VHVO is a gear with high by-catch. It has therefore the potential for by-catch in the Faroes due to the nature of the fishing operation and temporal and spatial overlap with marine mammals.

There are 6 pelagic trawlers reporting on average 1 whale per vessel per year. The WG noted that in comparison, UK observers have monitored over 150 fishing trips by pelagic trawlers targeting mackerel and herring in adjacent waters (ICES Divisions 6a and 4a) without any records of cetacean bycatch, although killer whales are often observed swimming around pelagic trawlers targeting mackerel during haulback, there has been no report of killer whale by-catch.

Demersal trawl

No by-catch has been reported in the Faroe Islands. In the US, however, a variety of small cetaceans and pinnipeds are by-caught in bottom trawls targeting groundfish. The WG also noted that in the UK during the 1980s around 20 porpoises had been recovered from demersal trawlers fishing around Shetland.

Purse seine

Pilot whales, killer whales and minke whales have all been reported as by-catch in the Faroe Islands.

Gillnet targeting herring in coastal waters

There has been no reported by-catch in the gillnet herring fishery in the Faroe Islands.

Gillnet targeting Greenland halibut and monkfish

There has been no reported by-catch, and by-catch risk is assumed to be low by the Faroe Islands because of the depth at which the gillnets are set.

In the UK, the by-catch rate is low in the monkfish fishery in deep water (over 150m) but high in shallower waters. In the US, however, the monkfish fishery typically has a high by-catch rate regardless of depth, due to the large mesh size used in the gear.

In conclusion, the WG noted that reliable by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidence of by-catch in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch. A responsible precautionary approach requires initiating a proper assessment of the by-catch risk in the various fisheries, beginning with those of higher concerns.

Animals taken as by-catch are not always identified to species, (for instance, 5 “whales” were reported in 2015/16 logbook data), and this should be improved.

In general, the pelagic pair trawl fishery appears to be a fishery with a high by-catch rate, simply from the number of vessels operating in the fishery and the recorded number of bycaught whales. For instance, out of 5 vessels in the fleet, there were 5 whales bycaught in 2016, which is 1 whale per boat on average. This is relatively high compared to similar vessels with more observer coverage in the UK.

Recommendations
In order to get a better understanding of the by-catch risk in the Faroese fisheries, and taking advantage of the Faroese political decision of increasing and improving the monitoring of the Faroese fisheries (upon recommendation from ICES), the group agreed to recommend as first steps and priorities:

1. The WG recommends that in regards to by-catch reporting:

    1.1. Add selection of local marine mammal species to e-logbook design, so species identification can be easily reported.

    1.2 Implement a reporting system for vessels below 15 GMT, as also recommended by the previous BYCWG.

2. WG recommends that in regards to by-catch observation:

    2.1 Improve reporting of by-catch on pelagic pair trawl fisheries by monitoring vessels in the fleet with an electronic monitoring video system (EM) or onboard observers. Electronic Monitoring might be more cost-effective than an observer scheme, particularly because only 5 vessels operate in the pelagic pair trawl fishery, and likely only a few hours per fishing trip need to be observed and videoed. The use of the EM could also be rotational. These fisheries are difficult to observe due to the high volume of catch and the multi-vessel nature of the fishery, so attention must be given to where the observer or cameras are placed and to the stage of the haul.

    2.2 Implement observer coverage in other fleets with potential for by-catch, such as the high vertical opening trawl fleet (6 vessels).

    2.3 Review the data already collected by fishery observers on the monkfish fishery during an experimental monitoring of the fishery prior to 2015.

    2.4 Include documentation of marine mammal by-catch in the protocol of fisheries observers, as well as other standard characteristics of the fleet (effort, location, month, etc.) to measure by-catch rates.

In addition, the WG mentioned that passive acoustic monitoring on the pelagic trawlers could indicate whether there is a routine association between killer whales and these gears or whether the by-catch of a pod of five killer whales was the consequence of a random event. This would help inform the by-catch risk in these gears.

9. GREENLAND

Nette Levermann (Ministry of Fisheries and Hunting) joined the meeting via videoconference on 3 May 2017 and presented paper SC/24/BYC/14, which gives information on the existing knowledge about marine mammal by-catch in Greenland. Its focus is on landings, use of different fishing gear, distribution of adjacent marine mammal species, and the fishery's potential for spatial and temporal overlap with marine mammals. This information and reported marine mammal by-catches were then used to discuss the risk of by-catch of marine mammals in general in Greenlandic waters.

The use of set gill nets and pound nets in coastal fisheries for Greenland halibut, cod, salmon and lumpfish which mainly occur during May-October. This period directly overlaps the period when the

harp seals and hooded seals, along with the large baleen whales are most abundant in the near shore Greenlandic waters.

The reporting of by-catch data comes from different sources:

1) Hunting grounds and living resources are open to harvest and use by Greenlandic citizens, subject to hunting licenses (full time or part time license). All catches have to be reported to the Ministry of Fisheries and Hunting where they are entered into the database. Until a new online reporting system was implemented in 2013, by-catches of seals and small cetaceans were required to be reported as catches.

Given that the vast majority of the fishermen who deploy fishing gear have a hunting licence, there is reason to believe that most by-catches of seals and small cetaceans are consumed or sold in the same way as the animals that are shot with rifle during regular hunting, and may have been reported as such.

2) There is a general ban on discard as well as an obligation to record and report all catches including birds and mammals, this applies for all Greenlandic and foreign vessels operating in Greenland waters. From 2016 this includes even small vessels i.e. below 6m length. It is obligatory for fishing vessels to deliver standardised logbooks to the Ministry of Fisheries and Hunting. The latest version of these logbooks includes an item for by-catch of marine mammals, which is entered into an electronic fisheries database at the Ministry of Fisheries and Hunting. The reporting of all marine mammal by-catch in logbooks is mandatory, as it is for the by-catches of commercially important fish species

3) A fishery observer scheme is enforced for all large Greenland vessels and for foreign vessels operating inside the Greenlandic EEZ. The observer scheme aims for a minimum coverage of 50 % of fishing trips in key fisheries and fisheries where there is a risk that one or more rules are not respected.

4) From April 2016 a new executive order on catch reporting has made it compulsory for the fishermen and buyers to report all catches, including by-catches which are not passed to the buyers. This includes all marine mammals, birds, fish or any other family of species. The systematically collection of data about by-catches in fisheries from the fishery it-self is stored and available for analysis in the fisheries database.

5) Other species registered as by-catch in Greenland include the entanglement of large whales as humpback-, minke-, bowhead and fin whales in fishing gear, with the highest number reported are the humpback whale. An average registration of three large whales annually is registered as entanglements in Greenland in the period 1998-2016, data reported to the IWC. The Greenland Government has in collaboration with the International Whaling Commission in June 2016 had a training course for local fishermen and wildlife officers on a "Fishermen assisted release program", when large whales are by-caught in fishing gear.

Discussion

In the salmon gillnet fishery in the 1970s there were high numbers of by-catch of killer whales, and harbour porpoises, but there have been no reports recently. No information was available to the WG as explanation for this.

In the Greenland shrimp fishery, exclusion grids have been used and since then no marine mammal by-catch has been recorded on the logbooks and the by-catch is therefore assumed to have been mitigated. However, the WG commented that the use of a grid does not necessarily imply that by-catch is prevented, because it depends on the design of the grid and how it functions as the trawl is fishing.

9.1. By-catch reporting and reliability

Greenland is an atypical case because any marine mammals that are caught, either directly or indirectly, are likely to be consumed so as long as the primary concern is to ensure that any by-catch is included in the total number of removals to be used in population assessments there is no real need to distinguish

hunted from bycaught animals. However, it is interesting to be able to distinguish between catch and by-catch, both regarding the certification of fisheries and in terms of mitigation (should the total removals not be considered sustainable). In an effort to improve the by-catch and hunting data collection and monitoring, Greenland implemented online reporting in 2013, and is continuing to improve the system.

Prior to 2013, it is assumed that by-catch of small cetaceans and seals would have been reported as catches – and therefore not distinguished from the hunt. Now, data from 2013-2016 include records of marine mammals taken as by-catch and during the hunts. The 2015/2016 data were validated by calling hunters and fishermen to check how they recorded the data. Of the 272 recorded "by-catches" (28 hunters reporting 72 monthly events of by-catches from April to December 2015 and January to September 2016. Data is summed per month for the reporting scheme. Species: harp seal young and adult, hooded seal, bearded seal, white-sided dolphin, harbour porpoise, narwhal, killer whale. Range 1-15 animals per hunter per month.), approximately two thirds were validated and of these, only 6 (4 events) were confirmed by-catches (others were shot by rifle, struck and loss, or not able to confirm). This indicates uncertainty in previous data as to the reporting category. The 6 recorded by-catch events were bearded seal and adult harp seal in the lumpfish fishery.

9.1.1. Large whales

The WG agreed with the Scientific Committee (NAMMCO 2016) that the reporting of by-catch of the larger species was reliable, as the Ministry of Fisheries and Hunting covers the financial expenses associated with by-catch of large whales. Also, the by-catch of large whales is usually also reported by the fisheries and hunting inspectors or by the municipality where the incident occurs. This is assuming the animal has not swum away with the gear.

9.1.2. Smaller whales

Smaller cetacean species are not subject to the species-specific executive order for quota species. The by-catch may have been reported as catch by the hunters, but this is not possible to validate. The executive order from 2016 (see point 4 above) on catch reporting should make the reporting more systematic and also provide a tool for validation.

9.1.3. Seals

There are no quotas for seal hunting, and it is unknown whether seals that were by-caught were previously reported as catch. However, the by-catch is required to be reported based on the executive order from 2016 (see point 4 above). This should make the reporting more systematic and also provide a tool for validation.

9.2. Recommendations

6. The WG suggested that for marine mammal species without regulatory measures (e.g. non-quota small cetaceans such as harbour porpoise, dolphins, pilot and killer whales) and some seals, a reporting system similar to that mandated by the species-specific executive orders (i.e., for large whales, beluga, narwhal and some seals) would be helpful.

7. The WG recommends that Greenland include in the online reporting system for the hunters some kind of automatic validation, e.g. a pop-up window requesting information on the by-catch and the fishery in which it occurs.

8. The marine mammal by-catch reports made in fishery logbooks previous to 2016 have become available in the electronic fisheries database maintained by the Greenlandic Fishery License Control Authority in the Ministry of Fisheries and Hunting. The WG recommends that an overview of this information be made available to WG for review.

9. The WG recommends that Greenland perform as soon as feasible the validation of by-catch reporting data from the licensed hunters' online system against those from the buyers to

understand levels of by-catch on a routine basis. This will help evaluate the new reporting system and will give an indication of the reliability of the overall reporting system.

10. The WG recommends that data collected by fisheries inspectors be summarized and made available. As the reporting of marine mammal by-catch is included in the protocols of fisheries inspectors, a report of the characteristics of any marine mammal by-catch events, in addition to information on the total fisheries effort, the number of trips observed, and the specific focus of the observation/inspection (fully monitored over the whole trip or just boarded to check gear type) would be helpful.

Suggestions for improving SC/24/BYC/14
The WG gave suggestions to Greenland that would help improve the tables in SC/24/BYC/14.

Table 2 and 3 in SC/24/BYC/14

- Investigate if data is available for other measures of effort instead of/in addition to landings (such as days at sea, trips, etc.)
- Also provide the characteristics of the gears (i.e. mesh size, depth of nets set, etc.)
- For the number of active boats with "N/A" recorded (no data available), look into whether there could be an estimate of effort from the number of licenses or gives the number of licenses as a proxy for effort.
- In the lumpfish fishery, data on the number of licenses are available but this does not indicate the scale of the fishery, hence the WG suggested that Greenland look into whether the number of nets is available for lumpfish. There's now a quota so that may be helpful
- Grid use in the trawls – include the information on what type of grid, whether it is mandatory or voluntary, etc.
- Indicate for all fisheries whether the by-catch data reporting is voluntary or mandatory

Table 5 in SC/24/BYC/14

- For the pelagic trawls, cetacean by-catch is seen in other areas, so Greenland should specify whether this fishery has had inspectors and still no observed catches, or just no reportings (which is considered unreliable).
- In general, look at all the gear types to identify if they are used in other areas and whether by-catch is seen in those fisheries. This can be used as a general indicator of whether there is risk of by-catch in Greenland.
- Indicate which fisheries have been monitored by fisheries observers and provide the monitoring effort, relative to trips taken.
- Add the mesh size and depth range for the gillnets.
- Include information on temporal overlap of fisheries with marine mammal presence in a column.
- Quantify the number of trips that fisheries inspectors have been on, including trips where the inspector was on board the whole time or if there was only a spot inspection.

Table 2 of SC/24/BYC/14. Overview of main regulated fisheries in West Greenland

Species	Areas (West Greenland)	Season	Gear type	Regulation	*Active boats 2016	*Landings in tons 2016	Potential mammalian by-catch
Shrimp	Offshore; Inshore Disko Bay	Year round	Shrimp trawl	Licences	15	68,931	Low risk. None registered after sorting grid was mandatory.
Greenland halibut	1.000-1.500 m depth off Nuuk & Qeqertarsuaq; Inshore Disko, Uummannaq and Upernavik. Qaanaaq	Peak in late summer, ends in November	Trawl Gill net/ long-line	Licences Open boats/dog sledge	274 1000	15,609	Data from 2016 under review
Scallop	Inshore from Nuuk to Upernavik.	Year round	Dredgers	Licences	4	735	Low risk. None registered.
Snow crab	Inshore from Upernavik and southwards	April - December	Crab pots	Licences	43	2,160	Entanglement of humpback and bowhead whales
Redfish	Offshore Southwest Greenland	June-October	Trawlers	Licences		9	Unknown, none registred.
Cod	Mainly inshore Offshore SW Greenland	Year round, peak June and July	Pound nets, hand lines, long-lines and set gillnets	Licences	NA	37,685	Entanglement of humpback whales (pound nets)
Capelin	Inshore, mostly Disko Bay and further north	May-July	Handnets	Licences	0	0	Very low risk
Atlantic salmon	Inshore	August 15 – October 31	Gill net Open boats	Licences	14	27	Unknown, none registred
Lumpfish	Inshore, 59°-72°N	March 01 – July 15	Gill net	Licences	NA	NA	Data from 2016 under review

Arctic char	Fresh water and close to a few rivers in central West Greenland	June 15 – September 25	Gill net	NA	NA	Low risk. None registered

*figures in estimated live weight from Greenland Fishery License Control Authority. Shrimp figures are from 2015. Division between East and West are in some cases based on estimation as quota types on which catches are recorded sometimes include both East and West.

Table 3 of SC/24/BYC/14. Overview of main regulated fisheries in East Greenland

Species	Areas (East Greenland)	Season	Gear type	Regulation	*Active boats 2005	*Landings in tons 2016	Potential mammalian by-catch
Shrimp		Year round; peak Dec-Apr.	Shrimp trawl	Licences	14	575	Low risk. None registered after sorting grid was mandatory
Greenland halibut		Year round	Trawl	Licences	14	8.325	Data from 2016 under review
Redfish	Offshore Irminger Sea	June-October	Trawlers	Licences	12	60	Unknown, none registred
Cod	Mainly offshore	Year round, peak June - July	Pound nets, hand lines, long lines and set gillnets	Licences	1	14.214	Entanglement of humpback whales (pound nets)
Capelin	Offshore 66°-69°N	Offshore: June 20 - April 30	Purse seines	Licences	2	0	Unknown, none registred
Lumpfish		March 01– July 15	Gill net	Licences	NA	NA	Data from 2016 under review
Mackerel		June – August	Trawl	Licenses	NA	36,211	Unknown, none registred
Herring		July-August	Trawl	Licenses	NA	NA	Unknown, none registred

*figures in estimated live weight from Greenland Fishery License Control Authority. Shrimp figures are from 2015. Division between East and West are in some cased based on estimation as quota types on which catches are recorded sometimes include both East and West.

Table 5 of SC/24/BYC/14 Estimated grouping of mammalian by-catch risk

Gear type	Estimated risk	Comments
Bottom dredges	Green	Low risk. No by-catch registered.
Bottom trawl	Yellow	Cetaceans follow the vessels and catches what falls out of the trawls. Grid is not mandatory for halibut bottom trawling, but is used in some cases to avoid Greenland shark. No by-catch registered.
Shrimp trawl	Green	Low risk. None registered after sorting grid was mandatory.
Crab pots	Yellow	Entanglement of humpback and bowhead whales reported.
Pelagic trawl	Green	Large pelagic trawls are dragged at high speed in the surface, potential for by-catches. No by-catch registered.
Gill nets	Red	Footnote[1]
Long-line	Green	No by-catch registered.
Pound nets	Red	By-catch of large whales reported.
Hand lines	Green	No by-catch registered.
Seine	Green	Large fishing gear, potential for by-catches. No by-catch registered.

10. OTHER BUSINESS

Mitigation measures in Greenland

The WG discussed a few possible mitigation measures that could be implemented in Greenland.

Greenland has had incidents of whales caught in lines for snow crab pots. Whales are also seen dragging the gear, which could also be from other areas and not Greenlandic gear. In the US large whales are often documented entangled in lobster pot lines. Several mitigation measures have been tested or implemented in the US fishery, including the use of weak links, but none has so proved unequivocally successful.

Whales are also seen caught in pound nets in Greenland. The WG noted that this has been an issue in Newfoundland, Canada, where acoustic deterrent devices were first trialled to prevent whales from becoming entangled in coastal trap nets. The WG suggested that Greenland contact Whale Release and Strandings in Newfoundland, or the Fisheries and Marine Institute of Memorial University of Newfoundland (Paul Winger) for more information.

The WG noted that for sea turtles caught in the leaders in pound nets, they have had success with fishing only the bottom of the net, i.e., keeping the net in the lower 1/3 of the water column. This results in less gear in the water to entangle the turtles, but it is unknown whether this would work for other fisheries, or for whales.

General Business

The WG recognizes that while it has recommended that marine mammal by-catch reporting is made mandatory in commercial logbook systems for vessels of all sizes, this information is not reliable without validation, which is difficult. While logbook reporting can be useful for qualitative indicators, the most reliable means to obtain information on by-catch is via dedicated monitoring by fisheries observers or electronic monitoring.

Aquaculture

[1] North Atlantic Marine Mammal Commission; Management Committee Working Group on Bycatch. National Progress Reports: Bycatch Reporting for 2005. NAMMCO/16/MC/BC/4.

There are ca 900 fish farms in Norway, however there are no reports of seals shot (Coastal Seals WG, NAMMCO 2016). The WG noted that this seems very unlikely given the levels of interactions seen between seals and fish farms in other countries. The Directorate is working on improving reporting, however Norway informed the WG that previous studies did not show issues with seals, but instead identified interactions with otters. Additionally, devices used to deter seals around the fish farms are being used to limit seal-fish farm interactions. Nevertheless, the WG encouraged the work of the Directorate to obtain improved data on the numbers of seals shot at fish farms. The WG also suggested that Norway should look at the numbers of fish mortalities at the fish farms that have been attributed to seals. If these are low, that would suggest that measures to minimise depredation are working; however if there are lots of mortalities due to seals, there are likely interactions (e.g., seals being shot).

Electronic Monitoring

Lotte Kindt-Larsen, DTU AQUA (Institut for Akvatiske Ressourcer, Lyngby Copenhagen), who was visiting, kindly agreed to make an *ad hoc* presentation about Remote Electronic Monitoring (REM) of by-catch (fish, birds and marine mammals), with which she has worked since 2008 in different regimes. Her presentation focussed on the monitoring of marine mammal by-catch. She described the system that has been developed for, and in co-operation with DTU Aqua with Anchor Lab (http://www.anchorlab.dk/), its characteristics, possibilities and constraints. The REM system recorded time, GPS position and closed-circuit television (CCTV) footage of all hauls. REM data could be used to identify fishing grounds, quantify fishing effort and document marine mammal by-catch. The time for videoing the tapes was reduced for marine mammals, as for such large animals the tape can be reviewed at high speed. DTU AQUA tried but abandoned the idea of developing automatic recognition software. Kindt-Larsen was overall very positive about REM for monitoring by-catch, particularly of marine mammals, and with the system that was finally adopted, which was cheap compared to others and to using observers, easy to set up even on small boat, and adaptable. The REM systems in use were connected on-line, which, among others, allowed Kindt-Larsen to check for and adjust their functioning and settings from her office.

11. NEXT MEETING

1. For all countries:
   - Provide information on all fisheries and gear types operating in the country, with levels of effort in each, and whether they are monitored for marine mammal by-catch. NAMMCO will provide a table of requested fields for countries to populate.
   - Provide any information on observed trips, following a format provided by NAMMCO as above.
   - Providing any new by-catch estimate(s) for review.

2. For Norway and Iceland, recommended revisions to the by-catch estimates presented at this meeting should be provided to the WG before the next Harbour Porpoise and Coastal Seals assessment meetings.

3. For Greenland, provide a progress report on recommendations 1 and 2 and data on Recommendations #3, 4 and 5.

4. For Faroes, provide data on Recommendation #2.3, and a progress report and/or data on Recommendation #1 and #2.1, 2.2 and 2.4.

References

Bjørge A, Skern-Mauritzen M and Rossman MC (2013) Estimated bycatch of harbour porpoise (*Phocoena phocoena*) in two coastal gillnet fisheries in Norway, 2006-2008. Mitigation and implications for conservation. *Biological Conservation* 161: 164-173.

Gilles A, Gunnlaugsson Th, Mikkelsen B, Pike DG, Vikingsson GA (2011). Harbour porpoise *Phocoena phocoena* summer abundance in Icelandic and Faroese waters, based on aerial surveys in 2007 and 2010. NAMMCO SC/18/AESP/11.

Hauksson E, Ólafsson HG and Granquist S (2014) *Talning útselskópa úr lofti haustið 2012* (Counting grey seal pups from the air in Fall 2012) (In Icelandic with English abstract). Veiðimálastofnun VMST/14050

NAMMCO (2016) Report of the 23rd meeting of the Scientific Committee. Tromsø, Norway.

Pálsson ÓK, Gunnlaugsson Th and Ólafsdóttir D (2015) By-catch of sea birds and marine mammals in Icelandic fisheries (In Icelandic with English abstract). Marine Research in Iceland no. 178.

Þorbjörnsson JG, Hauksson E, Sigurdsson GM and Granquist SM (2017) Aerial census of the Icelandic harbour seal (*Phoca vitulina*) population in 2016: Population estimate, trends and current status. Report of the Marine and Freshwater Institute (Iceland), HV 2017-009, ISSN 2298-9137.

Appendix 1: Technical comments on Norwegian by-catch estimates

Comments on Data Inputs to Models:

1. Questions remain about what exactly is in the CRF data and what were used to extrapolate the estimates. First, the group is concerned that the landings data used do not reflect all the landings from gillnet fishing activity in the area.

From SC/24/BYC/Info07 (Moan thesis):
"The CRF did not target cod and monkfish exclusively; other commercially important species (such as saithe (*Pollachius virens*, L. 1758), mackerel (*Scomber scombrus*, L. 1758), herring (*Clupea harengus*, L. 1758), haddock (*Melanogrammus aeglefinus*, L. 1758), and many more) were frequently fished as well. In the period 2006 – 2015, cod catches constituted 44.9% of total landings, and monkfish a mere 2.7%."

The WG suggested that estimates of by-catch rates be made for fixed gillnet gear, and include all landings from Directorate, not just cod and monkfish, and be stratified by time and area. Partitioning into mesh size groups would reduce variance around the by-catch rates even further. If mesh size is not available in the Directorate of Fisheries data, mesh size can be inferred from catch composition, which is correlated to mesh size and can serve as a proxy.

2. It would be helpful to see summary tables of the CRF data and the MRF data. Specifically, a summary of total landings by species for gillnet vessels fishing in the 8 statistical areas, grouped by vessel length. From the CRF data, similar information, plus observed by-catch.

3. The sampling unit is unclear in the analysis.

On pg 20: "Assuming each fishing trip is associated with the hauling of one set of nets (that have soaked for approximately 24 hours) in one location, then we may consider each fishing trip as one "event"".

Is the sampling unit a full trip (which consists of several net hauls), or a single haul?

4. Correlated data/vessel bias:
Pg 59: "One assumption underlying the entire analysis is that the data collected by this segment of about 20 of the approximately 6000 fishing vessels was representative for the whole fleet. This, however, is an unrealistic assumption. We may expect that different fishing vessels exhibit unique fishing patterns. Different vessels may tend to frequent the same particular fishing sites, use one specific kind of gear, fish at particular depths, specialize in one particular catch species, etc. A consequence of these vessel-specific fishing patterns is that observations associated with the same vessel most likely are correlated, and not independent, as is assumed."

The sample fleet is a relatively small number of boats compared to whole fleet (40 of 6,000). It would be helpful to evaluate bias in the sampling frame from individual vessel effects.

For future data collection, the WG suggested that Norway should build in mechanisms for random selection in contracting process, perhaps renewing contracts for the same vessel over a longer time period, ie. if vessel A fishes in year 1 that vessel wouldn't be allowed to compete again until year 4, etc.

5. Examine a time series of coastal gillnet trips by year and area to see how constant the effort has been, because patterns in the total effort can help interpret results, and to check effect of pooling over several years of data.

Comments on By-catch Estimation:

6. The WG had concerns about the bootstrap methodology (see pg 60):

It appears as if the bootstrap unit might have been a stratum, rather than the sample observation, which is the trip (or haul? See comment #3). Bootstrapping grouped records (as in a stratum) will underestimate the variance. Also, confidence intervals can be derived directly from bootstrap replicates, not from standard error around the replicates.

7. The WG also recommends the authors revisit the equation on pg 17, which adds a 1 to the denominator to avoid dividing by 0. However, the text reads as if the issue is 0 by-catch in numerator, which would be a zero by-catch rate, and not a problem. Adding a 1 to the denominator may inflate the by-catch estimate if the catch is < 1 ton.

8. The WG had concerns about the post-hoc stratification in the ratio estimates. Normally data should be stratified based on *a priori* biological assumptions, rather than patterns in the data. Perhaps the authors could define 'areas' based on patterns in porpoise or seal abundance and behaviour, rather than administrative fishing boundaries. Otherwise the authors should provide rationale for the stratification scheme, other than what has been provided, on pg 13.

AGENDA

1. CHAIRMAN WELCOME AND OPENING REMARKS
2. TERMS OF REFERENCE

    1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
    2. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
    3. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
    4. *Review the information from Greenland on reporting of by-catch for the different species.*

3. ADOPTION OF AGENDA
4. APPOINTMENT OF RAPPORTEURS
5. REVIEW OF AVAILABLE DOCUMENTS AND DATA
6. NORWAY
    - 6.1. By-catch data
    - 6.2. Fisheries and effort data
    - 6.3. Extrapolation method
    - 6.4. Evaluation of by-catch estimates
    - 6.5. Recommendations
7. ICELAND
    - 7.1. By-catch data
    - 7.2. Fisheries and effort data
    - 7.3. Extrapolation method
    - 7.4. Evaluation of by-catch estimates
    - 7.5. Recommendations
8. FAROESE
    - 8.1. Fleet description, including effort data
        - 8.1.1. Mid-water trawling
        - 8.1.2. Other
    - 8.2. Bycatch information
    - 8.3. Data gaps
    - 8.4. Recommendations
9. GREENLAND
    - 9.1. By-catch reporting and reliability
        - 9.1.1. Large whales
        - 9.1.2. Smaller whales
        - 9.1.3. Seals
10. OTHER BUSINESS
11. NEXT MEETING

Participants

Arne Bjørge (Invited Expert)
Institute of Marine Research
PO Box 1064, Blindern
N-0316 Oslo, Norway
Phone: +47 22958751
arne.bjoerge@imr.no

Geneviève Desportes (Secr., Convenor)
NAMMCO
PO Box 6453
N-9294 Tromsø, Norway
Mobile: +47 95021228
genevieve@nammco.no

Thorvaldur Gunnlaugsson (SC)
Marine Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
Phone: +354 5752080
thorvaldur.gunnlaugsson@hafogvatn.is

Rolf Harald Jensen (2 May 17 only)
Head of Section
Overvåkingstjenesten
Directorate of Fisheries
Tromsø, Norway
Mobile: +47 917 96 533
rolf-harald.jensen@fiskeridir.no

Nette Levermann (videoconference, 3 May)
Ministry of Fisheries, Hunting and Agriculture
Greenland Home Rule
POB 269
DK-3900 Nuuk, Greenland
Phone: + 299345344
NELE@nanoq.gl

Marjorie Lyssikatos (External Expert)
National Marine Fisheries Services Northeast
Fisheries Science Center
United States
Statesmarjorie.lyssikatos@noaa.gov

Bjarni Mikkelsen (SC)
Museum of Natural History
V. U. Hammersheimbsgøta 13
FO-100 Tórshavn, Faroe Islands
Phone: + 298 790576
bjarnim@savn.fo

Kimberly Murray (Chair, External Expert)
NOAA/Northeast Fisheries Science Centre
166 Water Street
Woods Hole, MA 02543 USA
Phone: +1 508-495-2197
kimberly.murray@noaa.gov

Simon Northridge (External Expert)
Scottish Oceans Institute
University of St Andrews
spn1@st-andrews.ac.uk

Jill Prewitt (Secretariat)
NAMMCO
PO Box 6453
N-9294 Tromsø, Norway
Mobile: +47 95487348
jill.prewitt@nammco.no

Guðjón Sigurdsson
Marine Research Institute
PO Box 1390
IS-121 Reykjavik, Iceland
Phone:
gudjon.mar.sigurdsson@hafogvatn.is

Documents

Working Documents

Number: SC/24/BYCWG/XX	Title	Agenda Item
01	Draft Agenda	
02	Participants List	
03	Lumpfish Effort Iceland 2016	
04	Mammal Data Iceland Gillnets	
05	Mammal Data Iceland Lumpfish	
06	Some background information for the Icelandic datasets (papers 03,04,05)	
07	Bycatch of grey and harbour seals in Norway	
08	Bjørge Moan Revised estimates of bycatch of harbour porpoise	
09	Document List	
10	Incidental by-catch of marine mammals in Icelandic waters	
11	Gill net fisheries in Norway for the period 20160101-20170428	
12	Overview from cases of bycatch with Humpback- and Killer whales in purse seine fisheries for Herring	
13	Fisheries in Faroese waters and potential bycatch risk of marine mammals	
14	Review of existing knowledge on marine mammal bycatch in Greenland	

For Information Documents

Number: SC/24/BYCWG/XX	Title	Agenda Item
Info01	Bycatch WG Report 2016	
Info02	Bjørge et al. 2013. Bycatch of harbour porpoises	
Info03	ICES_WGBYC Report 2016	
Info04	ICES_WGBYC Report 2015	
Info05	ASCOBANS 2015-Consolidated Bycatch Recommendation to EU	
Info06	ICES_Protected species bycatch_Final Advice_April15-2016	
Info07	Andre Moan 2016 Bycatch of harbour porpoise harbour seal and grey seal in Norwegian gillnet fisheries	
Info08	Review on existing knowledge about marine mammal by-catch in Greenland	
Info09	By-catch of sea birds and marine mammals in Icelandic fisheries	
Info10	US MMPA Fish and Fish Product Import Provisions of the Marine Mammal Protection Act; Final Rule	
Info11	Report of the NAMMCO Coastal Seals WG March 2016	