Report of the

23rd MEETING
of the

NAMMCO SCIENTIFIC COMMITTEE

Nuuk, Greenland
4-7 November 2016

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Report

1. CHAIRMAN'S WELCOME AND OPENING REMARKS

The new Chair of the NAMMCO Scientific Committee (SC), Dr Tore Haug, welcomed the participants (Appendix 2) to the meeting. The Chair particularly welcomed new members of the SC from Greenland, Iceland and Norway, and observers from Canada, Japan and Russia.

Haug noted that, although this meeting was the first in his current period as chair of the SC, it was not his first meeting ever as a chair. He has been a member of the SC since the start in 1993, and served as the committee's second chair in the period 1995-1997. He emphasized that demography is a challenge for the SC – many of the current members have been serving in the committee for a very long period, and the need for younger blood is evident. When he accepted to go for a new period as chair 20 years after, he reported that one of his ambitions was to use the chairman period to get in some good, new scientists to the group. He was very happy to see that this process had already started with five newcomers already at this meeting.

During his long period in the SC, Haug had noted many clear examples that management matters and works: Negative trends in populations of species such as walrus, narwhals and belugas have been stopped and even reversed due to good management based on advice from the SC of NAMMCO. The committee has good reasons to be proud of that. Furthermore, Haug was pleased to notice that NAMMCO has succeeded in getting coastal seal management from its previous "home-made" approach and into a scientific working group that now enables the NAMMCO SC to give good advice to its governments.

Haug also concluded that he was very content to see the advice-producing Working Group on Harp and Hooded Seals into the NAMMCO framework without losing the original ICES (and NAFO) affiliation which he found very important since it secures the participation from the two other very important seal-hunting nations in the North Atlantic: Canada and Russia. There are, of course, some dark clouds over current seal hunting with the EU ban on products and other controversies. But the Chair emphasized that one thing is for sure: We have secured that no opponents against sealing can ever claim that sealing in our countries are unsustainable.

Haug admitted that large whale issues are still something that our politicians have decided that we must share with the International Whaling Commission (IWC). How long this will last is impossible to guess, but it is obvious that the IWC is developing more and more into a dysfunctional organisation when it comes to the original aim: to manage whaling. At some point – presumably when IWC has transformed into a pure whale conservation organisation – Haug was sure that the large whale assessments and management in the North Atlantic would be an important NAMMCO-only issue. But he doubted that this would happen in his current period as chairman.

In the meantime, Haug continued, we must focus on other important issues. He was sure that one of these would be by-catches of whales and seals in various fisheries. It was very timely, he emphasized, that NAMMCO SC has now established a by-catch working group which he thought would be very important for the organisation in the coming years.

2. ADOPTION OF AGENDA

The agenda accepted as circulated (Appendix 1).

3. APPOINTMENT OF RAPPORTEUR

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

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

4.1. National Progress Reports

Canada

Several research programs are underway, and a list of publications in 2015 are included in the National Progress Reports.

In the Atlantic region, a grey seal aerial survey was conducted in January 2016, and a review of the status of grey seals was completed. There is considerable research effort investigating seal-fishery interactions and also grey seal demographic parameters. A survey of harp seals is planned for March 2017, and this will cover the entire Northwest Atlantic stock region. If possible hooded seals will also be covered if conditions permit. During Aug-Sept 2016, a North Atlantic International Sighting survey (NAISS) was completed. This survey focussed primarily on cetaceans. Results are expected to be reviewed in fall 2017.

Narwhal satellite telemetry efforts included tagging 5 narwhals. Of these, 3 are still working.

Research continued on the beluga stocks in the Hudson Bay, James Bay, and Cumberland Sound and status was evaluated as part of the marine mammal peer review process during 2016. A survey of ringed seals was completed during the spring, and surveys of narwhal in the Admiralty and Eclipse Sound areas were completed during summer 2016. Research looking at movements and stock identity of ringed seals continued during 2016. In the western Arctic, a review of the status of beluga in the Beaufort Sea will be completed this winter.

Japan

Bando updated the SC on marine mammal research activities in Japan in 2015-16. There were 4 main sources of information on cetaceans: 1) New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A); The first survey of NEWREP-A was conducted during austral summer season of 2015/16. 333 Antarctic minke whales were collected and samples and data were obtained to achieve two main objectives; i) improvement in the precision of biological and ecological information for the application of the RMP to the Antarctic minke whales; and ii) investigation of the structure and dynamics of the Antarctic marine ecosystem through building ecosystem models. 2) Whale Research Program under Special Permit in the western North Pacific (JARPNII); In 2015, coastal surveys were carried out in spring and fall in Sanriku and Kushiro regions, respectively and offshore survey was carried in summer. Data and samples for feeding ecology, pollutant, and stock structure studies were collected. 3) Dedicated sightings surveys in the North Pacific (summer); The 2015 survey focused mainly to obtain sighting data for abundance estimation of baleen whales; 4) IWC-POWER sighting survey in the North Pacific (summer) organized by the IWC SC; the 2015 survey mainly focused on large whales, particularly Bryde's whale. During these surveys, Photo-ID and biopsy samples were collected from large whales such as blue, fin, sei, Bryde's, humpback, Antarctic and common minke, northern and southern right, sperm and killer whales. Other activities involved the update of the DNA registers for large whales based on whales taken by NEWREP-A, JARPNII and by-catches, and recording of strandings. The National Research Institute of Far Seas Fisheries was involved mainly in research of several species of small cetaceans. See details in the Japan NPR.

The SC asked how the by-catch reporting is conducted in Japan. The reporting is done by the fisherman submitting reports to the Fisheries Agency.

Russian Federation
Zabavnikov updated the SC on marine mammal research activities by PINRO in the Eastern Barents Sea including the coastal zone along the Kola Peninsula and Pechora Sea, and also in the Norwegian Sea and in the British Islands westward.

The main purpose of this research is studying cetaceans and pinnipeds place and role in marine ecosystems and primarily their role as predators on fish species and other marine organisms in fisheries activities. During these research activities, data is collected about marine mammal distribution, numbers and sightings as part of marine ecosystem complex research including acoustic sounding and special trawling.

In addition to the research activities conducted by PINRO, various other marine mammal research is conducted by other Russian scientists at the Scientific-Research Institute (SRI) and Institution by National Academy of Science and SRI Ministry of Environmental Resources. Various companies working and exploiting the shelf for hydrocarbon raw materials also conduct monitoring research in the Barents and Kara Seas.

The main directions of PINRO research are observations onboard research vessels, coastal observations and aerial surveys. Marine mammal observers are also onboard commercial fisheries vessels regularly, however these observers mainly provide additional sightings rather than directed research.

The main results of PINRO as Russian research are presented in the National Progress Report.

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 1-5.

4.2.1. By-catch WG
4.2.2. Coastal Seals WG
4.2.3. Abundance Estimates WG
4.2.4. WGHARP
4.3. Other reports and documents
4.3.1. Disturbance Symposium

5. COOPERATION WITH OTHER ORGANISATIONS

The full observer's reports are available in Appendix 4.

5.1. IWC

Vikingsson reported from the IWC Scientific Committee which held its annual meeting (SC66b) in Bled, Slovenia 7-19. June 2016. The *Implementation Review* of North Atlantic fin whales that was initiated in 2013 was completed in 2016. The next review will be expected to occur around 2021. The Scientific Committee endorsed a new estimate of fin whale abundance in the Central North Atlantic of 40,788 (CV 0.17; 95% CI 28,476- 58,423) for use in the RMP/CLA.

The Implementation Review of North Atlantic common minke whale was initiated in 2014. The SC was unable to complete the *Implementation Review* at the annual meeting in 2016. The Committee agreed that the completion of the review and interpretation of the trial results should be undertaken inter-sessionally with the aim of completing the review at the 2017 annual meeting.

New abundance estimates for common minke whales from the NASS 2015 Icelandic/Faroese shipboard survey blocks were presented. The Committee endorsed the following 2015 estimates of common minke whale abundance for use in the CLA), corrected for perception bias: 36,185 (CV 0.31; 95% CI 19,942 to 65,658) for the surveyed Icelandic and Faroese blocks, of which 12,710 (CV 0.53; 95% CI 4,498 to 35,912) were found in coastal Icelandic waters.

The primary issues at this year's meeting comprised: (1) developing *SLA*s (*Strike Limit Algorithms*) and providing management advice for Greenlandic hunts, with focus on bowhead and fin whales; (2) providing management advice for the Greenland hunts and the humpback whale hunt of St. Vincent and The Grenadines; and (3) additional work related to the AWS (aboriginal subsistence whaling management scheme). Considerable progress on items (1) and (3) was made as a result of an AWMP intersessional Workshop.

For a number of reasons, primarily related to stock structure issues, development of *SLA*s for common minke whales is more complex than previous *Implementations* for stocks subject to aboriginal subsistence whaling. In 2008 the Committee endorsed an interim safe approach to setting catch limits for the Greenland hunts in that is valid until 2018. The Committee agreed to allocate highest priority to developing an *SLA* for this hunt in time for its recommendation to the Commission by 2018 at the latest.

New information was received about an increase in the bowhead quota for Canada in 2015 to seven that warranted further consideration.

The Scientific Committee reiterated its advice on annual strike limits for whaling in Greenlandic waters. For West Greenland these were these were 164 common minke whales, two bowhead whales, 19 fin whales, 10 humpback whales as well as 12 common minke whales off East Greenland.

The terms of reference for the working group on Non-deliberate Human-induced Mortality has been expanded to include consideration of non-deliberate Human Induced Mortality in all cetaceans rather than just large whales. The Committee stressed that the issue of by-catch is serious and extensive and that the IWC cannot fully address it alone.

The IWC has increasingly taken an interest in the environmental threats to cetaceans. An intersessional Workshop on Investigations of Large Mortality Events, Mass Strandings and International Stranding Response was held San Francisco, in December 2015 and a Workshop on Acoustic Masking and Whale Population Dynamics was held just prior to the SC annual meeting.

The potentially negative effects of the fast growing industry of whale watching has received increased attention within the IWC. The IWC has agreed a set of general principles to minimize the risk for adverse impacts and an online handbook is under development.

The DNA registers voluntarily maintained by Norway, Iceland and Japan were reviewed. Norway announced its plan to upgrade the Norwegian Minke Whale DNA Register (NMDR) by genotyping a suite of carefully selected SNPs which will still keep the register's primary function of traceability of whale products in Norway and the international market.

There were considerable discussions on the new Japanese research programme NEWREP-A (Antarctic). This year discussion focussed on progress with recommendations made by an expert panel and the committee in 2015. A final review of the JARPN II (N-Pacific) research programme was conducted at a specialist workshop that was held in early 2016. Scientific permit projects are highly controversial within the SC and discussions on both projects reflected widely different views within the committee.

A systematic compilation of abundance estimates submitted to the SC is underway. The aim of this work is to ensure consistency and to classify the abundance estimates into categories with respect to their use, in assessments etc. The concept of population status has been a subject of debate and considerable confusion (i.e. the IUCN global classification of species status). This will be a priority topic at next year's SC meeting. The Committee agreed to investigate ways in which the results of *Implementation Simulation Trials* (for the RMP and AWMP) could be used to provide information on status of whale stocks.

5.2. ASCOBANS

Desportes reported on the 8th Meeting of the Parties to the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) which took place 30 August to 1 September 2016 in Helsinki, Finland. Following the agreement by NAMMCO 24 that "*it was essential to increase the scientific cooperation between organisations dealing with marine mammals for the benefits of their conservation*" NAMMCO invited in its Opening Statement to MOP8 ASCOBANS "*to enhance the scientific cooperation between the two organisations to the benefits of small cetacean conservation*". Three issues of shared concerns were suggested for this enhanced cooperation: by-catch monitoring, estimation and mitigation; the assessment of North Sea harbour porpoises, a shared stock between NAMMCO and ASCOBANS; and the monitoring of the effects of persistent organic pollutants on marine top predators. Although MOP8 did not formulate a direct answer, the invitation was well received by several parties. The Secretariat is following up on this invitation with the ASCOBANS Secretariat, Chair and co-Chair.

5.3. ICES

Haug reviewed the 2016 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), the Working Group on Bycatch of Protected Species (WGBYC), and the Joint ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP). 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.

5.3.1. Joint ICES/NAFO/NAMMCO WGHARP

This fall was the first meeting of this group with NAMMCO as an official member. Prewitt updated the SC that there may be some issues between ICES, NAFO, and NAMMCO to discuss on the functioning of the WGHARP. For example, Greenland is represented by Denmark to ICES, however in NAMMCO Greenland is the member country. Additionally, the WGHARP may need to adopt Rules of Procedure to address such issues as confidentiality of the report and meeting documents, presence of observers to the meetings, invitations to external experts, election of chairs, etc. A similar set of ROPs is now in place for NAMMCO's other joint working group, the JCNB-NAMMCO JWG, and these new ROPs would likely follow this model. The Secretariat will follow up on issues such as this.

Haug noted that the WGHARP welcomed the involvement of NAMMCO to the group, particularly due to the ability of NAMMCO to invite (and financially support) external experts. At this meeting, NAMMCO invited Sophie Smout (UK) and Kimberly Murray (US), and the WG felt that it was valuable to have these new people to the group.

5.4. JCNB

In October 2015, the Joint Commission on Narwhal and Beluga met in Nuuk. They reviewed the report from the NAMMCO-JCNB Joint Scientific Working Group (JWG) meeting in Ottawa 11-13 March 2015 as well as the report from the Narwhal catch allocation sub-group (JWG_{sub}) which met 10-12 March 2014 and 9-10 March 2015. Hansen attended the meeting in her capacity as the JCNB co-chair of the JWG. The Commission commended the work of the JWG and JWG_{sub}, particularly on the work of developing the narwhal catch allocation (NCA) model. Hansen also informed the SC that Greenland has implemented the NCA model. Hammill also informed the SC that the NCA model was presented to the Canadian marine mammal peer review group in Canada, and it was generally accepted by the science group. Canada had some concern on how the population model dealt with stocks with little abundance information, but it should be possible to deal with this quite easily.

The full observer's report (Appendix 4) contains a list of questions to the JWG, recommendations to the parties, recommendations for future research, and recommendations on future research recommended for JWG.

5.5. Arctic Council

Prewitt attended the PAME/AMAP/CAFF Ecosystem Approach International Conference in Fairbanks, AK from 23-25 August 2016, which was focused on the status of implementation of Ecosystem Based Management in the Arctic. Norway was highlighted at the meeting for the implementation of their Ecosystem Based Management plans, especially in the Barents and Norwegian Seas. However, although marine mammals are a part of these plans, there was very little mentioned about incorporating marine mammals into the plans. Prewitt gave a presentation on how ecosystem based management could be incorporated more into NAMMCO's management advice.

Besides being observer at the AC, NAMMCO has become an active member of the Circumpolar Biodiversity Monitoring Program (CBMP) under the Arctic Council Working Group on the Conservation of Arctic Flora and Fauna (CAFF) and its Marine Mammal Expert Group. NAMMCO participated to the CBMP – Marine annual meeting in Iceland, October 25-27, which focused on reviewing and finalising the draft of the State of the Arctic Marine Biodiversity Report (SAMBR). Eleven species of Arctic marine mammal species had been chosen as Focal Ecosystem Components (FECs) for evaluating changes in Arctic biodiversity. This evaluation and specifically the elements pertaining to beluga and narwhal and the information contained in the database on stock abundance and trend status developed for the 11 Arctic species will provide a good starting point for the Global Review of Monodontids (GROM) organised by NAMMCO in March 2017 (See point 8.4.4.2), with CAFF as member of the Steering Committee. Other ways of enhancing the cooperation between CAFF and NAMMCO included the participation of NAMMCO to the Steering Group of the second Arctic Biodiversity Assessment Congress organised by CAFF in Finland in 2018 and the contribution of NAMMCO to the CAFF Arctic Biodiversity Data Service (ABDS).

Ugarte remarked that he has been on the CBMP from the beginning and he was pleased to see NAMMCO represented at the meeting and helping with the quality of the report.

6. ENVIRONMENTAL / ECOSYSTEM ISSUES

6.1. Marine mammals-fisheries interactions (R-1.1.5, 1.1.8)

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.*

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.*

6.1.1. <u>By-catch</u>

The ToRs of the WG on By-catch were established by SC 21:

1. *Identify all fisheries with potential by-catch of marine mammals*
2. *Review and evaluate current by-catch estimates for marine mammals in NAMMCO countries.*
3. *If necessary, provide advice on improved data collection and estimation methods to obtain best estimates of total by-catch over time.*

The specific aims of the first meeting were to establish the framework of the WG work and a) identify what data and other information were available and which data were missing to be able to evaluate current by-catch estimates in NAMMCO countries, b) recommend possible Chairs, and c) schedule the next meeting and define its specific TOR.

The WG met on February 29 at the Marine Research Institute, Reykjavik, Iceland with Desportes as convenor and with participants from Faroes (partly), Iceland and Norway (ANNEX 1). The Group reviewed the progress made in NAMMCO countries and in Europe since the joint ICES-NAMMCO workshop on Observation Schemes for Bycatch of Mammals and Birds (WKOSBOMB) in 2010.

It then established the status in the NAMMCO countries regarding by-catch reporting systems, types of fisheries and assumed by-catch risks as well as required and existing by-catch related data.

Norway
There is a mandatory logbook reporting for all commercial fishing vessels but there is little reporting in practice. The only reliable by-catch data originate from a coastal reference fleet (CRF) for the coastal gillnet fishery for cod and monkfish (19 vessels, 2 in each statistical fishing areas) as well as catch-recapture data of tagged seals. The CRF reports bycatch data and landings to the IMR. Fisheries of concern are assumed to only be the gillnet fishery for cod & monkfish, with species of concern being harbour and grey seals and harbour porpoises.

Main data gaps were identified as follows:

- Only fishery landings are available, and no fishing effort;
- Species identification of by-caught seals by the CRF is problematic;
- The low number of vessels also in areas with high by-catch limits the accuracy and reliability of by-catch data for these areas;
- The recreational fishery might be the most important coastal cod fishery in terms of fish catch, but there is no reporting of effort nor by-catch data. However, the use of gillnets is low in this fishery.
- The halibut gillnet fishery is increasing with likely high by-catch rate, although the effort is relatively low
- No data exist for the lumpsucker bottom set gillnet fishery with likely high by-catch, although the effort is relatively low.

Iceland
There is a mandatory electronic logbook reporting for all vessels including a 0-bycatch reporting, but there is little reporting in practice. The most reliable by-catch data originate from the March-April cod gillnet research survey and with fisheries observers (1% coverage of the fleet and representative geographical spreading). The main fisheries of most concern are assumed to only be the gillnet fishery for cod & lumpsucker, with species of concern being, respectively, harbour porpoise and harbour and grey seals.

Main data gaps were identified as follows:

- The most reliable by-catch data are for the gillnet cod fishery in March-April. Although April corresponds to the peak period, the fishery occurs year round. The seasonal pattern in by-catch rate is therefore poorly captured;
- The electronic logbook marine mammal by-catch data is poor

Faroe Islands
There is a mandatory logbook reporting only for vessels > 15m, but without species identification. As in Norway and Iceland, there is in practice very little reporting. Fisheries of most concern are the pelagic or semi-pelagic trawl fishery with very high vertical opening

(VHVO) and herring set gillnet. Species by-caught include common minke, killer and pilot whales, harbour porpoise and grey seals.

Main data gaps were identified as follows:

- The logbook by-catch reporting does not allow for species Id and its reliability has not been assessed;
- The effort data and composition of the fleet was not provided;
- Reliable by-catch rates are missing for all fisheries;
- By-catch information for the VHVO trawl fishery and the mackerel mid-water trawling fishery, both with a high by-catch risk, are lacking, but both fisheries are increasing

Greenland

By-catch are considered as removals and should be reported for all species (both with quota and without quota), but there is no information on the reliability of the reporting and consequently of the inclusion of the by-catch removals in the catch statistics.

The WG agreed that an independent, permanent NAMMCO by-catch WG, meeting every 1-2 years, with a link to the ICES WGBYC (inviting one of its members) was the best way to proceed with the ToRs established by the SC. Securing fisheries gear and statistics expertise was also a prerequisite. The ToR for the next meeting were defined as follows:

1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
2. *Review the Icelandic lumpsucker 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.*

The SC endorsed the review and the *Modus operandi* defined by the By-Catch WG. The Chair of the By-catch WG will be Kimberley Murray from NEFSC, NOAA, USA. Participants will include Mikkelsen (FO), Levermann (GL), Gunnlaugsson, Sigurdsson, Granquist and Eiríksson (IS), Bjørge, Berg, and Overvik (NO), Desportes (Convenor) and Prewitt (Secretariat). The next meeting of the WG is scheduled for April-May 2017. The SC agreed to the following recommendations:

- Norway, increase the reliability and the accuracy of the by-catch data in areas with high by-catch (i.e. especially Lofoten and Vesterålen) by increasing the number of vessels included in the CRF and insure a better species identification of by-caught seals.
- Iceland, obtain by-catch rate for the cod fishery outside the April peak season,
- Faroes, modify the logbook for allowing for by-catch species identification and provide to the next WG meeting data on the fleet especially on the pelagic and semi-pelagic trawl fisheries including VHVO trawl (fleet composition, relative effort and by-catch information).
- Greenland, provide information on the reliability of BC reporting for all species.

The Secretariat has been in contact with Arne Bjørge (NO) and Gudjon Sigurdsson (IS) and they are on track to have their information ready for a spring meeting.

<u>Discussion</u>
The SC **adopted** the recommendations of the BYCWG.

There was discussion on the recommendation that Iceland obtain information on seasonal variation in by-catch, and whether this is taken into account in Norway. The situation is different in Norway versus Iceland because the fishery in Norway is more time restricted, while the fishery in Iceland has a peak but occurs nearly year-round.

Ugarte informed the SC that through the MSC certification process for the lumpsucker and halibut fisheries, by-catch is under review. This information should be considered at the future By-catch WG.

6.1.2 Others

Interactions with aquaculture
Nilssen reported that the issue of seal interactions with fish farms was discussed at the CSWG in March. In Norway, there are 990 locations of salmon and trout farming and 79 for other fish species along the coast, ranging from south of Bergen up to Tromsø. It is legal to shoot seals that are interfering with the farms, but although it is mandatory to report, there are little or no reports. In the Faroe Islands, grey seals are shot at fish farms around the Faroes. There is a problem with reporting, in that the largest farm which comprises about ½ of the salmon farming is not reporting. From those that are reporting, it is estimated that at least 150-250 seals are shot each year in total. This level of removals is quite high, especially given an estimated abundance of 1,000 seals which is not based on a formal survey (see Item 7.4.2).

In Iceland there are less interactions between seals and fish farms because of the double-netting used around the pens. However, there are some interactions between harbour seals and the salmon fishery around the river mouths (see Item 7.5.2).

There is no new data on sealworms.

Depredation on Longline fisheries
Lennert et al. (SC/23/18) discusses the issue of depredation from killer whales taking fish from longlines. Ugarte noted that this is not likely to become a problem in Greenland because the longline fishery is conducted only from the ice during winter when killer whales are not present. The longline fishery in the Irminger Sea have had some reports of depredation from sperm whales. In Norway, there have been sporadic reports of sperm whales in Andenes taking halibut from longlines, and there is a new research project investigating this issue.

6.2. Multispecies approaches to management (R- 1.2.1, 1.2.2)

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.*

6.3. Economic aspects of marine mammal-fisheries interactions (R-1.4.7)

R-1.4.7 (NEW): *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).*

MareFrame is an EC funded research project which is set to be concluded in 2017. The primary focus of MareFrame is to investigate hurdles in the establishment of ecosystem based approaches to the management of marine resources, and develop tools and methodologies to aid in the implementation of said approaches. These are then applied in a number of case-studies in European waters where, in collaboration with stake-holders, models of ecosystems are being developed to investigate the effects of management decisions. Simultaneously a specialised modelling database program has been developed allowing for more rigorous comparisons different modelling frameworks, along with a model comparison protocol.

As a part the project, models of the Icelandic continental shelf ecosystem are being built in collaboration between the Marine and Freshwater Research Institution (MFRI) and University of Iceland (UI). This includes models built using three modelling frameworks, ATLANTIS, Gadget and Ecopath with Ecosim (EwE). These models vary considerably in terms of scope and applicability, notably the ATLANTIS model is a whole ecosystem model emulating the ecosystem on a daily basis and as such best suited in investigating strategic questions e.g. how to design a management procedure that is robust to fluctuations in temperature. Models developed using the Gadget framework aim to incorporate key processes that explain variations related to the resource that is of interest and is therefore better suited for tactical applications, i.e. calculating Total Allowable Catch.

During the meeting, the SC expressed interest in the potential of developing the modelling effort from the Icelandic case study further by extending the study to the Barents Sea ecosystem. It was noted that similar efforts have taken place in Norway. Notably the IMR has in recent years worked on the development of an ATLANTIS model of the Barents Sea ecosystem and in the beginning of 2017 IMR will launch the REDUS project, a project aimed at understanding and minimizing uncertainty in the management of commercially exploited fish stocks. A potential for defining a joint project based on the output from the MareFrame and REDUS projects was discussed and it was **agreed** that the secretariat would initiate discussions between the MFRI, IMR, UI and UiT.

6.4. Environmental issues (R-1.5.3)

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.*

See the discussion under Item 6.4.1 for the response to this request.

Ecological studies related to harp and hooded seals

Haug reported from a recent study of summer diet of hooded and harp seals in the Greenland Sea (Enoksen et al. 2016). Hooded seals are important predators in drift ice areas of the Greenland Sea (the West Ice) during spring and summer. Their summer (June-July) diet was studied in the West Ice in 2008 and 2010, based on analysis of gastrointestinal contents of 179 animals obtained in dedicated surveys. Polar cod dominated the diet. The importance of the squid *Gonatus fabricii* was lower in this study compared with previous hooded seal studies in the area, and krill only occurred sparsely. In addition to the hooded seals, also samples from 20 harp seals and of 70 harp seal faeces were obtained during the 2010 survey. The diet composition of the harp seals was dominated by amphipods (primarily *Themisto* sp.) and deviated significantly from the hooded seal diet, implying that the degree of food competition was relative low. The occurrence of polar cod, *Themisto* sp. and krill in the diets of the two seal species coincides well with the geographical and vertical distribution of these three prey items and the previously recorded dive depths of the seals. The inclusion of demersal fishes such as sculpins and snailfish in the diet of some hooded seals was more likely a result of increased availability rather than changes in prey preference, as these seals were collected above shallower waters.

Furthermore, Haug reported on a study of young harp seal migrations in the White and Barents Sea, based on data from satellite tags (Svetochev et al. 2016). Four harp seal pups had been caught and marked with satellite telemetry transmitters (STT) in the White Sea in March-April 2010, and the average tenure of STT was 226 ± 51.7 (103.6) days. In April the young seals ("beaters") drifted out of the White Sea with the drifting ice. They migrated north through the eastern part of the Barents Sea. Seals and arrived at northernmost point of their migration route, *i.e*. the edge of the pack ice in the August – October period. One seal made a trip into the Greenland Sea. The return migration of the seals was during winter along the Novaya Zemlya to the south-eastern part of the Barents Sea.

Future work

Haug and Zabavnikov 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 2007-2016 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 2017 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 2017. 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 2016. 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 2017 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.

Discussion

The SC discussed the whether the samples for the diet were taken from hooded seals over the deep water or on the shelf. Haug reported that a few animals were over the shelf and their diet contained more bottom fishes, especially polar cod. Boreal and temperate fish species appear to be moving northwards, and possibly competing with, or even eating, polar cod.

Pollution

The Secretariat updated the SC that there is a tentative plan for a scientist with expertise in pollution that will be doing review project on the effects of pollution on marine mammals, and possibly the humans consuming them.

6.4.1 Disturbance Symposium report

The NAMMCO organized Symposium, “Impacts of Human Disturbance on Arctic marine mammals, with a focus on Belugas, Narwhals & Walrus” was held 13–15 October 2015 at the University of Copenhagen, Denmark (ANNEX 5). The original idea for the Symposium came from the JCNB/NAMMCO JWG, due to concerns about considerable seismic activity in West Greenland. As the available information to address these issues was scattered, it was decided to have a Symposium as an initial step in gathering the information needed to answer the request. The Council further expanded the scope of the Symposium to include walrus, and the SC also recommended expanding to all Arctic species since all species could be affected by human activities in the Arctic.

The discussions at the Symposium were centred around different items, however a few issues were highlighted.

1) Impact assessments being conducted in one country on species/stocks that migrate to other countries. The Symposium participants agreed that impact assessments should include all range states.

2) Examples of industrial activities that were expanded after the approval was given.

3) The impacts of human activities on Arctic marine mammals are difficult to tease apart from the impacts of ongoing climatic changes.

While the Symposium participants discussed that there is generally not enough empirical data to give firm guidelines, there were discussions on general recommendations that can be made, which can be seen in Table 1.

The Symposium highlighted the need for physiological studies to assess the impacts of these human activities on individual animals. For example, there is very little knowledge on heart rate, behaviour, etc., concerning individual’s reactions. Studies on individual animals would provide data for setting thresholds.

A number of case studies were presented at the Symposium, with the Mary River project of particular concern, especially for narwhals. The project appears to be growing beyond the original scope, e.g., not just summer shipping, but almost year-round shipping, taking place in West Greenland in important areas for walrus, narwhals, belugas, whales, seals, and also birds.

<u>Discussion</u>

Regarding the requests which were the impetus for the Disturbance Symposium (**R-2.6.3, 3.4.9**), the SC notes that these requests have been answered as far as is possible with the information that is currently available. However, this request remains ongoing, and should be considered again when additional specific information is available.

Table 1. Risks, known impacts, data gaps, and possible mitigation steps for all Arctic marine mammals identified at the NAMMCO organized Symposium on the Impacts of Human Activities on Arctic marine mammals.

Threats/Risks	Known Impacts	Data gaps	Mitigation
1) Shipping *Noise and presence of ships in important habitat*	• Displacement from habitat (migration, foraging, resting, etc.) • Habitat disruption/ destruction; disruption of breeding/ moulting /haulout areas (particularly seals) • Physical impact (ship strikes for whales, collisions for seals)	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• Speed restrictions/seasonal closures? • Routing lanes/no-go areas/marine reserves • Exclusion areas and buffer zones around sites of oil/gas leases as well as sites of particular types of activity, based on "biological sensitivity" • Quieting technology, e.g. bubble curtains for pile-driving and other construction activities; ship-silencing devices, designs, protocols • Speed/time of day/seasonal restrictions • Better logistical planning/ coordination between companies/ shippers to limit activities • Rapid/real-time mitigation (Caspian seal example of aerial surveys)
2) Seismic exploration	• Displacement from habitat (migration, foraging, resting, etc.). Narwhal were identified as being particularly sensitive to seismic activities.	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• MMOs often used, but can be problematic for all species because animals may be impacted before detection • Determination of 'exclusion' ('safety') or 'mitigation' zones around noise-generating activities, monitored in 'real time' by visual observers and sometimes acoustic sensors (see summaries from Castellote et al. and Weissenberger) • Development and introduction of alternative technology, e.g. vibroseis to replace airgun seismic surveys
3) Fisheries	• Competition for prey		• Seasonal closures

Threats/Risks	Known Impacts	Data gaps	Mitigation
	• Displacement from foraging areas • Bycatch, e.g. increasing for humpbacks in Greenland (esp. pound nets, crab pods)		• Gear modification
4) Hunting (past and present)			• Enforcement of regulations • Ongoing need for monitoring (esp. walruses) • Shared stocks- international cooperation/responsibility
5) Tourism *Increasing throughout the Arctic*	• Seals and walrus- abandon haulout sites with disturbance (hunting or tourism)	• More information needed on behavioural responses to presence of tourists	• Development of guidelines/ education for tour guides and tourists • Walrus- recommendations for distance/downwind • Seals- calm tourists had less reaction from seals, guide information // Minimum distance for people
6) Multiple stressors/ cumulative impacts *Cook Inlet belugas are a serious example*		• Need for models to investigate cumulative impacts • E.g., Cook Inlet- not allowed to handle animals for tagging, physiological studies, etc.	• Implement mitigation for specific impacts above • For Cook Inlet, MMPA/ESA implementation is *not* working

Additionally, there was a new request for advice from the SC: **R-1.5.3** (NAMMCO-24):

"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 SC **recommends** that the issues regarding belugas and narwhals be discussed further at the JCNB-NAMMCO JWG. In particular, the SC **recommends** that the JCNB ensures that there is Canadian expertise on the industrial activities at the next meeting. This would likely be a resource management person from Canada who is involved with the environmental impact assessments for the Mary River Project, and similar projects.

Specifically, the SC requests that the following information to be available to the JWG for review at their next meeting:

- Activity log for the Mary River project
- How many tons of iron ore shipped out,
- How many ships have passed through to date, and are expected to pass through in the future,
- Information on ship strikes,
- Studies that are ongoing from the industry, when that information will become public.

The SC also **recommends** that the JWG meetings routinely include information sharing between Canada and Greenland on new human activities that are occurring in either country that could affect narwhals and belugas.

Although the Mary River project has been highlighted, the general concerns apply to any situations when human activities in one country may affect shared stocks. There is a need for a formalized mechanism for cross-border assessment for how these shared stocks are dealt with.

The SC discussed another project of potential concern in Greenland, the CITRONEN zinc mine in NE Greenland. The plans for this mine include possible shipping of zinc and lead ore through the NE water polynya in summer. Although the plan has been approved, the start of activities has been delayed.

This lead to a general discussion by the SC of how possible impacts on marine mammals are considered during approval process for industrial activities in Greenland. Ugarte informed the SC that the Government of Greenland has an Environmental Agency for Mineral Resources Activities, which is advised by the GINR and the University of Aarhus. The exploitation of minerals was previously a Danish issue, but with the self-rule agreement from 2009, Greenland gained full control over its mineral resources, and the GINR has now a department dedicated to advice the Government of Greenland in environmental issues related to Oil and Minerals.

The impact Assessment of the CITRONEN project does not describe in full details the transport to the open water areas. This could be an issue of concern, but the practical implications are unclear. This project started before the GINR was involved in environmental advice, so the institute's influence in its development has been limited.

The SC **recommends** that GINR is consulted when projects are in development, *before* final approval, or if the project plans change and/or develop further. The environmental department is responsible for these consultations and has an overview of all of the projects in development. The environmental department consults with marine mammal experts from other departments of GINR, including the Greenland members of the SC.

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

7.1. Harp Seal

7.1.1. 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*

7.1.2. Update

Hammill updated the SC that the ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP) met during 26-30 September 2016 Copenhagen, Denmark (ANNEX 4). The WG received presentations related to catch and abundance estimates, and ongoing research of White Sea/Barents Sea, Greenland Sea and Northwest Atlantic Ocean harp and hooded seal stocks. In attendance were scientists representing Canada (2), Greenland (1), Norway (3), UK (1), USA (1), and Russia (2), as well as participants from NAMMCO (1) and Denmark (1).

Reported catches for harp seals in 2016 were 1,442 in the Greenland Sea, 28 in the White Sea, and 146,614 animals from the Northwest Atlantic population. Haug noted that the catches in the Greenland Sea have been fairly low, at only 6% of the sustainable level. In the White Sea, there has been no commercial hunt since 2009. In 2016, the 28 animals were taken for scientific purposes.

No new survey information was available for any stock. For the Greenland Sea harp seal population, a population model estimates a 2017 abundance of 650,300 (471,200 – 829,300) seals. Using current catch levels, the model projects an increase in the 1+ population of 58% over the next 15 years. The equilibrium catch level (which maintains constant population size) is 21,500 (100% 1+ animals). If pups are hunted, two pups balance one 1+ animal. A catch of 26,000 animals (100% 1+) will reduce the population, but with a 0.8 probability that the population remains above N70 over a 15-year period.

In the White Sea, poor ice conditions were observed in 2015 and 2016. There was no suitable ice for pupping inside the White Sea, but seals with pups were observed on the ice at the entrance to the White Sea. Ice also accumulated in the southeastern Barents Sea. If poor ice conditions are encountered in the White Sea during 2017, the southeast Barents Sea will be searched to see if pupping also occurs in this area.

The model estimates of abundance for White Sea harp seals in 2017 is 1,408,000 (95% CI: 1,251,680 – 1,564,320). The last reproductive rates available are based on data from 2006. The WG was concerned about using the last observed fecundity rate of 0.84 in the future projections. Instead, an average of fecundity rates observed over the last 10 years, was used in the projections (F_{future} = 0.76). The harp seal population in the Barents Sea / White Sea is considered data poor because of the time elapsed since the last series of reproductive samples were obtained. This means that the Potential Biological Removal (PBR) approach for estimating catch quotas should be considered. However, in simulations based on the population model, using this approach resulted in a projected population decline of 25% over the next 15 years. The WG concluded that the PBR catch level was not suitable for providing advice on future catch quotas and recommended that equilibrium catch levels be used. The equilibrium catch level is 10,090 seals (100% 1+ animals). The model indicates an increase of 12% for the 1+ population over 15 years with no catch.

For Northwest Atlantic harp seals a population model was used to examine changes in the size of the population between 1952 and 2014, and then extrapolated into the future to examine the impact of different harvest simulations on the modelled population. Since 2008, there has been little change suggesting that the population has stabilized at around 7.4 million animals (95% CI= 6,475,800-8,273,600). A new survey is planned for March 2017.

Hammill informed the SC that the ICES ACOM has accepted the WGHARP report.

Discussion

The SC noted that there was only one catcher boat last year in the Greenland Sea. This was due to the subsidies being removed in 2015, with some re-implemented at a lower level in 2016. The WGHARP and the SC both noted that without the commercial hunt, it will be difficult to get reproductive data. There are plans for hunting in 2017 in both Greenland Sea and White Sea/Barents Sea.

The SC noted that the WGHARP attempted to use the Potential Biological Removal (PBR) method for the White Sea population, but this was found to give a less precautionary catch level. The SC suggested that it would be interesting to make a publication on the issue of why the PBR did not work for WGHARP.

The SC **endorsed** the work and the recommendations of the WGHARP.

7.1.3. Future work

The WGHARP plans to meet again in 2018.

7.2. Hooded seal

7.2.1. 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*

7.2.2. Update

As mentioned above, the ICES/NAFO/NAMMCO WGHARP met during 26-30 September 2016 Copenhagen, Denmark (ANNEX 4). Hammill reported that the estimated 2017 abundance of Greenland Sea hooded seals is 80,460 (59,020 – 101,900). All model runs indicate a population currently well below the Limit Reference Level. Following the precautionary approach framework developed by WGHARP, no catches should be taken from this population, with the exception of catches for scientific purposes. Eighteen animals, including 10 pups were taken for scientific purposes by Norway in 2016.

In regards to **R-2.1.9**, the SC noted that data analysis is ongoing and several publications will come out soon on these data.

For both **R-2.1.4** and **R-2.1.9**, the most important information necessary to answer these requests will be the new survey in 2018. Hooded seals were protected in 2007, and the survey in 2012 was likely too early to have seen any effects of the protection. The 2018 survey will have given enough time for the pups since protection to have reached sexual maturity and possibly show an increase in the population.

The SC **endorsed** the work and recommendations of the WGHARP.

7.2.3. Future work

The WGHARP plans to meet again in 2018.

7.3. Ringed seal

7.3.1. 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*

7.3.2. Update

R-2.3.1 The SC does not have the information to answer this request. If more information becomes available to answer **R-2.3.1**, then this would also help in answering **R-2.3.2**. The SC considers new abundance estimates and information on stock structure that have been previously recommended would be the most helpful in answering these requests.

The SC noted that catch statistics from Svalbard were available to the SC for the first time at this meeting. The statistics were available for the period of 2003-2015.

Lydersen presented additional information on movements of ringed seals around Svalbard, including 5 CTD tags collecting hydrographic data in front of glaciers.

Rosing-Asvid updated the SC that a planned drone-survey of ringed seals in Kangia (Jacobshavn Icefjord) was postponed to 2017 due to technical problems with the drone. This also postponed the development of a separate management plan for the special morph of ringed seals that occupy this fjord. Rosing-Asvid presented pictures of different types of ringed seals from Southeast Greenland, indicating that there might be other morphs there as well. He also presented a recent paper (Yurkowski *et al.* in press), with tracks of 130 ringed seals tagged in various part of Canada, Alaska and Greenland. These tracks also suggest that the Arctic ringed seals (*Pusa hispida hispida*), consist of a number of subpopulations. This will complicate management and there is a lot of work to do still in order to be able to separate these seals into different management units.

Discussion

The SC discussed whether the colour of the pelts change over the animal's lifetime. The YOY are generally more silver than the adults, but once they have their adult pelage, this does not change.

Regarding the recent movement studies suggesting possible stock structure, the SC r**ecommends** more satellite telemetry and collection of samples for genetics to inform on possible stock structure in Greenland, and across the Arctic.

For the Ilulissat seals, the recommended protection awaits the planned survey.

7.3.3. Future work

The SC **reiterates the previous recommendations** that a WG awaits more info on genetics and satellite tagging. Possible issues to be discussed by a WG could be:

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

7.4. Grey seal

7.4.1. Review of active requests (R-2.4.2)

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

7.4.2. Coastal Seals WG

The Coastal Seals Working Group met from 1-4 March 2016 in Reykjavik, Iceland (ANNEX 2).

The Terms of Reference for the meeting were to:

- assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway (see Table 2).
- address by-catch issues in Norway, Iceland, and the Faroe Islands
- re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
- develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).

Norway

Catches

Annual catches of grey seals in Norway have normally varied been in the range 31 and 518. After 2003, quotas were introduced. IMR recommended quotas of 5% of the population but the quotas were set at 25% of the population and a bounty system was introduced, which increased the catches to approximately 300-500 seals annually. After the management plan was implemented in 2010, quotas were reduced to 5% of the population which also were reduced catches to approximately 100-200 animals.

Genetics

The microsatellite data fits well with the current management areas, while the mitochondrial data shows sign of further subdivision.

Status

In Norway, Øigård et al. (2012) used a population model to describe the dynamics of the Norwegian grey seal population based on data from the three pup counts covering the entire grey seal distribution area in the period 1996-2008, as well as empirical data on hunting and by-catch mortalities. The model also required estimates of natural mortality and female reproductive rates, but since empirical data on these parameters were outdated or absent, they were estimated by the model using a Bayesian approach. Model runs indicated an increase in abundance of the total Norwegian grey seal population during the last 30-years, suggesting a total of 7,120 (5,710 – 8,540) animals (1+) in 2011, with an estimated pup production of 1,620 (95% CI 1,410-3,050). New surveys in the mid Norway management area (Trøndelag and Nordland counties) in 2014-2015 showed a significant decrease in the grey seal pup production, ranging between 34.8% and 47.5% of the counts in 2007-2008. In Finnmark the pup production in 2015 was equal to the results from 2006.

Table 2. Recent abundance and trends of grey seals in the North Atlantic.

Country	Recent Survey Year(s)	Abundance	Current trend
Norway			
Total	2011	Pup production (2006-2008): 1275 Total: 8,740 (95% CI 7,320-10,170)*	increasing
Trøndelag and Nordland	2014-2015	Pup production: 332?	ca 60% decline in pup production
Finnmark		206	stable
Iceland			
	2012	4,200 (95% CI: 3,400-5,000	declining?
Faroe Islands			
	None	~1,000-2,000**	unknown
Baltic			
	2014	~33,000	increasing
Wadden Sea	2015	4521	increasing
France	2007	150	
United Kingdom			
Total UK	2014	60,490	increasing
Republic of Ireland	2012	2,100 (pups)	increasing
Eastern Canada	2014	505,000 (95% CI: 329,000-682,000)	increasing

* Modelled estimate; ** This estimate is not based on survey data.

The population dynamics model of grey seals is too constrained to reproduce the inter-annual variability pattern observed in the pup production data, most likely due to lack of model complexity i.e. the model includes too few biological processes. The decline in pup production is likely due to high levels of by-catch in the monkfish fishery. The WG suggested that it could be interesting to plot the monkfish catches against the pup production. Although they do not have annual surveys, it could be a good visual comparison.

<u>Recommendations for Norway</u>

- Development of the model. The model must be re-examined to try and determine if it can be modified to account for the observed changes in pup production. Can the model estimate changes in mortality that could explain the drop in pup production?

    - First update the by-catch, using the coastal reference fleet, create an annual estimate of by-catch based on annual landings statistics. May start to capture the fluctuations.
    - Need to look at age structure of the by-catch, especially if some older animals are taken. Samples for age data should be collected (e.g., jaws).
- More frequent surveys, particularly in the areas of decline. A survey every 5 years is not sufficient to detect these rapid drops in pup production. Important areas could be identified to be surveyed in between other full-coast surveys. These data will also help refine the population model.
- Tagging of grey seal pups.
- Age-structure of the hunt: If the mark-recapture flipper tags are used for by-catch estimation, the age structure of the hunt needed because flipper tag recoveries from the hunt are used in the equation for by-catch estimates. The age structure of the hunt is assumed to be the same age structure as the by-catch, and this assumption needs to be tested
- Complete the genetics study within this year
- Increase the number of vessels in the reference fleet in the areas of high by-catch (especially Nordland)
- 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

<u>Evaluation of the Norwegian Harbour and Grey Seal Management Plans</u>
The WG agreed that the Norwegian management plans for harbour and grey seals managed the hunt, for which it was designed, well. However, recent information about the extent of the by-catches in a new fishery were not expected when the plan was implemented.

<u>Recommendations for the Norwegian Harbour and Grey Seal Management Plans</u>
- The target population levels for both species should be evaluated (as discussed for Iceland) as the levels are not based on any biological assessment. The current target levels are set equal to the highest numbers recorded in recent years.
- The WG agreed with the Norwegian evaluation of the management plan to recommend that the quota is set to 0 when the population is at 70% of the target level instead of 50%. This change was also previously recommended at the 2011 CSWG.
- Management plans should include all sources of mortality, not just the hunt.
    - The CSWG recommends that Norway continue working with the NAMMCO WG on By-catch to ensure that the by-catch estimates are as good as possible.
    - The WG also recommends that all anthropogenic removals are considered when setting hunting quotas. This implies that seals shot at fish farms and salmon rivers should be reported to the Directorate of Fisheries and that data on marine mammal by-catches in recreational fisheries should be generated.
- The WG noted that there is a conflict between seals and fish farms, but there is no mechanism in the application process for establishing new fish farms for consideration of seal distribution. A mechanism for consulting IMR when fish farms are being built should be required when management plans are revised.

<u>Discussion</u>
The SC discussed that many pups would have to have been removed over a long time period before a drop in the population would be observed. It is unknown whether adults are also taken in the by-catch. The previous surveys were conducted in 1996-1999, 2001-2003, and 2006-

2008, just as the monkfish fishery was increasing. The most recent survey has captured the probable drop in recruitment into the population.

An increase in the number of tagged animals, perhaps of different age classes, could improve the by-catch estimates. However, there is an issue that the tag itself could be making them more likely to be caught in the nets, therefore biasing the estimates.

The SC discussed the WG's comment that the target level of the population is not based on biological data and should be examined. The WG did not discuss a plan for evaluating this target level, and the SC **suggested** that the WG explore this further at a future meeting, such as looking at how target population levels are decided in other species (e.g., harp and hooded seals).

The SC **endorsed** the CSWG's list of general recommendations and recommendations for the Norwegian management plan.

Iceland

Catches

In Iceland, the number of direct recorded catches of grey seals are few, with only 1-2 recorded per year in recent years. However, it is not mandatory to report direct seal catches to the government.

Current management

In 2006, the Icelandic government published a management plan where a target grey seal population size of 4,100 was recommended (NAMMCO annual report, 2006). The plan states that management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor was "appreciably" defined.

Status

Pup counts, mainly aerial surveys, were conducted since 1980 (11 full surveys and 4 partial counts) of all breeding sites. Until 2005, only one count was performed at each site, but since then three counts were done at each site.

The reference point for the highest population level was 10,000 from a survey in 1991 but this should be considered a minimum estimate because the survey was only flown once.

The most recent abundance estimate in 2012 was 4,200 grey seals (95% CI: 3,400-5,000). Calculations based on the latest population count in 2012 reveal a 44% likelihood that the population was smaller than the recommended number of 4,100 animals.

Recommendations for Iceland

Primary

- A Management Plan should be developed including:
    - the frequency of surveys
    - legislation of seal hunting
    - 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)

<u>*Next steps*</u>

- 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

<u>Discussion</u>

Iceland updated the SC that there are plans to conduct a full aerial photographic survey in autumn 2017, with counts taken 3 times during the pupping period. A genetics study is also planned, and analysis will begin next year.

The SC **endorses** the recommendations of the CSWG and stresses that there must be a reporting system for direct catches. Without this information, it is impossible to model the status of the population.

Faroe Islands

<u>Catches</u>

In the Faroe Islands, salmon farmers have permits for shooting seals, when interacting with their fish farms. When fish farming increased (from the 1980s), culling of grey seals also increased. In 2009, a logbook system for fish farmers was implemented to register seals shot. The biggest company, with 21 of in total 35 fish farm licenses, is not reporting. 150-250 grey seals are estimated to be shot annually, based on reports from 40% of the fish farms.

<u>Stock identity</u>

A study on stock identity showed a strong population structure between the colonies, indicating that the grey seals in the Faroe Islands are separate from the seals in the UK.

<u>Migrations</u>

Movements of Faroese grey seals have been investigated using satellite tags. The seals were found to be stationary on the Faroe Plateau, where only a few of the seals were tracked outside the 100m depth contour. Also, for most of the tracking period the seals were distributed close to their preferred haul-out sites, which typically numbered one to three sites. Movements between locations occurred mainly in shallow waters. When making multiple trips to off-shore feeding areas, the seals typically repeated their tracks to the same area. No seal was found to move longer distances from land than 35 nautical miles and for no longer period than three days.

<u>Recommendations for Faroes</u>

The WG r**ecommended** that the Faroes develop a written monitoring plan that includes regular assessments.

The WG also recommended analyses that can be undertaken with the existing data and should be completed as soon as possible.

- Population Viability Analysis
    - Numbers of removals can be used to estimate minimum population size of grey seals in the Faroes that is necessary to sustain the levels of removals. This

requires that data is available from basically all parts of the Faroes. Longer time series of data on removals would give more robust estimates than shorter.

- Analysis of existing telemetry data
    - o The Faroes should coordinate with the UK on the existing telemetry data to look at possible migration between the UK and the Faroes. This would be particularly informative from animals tagged in the Hebrides and Orkney.

The WG also recommended new research that should be conducted in the Faroes, and prioritized these studies.

First Priorities

- Obtain minimum population estimates via haulout counts. These counts should be conducted at least 3 times on different days and cover the whole area. Comparable haulout counts should be repeated regularly to obtain trend information.
- 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 (animals in the water and, if possible, in caves) 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

Discussion

A preliminary photo-ID study was attempted in summer 2016, however this was deemed difficult to conduct, and would require a long-term dataset. The Faroe Islands plans to use the approach of haulout counts and telemetry studies next summer (2017). The SC awaits an update on this at the next meeting.

The SC **endorsed** the recommendations from the WG and agreed with the priority list.

In Greenland, no grey seals have been reported since 2010.

7.4.3. Update

Canada

Hammill gave a presentation on grey seals status and research in Canada. Grey seals have experienced rapid population growth. Several cod stocks in Atlantic Canada crashed in the early 1990s. Levels of recovery vary between the different stocks. The cod stock in the southern Gulf of St Lawrence (NAFO zone 4T) has not shown any signs of recovery. Predation by grey seals explains 50% of the natural mortality observed among cod greater than 50 cm in length. The majority of research on grey seals in is the Gulf of St Lawrence (Canada) has focused on seal-fisheries interactions.

Discussion

The SC discussed that if the seals are consuming large cod, they might not be eating the head. This would lead to an underestimation of the amount of cod in the diet, since the otolith would not be consumed. This has also been observed in Canada. Large cod are observed in seal stomachs (≤75cm). It is also unclear if seals do not eat the head only in cases of depredation from nets and longlines or if it is a more common phenomenon.

There was a discussion of why the grey seal population is experiencing this large increase. Hammill noted that one factor is a change in the hunting patterns of seal hunters that favours the seals. Additionally, some areas that were formally inhabited by humans have been abandoned, and new seal haulouts have been seen in these areas.

7.4.4. <u>Future work</u>

The SC **recommended** that the CSWG should plan to meet again in 2018, pending progress on the recommendations, and new information becoming available. This will be evaluated at the next SC meeting.

7.5. Harbour seal

7.5.1. <u>Review of active requests (R-2.5.2)</u>

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

7.5.2. <u>Coastal Seals WG</u>

As noted above, the Coastal Seals Working Group met from 1-4 March 2016 in Reykjavik, Iceland (ANNEX 2).

The Terms of Reference for the meeting were to:

- assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway (see Table 3).
- address by-catch issues in Norway, Iceland, and the Faroe Islands
- re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
- develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).

Norway

<u>Catches</u>

The catches of harbour seals from 1997-2015 are mainly between 300 and 500 animals. The hunt has been regulated by quotas (for each county) since 1997, and in 2003 the quotas increased due to bounties, and catches increased up to about 900 seals annually. In 2010, a management plan for harbour seals was implemented, and since then there have been decreases in the yearly reported catches. Hunters must sign into the hunt and report their catch to the county daily. The hunt is stopped when the quota is taken. The Directorate of Fisheries has not received any reports of removals around fish farms, but it is likely that there are removals.

<u>Stock identity</u>

The current management units for Norwegian harbour seals are defined by county limits. However, information on movements patterns of harbour seals in Norway as well as recent genetic evidence of fine scale population structure in Danish and Swedish waters, raise concerns that there may be population subdivision within counties. Analyses of 14 microsatellite markers show clear evidence of population subdivision between 3 breeding areas within Nordland county. All of these areas also show significant differences with samples collected in Sør-Trøndelag county and with samples from the more southern county of Møre and Romsdal. No significant difference was found between the two neighbouring counties Sør-Trøndelag and Møre and Romsdal, but this could be due to low sample size for Møre and Romsdal county.

Table 3. A summary of the current abundance and trends of harbour seals in the North Atlantic.

Country	Survey Year(s)	Abundance	Current trend
Norway			
Entire mainland coast	2011-2015	7,642	stable
western Finnmark	2013	395	stable
Iceland			
	2011 (full survey)	11,000-12,000	
	2014 (partial survey)	ca 8,000*	declining?
Greenland	None	<100	unknown
Russia			
Murman coast	1998	500	unknown
Sweden and Denmark			
Skagerrak	2015	6,000	increasing (6.6%/yr)
Kattegat/ Danish Straits	2015	10,000	increasing (6.2%/yr)
southern Baltic	2015	1,000	increasing (8.4%/yr)
Limfjord	2015	1,000	increasing (5.6%/yr)
Kalmarsund	2015	1,000	increasing (9%/yr)
Wadden Sea	-	25,000	uncertain (see 3.5)
France	2008	150	unknown
United Kingdom			
Scotland	2007-2014	23,355	local declines (Moray Firth)
England and Wales	2007-2014	4,806	stable or increasing
Northern Ireland	2007-2011	948	stable or increasing
Eastern Canada			
south of Labrador	1970s	12,700	unknown
Estuary and Gulf of St Lawrence	1994-2000	4,000-5,000	Unknown
Eastern United States	2012	75,834	decline?

* This abundance is calculated assuming that the populations are stable in the other parts of the country that were not surveyed in 2014 and therefore should be used with caution. See Item 3.2.

Status

In 2011-2015, the entire Norwegian coast was surveyed resulting in a minimum total population of 7,642 harbour seals (including 395 harbour seals in western Finnmark).

In surveys conducted in 1996-1999 and 2003-2006, the western part of Finnmark was not surveyed (Table 4.).

Table 4. Recent surveys for harbour seals on the Norwegian coast.

Survey Period	Abundance
1996-1999	7,465
2003-2006	6,938
2011-2015	7,247*

* not including west Finnmark

Recommendations 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.

The SC **endorsed** the recommendations of the CSWG.

Iceland

Catches and regulatory measures

Traditional hunting of harbour seals has decreased from around 3,000-4,000 in the 1980s to around 300 per year during the last decade. In Iceland, seal hunting does not require a specific hunting license, and no specific quota system has been established. Seal hunting is managed by land owners and there are no special protected areas or protected periods (e.g., breeding season) of the year for seals except those imposed by land owners and general regulations on hunting. It is not mandatory to report direct seal catches to the government.

Management

In 2006, the Icelandic government published a management plan where a minimum population size of 12,000 harbour seals was recommended (NAMMCO annual report, 2006). The management plan states that management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor a definition the term “appreciably.”

Current research on biological parameters and stock identity

A study on haulout patterns of harbour seals in Iceland has confirmed that the timing of surveys is appropriate (3 weeks from the end of July). Body condition of the harbour seal population was investigated by comparing blubber thickness measurements from 1981, 1995 and 2009. The results showed that blubber thickness was lower in 2009 compared to the two other years, both for female and male seals which indicate that the body condition of the seals has decreased.

Use of infrared cameras on drones for monitoring seal haulout sites is being developed.

The importance of harbour seals as prey species for killer whales is being investigated using stable isotope analysis.

Stock identity
Andersen et al. (2011) found that Icelandic harbour seals were significantly differentiated from harbour seals in Greenland, Northern Norway and Svalbard.

Recommendations for Iceland
- 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.

Discussion
Iceland updated the SC that there has been new welfare legislation that may affect the use of nets for seal hunting. The SC noted that this may make the last recommendation unnecessary, but this situation should be clarified.

A full survey was completed this summer, and although the analysis is not yet complete, the preliminary results confirm the decreases seen from the survey completed in 2014 (30-40% decrease). This is of concern, as the population level will be below the target population level. The new information on the preliminary results of the survey this summer confirm the conclusions of the WG.

The SC **endorsed** the recommendations of the WG and stressed the need for obtaining catch statistics. There is a system of collecting catch statistics on other species in place, and this system could be used to collect statistics on harbour seals. There is a hunt for harbour seals in Iceland, with over 80% of the hunt occurring around the river mouths with the aim of reducing predation on salmon. However, new data indicates that harbour seals are not eating salmon.

Other Updates
Lydersen noted 4 papers (Blanchet et al. 2014, Blanchet 2015, Blanchet et al. 2015, Blanchet et al. 2016) summarizing behaviour and pup development of harbour seals in Svalbard.

7.5.3. Future work

The SC **recommended** that a future CSWG should identify a level of sustainable removals in all areas, particularly in Iceland where the decline has been observed.

A new full abundance estimate for grey seals is expected next year. With the new work in the Faroe Islands on grey seals, and new information in Iceland, the SC recommended tentatively planning another meeting of the CSWG in 2018.

7.6. Bearded seal

Lydersen updated the SC on activities in CAFF related to bearded seals. Kit Kovacs is chair of a group that has developed a project with suggestions for monitoring programs. Monitoring programs for this species have been recommended repeatedly, however there is currently no comprehensive monitoring program in any of the Arctic countries. The CAFF group worked to compile all available data and suggest new research. However, none of the Arctic countries have financed their parts of the studies.

7.6.1. Update

In Greenland, there has been work on satellite tracking, and they have collected some diet samples. A project using passive acoustic monitoring is also ongoing looking at seasonal distribution and movements, especially in relation to seismic activities. There is survey data available, but no complete estimates for all Greenlandic areas.

In Svalbard, there has been a lot of published information on various aspects of bearded seal biology from the last 20 years. The SC noted that we have catch statistics from Svalbard for the first time, and welcomed this information.

Although data on this species is still limited, the SC noted that it appears that we have more information than ever before. Given this new information, the SC discussed the possibility of organizing a status meeting.

7.6.2. Future work

The SC **recommended** a future working group on bearded seals with the following information. This WG should involve the CAFF group.

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

The Terms of Reference for the bearded seal WG will be to:

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

The timing of this WG will be discussed further at SC24.

7.7 Walrus

7.7.1 Review of active requests (R-2.6.3)

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.*

7.7.2 Disturbance Symposium
Discussed under Item 6.4.1. See also ANNEX 5.

7.7.3 Update
Heide-Jørgensen presented some recent results from walrus studies in Northwest Greenland. Tagging of walruses with satellite transmitters deployed by traditional harpoons from small boats was conducted in the June 2010-15 in NW Greenland. The results show extensive movements as far west as the western parts of Devon Island and Jones Sound indicating that walruses in this area must be considered a shared stock between Greenland and Canada. The residence in Canadian waters of walruses tagged in Northwest Greenland lasted 3-4 months before the walruses returned to the NW Greenland coastal areas. Diving behaviour showed preference for shallow waters <50 m in the Smith Sound region and the extension of the shallow water areas in Smith Sound and adjacent water does not seem to support a walrus population >5000.

Lydersen updated the SC on the GPS logger project around Svalbard. 40 GPS tags on male walruses have been detected and in 2016 tracking data was received from 22 individuals. The SC await further results. Images from cameras deployed at walrus haulouts in Svalbard to look at disturbances, etc., are being analysed by a master's student. Preliminary results show that visitors are having little impact, and the larger impacts are caused by polar bears on haulouts with females and calves (not much impact on male haulouts).

Lydersen further updated the SC that 7 satellite tags were deployed on walruses in the Pechora Sea by their Russian collaborators.

Hammill informed the SC that they are performing a stock assessment on the stocks east Hudson Bay. These stocks have not been sampled before, and this is a first attempt to look at stock identification.

The SC received a new request from Council (**R-1.6.4**) which reads: *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.*

This request was discussed under agenda Item 11.2.

7.7.3.1 *Status of recommendations from 2013 Walrus WG*
The SC discussed the list of recommendations that were given by the WWG in 2013, and prioritized the list of recommendations.

From 2013 WWG:
<u>Recommendations for Research</u>
*The SC **recommends**:*

- *That new estimates of sex and age structure of the catch for West Greenland are obtained. The sex determination that is reported by the hunters should be validated using genetics.*

This has not been done. The age structure data would be useful to have for the population modelling. This would require a relatively large sample size over a short period of time.

- *That the fraction of the catches and abundances in Canada that belong to the West Greenland/Baffin Island population are clarified.*

This has not been done.

- *That complete catch statistics from Canada are collated.*

Hammill updated the SC that the catch data in Canada is currently available, and should be available for future WWG meetings.

- *That reliable reports of struck and lost are obtained for the entire range of the stocks in Greenland and Canada.*

This has not been done.

- *That regular abundance estimates (5-10 years) from Baffin Bay, West Greenland, and the southeast coast of Baffin Island are obtained.*

A new survey was conducted in 2014 in Baffin Bay, and in 2012 in West Greenland and SE Baffin Island. A new survey is planned for 2017 or 2018. There are also plans to survey East Greenland.

Based on these discussions, the SC **prioritized these recommendations** for a future assessment:

1) New abundance estimates
2) Age-structure of catches
3) Catch statistics from Canada (*available*)
4) Struck and lost rates. This is lowest priority for the assessment, however not having newer, reliable struck and lost rates will affect the quotas given (e.g., if the struck and lost rates that are being used are high, then the quotas will be lower). If better struck and lost rates are obtained, quotas may increase.

8. CETACEANS STOCKS - STATUS AND ADVICE TO THE COUNCIL

8.1. Fin whale

8.1.1. <u>Review of active requests</u> (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.*

8.1.2. Update

8.1.2.1. Abundance Estimates WG

Icelandic/Faroese shipboard survey

The Icelandic and Faroese components of the sixth North Atlantic Sightings Survey (NASS) was conducted between 10 June – 10 August 2015. Three vessels covered a large area of the northern North Atlantic (Fig. 1), similar to the earlier NASS, but for the first time applying fully independent double platform observer (IO) mode. The fin whale was a target species in all areas. One of the Icelandic survey vessels was conducting coincident fisheries surveys and some observation effort was on transit transects aligned with expected high fin whale density, so analyses were performed both including and excluding these data. Rejecting this compromised effort, the total corrected estimate for the survey area using all fin whale sightings was 40,788 (cv 0.17, 95% CI: 28,476 – 58,423). Restricting to the two highest categories for species identification confidence using the same effort reduced the total estimate to 35,605 (cv 0.18, 95% CI: 24,615 – 51,505).

While overall abundance over the entire survey area is not directly comparable between NASS as coverage has varied between surveys, the numbers seen here are the highest of any NASS in the Central North Atlantic.

There was some discussion of the potential for bias in distance estimation it was noted that, distance experiments were not conducted by Iceland during the survey. However, it was noted that binocular reticles were used more frequently by both platforms than in previous surveys and that their use improves distance estimation. It was suggested that it would be helpful in the future to have a more in-depth discussion on distance estimation and validation, and suggested the possibility of using drones to validate a sub-sample of distances.

It was noted that the survey was conducted over a longer period of time than previous surveys, and that the area west of Iceland was covered in two periods, from 10 June to 9 July and from 14 July to 10 August. It was suggested that it might not be appropriate to combine these two coverages if they produced very different estimates. Upon closer examination, it was determined that the sighting rates in the two periods were similar**,** so the group concluded that the combination was appropriate.

The SC **adopted** the MRDS estimates in SC/23/AE/04 that reject the compromised effort. The estimate including all fin whale sightings is the least biased and thus the most appropriate to use in assessments. The estimate incorporating only high and medium confidence sightings is more comparable to reported estimate for 2007. The uncorrected estimate using the same restrictions can be used for comparison to earlier estimates.

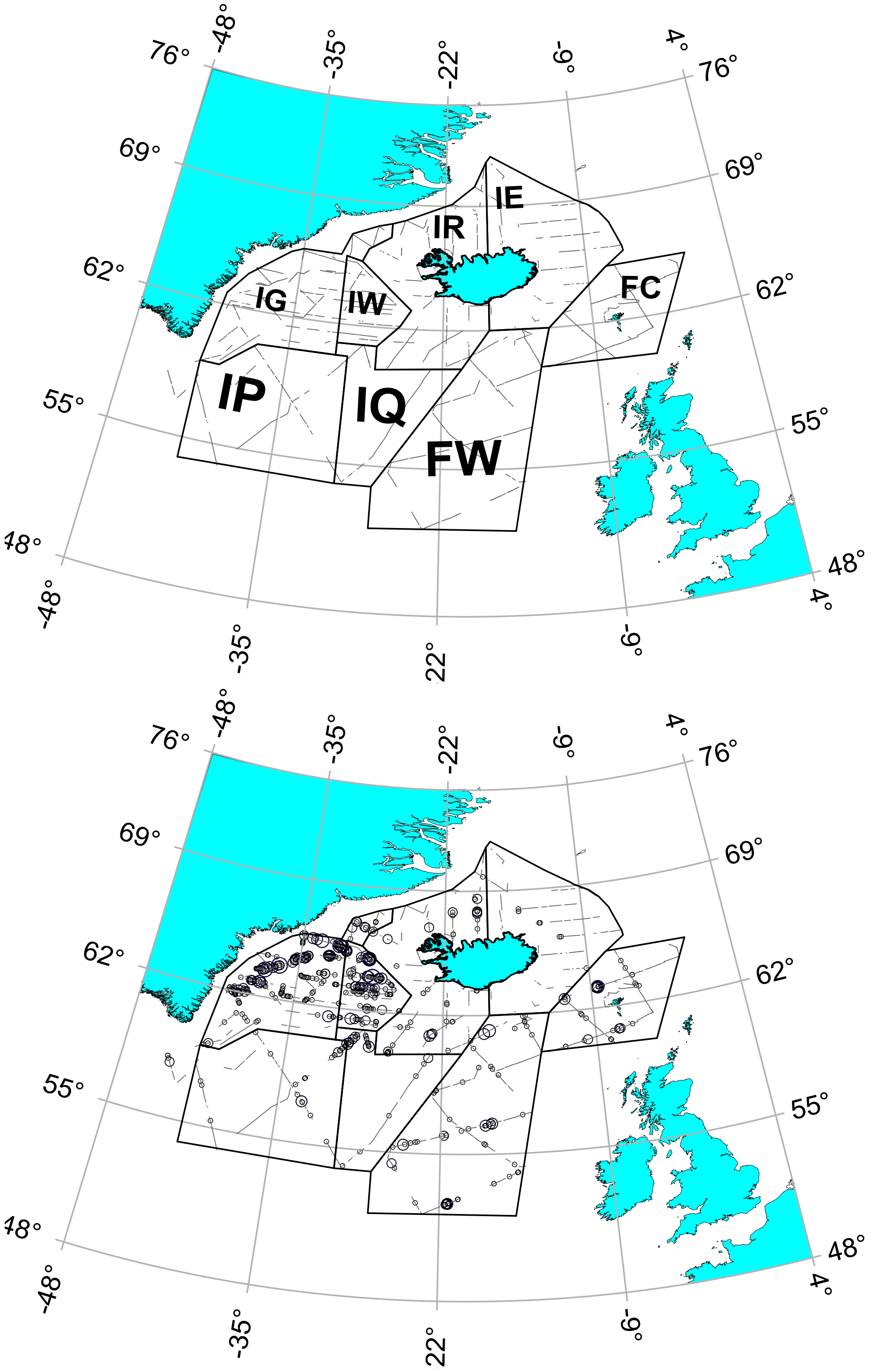

Fig.1. Stratification and survey effort (upper, BSS<=5) and sightings of fin whales (lower). Symbol size is proportional to group size in the range of 1 to 7.

Discussion
The SC discussed why the current AEWG decided to include all fin whale sightings for the 2015 analysis, while in 2007, only high and medium confidence sightings were included in the analysis. Iceland informed that this was due to a miscommunication during the analysis in 2007, and that all sightings should have been included, which would be consistent with the earlier (1987-2001) surveys. However, when comparing the 2015 estimates to the reported 2007 estimates, the estimate using only medium-high estimate should be used.

The SC noted that the estimate including all fin whale sightings (including low confidence identifications) is least biased because most of the large whales in the area are fin whales. The SC concluded that the 40,788 estimate was the most appropriate to use in the assessment at the meeting in January 2017.

Norway
Norway started a new survey cycle in 2014 and covered the Svalbard area that year. In 2015 Norwegian Sea was covered as well as a NASS extension survey to a large part of the Jan Mayen area north of the Icelandic coverage. In 2016 a complete coverage of the Jan Mayen area was conducted. Seeing these surveys in context, fin whales were primarily observed west off Spitsbergen. Other places with some fin whale density are off northern Norway, east of Jan Mayen and north of Iceland towards the Denmark Strait (Fig. 2). No estimate based on these data was available.

Greenland
An aerial line transect survey of whales in East and West Greenland was conducted in August-September 2015. The survey covered the area between the coast of West Greenland and offshore (up to 100 km) to the shelf break. In East Greenland, the survey lines covered the area from the coast up to 50 km offshore crossing the shelf break (Fig. 3). There were 103 sightings in East Greenland, and 16 sightings in West Greenland.

A method to correct the estimate for availability bias was proposed, and while the proposed method was thought to be acceptable, the dive data used for the correction is based on only one whale. To apply this method, dive data from 5-10 whales would be needed. The WG recognized that this data is difficult to obtain, but encouraged Greenland to continue efforts obtain more data to validate this approach.

The AEWG accepted the estimates corrected for perception bias of 465 (95% CI: 233-929) in West Greenland and 1,932 (95% CI: 1,204-3,100) in East Greenland.

The 2015 survey in East Greenland was the first in this area, and therefore there are no previous estimates to compare with the 2015 estimate. For West Greenland, the AEWG noted that the 2015 estimate can be compared to the previous estimate from 2007 (i.e., the surveys were conducted during the same time period, using the same platform, many of the same observers, etc.). The SC agreed with the AEWG, and therefore concluded that the decrease in West Greenland appears to be real (and not an artefact of survey methodology). It is clear that the decrease cannot be explained by the catches, which are too low to have caused the decline. The SC noted that they currently do not have enough information to given a reason for the decline, however it is likely that there are ongoing large scale ecosystem changes.

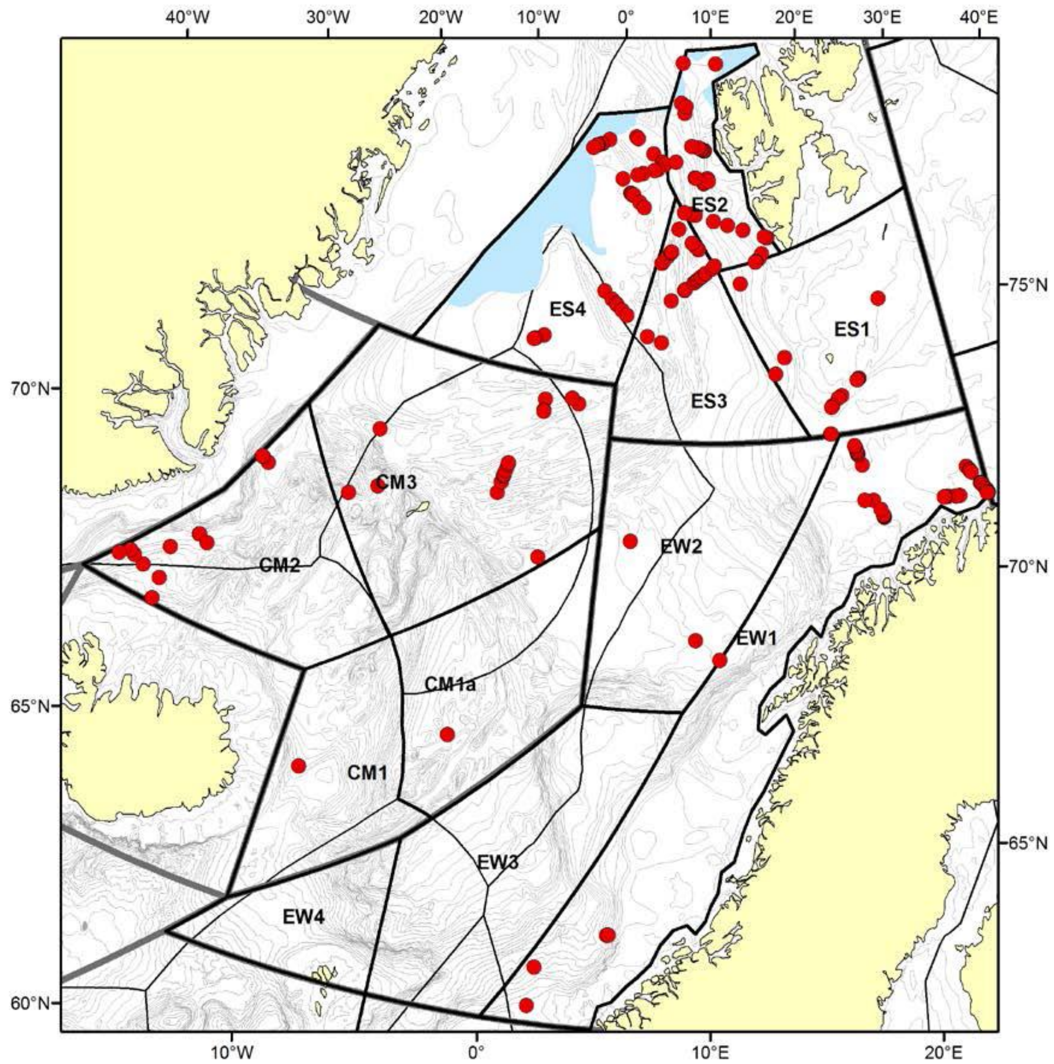

Fig. 2. The total survey area for the Norwegian surveys combined for 2014, 2015 and 2016: Primary fin whale sightings (red dots) made from platform A.

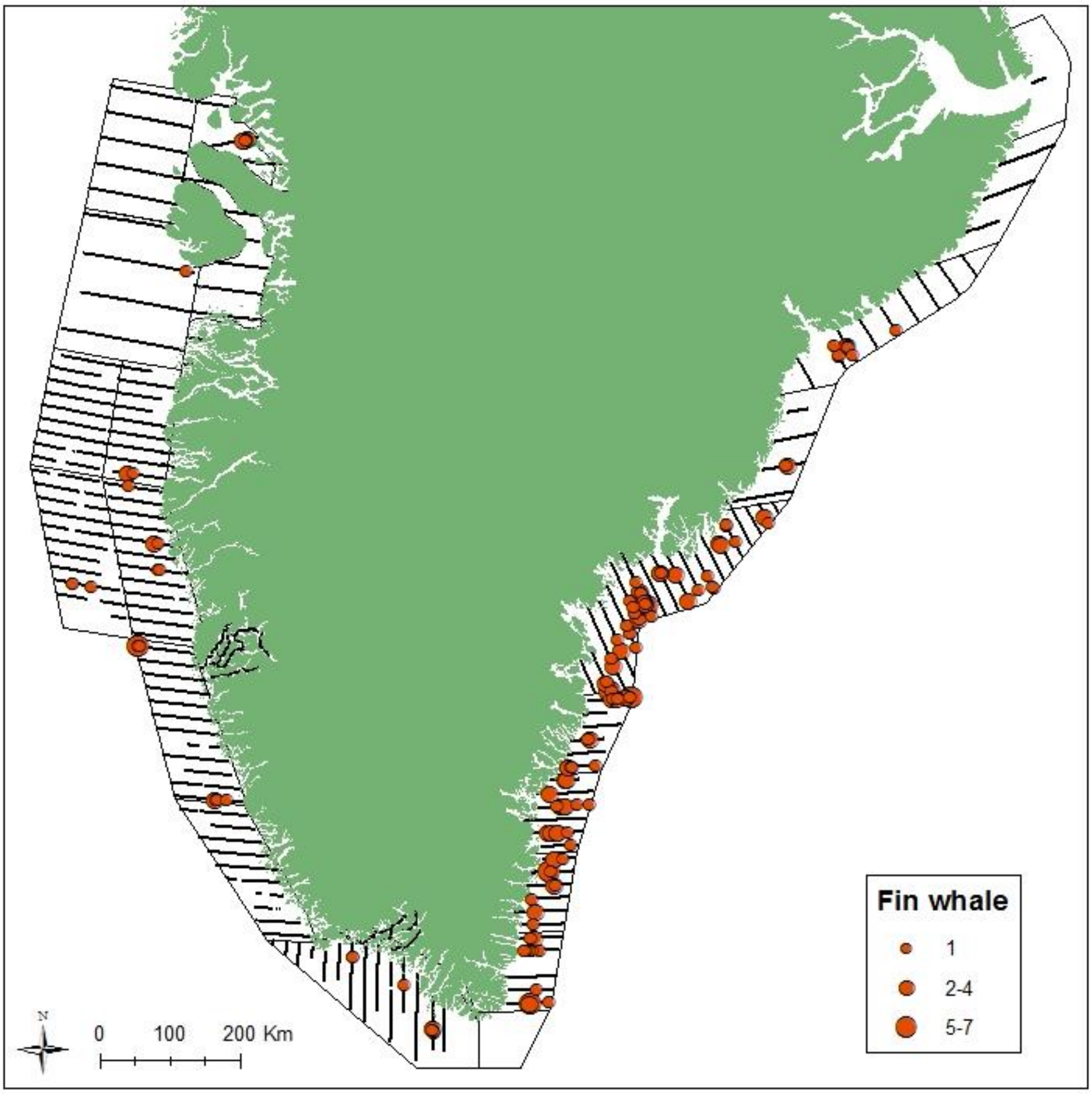

Fig. 3. Survey effort in sea states <5 and sightings with group sizes of fin whales in East and West Greenland.

General Discussion- combined estimates

The SC noted that it should be possible to produce a combined estimate for North Atlantic fin whales, including estimates from NASS2015 and the additional Norwegian surveys in 2015. Furthermore, producing a combined total estimate including estimates from the Norwegian, Canadian, American, and SCANS-III surveys in adjacent years should be explored. Although the surveys were all conducted over 2 years, it may be possible to combine the estimates with additional variance using the "Norwegian approach." This should be explored further.

The SC **recommended** that all the parties involved in fin whale estimation (NASS, Americans, Canadians, etc.) should cooperate to be able to work towards combining the estimates from different areas and different years.

8.1.2.2. Other Updates

Lydersen updated the SC on a fin whale that their team tagged near Svalbard and travelled down to Portugal, and the tag lasted 2 months. This is interesting when considering stock structure and summering grounds of fin whales in the North Atlantic.

During the Russian-Norwegian Ecosystem survey in 2015 in the northeastern Barents Sea, there were 9 sightings of fin whales, compared to 3 sightings in the previous survey. This information should be shared with the Norwegians, who plan to survey the Barents Sea in 2017.

8.1.3. Future work

Estimates from Norway will be presented at a future AEWG. Norway plans to survey the eastern Barents Sea in 2017.

8.1.3.1. Large Whale Assessment Working Group

This WG will aim to answer **R-3.1.7**.

R-1.7.12 will be discussed at the LWAWG meeting. See also Item 12.2.

8.2. Humpback whale

8.2.1. 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 (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."*

8.2.2. Update

8.2.2.1. Abundance Estimates WG

Iceland/Faroes shipboard and aerial

No estimate was presented at the AEWG, however there are likely enough sightings in the shipboard survey (Fig. 4) to generate an abundance estimate, which is expected in spring 2017.

Norway shipboard

The Norwegian ship surveys had relatively few sightings of humpbacks. Observations were sparsely distributed around Bear Island, in the Jan Mayen area and in the northern parts of the Norwegian Sea with a hot spot off northern Norway (Fig. 4). No estimate based on these data was available.

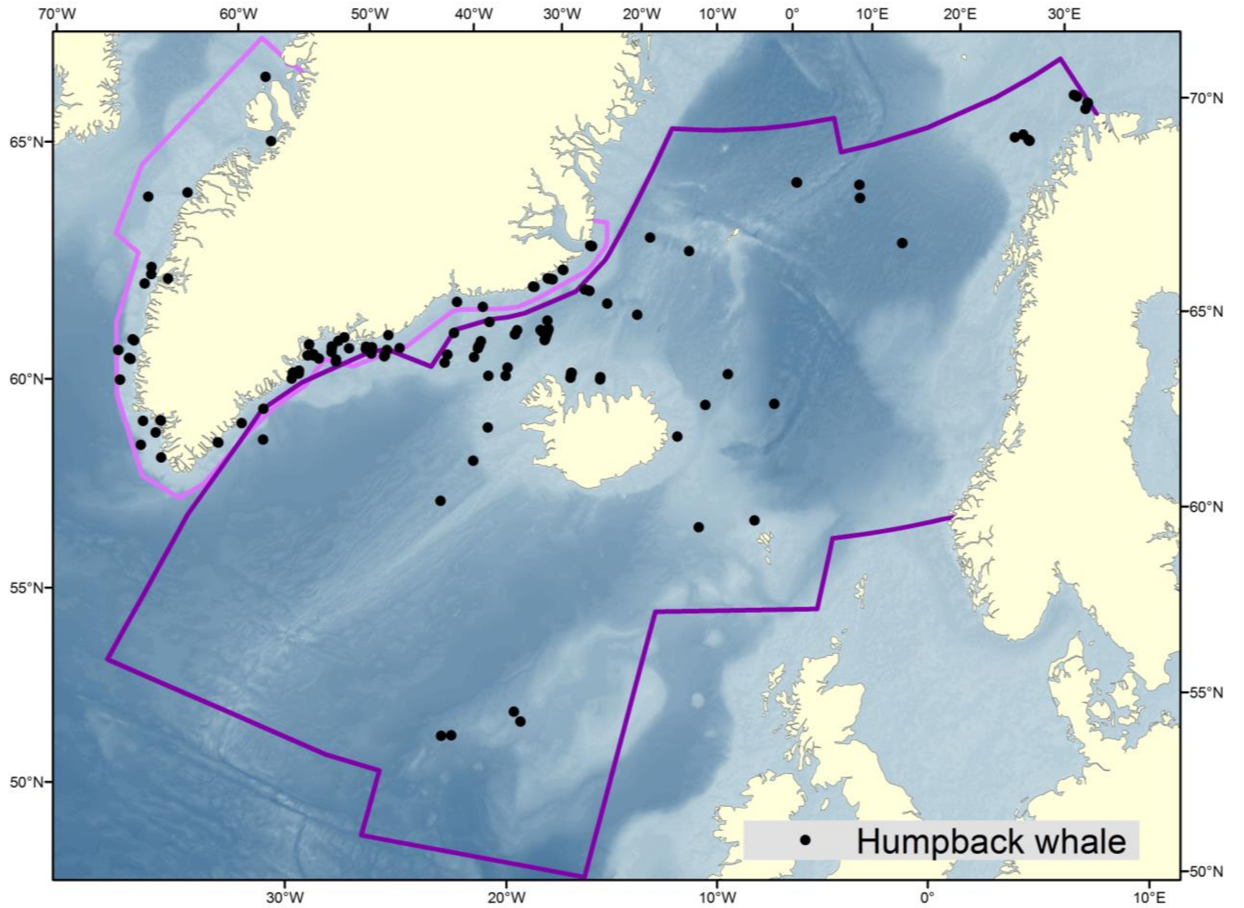

Fig. 4. Humpback whale sightings during NASS2015. This map does not include sightings during the 2015 Icelandic aerial survey.

Greenland

Abundance estimates for humpback whales in East and West Greenland were developed from data collected the 2015 aerial surveys (Fig. 5). The humpback whale abundance estimate was corrected for perception bias, availability bias and time-in-view using MRDS analysis methods, producing a fully corrected abundance estimate of 1,321 whales (cv=0.44; 95% CI= 578-3,022) in West Greenland and 4,012 whales (cv= 0.35; 95% CI= 2,044-7,873) in East Greenland.

The WG accepted the abundance estimates, and the SC **agreed**.

General

The WG suggested that it may be possible to add the East Greenland surveys to the Icelandic/Faroese estimates once those are developed.

The SC recognizes that the Greenlandic survey was a good survey, which was well designed. However, the SC noted that the confidence intervals are wide, which makes the estimates not significantly different from the 2007 estimates.

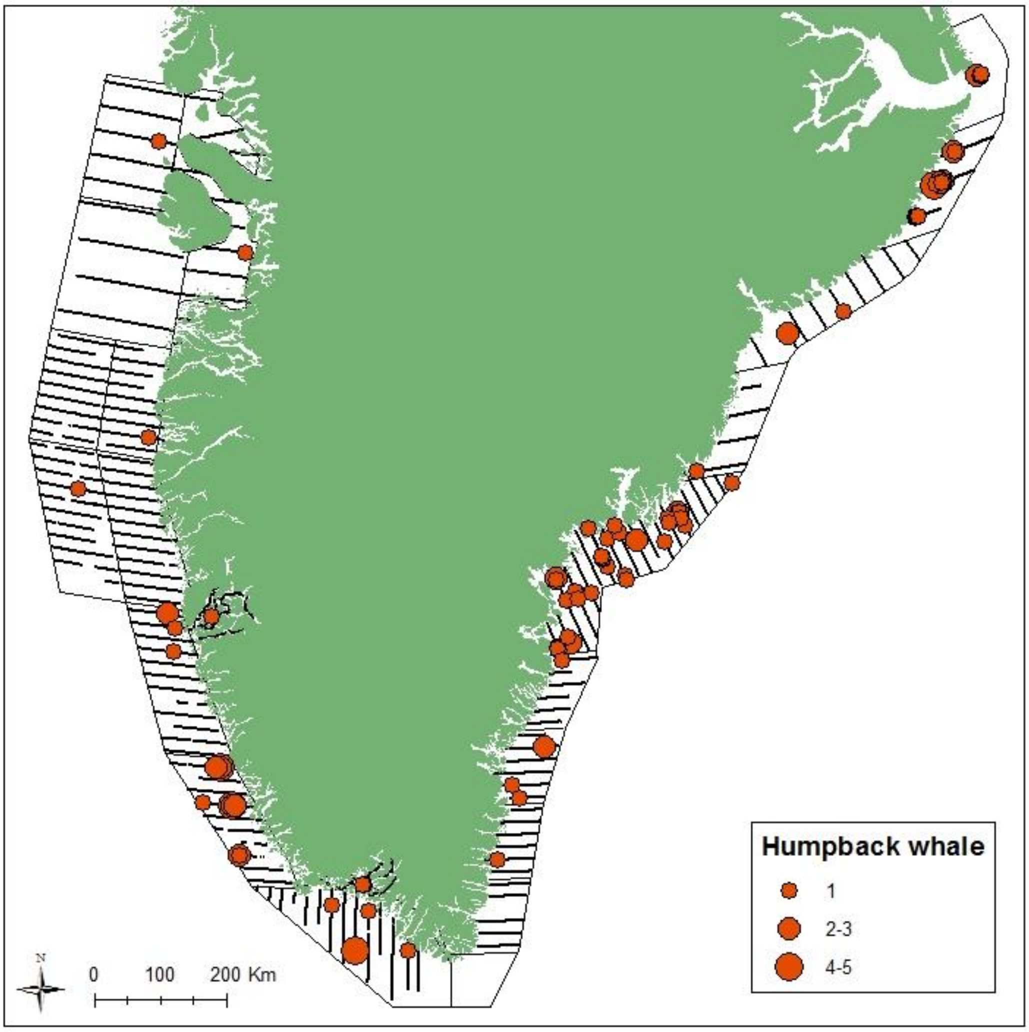

Fig. 5. Survey effort in sea states <5 and sightings with group sizes of humpback whales in East and West Greenland.

8.2.2.2. Other updates

Zabavnikov informed the SC that several humpback whales were seen in the entrance to the Kola Peninsula.

Greenland, Iceland and Norway are collecting photo ID pictures to look at possible movements between the areas.

8.2.3. <u>Future work</u>

8.2.3.1. Large Whale Assessment Working Group (25-27 January 2017)

The LWAWG will discuss **R-1.7.12** and **R-3.2.4**.

8.3. Common minke whale

8.3.1. 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.

8.3.2. Update
8.3.2.1. Abundance Estimates WG
Iceland/Faroes
Common minke whales were a secondary target species in the Icelandic and Faroes NASS-2015 shipboard survey. The surveyed area and general methodology was as described above for fin whales (section 8.1) including fully independent double platforms on each of the three vessels and the sharing of one of the vessels with fishery research. For the common minke whale analysis only data recorded in a BSS <4 were used.

Density was highest in blocks FC and IC (Faroese and Icelandic coastal areas; Fig. 6), and these two strata contributed more than half of the total uncorrected abundance estimate of 19,663 (cv 0.26, 95% CI 11,814 – 32,727). The total estimate corrected for perception bias was 36,185 (cv 0.31, 95% CI 19,942 to 65,658) for the survey area. The corrected estimate for Icelandic coastal waters (IC or CIC in RMP terms) was 12,710 (cv 0.52, 95% CI 4,498 to 35,912). These estimates are neither corrected for availability bias nor responsive movements. The first named is unlikely to be large for common minke whales, while the latter may be a source of considerable negative bias in the estimate.

The SC **agreed** with the recommendations of the AEWG and endorsed these abundance estimates, uncorrected for comparison to previous surveys, and corrected estimates for generating management advice. The SC noted that the effort north of Iceland, in the CM area, was very low and that the estimates from the Norwegian survey in this area should be preferred for use in assessments. The IO method used during NASS2015 produce more precise estimates compared the BT method which used in 2001 and 2007. This is likely due to the use of two fully staffed platforms using full searching effort, generating more sightings, and better use of sightings in estimating perception bias, which reduces variance. In addition, the IO method is logistically simpler in application.

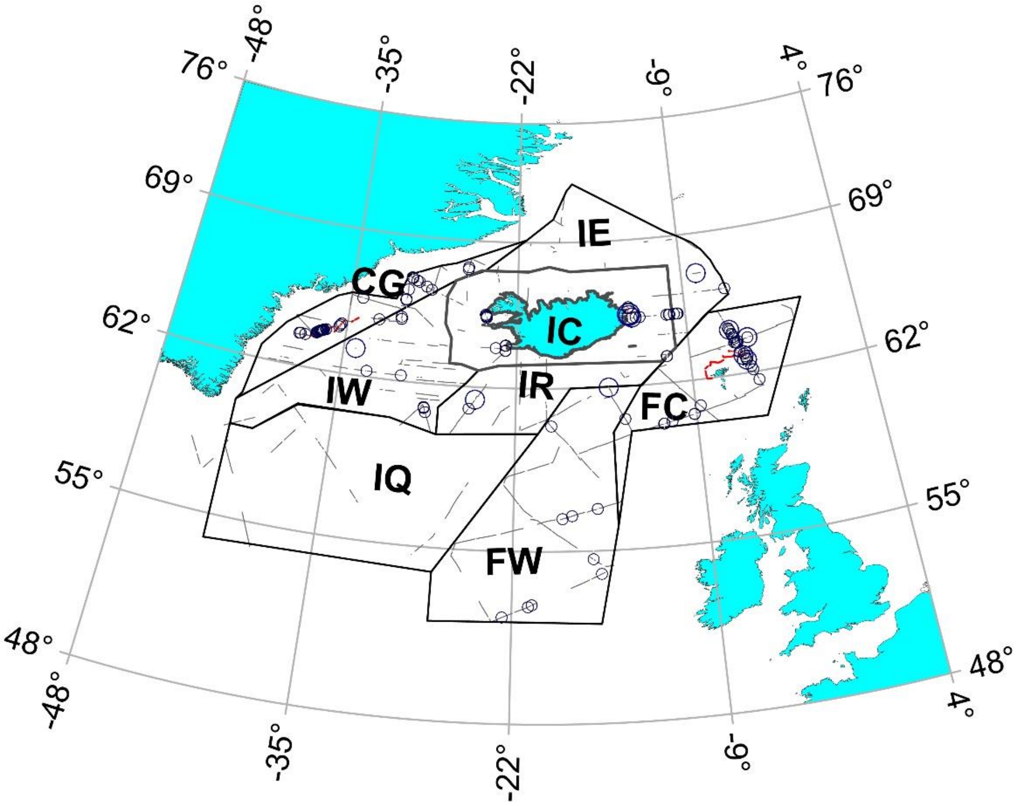

Fig. 6. Revised strata, realized effort (BSS<4) and sightings of common minke whales. Symbol size is proportional to group size from 1-3.

Aerial Iceland

The Icelandic aerial survey carried out in July 2016 is a continuation of a series of surveys, using nearly identical design and methodology, carried out in 1987, 1995, 2001, 2007 and 2009 (Fig. 7; Pike *et al.* 2008, 2009, 2011). The survey was attempted in 2015 but insufficient effort was realized due to poor weather conditions. The main target species of these surveys has been the common minke whale. In 2016 a Twin otter aircraft was used, for the first time allowing two full platforms each with 2 observers. As in 2015, a new electronic device called a Geometer was used to record sighting times and declination angles. Only 53% of planned effort was completed due to poor weather conditions. A total of 647 sightings were made, including 66 of common minke whales, 223 of white-beaked dolphins, 92 of harbour porpoises and 52 of pilot whales. Abundance estimates from this survey are feasible for common minke whales, white beaked dolphins harbour porpoises and perhaps pilot and humpback whales. However the value of producing these estimates must be weighed against the relatively low coverage of the survey. Abundance estimates for the target species will be finalized in early 2017.

The WG suggested that Iceland consider attempting the coastal aerial survey more frequently for shorter periods of time (e.g., 10 days every year), possibly using the "mosaic" approach used in the Norwegian survey program, with the goal of completing the entire survey over 3-5 years. This approach has many practical advantages, including the maintenance of a trained cadre of observers, more efficient use of equipment, a reduced risk of a "failed" survey and more predictable budgeting. The main disadvantage would be a decrease in precision because of the added variance due to interannual variation, but it was noted that several years of data are available to address this. The Icelandic delegates agreed to consider this approach.

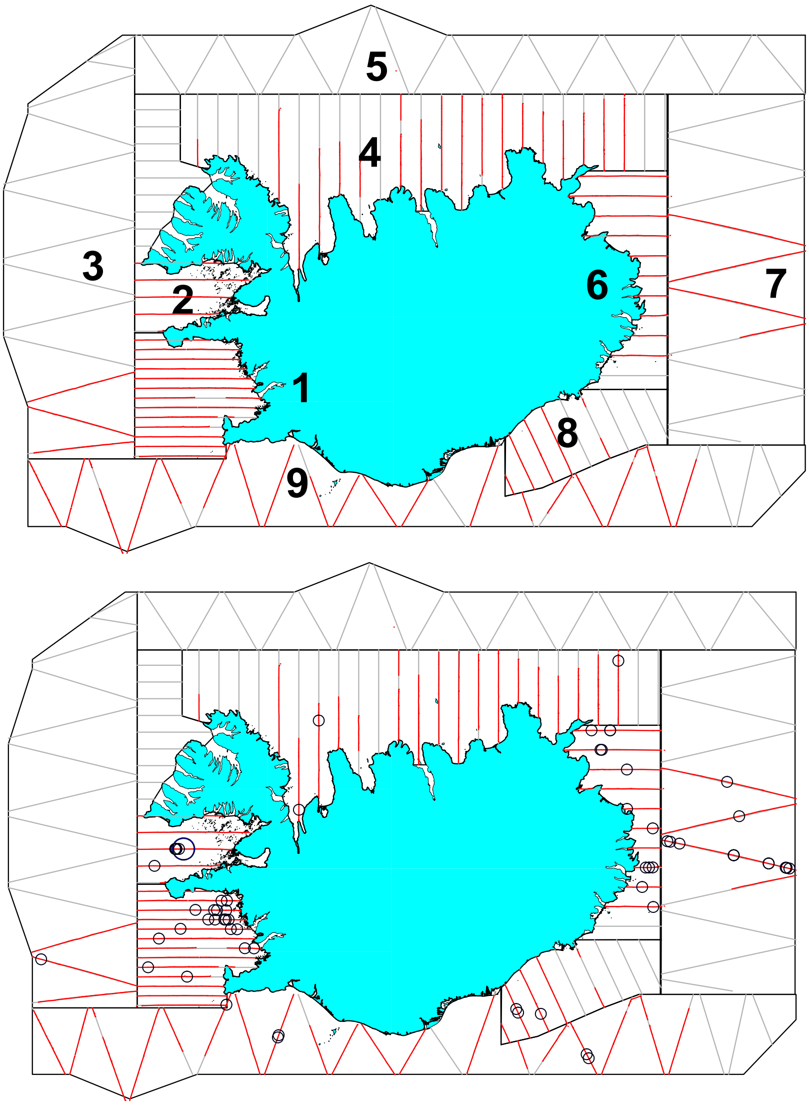

Fig. 7. Stratification and planned (black) and realized (red) effort (Top) and sightings of common minke whales (bottom) in the 2016 Icelandic aerial survey.

The SC **supported** the idea of spreading the effort over a few years, but had some concerns that with an area this small possible distributional shifts could be problematic. However, the SC agreed that with yearly attempts at the survey, there may be success in covering the entire survey area in at least one of the years, eliminating the need to combine strata surveyed in different years.

Norway

The combined results from the 2014-2016 data in the present Norwegian survey cycle indicate large shifts in distribution (Figs. 8 and 9). Preliminary estimates of common minke whale abundance show a considerable decrease in the Svalbard area (2014), a relative stable situation in the Norwegian Sea (2015) and a considerable increase in the Jan Mayen area (2015 and 2016). Full variance estimates for the preliminary estimates have not yet been calculated.

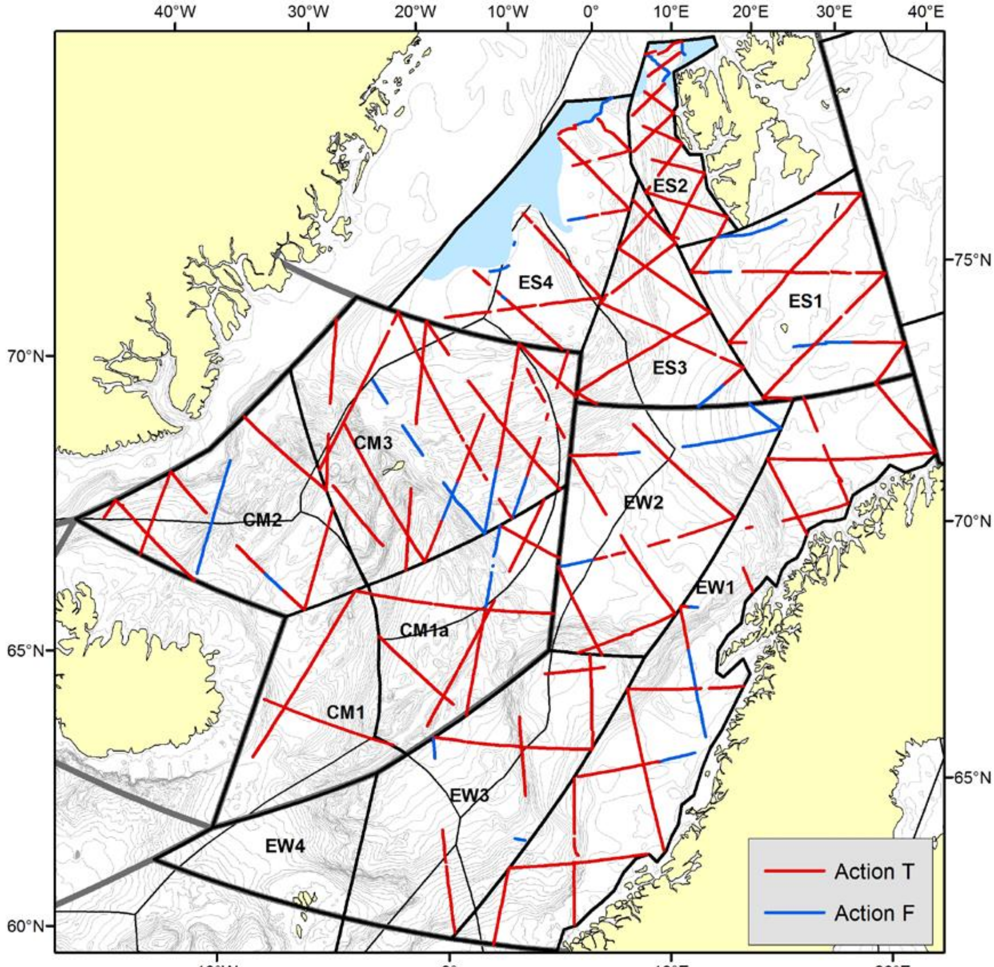

Fig 8. The total survey area for the Norwegian surveys combined for 2014, 2015 and 2016. Red lines show realised survey effort and blue lines are additional single platform effort.

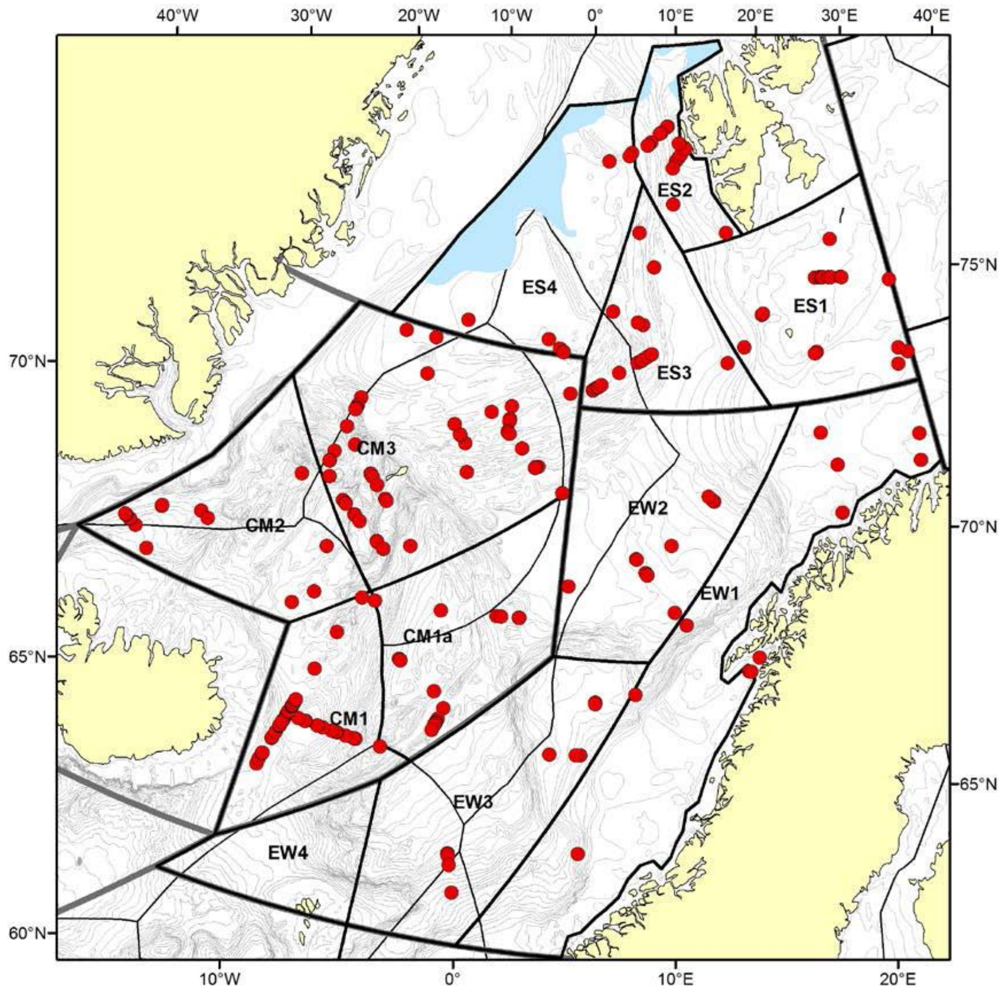

Fig. 9. Common minke whale sightings (Right) are shown as red dots.

Lydersen noted that many common minke whales have been seen in the fjords around Svalbard. The Norwegian surveys are offshore surveys and do not cover these areas.

Norway plans to survey in the Barents Sea in 2017, and will finish the cycle with the North Sea.

Greenland

Data on surface corrections for common minke whales were collected from 5 whales instrumented with satellite-linked time-depth-recorders in West Greenland. The common minke whale abundance estimate was corrected for perception bias, availability bias and time-in-view using MRDS analysis methods, producing a fully corrected abundance estimate of 4,204 whales (cv=0.47; 95% CI= 1,753-10,085) in West Greenland and 2,681 whales (cv= 0.45; 95% CI= 1,153-6,235) in East Greenland (Fig. 10).

Discussion

The SC **agreed** that these estimates from Greenland are from a well-designed survey, and are comparable to previous surveys.

As seen in other species in NASS2015 surveys, the 2015 estimate is lower than the 2007 estimate. Common minke whale quotas are relatively higher and fin and humpback whales, and the approach to assigning quotas is also different. This could present some difficulties for the next advice given by the IWC.

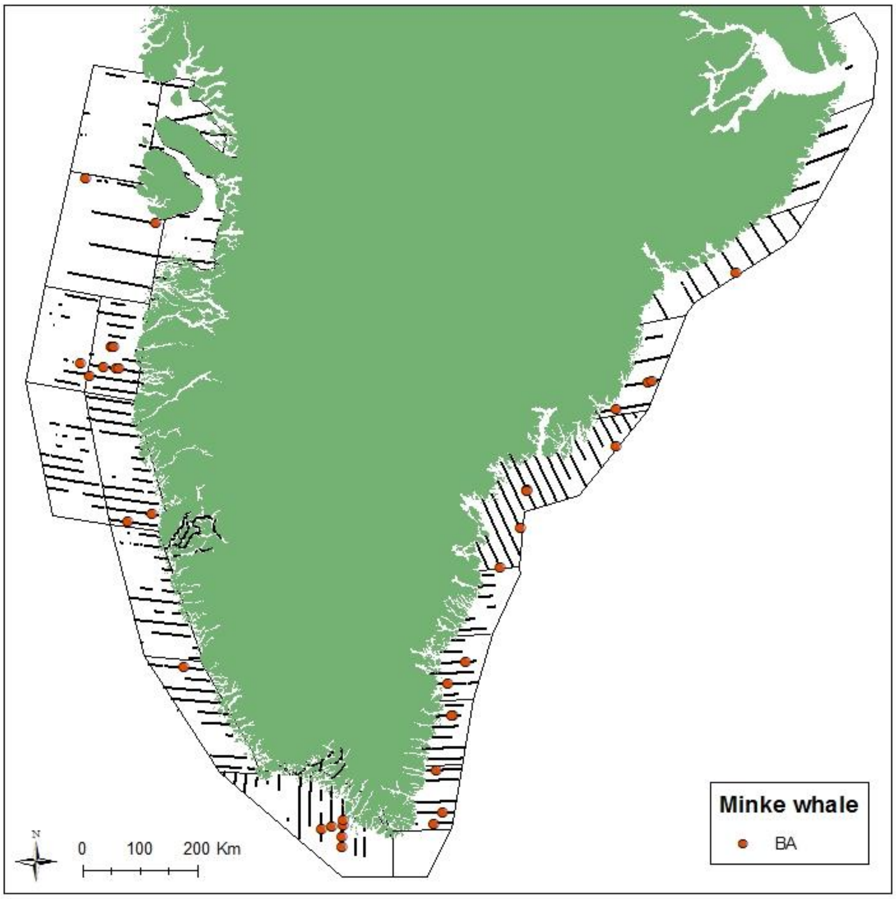

Fig. 10. Sightings and survey effort in sea states <3 for common minke whales in East and West Greenland.

8.3.2.2. Other updates

During the Russian-Norwegian ecosystem surveys in 2015, there were sightings of common minke whales for the first time in the Pechora Sea, in association with large aggregations of herring near Kola Bay. It may be possible to add these sightings to 2017 surveys in Eastern Barents Sea by Norwegian shipboard surveys.

8.3.3. <u>Future work</u>

8.3.3.1. Large Whale Assessment Working Group (25-27 January 2017)

The Iceland/Faroes abundance estimate will be used for the assessment at the January 2017 meeting.

8.4. Beluga

8.4.1. <u>Review of active requests</u> (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*

***NEW R-3.4.14** 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.*

8.4.2. Disturbance Symposium

The Disturbance Symposium was discussed under Item 6.4.1.

8.4.3. Update

Regarding **R-3.4.14**, Greenland noted that there was one beluga sighting in East Greenland during NASS2015. The conclusion of the SC is that it is very unlikely that the SC would be able to conduct an assessment in the future.

Lydersen updated the SC on fieldwork around Svalbard conducted during summer 2016 for an ongoing research project. The main goals are to:

1. Determine space use over the entire annual cycle - to discern how these whales move in relation to sea ice, bathymetry, glacier fronts and oceanographic conditions
2. Assess diet via stable isotope and fatty acid analyses bases on blood and blubber samples from live-captured whales
3. Update the general health status of Svalbard's white whales based on screening of serum samples
4. Conduct a screening of levels of various pollutants based on blood and blubber samples from live-captured whales +++

In 2016, 5 beluga were instrumented, bringing the total number to 18 animals. The SC looks forward to these results.

Hammill updated the SC that aerial surveys were conducted for belugas in Eastern Hudson Bay (EHB) and James Bay (JB), and Western Hudson Bay (WHB). He noted that the WHB belugas typically remain close to shore. In WHB, killer whales are frequently reported in this area. In the EHB and JB, belugas are general found further offshore. There are also fewer killer whale reports from EHB and JB.

8.4.4. Future work

Heide-Jørgensen updated the SC that a new paper has been accepted, Heide-Jørgensen et al 2016, "Rebuilding beluga stocks in West Greenland" which presents the results of 30 years of surveys, the introduction of quotas, and increasing stocks of belugas. This paper is a good example of a NAMMCO "success story."

8.4.4.1. *JCNB/NAMMCO JWG meeting: 8-11 March 2017*

Greenland does not plan to present any new information on belugas at the JCNB-NAMMCO JWG meeting.

8.4.4.2. *Global review of monodontids: 13-17 March 2017*

Prewitt updated the SC that the location of the meeting has been finalized. The organizing committee developed a list of about 40 participants, with experts covering all of the stocks of narwhals and belugas and necessary expertise.

A template of the desired information on each stock has been developed, and will be circulated to the participants shortly. Participants will be asked to complete the information for their stock and submit this information as working documents to the meeting.

There have been discussion that a volume of the *NAMMCO Scientific Publications* could be compiled from papers emanating from the working documents and results of this meeting. This idea will continue to be explored, but will be dependent upon the willingness of participants to develop and submit papers for publication.

8.5. Narwhal

8.5.1. 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*

8.5.2. Disturbance Symposium

The Disturbance Symposium was discussed under Item 6.4.1.

8.5.3. Updates

East Greenland

Heide-Jørgensen presented information from the latest instrumentations of narwhals in East Greenland. Seven narwhals were instrumented with satellite transmitters, stomach temperature pills, CTD tags and/or Acousonde tags from the field station in Hjørnedal, Scoresby Sound. A buzz detector has been developed to identify buzzes as proxies for feeding events in narwhals. It has been observed that narwhals have long periods without echolocation activity making them difficult to detect through passive acoustic monitoring. The main wintering ground for narwhals from this population is offshore the Blosseville Coast at the edge of shelf. One narwhal from a summer aggregation in Kangerlussuaq south of Scoresby Sound was tagged in August 2016 and in October it went north visiting all the fjords along the Blosseville Coast before it entered Scoresby Sound and joined the whales tagged in that area.

Recaptures of tagged narwhals after 1 and 2 years showed that the nylon pins used for mounting the tags are either rejected or will become encapsulated under the skin by re-epithelialisation around the pins.

Survey in East Greenland

An aerial survey for narwhals was conducted in East Greenland from 14-30 August 2016. The survey covered area from 64.4°N to 70°N as well as Scoresbysund (Fig. 11).

A twin otter airplane with a long-range fuel tank and four bubble windows with four observers on board was used. In total 67 observations of narwhals were made with a group size between 1-6 animals. No narwhals were observed South of 68°N. Furthermore, 6 common minke whales, 6 fin whales, 24 humpback whales and 9 unidentified large whales were observed.

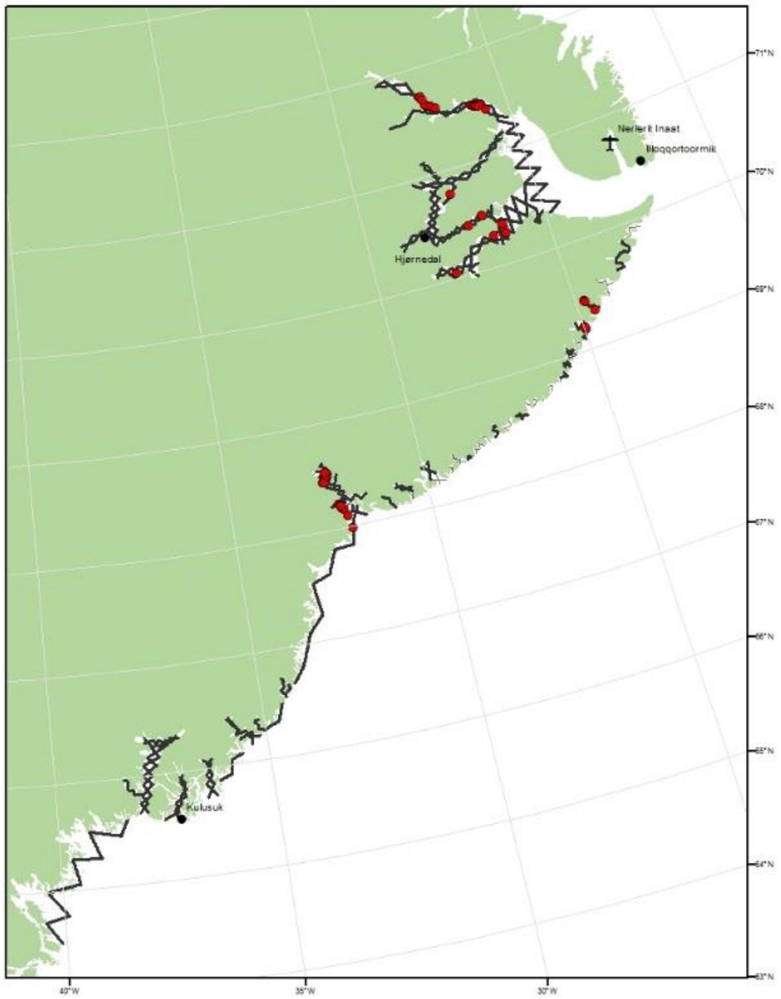

Fig. 11. Transects (black bold) and observations of narwhals (red dots) during the 2016 East Greenland aerial survey.

The developed MRDS abundance estimate will be presented at the JCNB JWG meeting in March 2017, and the SC looks forward to these results.

8.5.4. <u>Future work</u>

8.5.4.1. *JCNB/NAMMCO JWG meeting*

Among other information from Greenland, the results from the East Greenland survey will be presented.

Additional information that will be discussed, or will be requested to be available, at the meeting is discussed under Item 6.4.1.

8.5.4.2. *Global review of monodontids*

This item was discussed above under Item 8.4.3.2.

8.5.4.3. *Other*

Canada conducted surveys of Eclipse Sound and Admiralty Inlet, and deployed 5 satellite tags in 2016.

8.6. Sei whale

8.6.1. 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*

8.6.2. Update

There was one sighting in West Greenland and none in East Greenland.

The SC discussed that sei whales usually arrive around Iceland later in the season than the target species of NASS, and thus these surveys do not coincide with peak abundance of the species. Like in most previous surveys there were not enough sightings in NASS2015 to develop any abundance estimates.

Recent satellite tagging of sei whales at Azores (Prieto et al. 2014) indicates a migration corridor from northwest Africa towards the Labrador Sea with further possible links eastwards and westwards.

8.7. Bottlenose whale

8.7.1. Update

There was no update on the paper with the T-NASS 2007 and CODA data.

8.7.2. Future work

There are no plans for future work.

8.7.3. Abundance estimate

There were some sightings in the central Norwegian Sea, Jan Mayen area, and central Atlantic, especially in the Faroe Islands survey. However, this species is a low priority to develop an abundance estimate. There were also some sightings during the Greenlandic surveys, but there are no plans to generate an abundance estimate.

8.8. Killer whale

8.8.1. 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.*

8.8.2. Update

Abundance estimate

There were some sightings of killer whales during NASS2015 (Fig. 12), and the plan is to develop and abundance estimate from this data.

Greenland

A manuscript by Lennart and Richard (in review), “At the cutting edge of the future: unravelling depredation, behaviour and movement of killer whales in the act of flexible management regimes in Arctic Greenland” was forwarded to the SC and will be referred to a future WG on killer whales.

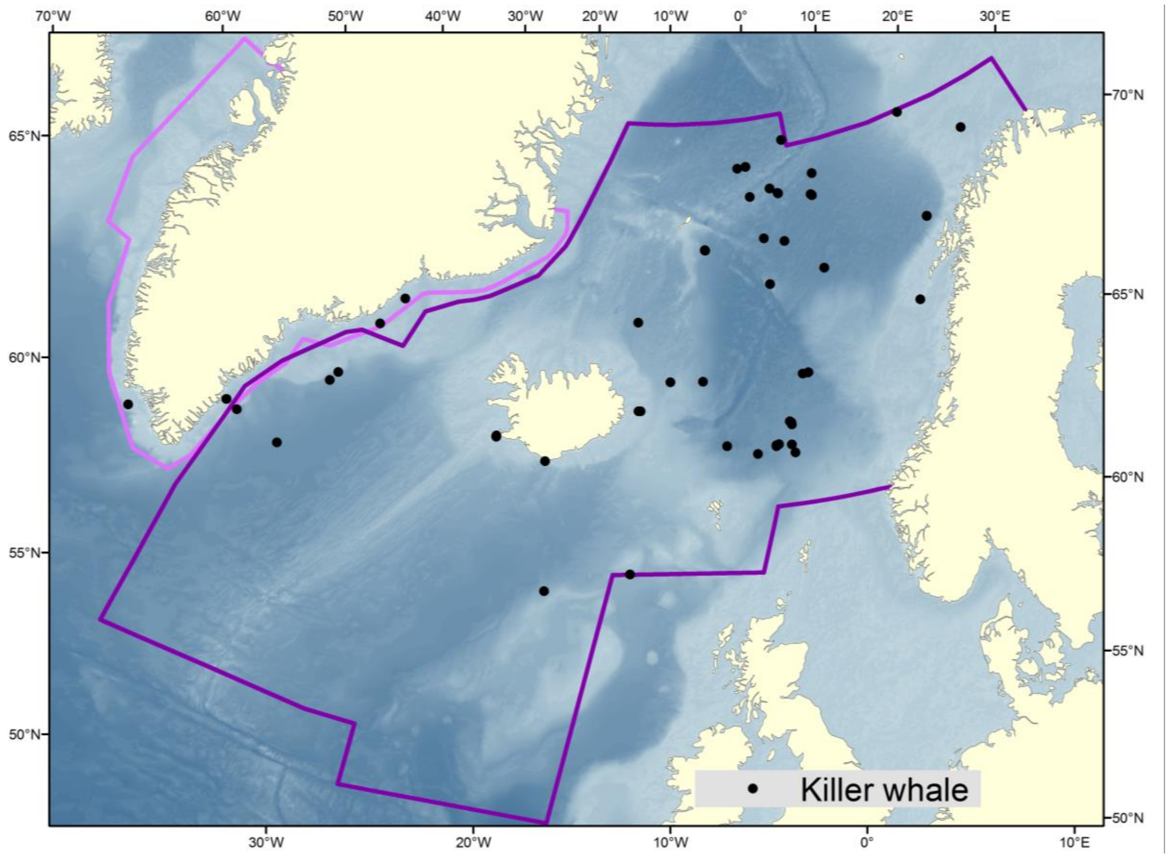

Fig. 12. Sightings of killer whales during NASS2015.

As discussed under Item 11, catches in Greenland have not been validated by the Ministry. The catches are now starting to be too old to be validated using the method of calling up the hunter, as the last validation of killer whale catches was in 2008. The SC **recommends** that catch validation should be done on an annual basis.

Samples for pollutants have been collected and are currently being analysed.

Norway
Research including satellite tagging to look at behaviour and movements is starting on the recent large numbers of killer whales seen outside of Tromsø, Norway. There are no results available yet, but the SC looks forward to reviewing these results. This work is being conducted by a PhD student at the University of Tromsø.

The SC also noted that there have been sightings north of Svalbard almost up to the ice edge.

Iceland
The MFRI's 3-yr research project on feeding ecology and behaviour of killer whales was completed in 2016. Funding has been secured for continuing this research for another 3 years.

Russia
During the Norwegian-Russian Ecosystem surveys in, there were a higher number of sightings between Svalbard and Franz Josef Land than previous surveys. There were also reports of killer whales taking harp seals. In 2016, killer whales were seen for the first time around in the southwestern part of the Barents Sea in association with large aggregations of herring during international ecosystem surveys of the northern seas.

General
The SC noted that there is possibly an overall expansion of killer whale's range, possibly related to climatic changes.

There have been several reports of killer whales taking seals and seal pups in Norwegian coastal waters, suggesting that there are not just fish eating killer whales in this area.

8.8.3. Future work
The SC noted that in answer to R-3.7.2, this is a species that is hunted in Greenland, with uncertain catch statistics, and no abundance estimate. Work is ongoing that will help in answering this request, and the SC **recommends** that this information is gathered with more speed in order for the SC to be able to monitor the hunt.

8.9. Pilot whale
8.9.1. 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*

8.9.2. Abundance Estimates Working Group
Iceland/Faroe Islands Shipboard
No abundance estimate from the NASS 2015 survey was available to the WG; the data had not been fully explored for duplicate sightings in advance of the meeting. A trend analysis of pilot whales in the North Atlantic, that has integrated previous NASS and SCANS/CODA surveys, was presented to the SC in 2014. The plan is to integrate the NASS 2015, together with the SCANS 2016 data, in the trend analysis.

The sightings of pilot whales during NASS2015 can be seen in Fig. 13. Group size estimations of pilot whales in ship surveys have been an issue of discussion in previous abundance estimation WGs. During the preparations of NASS 2015, it was recommended that potential solutions for more accurate group size estimation be explored, (e.g. independent aerial surveys). A drone was used for filming groups to use as a comparable group size estimate. The drone was deployed successfully. The drone data have not been explored yet, as the video is not yet available.

The plan was also to tag some pilot whales with satellite transmitters during the survey, in order to determine the presence of pilot whales within the survey area during the survey. Although one attempt was made to approach and tag animals offshore, from a small boat, it was not possible to get close enough to the animals.

The WG **recommended** that the analysis of the pilot whale data should be completed within the next few months, and the SC agreed.

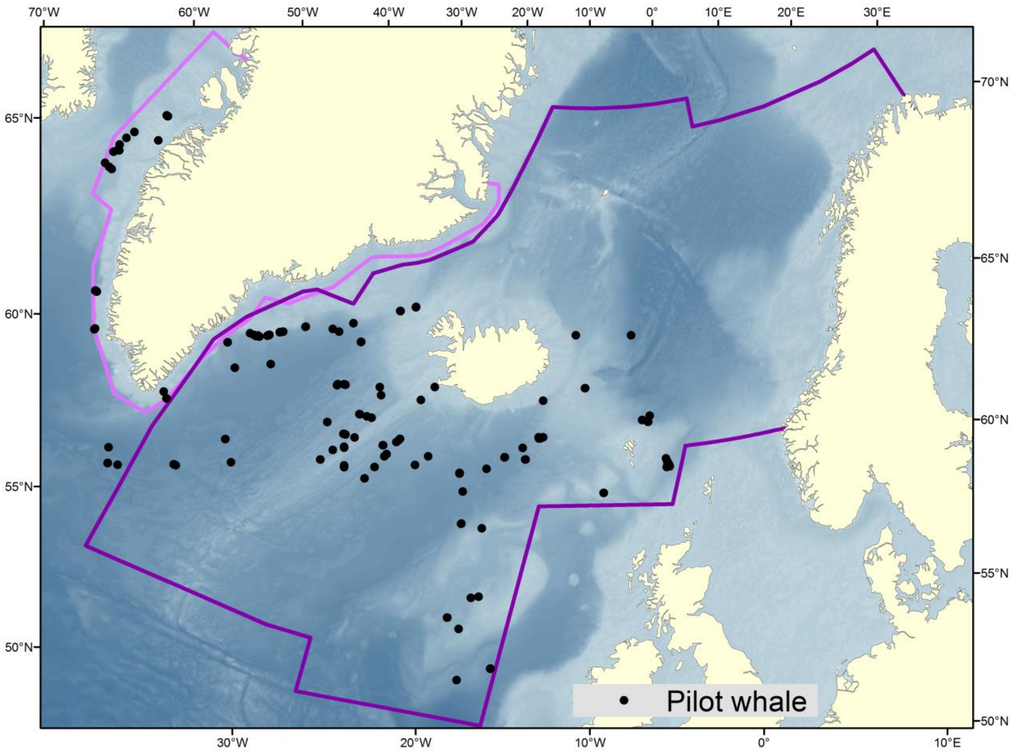

Fig. 13. Pilot whale sightings during NASS2015, not including the 2015 Icelandic aerial survey.

Greenland

An abundance estimate for pilot whales was presented to the AEWG. The pilot whale abundance estimate was corrected for perception bias and availability bias using MRDS analysis methods, producing a fully corrected abundance estimate of 11,993 whales (cv=0.52; 95% CI= 4,575-31,438) in West Greenland and 338 whales (cv= 1.01; 95% CI= 65-1,749) in East Greenland (Fig. 14).

The WG concluded that this survey was not designed to provide a complete coverage of the stock area in Baffin Bay and that the abundance estimates from West Greenland must therefore be considered a minimum estimate. The survey is only capturing a fraction of the population in Baffin Bay because there were sightings at the western edge of the strata, indicating that there are likely animals outside of the survey area. There are probably large fluctuations in abundance in West Greenland as reflected in recent surveys (e.g. 2007) and also in the catches. The SC **agreed** with the conclusions of the AEWG.

Norway

As usual, there were not many sightings of pilot whales during the summer surveys (See Fig. 13). Pilot whale groups are on the Norwegian coast later in the summer than when the surveys occur. Additionally, surveys are offshore, pilot whales are more coastal.

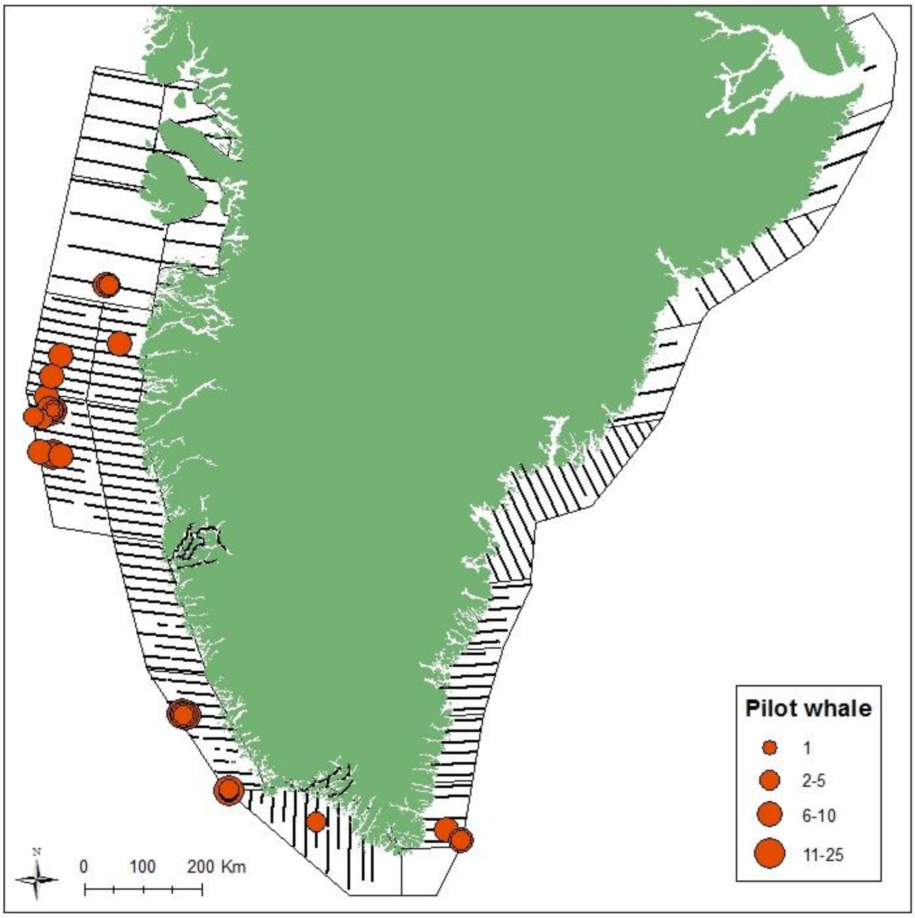

Fig. 14. Survey effort in sea states <5 and sightings with group sizes of pilot whales in East and West Greenland.

8.9.3. Update

In response to R-3.8.6- a full assessment is planned once the abundance estimate is complete, and the information from samples for biological information is available.

The Faroe Islands plan to continue attempting to tag groups of pilot whales.

8.10. Dolphins

8.10.1. Review of active requests (R-3.9.6)

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

8.10.2. Update

There has been only one harvest of white sided dolphins in the Faroe Islands since 2007. The analysis of the biological sampling from that catch is still in progress.

Greenland has collected some samples and can collect more if needed.

8.10.2.1. Abundance Estimate

During the East and West Greenland surveys in 2015, white-beaked dolphins were widespread in both East and Southwest Greenland (Fig. 15) but the number of sightings in West Greenland in 2015 was only half of the sightings in 2007.

The AEWG accepted the at-surface abundance estimates of 2,747 white-beaked dolphins (95% CI: 1,257-6,002) in West Greenland and 2,140 (95% CI: 825-5,547) in East Greenland with a joint perception bias of 0.99 (cv=0.01).

The SC noted that this is a decline from 2007, however it is not significant.

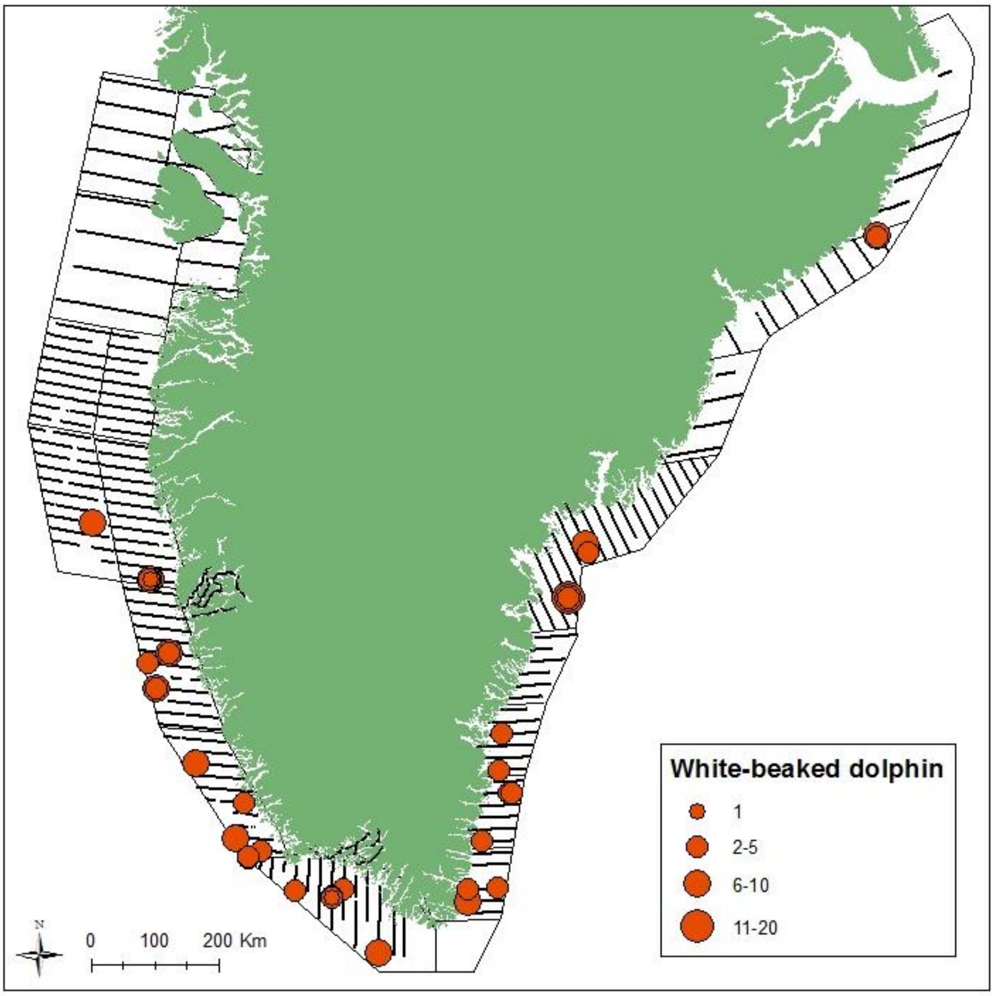

Fig. 15. Survey effort in sea states <5 and sightings with group sizes of white-beaked dolphins in East and West Greenland.

Iceland

There were a large number of sightings during the coastal aerial survey in 2016 and it should be possible to generate an abundance estimate (Fig. 16).

Norway

There were sightings of dolphins and the plan is to develop an abundance estimate. White beaked dolphins are sighted north of Svalbard.

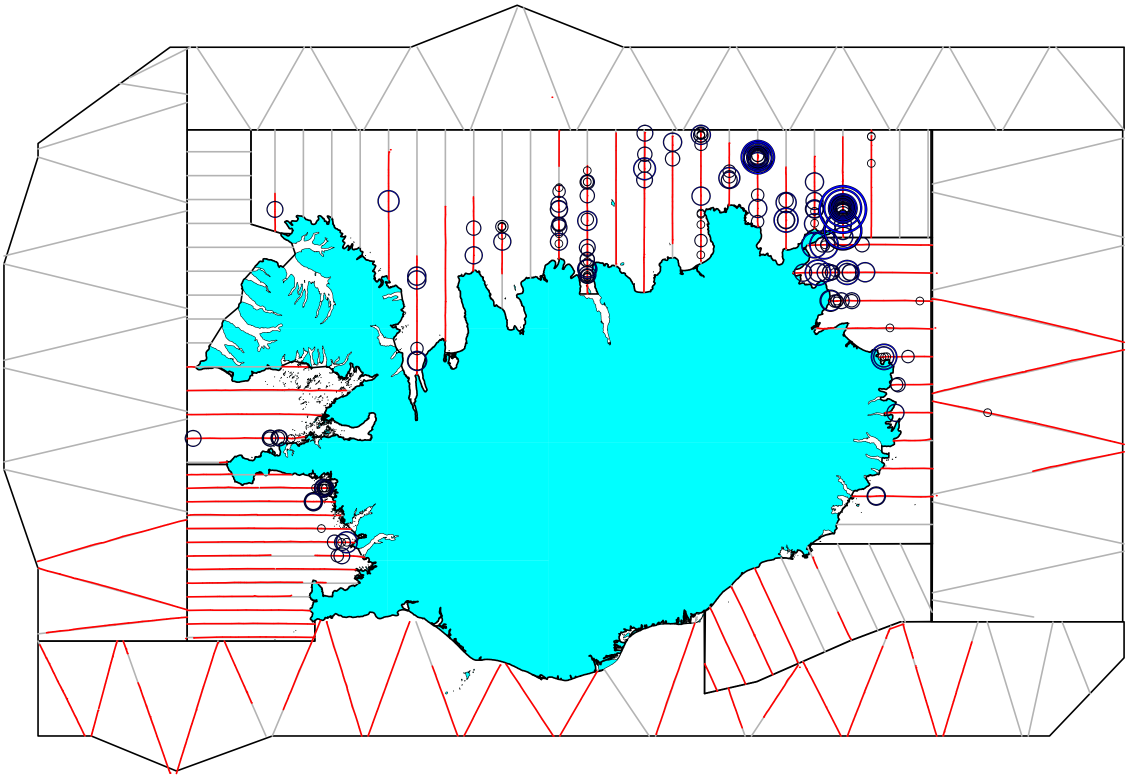

Fig. 16. Unique (non-duplicate) sightings of white-beaked dolphins (LA) in the Icelandic aerial survey of 2016. Symbol sizes are proportional to the group size limits given.

Russia

During Norwegian-Russian ecosystem surveys, the most sighted species was white beaked dolphins in the Barents Sea. Sightings usually occurred in areas with large capelin and polar cod aggregations.

8.11. Harbour porpoise

8.11.1. <u>Review of active requests</u> (R-3.10.1)

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

8.11.2. <u>Updates</u>

Norway

An increased research effort on harbour porpoises in Norway is being driven by the concerns regarding the by-catch.

The Norwegian coast from 62°N to Lofoten was covered by aerial surveys as part of the SCANS-III survey in 2016. The target species was harbour porpoises. The survey was very successful and abundance estimates are expected in spring 2017. The SCANS-III also covered the North Sea and areas around the British Isles as well as offshore areas as far south as the Iberian peninsula. Abundance estimates from a series of species are expected in due time .

In addition to the survey effort, a project collecting by-caught porpoises was initiated in 2016. About 70 harbour porpoises were collected obtained from fishermen in August, and more will be collected in spring. Samples are being collected for diet, genetics, body condition, and life history parameters.

Iceland
Over 1,300 Icelandic harbour porpoises have been genotyped at 11 microsatellite loci. Recent genetic work encompasses samples from Iceland develops SNPs for porpoises (Lah et al. 2016). This makes it possible to augment the microsatellite data in a relatedness study as a possible alternative way to estimate abundance.

Greenland
Heide-Jørgensen presented information on harbour porpoises from an ongoing PhD project. Porpoises tagged with satellite transmitters in central West Greenland in July-October made large scale movements in the North Atlantic after leaving the Greenland shelf area. It is believed that they feed on mesopelagic fish species at depth between 100 and 300m. The return to the coastal areas takes place in June and most porpoises showed site fidelity to the tagging area except for two that chose East Greenland as summering ground the year after they were tagged. Five tagged porpoises have been killed by hunters in West Greenland between 200 and 700 ds after tagging and they showed no pathological changes caused by the instrumentations.

8.11.2.1. Abundance Estimates

Greenland
An abundance estimate was developed for harbour porpoises from data collected during the 2015 aerial survey (Fig. 17). Data on surface corrections for harbour porpoises were collected from 9 whales instrumented with satellite-linked time-depth-recorders in West Greenland. The harbour porpoise abundance estimate was corrected for perception bias using MRDS analysis methods and availability bias using data from satellite tagged animals, producing a fully corrected abundance estimate of 83,321 harbour porpoises (cv= 0.34; 95% CI=43,377-160,047) in West Greenland and 1,642 harbour porpoises (cv= 1.00; 95% CI= 318-8,464) in East Greenland. This is an increase in WG from the 2007 estimate.

The WG accepted these estimates, and the SC **agreed**.

8.11.2.2. By-Catch Working Group

No new information was presented.

8.11.2.3. Catches in Greenland

There have been previous recommendations from HPWG and the SC to validate the catches. The SC discussed whether it is possible to have catches validated. An alternative method could be to use a trend of the catches in the assessment. Another option would be to survey hunters. The SC also noted that the Ministry should figure out how to assess whether by-catches are being reported either as direct catch or by-catch.

8.11.2.4. *Status of recommendations from 2013 HPWG*

- *Norway- update on reference fleet and bycatch estimates*
    - *Re-analysis and future work*

Reanalysis has been completed.

- *Norway- update on survey for HP in 2016*

Update above.

- *Norway- update on pinger experiments on monkfish gillnets*

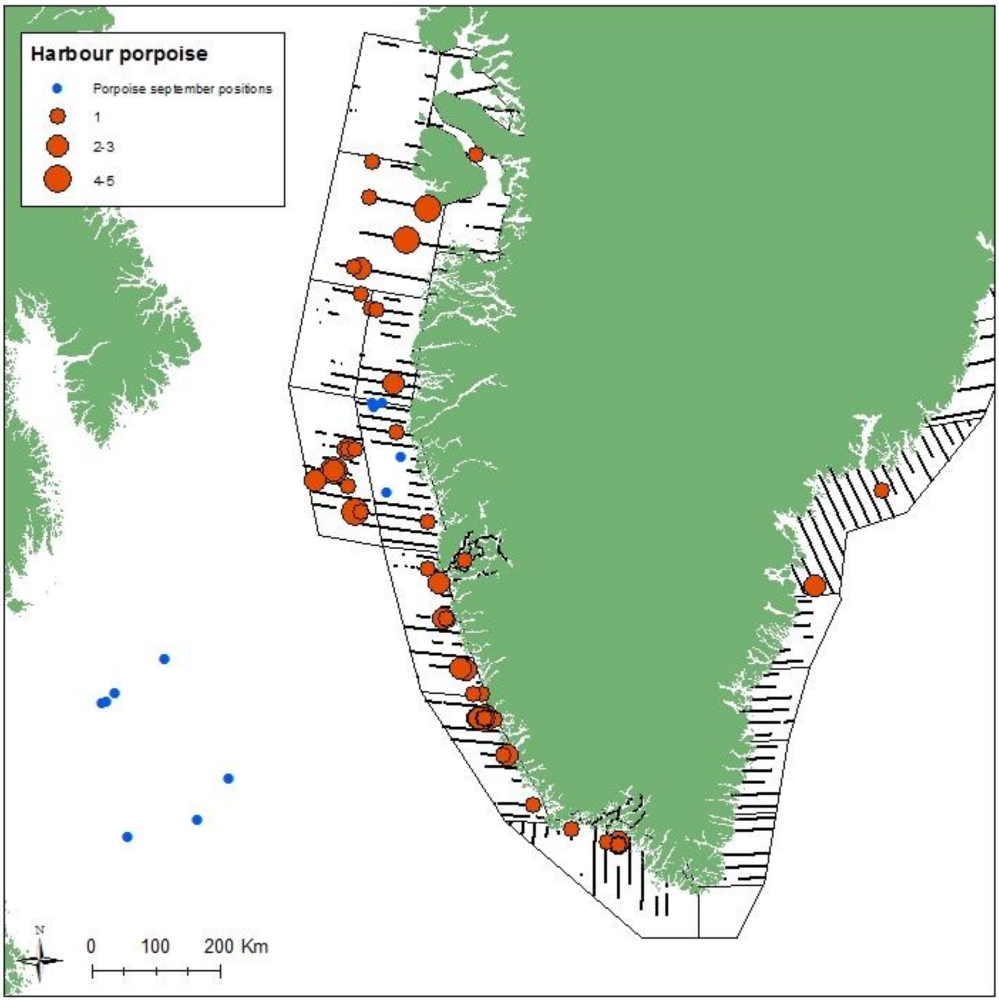

Fig. 17. Survey effort in sea states <3 and sightings with group sizes of harbour porpoises in East and West Greenland. Blue dots indicate satellite positions of harbour porpoises tagged inside the survey area and tracked in September 2015.

This work started in autumn 2016 in cooperation with IMR and the Norwegian Fisherman Association.

- *Greenland- update on tagging and surveys*

Update above.

- *Greenland- update on catch history validation*

Update above, this work has not been done.

8.11.3. <u>Future work</u>

The SC discussed a possible future HPWG. Norway and Iceland both stated that they will likely not have the information ready for a meeting until 2018.

For Greenland, there was concern before the 2015 survey that the catches were high. However, with the new abundance estimate from 2015, this level of catches is likely of less concern. Therefore Greenland is also fine with waiting until 2018 for the next HPWG.

The SC also supported the idea that a future meeting should include participants from ASCOBANS and other EU scientists.

8.12. Sperm whale

8.12.1. <u>Update</u>

No abundance estimates were presented at the AEWG, data are available from Iceland and Norway to develop an abundance estimate.

8.12.2. <u>Future work</u>

8.13. Bowhead whale

8.13.1 <u>Review of active requests</u> (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*

8.13.2 Update

Lydersen will update the SC on a new abundance next year.

Greenland updated the SC that they are conducting an in-depth analysis of 140 tags that have been deployed from 2004-2011. The SC awaits these results at a future meeting.

8.14 Blue Whales

8.14.1 <u>Update</u>

There were some sightings during the NASS2015 (Fig. 18), on the East Greenland shelf break. It is unlikely that an abundance estimate will be developed. There was 1 sighting in East Greenland and none in West Greenland.

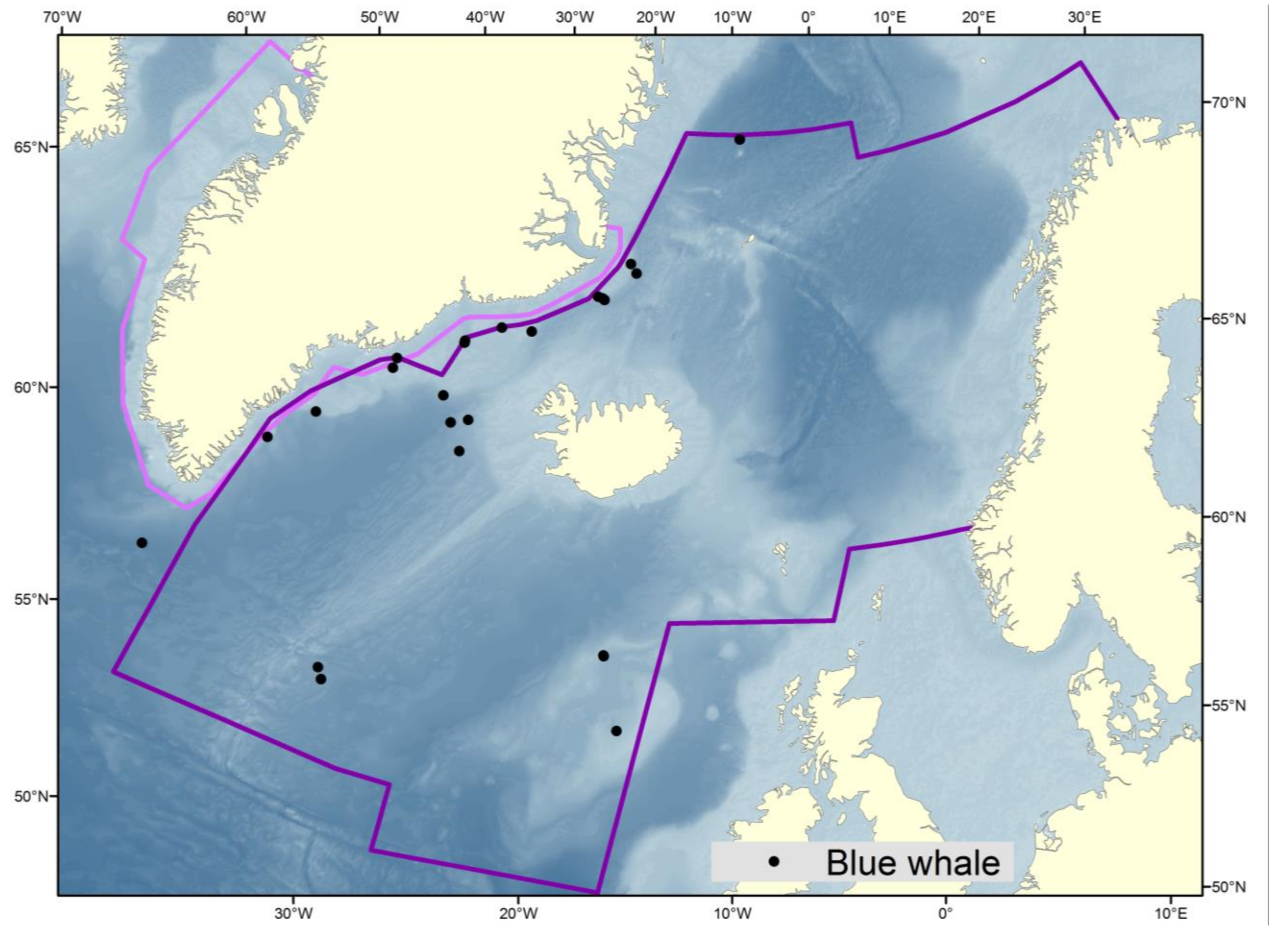

Fig. 18. Sightings of blue whales during NASS2015.

Lydersen reported on 16 biopsies that have been collected so far via cross bow dart. The samples will be analysed for diet (fatty acids and stable isotopes), ecotoxicology studies, and genetics. They are also tagging, starting late in the season to look at migration movements.

Satellite tracks of tagged whales have shown that blue whales move in the same pattern between Svalbard and Iceland through the Denmark Strait. Øien noted that this area was where the sightings of blue whales were during the surveys.

Lydersen reported that they are also collecting photos for photo-ID study. Iceland is also providing photos to the same study.

9 SURVEY PLANNING (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*

9.1 Abundance Estimates Working Group

As discussed under Item 8.3, Iceland is considering yearly coastal aerial surveys (see also ANNEX 3).

The SC commended Greenland on the large amount of good work presented to the AEWG.

9.2 Plans for future surveys

The SC remarked that NASS2015 was a successful survey, and especially thanked the Norwegian Ministry of Foreign Affairs Arktis 2030 program for a significant portion of the funding.

The AEWG (ANNEX 3) recommended "In general, it is **recommended** that surveys are repeated more frequently in areas where declines have been observed (e.g., West Greenland)." The SC **agreed** with this recommendation.

Hammill noted that the Canadians will likely survey again in another 8-10 years. Norway and Iceland will likely continue with the policy of aiming at surveying every 6 years, following the requirements of the RMP. This would set the timing of a next NASS/T-NASS in about 2021.

The SC **noted** that for a future NASS/T-NASS, they would like close cooperation with Canada and USA.

10. NAMMCO SCIENTIFIC PUBLICATION

10.1 Monodontid age estimation

The Monodontid volume is still ongoing. Eight papers have been published on-line, but several remain in progress and both editors and authors are not very active. Prewitt will try to speed up the process, so the volume can hopefully be finalized in early 2017.

10.2 Next volume

The SC discussed plans for future volumes in the series. The AE WG had suggested that the next volume be a NASS volume and include results from TNASS 2007 which had not been published, and results from NASS 2015 and associated surveys in 2016. A list of potential authors and papers were compiled, and Pike and Hansen were suggested as editors for the volume. The SC endorsed this proposal.

Another possible future volume could compile papers presented at the Global Review of Monodontids workshop. Of particular interest are papers from Russian scientists presenting their results at this meeting. These scientists do not usually publish in English, and the information is therefore not easily accessible. The SC agreed to return to the question after the workshop had been held.

11. DATABASE ON ABUNDANCE AND CATCHES

11.1 Abundance

The Secretariat continue to compile all of the abundance estimates that have been approved by the SC for use in assessments for all species and stocks in the NAMMCO area of interest.

In parallel the Secretariat had prepared two overview spreadsheets for use on the website, one for cetaceans (SC/23/05a) and one for seals (SC/23/05a). They collate for all stocks the most recent abundance estimate, date of the survey and references, the trend in abundance and the date and reference of the assessment, the kind of removals the stock is subjected to (direct catch, by-catch, struck and lost) and the annual direct catch for the last four years.

The spreadsheets were circulated to the SC prior to the meeting, further comments and corrections were forwarded to the Secretariat at the meeting and the final documents and their content were **endorsed** by the SC.

11.2 Catches

Amalie Jessen, Head of Delegation for Greenland, and Nette Levermann, both from the Department of Fisheries and Hunting under the Greenland Ministry of Fisheries and Hunting (APN), had been invited to present how catch statistics and Struck and Lost were collected and validated in Greenland.

11.2.1. Struck and Lost

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.*

Data on struck and lost (SL) presently used in assessments for some Greenland hunts (e.g. walrus) were collected in Canada and Greenland in the 1970s and 1980s and it is unknown whether these rates are still relevant.

The SC have commented that SL rates based on hunter interviews are often not reliable enough for use in assessments. It further agreed that the best method for collecting SL data was using observers in the different types hunts, as SL rates vary between species and hunts. The SC acknowledged that this would be logistically challenging and costly and would therefore perhaps not represent a prioritised parameter for improving assessments, see point 7.7.3.1 for walrus.

It was noted that in order to obtain more reliable reporting of SL, one possibility could be to not deduct SL from the quota for a certain period of time for species where the catch quota were not realised. This suggestion was however not discussed further by the SC.

Presently, depending on species, quota advice was given with and without including SL, i.e., sometimes as strikes and sometimes as landed animals. This is illogical and confusing and future quota advice should be streamlined.

11.2.2. Catch Reporting

SC 22 noted that in Greenland there are 2 different reporting schemes for catches (*Piniarneq* and *Særmeldingsskema*), and that a few of the quota-species are being reported in both systems. The two systems are inconsistent with respect to the reported catches. This inconsistency creates problems when attempting to determine which numbers should be used in assessments. The SC noted that it was important to know whether the smaller numbers in *Piniarneq* reflected a general underreporting for all species in that system, as some marine mammal species are only reported under this system. SC-22 therefore *recommended that Greenland should streamline their reporting system, and also conduct a study to investigate why the numbers are different between the reporting schemes*.

Levermann presented the Greenlandic reporting systems, which are both under the responsibility of APN.

Catch data series are used when giving species scientific and management advice. They are also used for getting local and regional hunt information and managing and allocating quotas. Reporting requirements are based on the hunting act, and hunting and species executive orders. *Særmeldingsskema* is for marine mammal species under quota (bowhead, fin, humpback and common minke whales and beluga, narwhal, walrus and polar bear) while the *Piniarneq*/Luli database is for the other species (both marine and terrestrial mammals and birds). Until now, however, a few marine mammal quota-species have also been kept in *Piniarneq*, which provides the possibility for differentiating between direct catch and by-catch as separate reporting of by-catch has been introduced in *Piniarneq* in 2015.

Marine mammal quota species can only be hunted by professional hunters (holders of professional hunting licenses), except narwhal and beluga for which up to 10 % of the quota can be given to leisure time hunters. In both cases, hunters should have a valid hunting license and a license for the marine mammal(s) they are allowed to catch. Reporting in *Særmeldingsskema* is ongoing and at the latest in the three weeks following the catch, and includes SL whales, as the system is used for managing the quota. It also includes species specific biological information and time to death.

Reporting in *Piniarneq* is done once a year, usually when applying for a new hunting licence, as the catch reporting is a requirement for renewing hunting licenses. The reporting on Year x covers the period October (Year x-1) to September (Year x). The executive order specifies that reporting shall take place from October 1-15 (year x), and the main reporting happens from October (year x) to August (year x+1). This means that the full reporting for Year x will only become available in August of Year x+2.

The reporting in *Piniarneq* is done based on the hunter domicile, not on the location of the catch. Most hunters are limited in how far they can travel to hunt (by, e.g., small boats) so this is not considered a problem in practice. However, in *Særmeldingsskema* the catch location is specified by GPS or place name and the quota are given by hunting areas based on species specific stock knowledge. For the quota-species, data from *Særmeldingsskema* become available up to ½ year after the finish of the quota year (quota year follows the Calendar year for all the marine species under quota), following data-entry validation.

There are two kinds of catch data validation, the first one only ensure correct entry of the data in the database, but do not validate the catch data themselves. The second relates directly to the catch data. If something unusual occurs, the hunters are phoned (when possible) and asked whether they can confirm the reported catch. Recently this happened for reported bottlenose whale catches, which after validation turned out to be harbour porpoises, the numbers having been originally misplaced in the line corresponding to bottlenose whale. This data validation is, however, only done if data in some way is different from what would be expected from the area in that time of the year.

Killer whale catches, although apparently increasing since 2010, have not been validated since 2008. APN informed that it was their responsibility to conduct the validation of the catch data.

Although hunting licenses are mandatory in Greenland, it is suspected that some hunters (leisure time hunters) hunt without paying a hunting license and therefore do not report their catches. Also only about 85% of the hunters having paid a hunting license report catches, and it is not known whether this represent a 15% 0-catches or unreported catches.

The SC thanked Levermann for her informative presentation, which clarified points discussed by the SC in previous years.

Jessen and Levermann explained the discrepancy between the two reporting systems, and the under-reporting in *Piniarneq*, for narwhal, beluga and walrus by the fact that some hunters having already reported their catch in the *Særmeldingsskema* did not feel that they had to report them again in the *Piniarneq* system, thus generating underreporting in the latter system. Under reporting was therefore not a systemic problem to the *Piniarneq* reporting, but was limited to these three species, for which a double reporting existed. The *Piniarneq*/Luli database has catch data from 1993, and *Særmeldingsskema* individual catch data from 2005/2006 or 1987 depending on the species. The *Særmeldingsskema* data have recently been compiled in species specific excel databases, making data queries easier and faster.

For assessment purposes, catch data of marine mammals under quota should be taken from the *Særmeldingsskema* database. The plan is to include these data in the Luli database, for only one reporting system in the future.

The reliability of the catch statistics was discussed. Jessen and Levermann were confident that the catch data were reliable for baleen whales, especially because the meat could only be sold when the two relevant authorities had stamped the catch certificate, hereby confirming reporting of the catch. The reliability for the three other quota species (narwhal, beluga and walrus) was greater than for the non-quota species, because the reporting should be within three weeks of the catch and APN would close the hunt until things were sorted out if APN or the municipality felt that there was a problem in catch reporting or unreported catches were notified to the agency.

The reliability of the catch data for non-quota species was more difficult to assess and vary between species. The catch data should be considered as minimum numbers, but would give reliable information on trends. The only way to assess the reliability of the catch would be to have numerous wildlife officers in hunting places, which was logistically and financially impossible in Greenland. There was no possibility of comparing the catch data with the amount of meat or skins available on the market, as a significant quantity was used for personal purposes.

The SC noted that the catch validation, with hunters asked to remember catches, months and sometimes years later was considered unreliable. It would be difficult/impossible to remember catch numbers a year(s) later, especially in the case of more common species such as harbour porpoises. Validation should ideally be made shortly after the catches were reported. Also, shorter reporting period may provide more accurate and reliable catch numbers. Jessen and Levermann mentioned that for *Piniarneq* they were working to move towards an online real-time reporting for the catch data for non-quota species, and were also looking into different type of apps for this purpose. The SC stressed the need to regularly carry out the validation of the catch reporting, especially when the only validation method was by calling the hunters.

12. WORK PROCEDURES IN THE SC

12.1 Ideas for future meetings of the SC

The SC agreed that involvement of the Vice-Chair in the preparation and running of the meeting, as well as in the reporting to the Council meetings was positive and should continue.

At SC-22, the SC agreed to continue discussing at the SC-23 meeting the meeting procedures which had been suggested to make the meeting as efficient and effective as possible and to strengthen the SC overall.

Suggestion no.1 – *"Strengthening scientific collaborations between the scientists in the SC. Among other options for joint projects of interest to all NAMMCO countries, one example is to resurrect the idea of developing satellite-tagging expertise within the SC. This could be done by requesting funds from NAMMCO. Another idea is where SC members could form stronger collaborations is a genetics study."*

As more and more information necessary to stock assessment derive from satellite tag studies (e.g. availability bias, stock discreetness, changes in distribution…), the SC agreed that a useful and beneficial cooperative project under NAMMCO would be the design of a "super" satellite tag (increased attachment and transmission period, increased sensitivity and capabilities, easier deployment, etc.:smaller, longer, better), for cetacean research, as seal tagging has been in general more successful than cetacean tagging. A preliminary project description would be developed by a small group, under the leadership of Heide-Jørgensen, and would be presented to Council 25 for approval.

Suggestion no. 2 – "*Add a new agenda item on "Collaborative work within the SC". The SC agreed that this item would come at the beginning of the meeting so that it can be discussed throughout the meeting."*

The SC agreed to this suggestion and that the report of the "Super Tag Group" could be on the agenda of the next SC meeting.

Suggestion no. 3 – *"Hold the SC meeting every other year, with the alternative year being a tele/video conference. This is in response to the financial concerns related to sending the full complement of SC members to the meetings. This suggestion will be discussed further at the next meeting."*

The SC agreed to continue holding a face to face meeting each year and alternate the location between NAMMCO countries.

Suggestion no. 4 – "*Encourage SC members in bringing presentations (e.g., powerpoint, videos) hightlighting research projects.*"

The SC agreed that this should be encouraged. Furthermore, the country organising the SC meeting should arrange for a more in depth presentation on a scientific project or subject of interest to the work of the SC. This presentation could be made by a member of the SC or a local scientist.

12.2 Development of management advice in NAMMCO

The SC noted that the Management Committee at NAMMCO/24 "*informed the SC that anytime management procedures from another organisation are used in formulating management advice, the SC should make sure that those procedures meet the NAMMCO management objectives before basing their advice on those procedures."*

The SC noted this information.

12.3 & 12.4 Participation and funding of External Experts

To inform its discussion, FAC had forwarded the following questions to the SC and the CHM, together with the background to its discussion (Doc/SC/23/16).

1. *As a rule, should NAMMCO have external experts participating in all meetings dealing with issues of a potentially controversial character (such as SC assessment/endorsement of abundance estimate meetings or TTD expert meetings)?*
2. *Who should be considered an external expert? Are all participants that are not a member of the specific NAMMCO committee per definition an external expert, or are there other defining criteria?*
3. *Which participants to a meeting should NAMMCO pay for?*

The SC agreed on the following answers:

Q1. As a rule, NAMMCO should have External Experts (EE)/External Reviewers (ER) participating in all WG/EG/PG meetings

Q2. EE is defined as any relevant experts/scientists who are not a member of the parent committee organising the meeting regardless of nationality, institution and involvement with the data collection / analysis / interpretation of the work to be discussed at the WG/EG.

ER is defined as any relevant experts/scientists who are not involved in the data collection / analysis / interpretation of the work to be discussed at the WG/EG - regardless of nationality and institution.

The SC further noted that a member of the SC can be considered as an ER in a meeting dealing with a subject of his/her competence if he/she have not had any involvement with the data collection and analysis.

Q3. NAMMCO should offer financial support to all EE and ER.

Hammill noted that DFO (Canada) always invites two external scientists to their review meetings, who have nothing to do with the work presented – and fund their participation.

12.5 Confidentiality of reports and meeting documents

At present, there is no mention on report confidentiality in the RoPs of NAMMCO committees, except for the SC. FAC sought the advice of the SC and the CHM on the terms of confidentiality of the reports emanating from all subsidiary bodies, i.e. committee reports and reports emanating from WG, EG and PG, as well as on the terms of confidentiality of meeting documents, both for committees and WG/EG/PG, giving different possible scenarios (Document SC/23/19).

The SC agreed to recommend the following terms of confidentiality:

- Adopted reports of subsidiary bodies can be released two weeks after they have been circulated to the parent body and the Council.

- They should include a standard preamble text stating "This report contains the views of the WG/EG/PG, and do not necessarily represent the view of the NAMMCO Scientific Committee and/or the Council, which will review the report as its/their next meeting in xxxx".

- Similar text should also be used if the report or some of its results are used in any forms of outreach (PR, website, FB…);

- Any NAMMCO "persons" (Committee members, FAC, Secretariat) has one week for vetoing the immediate release of a report and require that the report is first dealt with by the parent body and/or Council before being released (in case for example of sensitive results/topics, disagreement over the conclusions…).

The SC also agreed that meeting documents should not be made public, except for documents such as the agenda, ToRs and list of participants.

Hammill noted that in DFO, working group reports that supported the provision of advice, or had been accepted by the committee as Research Documents were released and published on the Canadian Science Advisory Secretariat (http://www.dfo-mpo.gc.ca/csas-sccs/index.htm) after they were adopted. In general, meetings documents were not made available to the public and were considered as non-existing after the meeting.

12.6 Assessment procedures used in NAMMCO

Currently, there is no document providing an overview of the management objectives and the procedures and rules which have led or are leading to stock assessment and management advice in NAMMCO, nor the decision made by Council regarding the same. These procedures differ from species to species and may differ between stocks. Such a document would be useful as an easily accessible memory of NAMMCO procedures for the SC, Council and the wider public, as well as any newcomer in the NAMMCO family.

The Secretariat is planning on preparing the draft of such an overview document and will circulate it intersessionally to the SC for comments, and present a final draft at the next SC meeting.

13 FUTURE WORK PLANS

13.1 Scientific Committee

13.1.1 2017 Meeting

The SC agreed to schedule the next annual meeting for the 3rd week in November 2017. Iceland will host the meeting and come back with more information on location in due time.

13.2 Working groups/Symposia/Other meetings

13.2.1 Large Whale Assessment (25-27 January 2017)

Chair: Lars Walløe, Convener: Gisli Vikingsson

Terms of Reference:

1) Long-term advice on common minke and fin whales in Iceland
2) Humpback whale advice Greenland
3) Possibly fin and common minke whales in Greenland.

Doug Butterworth has been invited to the meeting. The SC agreed to invite an additional external reviewers, and gave suggestions for experts to the Secretariat to contact.

The SC will meet intersessionally (late February/early March) to review the fin whale assessment for Iceland, in time for the Council meeting.

If necessary, there will be a 2nd meeting in the fall 2017. A final decision will depend on the outcome of the meeting in January.

13.2.2 JCNB/NAMMCO (8-11 March 2017)

NAMMCO Chair: Rod Hobbs (NOAA, USA), Convener: Mads Peter Heide-Jørgensen

JCNB Chair: Rikke Hansen

Terms of Reference:
1) Greenland: update assessments on narwhal and beluga
2) NAMMCO requests that the JCNB provide: 1) information on the Mary River Project including an expert with the relevant information (see item X) and 2) working papers on the Canadian High Arctic survey

The SC recommended inviting Eline Lorenzen and a PhD student from the University of Copenhagen to the meeting.

13.2.3 Global Review of Monodontids (13-16 March 2017)

Chair: Arne Bjørge, IMR (Norway)
Organizing Committee: Randy Reeves, Robert Suydam, Olga Shpak, Rikke Hansen, Steve Ferguson, Marianne Marcoux, Rod Hobbs, Tom Barry, Jill Prewitt

Terms of Reference:
1) share current scientific knowledge on the status of each stock,
2) identify the main gaps in knowledge,
3) identify key threats to each stock,
4) outline possible areas of scientific cooperation.

13.2.4 Bycatch WG (April 2017 tentative)

Chair: Kimberly Murray (NOAA, USA), Convenor: Geneviève Desportes

Terms of Reference:
1) Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;
2) Review the Icelandic lumpsucker 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.

Participants will include Mikkelsen (FO), Levermann (GL), Gunnlaugsson, Sigurdsson, Granquist and Eiríksson (IS), Bjørge (NO)

Additional potentially invited people are listed under Item 6.1.1.

13.2.5 Abundance Estimates WG (late 2017 or early 2018)

Chair: Daniel Pike, Convener: no decision made

Terms of Reference:
1) Icelandic coastal aerial survey
2) Remaining abundance estimates
3) Pilot whales

The SC agreed to postpone the meeting to 2018 and that one of the following external expert should be invited: Phil Hammond, Jack Lawson, Debi Palka.

13.2.6 Survey Workshop at SMM 2017

The Abundance Estimate Working group recommended organising a survey workshop in conjunction with the SMM in 2017 (SC/23/15). The aim of the Workshop would be to gather scientists involved in cetacean surveys in 2015 and 2016 from the NAMMCO countries, EU (SCANS-III), Canada, and the USA to discuss 1) the possibility of combining abundance estimates from the various cetacean surveys for the whole North Atlantic and 2) changes in abundance and distribution of cetaceans across the North Atlantic.

The SC agreed to convene the workshop and established an Organising Committee consisting of Rikke Hansen, Nils Øien, Gisli Vikingson, Bjarni Mikkelsen and Jill Prewitt from the Secretariat. It was agreed that participation at the workshop should be by invitation only.

The Organising Committee should seek collaboration with among others Jack Lawson (Canada), Phil Hammond (EU/SCANS-III), and Debra Palka (USA).

13.2.7 Preliminary plan for 2018

The SC acknowledged that based on decisions taken in this meeting including possible follow ups of these, the following 5 Working Groups could potentially meet in 2018:

1) ICES/NAFO/NAMMCO WGHARP
2) WG on Bearded seal
3) WG on Coastal seals
4) WG on Harbour porpoise
5) WG on Pilot whales

14. BUDGET

The SC reviewed the spending in 2016, and a forecast budget for 2017.

15. ANY OTHER BUSINESS

No additional items were discussed.

16. MEETING CLOSURE

16.1. Acceptance of report

The contents of the report was accepted on 7 November 2016 at the close of the meeting, and in final version by correspondence on 21 November 2016.

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Appendix 1.

NAMMCO SCIENTIFIC COMMITTEE
23rd MEETING
Nuuk, Greenland
4-7 November 2016

Draft 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
4.2 Working Group Reports
4.2.1 By-catch WG
4.2.2 Coastal Seals WG
4.2.3 Abundance Estimates WG
4.2.4 WGHARP
4.3 Other reports and documents
4.3.1 Disturbance Symposium report

5. COOPERATION WITH OTHER ORGANISATIONS

5.1. IWC [SC/23/07]
5.2. ASCOBANS [SC/23/06]
5.3. ICES
5.3.1. Joint ICES/NAFO/NAMMCO WGHARP [SC/23/17]
5.4. JCNB
5.5. Arctic Council [SC/23/09]
5.6. Other

6. ENVIRONMENTAL / ECOSYSTEM ISSUES

6.1 Marine mammals-fisheries interactions (R-1.1.5, 1.1.8)

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.*

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.*

6.1.1 Bycatch
6.1.2 Other

6.2 Multispecies approaches to management (R- 1.2.1, 1.2.2)

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.*

6.3 Economic aspects of marine mammal-fisheries interactions (R-1.4.7)
R-1.4.7 (NEW): *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).*

6.4 Environmental issues (NEW R-1.5.3)
NEW 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.*

6.4.1 Disturbance Symposium report [SC/23/12, SC/23/O03]

7 SEALS AND WALRUS STOCKS - STATUS AND ADVICE TO THE COUNCIL

7.1 Harp Seal [SC/23/17]
7.1.1 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*

7.1.2 Update
7.1.3 Future work

7.2 Hooded seal [SC/23/17]
7.2.1 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*

7.2.2 Update
7.2.3 Future work

7.3 Ringed seal

7.3.1 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*

7.3.2 Update

7.3.3 Future work

7.4 Grey seal

7.4.1 Review of active requests (R-2.4.2)

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

7.4.2 Coastal Seals WG [SC/23/14]

7.4.3 Update

7.4.4 Future work

7.5 Harbour seal

7.5.1 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*

7.5.2 Coastal Seals WG [SC/23/14]

7.5.3 Future work

7.6 Bearded seal

7.6.1 Update

7.6.2 Future work

7.7 Walrus

7.7.1 Review of active requests (R-2.6.3)

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.*

New Request from NAMMCO/24: 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.*

7.7.2 Disturbance Symposium [SC/23/12]

7.7.3 Update

7.7.3.1 *Status of recommendations from 2013 Walrus WG* [SC/23/10]

8 CETACEANS STOCKS - STATUS AND ADVICE TO THE COUNCIL

8.1 Fin whale

8.1.1 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.*

8.1.2 <u>Update</u>
8.1.2.1 Abundance Estimates WG [SC/23/15]
8.1.2.2 Other Updates
8.1.3 <u>Future work</u>
8.1.3.1 Large Whale Assessment WG

8.2 Humpback whale
8.2.1 <u>Review of active requests (R-3.2.4, 1.7.12)</u>
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 (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.* ***NEW 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."*

8.2.2 <u>Update</u>
8.2.2.1 Abundance Estimates WG [SC/23/15]
8.2.2.2 Other updates
8.2.3 <u>Future work</u>
8.2.3.1 Large Whale Assessment WG (25-27 January 2017)

8.3 Minke whale
8.3.3 <u>Review of active requests</u> (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.*

8.3.4 Update
8.3.4.1 Abundance Estimates WG [SC/23/15]
8.3.4.2 Other updates
8.3.5 Future work
8.3.5.1 Large Whale Assessment WG (25-27 January 2017)

8.4 Beluga
8.4.1 Review of active requests (R-3.4.9, 3.4.11, NEW 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 (NEW): *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.*

8.4.2 Disturbance Symposium [SC/23/12]
8.4.3 Update
8.4.4 Future work
8.4.4.1 JCNB/NAMMCO JWG meeting: 8-11 March 2017
8.4.4.2 Global review of monodontids: 13-17 March 2017

8.5 Narwhal
8.5.1 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*

8.5.2 Disturbance Symposium [SC/23/12]
8.5.3 Updates
8.5.4 Future work
8.5.4.1 JCNB/NAMMCO JWG meeting
8.5.4.2 Global review of monodontids
8.5.4.3 Other

8.6 Sei whale
8.6.1 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*

8.6.2 Update
8.6.3 Future work

8.7 Bottlenose whale
8.7.1 Update
8.7.2 Future work
8.7.3 Abundance estimate

8.8 Killer whale
8.8.1 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.*

8.8.2 Update
8.8.3 Future work

8.9 Pilot whale
8.9.1 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*

8.9.2 Abundance Estimates WG [SC/23/15]
8.9.3 Updates
8.9.4 Future work

8.10 Dolphins
8.10.1 Review of active requests (R-3.9.6)
R-3.9.6 (ongoing): *assessments of dolphin species*

8.10.2 Update
8.10.2.1 Abundance Estimate [SC/23/15]
8.10.3 Future work

8.11 Harbour porpoise
8.11.1 Review of active requests (R-3.10.1)
R-3.10.1 (ongoing): *comprehensive assessment of the species throughout its range*

8.11.2 Updates
8.11.2.1 Abundance Estimate
8.11.2.2 By-Catch WG [SC/23/13]
8.11.2.3 Catches in Greenland
8.11.2.4 Status of recommendations from 2013 HPWG
8.11.3 Future work

8.12 Sperm whale
8.12.1 Update
8.12.2 Future work

8.13 Bowhead whale
8.13.1 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*

8.13.2 Update
8.13.3 Future work

8.14 Blue Whales
8.14.1 Update
8.14.2 Future work

9 SURVEY PLANNING (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*

9.1 Abundance Estimates WG [SC/23/15]
9.2 Plans for future surveys

10 NAMMCO SCIENTIFIC PUBLICATIONS
10.1 Monodontid age estimation
10.2 Next volume?

11 DATABASES ON ABUNDANCE AND CATCHES
11.1 Abundance [SC/23/05a,b]
11.2 Catches
11.2.1 Struck and Lost (NEW 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.

11.2.2 Catch reporting

12 WORK PROCEDURES IN THE SC
12.1 Ideas for future meetings
12.2 Development of management advice in NAMMCO
12.3 Participation of External Experts [SC/23/16]
12.4 Funding of External Experts [SC/23/16]
12.5 Confidentiality of reports and documents [SC/23/19]
12.6 Management Procedures

13 FUTURE WORK PLANS
13.1 Scientific Committee
13.1.1 2017 Meeting (Iceland next in rotation)
13.1.1.1 Timing

13.2 Working groups/Symposia/Other meetings
13.2.1 Large Whale Assessment (25-27 January 2017)
13.2.2 JCNB/NAMMCO (8-11 March 2017)
13.2.3 Global Review of Monodontids (13-16 March 2017)
13.2.4 Bycatch WG (April 2017 tentative)
13.2.5 Abundance Estimates WG (June 2017)
13.2.6 Survey Workshop at SMM 2017
13.3 Other matters

14 BUDGET
14.1 Spending in 2016 [SC/23/11]
14.2 Budget for 2016/2017

15 ANY OTHER BUSINESS
15.1 Election of officers?

16 MEETING CLOSURE
16.1 Acceptance of report
16.2 Closing remarks

NAMMCO SCIENTIFIC COMMITTEE
23rd MEETING

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NAMMCO SCIENTIFIC COMMITTEE
23rd MEETING

LIST OF DOCUMENTS

Doc.No.	Title	Agenda item
SC/23/01a	Draft Agenda	1
SC/23/01b	Draft ANNOTATED Agenda	1
SC/23/02	Draft List of Documents	2
SC/23/03	Draft List of Participants	4
SC/23/NPR-F	National Progress Report – Faroe Islands	4.1
SC/23/NPR-G	National Progress Report – Greenland	4.1
	NPR- G Catches seals sældata 2012-2015	4.1
	NPR-G Catches cetaceans and walrus Kopi af Final Fangsttal kvoterede arter oversigt 2006-2016 DK	4.1
SC/23/NPR-I	National Progress Report – Iceland	4.1
SC/23/NPR-N	National Progress Report – Norway	4.1
	NPR- N Seal catches Svalbard	4.1
SC/23/NPR-C	National Progress Report – Canada	4.1
SC/23/NPR-J	National Progress Report – Japan	4.1
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SC/23/05b	Table Abundance & trends- pinnipeds	11.1
SC/23/06	Observer's report: ASCOBANS	5.2
SC/23/07	Observer's report: 66th meeting of the IWC Scientific Committee	5.1
SC/23/08	Observer's report on activities in ICES (Haug)	5.3
SC/23/09	Observer's report: Arctic Council	5.5
SC/23/10	Recommendations from 2013 WGs	7.7.3.1, 8.11.2.4
SC/23/11	NAMMCO Scientific Committee Expenses 2016 and Budget 2017	14
SC/23/12	Disturbance Symposium Report	4.3, 6.4.1, 7.7.2, 8.4.2, 8.5.2
SC/23/13	By-Catch WG Report	6.1.1, 8.11.2.2
SC/23/14	Coastal Seals WG Report	7.4.2, 7.5.2
SC/23/15	Abundance Estimates WG Report	8
SC/23/16	External Experts Attendance and Funding	12.3, 12.4
SC/23/17	WGHARP report	7.1, 7.2
SC/23/18	Lennart and Richard (in review) At the cutting edge of the future: unravelling depredation, behaviour and movement of killer whales in the act of flexible management regimes in Arctic Greenland	8.8
SC/23/19	Confidentiality of reports, meeting documents, etc.	12.5

BACKGROUND DOCUMENTS

Doc.No.	Title	Agenda item
SC/23/O/01	Report of SC 22	many
SC/23/O/02	NAMMCO24 Annual Report 2015	
SC/23/O/03	Citronen EIA non-technical summary_ENG	

SC/23/O/04	SC20 08 Harbour porpoise WG Report	
SC/23/O/05	Walrus WG 2013 Report	
SC/23/O/06	Solvang et al 2016 Minke whale condition	
SC/23/O/07	Reeves et al. Distribution of endemic cetaceans in relation to hydrocarbon development and commercial shipping in a warming Arctic	
SC/23/O/08	The Integrated Arctic Corridors Framework	
SC/23/O/09	Lennert (2016) What happens when the ice melts? Belugas, contaminants, ecosystems and human communities in the complexity of global change	
SC/23/O/10	Lah et al Spatially Explicit Analysis of Genome-Wide SNPs Detects Subtle Population Structure in a Mobile Marine Mammal, the Harbor Porpoise	
SC/23/O/11	Enoksen et al (2016) Recent summer diet of hooded *Cystophora cristata* and harp *Pagophilus groenlandicus* seals in the drift ice of the Greenland Sea	
SC/23/O/12	Blanchet (2015) At-sea behaviour of the world's northernmost harbour seal (*Phoca vitulina*) population in a changing Arctic	
SC/23/O/13	Blanchet et al (2014) Harbour seal *Phoca vitulina* movement patterns in the high-Arctic archipelago of Svalbard, Norway	
SC/23/O/14	Blanchet et al (2015) Harbour seal *Phoca vitulina* movement patterns in the high-Arctic archipelago of Svalbard, Norway	
SC/23/O/15	Blanchet et al (2016) Making it through the first year: Ontogeny of movement and diving behavior in harbor seals from Svalbard, Norway	
SC/23/O/16	Svetochev et al 2016 Satellite tagging and seasonal distribution of harp seal (juveniles) of the White sea-Barents sea stock	
SC/23/O/17	CAFF-Bearded Seals monitoring project	

OBSERVER'S REPORTS

5.1 IWC

Observer's Report of the 2016 Annual Meeting of the Scientific Committee of the International Whaling Commission's (IWC).

Gísli A. Víkingsson

The following is a short summary of the 2016 IWC SC report with emphasis on issues relevant for NAMMCO.

The IWC Scientific Committee held its annual meeting (SC66b) in 2015 in Bled, Slovenia 7-19. June 2016. The full SC report including Annexes can be found on the IWC website: https://archive.iwc.int/pages/view.php?ref=6127&search=%21collection73&order_by=relevance&sort=DESC&offset=0&archive=0&k=&curpos=0&restypes=

During 4-6 June, two pre-meetings were held on '*Acoustic Masking and Whale Population Dynamics*' and '*Review the South Atlantic Sanctuary Proposal* (SAWS)'.

General RMP issues

Investigations continued on the relationship between $MSYR_{mat}$ and $MSYR_{1+}$ using a proposed energetics-based model. While not affecting the ongoing *Implementation Reviews* of North Atlantic fin and common minke whales, the SC agreed that future RMP *Implementations* and *Implementation Reviews* should take the results obtained so far into account during sensitivity tests which explore density-dependence on natural mortality as well as fecundity.

The existing RMP requirements and guidelines for conducting surveys were written for design-based surveys only. In recent years, model-based analysis approaches have been suggested and the SC decided to address this specificially in a pre-meeting to the 2017 annual meeting.

As within NAMMCO, the IWC SC is often expected to provide advice on 'status'.However there are a number of ways in which the results of *Implementation Simulation Trials* (for the RMP and AWMP) could be used to provide such information. The Committee agreed that the issue of developing appropriate metrics of status should be considered at next year's Meeting.

RMP – Implementation related matters

North Atlantic fin whale *Implementation Review*

The *Implementation Review* of North Atlantic fin whales was initiated in 2013. For various, mostly technical, reasons the conclusion of this review has been delayed. A significant progress was made at an intersessional workshop held in Copenhagen, in March 2016 indcluding a recommendation to discontinue the consideration of three of the eight stock structure hypotheses (IV, VII and VIII). At the Annual meeting the SC reviewed the results of the *Implementation Simulation Trials* following the agreed Requirements and Guidelines.

Seven management variants were considered of which five (1,4,5,6 and 7) were acceptable in terms of conservation performace. Of these, variant 7 has the best catch performance. According to this variant 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 SC concluded that its *Implementation Review* of North Atlantic fin whales is now completed. The next review will be expected to occur around 2021.

A new abundance estimate of fin whales in the Central North Atlantic, based on NASS-2015 was presented and discussed (SC/66b/IA18). The estimated densities were higher than estimates from earlier surveys in the area between West Iceland and East Greenland and in the Faroese survey area south of Iceland. These estimates were carefully reviewed and the Committee endorsed the 2015 estimate of fin whale abundance of 40,788 (CV 0.17; 95% CI 28,476 to 58,423) for the surveyed area of the North Atlantic, for use in the CLA.

North Atlantic common minke whale *Implementation Review*
The Implementation Review of North Atlantic common minke whale was initiated with a joint AWMP/RMP workshop in 2014. As reported last year, the SC was unable to complete the *Implementation Review* in 2015.An intersessional workshop was held in Copenhagen in March 2016 with the objective to complete the review this year.

A significant progress was made during the workshop and at the annual meeting. The Committee agreed that conditioning has been successfully achieved for the North Atlantic common minke whale trials. However, there was insufficient time to complete the review and interpretation of the extensive trial results during the annual meeting. The Committee agreed that the completion of the review and interpretation of the trial results should be undertaken inter-sessionally.

New abundance estimates for common minke whales from the NASS 2015 Icelandic/Faroese shipboard survey blocks were presented (SC/66b/RMP2). The Committee endorses the following 2015 estimates of common minke whale abundance for use in the CLA), corrected for perception bias: 36,185 (CV 0.31; 95% CI 19,942 to 65,658) for the surveyed Icelandic and Faroese blocks, of which 12,710 (CV 0.53; 95% CI 4,498 to 35,912) were found in coastal Icelandic waters.

Working group on Non-deliberate Human-induced Mortality of Cetaceans (HIM)
The terms of reference for this working group has been expanded to include consideration of non-deliberate Human Induced Mortality in all cetaceans rather than just large whales. This WG discussed various aspects of HIM including bycatch, entanglement and ship strikes. The Committee stressed that the issue of bycatch is serious and extensive and that the IWC cannot fully address it alone. There is a need for greater collaboration with individual nations and other IGOs including FAO, CMS, CCAMLR, ACCOBAMS, ASCOBANS and ICES.

Aboriginal subsistence whaling management procedure (AWMP)
The primary issues at this year's meeting comprised: (1) developing *SLA*s (*Strike Limit Algorithms*) and providing management advice for Greenlandic hunts, with focus on bowhead and fin whales; (2) providing management advice for the Greenland hunts and the humpback whale hunt of St. Vincent and The Grenadines; and (3) additional work related to the AWS (aboriginal subsistence whaling management scheme). Considerable progress on items (1) and (3) was made as a result of an AWMP intersessional Workshop.

In Greenland, a multispecies hunt occurs and the expressed need for Greenland is for 670 tons of edible products from large whales for West Greenland; this involves catches of common minke, fin, humpback and bowhead whales.

Development of an SLA for the common minke whale hunt off Greenland
For a number of reasons, primarily related to stock structure issues, development of *SLA*s for common minke whales is more complex than previous *Implementations* for stocks subject to aboriginal subsistence whaling. In 2008 the Committee endorsed an interim safe approach to setting catch limits (164 common minke whales) for the Greenland hunts in that is valid until 2018. The Committee agreed to allocate highest priority to developing an *SLA* for this hunt in time for its recommendation to the Commission by 2018 at the latest.

Development of an SLA for the bowhead whale hunt off West Greenland
The development of an *SLA* for the bowhead whale hunt continued. At this meeting, new information was received about an increase in the quota for Canada in 2015 to seven that warranted further consideration. The Committee focused its work on determining that the *SLA* recommended at the February workshop is robust to reasonable assumptions made regarding future Canadian catches.

Aboriginal subsistence whaling management advice
Eastern Canada and West Greenland bowhead whales
No bowhead whales were taken in West Greenland in 2014 while two bowhead whales were taken in northeast Canada in 2014. Samples were reported to have been collected from one of the whales taken in Canada and 45 biopsy samples had been collected from West Greenland bowhead whales in 2014. The Committee welcomed this information and recommended continuation of the work. It also strongly encourages collaboration with Canada on genetic work.

Based on the agreed best 2012 estimates of abundance for bowhead whales (1,274 CV=0.12), and using the agreed interim approach, the Committee repeats its advice that an annual strike limit of two whales will not harm the stock.

Common minke whales off West Greenland
In 2009, the Committee was able to provide management advice for this stock for the first time. This year, using the agreed interim approach and last year's revised estimate of abundance (16,100 CV=0.43), the Committee advises that an annual strike limit of 164 will not harm the stock.

Common minke whales off East Greenland
Catches of minke whales off East Greenland are believed to come from the large Central stock of minke whales. The most recent strike limit of 12 represents a very small proportion of the Central stock The Committee advised that the strike limit of 12 will not harm the stock.

Fin whales off West Greenland
Based on the agreed 2007 estimate of abundance for fin whales (4,500 95% CI 1,900-10,100), and using the agreed interim approach, the Committee advised that an annual strike limit of 19 whales will not harm the stock.

Humpback whales off West Greenland
Based on the Humpback SLA that was agreed by the Commission last year, the Committee agreed that an annual strike limit of 10 whales will not harm the stock.

Environmental concerns

The IWC has increasingly taken an interest in the environmental threats to cetaceans. These are discussed within the Standing Working Group on environmental concerns. At the 2016 meeting updates were reviewed concerning chemical pollution, oil spill impacts, diseases of concern, strandings and large mortality events, acoustic pollution (noise), climate change, Arctic issues and marine debris. An intersessional Workshop on *Investigations of Large Mortality Events, Mass Strandings and International Stranding Response* was held San Francisco, in December 2015 and a Workshop on *Acoustic Masking and Whale Population Dynamics* was held just prior to the SC annual meeting. Both reports were discussed in detail and resulted in adoption of a long list of recommendations.

Whale watching

The potentially negative effects of the fast growing industry of whale watching has received increased attention within the IWC. The IWC has agreed a set of general principles to minimize the risk for adverse impacts and an online handbook is under developement.

A new study on impacts of whalewatching vessels on solitary adult sperm whales off Andenes in northern Norway indicated significant effects on fluking behaviour.

DNA testing

The DNA registers voluntarily maintained by Norway, Iceland and Japan were reviewed. Norway announced it's plan to upgrade the Norwegian Minke Whale DNA Register (NMDR) by genotyping a suite of carefully selected SNPs which will still keep the register's primary function of traceability of whale products in Norway and the international market.

Scientific permits

There was considerable discussions on the new Japanese research programme NEWREP-A (Antarctic). This year discussion focussed on progress with recommendations made by an expert panel and the committee in 2015.

A final review of the JARPN II (N-Pacific) research programme was conducted at a specialist workshop was in early 2016.

Scientific permit projects are highly controversial within the SC and discussions on both projects reflected widely different views within the committee.

Compilation of agreed abundance estimates and summary of status.

A systematic compilation of abundance estimates submitted to the SC is underway. The aim of this work is to ensure consistency and to classify the abundance estimates into categories with respect to their use, in assessments etc.

The concept of population status has been a subject of debate and considerable confusion (i.e. the IUCN global classification of species status). This will be a priority topic at next year's SC meeting.

5.2 ASCOBANS

ASCOBANS MOP8, Helsinki, Finland, September 30 – October 1, 2016

Geneviève Desportes

The 8th Meeting of the Parties to the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) took place 30 August to 1 September 2016 in Helsinki, Finland.

Along with discussions surrounding strategic and institutional subjects, ASCOBANS Parties considered species action plans and resolutions on current conservation challenges, including ocean energy, pollution from Polychlorinated Biphenyls, unexploded underwater munitions, anthropogenic noise, by-catch and cumulative impacts. ASCOBANS expects that the concerted action agreed by ASCOBANS Parties at the meeting for addressing such global threat would not only reduce their impacts on species in the ASCOBANS area but also help raise awareness and contribute to a global response needed to tackle these pressing issues affecting all life in our oceans. Thirteen resolutions were adopted, including one on By-Catch PCBs, Common Dolphin, Ocean Energy, Noise and Cumulative Impacts.

At NAMMCO-24 (February 2016), Council *"agreed that it was essential to increase the scientific cooperation between organisations dealing with marine mammals. NAMMCO should therefore aim at strengthening its cooperation with the Arctic Council, the International Council for the Exploration of the Sea (ICES), the International Whaling Commission (IWC), OSPAR, the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and any other international instrument, which may require the advice of NAMMCO."*

Following this decision, the NAMMCO Opening Statement delivered MOPs8 conveyed in invitation to ASCOBANS "*to enhance the scientific cooperation between the two organisations to the benefits of small cetacean conservation. Three issues of shared concerns come to mind: by-catch monitoring, estimation and mitigation; the assessment of North Sea harbour porpoises, a shared stock between NAMMCO and ASCOBANS; and the monitoring of the effect of persistent organic pollutants on marine top predators."* See below the full text of the NAMMCO OS.

STATEMENT TO THE
8TH MEETING OF THE PARTIES TO ASCOBANS

NAMMCO is an international regional body for cooperation in research, conservation, and rational management of all species of cetaceans (whales and dolphins) and pinnipeds (seals and walruses) in the North Atlantic. **NAMMCO** focuses on modern approaches to the study of the North Atlantic marine ecosystem as a whole and to better understand the role of marine mammals and the impact of anthropogenic activities in this system.

With due regard to the needs of coastal communities, the **NAMMCO** Member States, Faroe Islands, Greenland, Iceland and Norway, confirmed at the 2016 Council Meeting in February their commitment to ensuring the effective conservation and the sustainable and responsible use of marine mammals - through active regional cooperation on research and improvement of hunting methods and science-based management decisions. The increasing stocks of narwhal, beluga and walrus off Greenland are a clear result of sound and science-based management, following advice from **NAMMCO**.

Climate change carries serious consequences for marine mammals. This can already be seen from the decreasing blubber thickness of harp seals and minke whales in the Barents Sea, and the changes in geographical distribution of minke whale and fin whale around Iceland.

Therefore, aware that direct catches represent only the most apparent anthropogenic pressure, and that marine mammals also face multiple, cumulative and synergistic threats, **NAMMCO** reiterated its will to progress towards effective ecosystem-based management and monitoring of other direct or indirect anthropogenic disturbances, such as by-catch and entanglements, noise, pollution, climate change and increased human activities in the Arctic (shipping, fishing, mining, tourism…).

NAMMCO believes that with climate change, and other environmental changes, and their unforeseeable consequences for marine mammals - and coastal communities, it is essential to join forces and strengthen the scientific cooperation between organisations dealing with marine mammals for the benefits of their conservation.

At the occasion of the 8th Meeting of the Parties, **NAMMCO** therefore invites **ASCOBANS** to enhance the scientific cooperation between the two organisations to the benefits of small cetacean conservation. Three issues of shared concerns come to mind: by-catch monitoring, estimation and mitigation; the assessment of North Sea harbour porpoises, a shared stock between **NAMMCO** and **ASCOBANS**; and the monitoring of the effect of persistent organic pollutants on marine top predators.

NAMMCO wishes all the participants a productive meeting and success in addressing the pressing conservation issues facing cetaceans within the waters of the Agreement and looks forward to discussing ways of implementing an enhanced cooperation between our two organisations.

5.3 ICES

REPORT FROM THE 2016 ACTIVITIES IN ICES

Tore Haug
Institute of Marine Research, Tromsø, Norway

ICES WGMME

The ICES Working Group on Marine Mammal Ecology (WGMME) met at the headquarters of Instituto Español de Oceanografía (IEO) in Madrid, Spain, during 8–11 February 2016, to work on five Term of Reference. Two of these related to a request for OSPAR.

The first was a review the draft OSPAR assessments of (a) the abundance and distribution of harbour seals and grey seals and (b) grey seal pup production in the Northeast Atlantic. In general, the WG found that the assessments produced were of a high quality, clear and scientifically robust, although some specific revisions to the text were suggested.

The second part of the request involved collation of data and assessment of status for cetaceans in the OSPAR area. In relation to coastal bottlenose dolphins and killer whales, most time-series of abundance data are rather short in relation to the generation time of these long-lived animals. Assessment was only possible for five populations, with an indicative assessment provided for another. The time-series of monitoring data were too short to undertake the assessment for the remaining. In many locations around the eastern North Atlantic Ocean, coastal bottlenose dolphin populations declined or disappeared before or during the 20th century, but most of the current populations seem to be stable. Human pressures include disturbance (mainly from recreational activities), direct and indirect fisheries impacts, and pollution. The population consequences of human activities remain to be elucidated and the difficulty of doing so is compounded by the ephemeral nature of some coastal populations. In addition, the relationships between coastal bottlenose dolphins and wider ranging offshore populations remain unclear. For most other cetacean species there is only one robust estimate of abundance. For those species for which there are multiple estimates of abundance, the time-series are short relative to the life cycle of the species and the precision of the estimates is generally low leading to poor power to detect trends from these data. It is therefore not possible to infer with any confidence whether populations are decreasing, stable or increasing. However, there has been a clear shift in harbour porpoise distribution from north to south in the North Sea. Notwithstanding the inability to detect trends, recent estimates of abundance are either similar to or larger than comparable earlier estimates. Despite the multiple pressures and threats facing cetaceans in this region, with the data available, there is currently no evidence of an impact of anthropogenic activity on either distribution or abundance of cetacean species in OSPAR Regions II, III and IV. More data are needed to make an informed assessment; results from a large-scale survey in summer 2016 will aid this process.

In addition, the WG reviewed and reported on (a) new information on population abundance, population/stock structure and management frameworks for marine mammals and (b) information on negative and positive ecological interactions between grey seal and other marine mammals. In relation to the latter topic, a Workshop is proposed for 2017. The WG also reported on the status of the ICES seal database, suggesting that it could be merged with a new database on seals and seabirds being developed for OSPAR.

ICES WGBYC

The ICES Working Group on Bycatch of Protected Species (WGBYC) will not meet physically in 2016, but some WGBYC members will secure attendance at other relevant ICES WG meetings in 2016 and report back to WGBYC with feedback afterwards.

ICES WGHARP

The ICES Working Group on Harp and Hooded Seals, now the ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP) met during 26-30 September 2016 at the ICES Headquarter in Copenhagen, to assess the status and harvest potential of stocks of Greenland Sea harp and hooded seals and harp seals in the White Sea and in the Northwest Atlantic. The WG received presentations related to catch (mortality) estimates, abundance estimates, and biological parameters of all the stocks in question.

ICES ASC

The 2016 ICES Annual Science Conference (ASC) was held in Riga, Latvia 19-23 September 2016. 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 – particular relevant sessions were: “Ecosystem changes and impacts on diadromous and marine species productivity”, “Looking backwards to move ahead: how the wider application of new technologies to interpret scale, otolith, statolith and other biomineralised age-registering structures could improve management of natural resources”, “The role of zooplankton in exploited ecosystems: top-down and bottom-up stresses on pelagic food webs” and “Arctic ecosystem services: challenges and opportunities”.

More information is available at the ICES website www.ices.dk.

5.4 JCNB

Summary of the 13th meeting of the Canada/Greenland JCNB commission report from the 13th meeting held October 6-8 2015.

Rikke G. Hansen
Greenland Institute of Natural Resources

In October 2015, the Joint Commission on Narwhal and Beluga met in Nuuk. They reviewed the report from the NAMMCO-JCNB Joint Scientific Working Group (JWG) meeting in Ottawa 11-13 March 2015 as well as the report from the Narwhal catch allocation sub-group (JWG_{sub}) which met 10-12 March 2014 and 9-10 March 2015. Hansen attended the meeting in her capacity as the JCNB co-chair of the JWG. The Commission commended the work of the JWG and JWG_{sub}, particularly on the work of developing the narwhal catch allocation (NCA) model. Hansen also informed the SC that Greenland has implemented the NCA model. Hammill also informed the SC that the NCA model was presented to the Canadian marine mammal peer review group in Canada, and it was accepted.

The JCNB forwarded a list of questions to the Joint Working Group.

<u>JCNB questions to the JWG</u>

1. What is the relationship between Kane Basin, Smith Sound and Jones Sound narwhal groups and other narwhal stocks and aggregations?
2. What is the relationship between beluga harvested in Igloolik, Hall Beach, Gjoa Haven and Taloyoak and the Somerset Island stock?
3. What is the impact of current tracking methods (satellite tagging) for narwhal and beluga, including the impact of capture, handling and tag deployment activities? (Currently ongoing – publication(s) soon)
4. What approaches and methods could be used or developed, as alternatives to current methods (e.g. genetics, stable isotopes, fatty acids, contaminants), which would provide the equivalent or further information on stock discrimination and movements?
5. What is the relationship between beluga and narwhal and commercial fisheries (both effects of narwhal and beluga on fisheries and effects of commercial fisheries activities on narwhal and beluga)?
6. Are the recommended closures by the JWG (2005, 2012 & 2015) for beluga necessary given the fact that quotas and other management regulation have been implemented for West Greenland? Is there any evidence that these closures would lead to recovery of beluga in these areas?

The JCNB also formulated a list of recommendations to the parties.

JCNB recommendations to the parties

The Commission recommends to the parties that the researchers work with local communities and hunters to design studies and collaborate on conducting field work, where this is not already in place.

The Commission encourages continued dialogue between hunter groups in Greenland and Canada to enhance relationships and share expertise. E.g. hunting methods, utilization, "hunter exchange programs".

The Commission encourages the continued dialogue and exchange of data between scientists in Canada and Greenland to enhance relationships and share expertise, following Rules of Procedure in the Joint Working Group.

The Commission recommends to the parties that the parties develop approaches and methods to record behavioural and morphological differences in narwhal and beluga that can contribute to stock identity.

The Commission recommends to the parties to continue to develop cooperation with hunters and hunter organizations, to analyze and undertake the necessary steps to determine accurate struck-and-lost rates that are valid for various hunting methods and circumstances.

The Commission recommends to the parties that appropriate mechanisms and plans be in place for the collection of biological samples and observations from community hunts and unusual mortality events (e.g. ice entrapments).

The Commission further recommends that the parties develop a protocol to deal with entrapments including identification, timely response, and coordination among agencies.

JCNB recommendations on future research

Development of a multi-year survey and tagging plan for stocks of narwhal and beluga to ensure that there is a regular re-assessment of each stock (e.g. frequency and numbers), so abundance estimates do not become outdated.

Research to determine impacts of killer whales on behavior and survival of narwhal and beluga (ongoing)

Research to examine the effect of changing ice conditions on narwhal and beluga populations including ice conditions and currents.

Identify the research priorities for beluga and narwhal which need to be addressed in order to fill gaps identified by the JWG in the development of the allocation model.

What level of science information is sufficient to move from data-poor to data-rich management approaches and is there a middle ground? Furthermore, what should be considered when developing harvest scenarios that maintain population levels or allow the population to increase to assumed historical levels?

JCNB recommendations on future research recommended for JWG

1. Continue to identify hunt seasons for narwhal and hunt areas individually (e.g. each hunt season may have different areas hunted), using hunter knowledge and GPS locations of takes (where available).
2. Some communities in Canada have taken a larger proportion of males (as high as 80%). How does this increased take of male narwhal affect the population dynamics model results?
3. Aerial survey on narwhal in East Greenland is required as the 2008 survey is outdated and requires updating.
4. More satellite tag and dive data from the stocks in West Greenland and Eastern Canada need to be obtained regarding movement between summer aggregations and information for availability bias for survey correction factors.
5. Further advice regarding whether to manage Admiralty Inlet and Eclipse Sound narwhal stocks as two separate management units or a single management unit is required.
6. Identify origin of sighted belugas in East Greenland (Tasiilaq area) which were observed recently (e.g., fall, 2014 & 6 Oct. 2015).

5.5 Arctic Council

CAFF's CBMP-Marine annual meeting, Akureyri, Iceland, October 25-27, 2016

The Circumpolar Biodiversity Monitoring Program (CBMP) under the Arctic Council Working Group Conservation of Arctic Flora and Fauna organizes its work around the major ecosystems of the Arctic, marine, freshwater, terrestrial and coastal. GD is member of the Marine Mammal Expert Group since the last October 2015 meeting.

The CBMP – Marine held its annual meeting in Iceland, October 25-27. The aim of the meeting for the different Expert Groups was to review and finalise the draft of the State of the Arctic Marine Ecosystem Report (SAMBR - to be released to the Arctic Council Ministerial meeting in April 2017), handling the comments from the CAFF Board review, discussed the key findings and the advices for monitoring. The report presents baselines, trends and drivers of Arctic marine biodiversity at different trophic levels (Arctic sea ice biota, plankton, benthos, fishes, seabirds and marine mammals) by Arctic Marine Areas in the light of climate change. The Marine Mammal Expert Group focused on reviewed and completed the abundance and trend dataset (and cascading text and graphs) for all the Arctic stocks of the 11 marine mammals that had been chosen as Focal Ecosystem Components (FECs) for evaluating changes in Arctic biodiversity: beluga, narwhal, bowhead whales, ringed bearded, harp, hooded, spotted and ribbon seals, walrus and polar bear.

Meeting with CAFF Executive Secretary, Tom Berry, Akureyri, Iceland, October 28, 2016

Geneviève Desportes and Tom Barry discussed ways of increasing the cooperation between CAFF and NAMMCO, respecting each organisation identity and focus but supporting each other work and avoiding duplication of work. One specific point on the agenda was the Global Review of Monodontids (GROM) organised by NAMMCO. CAFF/Berry has joined the Steering Group in Spring. The SAMBR report and particularly the points and stock review relevant to narwhal and beluga represented a good start point for the GROM. Possibility for a broader dissemination of the results, data and conclusion of the Workshop through both organisations were discussed, as well as the possible funding of a Russian scientist through a special CAFF Russian fund. There existed the possibility possibility of storing the dataset developed at the WS in the CAFF Arctic Biodiversity Data Service (ABDS, http://www.abds.is/). CAFF proposed that NAMMCO be part of the Steering Group of the next Arctic Biodiversity Assessment Congress to be hold in Finland in 2018 (see here the 2014 Congress http://www.arcticbiodiversity.is/index.php/congress).

NAMMCO Scientific Committee Working Group on By-catch

REPORT
29 February, Marine Research Institute, Reykjavík, Iceland

As convenor of the planning meeting, Desportes welcomed the participants and thanked the Marine Research Institute for hosting the meeting.

She reviewed the TORs for the NAMMCO BYC WG as established by SC/21:
1. Identify all fisheries with potential by-catch of marine mammals
2. Review and evaluate current by-catch estimates for marine mammals in NAMMCO countries.
3. If necessary, provide advice on improved data collection and estimation methods to obtain best estimates of total by-catch over time.

The specific aims of this meeting were to establish the framework of the WG work and to identify a) what data and other information were available and which data were missing to be able to evaluate current by-catch estimates in NAMMCO countries, b) identify possible Chairs, and c) scheduling the next meeting and its specific TOR.

1. UPDATE SINCE 2010 (WKOSBOMB WS)

1.1 Conclusion of the joint ICES-NAMMCO workshop on bycatch (2010)

The WS on Observation Schemes for Bycatch Of Mammals and Birds (WKOSBOMB) reviewed ways of monitoring by-catch (both direct and indirect and best practice), data collection management, fleet effort data needed for raising by-catch rates and raising procedures (ICES WKOSBOMB 2010). The newly developed by-catch monitoring method using CCTV cameras was presented and its potential underlined and welcomed.

One of the main output of WKOSBOMB should have been to develop guidelines describing best practice for conducting marine mammal and seabird by-catch monitoring, but these guidelines were never finalised.

1.2 Progress since 2010

1.2.1 In NAMMCO countries

Norway

There are two reference fleets (RF) in Norway. The offshore RF (ORF) is constituted of 15 larger vessels >15 m and fishing offshore using gears such as long lines (9), bottom trawl for cod (4) and bottom trawl (2). The coastal RF (CRF) is composed of approximately 19 vessels, with at least 2 vessels in each of 9 Norwegian statistical coastal fishing areas (waters out to 4 nm). They use gillnets for cod (half mesh size 80-105 mm) in the winter/spring and for monkfish (half mesh size 180 mm, from shallow waters down to 400m depth) in summer/autumn. Nets with half mesh of 80-105mm are also used for other species according to season and availability. Vessels are contracted for a year at a time to collect information on fishing effort, catch and all by-catches (including marine mammals and seabirds). The CRF vessels receive economic incentives for reporting catch and effort, and for taking biological measurements and samples. Every vessel has a contact person at the IMR, which from time to time observe the fishing operations. If the data reported by the vessel are different from the data observed by IMR staff, the contract can be cancelled.

Norway uses the by-catch data from the coastal reference fleet (CRF) to estimate the by-catch rate (using GAM models) in the cod and monkfish fisheries, and landing statistics from the Directorate of Fisheries for the same species and gear types to extrapolate to the entire fisheries. There is no effort data from the commercial coastal fleet of vessels less than 15m total length (which comprises about 5000 vessels). Therefore, the landings statistics are used for the extrapolation.

The statistics provided to Bjørge for his first analysis of by-catch in the cod and monkfish fishery (Bjørge et al. 2013) were inaccurate, as they included all Norwegian cod and monkfish landings and not only landings from the coastal gillnet fisheries for cod and monkfish, thus leading to an overestimation of total by-catch in those fisheries. The previous estimate was 6900 harbour porpoises a year, but preliminary analyses based on correct landing statistics indicate that the actual bycatch will be closer to 3300 porpoises a year with a CV of ca 10%. The reanalysis will be finalized this year, providing by-catch estimates for harbour porpoises, grey and harbour seals. The by-catch estimates provided to this meeting for grey and harbour seals (NAMMCO/SC/23/BYC04) are based on the correct landings.

Collection of by-catch data will also be initiated in the lumpfish fishery, where by-catch rates are likely to be high but the overall effort is small. The by-catch of marine mammals should therefore be limited, but might be significant for seabirds.

Discussion
The by-catch rate provided by the CRF is thought to be reliable because of the contact person at the IMR that periodically observes the fishing operations and compares observed and reported data. Also as the contract is for one year, this arrangement is less prompt in causing changes in fishing methods/areas in order to minimising by-catch (as has been observed in some fisheries). Vessels in the coastal reference fleet are thought to be representative of the fishery. The IMR chooses the "average" vessels among the received applications. Landings data for the whole fisheries collected by the Directorate of Fisheries are also considered to be reliable.

In the Trøndelag -Lofoten area, a recent significant decline in grey seal pup production has been observed. This could be due to the by-catch in monkfish fishery. The monkfish fishery is a relatively new fishery and has little regulation (and level of enforcement not known) and has been moving north from Trøndelag as the local stocks get depleted. The bycatch of young grey seals is known to be high and a decline in pup production could be expected after an approximate time leg of five years.

Mitigation – Bjørge has recently received funding for conducting pinger experiments, which will start in the monkfish fishery this summer, and then in the cod fishery next winter. Standard pingers from Aquamark and Future Ocean will be used, as well as a few banana pingers. These pingers have been specifically developed for, and are efficient in, mitigating by-catch of harbour porpoises. SMRU has also carried out some developing work on pingers for grey seals (different sounds).

Bjørge mentioned that he tested Future Ocean pingers resulting in the pingers breakup, although it was uncertain whether it was due to the pressure (down to 400m) or handling (e.g., when net is being hauled). Future Ocean has made changes in the design to make more robust pingers.

Bjørge et al. (2013) also suggested as a mitigation measure, that gillnets with large mesh sizes should be prohibited in shallow waters, as by-catch rate are higher in shallow waters, even if by-catch occurs down to 400m. Desportes reported that gillnet with mesh under 90mm were considered by-catch safe (ASCOBANS 2015a). Norway does not have data to examine this, but it could be interesting in terms of possible mitigation.

Iceland

The cod gillnet and the lumpsucker fisheries are the main problem concerning by-catch of marine mammals in Iceland (NAMMCO/SC/21/11). An electronic log system was put in place 3-4 years ago in the gillnet fishery. However, the reporting of by-catch using the electronic log system dropped significantly compared with the hand written logbook. Either the fishermen did not understand how to report by-catch, or they did do not want to participate. During MRI's annual April cod gillnet research survey, all by-catch is recorded by the scientists on board the vessels, with representative coverage around the entire country. These data are (about 1% of the total fleet effort now) were considered the most reliable to extrapolate to the cod fishery, but the information on seasonal changes is now outdated. Data from the Directorate of Fisheries observer scheme were used to estimate by-catch rate in the lumpsucker fishery. The most common marine mammal by-catches observed in the Icelandic fishery are of harbour porpoises, harbour and grey seals, but some dolphins, harp, ringed and bearded seals are also by-caught, as well as seabirds.

Mitigation – The MRI is working with Bird Life International to begin using lights to mitigate seabird by-catch and pingers in 2017. Trials will be conducted during the cod survey.

Discussion

Electronic logbooks are not considered reliable yet, however reporting is increasing. The Directorate is working at making the electronic logbooks easier to use. Currently, zero by-catch is rarely reported in the electronic logbook, and no by-catch reported can either mean no by-catch or lack of reporting.

Greenland

By-catch are considered as removals and should be treated as direct catches. It is however not clear whether all by-catches are reported as catch and therefore are reliably included in catch statistics.

Faroes

Electronic logbooks have been introduced for the fleet larger than 15 GRT in 2013, with registration of marine mammal as mandatory. Zero by-catch is asked to be reported. However, the registration of the species is not an option in the logbook.

1.2.2 & 1.2.3 In ICES and Europe

The ICES WGBYC has been discussing at length the reliability of the monitoring and reporting conducted in the EU, noting that by-catch data are patchy, their reliability unequal, and the monitoring effort often too low to allow an extrapolation to a whole fishery. UK is likely the country putting the largest effort into monitoring, followed by France and now the Netherlands with a large Remote Electronic Monitoring (REM) project covering about 10% of the gillnet fleet.

In general, the situation is not good for by-catch monitoring in Europe, and may become worse with the by-catch monitoring integrating in the new Data Collection Framework (DCF, discard monitoring), as this monitoring is designed to quantify the discard of commercial species and not for the monitoring of protected species. Among other problems, gillnet fisheries are under-prioritised as they do not generate much discard. However, they are the gears generating most of the marine mammal by-catch. The ICES WGBYC data continues to demonstrate the failures of the current DCF to capture by-catch of rate event species, including marine mammals. Dedicated marine mammal by-catch observers report by-catch rates much higher than DCF observers in similar fisheries (e.g. ICES WGBYC 2014, 2015).

One problem is that DCF observers have many tasks to carry out, some under the deck. They often do not have time to check for marine mammals falling out of the net when being hauled, while it is known that a non-negligible number of, in particular, harbour porpoises fall out, especially from smaller mesh gillnets.

Certainly an important progress since 2010 is the full development of Remote Electronic Monitoring (REM, using CCTV cameras), and its adaptation to all kinds of vessels, including smaller vessels (ASCOBANS 2015b). REM has been validated and produced in fact better data than dedicated observers, and it is now used extensively in Denmark and the Netherlands. The system in particular is able to capture video of animals falling out of the net during hauling. Videos must be examined afterwards, representing many hours of effort. For marine mammals, however, the videos can be examined at relatively high speed, thus speeding up the process. Although the initial financial investment can be high, it has been calculated than in Denmark it is cheaper to invest in REM and analyse the data on land, than to have dedicated observers on board. Also, one advantage is that the original data remains intact.

The WG wondered how such system would perform in the dark, in conditions like in Northern Norway.

In terms of mitigation, pingers are /have been used mainly by UK and Denmark under the EU regulation 812, although the enforcement is not always very clear. Sweden has been working a lot and successfully with gear modification and the development of alternative gears, in particular to prevent seal damage to the catch and to reduce bycatch of seals.

1.2.4 Things coming up

The International Fisheries Observer and Monitoring Conference will take place in August 2016 in San Diego, CA (http://www.ifomc.com/). Bjørge informed that the conference did not seem to be dealing much with marine mammals, but mainly concerned with fish discard and by-catch.

2. UPDATE ON BY-CATCH REPORTING SYSTEMS IN NAMMCO COUNTRIES

2.1 Faroe Islands

Starting in 2013, the reporting of by-catch in the logbooks have become mandatory for vessels above 15 GMT (about 15 m), including the registration of zero by-catch, but no identification of species. There is no by-catch reporting system for vessels below that size.

Discussion
The WG recommended as a priority a modification of the logbook for allowing species identification to be recorded, especially as it does not increase much the workload. A reporting system should also be implemented for smaller vessels.

By-catch reporting in the logbook is very low in the Faroes and the same problem with a typical lack of reporting from the fisherman is expected, as in Norway and other countries.

2.2 Greenland
No information received.

2.3 Iceland
Logbooks are mandatory for vessels of all sizes, and landings and by-catch of marine mammals and birds should be reported. Most, if not all, cod gillnet boats report net lengths and soak time. In the lumpsucker fishery, some of the smaller vessels report net lengths and time soaking, but this is not mandatory. Generally in Iceland, the scope of the reporting (mandatory or not) depends of the nature of the fishery not of the size of the vessels.

It is not allowed to sell bycaught marine mammals and seabirds in Iceland.

2.4 Norway
It is mandatory for all vessels larger than 15m to have electronic logbooks and to report by-catch of marine mammals and birds by species, with a special column designed for this reporting. Although the bycatch of marine mammals is low in the offshore fleet of larger vessels (Bjørge et al. 2007) it is assumed to occur. However, there are just no reports in logbooks, so this reporting is not a reliable source of by-catch data.

3. REVIEW OF TYPES OF FISHERIES IN NAMMCO COUNTRIES AND IDENTIFICATION OF THOSE WITH POTENTIAL BY-CATCH OF MARINE MAMMALS

3.1 Faroe Islands
- The pelagic pair trawling mackerel, blue whiting and herring fisheries using pelagic or semi-pelagic trawl with very high vertical opening, (VHVO) are increasing, while marine mammals (pilot and minke whales) have been reported by-caught in these fisheries. The by-catch risk might therefore be increasing.
- Semi pelagic trawl are known to take e.g. pilot, minke, and killer whales.
- Purse seines are reported taking dolphins, killer whales as well as baleen whales such as minke whales.
- Grey seals and harbour porpoises have been reported to be caught on longlines, however the longline halibut fishery, which was likely the most problematic fishery, has ended.
- Harbour porpoises have been reported by-caught in herring set gillnet in shallow waters.
- A fishery for greater argentine is using high vertical opening trawls, but it is unknown if by-catch of marine mammals occurs in this fishery.

The Faroes have gillnet fisheries for monkfish and Greenland halibut, but they operate in relatively deep waters, below 380m and 500m respectively and are therefore assumed to not be a problem with regard to by-catch.

3.2 Greenland

No information provided.

3.3 Iceland

- Gillnet fishery for cod and lumpsucker generate marine mammal by-catch. In the lumpsucker fishery by-catch rates are high, but effort is now low due to limits on number of nets and effort days (around 20). The cod gillet fishery effort has decreased appreciably in recent years/decades.
- Bottom trawlers have very low by-catch - maybe 1 seal per year.
- Pelagic capelin fisheries sometimes entrap humpbacks, but they usually escape.
- The pelagic trawling fishery has been increasing in recent years, but no by-catch has been reported in log books nor in the Directorate of Fisheries observer scheme or by scientists on board those vessels.

Iceland has no halibut fishery (as halibut are protected due to low population), no turbot fishery, and no trammel net fishery. These fisheries are usually associated with high by-catch in other countries.

Nets are not allowed in recreational fisheries in Iceland. These fisheries are restricted to hand held angling, and therefore are not believed to involve any marine mammal bycatch.

Harbour porpoise, harbour seal and grey seal are the species the most represented in the Icelandic by-catch.

3.4 Norway

- Bottom set gillnets for cod (75 – 105 mm mesh) and monkfish (180 mm mesh size) are the most problematic fisheries.
- Bottom set gillnet for lumpsucker also have by-catch but the effort is low.
- The halibut fishery might also generate by-catch, but the effort is much smaller than that of the cod fishery. However this fishery, which uses nets similar to the monkfish fishery, has increased in recent years and should be monitored.
- In Finnmark, some trapnets for salmon catch harbour porpoises. The porpoises can normally be released alive.
- In Finmark lots of harp seal pups are caught in some years.

The salmon driftnet fishery stopped in 1988. This fishery had high by-catches of harbour porpoises. Floating longlines for salmon are now prohibited in Norway, but when in use they were taking lots of young hooded seals. There is no pelagic trawling at the moment. Purse-seine are not a problem for marine mammals.

Cod traps have been used in coastal fisheries, the cod being sold live. It was profitable, but has ended because of the high cod worm infestation rate, particularly in those areas where the traps were used. By catch was a problem for coastal seals.

Trammel nets are used - some by the recreational fishery, close to land, mainly for crabs.

In Norway, gillnets can be used in the recreational fishery. No licence is needed and no reporting of catch is required, therefore no statistics are available. However, it is a fairly large fishery, especially for cod, and more coastal cod may actually be caught by recreational fishers than commercially. The number of nets is regulated, but there is no limit on landings. Levels of by-catch are unknown.

The three species of concern are grey and harbour seals, and harbour porpoises. In recent years, humpback whales have becoming entangled in the Troms area when they feed in wintering herring in the fjords.

Very little by-catch is recorded in the offshore fleet, and no grey and harbour seals are taken, and seldom harp seals. The Directorate of Fisheries observers were asked to report bycatch of marine mammals during one year on the larger vessel fleet, however, as no by-catch was observed, so this monitoring stopped.

4. IDENTIFICATION OF EXISTING & NEEDED BY-CATCH-RELATED DATA AND OWNERS OF THE DATA

4.1 By-catch data

Norway

The data from reference fleet is owned by IMR, as well as the mark recapture data for tagged seals. Landing statistics are from the Directorate of Fisheries, but there is very good cooperation between the two institutions and it is no problem in getting the data.

In Norway, the by-catch data originate from the reference fleet and the recovery of tagged seals.

The WG recommended that more reference vessels be used in the area where by-catches are largest, i.e. especially the Lofoten - Vesterålen area, in order to get more accurate and reliable by-catch data.

Iceland

It would be good to have more observers. The March/April cod gillnet survey is a great source of data over a 10 year-period. Although capturing the peak of the gillnet season it does not provide information on seasonal changes in by-catch rate, which is needed, and therefore information from the old hand written log books was used. One possible solution, if electronic recording does not improve, could be to contract the vessels that are already contracted for the gillnet research survey in the spring to year round and use them as a reference fleet.

The fishery observer data is improving, but was not reliable in the past. It became more reliable about 2 years ago, according to the Directorate, after they instructed the observers about the importance in recording by-catch data.

Data from the electronic logbooks are presently not reliable. Improvements of the software are being made by the Directorate of Fisheries to facilitate reporting. It may be possible to look at some vessels that are reliable and use their data as a reference fleet. Reporting of zero by-catch is required in the logbook.

Faroes

The reliability of the reported by-catch data has never been assessed. It is especially important to get reliable data for fisheries identified as problematic such as the mackerel mid water trawling fishery which is increasing in effort in recent years, and where the by-catch is relatively high.

Very-high vertical opening (VHVO) trawl are used in the Faroes. Mikkelsen was not sure whether there was by-catch, however he will follow up and try to get reporting from the fishery this summer. VHVO trawl have been identified as being very problematic with regards to by-catch in Spain.

4.2 Fleet effort

Norway

Only landings are available for the coastal fisheries (vessel < 15m). For the larger vessel fisheries, logbooks can be used if there are by-catches reported.

Iceland

Effort is recorded as number of pulled nets, total length, and soaking time.

The WG discussed the use of automatic recording to get effort data. Norway has this for larger vessels, and Iceland has used automatic recording as well, including larger and smaller vessels, mainly as a safety feature. Most, if not all commercial vessels have this. It records length of net and GPS position. Bjørge reported that he tried to use it to obtain effort data, but it is a large, unwieldy amount of data.

Faroes

The information was not available and will be provided at the next meeting.

4.3 By-catch Estimates

Only Norway and Iceland have estimated total by-catch for the few fisheries considered most important.

4.4 Data gaps

In Norway there might be a problem with the species identification of by-caught seals. This will be discussed in a coming meeting with the Coastal reference fleet.

In the Faroes, reliable by-catch data are missing for all fisheries. Reporting is mandatory for vessels over 15 GMT using logbooks, but as elsewhere very little by-catch reporting. Species identification of the by-catch is not available.

In Iceland, information on seasonal changes in by-catch rate is missing.

5. BEST *MODUS OPERANDI* FOR REVIEWING AND EVALUATING EXISTING BY-CATCH ESTIMATE

5.1 Needed external expertise

The WG is meant to be a permanent WG, with a more or less fixed membership, meeting every 1-2 years. The WG would not look at the impact of by-catch on marine mammals populations, but would review the by-catch estimates to be used in impact assessment and population modelling. It may also discuss mitigation possibilities, if the SC so wishes.

Some fishery expertise was needed, both in terms of fishery statistics (sampling, effort), but also gear specialists.

5.2 Best forum

The group agreed that at this point the best forum was a NAMMCO working group, but that links should be developed with the ICES WGBYC with the aim of future joint meetings.

This could be done by inviting the ICES WGBYC chair, Marjorie Lyssikatos, or members such as, e.g., Simon Northridge (UK), Ronan Cosgrove (Ireland) and Lotte Kindt-Larsen (Denamrk) to the NAMMCO WG.

5.3 Planning of next BY-CATCH working Group meeting

5.3.1 Terms of reference

The TOR of that particular meeting will be to:

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

5.3.2 Date and place

Norway should have the reanalysis of the by-catch data (porpoise and seals) ready for the late fall, including the data up to 2015. There will be a meeting with the Coastal reference fleet late in December 2016, and Bjørge will participate and discuss how more reliable species identification of seals can be achieved. Iceland is currently reanalysing some older data and will need to analyse the data from the 2016 April cod survey.

The group agreed that the date of the next meeting would be decided in August according to progress in the analyses. Prewitt will contact the group at that time. If both the Norwegian and Icelandic analyses are completed, the WG could meet in February-March 2017.

5.3.3 Agenda

Not determined, but see ToRs for the meeting under point 5.3.1

5.3.4 Invited experts

Interesting experts to invite would be:
From Norway, Erik Berg (IMR, Tromsø), expert in fisheries statistics and gear specialist (coastal cod and halibut); Modulf Overvik (Directorate of Fisheries) working with the fishery database, and sampling and effort data
From Iceland, Haraldur Einarsson, a fishing gear specialist.
From the ICES BYCWG, preferably Marjorie Lyssikatos (chair), or Simon Northridge, Finn Larsen or Lotte Kindt-Lassen (especially with regards to REM and mitigation).

5.4 Identification of a WG Chair

A recommendation from Secretariat is that the Chair is not a stakeholder- not someone from NAMMCO countries tabling data to be reviewed by the WG.

Several names were proposed Simon Northridge and Nora Hanson (ICES MME), both from SMRU, UK; Garry Stenson & Jack Lawson from Canada; Ronan Cosgrove from Ireland; Lotte Kindt-Larsen (has worked with REM and pinger experiment, lots of contact with fishermen in DK). Kimberley Murray, from NOAA/Northeast Fisheries Science Centre.

Several participants felt that Murray would be an appropriate chair.

5.5 Other business

No other business was raised.

6. AOB

The WG members are at present Arne Bjørge (NO), Thorvaldur Gunnlaugsson and Guðjón Sigurdsson (MRI, IS), Sandra Granquist (Seal Centre, IS), Guðni Magnús Eiríksson (Fisheries Directorate, IS, responsible for the reporting (logbook) system), Bjarni Mikkelsen (Faroes), Nette Levermann (Greenland), Geneviève Desportes (Convenor).
The report was adopted by correspondence on March 15, 2016.

7. REFERENCES

ASCOBANS. 2015a. Draft Submission of ASCOBANS Advice on the Requirement of Legislation to Address Monitoring and Mitigation of Smalll Cetacean ByCatch. AC22/Doc.4.1.b. Available at http://www.ascobans.org/sites/default/files/document/AC22_4.1.b_DraftSubmission_EUBycatchLegislation.pdf

ASCOBANS. 2015b. Report of the ASCOBANS Workshop on Remote Electronic Monitoring with Regards to Bycatch of Small Cetaceans. Available at the ASCOBANS Secretariat

Bjørge, A., Borge, A. and Kleven, S. 2007. Observed and reported bycatches of marine mammals in the Norwegian shelf and offshore fisheries. NAMMCO/15/MC/BC7. 9pp.

Bjørge, A., Skern-Mauritzen, M. & Rossman, M.C. 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.

ICES WKOSBOMB. 2010. Report of the Joint NAMMCO-ICES Workshop on observation schemes for bycatch of mammals and birds. 28 June – 1 July 2010, Copenhagen, Denmark. ICES CM 2010/ACOM:33. 36pp.

ICES WGBYC. 2015. Report of the Working Group on the Bycatch of Protected Species. 2–6 February 2015, Copenhagen, Denmark. ICES CM 2015/ACOM:26. 80pp.

ICES WGBYC. 2014. Report of the Working Group on the Bycatch of Protected Species. 4–7 February 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:28. 94pp.

APPENDIX 1 - AGENDA

1. UPDATE SINCE 2010 (WKOSBOMB WS)
    - 1.1. Conclusion of ICES-NAMMCO WS on bycatch in 2010
    - 1.2. Progress since then
        - 1.2.1. In NAMMCO
        - 1.2.2. In ICES
        - 1.2.3. In Europe
            - 1.2.3.1. Bycatch assessment and monitoring
            - 1.2.3.2. Bycatch mitigation
        - 1.2.4. Things coming up
            - 1.2.4.1. International Fisheries Observer and Monitoring Conference

2. UPDATE ON BYCATCH REPORTING SYSTEMS IN NAMMCO COUNTRIES
    - 2.1. Faroe Islands
    - 2.2. Greenland
    - 2.3. Iceland
    - 2.4. Norway

3. REVIEW OF TYPES OF FISHERIES IN NAMMCO COUNTRIES AND IDENTIFICATION OF THOSE WITH POTENTIAL BYCATCH OF MARINE MAMMALS
    - 3.1. Faroe Islands
    - 3.2. Greenland
    - 3.3. Iceland
    - 3.4. Norway

4. IDENTIFICATION OF EXISTING & NEEDED BYCATCH-RELATED DATA AND OWNERS OF THE DATA
    - 4.1. Bycatch data
    - 4.2. Fleet effort
    - 4.3. Bycatch Estimates
    - 4.4. Data gaps

5. BEST *MODUS OPERANDI* FOR REVIEWING AND EVALUATING EXISTING BYCATCH ESTIMATE
    - 5.1. Needed external expertise
    - 5.2. Best forum
    - 5.3. Planning of next BYCATCH working Group meeting
        - 5.3.1. Terms of reference
        - 5.3.2. Date and place
        - 5.3.3. Agenda
        - 5.3.4. Invited experts
    - 5.4. Identification of a WG Chair
    - 5.5. AOB

6. AOB

APPENDIX 2 – LIST OF DOCUMENTS

Meeting documents

SC/23/BYC/01	Agenda
SC/23/BYC/02	List of participants
SC/23/BYC/03	List of documents
SC/23/BYC/04	Bjørge, Moan, Nilssen and Øigård. Bycatch of harbour and grey seals in Norway.
SC/23/BYC/05	Mikkelsen. Fisheries in Faroese waters and the potential for bycatch of marine mammals.

Background documents

SC/23/BYC/O01	ICES WKOSBOMB. 2010. Report of the joint NAMMCO-ICES workshop on observation schemes for bycatch of mammals and birds.
SC/23/BYC/O02	ICES WGBYC. 2015. Report of the Working Group on Bycatch of Protected Species.
SC/23/BYC/O03	ICES WGBYC. 2014. Report of the Working Group on Bycatch of Protected Species.
SC/23/BYC/O04	ICES WGBYC. 2013. Report of the Working Group on Bycatch of Protected Species.
SC/23/BYC/O05	ASCOBANS. 2015. Workshop on Remote Electronic Monitoring with Regards to Bycatch of Small Cetaceans.
SC/23/BYC/O06	ASCOBANS 2015. Draft Submission of ASCOBANS Advice on the Requirements of Legislation to Address Monitoring and Mitigation of Small Cetacean Bycatch.
SC/23/BYC/O07	Bjørge et al. 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.
SC/23/BYC/O08	Bjørge et al. 2002. Dispersal and Bycatch mortality in Gray, *Halichoerus grypus*, and harbour, *Phoca vitulina*, seals tagged at the Norwegian coast. MARINE MAMMAL SCIENCE, 18(4):963-976.
SC/23/BYC/O09	Bjørge et al. 2005. Observed and Reported Bycatches of Marine Mammals in Norwegian Shelf and Offshore Fisheries. NAMMCO/15/MC/BC/7
SC/23/BYC/O10	Bjørge et al. 2005. Spatial Structure of Norwegian Fisheries and the associated Risk for Bycatches of Marine Mammals. NAMMCO/15/MC/BC/6.
SC/23/BYC/O11	Needle et al. 2014. Scottish science applications of Remote Electronic Monitoring. ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu225.

APPENDIX 3 – LIST OF PARTICIPANTS

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Report of the NAMMCO Working Group on Coastal Seals 2016

1-4 March 2016
Reykjavik, Iceland

Report of the
NAMMCO Working Group on Coastal Seals 2016
1-4 March 2016
Reykjavik, Iceland

The Chair of the Coastal Seals Working Group, Kjell Tormod Nilssen, welcomed the participants to the meeting and commented that the WG had good representation from around the North Atlantic.

The original agenda was modified to discuss agenda Item “Seal Interaction with Fisheries and Aquaculture” first so that the by-catch information could be included in the population assessments. The modified agenda is available in Appendix 1.

1. TERMS OF REFERENCE

Nilssen reviewed the Terms of Reference for the meeting:

- assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway.
- address by-catch issues in Norway, Iceland, and the Faroe Islands
- re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
- develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).

2. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The participants’ attention was drawn to the documents that were available to the WG (Appendix 2).

3. SEAL INTERACTION WITH FISHERIES AND AQUACULTURE

The WG discussed the nature and scope of interactions between seals and fisheries and aquaculture in Norway, Iceland, and the Faroe Islands.

a. Geographical review
b. Problem size
c. Mitigation methods in use

Norway
Bjørge presented paper SC/23/CSWG/08. Three different sources (mark recapture data, data from the Coastal Reference Fleet (a monitored segment of the coastal fishing fleet), and from modelling population trajectories) were used to estimate levels of by-catch of grey and harbour seals in Norway. The total harvest of grey and harbour seals is known for the period 1997-2014. Information is also available on the total number of flipper-tagged seals, the total number of tagged animals in the hunt, and the total number of returned tags from fishery by-catch during the same period (Table 1.).

Table 1. The total numbers of harvested and flipper-tagged grey and harbour seals, and tags recovered from the harvest and by-catch.

Species	Total harvest 1997-2014	Total tagged	Total tagged harvest	Total tagged by-catch
Grey seals	4311	2642	73	142
Harbour seals	7991	174	7	9

Assuming equal proportions of tagged animals among harvested seals and bycaught seals, the by-catch is:

Total by-catch = Tagged by-catch x Total harvest / Tagged harvest.

For grey seals this resulted in an estimate of total by-catch of 8,379 animals for the period 1997-2014, with an annual by-catch of 466 grey seals. The estimated total by-catch of harbour seals for the period 1997-2014 was 9,989 animals resulting in an annual by-catch of 555 harbour seals. The by-catch of grey seals is about twice the annual hunt (240 seals) and the by-catch of harbour seals is about 125% of the hunt.

Data from a monitored segment of the coastal fishing fleet were used to calculate by-catch rates, (number of bycaught seals per kg of the target species) in gill net fisheries for cod (*Gadus morhua*) and monkfish (*Lophius piscatorius*). General Additive Models (GAMs) were used to model by-catch rates and landing statistics from the Directorate of Fisheries which was then used to extrapolate to the entire fisheries with the same gear type. This gave an estimate of annual by-catch of 479 harbour and 84 grey seals in two gill net fisheries in the period 2006-2014. However, young grey seals could have been wrongly identified as harbour seal resulting in an under estimate of grey seals and overestimate of harbour seals.

A modelling approach to population trajectories of grey seals in Sør-Trøndelag and Nord-Trøndelag counties required an annual by-catch of 150 and 80 seals, respectively, in the two counties to explain a recent decline in observed pup production. However, the model fit was not good.

It is likely that the level of by-catches has been increasing in recent years north of 62°N due to an increase in fishing effort with large mesh gill nets, particularly in the monkfish fishery.

Discussion

The monkfish fishery started in Sør-Trøndelag and has moved north to Troms county in recent years. This is a relatively new fishery that increased in effort in the 1990s, and prior to 2010, each boat was allowed to use 1,000 gillnets (about 27 km in length). After 2010, a regulation was introduced to limit each boat to 500 gillnets. This is a new source of mortality that has been introduced into the area and this mortality is possibly the main reason for the rapid and significant decline in observed grey seal pup production in the Trøndelag counties. The conclusion was that the current grey seal population model (Øigård et al. 2012) is too 'stiff' to account for the rapid changes in pup production, and IMR is working on improving the model's ability to handle the data.

The WG suggested investigating whether the model can predict the 2012 pup production, which could give an idea of whether estimates of by-catch are reasonable.

The group discussed whether Norway has an estimate of non-reported recapture of tagged seals. Norway reported that these figures are not available, and the rate of under-reporting is unknown, therefore these by-catch estimates based on mark recapture data are considered minimum estimates. Underreporting of recovered tags and tag loss could contribute to underestimating the by-catch.

The WG also discussed how movements of animals in and out of tagging areas may influence tag recovery (and reporting of tag recovery) and therefore the estimates. For example, these by-catch estimates do not include animals that are tagged in Russia. In a previous joint Russian/Norwegian tagging program in the early 1990s many tags were recovered in Norwegian waters. There might also be migration of grey seals from Norway to Russia, UK, and other locations, and are not accounted for in these estimates. In addition, Bjørge and McConnell (1986) reported that many tags were recovered in Norway from grey seals tagged in the UK indicating that as many as 650 UK grey seals entered the Norwegian coast annually during the period 1960-1981.

The by-catches in the cod fishery peak in February-April while the higher levels seen in the monkfish fishery occur from July-December. The autumn removals probably have a more important impact on the population due to pups being most vulnerable to by-catch during the first 4 months after birth (Bjørge et al. 2002b). In a tagging study in Nordland county in 2012, four of five tagged grey seal pups were documented caught in gill nets a few months after tagging, and the track of the fifth pup indicated that it was caught. This should be considered in the population modelling.

The WG noted that knowing the age structure of the harvest and the by-catch is important if the ratio of the tagged seals to untagged seals from hunt is used to estimate by-catch. If the age structure is different between the harvest and the by-catch, this could result in a bias in the estimate of the by-catch. The model assumes age structure is the same, but this may not be correct. For example, in Canada, the age structure of the commercial harvest and "personal use" harvest is much different than the by-caught age structure.

The group also discussed whether the estimated by-catch levels can explain the observed drop in the grey seal pup production. If the by-catch rate is increasing over time, there is a lag in the effect on the pup production. The WG also suggested that the annual landings of the target fish species could be used to evaluate annual differences in by-catch estimated from the coastal reference fleet.

There may be other sources of mortality than by-catch and harvest, and these other sources might be showing up in the model. It is known that there is some predation by killer whales (*Orcinus orca*). It is unknown whether the number of killer whales is increasing in these areas, but it is known that the killer whale distribution is changing. During the winter, killer whales follow the over wintering herring and may move closer to seal colonies. In addition, killer whales along the Norwegian coast have been known to eat harbour and grey seals. In Scotland, killer whale predation on harbour seals seems to be on the increase.

The WG discussed whether killer whales in the North Atlantic are specialist predators on fish or mammals, but noted that while killer whales may eat both fish and mammals, individual pods of killer whales may be specialists to fish or mammals.

Grey seals may also be a source of mortality for harbour seals, either as predators or as competitors. In various areas where harbour seals and grey seals overlap, the population growth rate of harbour seals is usually lower. This has been seen in the Baltic Sea, Sable Island (Canada), Scotland, and New England (USA).

For the current grey seal assessment, even though the population model may not be completely accurate, it is known that the mark-recapture estimates are likely more realistic, and should be used in this population assessment. For near future grey seal assessments, the mark-recapture would not work because there has not been recent tagging. Therefore, future assessments should use data from the reference fleet, and explore the possibility of estimating annual variation in by-catches.

Fish farming
The aquaculture industry in Norway is extensive and in 2015 it comprised 990 locations for salmon (*Salmo salar*) and trout (*Oncorhynchus mykiss*) farming, 79 locations for other fish species, and 151 locations for shellfish farming. The industry is distributed along the entire coastline, but the highest numbers of farms is on the west coast from Hordaland to Nordland county.

In order to investigate the level of interaction between seals and fisheries, Norway tagged 29 harbour seals with radio tags in an area in Møre with 3 fish farms and a high density of harbour seals (Bjørge et al. 2002a). The tagged seals were not attracted to the farms, and the fish farmers did not report conflicts with seals in the area when interviewed. However, in other areas, farmers report on conflicts with seals that are thought to be grey seals. Farmers are allowed to shoot seals near farms and reporting is mandatory, but little to no reports are provided to the Directorate.

<u>Faroes</u>

By-catch
It is not thought that by-catch of grey seals in Faroese fisheries is a problem because there is no gillnet fishery in shallow waters. The longline fishery for halibut may be the only somewhat problematic fishery, but it is believed to by-catch less than 10 animals annually. This is not supported by data, but communication with fishermen has not revealed reports of more by-catch.

Removals at fish farms
For the Faroes, the most significant interaction of grey seals is in connection with salmon farming, and occurs in the vicinity of the sea farms spread around in the archipelago. Salmon farmers have been licensed with rifle permits for shooting seals, when interacting with their sea farms, as a protective act. The salmon farming industry grew significantly in the early 1980s, with farms started at suitable sheltered locations around in the islands. With the development of this industry, culling of grey seals also evolved. Hunting logbooks have not been mandatory, and therefore no statistics are available on the number of grey seals harvested at salmon farms from the early days of the industry. No management regime has been implemented; fish farmers are free to shoot all seals approaching the farm.

In 2009, a logbook recording system for fish farmers was implemented to register seals shot at sea farms. The aim was to gain reliable harvest statistics on a mandatory basis, following a recommendation by the NAMMCO Scientific Committee. All sea farms were asked to register seal harvests on a monthly basis, and deliver statistics annually. It has taken time to have the reporting system introduced and improved. The system is not optimal, and there is still a demand to remind the industry, consisting of four companies operating at 35 localities today, to deliver their annual harvest statistics.

The grey seal harvest statistics from the Faroes are not complete (the largest company, with 21 of the 35 fish farm licenses, is missing in the statistics). In 2010, when harvest numbers were available from all farms, around half the seals were shot at farms of this company. Total harvest numbers for three companies (40% of fish farms) were ca. 153 seals in 2011, 132 seals in 2012, 63 in 2013, 113 in 2014 and 94 in 2015. Anticipating that these numbers represent about half the removed seals, the total numbers of grey seals removed at aquaculture farms in the Faroe Islands are estimated to be around 150-250 grey seals annually.

Other possible removals
There is no recreational hunt for grey seals in the Faroes. The tradition of seals as food has waned; therefore, although there could be removals that are not documented, these are likely low.

Other induced mortality, i.e. reporting on suspicious sighting of dead seals, perhaps indicating a virus outbreak or other illnesses have never been documented or described in the literature. Perhaps a more notable source of mortality, especially for the small grey seal population in the Faroes, could be predation by killer whales.

<u>Discussion</u>
The WG noted that there is no reliable population estimate. A best rough estimate is around 1,000-2,000 animals. The removals via aquaculture may be high enough to have kept the population at low levels. These removal levels (150-250 seals) are around 10-20% of the rough estimate of population size. The group expressed concerns that removals seem high compared to the population levels.

The Faroes do not have an age structure of the removals from either by-catch or grey seal removals at fish farms. Information from other areas indicates that it is likely that it is the adults feeding at farms as specialists. For example, in the UK, seals that are shot in association with aquaculture are usually adult males who are holding territory. There have been previous recommendations to the Faroes to collect the carcasses to obtain biological parameters of the culled seals.

The WG discussed the inter-annual variability in levels of removals that are reported. There does appear to be wide variability based on the logbooks that have had multiple years reporting (up to four fold in successive years).

As discussed in further detail under Item 4.3, the WG noted that the abundance of this population is unknown, and it is important to get at least a minimum population estimate in order to assess whether the level of removals is sustainable.

<u>Iceland</u>

By-catches of seals in Iceland should, according to legislation, be reported. The Marine Research Institute (MRI) is systematically collecting by-catch information on all marine mammal species in an annual gill net survey. Comparison of that data with logbooks has, however, shown that a large proportion of by-caught marine mammals are not reported. The most reliable by-catch numbers could be obtained by extrapolating numbers from a cod gill net research programme and fishery inspection trips on lumpsucker (*Cyclopterus lumpus*) boats.

Gunnlaugsson et al. 2014 described recent efforts to obtain by-catch estimates. In 2013, a study was initiated to obtain by-catch estimates. Reports from inspectors on board vessels and the fishermen reports were compared in the lumpsucker fishery. There were some discrepancies in reported numbers (both ways, with inspectors reporting numbers both higher and lower than the fishermen), and it appears that some of these can be explained by incorrect dates on the fisherman's reports. MRI has developed a correction factor for fishermen's logbook reports.

Discussion
The WG noted that Iceland does not have information on the age structure of the by-caught animals.

Fish farming
In Iceland there are approximately 10 fish farms, and the industry is increasing. The farms are generally not subject to predation from seals due to the use of double netting that is mainly used to keep cormorants and other birds out, but also keeps the seals out.

Fish farmers are allowed to shoot seals near the farms, but it is unknown how many are shot per year. A survey (described in Osmond 2013) was put out to fish farmers to investigate this, but resulted in only a few responses. However, the removals are thought to be low, about 2-3 per year.

Interaction with salmon fishery
The main harbour seal hunting occurs around the river mouths. Since it is likely that not all hunters are included in the present catch statistics, there is a clear need for an improved catch reporting system. There is insufficient regulation for hunting seals and it is not required to report numbers of shot seals.

Iceland is currently conducting research into diets to look at whether seals are eating salmonids, but thus far have found little evidence of predation on salmon (via hard parts, stable isotopes, prey-DNA and low reports of injuries on the salmon in rivers from seals). The WG discussed the likelihood of detecting salmon hard parts in scat and cautioned that otoliths may not always pass through the GI tract intact, and some species, such as salmonids, erode easily and may therefore be hard to detect. However, vertebrae should be recoverable and can provide evidence of species consumed. Iceland noted that they are aware of this problem and that vertebrae are also collected, and that the combination of different methods is used due to this potential problem with salmonid otoliths.

Smout cautioned on using broad scale sampling because there may be specialist seals that are concentrating on the salmon, and if they are not sampled then it appears that the seals do not eat salmon. Iceland noted that they were attempting to avoid this problem by collecting as many samples as possible to try and detect possible salmon specialists. They currently have a large number of samples. One idea that was discussed to attempt to identify salmon specialists was a photo ID study. This could be a "citizen science" type of project where people are asked to take photos of "problem seals", and attempt to individually identify these specialists.
The group discussed using pingers at the river mouths to deter seals from the area. This is potentially problematic for a few reasons. One problem is that pingers can also lose their

effectiveness over time and end up being an attractant, almost like a "dinner bell" which indicates the presence of fish to the seals. However, there are now some new types of pingers with particularly aversive sounds that appear to last longer as a deterrent. Another problem is that the area is actually an important pupping site, and it could be a problem for the seal population to be deterred from this area.

Nematode infestation
Previous studies showed high parasite (sealworm) loads. There was a bounty on grey seals prior to 2009 and harbour seals until 1995 to try and reduce parasite loads in fish. No follow up studies on parasite loads were conducted after 1999 to see if decreasing the seal population had an effect on parasites. Although the relationship between seal population size and infestation rate is not 1:1, it would be interesting to measure the current infestation levels as seal populations are decreasing. Samples should be obtained from the area where the previous studies were carried out.

Sealworms are also an issue in Norway, and seals have been culled in the past in order to try to reduce the sealworm population, however no studies were conducted to follow up the sealworm abundance in fish after culling seals. After the PDV-epidemic in 1988 which resulted in a decline of more than 50% of the harbour seal population in Østfold county, a sharp decrease in sealworm infestation rate in cod was observed. However, the decrease in infection levels appeared to be short-lived, with higher worm burdens in cod a year after the observed decrease (Clers and Andersen 1995).

4. STATUS OF HARBOUR SEAL STOCKS
   a. Information on catches and regulatory measures
   b. Current Research (Biological parameters, stock identity, distribution/migration)
   c. Population assessments

The WG discussed the status of harbour seals stocks in the North Atlantic. A summary of the current abundance and trend is provided in Table 2.

4.1 Norway

Catches
Document SC/23/CSWG/10 provides information on the catches of harbour seals from 1997-2015 (Table 3). The hunt has been regulated by quotas since 1997, and in 2003 the quotas and bounties were increased. In 2010, a management plan for harbour seals was implemented, and since then there have been decreases in the yearly reported catches. The Directorate of Fisheries has not received any reports of removals around fish farms, but it is likely that there are removals.

Hunters must sign into the hunt and report their catch to the county daily. The hunt is stopped when the quota is taken.

<u>Discussion</u>
Traditionally seals were mainly hunted for the meat, but the skin was also used. After 1945, the hunt greatly reduced the harbour seal population, and in some areas the seals were protected.
Stock identify
The current management units for Norwegian harbour seals are defined by county limits (see Fig. 1) and hunting quotas are given by county (SC/23/CSWG/05). However, information on

movements patterns of harbour seals in Norway (Bjørge et al. 2002b; Ramasco 2015) as well as recent genetic evidence of fine scale population structure in Danish and Swedish waters (Olsen et al. 2014), raise concerns that there may be population subdivision within counties.

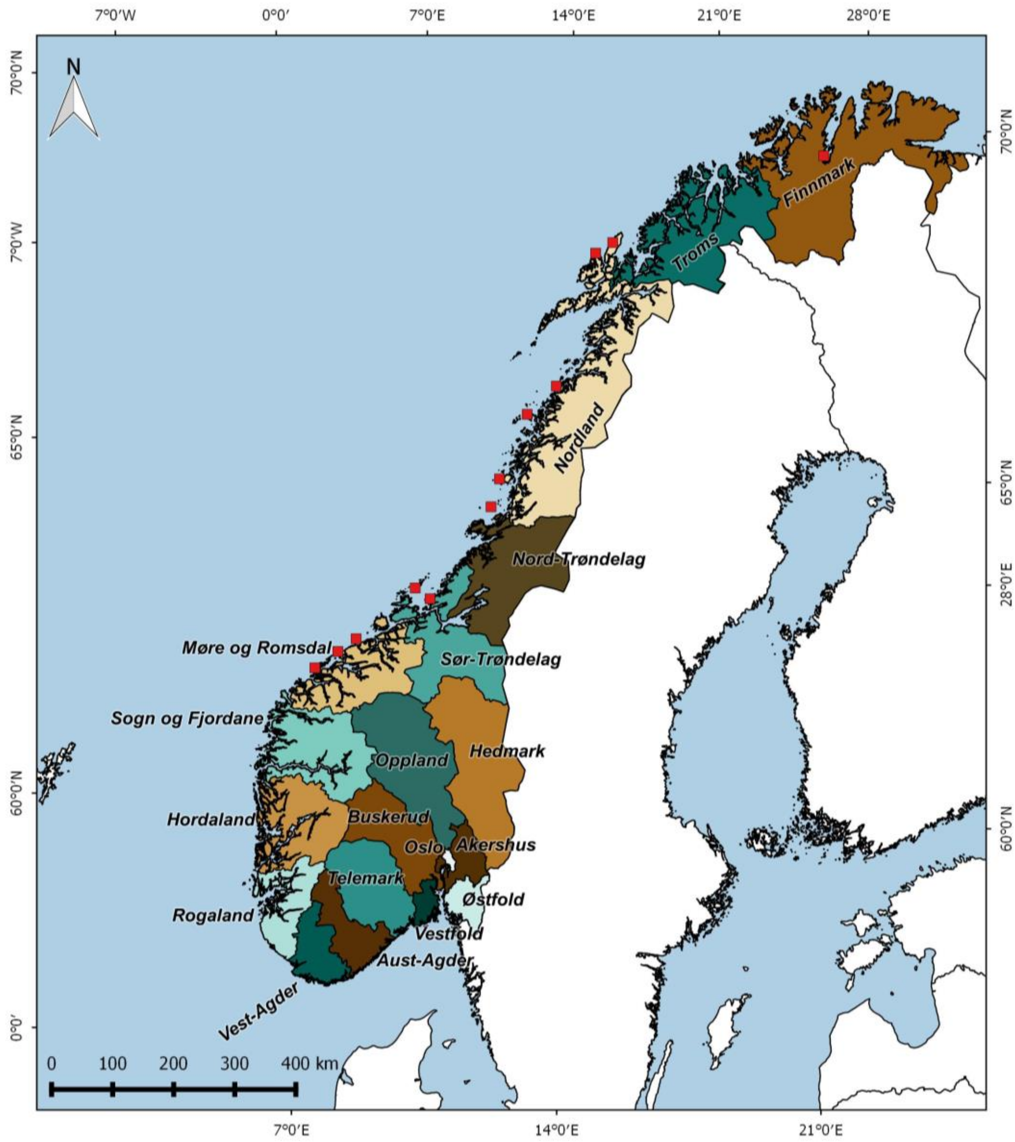

Fig. 1. Counties in Norway. Red squares indicate locations where DNA samples were collected.

In particular, in some of the counties that are quite large (with a long coastline), the management units are likely much bigger than the biologically significant populations. In order to investigate this, a genetics study was initiated to look at the population structure, particularly within the largest counties. For the past few years, genetic samples have been collected in breeding colonies along the Norwegian coast (Fig. 1) to evaluate the delineation of management units. So far, 173 samples are available from 6 major breeding areas. Analyses of 14 microsatellite markers for these samples show clear evidence of population subdivision between 3 breeding areas within Nordland county. All of these areas also show significant differences with samples collected in Sør-Trøndelag county and with samples from the more southern county of Møre and Romsdal. No significant difference was found between the two neighbouring counties Sør-Trøndelag and Møre and Romsdal, but this could be due to low sample size for Møre and Romsdal. Only 4 samples were available for the northernmost county of Finnmark and therefore no conclusions can be drawn from this material. Earlier analyses of mitochondrial sequences from hunted samples in Finnmark and Troms counties have, however, shown significant differences between the Porsangerfjord area and neighbouring areas on the coast of northern Troms and western Finnmark (Frie, unpubl. data). In addition, mitochondrial control region sequences will also be analysed for the breeding samples and more breeding samples will be included in the analyses as they become available.

Table 2. A summary of the current abundance and trends of harbour seals in the North Atlantic. More detail is provided under each country's agenda Item.

Country	**Survey Year(s)**	**Abundance**	**Current trend**
Norway			
Entire mainland coast	2011-2015	7,642	stable
western Finnmark	2013	395	stable
Iceland			
	2011 (full survey)	11,000-12,000	
	2014 (partial survey)	ca 8,000*	declining?
Greenland	None	<100	unknown
Russia			
Murman coast	1998	500	unknown
Sweden and Denmark			
Skagerrak	2015	6,000	increasing (6.6%/yr)
Kattegat/ Danish Straits	2015	10,000	increasing (6.2%/yr)
southern Baltic	2015	1,000	increasing (8.4%/yr)
Limfjord	2015	1,000	increasing (5.6%/yr)
Kalmarsund	2015	1,000	increasing (9%/yr)
Wadden Sea	-	25,000	uncertain (see 3.5)
France	2008	150	unknown
United Kingdom			
Scotland	2007-2014	23,355	local declines (Moray Firth)
England and Wales	2007-2014	4,806	stable or increasing
Northern Ireland	2007-2011	948	stable or increasing
Eastern Canada			
south of Labrador	1970s	12,700	unknown
Estuary and Gulf of St Lawrence	1994-2000	4,000-5,000	Unknown
Eastern United States	2012	75,834	decline?

* This abundance is calculated assuming that the populations are stable in the other parts of the country that were not surveyed in 2014 and therefore should be used with caution. See Item 3.2.

Table 3. Harbour seal catches in Norway.

Year	Østfold	Vestfold and Telemark	Rogaland	Sogn og Fjordane	Møre og Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland	Troms	Finnmark	SUM
1997	9	0	4	12	10	3	4	12	4	2	**60**
1998											**83**
1999	5	0	19	24	72	36	12	102	22	16	**308**
2000	10	0	33	78	30	51	2	115	31	9	**359**
2001	18	0	31	83	64	60	12	160	29	9	**466**
2002	28	0	34	67	63	76	5	101	33	5	**412**
2003	19	0	28	95	0	123	10	154	23	15	**467**
2004	19	0	35	93	68	82	6	111	87	48	**549**
2005	22	0	36	93	42	101	13	109	87	111	**614**
2006	7	0	44	40	37	86	18	197	69	40	**538**
2007	28	0	47	41	67	178	18	386	95	45	**905**
2008	18	0	46	42	62	185	19	383	95	50	**900**
2009	30	0	35	40	64	140	22	111	100	43	**585**
2010	9	0	17	13	25	33	6	37	9	10	**159**
2011	14	0	15	0	0	21	5	106	64	5	**230**
2012	15	0	12	0	0	89	5	164	60	10	**355**
2013	13	0	28	22	19	118	6	222	57	26	**511**
2014	10	0	26	20	20	15	0	211	78	29	**409**
2015	10	25	14	26	19	15	0	141	27	20	**297**

Status

Harbour seals were counted along the entire mainland Norwegian coast at known haulout sites during the moulting period from mid-August to early September 2011-2015. In 2011 and 2012, moulting areas from Rogaland to Finnmark counties and in Østfold county were covered by aerial photo surveys flown at altitudes of approximately 245-275 m during low tide (± 2 hours). Surveys in Østfold county were flown at approximately 90 m. The small tidal amplitudes in Østfold permitted counts to be carried out during day time irrespective of the tidal cycle. Usually three independent surveys were conducted. Visual counts using binoculars from small boats and land were also carried out in areas not covered by aerial surveys, or where results from the aerial surveys seemed to be incomplete. The surveys revealed a minimum total population of 7,642 harbour seals along the mainland Norwegian coast in 2011-2015. In western Finnmark, 395 harbour seals were counted in 2013. West Finnmark was not covered in the two previous surveys. The 2011-2015 count of 7,247 harbour seals (not including West Finnmark) is close to the counts of 6,938 animals in 2003-2006 and 7,465 in 1996-1999.

Discussion

Seals in the water are counted during the boat-based counts, but only counted close to haulout sites in the aerial surveys, likely underestimating seals in the water in the aerial surveys. The WG asked what proportion of the counts are based on the boat-based counts versus the aerial counts, and whether there could be an issue with sometimes counting the animals in the water and sometimes not. Norway informed the WG that the numbers of animals counted in the water are generally very small and therefore have little effect on the counts. The group concluded that as long as the methods are kept consistent, it works fine as index numbers and trend analysis.

It could be important to investigate whether haulout behaviour has changed over time. For example, seal haulout behaviour may have changed due to behavioural changes in response to predation and/or disturbance. Some harbour seal areas in Norway may be affected by tourism (e.g. kayaks) and some fishing activity. In the UK, modelling of the haulout behaviour of harbour seals revealed that the most important covariate ended up being day of the week which was found to be related to the weekend days when people were out walking their dogs close to seal haulouts.

Request from the Norwegian Directorate of Fisheries
The Directorate has asked for advice on setting a quota for seals in Aust-Agder county, citing an influx of seals from the Swedish coast.

The Secretariat noted that this request did not follow the proper procedures for requests for advice from the NAMMCO Scientific Committee, and that the WG therefore was not in a position to give formal advice on this issue. Nevertheless, the WG did comment that there is no data supporting seals coming from other areas into Norwegian Skagerrak. Additionally, there are too few seals in this area to set a quota. Norway is planning to start telemetry studies on seals in Norwegian Skagerrak to get information on possible movements between areas and may be able to comment further after the result from these studies are available.

Recommendations 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.

4.2 Iceland

Management
In 2006, the Icelandic government published a management plan where a minimum population size of 12,000 harbour seals was recommended (NAMMCO annual report, 2006). The management plan states that management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor a definition the term “appreciably”. A partial harbour seal count in 2014 indicates that the population was already under the recommended population size (see population assessment below).

Catches and regulatory measures
Traditional hunting of harbour seals has decreased from around 3,000-4,000 in the 1980s to around 300 per year during the last decade. In Iceland, seal hunting does not require a specific hunting license (only the license to own a weapon), and no specific quota system has been established for the seal populations. Seal hunting from land and shallow waters is managed by land owners and there are no special protected areas or protected periods (e.g., breeding season)

of the year for seals except those imposed by land owners and general regulations on hunting. It is not mandatory to report direct seal catches to the government. Members of the Seal Farmers Union (SFU) can voluntarily report their catch statistics to the organization and other known hunters are contacted directly by the Icelandic Seal Center.

The catch numbers from the early years are likely reliable because there was a bounty (to reduce sealworms), so hunters had a good incentive to report their numbers. Recent catch numbers are less reliable.

Population Assessment
Harbour seal surveys are conducted during the moulting period in August, and in the first nine surveys the entire coastline was surveyed at least once. During the latest full census in 2011 (Granquist et al. 2011), the survey method was updated following Teilmann et al. (2010) and the whole coast was counted 3-4 times instead of once like in earlier surveys. The population size in 2011 was estimated to be between 11,000 and 12,000 animals.

Due to financial reasons a full census has not been conducted since 2011. However, a partial count was carried out in 2014, where areas with known high harbour seal density were counted (northwest, west and south west parts of Iceland). In the same areas that were surveyed in 2014, 62.0% (SD = 5.07%) of the seals were found in the survey from 2011, and hence given that the distribution of the seals has not changed severely, these areas should give a fairly good indication of the status of the population. The results showed that on average, the annual decrease was 28.55% in the surveyed areas. It should, however, be underlined that there are too many unknown variables to know if the decrease is applicable to the rest of the country (Granquist et al. 2014). Nevertheless, assuming that the decrease found in 2014 only applies to the counted areas and that the population is stable in other areas, the whole population is estimated to have decreased from ~11,500 to ~8,000 animals between 2011 and 2014.

There is a large uncertainty regarding reasons behind the possible decline and further research regarding this is necessary. One theory has been that a decrease in sandeel (*Ammodytes marinus*) could have affected the seal population. Hunting could have played an important role in the harbour seal population decrease, but it is uncertain how much. Due to low reliability of direct catches and by-catch numbers, the reported numbers of removals can be seen as a minimum and hence, human removals probably have an effect on the seals. The knowledge about the stock identity of the Icelandic harbour seal population is also scarce and more research regarding pup production, general age distribution in the population, etc. is needed.

Current research on biological parameters and stock identity
A study on haulout patterns of harbour seals in Iceland has confirmed that the timing of surveys is appropriate. The distribution of seals showed a bimodal pattern, with the first peak occurring in late May/early June and the second peak occurring in late July/early August, corresponding to pupping and moulting period respectively (Granquist and Hauksson 2016). Further, factors affecting the haulout probability were air-temperature, tide height and wind-direction which of only tide height has been possible to taken in to consideration in previous censuses. According to the results of Granquist and Hauksson (2016), the population should preferably be surveyed during a period of approx. 3 weeks, starting in the end of July. A challenge with the Icelandic census is, however, that a fairly large coastline has to be covered in a short amount of time, which has been proven to be hard due to often bad weather conditions and poor visibility and hence few possible flying days. This has resulted in prolonged survey time, which could reduce the significance of the results.

A more detailed study of the timing of pupping and factors affecting pupping under Icelandic conditions is planned and a pilot study on Vatnsnes, NW Iceland shows that the peak of the pup/adult ratio was reached the 15th of June and that the main pupping period was late May/early June (Hauksson and Granquist 2016).

The condition of the harbour seal population was investigated by Hauksson and Ólafsson (2016) by comparing blubber thickness on the lower end of sternum from seals caught in 1981, 1995 and 2009. The results showed that blubber thickness was lower in 2009 compared to the two other years, both for female and male seals which indicate that the condition of the seals has decreased. The reason for this needs further investigation.

In collaboration with an engineering company in Iceland (Svarmi ehf), possibilities for using infrared cameras on drones for monitoring seal haulout sites is being developed.

The importance of harbour seals as prey species for killer whales is being investigated using stable isotope analysis.

Stock identity

Andersen et al. (2011) found that Icelandic harbour seals were significantly differentiated from harbour seals in Greenland, Northern Norway and Svalbard. Two subsamples from Iceland analysed by Andersen et al. (2011) did not show significant differentiation, but their haplotype composition differed strongly from earlier data presented by Stanley et al. (1996). The reason for this discrepancy is not clear but could possibly derive from sequencing problems in the earlier analyses when technical aspects of sequence analysis were less developed.

Muscle samples from Icelandic harbour seals will be included in a study of harbour seal DNA from several populations including Norway and the UK, the study will hopefully help resolving uncertainties.

Discussion

The WG noted that it is somewhat illogical that it is mandatory to report by-catches, but not hunted animals.

The WG discussed at length the target population level for harbour seals that has been set by the Icelandic government, which is not based on any biological assessment. Over the past decade, a number of approaches have been developed to manage marine mammal populations. These management approaches incorporate the precautionary approach (PA) which strives to be more cautious when information is less certain, does not accept the absence of information as a reason for not implementing conservation measures, and defines, in advance, decision rules for stock management when the resource reaches clearly stated reference points (Punt and Smith 2001). The basis for this approach is to identify points or levels, referred to as conservation (limit), precautionary and target reference points, that provide an indication of the status of a population (ICES 2001). The NAMMCO/ICES/NAFO Working Group on Harp and Hooded Seals has developed an approach that has been adopted by Norway, Russia and Canada to manage harp and hooded seals. It is also consistent with the approach developed by HELCOM. Using the highest population level observed or inferred as the reference level, WGHARP identifies a precautionary level at 70% of the reference and a critical level at 30% of the reference level. Below the critical level, the population is considered to be in danger of serious harm while a population that falls between the critical and precautionary levels is considered to be a conservation concern.

If a similar management approach was adopted for Icelandic harbour seals, the reference level would be 33,000 which was the highest population observed. The Precautionary level would be 23,100 and the Critical level would be approximately 10,000. The current minimum number identified in the Icelandic Management Plan would fall within the cautionary zone, only slightly above the Critical Level. The most recent full population survey (2011) was 11,000 and would place the population just above the Critical Level. However, if the population estimate of 8,000 (from the partial survey in 2014) was used it could place the population below the Critical Level.

The IUCN has developed criteria to identify when populations are a conservation concern. One of the key indicators is a decline in abundance from historical levels. For example, IUCN considers a 50% decline in abundance over a period of up to 3 generations to be sufficient to classify a population as Threatened while a decline of 70% would indicate that a population should be considered Endangered. Harbour seals are considered to have a generation time of 15 years which would result in considerations of declines over a period of up to 45 years. The Icelandic harbour seal population would meet the criteria for Endangered according to the IUCN framework

Recommendations for Iceland

- 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.

4.3 Greenland

At SC/22, Greenland reported that "…a new small group of harbour seals (three mothers with pups) was documented. Only four regularly used haulout places (with a total of less than 100 seals) is presently known in Greenland. All hunting on this species was banned in 2010 and it is believed that several small remnant populations still exist, but live undetected."

4.4 Sweden and Denmark

Annual harbour seal population growth rates after 2002 varied between 5.5 and 9% among areas, which is considerably lower as compared with earlier decades, when annual growth rates varied between 11 and 12%.

Total projected numbers in 2015 amounted to about 6,000 harbour seals in the Skagerrak, with a rate of increase of 6.6% per year (since 2002), and there are signs of that the population is approaching the carrying capacity.

The Kattegat/Danish Straits harbour seal population size is estimated at 10,000, with a rate of increase of 6.2% from 2002-2015. This rate is lower than the +12% increases seen in previous years, suggesting that the growth is levelling off, possibly caused by density dependent effects.

The Southern Baltic harbour seal population is 1,100, with an average annual rate of increase of 8.4% up to 2015.

The size of the Limfjord harbour seal population appears to have been fluctuating around 1,000 individuals since the early 1990s and appears to have reached its carrying capacity, although an annual increase at 5.6% is suggested by the surveys from 2003-2015. However, genetic analysis indicates that there may be movement of seals between this area and the Wadden Sea.

The harbour seal population in Kalmarsund is genetically divergent from adjacent harbour seal populations (Goodman et al. 1998) and experienced a severe bottle-neck in the 1970s, when only some 30 seals were counted. Long-term isolation and low numbers have resulted in low genetic variation in this population (Härkönen et al. 2006). The population has increased annually by 9% since 1975 and counted numbers amounted to about 1000 seals in 2014. See also Härkönen and Isakson (2011).

Discussion
The WG inquired whether grey seals could be having an impact on the Kattegat/Skagerrak harbour seals, however the grey seal population is small in this area so it is unlikely.

4.5 Mainland Europe

The Wadden Sea Secretariat writes on their home page: “Since the last massive epizootic in 2002, which killed almost half of the population, harbour seal numbers increased constantly until 2013. The experts considered recent growth rates as a sign that the overall increase of the population has slowed down. Traditionally the seal counts are conducted during the moulting period in August, when many animals rest on haul out sites on sand banks and beaches. Consequently, last year’s influenza effects were documented for the first time in this year’s seal numbers. In Denmark and Schleswig-Holstein, which were mostly affected by the disease, 3,400 harbour seals were found dead or severely sick. In Lower Saxony and the Netherlands only a small number of dead animals were found later in the year. Last year’s assumptions by the TSEG that the disease might not have a major impact on the overall population were finally confirmed by seal numbers in 2015. During the surveys a total of 26,435 harbour seals were counted in the Danish, Dutch and German Wadden Sea”

Harbour seals in France occur in three areas: Baie du Mont Saint Michel, Baie des Veys and Baie de Somme. The largest colony is situated at the Baie de Somme, with a maximum of 186 individuals recorded on one occasion in the summer of 2008. No later data are available.

4.6 United Kingdom

Smout gave an update on the status of harbour seals in the UK.

Latest UK survey results

From August surveys carried out between 2007 and 2014, the minimum number of harbour seals counted in Scotland was 23,355 and in England & Wales 4,806 making a total count for Great Britain of 28,161. Including 948 harbour seals counted in Northern Ireland in 2011, the UK harbour seal total count for this period was 29,109.

In the annually surveyed part of the Moray Firth (Helmsdale to Findhorn), the moult count was the lowest ever recorded for this area. The severe decline continued in the Firth of Tay & Eden Estuary harbour seal Special Areas of Conservation (SACs see http://jncc.defra.gov.uk/page-23 and http://jncc.defra.gov.uk/ProtectedSites/SACselection/SAC_list.asp?Country=S), with the 2014 moult count (29) being the lowest recorded to date, 42% lower than the 2013 count (50). This new count suggests that only 6% of the average population counted between 1990 and 2002 currently remain within this harbour seal SAC. No additional declines have been identified in other parts of the UK, for which new data are available (i.e. east coast of England, W Scotland), and populations seem to be stable or possibly even increasing. Surveys planned for August 2016 will hopefully complete the current round-Scotland survey.

Intensive study in the Northern Moray Firth Area

Behavioural, demographic and population data from a population in part of the Moray Firth (north- east Scotland) were used to fit an age-structured population model in order to estimate vital rates and changes in these rates over time. A Bayesian hidden process approach facilitated detailed modelling of observation errors e.g. allowing for the behaviour of animals to influence the probability of observing them. The effects of removals due to shooting were included. Forecasts from the model suggest a slow population recovery in the near future. Of the demographic rates, the fecundity rate seems to vary most rapidly, suggesting this parameter is particularly sensitive to short-term environmental changes. The possible impact of covariates on vital rates was also investigated including prey, environmental indices, and biological variables such as grey seal population density and concentration of biotoxins. Evidence of an effect was found for two of these: (a) grey seal abundance (affecting pup survival) and (b) sandeel abundance (affecting fecundity).

4.7 Russia

No new information was available to the WG. Table 2 gives an abundance estimate from 1998 as reported in Zyryanov and Egorov (2010).

4.8 Canada

Little is known about the current status of harbour seals in eastern Canada given the last, and only comprehensive, study was conducted in the early 1970s when the total population south of Labrador was estimated to be 12,700 (Boulva and McClaren 1979). Since then research has been limited to specific areas. After increasing during the 1980s, harbour seal abundance on Sable Island underwent a rapid decline through the 1990s when it was estimated to be less than 100 animals (Bowen et al. 2003). In contrast, harbour seals are reported to have increased in the Bay of Fundy although the numbers are not known. Sjare et al. (2005) found that the distribution of harbour seals in Newfoundland and Labrador was generally consistent with observations made in the 1970s. There was also limited evidence suggesting that local abundance of seals at some known haulout sites in the more southern portions of the province may have increased while abundance at sites in more northern areas of the west, northeast and Labrador coast are generally consistent with reports from the 1970s (Sjare et al. 2005). Based on surveys carried out between 1994-2000, abundance of harbour seals in the Estuary and Gulf of St. Lawrence was estimated to be approximately 4,000–5,000 animals (Robillard et al. 2005). However, trends in abundance could not be determined due to the small number of surveys.

Discussion

The WG noted that the last survey in eastern Canada was conducted 45 years ago, and whether this stock could be considered data deficient in the IUCN system.

The WG suggested that Canada collect data on harbour seals in eastern Canada, especially an abundance estimate.

4.9 Eastern US

Abundance and Removals

The most recent abundance survey for harbour seals in the U.S. was conducted in May 2012. Aerial photographic surveys and radio tracking of harbour seals on ledges along the Maine coast were conducted during the pupping period, to count seals and to develop a correction factor for the fraction of seals not observed. The corrected estimate of harbour seal abundance in 2012 was 75,834 (CV=0.15) (Waring et al. 2015a). The 2012 population estimate was 24% lower than the 2001 estimate of 99,340 (CV=0.09) (Gilbert et al. 2005). Currently there is some uncertainty in the patterns of harbour seal abundance and distribution in the Northeastern U.S. Johnston et al. (2015) document a decline in stranding and by-catch rates of harbour seals, providing support for an apparent decline in abundance. However, there has been very little systematic research conducted on fine-scale changes in habitat use, particularly in relation to the sympatric population of grey seals. Therefore, a decline in the apparent abundance of harbour seals could be explained by changing distributions and survey designs. There are plans to conduct a new survey in the next few years.

For the period 2008-2012, the total human caused mortality and serious injury to harbour seals was estimated to be 441 per year (Waring et al. 2015b). This includes 431 (CV=0.12) mortalities in U.S. commercial fisheries, and 10 from non-fishery related causes.

5. STATUS OF GREY SEAL STOCKS

a. Information on catches and regulatory measures
b. Current Research (Biological parameters, stock identity, distribution/migration)
c. Population assessments

The WG discussed the status of grey seals stocks in the North Atlantic. A summary of the current abundance and trend is provided in Table 4.

5.1 Norway

Catches

Prior to 2003 catches were reported in block periods, so they are reported as an average per year. After 2003, quotas were introduced. IMR recommended quotas of 5% of the population but the quotas were set at 25% of the population. The highest catches were in the northernmost counties of Troms and Finnmark (Fig. 1, Table 5). Tags from animals tagged in Russia have been recovered in northern Norway and two animals satellite tagged in Russia moved to Norway (Henriksen et al. 2007)

Genetics

The microsatellite data fits well with the current management areas, while the mitochondrial data shows sign of further subdivision (Frie unpubl. data).

Table 4. Recent abundance and trends of grey seals in the North Atlantic.

Country	**Recent Survey Year(s)**	**Abundance**	**Current trend**
Norway			
Total	2011	Pup production (2006-2008): 1275 Total: 8,740 (95% CI 7,320-10,170)*	increasing
Trøndelag and Nordland	2014-2015	Pup production: 332?	ca 60% decline in pup production
Finnmark		206	stable
Iceland			
	2012	4,200 (95% CI: 3,400-5,000	declining?
Faroe Islands			
	None	~1,000-2,000**	unknown
Baltic			
	2014	~33,000	increasing
Wadden Sea	2015	4521	increasing
France	2007	150	
United Kingdom			
Inner Hebrides	2014	4,054 (pups)	slight decline
North Sea	2014	6,627 (pups)	increasing
Republic of Ireland	2012	2,100 (pups)	increasing
Eastern Canada	2014	505,000 (95% CI: 329,000-682,000)	increasing

* Modelled estimate; ** This estimate is not based on survey data.

Pup production surveys and modelling

Øigård et al. (2012) used a population model to describe the dynamics of the Norwegian grey seal population based on data from the three pup counts covering the entire grey seal distribution area in the period 1996-2008, as well as empirical data on hunting and by-catch mortalities. The model also required estimates of natural mortality and female reproductive rates, but since empirical data on these parameters were outdated or absent, they were estimated by the model using a Bayesian approach. Model runs indicated an increase in abundance of the total Norwegian grey seal population during the last 30-years, suggesting a total of 7,120 (5,710 – 8,540) animals (1+) in 2011. Including an estimated pup production of 1,620 (95% CI 1,410-3,050), resulting in a total of 8,740 (95% CI 7,320-10,170) animals estimated in 2011.

New boat based surveys carried out in the entire area from Froan in Sør-Trøndelag to Lofoten in Nordland in 2014-2015 showed a significant decrease in the grey seal pup production compared with the counts in the period 2007-2008. The 2014-2015 pup counts in each area ranged between 34.8% and 47.5% of the counts in 2007-2008. In Finnmark the pup production in 2015 was approximately equal to the results in 2006.

Table 5. Grey seal catches in Norway. See Fig. 1 for county locations.

Year	Rogaland	Sør-Trøndelag	Nord-Trøndelag	Nordland	Troms	Finnmark	SUM
1980	0	0	14	8	3	55	**80**
1981	0	0	31	20	3	55	**109**
1982	0	80	10	65	3	55	**213**
1983	0	55	0	78	3	55	**191**
1984	15	200	8	146	3	55	**427**
1985	5	32	0	0	3	55	**95**
1986	5	10	0	16	3	68	**102**
1987	5	10	22	38	3	68	**146**
1988	5	10	5	20	3	68	**111**
1989	5	10	5	20	3	68	**111**
1990	5	10	5	20	3	68	**111**
1991	5	10	5	3	3	5	**31**
1992	5	10	5	3	3	5	**31**
1993	5	10	5	3	3	5	**31**
1994	5	10	5	3	3	5	**31**
1995	5	10	5	3	3	5	**31**
1996	5	10	5	3	3	5	**31**
1997	5	10	5	3	3	5	**31**
1998	5	10	5	3	3	5	**31**
1999	9	44	14	7	3	53	**130**
2000	70	45	5	31	3	22	**176**
2001	27	20	12	34	12	0	**105**
2002	23	24	19	20	5	19	**110**
2003	44	96	46	120	9	50	**365**
2004	30	67	51	94	42	54	**338**
2005	51	48	34	105	14	127	**379**
2006	60	51	27	69	39	129	**375**
2007	60	40	23	134	35	174	**466**
2008	60	40	72	103	37	203	**515**
2009	67	31	62	119	4	235	**518**
2010	38	19	38	41	20	208	**364**
2011	23	7	5	25	25	26	**111**
2012	17	8	14	16	8	12	**75**
2013	31	14	20	58	1	59	**183**
2014	65	11	19	41	12	68	**216**
2015	59	0	0	17	1	4	**81**

These new pup counts were included in the Øigård et al. (2012) model resulting in estimated populations in 2016 of 453 (95% CI: 300-606), 263 (95% CI: 108-418), 1,128 (95% CI: 685-1,571) and 1,328 (95% CI: 914-1,742), respectively for the counties Sør-Trøndelag, Nord-Trøndelag, Nordland and Finnmark. When assuming the same population sizes in 2016 as in 2006-2008 for the counties Troms and Rogaland, the total number of grey seals in Norway was suggested to be 3,850 animals (95% CI: 3,504-4,196) in 2016.

The population dynamics model of grey seals (Øigård et al. 2012) is too constrained to reproduce the inter-annual variability pattern observed in the pup production data, most likely as a result of lack of model complexity i.e. the model includes too few biological processes. Also, the lack of updated pup counts in Troms and Rogaland suggest that the 2016 estimate should be re-examined and the 2011 estimate considered to be the most recent acceptable.

<u>Discussion</u>
A significant decline in pup production has been observed in the counties Sør-Trøndelag, Nord-Trøndelag and Nordland, suggesting a possible decline in the total population. However, the current population model is unable to account for the decline, therefore the total abundance estimate is not reliable. The decline in pup production is likely due to high levels of by-catch in the monkfish fishery. The WG suggested that it could be interesting to plot the monkfish catches against the pup production. Although they do not have annual surveys, it could be a good visual comparison.

Detailed suggestions were given for improvements for the modeling, such as incorporating improved input estimates of by-catch for the model, age structure of the by-catch, and temporal (and spatial, if possible) variation in by-catch. Another suggestion was to use the modelling to estimate 'catchability' parameters for grey seals in fishing gear. These would directly scale actual fishing effort (or catch, although that is less useful as an index) into seal deaths. It might be possible to use observed by-catch rates from the reference fleet as priors for these catchabilities. Catchabilities could be estimated as a function of seal age.

Recommendations for Norway

- Development of the model. The model must be re-examined to try and determine if it can be modified to account for the observed changes in pup production. Can the model estimate changes in mortality that could explain the drop in pup production?
    - First update the by-catch, using the coastal reference fleet, create an annual estimate of by-catch based on annual landings statistics. May start to capture the fluctuations.
    - Need to look at age structure of the by-catch, especially if some older animals are taken. Samples for age data should be collected (e.g., jaws).
- More frequent surveys, particularly in the areas of decline. A survey every 5 years is not sufficient to detect these rapid drops in pup production. These data will also help refine the population model.
- Tagging of grey seal pups
- Age-structure of the hunt: If the mark-recapture flipper tags are used for by-catch estimation, the age structure of the hunt needed because flipper tag recoveries from the hunt are used in the equation for by-catch estimates. The age structure of the hunt is assumed to be the same age structure as the by-catch, and this assumption needs to be tested

- Complete the genetics study within this year
- Increase the number of vessels in the reference fleet in the areas of high by-catch (especially Nordland)
- Increased survey effort on grey seal assessments in areas of significant decline. Important areas could be identified to be surveyed in between other full-coast surveys.
- 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

Additional recommendations related to the evaluation of the Norwegian management plan for grey seals are listed in Item 6.

5.2 Iceland

Current management
In 2006, the Icelandic government published a management plan where a target grey seal population size of 4,100 was recommended (NAMMCO annual report, 2006). Management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor was "appreciably" defined. Calculations based on the latest population count in 2012 reveal a 44% likelihood that the population was smaller than the recommended number of 4,100 animals, which should be consideration in regards of management and exploitation of the population.

The regulations for hunting are the same as for harbour seals. The number of direct catches of grey seals are few, with only 1-2 recorded per year in recent years.

Status
Pup counts were conducted during the pupping period since 1980 (11 full surveys and 4 partial counts) of all breeding sites. The assessments are mainly performed via aerial surveys, with some ground and boat based surveys. The pupping period is 29 September-31 October, with the peak at 5 October. Until 2005, only one count was performed at each site, but since then three counts were performed at each site. The pup counts are minimum estimates because they are not corrected for possible missed pups.

The most recent abundance estimate (from the 2012 survey) is 4,200 (95% CI: 3,400-5,000).

The reference point for the highest population level was 10,000 from a survey in 1991 but this should be considered a minimum estimate because the survey was only flown once and therefore seals may have been missed on that particular day.

In 2007-2010, 58 hunted seals were aged and found to be mainly pups and juveniles.

A tagging study has begun, where 200 pups have been tagged so far. Tagging will continue during the next population count. So far, only 3 tags have been recovered from by-catch.

Discussion
As similarly discussed for the harbour seal (Item 3.2), the target population size set by the Icelandic government is not based on biological assessments.

If a similar management approach (see Item 3.2, harbour seals) was adopted for Icelandic grey seals, the reference level would be 10,000 which was the highest population observed. The

Precautionary level would be 7,000 and the Critical level would be 3,000. The current minimum number identified in the Icelandic Management Plan would fall within the cautionary zone, above the Critical Level. The most recent population estimate (~4,200) would place the population below the Precautionary Level.

The WG also discussed that this population might not be above the minimum viable population size (Traill et al. 2010) necessary to maintain genetic diversity, which has been estimated to be around 5000 individuals (95% CI = 3577–5129).

Additionally, the rate of decline may be greater than it appears (i.e., the previous population size was larger) because the previous estimates are not as reliable as the estimates since 2005.

Stock structure
Frie also noted that genetics studies (Frie 2009) indicate that the Icelandic grey seals are an isolated population.

Recommendations for Iceland

Primary

- A Management Plan should be developed including:
    - the frequency of surveys
    - legislation of seal hunting
    - 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

5.3 Faroes

Mikkelsen presented paper SC/23/CSWG/16. For grey seals in Faroese waters, the most updated knowledge was on stock identity. Grey seal samples from Faroe Islands were integrated in a study on population structure and demographic history, using samples from 22 colonies from Western and Eastern Atlantic and the Baltic Sea (Klimova *et al*., 2014). The markers used were represented by a 350 base-pairs region of the mitochondrial hypervariable and up to nine microsatellites. The overall finding of the study was a strong population structure among the colonies. Interestingly, a highly asymmetrical pattern of gene flow was inferred, with the Orkney Islands being a sort of emigrants to other areas in the Eastern Atlantic. Furthermore, the expansion across the species range had mainly occurred in the postglacial period. Additionally, Cammen *et al*. (2011), when studying the genetic diversity in the major histocompatibility complex of grey seals from 8 colonies in UK, Sable Island and the Faroe Islands, found significant genetic differences between all colonies. With respect to the grey seal colony in the Faroe Islands, the results show that they have evolved from UK colonies sometimes after the postglacial period, and that the colony has been isolated, evolving to a distinct population.

Movements of Faroese grey seals have been investigated using satellite tags. The seals were found to be stationary on the Faroe Plateau, where only a few of the seals were tracked outside the 100m depth contour. Also, for most of the tracking period the seals were distributed close to their preferred haul-out sites, which typically numbered one to three sites. Movements between locations occurred mainly in shallow waters. When making multiple trips to off-shore feeding areas, the seals typically repeated their tracks to the same area. No seal was found to move longer distances from land than 35 nautical miles and for no longer period than three days. The overall movement pattern demonstrated that Mykines, Dímun and Fugloy are hot spot areas for grey seals in the Faroes.

Movements of UK grey seals to the Faroe Islands have been documented based upon both flipper and satellite tags (Hammond *et al*. 1993, Boyd and Campbell 1971, McConnell *et al*. 1999). Although a connection between Faroese and British grey seals has been demonstrated, showing that Faroese waters could be part of the space used by grey seals from the British Isles (Matthiopoulos *et al.* 2004), the intensity or influence of such a migration is not known. Of 199 grey seals tagged with satellite transmitters in UK, two seals travelled to the Faroes (1% of the tagged animals).

Population assessment

There has not been a population assessment for Faroese grey seals. Grey seals seldom haul out in high numbers in the Faroes. At most, up to 30 can be seen at favourable haulout sites, with the exception of the island of Mykines which is probably the most densely populated and frequently used area, where up to 300 seals can be seen at times. The present population size is probably on the level of 1,000-2,000 animals. Irregular observations around the islands indicate that the Faroese population has not shown a rapid increase, as has been evident for colonies around Britain (NAMMCO 2003) and in West Atlantic (Bowen *et al*. 2003). The main reason is thought to be because seals are subject to removals around salmon sea farms. This removal, which seemingly is keeping the population at a low level, started with the establishment of aquaculture in the islands in late 1970s. Also, high pup mortality, especially during the intense fall storms which could wash pups off breeding grounds, may affect population growth of grey seals in the Faroes. Many former breeding grounds, described by Landt (1800), are not in use today. The reason may be increased human activities and landscape deformation, forced by wave action, eroding the steep foreland of the Faroes (Reinert 1982, pers. obs.). A reduction in the number of protected breeding grounds, acting as a factor of density-dependence, may have affected breeding success. For the relatively small population of grey seals in the Faroes, removal of a significant number of animals around fish farms, together with high pup mortality, will have the potential for a significant impact on the size and development of the population.

Discussion

As discussed under Item 3, the impact of removals at fish farms may be high considering the uncertain, and small, estimated population level. The WG recommended that the Faroes 1) obtain reliable and complete removal numbers and 2) calculate the necessary population size to sustain the removals.

The Faroes appears to have a localized population based on telemetry and molecular markers (Klimova et al 2014), that is significantly different from Norwegian grey seals. Frie (unpubl. data).

Recommendations for the Faroe Islands

Recommendations for research and monitoring are discussed under agenda Item 7.

5.4 Baltic

The Baltic grey seal (*Halichoerus grypus macrorynchus*) is a recognised subspecies of the Atlantic grey seal (*H.g.grypus*). The subspecies is motivated by distinct geographical distribution range in the Baltic Sea and a difference in birth timing (Oct. –Jan. in East Atlantic, Jan. - March in the Baltic).

In the Baltic, the grey seal has been heavily hunted during the 20th century and also the fertility rates were reduced by environmental toxins in the second half of the century. The population went through a depression in the 1970s with numbers as low as only 3,000 individuals (Harding and Härkönen 1999). In the last decades of the 20th century the population started to recover and currently the species is classified as "least concern" in the HELCOM Red List of Species (HELCOM 2013).

Given the continuous distribution of the species and free movement of individuals in the Baltic Sea the species is treated as a single management unit, and the grey seal management principles are defined by the HELCOM Seal Recommendation (HELCOM 2006). The long term objectives are: to allow population growth towards the carrying capacity, to allow the breeding seals to expand to suitable distribution in all areas of the sea, and attaining health status that secures continued existence of the populations. The population target limit is defined by the ecological carrying capacity.

The grey seal population is monitored by counting the hauled out proportion of the animals during the annual moult. The counts are based on aerial photography and monitoring effort is synchronised between countries to reduce double counting. Population increase is calculated from the counts and has reached 10-12% per annum during the early 2000s, but has slowed to about 6% in recent years. Counted numbers fluctuate annually because of weather and other factors, but clear increasing trends in populations can be observed in all parts of the Baltic Sea. In sub–areas, the increase in seal counts is most notable in Southern Sweden - Danish Belts. Pup numbers cannot be used for population estimate in the Baltic as the species prefers ice as a breeding platform where pups are more difficult to count.

Discussion
When ice-conditions are poor, the seals will move to breed on land in roughly the same area. If there is ice present at all, they will breed on the ice. Therefore, accounting for pups on the ice could be very important, however the abundance estimates are based solely on the moult counts, not a population dynamics model.

Breeding time is earlier in the southern Baltic (January-early February). Younger females tend to breed earlier than older females in the Baltic, however in the UK younger females breed later.

Jüssi noted that weaning weights of pups born on the ice are higher than pups born on land, and weaning weights of ice-born pups in recent years are lower than in the 1990s. The WG noted that the weaning weights were not significantly different in different areas. Despite the differences, the lower weaning weights may not be below the critical weaning mass limit. Information on survival of the pups after weaning would be interesting.

5.5 Russia (Murman Coast)

There is no updated population estimate since the early 1990s on grey seals (Haug et al. 1994) from Russia, when the total grey seal population were calculated to be about 3400.

5.6 United Kingdom and Republic of Ireland

Smout presented information on status of grey seals in the UK and the Republic of Ireland.

In the 2014 grey seal breeding season, pup production at the Inner Hebrides colonies was estimated to be 4,054, slightly lower than the 2012 estimate of 4,088.

At the four English North Sea colonies, pup production in 2014 was 6,627 compared with 4,963 in 2012 and 5,539 in 2013. There was a massive increase in the number of pups born at Blakeney Point (2,425 pups born in 2014 compared with 1,560 in 2013) which is now the biggest grey seal breeding colony in England, overtaking Donna Nook (1,799 pups) for the first time.

Some investigations were carried out, based on the existing Bayesian state-space modelling methodology for British grey seal populations. The model allowed for density dependence in pup survival, using a flexible form for the density dependence function, and assumed no movement of recruiting females between regions. This model is identical to that used to provide last year's advice, and the same "revised" priors were used, including a prior on adult sex ratio. One small change in data was that the total population size estimate was adjusted to account for the fact that the population model is based only on regularly monitored breeding colonies (approx. 94% of the total population). We used the model to predict past the last data point (2012) to give estimates of population size in 2014. Estimated adult population size in 2014 was 95,200 (95% CI 76,400-127,500).

The model assumes constant adult (i.e., aged 6+) female survival. The prior distribution has support in the range (0.8, 1.0) with a prior mean of 0.91 (SD 0.05); the posterior mean is an implausibly high 0.99 (SD 0.01). We investigated the effect of constraining the prior to the range (0.8, 0.97). Posterior mean adult survival with this revised prior was 0.95 (SD 0.03); estimated population size with this revised prior was 105,200 (95% CI 87,000-128,800).

Female survival is currently assumed to be the same for all ages. We investigated the possible effect of including survival senescence, and concluded that adding it would make no practical difference to the modelled population dynamics.

Sex ratio is an important parameter in the model, scaling estimates of adult female population size from the population dynamics model to total population size (total population refers to the population of moulting 1+ animals). The current prior 1.7 (SD 0.02) that is applied to the female numbers from the population model is highly informative (assuming that there are 0.7 male to 1 female). We investigated the consequences of using a less informative prior suggested in a previous briefing paper (prior mean 1.2, SD 0.63). With this prior (and the revised prior on adult female survival), total population size was estimated to be much lower (88,600 with 95%

CI 70,200-111,700), but the ratio of total population:adult females was an implausibly low 1.14 (SD 0.09).

In the Republic of Ireland, an increasing trend in pup production was observed in 2012. A pup production count in 2005 showed 1,600 pups while a new estimate in 2012 indicated an increase to 2,100 pups.

Discussion

The WG identified a couple of issues with the model. Firstly, the model shows that fecundity is high, but pup survival is very low. There may be inconsistency between the "independent estimate" and the pup counts, forcing fecundity to be too high. The August survey is probably not reliable because there is likely a lot less grey seals in the UK versus in the breeding season.

The problem may also lie with the sex ratio which is assumed to be 1.7 but is based on very old data. Further modelling did not give any information on the sex ratio, suggesting that more information is needed.

The main problem with the model is putting all density dependence on pup survival, which forces the fecundity rate up to unrealistic levels. If the density dependence was split between pup survival and fecundity, then the rate should be more realistic. The WG suggested testing the model's ability to predict the density dependent relationship for both fecundity and pup survival at a single point.

In addition, vital population parameters estimated by the model-fitting process deviate dramatically from empirical data on grey seals and all other phocid seals. Numbers of pups in the UK have increased by 5-6% per year over a longer period and amount to about 58,000. Therefore, there must have been a steady recruitment of females to the adult population section by 6-7% per year (assuming that pregnancy rates do not change and constant juvenile survival). Consequently, each sub adult cohort must have been more numerous than subsequent adult cohorts. This means that the very high pup mortality used in the model is unrealistic. If empirical values on vital population parameters for grey seals based on estimates from other areas are used in a Leslie matrix, the female population size needed to produce 58,000 pups would be about 130,000 females of all age classes, and the total population size including males could be about 250,000 (however, this depends on the sex ratio in the UK population which is not currently well known). The model fit currently has very low juvenile survival compensated by very high adult female survival and high fecundity. Further work is needed on the model to make the outputs (estimates of vital rates) more realistic.

5.7 Mainland Europe

Härkönen reported on annual pup production and moult counts in the Wadden Sea (Danish, German and Dutch coasts). Following a remarkable increase in 2014, the total number of grey seals in the Wadden Sea was 4,521 during the moulting period in spring. This is an increase of 5% compared to last year. The number of 829 pups indicates a further growth of the breeding population. For the first time specific grey seal counts in Denmark were conducted and the first newborn pup in the Danish Wadden Sea was documented. It seems that the grey seal population is establishing itself further in the Wadden Sea area and that the population is expanding northwards

In France, the most recent data available was a count of 150 grey seals 2007.

5.8 Eastern Canada

Canadian grey seals form a single genetic population that is divided into three groups for management purposes based on the location of breeding sites. Most pups (81%) are born on Sable Island (Sable), while 15% are born in the Gulf of St Lawrence (Gulf) and 4% are born along the coast of Nova Scotia (CNS). These proportions have changed over time, with a decline in the fraction of the population born in the Gulf.

The most recent assessment of Canadian grey seals was completed in 2014. A population model incorporating estimates of reproductive rates up to 2012 was fitted to pup production estimates up to 2010 to describe the dynamics of the grey seal population in Atlantic Canada. Combining all three herds, the model estimated a total 2014 grey seal pup production in Atlantic Canada of 93,000 (95% CI=48,000-137,000) animals, with an associated total population of 505,000 (95% CI=329,000-682,000). The model predicts that population size in all three management areas continues to grow.

Surveys to estimate current pup production were completed in February 2016. The results of these surveys, and a new estimate of total abundance, are expected in the fall of 2016.

In Canada, removals from the population from 2008-2013 include animals taken in the commercial harvest (1+) (an average of 389 per year), for scientific collections (an average of 205 per year), and as nuisance animals (an average of 3461 per year) (DFO 2014). Estimates of the number of seals killed as nuisance seals are poorly known. There are no data available on incidental catches, but the numbers are thought to be small.

5.9 Eastern US

Abundance and Removals
Efforts are underway to derive a minimum population estimate and population trend for the portion of the grey seal stock in U.S. waters, based on aerial surveys conducted in Massachusetts from 2005-2015 during grey seal moulting periods. In addition, the use of fixed-wing and rotary drones, as well as manned aircraft, was used to conduct surveys in 2016 over the grey seal breeding grounds in the U.S. These data will be used in coordination with those collected by Department of Fisheries & Oceans Canada (DFO) in 2016 to estimate pup production over the entire range of the stock.

For the period 2008-2012, the total estimated human caused mortality and serious injury to grey seals in U.S. waters was 1,095 per year (Waring et al. 2015b). This includes 1,086 (CV=0.11) mortalities in U.S. commercial fisheries and 9 from non-fishery related causes. Analysis of by-catch rates from fisheries observer programs likely underestimates lethal (Lyle and Wilcox 2008), and greatly under-represents sub-lethal, fishery interactions. Photographic analysis of grey seals at haulout sites on Cape Cod, Massachusetts revealed 5-8% of seals exhibited signs of entanglement (Sette et al. 2009).

6. REVIEW OF HARBOUR AND GREY SEAL STUDIES ON ECOLOGY

General
The WG noted that harbour seals appear to be declining in many areas where grey seals are increasing. There are some hypotheses that involve grey seals causing the decline, either

through competition for prey or breeding/haulout areas. Although there have been observations of grey seals predating on harbour seal pups, there are little data to indicate if this could have any impact on the harbour seal populations.

Norway

<u>*Grey seal diet*</u>
In order to achieve the knowledge of feeding habits and prey consumption of grey seals, data were sampled in selected areas along the Norwegian coast. Prey were recovered from 298 grey seals, including 128 gastrointestinal tracts and 177 faecal samples, collected between spring 1999 and winter 2007 in the Nordland, Finnmark and Rogaland counties. The grey seals fed on a wide variety of mainly benthic fish, where the most important prey were the gadoids cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*), and the wolffish (*Anarchichus* spp).

Total annual grey seal prey consumption of various species was estimated using a bio-energetic model. The input variables in the model are seal numbers, energy demands, diet composition in terms of biomass and the energy density of prey species throughout the year. Assumed that the observed grey seals diet composition in the sampling areas are representative for the diets in the three management regions Lista - Stad, Stad - Lofoten, Vesterålen - Finnmark, the mean total annual consumption of 3850 grey seals (95% CI: 3504-4196) of various fish species was estimated to be 8 240 tonnes (95% CI: 4664-12846) in Norwegian waters. The total estimated grey seal consumption of wolffish was 2088 tonnes (95% CI:1227-3164), while the total consumption of cod was 2102 tonnes (95% CI: 1311-3164). Mean consumption estimates of saithe, haddock and unidentified codfish were respectively 720, 311 and 2570 tonnes.

The estimated grey seal prey consumption of gadoids is low compared with fishery catches (commercial and recreational/tourist fishery) and with stock sizes of cod, haddock and saithe. Future studies of grey seal feeding habits should include diet samplings throughout the year, and telemetric studies to detect important feeding areas.

<u>*Harbour seal diet*</u>
Nilssen presented on a local study on harbour seal diets (Ramasco 2016): “The local coastal cod stock of the Porsangerfjord has drastically declined in the 80’s and never fully recovered since. A population of harbour seals, known to be resident in the fjord all year round, has been hypothesised to act as predator-pit for cod in the area, affecting its lack of recovery. In order to understand the role of these seals in this local marine ecosystem, their foraging behaviour was investigated by assessing the presence of preference for certain prey and the behavioural response to the seasonal dynamics of prey distribution in the fjord. The movement patterns of individual harbour seals (n = 15) were followed between 2009 and 2013. The data obtained (i.e. GPS location, time-depth dive profiles, etc.) were first thoroughly analysed to provide a robust interpretation of the behavioural patterns of activities of the single individuals and identify the methodological caveats in the detection of foraging behaviour. Among the major results, two types of resting behaviour at sea were described, in the form of prolonged periods at surface but also as resting dives, a behaviour never documented before for this species. The patterns of activity suggested that harbour seals mainly forage during daylight in autumn and spring in this area. The foraging locations identified were then compared to the availability of potential prey in the fjord (i.e. herring, capelin, small and large codfish and sculpins). The availability of prey was assumed to be dependent on their biomass densities, their distance from the seals’ haulout sites and the accessibility of the areas where prey was located. The latter could be restricted,

for example, by the presence of sea ice in winter and spring. Results on the analyses of prey selection suggested that harbour seals in Porsangerfjord had a preference for small size fish (< 25cm). Small codfish was 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 in these areas during the winter season, however, provoked a shift to small codfish, due to the sudden inaccessibility of the pelagic fish. A strong reversed trend was observed in late spring when the ice melted and pelagic fish was preferred again. The results suggest the preference for small aggregated fish close to the haulout areas. The impact of harbour seals on the cod population of Porsangerfjord can be therefore hypothesized to change across seasons and to be lowered by the availability of highly aggregated pelagic fish during winter and spring."

Discussion

Bjørge reported that there are geographical differences in diet and also some interannual variability (Olsen and Bjørge, 1995, Berg et al. 2002).

In general, a small proportion of cod is found in the diet of harbour seals throughout Norway. Diet samples have indicated that grey seals are eating some cod, although the grey seal populations are probably too low to have any significant effect on the cod stocks in Norway.

Iceland

Diet

In the period 1992-94 (Hauksson & Bogason, 1997) collected stomach data for investigating diet of seal in Icelandic waters. In 2007-2010 seal stomachs were collected in the north-western coastal waters of Iceland, which made a comparison between diets of seals in the areas possible. This comparison revealed some switching in prey-species of seals in-between these periods, such as harbour seals feeding less on herring (*Clupea harengus*) and saithe (*Pollachius virens*), but more on capelin (*Mallotus villosus*), grey seals feeding less on sandeel (*Ammodites* spp.), saithe and bull-rout (*Myoxocephalus scorpius scorpius*), and more on lumpsucker (*Cyclopterus lumpus*), and harp seals (*Phoca groenlandica*) feeding less on sandeel, herring and saithe, but more on capelin, in the latter period, than the former. These shifts in diet are markedly similar to the environmental and biotic changes which had occurred in Icelandic waters in these periods; according to the annual ground fish abundance survey carried out by the Marine Research Institute, Reykjavik, Iceland, since 1985 there has been an increasing cod (*Gadus morhua*) population, haddock (*Melanogramus aeglefinus*) have been getting more abundant in the colder northern waters, capelin distribution has shifted toward more northerly feeding grounds, and last but not least ,nearly a total collapse of the lesser sand-eel (*Ammodites marinus*) population, at least in the southern waters of Iceland.

Discussion

The WG commented that in the absence of direct observations of historical sandeel abundance, an index of relative abundance can be deduced from historical variations of sandeel proportions in the diet of haddock, as done in recent ecological studies on common minke whales (Víkingsson et al. 2014, 2015).

Body condition

In this study seasonal change in blubber distribution and body morphology of 229 harbour seals, mostly pups and juveniles caught in northwestern Icelandic waters in the season May – July during 2007 – 2010 were examined. The young harbour seals were fattest, in best condition in beginning of July and leaner in April and in the end of July, which could be related to the beginning of the moulting in July. There were statistically nonsignificant indications that juvenile females and males were in worse shape (leaner) in the period 2007-2010, than the two earlier periods, 1979-1983 and 1990-2000, in May and June respectively, although data were limited. The authors speculate that evidence for worse condition could be related to poorer feeding opportunities in the latest period, compared to the two former periods, due to collapse of the lesser sandeel (*Ammadytes marinus*) population in Icelandic waters.

<u>Discussion</u>
The WG discussed that the body location on the seal where the blubber depth measurement is taken is important. Hauksson informed the WG that measurement was taken from 4 cuts along the dorsal and 4 cuts along the ventral side of the animals.

The WG also discussed that the energy content of the sandeels may vary seasonally, as for other species such as herring and capelin, and therefore it is important to consider this when classifying sandeels as an energy rich prey item.

Iceland noted that there also are some regional differences in consumption of sandeels by seals. The collapse of sandeel seems to be correlated to poor breeding success in seabirds. The reason for the sandeel collapse is unknown.

<u>Tourism</u>
A study on Vatnsnes, NW Iceland, showed that the harbour seals distribution changed during the main tourist period and that seals increased their vigilance during periods with many tourists in the area. However, this effect was also shown to depend on the behaviour of tourists since calm tourists had less impact on the seals (Granquist and Sigurjónsdóttir 2015). A review of seal watching codes of conduct was made (Öqvist 2014) and the potential to reduce negative impact on the seals during seal watching by interpretations on signs has been investigated (Marschall 2015). The effect of a seal watching boat on the behaviour of harbour seals has also been investigated and the results show that the boat affect the vigilance level of the seals, and that there is a correlation between flush response of the seals and the distance between the boat and the seal colony (Clack 2016).

<u>Discussion</u>
The frequency of the tourism (i.e., source of disturbance) was discussed. The boat trips can occur 3 times per day if tickets are sold. On the land site near the seal center, there is a constant flow of people (i.e., there are not set visiting times), and over the course of the year there are seasonal peaks.

Canada
The WG discussed Harvey et al. (2012), Hammill et al. (2014), and Swain et al. (2015). The potential impact of grey seals on depleted demersal fish populations (e.g. Atlantic cod, white hake and thorny skate) in the southern Gulf of St. Lawrence (sGSL), Canada was discussed. Twenty years ago, the Atlantic cod population collapsed due to overexploitation. Despite negligible levels of fishing mortality and strong rates of production of small juvenile fish, these populations have shown no sign of recovery and some continue to decline. Lack of recovery is due to dramatic increases in the natural mortality of larger individuals in these populations. Predation by grey seals has been proposed as an important cause of this high mortality. Stenson presented results from studies including population dynamics of the named fish species and others based on stratified-random bottom-trawl surveys conducted by the Canadian Department of Fisheries and Oceans (DFO) in the sGSL each September since 1971; on habitat use by

demersal fishes in relation to predation risk (grey seals) at large spatial and temporal scales in the southern Gulf of St. Lawrence ecosystem; telemetry studies of grey seals in relation to distribution of these fish species (and others) during late autumn and winter; diet studies of grey seals taken in overwintering areas in deeper waters of these fishes.

Distributions of cod, hake and skate have been correlated to the risk of predation by seals, with distribution shifting into lower risk areas as predation risk increased. Non-prey species did not show similar changes in habitat use. Spatial variation in fish condition suggests that these low-risk areas are also less profitable for cod and skate in terms of food availability. The effects of density dependence and water temperature were also important in models, but did not account for the changes in habitat use as the risk of predation increased.

Data from satellite transmitters deployed on grey seals (between 1993 and 2005) and winter bottom-trawl survey data (1994 to 1997) showed that the distribution of searching effort by male grey seals varied throughout the winter. In early winter, males concentrated their movements around St. Paul’s Island. In late winter, they were found to the southeast of this area, where females also occurred. The fish community differed between apparent foraging and non-foraging areas. Densities of small plaice, hake and redfish, large herring and cod of all sizes were relatively high in the male grey seal foraging zones; female foraging zones were characterized by higher densities of small plaice and redfish and large cod. Areas where grey seal foraging was not concentrated were characterized by high densities of medium and large redfish as well as large turbot and witch flounder.

In the Cabot Strait, where overwintering aggregations of cod were present, cod accounted for 68% (range 57–80%) of the male grey seal diet from stomachs, and 46% (range: 31–64%) of the diet determined from intestines. The mean length of cod consumed by seals was in the range from 28 cm to 39 cm in different areas but larger cod was also taken. Cod and hake were more important to the diet of males than that of females. The contribution of cod to the diet of grey seals foraging in the cod overwintering area was much greater than has been reported elsewhere.

Discussion

In general, there is good evidence that male grey seals feed on overwintering cod, and larger fish than had been previously thought, however it is unclear whether the level is sufficient to be limiting the recovery of the cod.

The WG noted that there could also be competition between grey seals and cod for prey. Frank et al. (2005) describes a cascading effect of changes in cod populations with increasing populations or influx of pelagic species, providing more food for grey seals. Although it was noted that some researchers believe that this paper may have mis-interpreted the data on abundance of pelagic fish.

UK

Smout presented Jones et al. (2015) which uses seal telemetry used to create habitat usage maps.

ABSTRACT: “Species distribution maps can provide important information to focus conservation efforts and enable spatial management of human activities. Two sympatric marine predators, grey seals *Halichoerus grypus* and harbour seals *Phoca vitulina*, have overlapping ranges on land and at sea but contrasting population dynamics around Britain: whilst grey seals have generally increased, harbour seals have shown significant regional declines. We analysed 2 decades of at-sea movement data and terrestrial count data from these species to produce high resolution, broad-scale maps of distribution and associated uncertainty to inform conservation and management. Our results showed that grey seals use offshore areas connected to their haul-out sites by prominent corridors, and harbour seals primarily stay within 50 km of the coastline. Both species show fine-scale offshore spatial segregation off the east coast of Britain and broad-scale partitioning off western Scotland. These results illustrate that, for broad-scale marine spatial planning, the conservation needs of harbour seals (primarily inshore, the exception being selected offshore usage areas) are different from those of grey seals (up to 100 km offshore and corridors connecting these areas to haul-out sites). More generally, our results illustrate the importance of detailed knowledge of marine predator distributions to inform marine spatial planning; for instance, spatial prioritisation is not necessarily the most effective spatial planning strategy even when conserving species with similar taxonomy."

Discussion

It was noted that the telemetry has been pooled from many different years, but one question is whether space use has changed over time.

7. EVALUATE THE NORWEGIAN MANAGEMENT PLANS FOR HARBOUR AND GREY SEALS

Bjørge presented Paper SC/23/CSWG/04. Management plans for coastal seals (harbour and grey seals) in Norway were adopted and implemented by the Ministry of Fisheries and Coastal Affairs on the 5th November 2010. There is now a five-year period of experience on how these plans have performed as the basis for management of seal populations in Norway. The overarching goal in the management plans is to ensure viable populations of harbour and grey seals within their natural distribution areas. In practical management, however, the government must balance the desire for the preservation of large seal populations against damage on fisheries and aquaculture in the coastal zone.

Harbour seals are monitored by counting hauled out seals during the moulting period and the government decided that the harbour seal population should be stabilized at a level where 7,000 moulting seals can be recorded. Grey seals are monitored by counting pups and the government decided that the population should be stabilized so that 1,200 pups can be recorded annually. These population levels are defined as the Target Level and quotas should be used to stabilize populations at these levels.

After a decade with high quotas and a declining population of harbour seals, since 2011 quotas were based on scientific advice in accordance with the management plan. This resulted in an initial increase before the population stabilized at the Target Level (TL).

It can therefore be concluded that the introduction of the management plan in combination with a new mechanism for providing scientific management advice (e.g. on quotas) resulted in a sound management of harbour seals that has fulfilled the politically decided objectives for management of the species in Norway.

The harbour seal is managed with the county borders as management unit. Using counties as administrative management areas for harbour seals is functioning well for the practical management (setting quotas, allocating hunting licenses, collating hunting statistics, etc). However, this should not prevent the completion of a genetic study to explore the population structure of harbour seals along the Norwegian coast in order to develop a better understanding of the biological units to conserve.

Until recently, the population of grey seals has been increasing slightly, and a survey in 2006-2008 revealed an annual pup production of 1,275. The quotas based in the years 2012-2014 were based on scientific advice in accordance with the management plan. In 2014 the Trøndelag counties and the southern part of Nordland county were surveyed and a significant and unexpected reduction in pup production was revealed. The recorded pup production was less than 50% of the pup production recorded in 2006-2008. According to the management plan the quotas should then be set to zero for these areas. The quota was immediately set to zero for these areas. In 2015 the northern part of Nordland county (the areas between Vega and Lofoten) were surveyed. This completed the survey of the Central Management Unit (Stad-Lofoten), and the total number of pups recorded in the area was less than 50% of the Target Level for the area and a zero quota was set for the Central Management Unit.

The management plan, in combination with the Scientific Advisory Board, provided the basis for quick management response to the reduction in pup production recorded by the abundance surveys. It can therefore be concluded that the management plan has performed well. The reason for the recent dramatic decline in recorded pup production is not clear. However, the decline is most likely caused by factors not regulated by the management plan, e.g. fisheries by-catch, reproductive failure due to illness, increased mortality due to illness, possible predation by killer whales, etc.

The NAMMCO WGCS in 2011 recommended that 0.7 TL should be the limit for setting quotas to zero. In the current case with the grey seals in the Central Management Area the decline had exceeded 0.5 TL before it was detected by the abundance surveys. However, this was mainly due to the timing of the surveys. The conclusion we draw from this is that large changes in pup production may occur within the five-year interval between surveys. The survey intervals should therefore not be extended, but rather shortened. We also advise that 0.7 TL should be the limit for setting quotas to zero in accordance with the recommendation from NAMMCO (2011).

Norway will maintain the three Management Units for grey seals based on biological evidence (the Southern MU from Lista to Stad; the Central MU from Stad to Lofoten; and the Northern MU from Vesterålen to Varanger). However, the first hand administration of hunting licenses and collation of hunting statistics are undertaken by the county authorities. For practical reasons we therefore suggest that administrative Management Areas should follow the county borders and that quotas are set for each county within the wider Management Units.

The management plans contain advice on research and monitoring. The abundance monitoring programme is carried out following the principles outlined in the management plans. However, the management plans advised on other research topics relevant for the management of the coastal seals. In particular, there were recommendations for research on the interactions between seals and fisheries. One aspect of such interactions is by-catch of seals in fisheries. Monitoring of by-catches of marine mammals is currently undertaken by the IMR. These by-catches are considerable and should be accounted for when generating hunting quotas.

According to the current legal regulation for management of seals at the Norwegian coast, it is legal to shoot seals that damage fish farms. It is important that seals shot at fish farms are reported to the Directorate of Fisheries and included in the statistics of animals removed from the populations. To mitigate the conflict between seals and fish farms there should be a mechanism for consulting seal experts at IMR when the location of new fish farms is planned. Such consultations could possibly be mentioned in the management plans.

Discussion

The WG agreed that the Norwegian management plans for harbour and grey seals managed the hunt, for which it was designed, well. However, recent information about the extent of the by-catches in a new fishery were not expected when the plan was implemented.

The WG noted that, similar to Iceland, the target population levels set by the Norwegian government for seals are not based on biological assessment. Although the Norwegian populations of seals are less at risk of loss of genetic diversity because they are connected to the UK and Russian populations, and the historical population levels (Øynes 1964, 1966) were lower than the current population levels for both species, this target level should be re-examined (see below).

Recommendations for the Norwegian Harbour and Grey Seal Management Plans

- The target population levels for both species should be evaluated (as discussed for Iceland) as the levels are not based on any biological assessment. The current target levels are set equal to the highest numbers recorded in recent years.
- The WG agreed with the Norwegian evaluation of the management plan to recommend that the quota is set to 0 when the population is at 70% of the target level instead of 50%. This change was also previously recommended at the 2011 CSWG.
- Management plans should include all sources of mortality, not just the hunt.
    - The CSWG recommends that Norway continue working with the NAMMCO WG on By-catch to ensure that the by-catch estimates are as good as possible.
    - The WG also recommends that all anthropogenic removals are considered when setting hunting quotas. This implies that seals shot at fish farms and salmon rivers should be reported to the Directorate of Fisheries and that data on marine mammal by-catches in recreational fisheries should be generated.
- The WG noted that there is a conflict between seals and fish farms, but there is no mechanism in the application process for establishing new fish farms for consideration of seal distribution. A mechanism for consulting IMR when fish farms are being built should be required when management plans are revised.

8. MONITORING PLAN FOR FAROE ISLANDS AND RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT

8.1 Recommendations for future research

The WG **recommended** analyses that can be undertaken with the existing data and should be completed as soon as possible.

- Population Viability Analysis
    - Numbers of removals can be used to estimate minimum population size of grey seals in the Faroes that is necessary to sustain the levels of removals. This requires that data is available from basically all parts of the Faroes. Longer time series of data on removals would give more robust estimates than shorter.

- Analysis of existing telemetry data
    - The Faroes should coordinate with the UK on the existing telemetry data to look at possible migration between the UK and the Faroes. This would be particularly informative from animals tagged in the Hebrides and Orkney.

The WG also **recommended** new research that should be conducted in the Faroes, and prioritized these studies.

First Priorities

- Obtain minimum population estimates via haulout counts. These counts should be conducted at least 3 times on different days and cover the whole area. Comparable haulout counts should be repeated regularly to obtain trend information.
- 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 (animals in the water and, if possible, in caves) 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

The WG further **recommended** that the Faroes develop a written monitoring plan that includes regular assessments.

9. OTHER BUSINESS

The WG noted that the management objectives for seals are approached differently when compared to other species managed within NAMMCO.

10. MEETING CLOSURE

The report was accepted preliminarily on 4 March 2016, and the final version on 22 April 2016 via correspondence. The WG thanked the Chair for his able chairmanship. The Chair thanked the rapporteur and participants for their hard work and input. The WG thanked MRI for the good meeting facilities and wonderful hospitality.

The meeting was closed at 16:30 on 4 March 2016.

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Appendix 1 – AGENDA

1. TERMS OF REFERENCE
    - assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway.
    - address by-catch issues in Norway, Iceland, and the Faroe Islands
    - re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
    - develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).
2. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
3. SEAL INTERACTION WITH FISHERIES AND AQUACULTURE
    a. Geographical review
    b. Problem size
    c. Mitigation methods in use
4. STATUS OF HARBOUR SEAL STOCKS
    a. Information on catches and regulatory measures
    b. Current Research (Biological parameters, stock identity, distribution/migration)
    c. Population assessments

    4.1 Norway
    4.2 Iceland
    4.3 Denmark
    4.4 Greenland
    4.5 Sweden
    4.6 Mainland Europe
    4.7 United Kingdom
    4.8 Russia
    4.9 Eastern Canada
    4.10 Eastern US
5. STATUS OF GREY SEAL STOCKS
    a. Information on catches and regulatory measures
    b. Current Research (Biological parameters, stock identity, distribution/migration)
    c. Population assessments

    5.1 Norway
    5.2 Iceland
    5.3 Faroes
    5.4 Baltic
    5.5 Russia (Murman Coast)
    5.6 United Kingdom
    5.7 Mainland Europe
    5.8 Eastern Canada
    5.9 Eastern US
6. REVIEW OF HARBOUR AND GREY SEAL STUDIES ON ECOLOGY
7. EVALUATE THE NORWEGIAN MANAGEMENT PLANS FOR HARBOUR AND GREY SEALS
8. MONITORING PLAN FOR FAROE ISLANDS *(if approved by Council)*
9. RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT
    7.1 Recommendations for future research
    7.2 Recommendations for management, by area and stock
10. OTHER BUSINESS

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Appendix 3 – LIST of DOCUMENTS

Meeting Documents

Document Number	Title	Agenda Item
SC/23/CSWG/01	Agenda	
SC/23/CSWG/02	Participant List	
SC/23/CSWG/03	Document List	
SC/23/CSWG/04	Bjørge & Nilssen. Five years experience with management plans for harbour and grey seals in Norway. Is there a need for revision?	7
SC/23/CSWG/05	Nilssen et al. Status of harbour seals along the Norwegian coast in 2011-2015	3.1
SC/23/CSWG/06	Hauksson, E. et al. Seasonal and inter-periodical feeding of Grey (*Halichoerus grypus*) and Harbour seals (*Phoca vitulina*) in north-western coastal waters of Iceland, in 1990-1994 and 2007 - 2010, with a note on the diet of Harp (*Phoca groenlandica*) seals.	
SC/23/CSWG/07	Jüssi. Review of current status of the Baltic grey seals	
SC/23/CSWG/08	Bjørge. Levels of bycatch of harbour and grey seals in Norwegian fisheries.	5
SC/23/CSWG/09	Grey seal 2016 status in Norway	
SC/23/CSWG/10	Coastal seal catches Norway	
SC/23/CSWG/11	Status of Baltic harbour seals	
SC/23/CSWG/12	Status of the grey seal population in Iceland	
SC/23/CSWG/13	Management and status of harbour seal population in Iceland 2016: Catches, population assessments and current research	
SC/23/CSWG/14	Condition of harbour seals (*Phoca vitulina*) in the period 2007-2010, in Icelandic northwestern waters. Comparison with data from earlier periods, 1979-1983 and 1990-2000	
SC/23/CSWG/15	Current status grey seals Faroes 2016	
SC/23/CSWG/16	Hauksson, E and Granquist, S. 2016. Timing of birth and pup production of Harbour Seal (*Phoca vitulina*) on Vatnsnes, NW-Iceland.	
SC/23/CSWG/17	Preliminary analysis of population structure in Norwegian harbour seals	
SC/23/CSWG/18	Diet and prey consumption of grey seals (*Halichoerus grypus*) in Norwegian waters	

For Information Papers

Document Number	Title	Agenda Item
SC/23/CSWG/O01	Management plan for Norwegian grey seals	
SC/23/CSWG/O02	Management plan for Norwegian harbour seals	
SC/23/CSWG/O03	Report of the NAMMCO CSWG (2011)	
SC/23/CSWG/O04	Report 2003 WG_Grey_Seals	
SC/23/CSWG/O05	2006 Harbour_seals_Rep_final	
SC/23/CSWG/O06	Kvoter på kystsel i 2016 with cover (to be translated at the meeting)	
SC/23/CSWG/O07	Osmond. Seals and Aquaculture in Iceland	
SC/23/CSWG/O08	Nebel. The consumption of commerically valuable fish by pinnipeds in Northwest Icelandic waters.	
SC/23/CSWG/O09	Ramasco Dissertation. Spatial and temporal patterns of foraging of harbour seals (*Phoca vitulina*) in Porsangerfjord from behavioural interpretation to resource selection	
SC/23/CSWG/O10	Klimova et al 2014 Global population structure and demographic history of the grey seal	
SC/23/CSWG/O11	Harbour seal population modelling: the Moray Firth	
SC/23/CSWG/O12	The status of UK harbour seal populations in 2014, including summer counts of grey seals	
SC/23/CSWG/O13	Grey seal pup production in Britain in 2014 A progress report	
SC/23/CSWG/O14	2012 Population Estimate for the Harbor Seal (*Phoca vitulina concolor*) in New England Waters	
SC/23/CSWG/O15	Harbor seal (*Phoca vitulina concolor*): Western North Atlantic Stock (US Stock Assessment)	
SC/23/CSWG/O16	Stock Assessment of Canadian Grey Seals (*Halichoerus grypus*)	

WORKING GROUP ON ABUNDANCE ESTIMATE
Copenhagen, October 16-18, 2016
REPORT

1. CHAIRMAN WELCOME AND OPENING REMARKS

Daniel Pike welcomed the participants (Appendix 2) to the meeting and thanked everyone for their attendance. He reminded the participants that the WG will review abundance estimates generated from the NASS2015 and any surveys that have occurred since then, for use in assessments by NAMMCO.

2. ADOPTION OF AGENDA

The agenda was adopted (Appendix 3).

3. APPOINTMENT OF RAPPORTEURS

Prewitt was nominated as rapporteur, with help from participants as needed.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Pike reviewed the documents available to the meeting (Appendix 4). Six working papers were available, as well as several background documents.

5. FIN WHALES

5.1 Shipboard Iceland/Faroes

Pike presented SC/23/AE/04 which gives abundance estimates for fin whales from the Icelandic and Faroese NASS2015 shipboard surveys.

The Icelandic and Faroese components of the sixth North Atlantic Sightings Survey (NASS) was conducted between 10 June – 10 August 2015 (Gunnlaugsson and Vikingsson 2015). Three vessels covered a large area of the northern North Atlantic, similar to the earlier NASS, but for the first time applying fully independent double platform observer (IO) mode. The fin whale was a target species in all areas. Realized effort and fin whale sightings are shown in Fig 1. In addition to stratum and total abundance estimates, regional estimates, each of which includes a combination of the original strata, were required for population modelling purposes. These included estimates east and west of 18° W, which required the division of stratum FW into W (FW_W) and E (FW_E) sections. A contiguous area north and east of Iceland around Jan Mayen Island was covered simultaneously by a Norwegian vessel as a part of an annual cyclic mosaic survey (see section 5.2). One of the Icelandic survey vessels was conducting coincident fisheries surveys and some observation effort was on transit transects aligned with expected high fin whale density, so analyses were performed both including and excluding these data. Rejecting this compromised effort, the total corrected estimate for the survey area using all fin whale sightings was 40,788 (cv 0.17, 95% CI 28,476 to 58,423). Restricting to high and medium confidence sightings using the same effort reduced the total estimate to 35,605 (cv 0.18, 95% CI 24,615 to 51,505). While overall abundance over the entire survey area is not directly comparable between NASS as coverage has varied between surveys, the numbers seen here are the highest of any NASS in the Central North Atlantic. Compared to the most recent previous survey conducted in 2007, increases were seen in the area between West Iceland and East Greenland

and particularly in the Faroese survey area southeast of Iceland, where abundance was more than 26 times that seen in 2007.

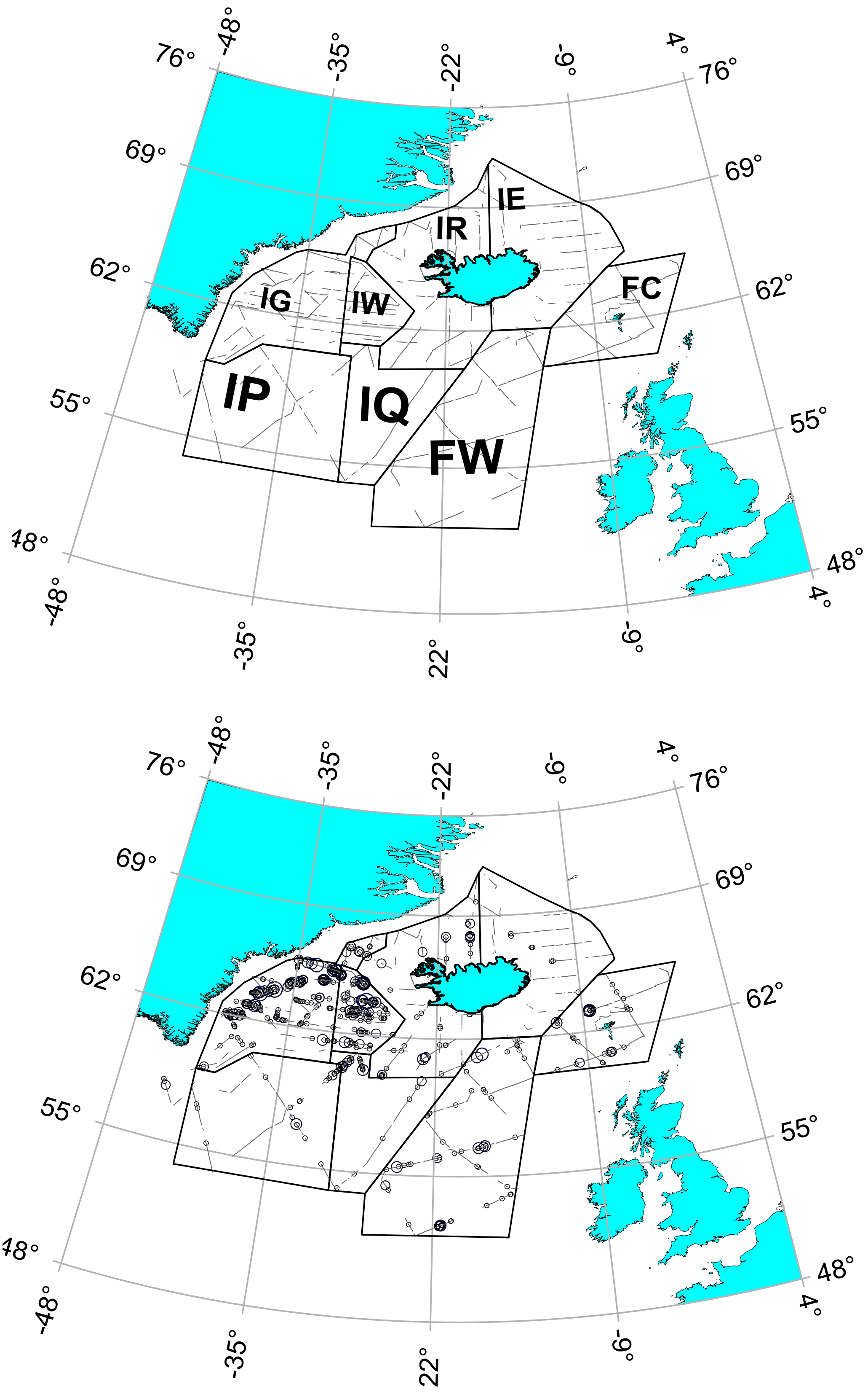


Fig.1. Stratification and survey effort (upper, BSS<=5) and sightings of fin whales (lower). Symbol size is proportional to group size in the range of 1 to 7.

Discussion

In discussion of the potential for bias in distance estimation it was noted that, unlike in previous surveys, no distance experiments were conducted by Iceland during the survey. The Faroe Islands conducted one experiment using sticks (rulers) to measure distance to targets during their survey but the results were not presented to the group. Gunnlaugsson pointed out that binocular reticles were used more frequently by both platforms than in previous surveys and that their use improves distance estimation. Also, the observers learn from using them, which improves their "naked-eye" distance estimates. Pike noted that it would be helpful in the future to have a more in-depth discussion on distance estimation and validation, and suggested the possibility of using drones to validate a sub-sample of distances.

The WG noted the higher abundance estimates from the NASS2015 than previous surveys, and that this could be due to stock growth, distributional shifts or some combination thereof. Vikingsson noted the long-term increase in numbers west of Iceland since 1987, and that the distribution in this area has expanded to include the central deep waters of Denmark Strait (Vikingsson et al. 2009). This appears to be related to an increase in ocean temperature and perhaps productivity in the area (Vikingsson et al. 2015).

The group noted that the survey was conducted over a longer period of time than previous surveys, and that the area west of Iceland was covered in two periods, from 10 June to 9 July and from 14 July to 10 August. It was suggested that it might not be appropriate to combine these two coverages if they produced very different estimates. Upon closer examination, it was determined that the sighting rates in the two periods were similar, so the group concluded that the combination was appropriate (Fig. 2, Table 1).

The WG **accepted** the MRDS estimates in SC/23/AE/04 that reject the compromised effort. The estimate including all fin whale sightings is the least biased, while the estimate incorporating only high and medium confidence sightings is more comparable to reported estimates for 2007. The uncorrected estimate using the same restrictions can be used for comparison to earlier estimates.

The WG noted that the distribution of fin whales in this area was similar to 2007 survey. However, the 2014 catches were from primarily south and east of Iceland, and whalers found very few whales west of Iceland.

Table 1. Fin whale sightings from strata IG and IW (see Fig 2) in the Icelandic/Faroese survey in in two time periods. Effort and sightings along "compromised" transects (see section 5.1) is excluded.

DATE1	DATE2	SPECIES	EFF	SIGHTINGS	BP_100NM
10-Jun	09-Jul	BP	1387	173	12.472963
10-Jul	10-Aug	BP	1392	212	15.229885

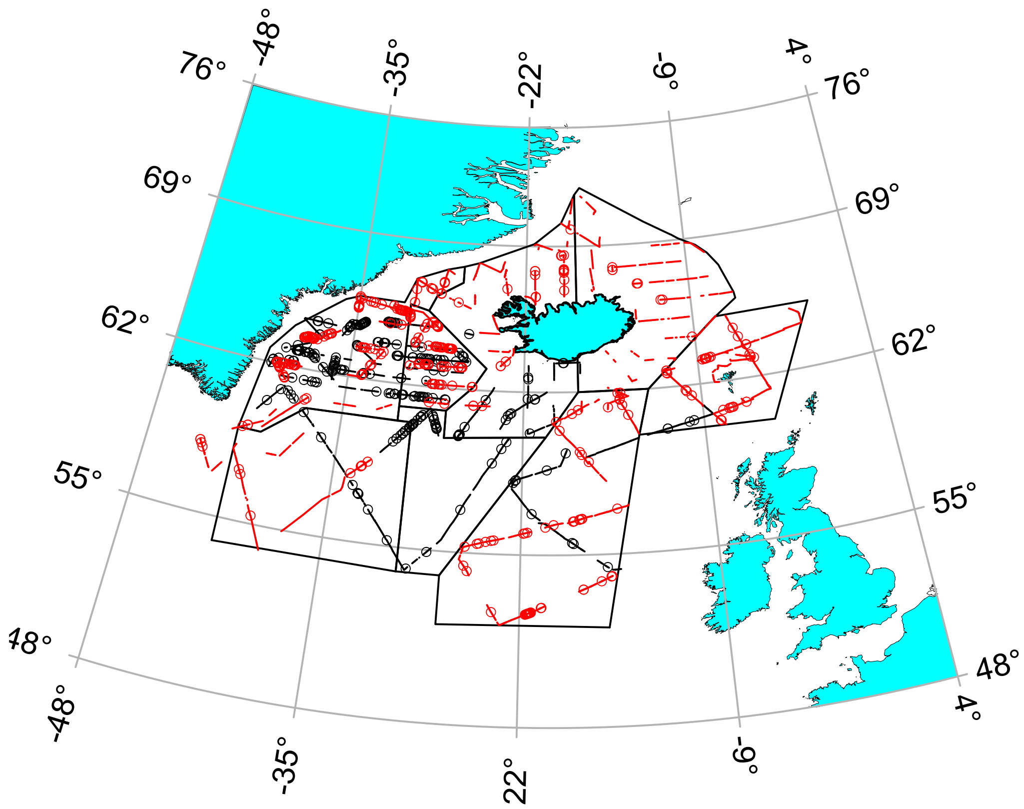


Fig. 2. Survey effort and sightings of fin whales from 10 June to 9 July (black) and from 10 July to 10 August (red).

Iceland updated the WG that they have had cetacean observers on capelin surveys (16 Sept-3 Oct 2015, 10 Sept-4 Oct 2016) with the NASS2015 platforms and methods. The sighting rates of fin whales were similar in these surveys in the EG area as during the midsummer NASS surveys (Fig. 3; also SC/22/21), while humpback whales are then heavily concentrated farther north on spots where capelin in detected. A point estimate of about 5,000 fin whales was obtained for the capelin area in 2015 (area within grey borders on Fig 3).

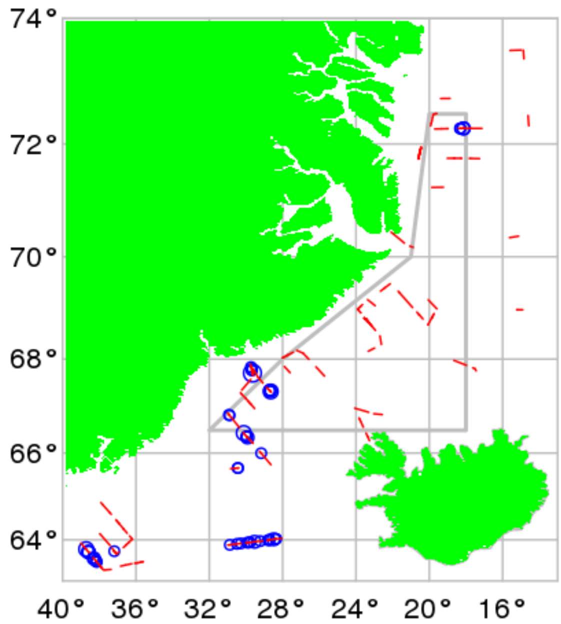


Fig. 3. Surveyed tracks and fin whale sightings (group size 1-5) during the Icelandic 2016 capelin survey (16 Sept.-3 Oct. 2015, 10 Sept.-4 Oct. 2016).

The WG **accepted** the abundance estimates from NASS2015 (Appendix 1).

5.2 Shipboard Norway

The Norwegian shipboard survey in 2015 covered the Norwegian Sea and an extension area around Jan Mayen (SC/23/AE/09 and SC/23/AE/O04). Fin whales were observed to be rather concentrated off northern Norway but were otherwise sparse in the survey area (Fig. 4). A few sightings (7 observations) of fin whales were made northeast of Jan Mayen. During the 2016 survey of the complete *CM* management area, 26 sightings were made from the primary platform. These were made in the southeastern area connected to the Denmark Strait and otherwise around Jan Mayen. No fin whale estimates based on these observations were presented to the meeting.

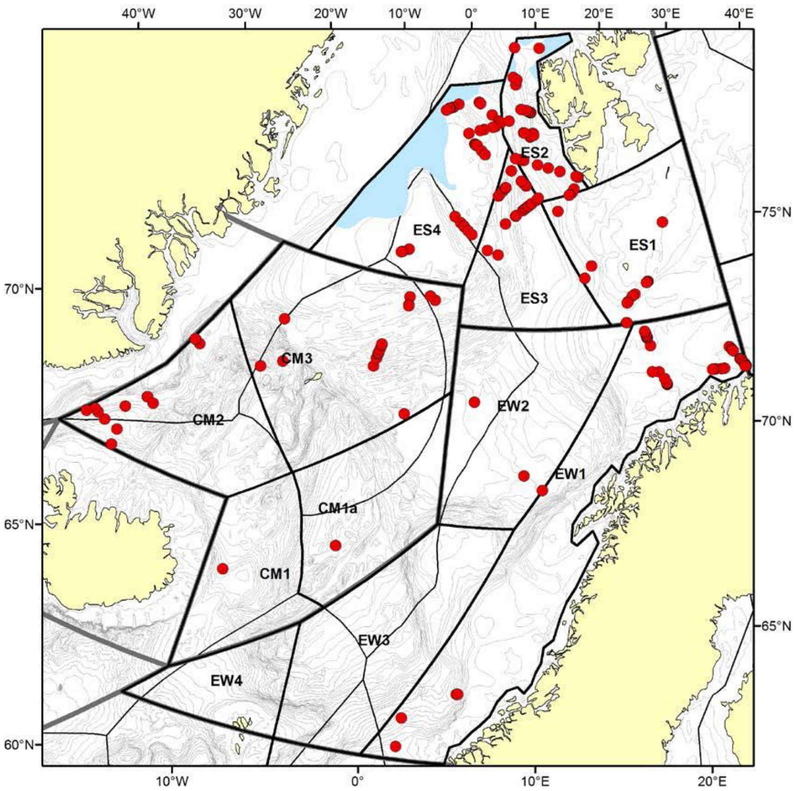


Fig. 4. The total survey area for the Norwegian surveys combined for 2014, 2015 and 2016: Primary fin whale sightings (red dots) made from platform A.

<u>Discussion</u>
Norway plans to generate abundance estimates for the large whales, but it is unclear at this time whether it will be possible to combine these estimates with those from the Icelandic surveys. The current mosaic survey cycle is 2014-2019, and estimates from the previous two mosaic survey cycle have not been produced. The WG encourages Norway to develop these estimates before the next meeting of the AEWG. This would likely increase the total estimate for the North Atlantic used by IUCN (ca 50,000 fin whales), which is primarily based on estimates around Iceland and Spain, and not including the whales seen around Northern Norway and Svalbard.

5.3 Aerial Greenland

An aerial line transect survey of whales in East and West Greenland was conducted in August-September 2015 (SC/23/AE/08). The survey covered the area between the coast of West Greenland and offshore (up to 100 km) to the shelf break. In East Greenland, the survey lines covered the area from the coast up to 50 km offshore crossing the shelf break. The search area covered was ~115,000 km2, 3,999 km on effort in Beaufort sea state <5, 3,499 km on effort in Beaufort sea state <3 (East Greenland) and ~221,000 km2, 9,003 km on effort in Beaufort sea state <5, 6,877 km on effort in Beaufort sea state <3 (West Greenland).

A common detection function was used for both the East and West Greenland surveys.

The estimates corrected for perception bias was 465 (95% CI: 233-929) in West Greenland and 1,932 (95% CI: 1,204-3,100) in East Greenland. These estimates are uncorrected for availability bias and both are therefore negatively biased. Heide-Jørgensen presented a possible means of correcting for availability bias. The observed surface time for one fin whale tracked in West Greenland was 18.13% and the average time-in-view of all fin whale sightings in East and West Greenland <700m from the trackline (n=136) was 10.3s with a bootstrapped cv of 0.10. Heide-Jørgensen and Simon (2007) observed that fin whales in West Greenland blew 50 times per hour (cv=0.07) when excluding observation periods <30min. This corresponds to an average duration of surfacing per hour of 13.1s (2,600*0.1813/50), assuming that fin whales blow every time they surface, and an average duration of dives of 58.9s (3,600-(1-0.18))/50). Using these values in model by Laake et al. (1997) increases the availability for fin whales to 31.26% (cv=0.10) and applying this to mark-recapture-distance sampling (MRDS) estimates gives fully corrected abundance estimates of 6,180 (cv= 0.26, 95%CI: 3,744-10,203) and 1,487 (cv=0.35, 95%CI: 745-2,970) fin whales in East and West Greenland, respectively.

Discussion

Fin whale abundance in West Greenland has apparently declined since 2007 from 4,400 to 465, a decrease of 89%. The proposed availability bias correction would increase both the 2007 and 2015 estimates, retaining the observed decline in abundance. Corrected estimates would however be useful for assessment purposes.

The WG noted that while the proposed method is acceptable, the dive data used for the correction is based on only one whale. To apply this method, dive data from 5-10 whales would be needed. The WG recognizes that this data is difficult to obtain, but encourages Greenland to continue efforts obtain more data to validate this approach.

The WG **recommended accepting** the MRDS abundance estimates (Appendix 1). However, when comparing to earlier surveys, the conventional distance sampling (CDS) estimates may be more appropriate.

The WG suggested cue counting for fin whales could provide fully corrected estimates without the need for additional data (i.e. only a cueing rate is required), but recognizes that it may be logistically difficult to implement during a multi-species survey.

5.4 Combined Estimates

The WG noted that the Greenlandic surveys were originally planned to occur at the same time as the Icelandic shipboard surveys, making them synoptic. However, the funding for the surveys came in very late, and by the time it was secured, the planes were not available before the 15th of August, which was after the Icelandic surveys had been completed. Despite this difference in timing, the WG concluded that the East Greenland estimates could be combined with the estimates from the Icelandic surveys. This is because the density of fin whales in this area appears to be stable between ca 1 June and 1 September, and possibly into October (see Fig. 2 and Fig. 3)

6. MINKE WHALES

6.1 Shipboard Iceland/Faroes

New abundance estimates of common minke whales from the Icelandic-Faroese shipboard part of NASS2015 were presented in SC/23/AE/05. The surveyed area and general methodology was as described above for fin whales (section 5.1.) including fully independent double platforms on each of the three vessels and the sharing of one of the vessels with fishery research. For the common minke whale analysis only data recorded in a BSS <4 were used. The designed strata were post-stratified so that block boundaries aligned with stock divisions recognized by the IWC, and also to correspond with realized effort.

Density and abundance were estimated using stratified line transect methods (Buckland *et al.* 2001) using the DISTANCE 6.2 (Thomas *et al.* 2010) software package.

Sightings on compromised transects (transits oriented parallel to coastlines) were included in the overall detection function but not in the estimation of encounter rate or group size within strata.

Density was highest in blocks FC and IC (Faroese and Icelandic coastal areas), and these two strata contributed more than half of the total uncorrected abundance estimate of 19,663 (cv 0.26, 95% CI 11,814 – 32,727). The total estimate corrected for perception bias was 36,185 (cv 0.31, 95% CI 19,942 to 65,658) for the survey area. The corrected estimate for Icelandic coastal waters (IC or CIC in RMP terms) was 12,710 (cv 0.52, 95% CI 4,498 to 35,912). These estimates are neither corrected for availability bias nor responsive movements. The first named is unlikely to be large for common minke whales, while the latter may be a source of considerable negative bias in the estimate.

Discussion
The WG noted that the effort north of Iceland, in the CM area, was very low and that the estimates from the Norwegian survey in this area should be preferred for use in assessments.

The WG discussed the setup on the Faroese surveys of having observers side-by-side and whether observers could cue each other. While there is visual isolation, the observers can hear each other, therefore there is some potential that observers could alert each other to presence of whales, which might increase the proportion of duplicate sightings. Mikkelsen felt that this did not occur under most conditions. Nevertheless, future surveys using this setup, which operationally functioned well, should take measures to limit this possibility.

The IO method used during NASS2015 produce more precise estimates compared the BT method which used in 2001 and 2007. This is likely due to the use of two fully staffed platforms using full searching effort, generating more sightings, and better use of sightings in estimating perception bias, which reduces variance. In addition, the IO method is logistically simpler in application.

The WG **accepted** these abundance estimates (Appendix 1): uncorrected for comparison to previous surveys, and corrected estimates for generating management advice.

6.2 Shipboard Norway

In 2014 a new survey cycle (2014-2019) was started. The first year 2014 was dedicated to the Svalbard area (management area ES), while the Norwegian Sea (EW) was the dedicated survey area in 2015. In addition, an extension survey was conducted in the Jan Mayen area (CM). CM received a complete coverage in 2016. The complete data set collected 2014-2016 so far during the present survey period has been used to calculate preliminary minke whale abundance estimates for the surveyed areas. Over the three years 2014-2016 a total primary effort of 18,718 km was conducted (Fig. 5). The total survey area was 2,085,102 km^2. A total of 510 sightings of groups (sum platform A and B) were made during primary search effort. They were distributed all over the survey areas although at varying densities. The total estimate for the areas surveyed in 2014 to 2016 is 81,527.

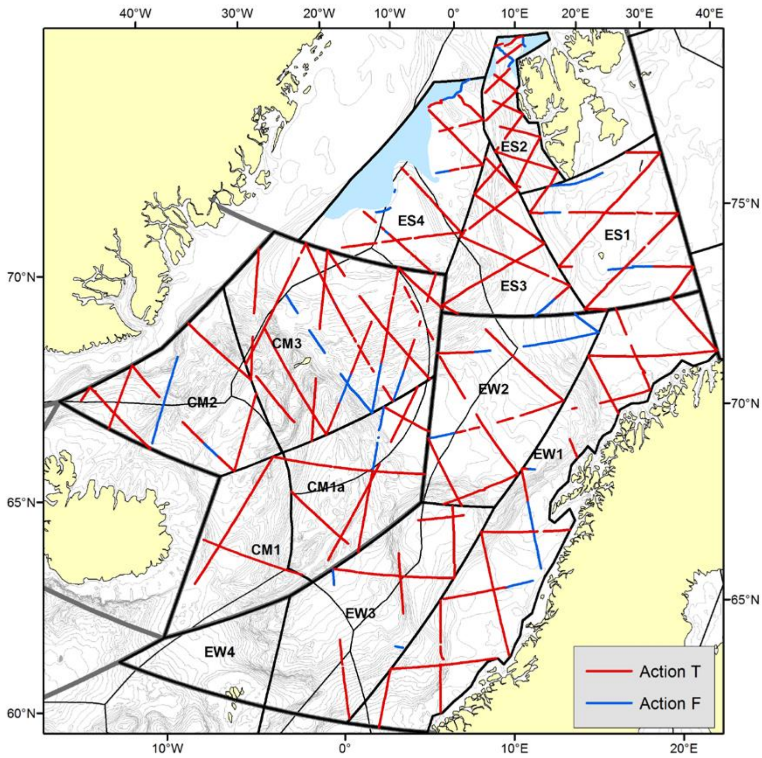


Fig. 5. The total survey area for the Norwegian surveys combined for 2014, 2015 and 2016. The Small Management Areas as decided at the Implementation Review in 2003 have been further divided into survey blocks carrying the SMA name and a number. Also shown are transect lines covered in primary search mode (realised survey effort - red lines. The blue lines are additional single platform effort). The stratum EW4 did not receive any coverage. The ice coverage in SMA ES is based on mid-July 2014 maps from the Norwegian Meteorological Institute.

While the survey cycle has not been completed, it is quite evident that considerable distributional changes are occurring in the Northeast Atlantic. In the previous cycle 2008-2013 there was an increase in minke whale abundance in the Svalbard area (ES). In 2014 the corresponding abundance was only 45% of that observed in 2008 and the lowest number since 1995. For the Norwegian Sea (EW) the estimate was similar (2015) or decreasing (2016 analysis) to the previous survey in 2011. And, for the Jan Mayen area there was an increase in numbers which may be 3-5 times larger than earlier estimates.

<u>Discussion</u>

Until 2016, the large decrease in minke whale abundance seen in Icelandic coastal waters since 2001 had not been matched by a concomitant increase in the abundance seen by Icelandic and Norwegian ship surveys since that time, leaving open the question of the fate of these "missing whales". One conjecture has been that the whales had moved farther north into the CM medium area. While estimates from 2009 did not show any increase in this area, the preliminary estimates from the most recent survey completed in 2016 suggest that abundance has indeed increased in this area. While this may indicate a shift in distribution from Icelandic coastal waters to CM, it leaves unanswered the question of where these whales were prior to 2016. In this respect, it was noted that large areas to the north and northwest of Iceland had little or no survey coverage during 2010-2015. It is apparent that minke whales show a degree of behavioural flexibility in their spatial and temporal migrations, as large variations in distribution have been seen throughout the NASS and Norwegian survey areas.

Vikingsson noted that there have been large ecosystem shifts in Iceland in recent years, with many fish species shifting northwards, including very important prey species for minke whales (Vikingsson et al 2015). Sandeels have been shown to be up to 80% of the diet of minke whales in some areas, and the sandeel population crashed around Iceland in about 2005. Capelin, another important diet item, also moved away from coastal Iceland towards Greenland.

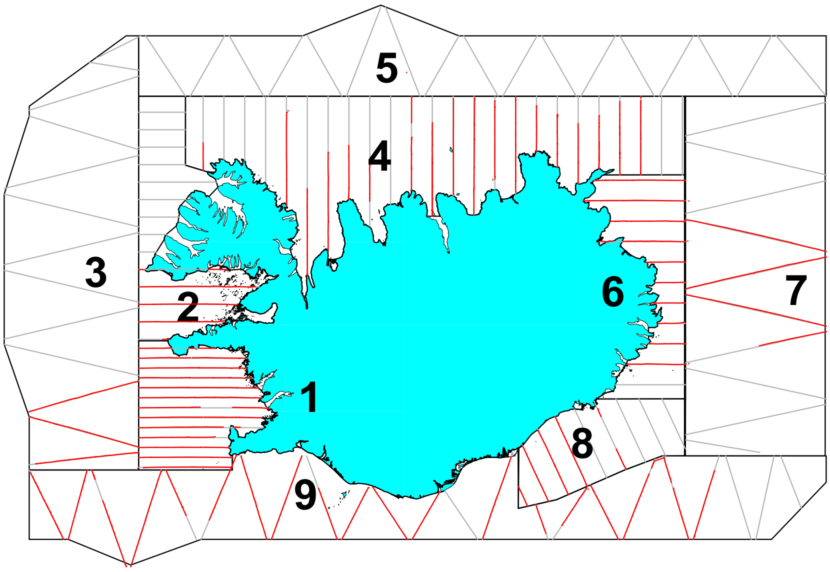
The WG recommended satellite tagging, with priority on a smaller number of high-duration tags versus a larger number of lower duration tags. It was suggested that this may require the live-capture and handling of a small number of minke whales. Such attachments have resulted in tag lifespans of over 800 days on other species.

The large fluctuations in numbers seen in the Norwegian and Icelandic surveys for the *Small areas* suggest that these areas are too small to be considered as independent management areas.

6.3 Aerial Iceland

The Icelandic aerial survey carried out in July 2016 (SC/23/AE/07) is a continuation of a series of surveys, using nearly identical design and methodology, carried out in 1987, 1995, 2001, 2007 and 2009 **(**Pike *et al.* 2008, 2009, 2011). The survey was attempted in 2015 but insufficient effort was realized due to poor weather conditions (Pike 2015). The main target species of these surveys has been the common minke whale, however sightings of all species are registered. The cue counting procedure has been used for minke and other baleen whales, while for other species standard line transect methods are employed. In 2016 a Twin otter aircraft was used, for the first time allowing two full platforms each with 2 observers. As in 2015, a new electronic device called a Geometer was used to record sighting times and declination angles. Other data were recorded using time-stamped vocal recordings. In addition a video camera recorded a continuous record of the trackline. Only 53% of planned effort was completed due to poor weather conditions (Fig. 6). Duplicate sightings have been identified using an algorithm-based methodology developed by Southwell *et al.* (2002). A total of 647 sightings were made, including 66 of minke whales, 223 of white-beaked dolphins, 92 of harbour porpoises and 52 of pilot whales. Minke whale numbers in comparable areas were low compared to surveys carried out before and including 2001, and similar to ones done after that. Abundance estimates from this survey are feasible for minke whales, white beaked dolphins harbour porpoises and perhaps pilot and humpback whales. However the value of producing these estimates must be weighed against the relatively low coverage of the survey.

<u>Discussion</u>
Abundance estimates from this survey will be developed within the next several months. Overall, the 2016 survey had poor coverage, but adequate coverage in what were the most important blocks earlier surveys.



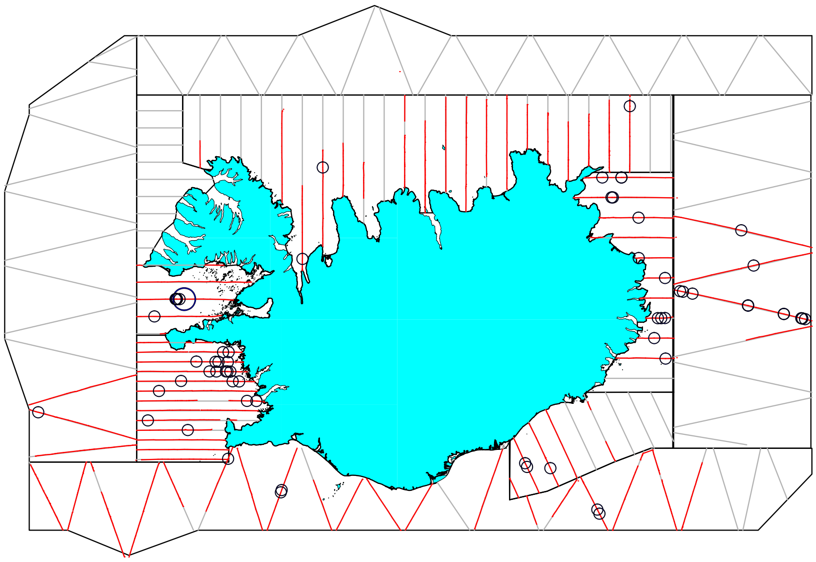


Fig. 6. Stratification and planned (black) and realized (red) effort (upper) and sightings of minke whales (lower) in the 2016 Icelandic aerial survey.

The WG suggested that Iceland consider attempting the coastal aerial survey more frequently for shorter periods of time (e.g., 10 days every year), possibly using the "mosaic" approach used in the Norwegian survey program, with the goal of completing the entire survey over 3-5 years. This approach has many practical advantages, including the maintenance of a trained cadre of observers, more efficient use of equipment, a reduced risk of a "failed" survey and more predictable budgeting. The main disadvantage would be a decrease in precision because of the added variance due to interannual variation, but it was noted that several years of data are available to address this. The Icelandic delegates agreed to consider this approach.

6.4 Aerial Greenland

An abundance estimate for minke whales was developed from data collected during the same aerial survey that was described above (Item 5.3).

Data on surface corrections for minke whales were collected from 5 whales instrumented with satellite-linked time-depth-recorders in West Greenland. The minke whale abundance estimate was corrected for perception bias, availability bias and time-in-view using MRDS analysis methods, producing a fully corrected abundance estimate of 4,204 whales (cv=0.47; 95% CI= 1,753-10,085) in West Greenland and 2,681 whales (cv= 0.45; 95% CI= 1,153-6,235) in East Greenland.

Discussion

The WG noted the remarkably low perception bias for all species in this survey. It was suggested that this was probably due to the use of highly experienced observers.

The WG discussed the correction factors for availability bias used for some species While the correction based on whales breaking the surface is simple in concept and application, the surfacing data, which is collected through satellite tag deployments, is vulnerable to bias due to 1) differences in placement of the satellite transmitter on the whale and 2) calibration drift in the depth transducer. As imprecision in this estimate will have a large effect on the abundance estimate, and the WG agreed that it is better to use the 0-2m depth for the availability correction factor, combined with the MRDS estimate.

The WG **endorsed** the MRDS estimate using the 0-2m correction for availability bias.

6.4.1 Trends in abundance

The time series of aerial surveys of large cetaceans off West Greenland conducted at regular intervals since 1984 was used to construct an index of the relative abundance of minke whales in the area (SC/23/AE/06). The effort was corrected for varying detection probabilities but no correction could be applied for the lack of coverage in South Greenland in 1984 and 1985 (south of 62°N). The resulting indices of relative minke whale abundance show large variation suggesting there is not a consistent fraction of minke whales from the North Atlantic that use the West Greenland banks as a summer feeding ground. The results suggest it is unlikely that pronounced site fidelity, coastal or offshore, occurs with West Greenland minke whales. It is more likely that some environmental factors influence the fraction of whales that move into West Greenland to feed in summer.

Discussion

The WG agreed that uncorrected line transect density provided a robust index of abundance, as biases due to perception and availability are unlikely to vary much between surveys. These results suggest that the surveys are capturing a variable component that is moving in and out of the area, as there is a great deal of variation between surveys, and no unidirectional trend.

6.5 Combined Estimates

The WG agreed that the estimates from the Norwegian and Icelandic shipboard surveys from 2015 can be combined. However, the estimate from the Norwegian survey in 2016 could not be combined with these because of the observed inter-annual variation in distribution. It will be possible to combine the Norwegian 2016 data with data from the aerial survey in Iceland 2016.

The WG discussed whether the Icelandic shipboard estimates could be combined with estimates from the Greenlandic aerial survey. Although there is no data on minke whale movements and distribution during this time, the likelihood of a positive bias due to directional movement of minke whales from the Icelandic survey area into East Greenland coastal waters in the short time between the surveys seems small. The WG therefore concluded that these estimates are additive.

7. HUMPBACK WHALES

7.1 Shipboard Iceland/Faroes

There are adequate numbers of humpback sightings concentrated to the northwest of Iceland to derive an abundance estimate from these surveys (Fig. 7). The WG recommended that such an estimate be presented at the next meeting.

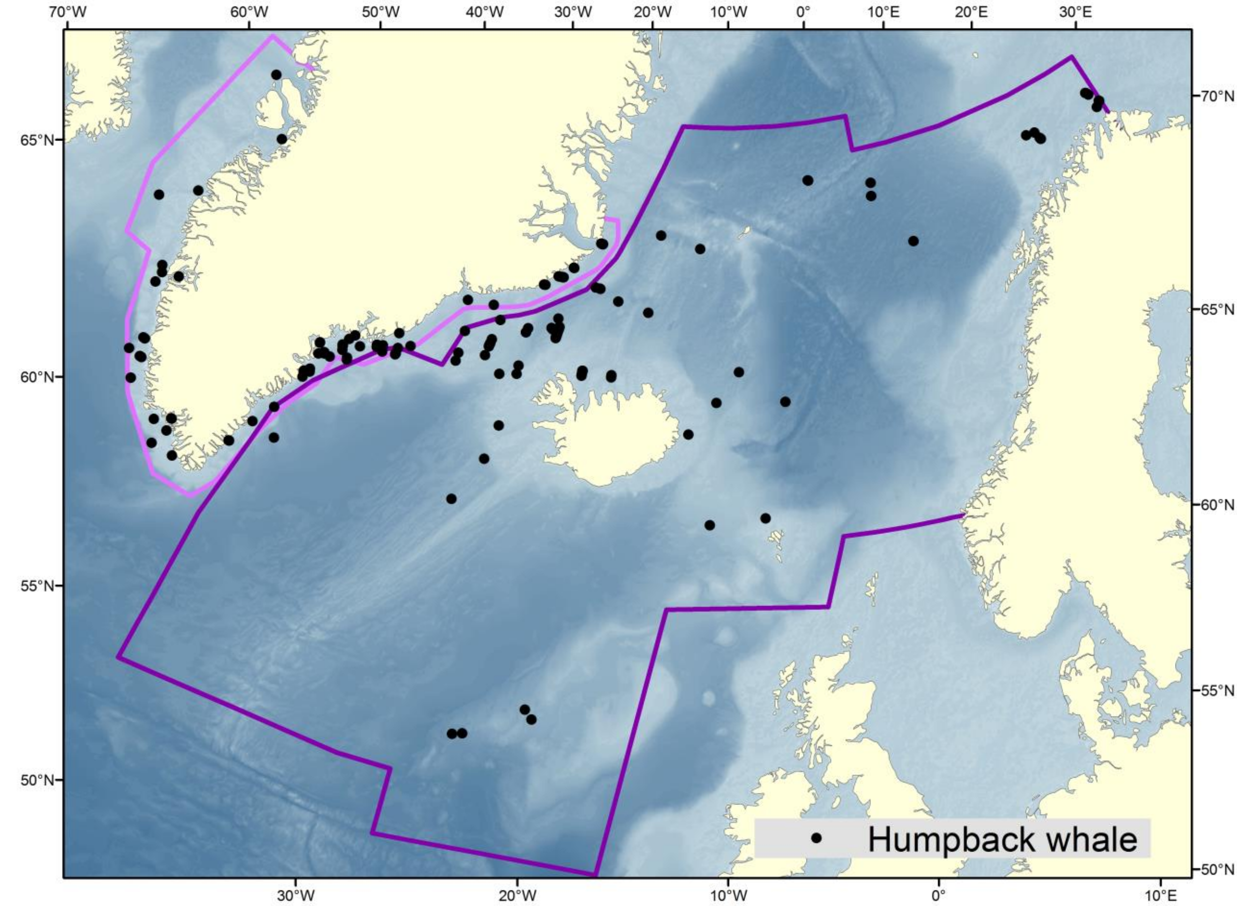


Fig. 7. Humpback whale sightings during NASS2015. This map does not include sightings during the 2015 Icelandic aerial survey.

7.2 Shipboard Norway

In the Norwegian 2015 survey only 14 primary sightings of humpback whales were made. One sighting was made northeast of Jan Mayen; the others were recorded in coastal areas off northern Norway. During the survey of CM in 2016, 12 primary sightings were made of humpbacks. They were thinly distributed in the northern areas of the Jan Mayen blocks. No estimate was presented to the meeting based on these sightings.

The WG **recommended** that Norway develop the large whale estimates before the next meeting.

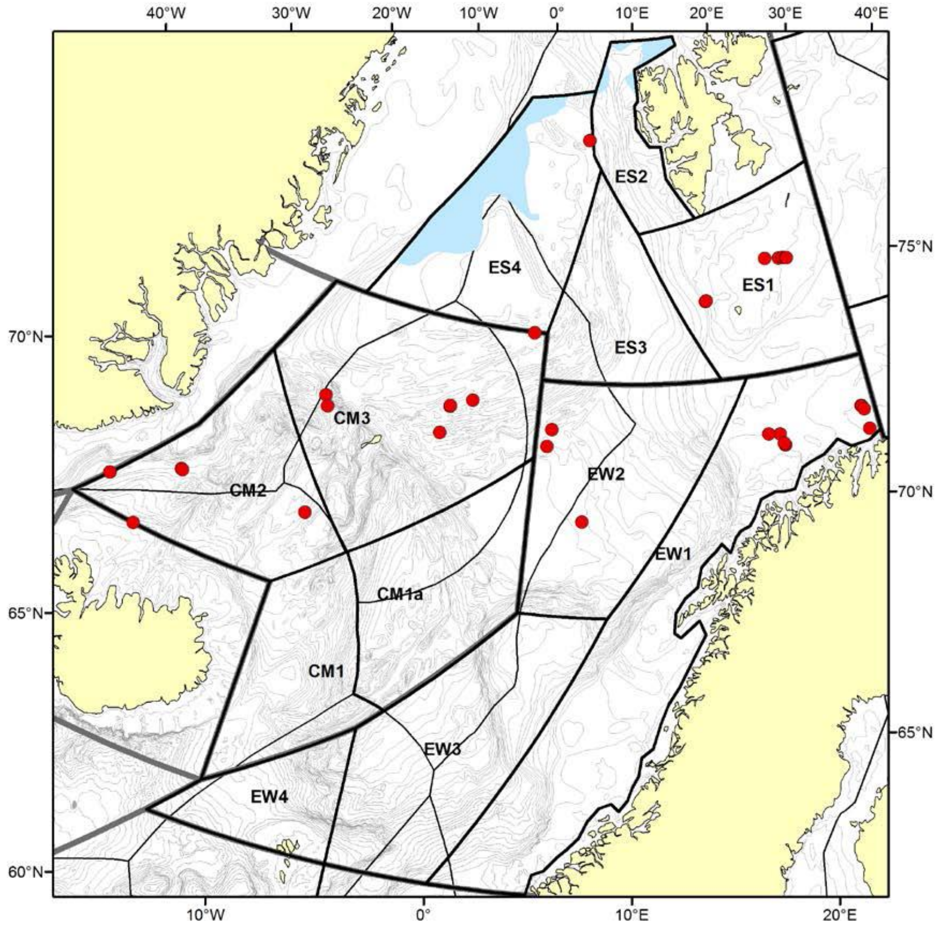


Fig. 8. The total survey area for the Norwegian surveys combined for 2014, 2015 and 2016: Primary humpback whale sightings (red dots) made from platform A.

7.3 Aerial Iceland

The 2015 survey was not successful due to poor weather. In 2016, there were 40 sightings, mainly off northern Iceland, but the survey was not able to cover the areas where most humpbacks whales would be expected (NW area). The utility of an estimate from this survey would therefore be limited.

7.4 Aerial Greenland

An abundance estimate for humpback whales in East and West Greenland were developed from data collected during the same aerial survey as described above (Fig. 8, Item 5.3, SC/23/AE/08). The humpback whale abundance estimate was corrected for perception bias, availability bias and time-in-view using MRDS analysis methods, producing a fully corrected abundance estimate of 1,321 whales (cv=0.44; 95% CI= 578-3,022) in West Greenland and 4,012 whales (cv= 0.35; 95% CI= 2,044-7,873) in East Greenland.

Stratum E1 (near Scoresby Sound) were discarded from the abundance estimation because of the low effort in this strata.

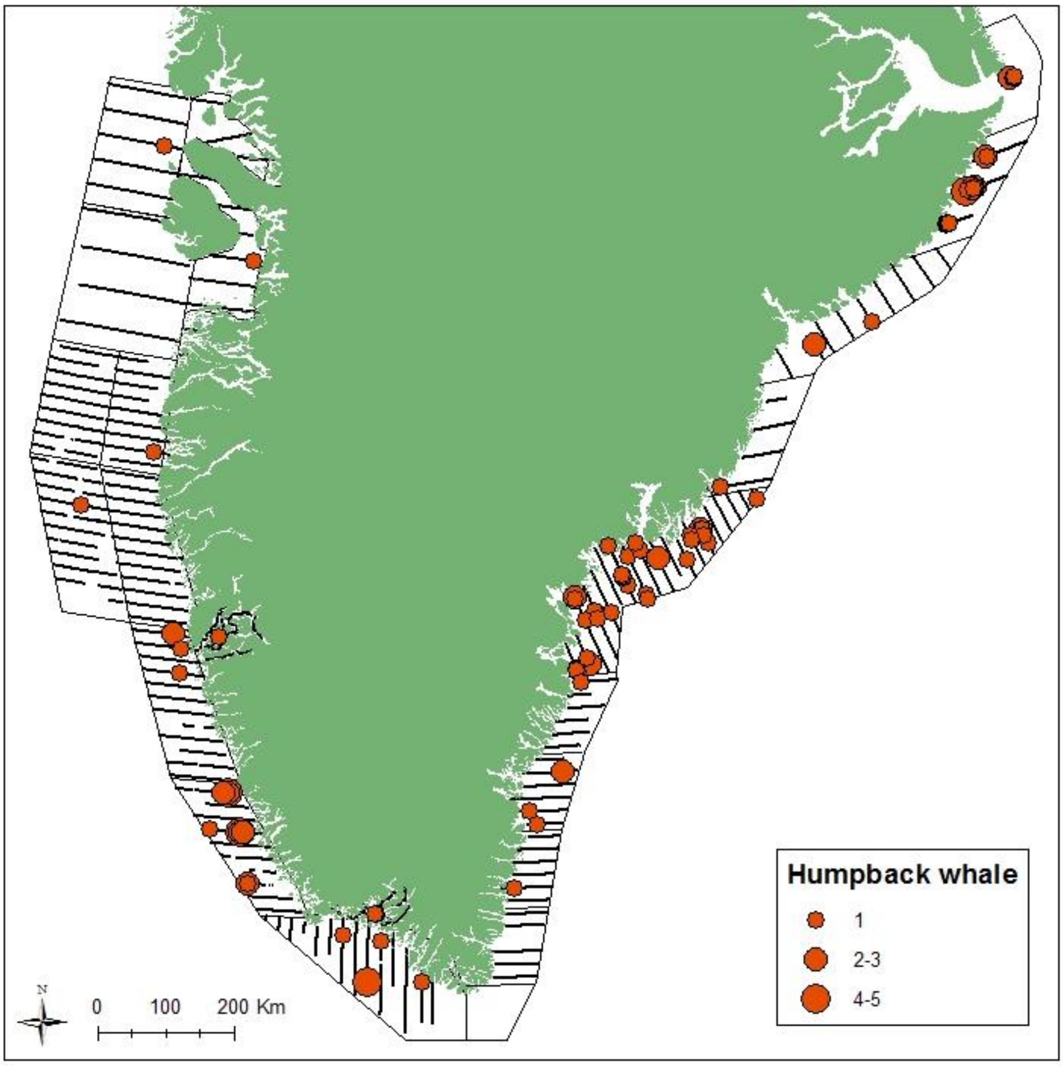


Fig. 8. Survey effort in sea states <5 and sightings with group sizes of humpback whales in East and West Greenland.

Discussion

The 2015 estimate for West Greenland is substantially lower than the previous survey in 2007 (50% decline). The WG did not identify any methodological problems with the survey; there was good coverage that was similar to that in 2007. There was slightly less effort in the northern strata, but this was not seen as problematic.

The WG **accepted** the MRDS estimates for both East and West Greenland.

7.5 Combined estimate

The WG recommended that the Icelandic estimate could be added to the EGL survey, for the same reasons as combining the fin and minke abundance estimates, i.e., there is evidence that the humpback whales remain in the area during the entire coverage period (Fig. 9).

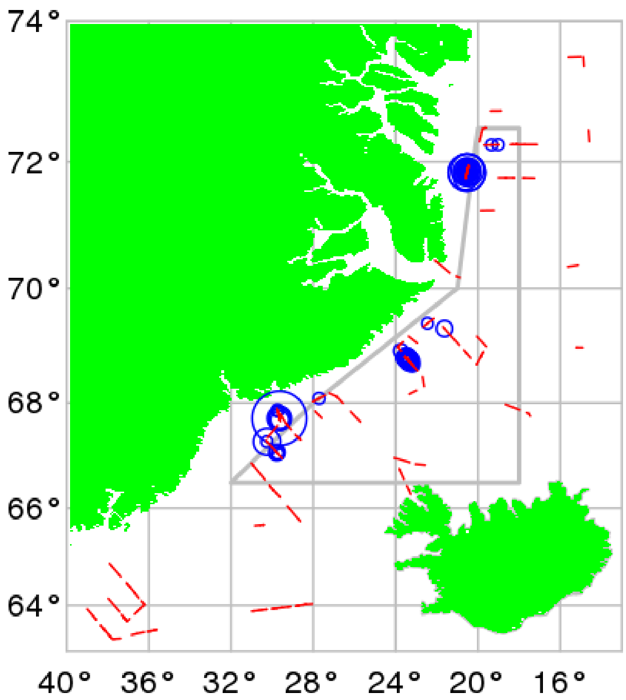


Fig. 9. Realized effort (red) and humpback whale sightings (blue circles) during the capelin survey 16 September to 4 October 2015 imposed on the NASS-15 vessel surveyed blocks (grey lines).

8. PILOT WHALES

8.1 Iceland/Faroes

No abundance estimate from the NASS 2015 survey was available to the WG; the data had not been fully explored for duplicate sightings in advance of the meeting. A trend analysis of pilot whales in the North Atlantic, that has integrated previous NASS and SCANS/CODA surveys, was presented to the SC in 2014. The plan is to integrate the NASS 2015, together with the SCANS 2016 data, in the trend analysis.

The sightings of pilot whales during NASS2015 can be seen in Fig. 10. Group size estimations of pilot whales in ship surveys have been an issue of discussion in previous abundance estimation WGs. During the preparations of NASS 2015, it was recommended that potential solutions for more accurate group size estimation be explored, (e.g. independent aerial surveys). A drone was used for filming groups to use as a comparable group size estimate. The drone was deployed successfully. The drone data have not been explored yet, as the video is not yet available.

The plan was also to tag some pilot whales with satellite transmitters during the survey, in order to determine the presence of pilot whales within the survey area during the survey. Although one attempt was made to approach and tag animals offshore, from a small boat, it was not possible to get close enough to the animals.

Discussion

The WG **recommended** that the analysis of the pilot whale data should be completed within the next few months.

The WG noted that there were adequate sightings in the Icelandic and Faroese surveys to derive an estimate, particularly in the northern areas.

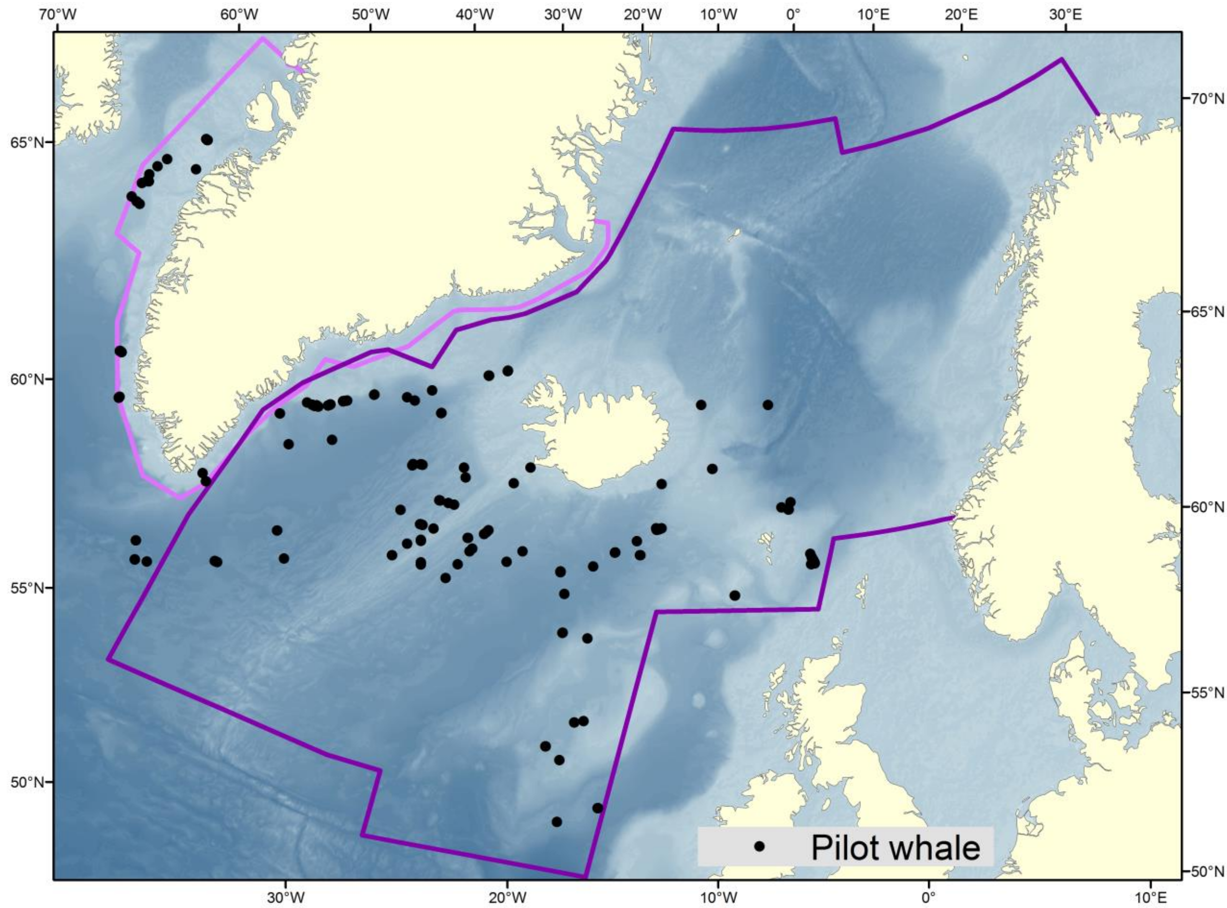


Fig. 10. Pilot whale sightings during NASS2015, not including the 2015 Icelandic aerial survey.

The WG discussed whether the group size estimation was necessary and whether there was any indication that the group sizes of offshore groups are different from the coastal areas. It has been previously suggested that aerial video of pilot whale groups could be useful in this context. The WG noted that the field experiments that were conducted were not successful in obtaining independent group size estimates for pilot whales. If the drone video becomes available, the WG encourages the Faroe Islands to analyse these data.

Mikkelsen noted that the plan is to combine the estimate from their survey with the results of the SCANS-III survey that was conducted in 2016. The WG will need to see the results of both of these surveys in order to determine whether this is possible.

8.2 Aerial Greenland

An abundance estimate for pilot whales was developed from the same survey as described above (Fig. 11, see Item 5.3). The pilot whale abundance estimate was corrected for perception bias and availability bias using MRDS analysis methods, producing a fully corrected abundance estimate of 11,993 whales (cv=0.52; 95% CI= 4,575-31,438) in West Greenland and 338 whales (cv= 1.01; 95% CI= 65-1,749) in East Greenland.

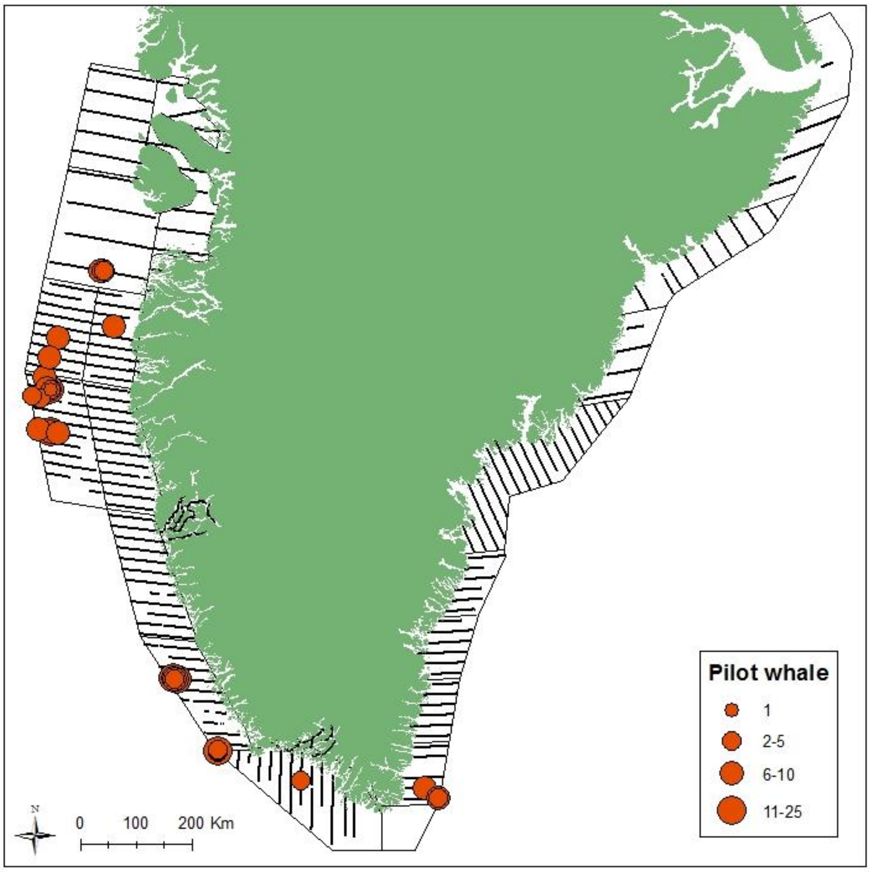


Fig. 11. Survey effort in sea states <5 and sightings with group sizes of pilot whales in East and West Greenland.

Discussion

The WG concluded that this survey was not designed to provide a complete coverage of the stock area in Baffin Bay and that the abundance estimates from West Greenland must therefore be considered a minimum estimate. The survey is only capturing a fraction of the population in Baffin Bay because there were sightings at the western edge of the strata, indicating that there are likely animals outside of the survey area. There are probably large fluctuations in abundance in West Greenland as reflected in recent surveys (e.g. 2007) and also in the catches.

The WG noted that the 0-7m depth interval used in deriving the availability correction factor was considered conservative and probably results in a negatively biased abundance estimate.

The WG **accepted** the estimate for West Greenland as a minimum given the caveats above regarding the distribution offshore with incomplete coverage of the stock, and endorsed the estimate for East Greenland.

8.3 Shipboard Norway

There were no sightings of pilot whales in 2015, and only a few sightings in 2016 in the southern part of the Jan Mayen (CM) area (see Fig. 10).

9. HARBOUR PORPOISES

9.1 Aerial Greenland

An abundance estimate was developed for harbour porpoises from data collected during the same aerial survey described above (Item 5.3; Fig. 12; SC/23/AE/08). Data on surface corrections for harbour porpoises were collected from 9 whales instrumented with satellite-linked time-depth-recorders in West Greenland. The harbour porpoise abundance estimate was corrected for perception bias using MRDS analysis methods and availability bias using data from satellite tagged animals, producing a fully corrected abundance estimate of 83,321 harbour porpoises (cv= 0.34; 95% CI=43,377-160,047) in West Greenland and 1,642 harbour porpoises (cv= 1.00; 95% CI= 318-8,464) in East Greenland.

Discussion

In 2015, 50% of satellite tagged harbour porpoises were outside of the West Greenland survey area during the survey period. This suggests that this estimate is an underestimate because the survey clearly missed animals from this stock that were outside the survey area at the time of the survey.

The WG **accepted** the abundance as a minimum estimate in West Greenland. This is an increase since 2007, while for all other species abundance estimates have declined.

The WG **accepted** the estimate for East Greenland.

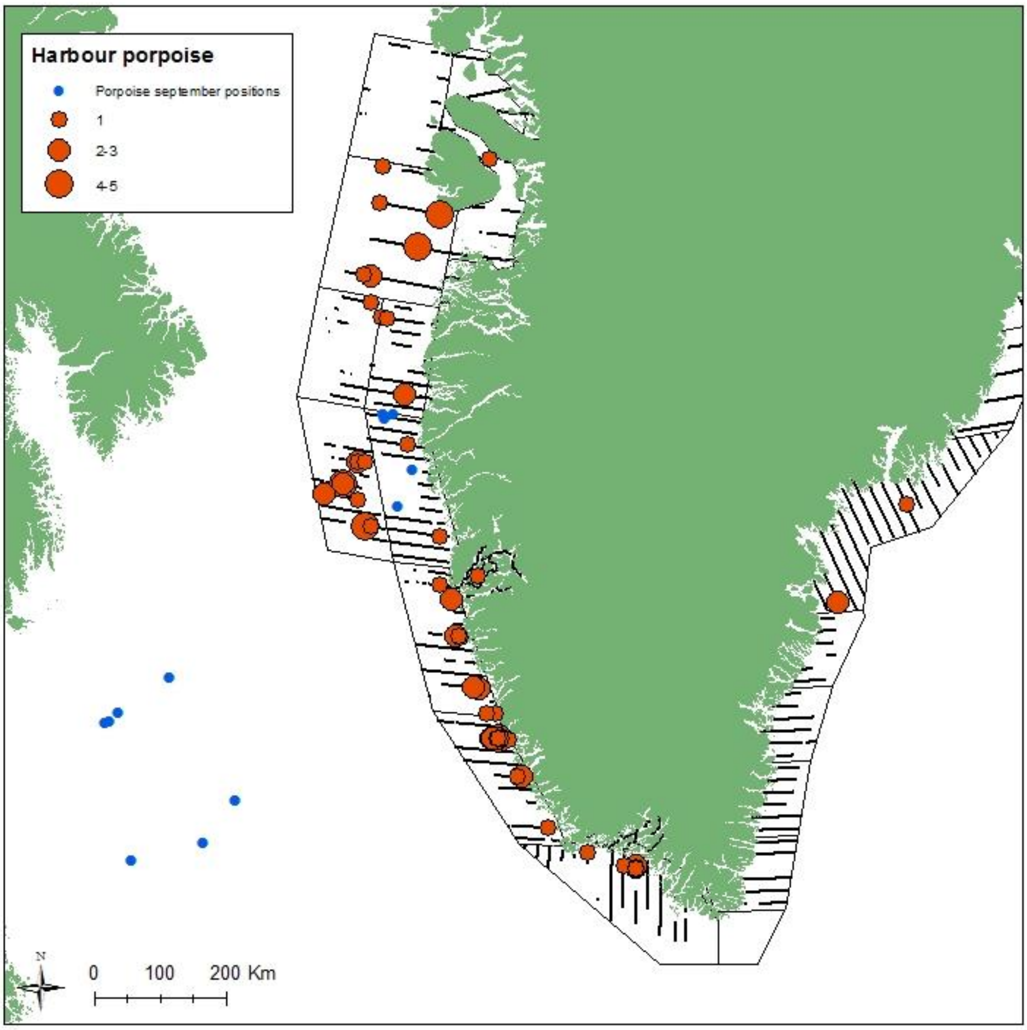


Fig. 12. Survey effort in sea states <3 and sightings with group sizes of harbour porpoises in East and West Greenland. Blue dots indicate satellite positions of harbour porpoises tagged inside the survey area and tracked in September 2015.

9.2 Aerial Iceland

There were 92 sightings of harbour porpoises during the 2016 survey (Fig. 13), and it should be possible to develop an abundance estimate. There is a previous estimate of harbour porpoises in Iceland from 2007 that the 2016 estimate could be compared to.

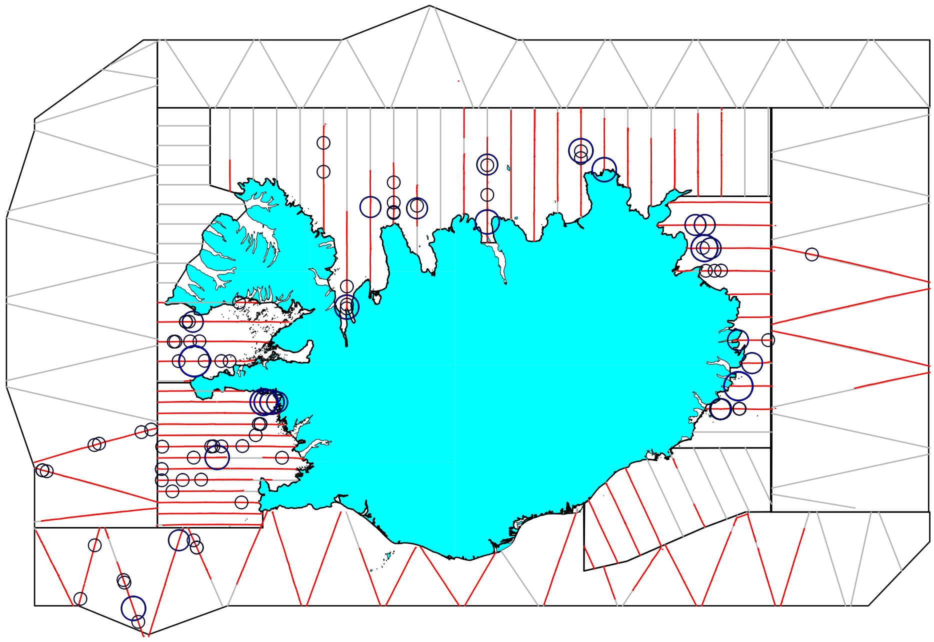


Fig. 13. Unique (non-duplicate) sightings of harbour porpoises (PP) in the Icelandic aerial survey of 2016. Symbol sizes are proportional to the group size limits given.

10. OTHER SPECIES

10.1 White-beaked dolphins

10.1.1 Aerial West Greenland

White-beaked dolphins were widespread in both East and Southwest Greenland (SC/23/AE/08; Fig. 14) but the number of sightings in West Greenland in 2015 was only half of the sightings in 2007.

The expected group size was 4.2 (cv=0.19) in West Greenland and 4.5 (0.19) in East Greenland. A half-normal key with sea state as a variable in the DS component was chosen for the MRDS model that provided at-surface abundance estimates of 2,747 white-beaked dolphins (95% CI: 1,257-6,002) in West Greenland and 2,140 (95% CI: 825-5,547) in East Greenland with a joint perception bias of 0.99 (cv=0.01, Table 5).

Hansen and Heide-Jørgensen (2013) used data from a single white-beaked dolphin from Iceland to develop an availability correction factor and applying this to the at-surface abundance gave a fully corrected estimate of 15,261 dolphins (cv=0.41; 95% CI= 7,048-33,046) in West Greenland and 11,889 dolphins (cv= 0.40; 95% CI= 4,710-30,008) in East Greenland.

Discussion

This estimate indicates a decline in West Greenland from the 2007 survey. There is no previous estimate for East Greenland for comparison.

The correction factor for availability is based on data from only one dolphin tagged off Iceland and should therefore be considered provisional. The WG noted that it is likely there are animals outside of the survey area because dolphins were seen on the ends of the transects, there for the survey is probably capturing only a portion of the West Greenland population. The decline observed since 2007 could possibly be more a function of a distributional shift.

The WG **accepted** the abundance estimates, corrected for perception bias, for East and West Greenland.

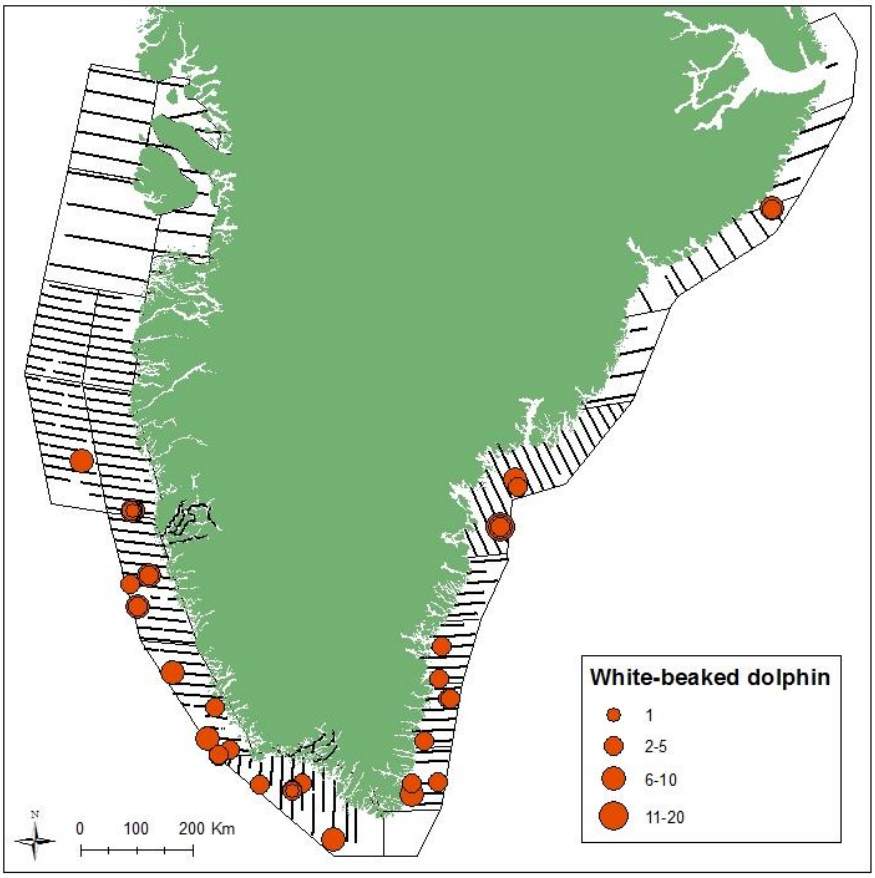


Fig. 14. Survey effort in sea states <5 and sightings with group sizes of white-beaked dolphins in East and West Greenland.

10.1.2 Aerial Iceland

White-beaked dolphins were the most commonly sighted species (Fig. 15), and therefore it is possible to develop an abundance estimate. The WG recommended that Iceland complete this analysis before the next meeting.

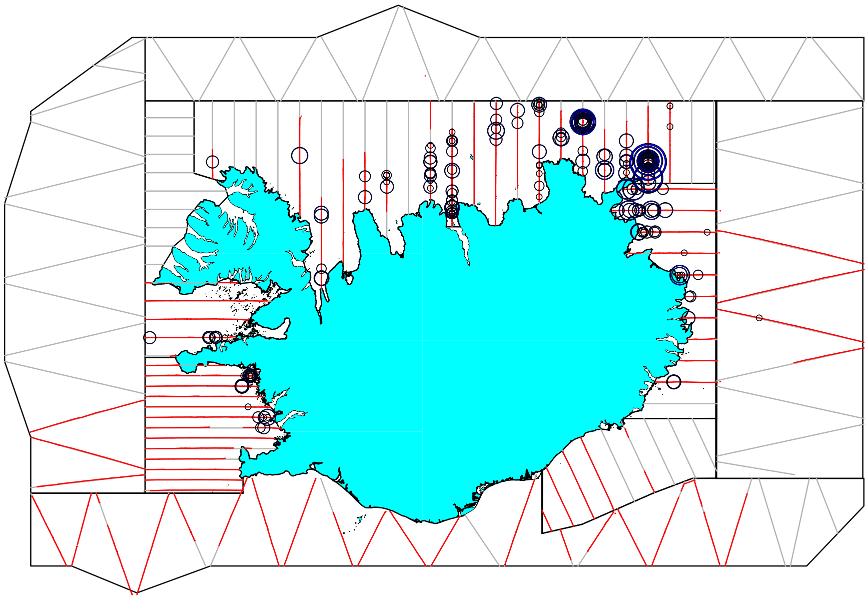


Fig. 15. Unique (non-duplicate) sightings of white-beaked dolphins (LA) in the Icelandic aerial survey of 2016. Symbol sizes are proportional to the group size limits given.

10.2 Other species

SC/23/AE/08 also contained information on sightings of additional species: sei whale, blue whale, sperm whale, and bottlenose whales seen during the aerial surveys in West and East Greenland (Fig. 16).

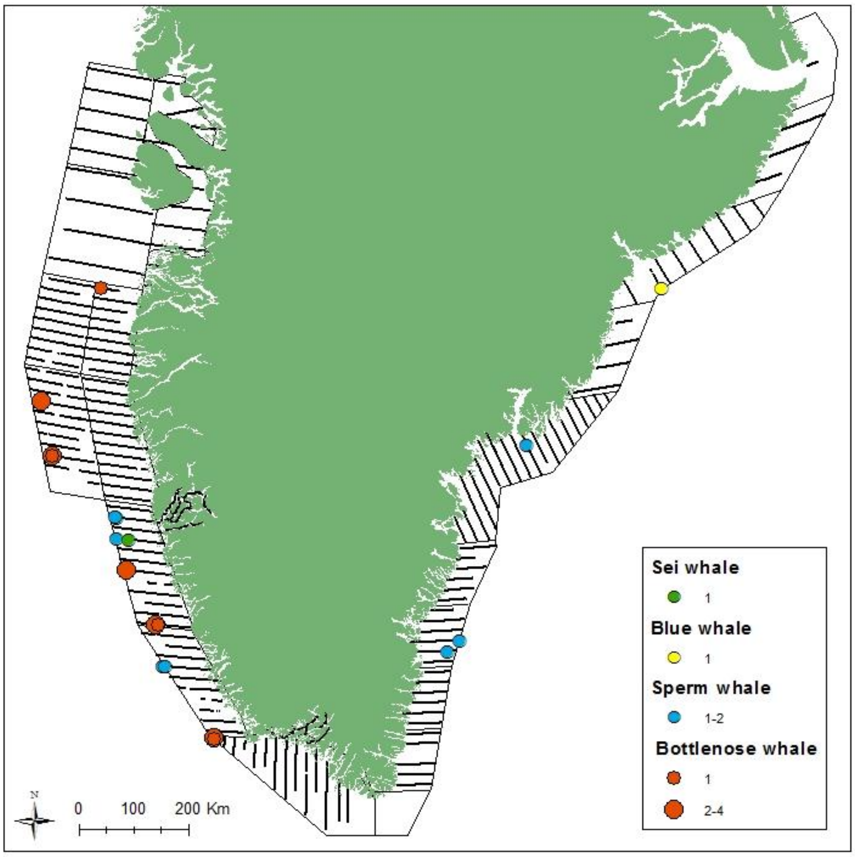


Fig. 16. Survey effort in sea states <5 and sightings with group sizes of sei, blue, sperm and bottlenose whales in East and West Greenland.

10.3 Killer whales

Sightings of killer whales during NASS2015 are shown in Fig. 17.

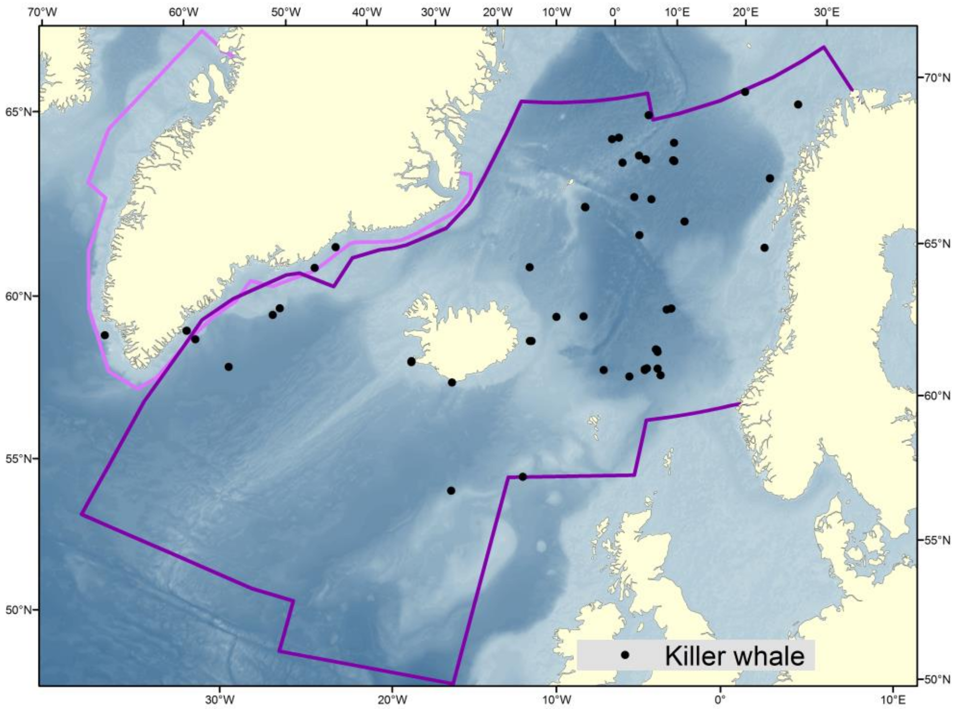


Fig. 17. Sightings of killer whales during NASS2015.

11. ADDITIONAL ANALYSES TO BE CARRIED OUT

Analyses that are still awaited were discussed under the individual species agenda items, and also summarized in Table 2.

Table 2. Analyses that are expected and/or possible to be developed.

Country/Survey	Species	Expected
Norway	Fin (previous and current cycle)	Spring 2017
	minke (current cycle)	Spring 2017
	humpback (previous and current cycle)	Spring 2017
Iceland aerial	minke	Spring 2017
	harbour porpoise	Spring 2017
	white-beaked dolphin	Spring 2017
Iceland/Faroes shipboard	pilot whale	Spring 2017
	humpback	Spring 2017

The WG **recommended** that abundance estimates should be developed for other species if the data permits.

The WG has **recommended** for certain species when abundance estimates can be combined, and this will be the responsibility of the appropriate assessment groups.

12. DUPLICATE IDENTIFICATION

Pike gave a presentation on the identification of duplicate sightings in aerial and ship surveys. Duplicate sightings are defined as those made by independent platforms of the same cue or group of animals. Duplicate identification is usually uncertain as there is no independent means of determining whether or not two sightings are in fact duplicates. Conceptually, if two sightings occur in the same place at the same time, they must be duplicates. However sighting location is measured with often considerable error, so duplicate determination must rely on the degree of similarity of sighting location, species identity, group size and other available covariates. In most reports of aerial surveys, little detail is given about the method used to identify duplicates, but most rely on some combination of similarity in beam time, declination angle and sometimes group size. Duplicate identification is straightforward when sightings are isolated in space and time, as is usually the case with minke whales, but much more difficult when species have an aggregated distribution, as seen with many dolphins, narwhal and pilot whales. Pike presented a method developed by Southwell *et al.* that uses differences in covariates such as sighting location, group size and species identification, and data-determined threshold levels for these differences, to derive a dissimilarity index for duplicate pairs, allowing the objective identification of duplicates from aerial surveys. This method was further developed by Pike and Doniol-Valcroze (2015) by comparing same-side between platform pairs (which contain duplicates) to opposite side pairs (which do not contain duplicates) using logistic regression, thereby deriving a similarity index that weights the importance of the available covariates in identifying duplicates. Pike concluded that the most important means of improving the accuracy and certainty of duplicate identification was to increase the precision of distance measurements and sighting times. Given that duplicate identification is probabilistic, uncertainty in duplicate identification should be incorporated in abundance estimates.

Øien described the methodology used to identify duplicate surfacings of minke whales used in the Norwegian survey program and documented by Bøthun and Skaug (2009). The procedure uses the tracks of minke whales documented by each platform to match surfacings by coincidence in space and time. The routine has been extensively tested using simulated and real survey data and found to correctly identify about 90% of true duplicate surfacings, with a very low rate of "false positive" identification. For other species, which are not tracked in the Norwegian surveys, duplicate identification is not algorithm-based and relies on coincidence in location variables such as sighting time and distance. Duplicate identification for large whales is therefore much more uncertain than that for minke whales.

In the Icelandic/Faroese surveys, duplicates are also identified by coincidence in space and time. While the routine is not algorithm-based, effort is made to be systematic in duplicate identification. Gunnlaugsson noted that field data collection methods would have to be improved to fulfil the data requirements of a fully algorithm based method.

In the Greenlandic aerial surveys, duplicates are identified by coincidence in space and time, with duplicate sightings having beam times of +- 3 seconds and perpendicular distances of +-200 m. In uncertain cases ancillary data such as group size is used. Duplicates are usually identified by the observers immediately after the flight, while memory is fresh.

<u>Discussion</u>

There was considerable discussion about the appropriate procedure to use in cases when two platforms disagreed about species identity in what was otherwise obviously a duplicate sighting, specifically in the common case where one platform identifies species A while the other cannot identify to species (U). Gunnlaugsson considered that AU duplicates should be omitted from the analysis, because including them, for example by editing the species identity to AA, increases the number of AA duplicates and therefore lowers the abundance estimate for A. Gunnlaugsson provided a simple simulation that demonstrated that, if all the sighted A and U whales were in fact species A, omitting AU duplicates would produce an accurate estimate of the number of A, while editing AU duplicates to AA based on ancillary information would produce a negative bias by inflating p(0) for species A by increasing the number of duplicate sightings. Agreement was reached by correspondence after the meeting that, in cases where the species identity of otherwise obvious duplicates did not match, omitting these pairs from the abundance estimation was the correct procedure to produce an unbiased estimate of abundance. It was noted that this is primarily an issue for ship surveys, as inter-platform disagreement in species identity is rare in the Icelandic and Greenlandic aerial surveys.

The WG agreed that improving the accuracy and precision of distance measurements and the timing of sightings is the best way to reduce uncertainty in duplicate identification. In aerial surveys, use of the newly developed Geometer (see Item 6.3) provides a means of doing this. In ship surveys, the use of binocular reticles to measure distance when possible improves accuracy and also improves the accuracy of distance estimates without binoculars by observers. There should also be a greater emphasis of instrumentation to record cue times accurately.

The WG agreed that algorithm-based methods of duplicate identification should be preferred, as they make the procedure objective and replicable. However, it was recognized that, in some cases, field methodology will have to be improved, as noted above, to facilitate this. The Norwegian survey procedures provide one example of how this can be achieved, at least for minke whales.

An additional issue is data selection in duplicate pairs where distances, angles and other variables vary somewhat between platforms. Some analysts use the average between-platform values, while others choose the "best" estimates based on observer experience, the time the sighting was in view or other factors. The best procedure will depend on the specific conditions of the survey; for example, on some surveys one platform has very experienced observers while the other does not.

It was agreed that better documentation of the methods used to identify duplicates was required. This should include the choice of threshold covariate levels, selection algorithms and data choice for cases where there is difference in measurements (e.g. perpendicular distance) between platforms in duplicate pairs. Ideally, working papers should include a complete tabular presentation of all sightings, including covariates and species identity for all pairs identified as duplicates.

13. PUBLICATION OF SURVEY RESULTS

The AE WG again **recommended** (NAMMCO 2009, 2010, 2011, 2012) that results from NASS2015 and any unpublished results from T-NASS 2007 and other surveys be published in a new volume of the *NAMMCO Scientific Publications* (Table 3). Papers can be published as they are completed, i.e., it is not necessary to wait for all papers in the volume to be completed before publication begins online.

The WG suggested Daniel Pike and Rikke Hansen as possible scientific editors on the volume. As for the volume format, the WG suggested that authors should develop their papers either by species or survey however they wish. The volume could then contain an overview paper of each survey with distribution maps, and refer to specific surveys.

The WG also recommended that the Canadians be encouraged to publish their unpublished papers from the 2007 survey (and additional survey data if available).

Table 3. List of prospective scientific papers from NASS2015 and earlier surveys to be prepared for a coordinated publication in a single volume.

Paper Subject/ Working Title	Authors (provisional)	Survey
The North Atlantic Sightings Surveys: Counting whales in the North Atlantic.	Hansen, Pike et al.	All.
Abundance of whales in East and West Greenland in 2015	Hansen et al.	NASS2015
An index of the relative abundance of minke whales in West Greenland	Heide-Jørgensen and Hansen	NASS2015
Estimates of the relative abundance pilot whales (*Globicephala melas*) from North Atlantic Sightings Surveys, 1987 to 2015.	Pike, Mikkelsen, Desportes, Gunnlaugsson, Bloch.	NASS 1987-2015
Trends in the abundance of fin whales in the Central North Atlantic, 1987 – 2016.	Vikingsson, Pike, Gunnlaugsson et al.	TNASS 2007, NASS2015
Abundance of minke whales from recent NASS aerial and ship surveys	Pike, Gunnlaugsson, Vikingsson et al.	TNASS 2007, NASS2015 Aerial 2009, 2016.
Abundance of humpback whales from recent NASS aerial and ship surveys	Pike, Gunnlaugsson, Vikingsson et al.	TNASS 2007, NASS2015 Aerial 2009, 2016.
The Geometer: a device for measuring and recording times and angles in aerial surveys.	Thorgilsson, Pike, Gunnlaugsson, Hansen et al.	NASS 2015, Aerial 2016
Abundance of other species (blue, sei, northern bottlenose, killer, dolphins) from recent NASS aerial and ship surveys	Pike, Gunnlaugsson, Vikingsson et al.	TNASS 2007, NASS2015 Aerial 2009, 2016.
Large whales- Norwegian surveys (2 previous cycles)	Øien, et al.	2 previous mosaic cycles
Porpoises (Norway?)	???	SCANS-III + Norwegian surveys
Odontocetes	Øien	Nils surveys 2002-16(?)
Small toothed whales	Desportes?	T-NASS 2007
Recent abundance estimates of cetaceans off the NE USA.	Palka	SNESSA
Distribution and Abundance of Cetaceans off NE Canada in 2007.	Lawson?	Can T-NASS 2007
SC/16/AE/14 (find paper)		

14. FUTURE SURVEYS

A future NASS/T-NASS will likely occur in 5-7 years (ca 2021). The WG discussed whether there were any methodological/technical/logistical concerns with the surveys that the abundance estimates presented at this meeting were generated from, and therefore if there was a need for surveys before this time period. The WG saw no technical issues with the Icelandic shipboard and Greenlandic aerial surveys.

The WG **recommended** that Iceland consider more frequent coastal aerial surveying (see Item 6.3 for discussion).

Norway intends to continue their mosaic surveys where smaller parts of the larger survey area are covered each year to form a complete coverage of the northeast Atlantic during a six-year cycle.

In general, it is **recommended** that surveys are repeated more frequently in areas where declines have been observed (e.g., West Greenland).

15. OTHER ITEMS

15.1 Workshop at SMM 2017

The WG discussed the possibility of organizing a workshop at the next Society Marine Mammalogy conference (23-27 October 2017 in Halifax, Nova Scotia, Canada). This workshop would involve participants from NASS2015 (and other NAMMCO associated surveys), SCANS-III, Canadian, and USA surveys in the past few years to discuss cetacean distributions and abundance in the North Atlantic.

WG **recommended** proceeding with planning for this workshop.

16. NEXT MEETING

Several analyses are expected to be completed in the next year or so. The WG **recommended** tentatively planning a meeting of the AEWG in June 2017. The Secretariat will confirm in April that the analyses will be ready for a June meeting.

17. ADOPTION OF REPORT

The report was adopted provisionally on 18 October 2016, and in final form via correspondence on 28 October 16.

Pike thanked the group for their helpful comments, suggestions, and their hard work. He also thanked Prewitt for rapporteuring, and the participants for their contributions.

The participants thanked the Chair for his hard work and a well-run meeting.

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Table 1. Abundance estimates accepted by the Abundance Estimates Working Group (16-18 October 2016) for use in population assessments/generating management advice. Other estimates (e.g., uncorrected, etc.) might be more appropriate for used in comparison to previous surveys (see discussion under species agenda items).

Species	**Location/Survey**	**Abundance Estimate**
Fin whales	Iceland/Faroe Islands	35,605 (cv 0.18, 95% CI 24,615 to 51,505) p
	West Greenland	465 (95% CI: 233-929) p
	East Greenland	1,932 (95% CI: 1,204-3,100) p
Minke whales	Iceland/Faroes NASS2015 survey area	36,185 (cv 0.31, 95% CI 19,942 to 65,658) p
	IC/CIC area	12,710 (cv 0.52, 95% CI 4,498 to 35,912) p
	West Greenland	4,204 (cv=0.47; 95% CI= 1,753-10,085) p,a
	East Greenland	2,681 (cv= 0.45; 95% CI= 1,153-6,235) p,a
Humpback whales	West Greenland	1,321 (cv=0.44; 95% CI= 578-3,022) p,a
	East Greenland	4,012 (cv= 0.35; 95% CI= 2,044-7,873) p,a
Pilot whales	West Greenland	11,993 (cv=0.52; 95% CI= 4,575-31,438) p,a
	East Greenland	338 (cv= 1.01; 95% CI= 65-1,749) p,a
Harbour porpoises	West Greenland	83,321 (cv= 0.34; 95% CI=43,377 -160,047) p,a
	East Greenland	1,642 (cv= 1.00; 95% CI= 318-8,464) p,a
White-beaked dolphins	West Greenland	2,747 (95% CI: 1,257-6,002) p
	East Greenland	2,140 (95% CI: 825-5,547) p

p= corrected for perception bias
a= corrected for availability bias
u= uncorrected

WORKING GROUP ON ABUNDANCE ESTIMATES
Copenhagen, October 16-18, 2016

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WORKING GROUP ON ABUNDANCE ESTIMATE
Copenhagen, October 16-18, 2016

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8. **PILOT WHALES**
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10. **OTHER SPECIES**
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11. **ADDITIONAL ANALYSIS TO BE CARRIED OUT**
12. **DUPLICATE IDENTIFICATION**
13. **PUBLICATION OF SURVEY RESULTS**
14. **FUTURE SURVEYS**
15. **OTHER ITEMS**
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WORKING GROUP ON ABUNDANCE ESTIMATE
Copenhagen, October 16-18, 2016

Document List

Working Documents

Doc. No.	Title	Agenda Item
SC/23/AE/01	Draft Agenda	2
SC/23/AE/02	Participant List	1
SC/23/AE/03	Document List	4
SC/23/AE/04	Pike et al. Estimates of the abundance of fin whales (*Balaenoptera physalus*) from the NASS Icelandic and Faroese ship surveys conducted in 2015.	5.1
SC/23/AE/05	Pike et al. Estimates of the abundance of common minke whales (*Balaenoptera acutorostrata*) from the NASS Icelandic and Faroese ship surveys conducted in 2015.	6.1
SC/23/AE/06	Heide-Jørgensen and Hansen. An index of the relative abundance of minke whales in West Greenland	6.4
SC/23/AE/07	Pike. Icelandic aerial survey 2016: Survey report	6.3, 7.1
SC/23/AE/08	Hansen et al. Abundance of whales in East and West Greenland in 2015.	
SC/23/AE/09	Øien. Updates 2014-2016: Preliminary abundance estimates	

Background Papers

SC/23/AE/O01	Pike and Doniol-Valcroze. Identification of duplicate sightings from the 2013 double-platform High Arctic Cetacean Survey	12
SC/23/AE/O02	Southwell et al. 2002. An Automated System to Log and Process Distance Sight-Resight Aerial Survey Data	12
SC/23/AE/O03	Icelandic aerial survey 2015: Survey report	6.3, 7.1
SC/23/AE/O04	Report of the Norwegian 2015 survey for minke whales in the Small Management Area EW–Norwegian Sea and NASS2015 extension survey in the Small Management Area CM – Jan Mayen area	
SC/23/AE/O05	Bøthun and Skaug. Description and performance of an automatic duplicate identification routine	
SC/23/AE/O06	Updates 2014-2016: Preliminary abundance estimates of common minke whales in Svalbard 2014, the Norwegian Sea and Jan Mayen 2015, and the Jan Mayen area 2016,	

	with distributional maps for minke, fin, humpback and sperm whales
SC/23/AE/O07	Gunnlaugsson et al. Cruise Report of the Icelandic NASS 2015 Cetacean census vessel survey

REPORT OF THE WORKING GROUP ON HARP AND HOODED SEALS (WGHARP)
26-30 September 2016, Copenhagen, Denmark

Executive Summary

The ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP) met during 26-30 September 2016 Copenhagen, Denmark. The WG received presentations related to catch and abundance estimates, and ongoing research of White Sea/Barents Sea, Greenland Sea and Northwest Atlantic Ocean harp and hooded seal stocks. The WG concluded their meeting on 30 September 2016. In attendance were scientists representing Canada (2), Greenland (1), Norway (3), UK (1), USA (1), and Russia (2), as well as observers from NAMMCO (1) and Denmark (1) (Annex 1).

Reported catches for harp seals in 2016 were 1 442, 28, and 146 614 animals from the Greenland Sea, White Sea, and NW Atlantic populations respectively. Total hooded seal catches were 18 pups from the NE Atlantic and 1 856 animals from the NW Atlantic population including Greenland harvests.

Current research on the Greenland Sea harp seal has focused on the animal welfare aspects of different killing methods. Data collection has ended and analyses are underway. Software-based seal detection methodology has been developed. Evaluating the seal detection scheme using a validation dataset, an accuracy of 99.7% was obtained. False positives occur and therefore a semi-automatic approach was implemented, where a human reader checks if detections correspond to actual seal pups, and can modify the results if necessary.

No new survey information was available for any stock. For the Greenland Sea harp seal population a population model estimates a 2017 abundance of 543 800 (95% CI: 366 500 – 719 400) 1+ animals and 106 500 (95% CI: 76 500 – 136 400) pups. The total population estimate is 650 300 (95% CI: 471 200 – 829 300) seals. Using current catch levels, the model projects an increase in the 1+ population of 58% over the next 15 years. The equilibrium catch level (which maintains constant population size) is 21 500 (100% 1+ animals). If pups are hunted, two pups balance one 1+ animal. A catch of 26 000 animals (100% 1+) will reduce the population, but with a 0.8 probability that the population remains above N70 over a 15 year period. Catch estimates are lower than previous advice due to changes in fecundity rates used in the projection. Because future fecundity rates are not known, an average of the fecundity rates observed over the past decade was used in the projections. This resulted in an average fecundity rate of 0.84, which is lower than the rate observed in 2016 (F=0.91)

In the White Sea, poor ice conditions were observed in 2015 and 2016. There was no suitable ice for pupping inside the White Sea, but seals with pups were observed on the ice at the entrance to the White Sea. Ice also accumulated in the southeastern Barents Sea. If poor ice conditions are encountered in the White Sea during 2017, the southeast Barents Sea will be searched to see if pupping also occurs in this area.

The model estimates of abundance for White Sea harp seals in 2017 is 1 197 000 (95% CI: 1 042 800 – 1 351 200) 1+ animals and 211 000 (185 100 – 236 900) pups. Total estimate is 1 408 000 (95% CI: 1 251 680 – 1 564 320). The last reproductive rates available are based on data from 2006. The WG was concerned about using the last observed fecundity rate of 0.84 in the future projections. Instead, an average of fecundity rates observed over the last 10 years, was used in the projections (F_{future} = 0.76). The harp seal population in the Barents Sea / White Sea is considered data poor because of the time elapsed since the last series of reproductive

samples were obtained. For this reason, the catch option to reduce the population to N70 was not examined for this stock. Because the stock is Data Poor, this means that the Potential Biological Removal approach for estimating catch quotas should be considered. However, in simulations based on the population model, using this approach resulted in a projected population decline of 25% over the next 15 years. The WG concluded that the PBR catch level was not suitable for providing advice on future catch quotas and recommended that equilibrium catch levels be used. The equilibrium catch level is 10 090 seals (100% 1+ animals). The model indicates an increase of 12% for the 1+ population over 15 years with no catch.

For Northwest Atlantic harp seals a population model was used to examine changes in the size of the population between 1952 and 2014, and then extrapolated into the future to examine the impact of different harvest simulations on the modelled population. The working group examined the level of catches necessary to reduce the harp seal population to 6.8 million or 5.4 million animals assuming catches consisted of 90% Young of the Year (YOY) or 50% YOY, and occurred over different time periods (5, 10,and 15 years). Then, once the herd was reduced, the level of catch possible that would maintain a 95% probability of remaining above the Limit Reference Level. The impacts of the different catch options on the projected population were tested under two scenarios. The first scenario (Model A) assumed that reproductive rates and Greenland catches were similar to that seen over the past 10 years. The second scenario, referred to as Model B, assumed that both future reproductive rates and Greenland catches behave in a density-dependent manner. The predicted changes in the population trajectory were affected very strongly by the age composition of the harvest used to reduce the population, the speed at which the reduction was achieved and on model assumptions concerning density-dependence.

The results of the modelling exercise indicated that more animals would need to be removed if the population reduction was to be achieved rapidly, or with a harvest comprised primarily of YOY. Under Model A, once the target level was achieved, the catch levels that would ensure a 95% probability of remaining above the Critical Reference Limit were much lower than the harvest levels allowable during the reduction phase. Under Model B, the numbers of animals needed to be removed to achieve the reduction target of 6.8 million animals, were similar to the numbers of animals needed to reduce the population to the same level, but under Model A. However, with Model B and a reduction target of 6.8 million animals, much higher harvests were allowed over the 15 years following the reduction due to the increased reproductive rates and reduced Greenland catch that were assumed. Under all scenarios, the uncertainty associated with estimates of population size increased considerably as time since the last survey also increased. The objective of the exercise was to have a 95% likelihood of remaining above the limit reference point (2.4 million) rather than to maintain the population at the reduction target level. As a result, in some scenarios, high catches could be taken after the initial reduction. However, these would result in a continued reduction in the population. If the management objective had been to maintain the population at the reduction target level, the 'post reduction' catches would have been much smaller.

These simulation results are very sensitive to model assumptions and should be considered for illustration only.

The summer (June-July) diet of Greenland Sea hooded seals was studied in the West Ice in 2008 and 2010, based on analysis of gastrointestinal contents of 179 animals obtained in dedicated surveys. Polar cod dominated the diet. The importance of the squid *Gonatus fabricii* was lower in this study compared with previous hooded seal studies in the area.

The estimated 2017 abundance of Greenland Sea hooded seals was 66 860 1+ animals (95% CI: 45 860 – 87 860) and 13 600 (9 250 – 17 950) pups. The estimated total 2017 population is 80 460 (95% CI: 59 020 – 101 900). All model runs indicate a population currently well below the Limit Reference Level. Following the precautionary approach framework developed by WGHARP, no catches should be taken from this population. Previously, ICES recommended that no harvest of Greenland Sea hooded seals should be permitted, with the exception of catches for scientific purposes. Eighteen animals, including 10 pups were taken for scientific purposes by Norway in 2016.

Opening of the meeting

The ICES/NAFO/NAMMCO Working Group (WG) on Harp and Hooded Seals (WGHARP) met during 26-30 September, 2016 at ICES headquarters, in Copenhagen, Denmark. The WG received presentations related to estimates of catch, abundance, biological parameters and current research of relevance to White Sea/Barents Sea, Greenland Sea and Northwest Atlantic Ocean harp and hooded seal stocks. The WG provided catch options for the West Ice/Greenland Sea harp and hooded seals and White Sea/Barents Sea harp seals. The WG also discussed the implications of possible management objectives proposed for the Northwest Atlantic harp seal population. In attendance were scientists from Canada (2), Greenland (1), Norway (3), UK (1), USA (1) NAMMCO (1), Denmark (1), and Russia (2), (Annex 1).

Adoption of the agenda

The agenda for the meeting, as shown in Annex 2, was adopted at the opening of the meeting on 26 September 2016.

Terms of reference - WGHARP – Group on Harp and Hooded Seals

The ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP) chaired by Mike Hammill, Canada, will meet in ICES HQ, Copenhagen, Denmark, 26-30 September 2016 to:

Harp and hooded seals: Northeast Atlantic stocks:

a. Address the special request from Norway on the Management of Harp and Hooded Seal stocks in the Northeast Atlantic by assessing the status and harvest potential of the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea, and of the hooded seal stock in the Greenland Sea. ICES should also assess the impact on the harp seal stocks in the Greenland Sea and the White Sea/Barents Sea of an annual harvest of:

i) current harvest levels;

ii) sustainable catches (defined as the fixed annual catches that stabilizes the future 1 + population);

iii) catches that would reduce the population over a 15-year period in such a manner that it would remain above a level of 70% of the maximum population size, determined from population modeling, with 80% probability.

b. Evaluate new model developments and comparisons with the old assessment model

Harp seals: Northwest Atlantic stock:

c. Explore the impact of proposed harvest strategies that would maintain the North Atlantic harp seal population at a precautionary level of a PA framework, using the Canadian levels as a case study, and that would have a low risk of decreasing below the critical level.

Note - The terms of reference regarding item b were not addressed at the meeting.

MAIN REPORT

HARP SEALS (PAGOPHILUS GROENLANDICUS)

STOCK IDENTITY

No new information

THE GREENLAND SEA STOCK

Information on recent catches and regulatory measures

Catches

Based on advice from WGHARP (ICES 2013) the 2015-16 TAC for harp seals in the Greenland Sea was set at 21 270 1+ animals (where 2 pups balanced one 1+ animal), i.e. the estimated removal level that would reduce the population by 30% to N70 over the next 10 year period (see ICES 2013)(Annex 8, table 1). The total removals of Greenland Sea harp seals in 1946-2016 are shown in Annex 7, Table 1. No Russian vessels have hunted in this area since 1994. Total catches (performed by one vessel each year) of harp seals were 2,237 (including 2,144 pups) in 2015 and 1,442 (including 426 pups) in 2016 (Annex 7, Table 1).

The group was informed, that up to the 2014 season, Norwegian seal hunts were subsidized by the Norwegian government. For the 2015 season these subsidies were completely removed. They were reinstated in 2016, however on a considerably lower scale than in previous years.

Current research

Sealing methods

A project including collection of material to assess efficiency and animal welfare issues in the Norwegian commercial seal hunt was started in 2013, continued in 2014 and field efforts ended after the commercial harp seal hunt in the Greenland Sea in April/May 2015. Analyses of the collected material are in progress.

Identification of seals on digital imagery

Pup production of harp and hooded seals are based primarily on photographic surveys, which are time-consuming to analyse manually. Software-based detection methodology using artificial intelligence (deep learning) has been developed as a collaboration between the Norwegian Computing Centre and Institute of Marine Research, Norway and Fisheries and Oceans, Canada. Deep learning has revolutionized image analysis over the last four years in terms of its ability to extract content and information from images. The developed deep learning scheme is based on a deep convolutional neural network and initial tests of the proposed deep learning based seal detection scheme shows that seals can be detected with a very high accuracy. By evaluating the proposed method on a validation dataset, an accuracy of 99.7% was obtained. False positives occur and therefore a semi-automatic approach was implemented, where a reader may evaluate the detected seal pups and modify the results if necessary.

A new method for estimating the pup production using a geo-spatial point process is under development. If successful, this may lead to improvements in estimates of variance associated with the pup abundance surveys.

Biological parameters

Mean age of maturity (MAM) was estimated at 6.15±0.6 years for a sample of 197 Greenland Sea harp seals collected early in the moulting period in 2014 (Frie SEA246). This estimate is not significantly different from the long term average of 5.6 years estimated for the period 1964-1990, but is significantly different from the 2009 estimate (7.6 years). The ovary-based pregnancy rate for the 2014 sample was 0.91±0.02, which is significantly higher than estimates for the period 1991-2009, but similar to values from 1964 and 1978. The estimated MAM for 2014 was only 0.5 years lower than the mean age of primiparity (MAP) estimated for the same sample, due to near absence of first time ovulators. Further comparisons of MAM and MAP for Greenland Sea harp seals suggest that first time ovulators were poorly represented in samples from 1990, 1991 and 2009. The difference between MAM and MAP for these samples was close to 1 year implying an unrealistically high pregnancy rate of 100% for first time ovulators. In comparison, the difference between MAM and MAP for samples collected in 1959-64, 1978, 1987, 1990 was 1.5 years. The timing of sampling in 2009 and 2014 was similar to, or slightly later than in 1978, suggesting that a seasonal delay of ovulation in young females is not the main reason for the low occurrence of first time ovulators in the more recent Greenland Sea samples. Mark-recapture analyses for the Greenland Sea (Øien and Øritsland 1995) have previously suggested temporal emigration of some cohorts up to the time of first pupping, which could explain the absence of the first time ovulators in the 2014 Greenland Sea sample.

Population assessment

No new survey information is available. The next survey is planned for March 2018.

The current abundance of harp seals in the Greenland Sea was estimated using a population dynamics model that incorporates historical catch records, historical fecundity rates, and age specific proportions of mature females. The model is fitted to independent estimates of pup production (Øigard and Haug SEA240). It is a deterministic age-structured population dynamics model with 3 unknown parameters (pup mortality, mortality of 1 year and older seals, initial population size). This model is the same as used previously by the WG to provide advice for this stock.

Model Input

Two types of reproductive data are used: information on the proportion of females that are mature at a given age (i.e., maturity ogive) and the proportion of mature females that are pregnant at a given year (i.e. fecundity rate). Historical data on the maturity curve are sparse, consisting of only three curves (Table 1). One curve is from the period 1959 – 1990, one is from 2009 and the last one is from 2014. For the periods with missing data (1990 – 2009 and 2009 – 2014), a linear transition between the available maturity curves is assumed. Figure 1 shows the maturity curves from Table 1, along with the linear interpolation between the curves in years with missing data.

Table 1. Estimates of proportions of mature females (pi,t). The P1 estimates are from the period 1950 - 1990 (ICES, 2009), the P2 estimates are from 2009 (ICES, 2011) and the P3 estimates are from 2014 (Frie, SEA246).

Age	1	2	3	4	5	6	7	8	9	10	11	12	13
P1	0	0	0.06	0.29	0.55	0.74	0.86	0.93	0.96	0.98	0.99	1.00	1.00
P2	0	0	0	0	0.06	0.28	0.55	0.76	0.88	0.95	0.98	0.99	1.00
P3	0	0	0	0	0.33	0.71	0.89	0.96	0.99	0.99	1.00	1.00	1.00

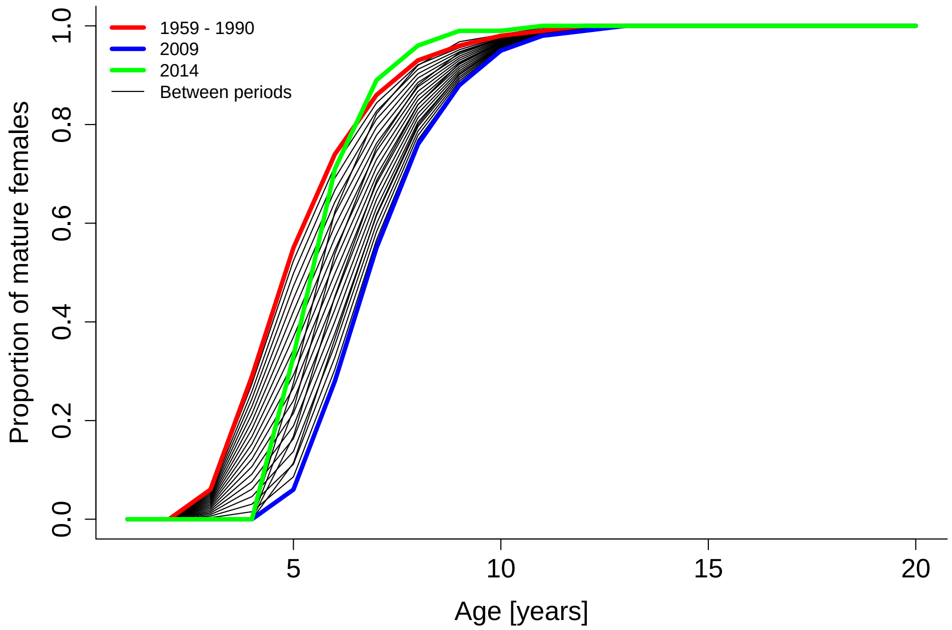

Fig. 1. Proportion of mature females and the interpolated values for years without data among Greenland Sea harp seals in three periods. Values are taken from Table 1.

The model uses historical values of the fecundity rates F rates that are obtained through sampling during the commercial hunt (Table 2). Data are available from a Russian long-term data set (1959 - 1991) (Frie et al. 2003) as well as Norwegian data for 2008 and 2009 (ICES, 2011). A new pregnancy rate for 2014 was presented (Frie, SEA246). The long term data set on pregnancy rates relies on the assumption that pregnancy in the previous cycle can be estimated based on the presence/absence of a large luteinised Corpus albicans (LCA) in the ovaries of females sampled in April-June (ICES, 2009). A similar approach has previously been used for estimation of pregnancy rates of ringed seals (Stirling, 2005). In periods where data are missing, a linear transition between estimates was assumed. Figure 2 shows the available historical pregnancy rates and the interpolated values for years with missing data. As opposed to being part of the data to which the model is fit by maximum likelihood, these rates are treated as fixed values (with no variance) by the population dynamics model.

Table 2. Estimates of proportion of Greenland Sea harp seal females giving birth. It is assumed that the fecundity rate and pregnancy rate are the same. Data from (ICES, 2011) and (Frie, SEA246).

Year	Fecundity rate	Standard Deviation
1964	0.92	0.04
1978	0.88	0.03
1987	0.78	0.03
1990	0.86	0.04
1991	0.83	0.05
2008	0.80	0.06
2009	0.81	0.03
2014	0.91	0.03

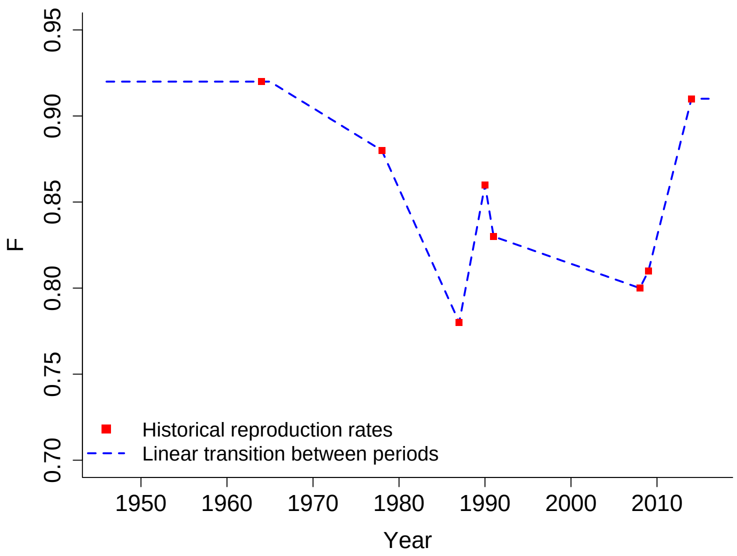

Fig. 2. Historical fecundity rates F of mature females Greenland Sea female harp seals and the interpolated values for years with missing data. Values are taken from Table 2.

Pup production estimates are available from mark-recapture estimates (1983-1991) and aerial surveys conducted (2002-2012) (Table 3). Catch levels for the period 1946 – 2016 are listed in Appendix 7, Table 1).

Table 3. Estimates of Greenland Sea harp seal pup production (ICES 2011, Øigård et al., 2010, Øigård et al. 2014a, ICES 2013). The data from 1983-1991 are mark-recapture estimates; those from 2002, 2007 and 2012 are from aerial surveys.

Year	Estimated Number of Pups	Coefficient of Variation.
1983	58 539	0.104
1984	103 250	0.147
1985	111 084	0.199
1987	49 970	0.076
1988	58 697	0.184
1989	110 614	0.077
1990	55 625	0.077
1991	67 271	0.082
2002	98 500	0.179
2007	110 530	0.250
2012	89 590	0.137

Population model
The population model used to assess the abundance for the Greenland Sea harp seal population is a deterministic age-structured population dynamics model (Øigard and Haug SEA240).

For initiation of the model it is assumed that the population had a stable age structure in year y_0 = 1945, i.e.,

$$N_{i,y_0} = N_{y_0} s_{1+}^{i-1}(1 - s_{1+}), \quad i = 1,\ldots, A-1, \qquad (1)$$

$$N_{A,y_0} = N_{y_0} s_{1+}^{A-1}. \qquad (2)$$

Here A is the maximum age group containing seals aged A and higher, set to 20 years (ICES, 2013), and N_{y_0} is the estimated initial population size in the first year (y_0). The model is parameterized by the natural mortalities M_0 and M_{1+} for the pups and seals 1 year and older seals, respectively. These mortalities determine the survival probabilities s0 = $\exp(-M_0)$ and s1+ = $\exp(-M_{1+})$.

The model has the following set of recursion equations:

$$\begin{aligned} N_{1,y} &= (N_{0,y-1} - C_{0,y-1})s_0, \\ N_{a,y} &= (N_{a-1,y-1} - C_{a-1,y-1})s_{1+}, \quad a = 2,\ldots, A-1, \\ N_{A,y} &= \left[(N_{A-1,y-1} - C_{A-1,y-1}) + (N_{A,y-1} - C_{A,y-1})\right]s_{1+}. \end{aligned} \qquad (3)$$

Data are not available to estimate age-specific mortality rates. Therefore, it is assumed that the mortality rates are constant across ages within the 1+ group. The $C_{a,y}$ are the age-specific catch numbers, but catch records are available only as the number of pups and number of 1+ seals caught. To obtain $C_{a,y}$ in (3) we assume that the age-distribution in the catch follows the estimated age distribution of the population (Skaug et al., 2007):

$$C_{a,y} = C_{1+,y}\frac{N_{a,y}}{N_{1+,y}}, \quad a = 1,\ldots, A, \qquad (4)$$

where $N_{1+,y} = \sum_{y=1}^{A} N_{a,y}$, with $N_{a,y}$ being the number of individuals at age a in year y.
The modelled pup abundance is given by

$$N_{0,y} = \frac{F_y}{2}\sum_{a=1}^{A} p_{a,y}N_{a,y}, \qquad (5)$$

where $N_{a,y}/2$ is the number of females at age a in year y, Fy is the fecundity rate and $p_{a,y}$ are the age specific proportions of mature females in year y.

Assuming normality for the pup production counts, their contribution to the log-likelihood function is

$$\sum_t -\log(cv_{0,y}) - \frac{1}{2}\frac{(N_{0,y} - n_{0,y})^2}{cv_{0,y}n_{0,y}}, \qquad (6)$$

where $n_{0,y}$ and $cv_{0,y}$ denotes the survey pup production count and corresponding coefficient of variation (CV) for year y, respectively (Table 3).

The model calculates a coefficient D_{1+}, which describes the increase or decrease in the 1+ population trajectory over a 15-year period,

$$D_{1+} = \frac{N_{1+,2032}}{N_{1+,2017}}.$$

(7)

The coefficient is used for finding the equilibrium catch levels. The equilibrium catch level is defined as the constant catch level that results in the population size in 2032 being the same as in 2017, i.e., the catch level that give D_{1+}s = 1.

The population dynamics model is a Bayesian type model as priors are imposed on the parameters. A vague normal prior is assumed for the initial population size N_{yo} and a truncated normal prior for both the pup mortality M_{0+} and the mortality for the 1+ group M_{1+} (Table 4).

The combined likelihood-contributions for these priors are

$$-\frac{1}{2}(\mathbf{b}-\mathbf{m})^{T}\Sigma^{-1}(\mathbf{b}-\mathbf{m})-\frac{1}{2}\ln|\Sigma|-\frac{3}{2}\ln(2\pi),$$

(8)

where b = ($N_{a,y}$, M_0, M_1)T is a vector containing the parameters estimated by the model, T denotes the vector transpose, m is a vector containing the respective mean values of the normal priors for the parameters in b, and Σ is a diagonal matrix with the variance of the respective prior distributions on the diagonal. The mean of the prior for M_0 was set at three times the mean of M_{1+}.

All parameter estimates are found by minimizing the likelihood function using the statistical software AD Model Builder (Fournier et al., 2012). AD Model Builder calculates standard errors (SE) for the model parameters, as well as the derived parameters such as present population size and D. It uses a quasi-Newton optimization algorithm with bounds on the parameters, and calculates estimates of standard errors of model parameter using the "delta-method" (Skaug et al., 2007). The catch data enter the model through Eq. (3), but do not contribute to the objective function. Handling of data and visualizations were done in R (R Core Team, 2015).

The estimated population sizes and parameters used in the model, along with the normal priors, used are presented in Table 4. The model trajectory indicates a substantial increase in the population abundance from the 1970s to the present (Fig. 3). The model estimates are stable for various choices of initial values. Even though the priors for M0, and M1+ are relatively non-informative, increasing the mean of the prior to 0.3 and 0.1, respectively, caused a 0.1% change in the total population estimate. Due to the limited data available, mortality cannot be estimated independently and the model estimates of M_0 and M_{1+} are highly correlated (-0.95).

The model estimates a 2017 abundance of 543 800 (95% CI: 366 500 – 719 400) 1+ animals and 106 500 (95% CI: 76 500 – 136 400) pups. Total estimate is 650 300 (95% CI: 471 200 – 829 300) seals.

Table 4. Greenland Sea harp seals: Estimated and derived mean values and standard deviations of the parameters used in the model. Priors used are shown in brackets. Nmax is the historically largest total population estimated by the model, N_{70} is 70% of N_{max}, N_{lim} is 30% of N_{max} and N_{lim} is the estimated population size using 20th percentile of the log-normal distribution.

Parameters	Model estimates	
	Mean	SD

N0y	283 600 (900 000)	25 611 (900 000)
M0	0.27 (0.24)	0.19 (0.2)
M1+	0.12 (0.08)	0.02 (0.1)
N_{max}	650 300	-
N_{70}	455 210	-
N_{lim}	195 090	-
N_{min}	567 879	-
$N_{0,2017}$	106 500	15 305
$N_{1+,2017}$	543 800	90 050
$N_{Total,2017}$	650 300	91 338

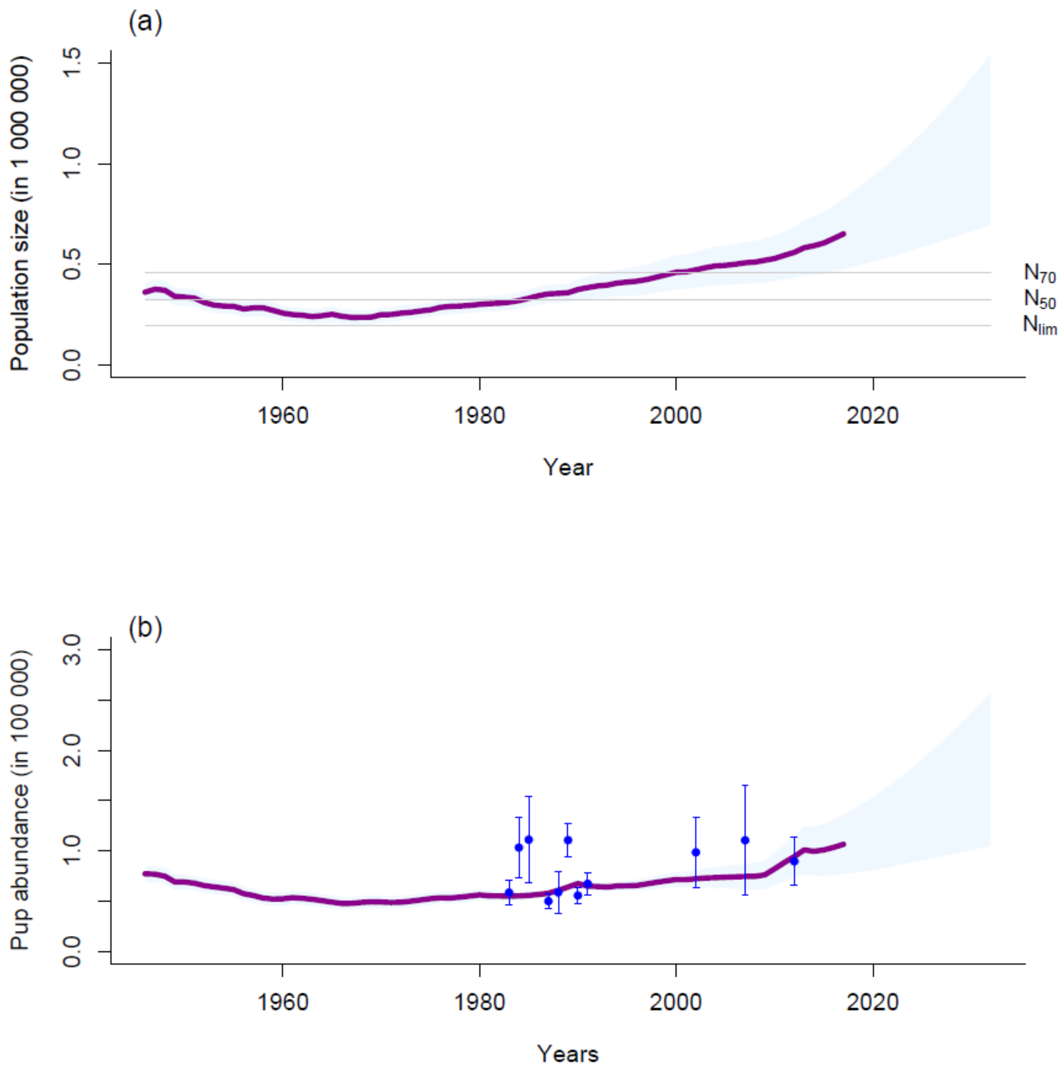

Fig. 3. Greenland Sea harp seals: Modelled population trajectories for pups and total population (full lines), 95% confidence intervals. Future projections are illustrated by confidence bands. N_{70}, N_{50}, and N_{lim} denote the 70%, 50% and 30% of the estimated maximum population size, respectively. Observed pup production estimates and 95% confidence intervals are shown in blue.

Catch options

The most recent reproductive rates available are based on data from 2014 (Frie, SEA 246) and pup production estimates are based on data from 2012 (ICES, 2013), i.e., less than 5 years old. Based on this, the WG considers the harp seal population in the Greenland Sea as data rich and catch advice can be provided with the use of an appropriate population model. Hammill and Stenson (2010) explored the impact of extrapolating catches on our ability to monitor changes in the population given the precision and frequency of pup production surveys. They found that catches should be projected over a period of at least 15 years to determine their impact on the population. In 2013 the WG recommended that in the future, the impact of the various catch scenarios should be explored over a 15 year period rather than 10 years used previously (ICES, 2013). The impact of various catch scenarios are therefore explored over a 15 year period. The catch scenarios are:

1) Current catch level (average of the catches in the period 2012 – 2016)
2) Equilibrium catches
3) Catches that would reduce the population to N_{70} with probability 0.8 over a 15-year period

Current catch level is defined as the average catch level of the last 5 years, i.e., the average catch level of the period 2012 – 2016. The equilibrium catch level is defined as the (fixed) annual catch level that stabilizes the future 1+ population under the estimated model. The proportion of pups in catch used was 0% and 80.4%. Option 3 is the highest harvest level that would ensure with 80% probability that the population size does not fall below N_{70} over a 15 year period.

The WG was concerned about the uncertainty in the pregnancy rates and felt that using the last observed fecundity rate in the projections was not appropriate given observed historical variation. They considered that it was more appropriate to use an average of the fecundity rates observed over the past decade in projections of the population size. This is consistent with the practice used for other harp seal stocks. The fecundity rate used for projections was Ffuture = 0.84.

The estimates for the various catch options are given in Table 5. Using current catch levels the model projects an increase in the 1+ population of 58% over the next 15 years. The equilibrium catch level is 21 500 (100% 1+ animals). If pups are hunted, two pups balance one 1+ animal. A catch level of 26 000 animals (100% 1+) will reduce the population to N_{70} with an 0.8 probability that the population remains above this level over a 15 year period.

Table 5. Catch options with relative 1+ population size (D1+) in 15-years (2032) for harp seals in the Greenland Sea.

Catch option	Proportion pups in catches	Pup catch	1+ catch	Total catch	D1+ (95% CI)
Current level	80.4%	5 992	1 465	7 456	1.58 (1.30-1.86)
Equilibrium	0%	0	21 500	21 500	1.00 (0.61-1.40)
Reduce to N70a)	0%	0	26 000	26 000	0.85 (0.40-1.29)

a) Catches that would reduce the population to 70% of current level with 0.8 probability over 15 years.

The available data on fecundity are limited. The population model does not consider the uncertainty in the estimated fecundity rates. Instead it treats the available data on fecundity and age specific maturity as known quantities. Therefore the confidence intervals around model projections are underestimated. The WG recommends that the model should be modified to account for the uncertainties of these reproductive data.

THE WHITE SEA AND BARENTS SEA STOCK

Information on recent catches and regulatory measures

Due to a sharp decline in pup production observed after 2003, ICES (2013, 2014) recommended that removals be restricted to the estimated sustainable equilibrium level which was 17,400 and 19,200 1+ animals (where 2 pups balanced one 1+ animal) in 2015 and 2016, respectively. The Joint Norwegian-Russian Fisheries Commission has followed this request of which 7,000 seals of this TAC was allocated to Norway and the remaining quota allocated to Russia in both years (Annex 8, Table 2). A ban on all pup catches prevented Russian hunting in the White Sea during the period 2009-2014. This ban was removed before the 2015 season. However, the availability of ice was too restricted to permit sealing, resulting in no commercial Russian harp seal catches in the White Sea in 2015 (Annex 7, Table 2). This was also the case in 2016. Also, no Norwegian vessels hunted in the southeastern Barents Sea (the East Ice) in 2015 and 2016. In September 2016, 28 harp seals (1+ animals) were taken for scientific purposes north of Svalbard – presumably from the White Sea / Barents Sea population (Appendix 7, Table 2;).

Current research

<u>Ice conditions and possible influence on harp seal pupping</u>

Information on ice conditions in the White Sea and south-eastern part of the adjacent Barents Sea area was obtained from satellite imagery, ice-charts and ship captains during January-April 2015 and 2016 to examine possible impacts of ice conditions on harp seal pupping.

In 2015, the remote sensing data showed extensive ice cover, throughout the White Sea and in the adjacent south-eastern part of the Barents Sea during February. Ice conditions considered optimum for harp seal pupping were present at this time. During March the ice had largely disappeared from the main ‘basin’ of the White Sea. Heavier ice remained in the entrance to the White Sea and in south-eastern part of the Barents Sea (Fig 4), but warm temperatures and warm southerly winds contributed to ice destruction and by mid-March there was very little ice remaining in the White Sea, with ice cover being restricted along the coast at the entrance to the White Sea and in the southeastern Barents Sea. A large patch of whelping animals was seen in each of these areas. Pup mortality was considered to be relatively high.

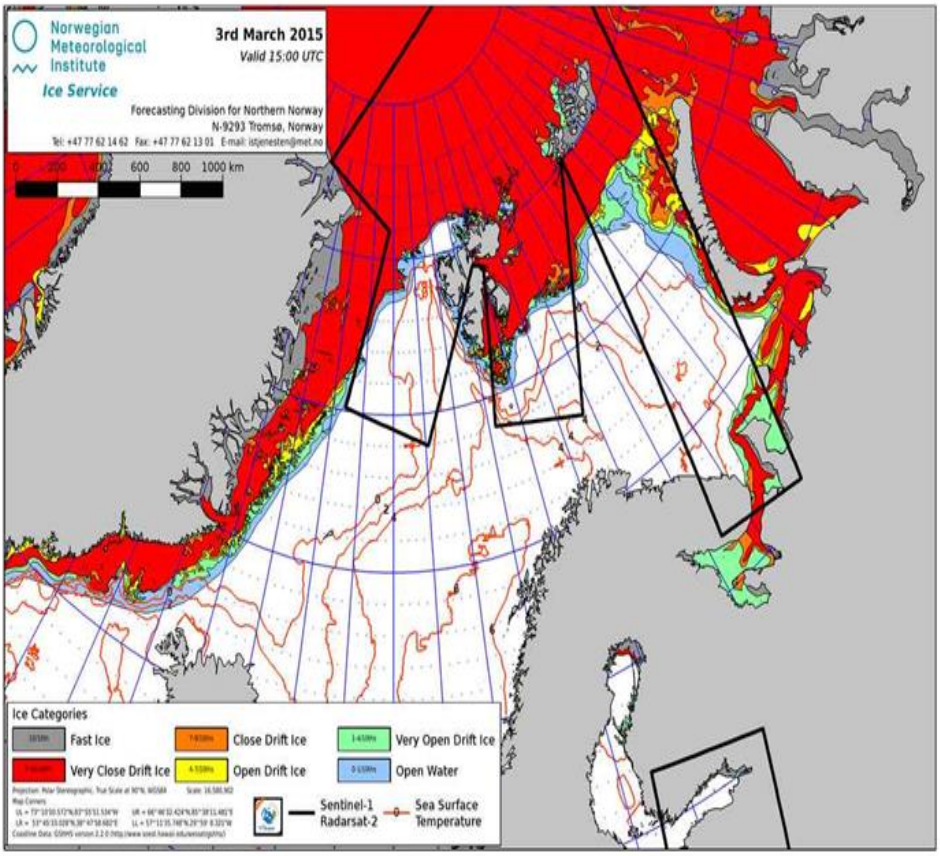

Fig. 4. Map showing ice cover in the White Sea and southeastern Barents Sea on 3 March 2015. Ice map is from the Norwegian Meteorological Institute, TromsØ Norway.

In 2016, suitable ice conditions in the White Sea were observed in January, but the ice deteriorated rapidly and by March suitable ice for harp seal pupping was only observed along the coast at the entrance to the White Sea and in the eastern Barents Sea. Total ice cover was lower than in 2015, but more suitable ice for pupping appeared to be present. Consequently, mortality was considered to be lower in 2016 compared to 2015.

Working papers on the age of maturity and pregnancy rates of harp seals in the White Sea and estimates of abundance using cohort and stock production models were made available to the working group but were not discussed in detail because the authors were unable to be present (Shafikov SEA244 ; Korzhev and Zabavnikov SEA242).

Biological parameters

For the Barents/White Sea stock an even more pronounced under-representation of first time ovulators was observed than among the Greenland Sea harp seals. Estimates of MAM and MAP were virtually identical for all available samples from the early 1960s to 2006. The implications of this depend on the underlying reason for the small numbers of first time ovulators in the samples. If the main reason was a seasonal delay in timing of first ovulation, MAM will be overestimated, but estimates of MAP would be reliable. If the main reason was spatiotemporal segregation of reproductive classes, MAP may be underestimated due to under-representation of nulliparous females. More information on the seasonal distribution of first time ovulators is needed to understand why they are not being seen in the sample collecitons

The WG noted that biological material sufficient for establishing an ogive was last collected in 2006, and that data for calculations of fertility rates have not been collected from this area since 2011. The WG recommends that efforts be made to obtain samples, to evaluate reproductive rates for use in the population model and body condition information as well.

Population assessment
No new survey information. A new survey is planned for March 2017

Population Assessment
The population dynamics model has the same structure as that used to model Greenland Sea harp and hooded seals. It incorporates historical catch records, fecundity rates, age specific proportions of mature females, and fits to estimates of pup production to estimate the population trajectory.

Two types of reproductive data are used in the model: information on the proportion of females that are mature at a given age (i.e., maturity ogive) and the proportion of mature females that are pregnant at a given year (i.e. fecundity rate). Estimates of age specific proportions of mature females are available for four historical periods; 1962 - 1972, 1976 - 1985, 1988 - 1993, and 2006 (Table 6; Frie et al., 2003; ICES, 2009; ICES, 2013). For years with no data a linear interpolation of the age specific proportions of mature females between two periods is assumed (Fig. 5; ICES, 2013).

Table 6. Estimates of proportions of mature Barents Sea / White Sea harp seal females (p) at ages 2-15 in four historical periods: P1 = 1962-1972 P2 = 1976-1985; P3 = 1988-1993; P4 = 2006;. Data from ICES (2014).

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15
P1	0	0.01	0.17	0.64	0.90	0.98	0.99	1.0	1.0	1.0	1.0	1.0	1.0	1.0
P2	0	0	0	0.24	0.62	0.81	0.81	0.95	0.98	0.99	0.99	1.0	1.0	1.0
P3	0	0	0.02	0.08	0.21	0.40	0.59	0.75	0.85	0.91	0.95	0.97	0.98	0.99
P4	0.01	0.02	0.05	0.11	0.25	0.55	0.90	0.99	1.0	1.0	1.0	1.0	1.0	1.0

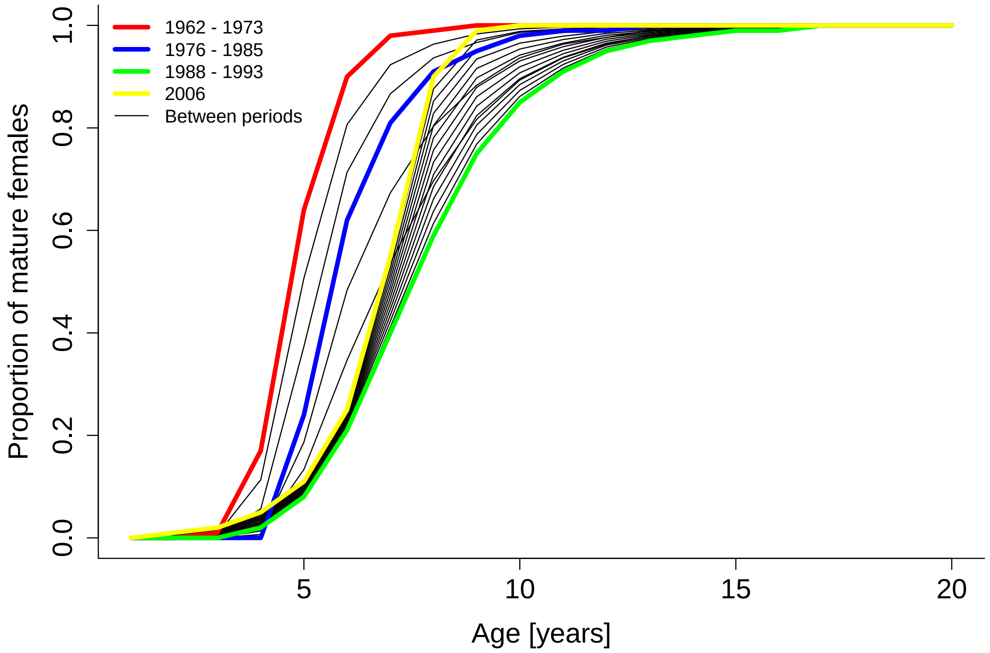

Fig. 5. Proportion of mature females and the interpolated values for years without data among Barents Sea / White Sea harp seals. Values are from Table 6.

The model also uses historical values of the fecundity rates that are obtained through sampling during commercial hunt. Barents Sea / White Sea population fecundity data are available as mean estimates in the period 1990 – 1993, and from 2006 and 2011 (Table 7; Kjellqwist et al., 1995; ICES, 2008;Frie SEA246). The population dynamics model sets fecundity with no variance. For periods where there are no pregnancy rate data, values were interpolated assuming a linear transition from 0.84 in 1990 to 0.68 in 2006, increasing again to 0.84 from 2006 to 2011. Prior to 1990 a constant pregnancy rate was assumed and set at 0.84. After 2011, the WG was concerned about the uncertainty in the pregnancy rates and felt that using the last observed fecundity rate in the projections was not appropriate given observed historical variation. They considered that it was more appropriate to use an average of the observed fecundity rates in the projections.

Table 7. Estimates of proportion of Barents Sea / White Sea harp seal females giving birth. Data from ICES (2011) and Frie (SEA246)

Year	Fecundity rate	Standard Deviation
1990 - 1993	0.84	0.05
2006	0.68	0.06
2011	0.84	0.10

Pup production estimates are available from surveys conducted in 1998 – 2013 (Table 8) (ICES 2011; 2014). The catch records come from commercial hunt and distinguish between the number of pups (0-group) and the numbers of 1+ animals caught per year, but contain no additional information about the age composition of the catches. The modelling period begins in 1946, because catch data prior to then are unreliable (Iversen, 1927; Rasmussen, 1957; Sergeant, 1991).

Table 8. Timing of Russian surveys, estimated numbers of pups and coefficients of variation (CV) for harp seals in the Barents Sea / White Sea. Numbers and CVs are drawn from ICES (2011) and ICES (2014). All unspecified surveys were flown using multispectral sensing systems

Year	Survey Period	Estimated Number of Pups	Coefficient of Variation
1998	12 & 16 March	286,260	0.150
2000	10-12 March - photo 18 March -	322,474a 339,710b	0.098 0.105
2002	20 March	330,000	0.103
2003	18 & 21 March	328,000c	0.181
2004	22 March – photo 22 March -	231,811 234,000	0.190 0.205
2005	23 March	122,658	0.162
2008	19-20 March	123,104	0.199
2009	14-16 March	157,000	0.108
2010	20-23 March	163,022	0.198
2013	15-21 March	128,786	0.237

a) First 2000 estimates represented the sum of 291,745 pups (SE = 28,708) counted plus a catch 30,729 prior to the survey for a total pup production of 322,474
b) Second 2000 estimate represents the sum of 308,981pups (SE = 32,400) counted plus a catch of 30,729 prior to the survey for a total pup production of 339,710
c) 2003 estimate represents the sum of 298,000 pups (SE = 53,000) counted, plus a catch of 35,000 prior to the survey for a total pup production of 328,000

The estimated population sizes, and priors used are presented in Table 9. Figure 6 shows the model fit to the observed pup production estimates and the modelled total population trajectory. The fit to the early pup production estimates is poor, and the model does not capture the dynamics of the survey pup production estimates. The model indicates that harp seal abundance in the Barents Sea/White Sea declined from 1946 to the early 1960s, increased from the early 1960s to early 1980s, but then declined again until around 2007. The model suggests an increase in population size since 2007.

The model estimates are stable for various choices in priors. Even though the priors for M_0 and M_{1+} are relatively non-informative, increasing the mean of the prior to 0.3 and 0.1, respectively, caused a 0.1% change in the total population estimate. Due to the limited data available, mortality cannot be estimated independently and the model estimates of M_0 and M_{1+} are highly correlated (-0.95).

Because the fecundity rates are fixed values in the model, there is no uncertainty associated with this parameter, meaning that the uncertainty of the modelled abundance is underestimated.

The 2017 model estimates of abundance is 1 197 000 (95% CI: 1 042 800 – 1 351 200) 1+ animals and 211 000 (95% CI: 185 100 – 236 900) pups. Total estimate is 1 408 000 (95% CI 1 251 680 – 1 564 320).

Table 9. Barents Sea / White Sea harp seals:
Estimated and derived mean values and standard deviations of the parameters used in the model. Priors used are shown in brackets. Nmax is the historically largest total population estimated by the model, N70 is 70% of Nmax, Nlim is 30% of Nmax, and Nmin is the estimated population size using 20th percentile of the log-normal distribution.

Parameters	Model estimates	
	Mean	SD
Ny0	1 701 500 (1 000 000)	141 450 (2 000 000)
M0	0.27 (0.27)	0.05 (0.05)
M1+	0.13 (0.09)	0.006 (0.05)
N_{max}	2 115 300	-
N_{70}	1 480 710	-
N_{lim}	634 590	-
N_{min}	1 332 826	-
$N_{0,2017}$	211 000	13 200
$N_{1+,2017}$	1 197 000	78 650
$N_{Total,2017}$	1 408 000	79 750

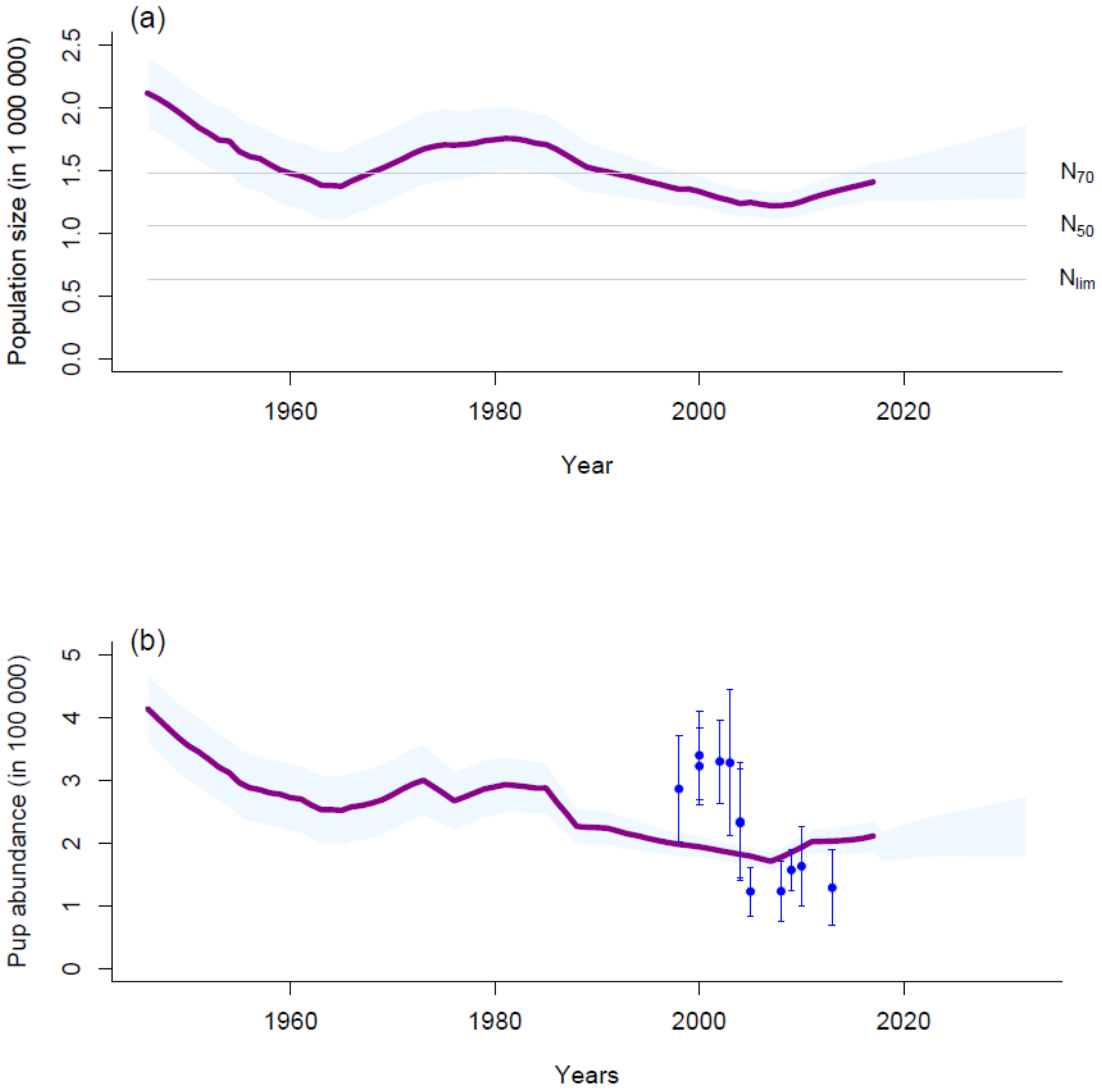

Fig. 6. Barents Sea / White Sea harp seals: Modelled population trajectories for pups and adults (full lines), 95% confidence intervals Future projections are illustrated by confidence bands. N_{70}, N_{50}, and N_{lim} denote the 70%, 50% and 30% of the historical maximum population size, respectively. Observed pup production estimates and 95% confidence intervals are shown in blue.

Catch options

The various catch scenarios requested are:

1) Current catch level (average of the catches in the period 2012 – 2016)
2) Equilibrium catch level
3) Catches that would reduce the population to N_{70} with probability 0.8 over a 15-years period

Current catch level is defined as the average catch level of the last 5 years, i.e., the average catch level of the period 2012 – 2016. For pups there has been zero catch in this period, and for the 1+ group 9 seals were caught in 2012 and none for the other years. Because of this we have set the current catch level to be zero for both the pups and the 1+ group. The equilibrium catch level is defined as the (fixed) annual catch level that stabilizes the future 1+ population under the estimated model over a period of 15 years. It was assumed that no pups were taken in the catch

The last reproductive rates available are based on data from 2006 (ICES, 2011), i.e., more than 5 years old. The WG was concerned about using the last observed fecundity rate of 0.84 in the future projections. An average of the most recent observed fecundity rates, i.e. observed fecundity rates the last 10 years, was used
for the population projections. The averaged fecundity rate used for future projections was F_{future} = 0.76.

The harp seal population in the Barents Sea / White Sea is considered data poor because of the time elapsed since the last series of reproductive samples were obtained. As a result the catch option 3 (Catches that would reduce the population to N_{70} with probability 0.8 over a 15-years period) was not examined.

Since the populations is classified as data poor and is above a critical limit (N_{lim}) the Potential Biological Removal (PBR) approach for estimating catch quotas should be considered in addition to the requested catch options.

The PBR has been defined as:

$$PBR = \frac{1}{2} R_{\max} F_r N_{\min},$$

where R_{max} is the maximum rate of increase for the population, Fr is the recovery factor with values between 0.1 and 1, and Nmin is the estimated population size using 20th percentile of the log-normal distribution. R_{max} is set at a default of 0.12 for pinnipeds.

Given the still unexplained drop in pup production first observed in 2004 and that the pup production since then seems to remain low, we used a recovery factor Fr of 0.5 as in the previous assessment. The PBR catch option assumes that the age structure of the removals is proportional to the age composition of the population, i.e., 14% pups in catch. A catch consisting of a higher proportion of pups would be more conservative, but a multiplier to convert age 1+ animals to pups is inappropriate for the PBR.

Setting future harvests at the PBR level resulted in a 33% reduction of the 1+ population over the next 15 years. Since the model indicates a decline of the population using a PBR catch level with a recovery of Fr = 0.5, we also used a smaller recovery rate of Fr = 0.25. The model indicated a reduction of 10% of the 1+ population over the next 15 years using this PBR catch level. The precision of the 2017 model estimate is fairly high with a CV of 0.07. The WG feels that the uncertainty of the population dynamics model is underestimated and a CV of 0.07 is too low. Because of this, the resulting PBR catch level is likely to be over-estimated. Increasing the CV when calculating the PBR catch level, i.e., increasing the uncertainty about the model estimate of the 2017 abundance, will lower the PBR catch quota. However, using FR=0.5, and an Nmin, that assumed a substantial increase of the CV to 0.30 still resulted in a PBR that caused the estimated 1+ population to decrease by 25% over the next 15 years. The WG concluded that the PBR catch level was not suitable for providing advice of future catch quotas and recommended that equilibrium catch levels be used.

The estimates for the various catch options are given in Table 10. The model indicates an increase of 12% for the 1+ population over 15 years with no catch. Equilibrium catch level is 10 090 seals (100% 1+ animals). If pups are hunted two pups balance one 1+ animal.

Table 10. Catch options with relative 1+ population size (D1+) in 15-years (2032) for harp seals in the Barents Sea / White Sea.

Catch option	Proportion pups in catches	Pup catch	1+ catch	Total catch	Change of the 1+ population over 15 years (95% CI)
Current level	0%	0	0	0	1.12 0.99-1.25
Equilibrium	0%	0	10 090	10 090	1.00 (0.87-1.13)
PBR, Fr = 0.50	14%	5598	34 387	39 985	0.67 (0.52-0.81)
PBR, Fr = 0.25	14%	2799	17 193	19 992	0.90 (0.76-1.03)
PBR, Fr = 0.50, CV = 0.3	14%	4 619	28 371	32 990	0.75 (0.61-0.87)

In this assessment, the equilibrium catch, is much lower than that estimated in the previous assessment. This is because of the lower pregnancy rates assumed in the projections and this highlights the need for new samples.
Furthermore, uncertainty in the reproductive data needs to be incorporated into the assessment model.

THE NORTHWEST ATLANTIC STOCK

Information on recent catches and regulatory measures

Canada

Between 2003 and 2010 the harp seal quota in Canada ranges from 270 000 to 330 000. In 2011 the quota was raised to 400 000. Since then it has been 'rolled over' annually (Annex 8,Table 3). The TAC includes allocations for aboriginal harvesters (currently 6 840), development of new products (20 000) and personal use (2 000). There is no specific allocation or quotas for catches in Arctic Canada.

Following a peak catch of 365 971 harp seals in 2004, catches have declined significantly (Annex 7, Table 4). Despite the high quotas, catches have remained below 80 000 since 2009. In 2015, catches dropped to a low of 35 304 (8.8% of the TAC) due primarily to the lack of markets. Although still low, catches increased to approximately 66 865 (16.7% of the TAC) in 2016. Catches in the Canadian Arctic are not known but are thought to be small (<1000).

The vast majority of harp seals taken in the Canadian commercial hunt are young of the year, accounting for >98% of the catch during the past decade. However, in 2016, a small meat hunt for adult seals occurred during late February and early March. The actual age structure of the hunt in 2016 will not be available until Statistics Branch completes their examination of the purchase slips. For this reason the age is listed as unknown. The age structure of the 2015 catches may also change once this check is completed.

Greenland

Greenland catches of harp seals have been reported up to 2014. Catches over the past decade have varied from 59 769 in 2012 to 95 954 in 2006 with an average catch on 78 749 (Annex 7 Table 5). The reported catch for 2013 and 2014 was 81 196 and 63 059, respectively. Along the west coast where the majority of seals were caught, the % adults reported varied between ¼ and 1/3 of the catch.

The most recent catch reports differ slightly from previous reports. However, the reasons for these changes are not clear. Therefore, tables presented here include the previous reported catches for the period up to 2011. They will be updated if necessary once the reason for any changes are clarified (Annex 7, Table 6).

Total reported catches for Canada and Greenland are summarized in Annex 7,Table 3. In Annex 7, Table 7 presents estimated total removals including by-catch in Canadian and US fisheries, and estimates of struck and lost (Stenson and Rosing-Asvid SEA 245). It also assumes that Canadian catches in 2016 were all young of the year.

Current research

Female harp seal attendance to their pups, and nursing patterns, under varying environmental conditions were examined at the Front whelping patch to determine if these patterns change in response to changing weather conditions (Perry et al 2016). The behaviour of 158 harp seal females and pups was recorded every three minutes during daylight hours; air and water temperature, and wind speed were recorded at the beginning of each observation session. GAMM models were used to examine the importance of time and environmental conditions in predicting attendance and nursing patterns. The best model for predicting attendance included time of day, air temperature, wind speed, and the interaction between wind and air temperature. The best model for predicting nursing included wind speed, air temperature, and time of day. Females were more likely to attend their pups during the afternoon when solar radiation appeared to be high, but reduced attendance during high winds and/or low temperatures. The likelihood of attending females nursing during these poor weather conditions was greater than when conditions were better. Thus, females were less likely to be present when weather conditions were poor but when present, they were more likely to be provisioning their pups. This strategy may help these females defray the thermoregulatory demands on their limited resources while ensuring that their young attain weights that are likely to increase post-weaning survival and hence maternal fitness.

Biological Parameters

The long-term monitoring of late-term pregnancy rates, fecundity and abortion rates of Northwest Atlantic harp seals has continued with annual samples being collected off the coast of Newfoundland and Labrador.

Stenson et al (2016) described a study of late term pregnancy and abortion rates in Northwest Atlantic harp seals based upon samples collected off the coast of Newfoundland, Canada. Since the 1950s, pregnancy rates have declined while inter-annual variability has increased. Using a beta regression model to explore the importance of biological and environmental conditions, they found that while the general decline in fecundity is a reflection of density-dependent processes associated with increased population size, including the late term abortion rates captured much of the large inter-annual variability. Change in the abortion rate is best described by a model that incorporates ice cover in late January and capelin, a major prey of harp seals, biomass obtained from the previous fall. A previous study has shown that capelin abundance is correlated with ice conditions suggesting that late January ice conditions could be considered a proxy for environmental conditions that influence a number of prey species.

Preliminary data on the condition of harp seals collected off the coast of southern Labrador and NE Newfoundland between 1979 and 2012 presented to the WG indicates that there appears to be a positive correlation between annual average condition and annual pregnancy rates. There appears to be a negative, non-linear, relationship between annual average condition and annual abortion rates. There also appears to be a strong correlation between mean winter (December – February) blubber thickness and annual pregnancy rates.

Population Assessment

No new information on current abundance was presented. However, the importance of the assumption used to describe the density dependent relationship in the NWA harp seal model was illustrated as part of the advice to Canada (see below).
A new pup production survey is planned for March 2017

HOODED SEALS (CYSTOPHORA CRISTATA)

The Greenland Sea Stock
Information on recent catches and regulatory measures

Concerns over low pup production estimates resulted in a recommendation from ICES that no harvest of Greenland Sea hooded seals should be permitted, with the exception of catches for scientific purposes(ICES 2008) (Annex 8, Table 1). This advice was immediately implemented (Annex 8, Table 1). The total removals of Greenland Sea hooded seals in 1946-2016 are shown in Annex 6, Table 1. Total catches for scientific purposes (all taken by Norway, Russian sealers did not operate in the Greenland Sea) in 2014 were 11 (whereof 5 pups) in 2015 and 18 (whereof 10 pups) in 2016.

Current research

Diet

Hooded seals are important predators in drift ice areas of the Greenland Sea (the West Ice) during spring and summer. Their summer (June-July) diet was studied in the West Ice in 2008 and 2010, based on analysis of gastrointestinal contents of 179 animals obtained in dedicated surveys (Enoksen et al. In press). Polar cod dominated the diet. The importance of the squid Gonatus fabricii was lower in this study compared with previous hooded seal studies in the area, and krill only occurred sparsely. In addition to the hooded seals, samples of 20 harp seal digestive tracts and 70 harp seal faeces were also obtained during the 2010 survey. The diet composition of the harp seals was dominated by amphipods (primarily Themisto sp.) and deviated significantly from the hooded seal diet, implying that the degree of food competition was relative low. The occurrence of polar cod, Themisto sp. and krill in the diets of the two seal species coincides well with the geographical and vertical distribution of these three prey items and the previously recorded dive depths of the seals. The presence of demersal fishes such as sculpins and snailfish in the diet of some hooded seals was more likely a result of increased availability rather than changes in prey preference, as these seals were collected above shallower waters.

Morphometric data

Morphometric parameters of female hooded seals collected in the Greenland Sea (GS) 1958-2010 were compared to female Northwest Atlantic (NWA) hooded seals from the period 1956-76. Reproductive data available for a subset of the NWA data set have previously been shown to exhibit the highest reproductive rates recorded for hooded seals, while reproductive rates for the GS hooded seals have been low during this period of dramatic decline in population size. One of the central findings of the study is that length-at-age of parous females was consistently lower in GS females compared to the NWA hooded seals. Length-at-age of GS hooded seals furthermore declined significantly in the late 1970s and remained low up to the late 1990s. The most recent sample from 2008-10 showed a return to the 1958 level. A similar pattern of decline and subsequent increase occurred for average length of primiparous females (ALPP). ALPP for the period 1958-75 and 2008-10 was not different from value for the NWA samples, but a significant drop in ALPP was observed during the period 1980-1999. The drop in length-at-age and ALPP in the late 1970s occurred after signs of marked boom and bust dynamics of fisheries for potential hooded seal prey species like redfish and Greenland halibut. Conversely the later increase in length at age and ALPP in the 2008-10 occurred after a documented recovery of redfish and Greenland halibut in the Norwegian Sea area and around Svalbard. These two species have, however, not been documented in diet studies of GS hooded seals, which have focused on the diet in the pack ice areas, dominated by high arctic species like polar cod (Boreogadus saida) and the squid Gonatus fabricii. The geographical distribution of these high Arctic species has likely declined during the warm period after 2000, but the density of prey available to the hooded seals close to the pack ice could have increased.

Biological parameters
No new information

Population assessments
No new surveys have been completed

The same population model used for the Greenland Sea harp seal population is used in this assessment of the Greenland Sea hooded seal population.

Maturity curves were constructed based on female reproductive material collected over the period 1990-94 and 2008-10 (Table 11, ICES 2011).

Table 11. Estimates of proportions of mature females (pi,t). The P1 estimates are from ICES (2008) and the P2 estimates are from ICES (2011). Mature females had at least one CL or CA in the ovaries.

Age	1	2	3	4	5	6	7	8	9	10	11
P1	0	0.05	0.27	0.54	0.75	0.87	0.93	0.97	0.98	0.99	1.00
P2	0	0	0.06	0.60	0.89	0.97	0.99	1.00	1.00	1.00	1.00

The record of historical fecundity rate is sparse, but the observed fecundity rates are all around 0.7 (ICES, 2013). A fixed fecundity rate of F = 0.7 was used for all years when modelling the Greenland Sea hooded seal population.

Pup production estimates are available from aerial surveys conducted in 1997, 2005, 2007, and 2012 (Table 12, ICES 2011, Salberg et al., 2008, Øigård et al., 2014). Catch levels for the period 1946 – 2016 are presented in Annex 6, Table 1.

Table 12. Estimates of Greenland Sea hooded seal pup production, based on data from ICES (2011), Salberg et al., 2008 and Øigård et al., 2014.

Year	Estimated Number of Pups	Coefficient of Variation.
1997	23 762	0.192
2005	15 250	0.228
2007	16 140	0.133
2012	13 655	0.138

The estimated population, along with the parameters for the normal priors used are presented in Table 13. The mean of the prior for M_0 was set to be three times the mean of M_{1+}.
The population trajectory is shown in Figure 7. The model indicates a substantial decrease in abundance from the late 1940s and up to the early 1980s. In the most recent two decades, the population appears to have stabilized at a low level.

A 2017 abundance of 66 860 1+ animals (95% CI 45 860 – 87 860) and 13 600 (95% CI 9 250 – 17 950) pups is obtained. The estimated total 2017 population of hooded seals in the Greenland Sea is 80 460 (95% CI 59 020 – 101 900). For comparison the total estimated population of hooded seals on the Greenland Sea was 82 830 seals in 2013 and 85 790 in 2011 (ICES 2011,2013).

Table 13. Greenland Sea hooded seals: Estimated mean values and standard deviations of the parameters used in the model. Priors used are shown in brackets. Nmax is the historically largest total population, N_{70} is 70% of N_{max}, N_{lim} is 30% of N_{max}, and N_{min} is the estimated population size using 20th percentile of the log-normal distribution.

Parameters	Mean	SD
N0y	1 086 890	394 940
M0	0.34	0.02
M1+	0.17	0.05
$N_{\max}$	1 302 800	-
N_{70}	911 960	-
$N_{\lim}$	390 840	-
$N_{\min}$	75 241	-
$N_{0,2017}$	13 600	2 218
$N_{1+,2017}$	66 860	10 714
$N_{Total,2017}$	80 460	10 941

Catch options

All model runs indicate a population currently well below Nlim (30% of largest observed population size). Following the precautionary approach framework developed by WGHARP (ICES2005), no catches should be taken from this population.

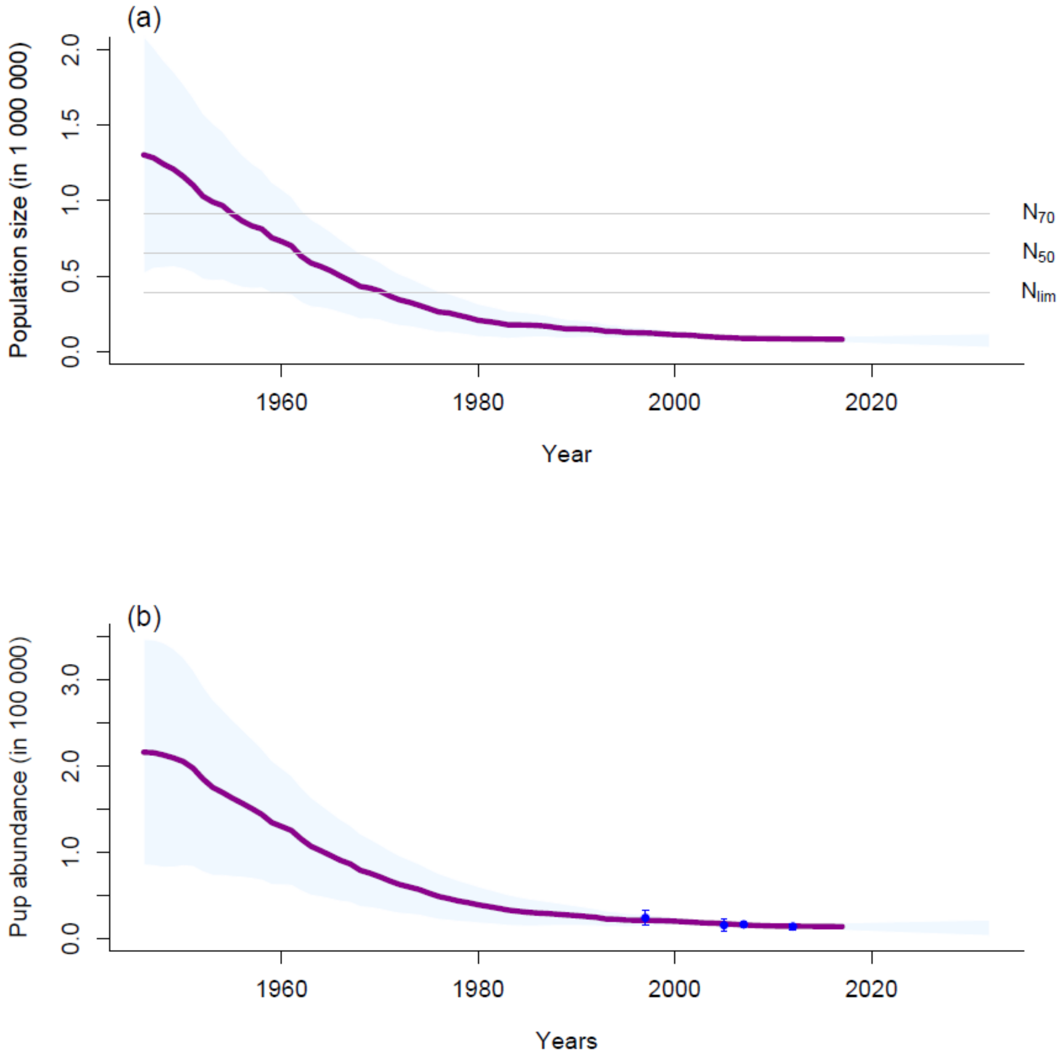

Fig. 7. Greenland Sea hooded seals: Modelled population trajectories for adults (a) and pups (b) (mean=solid line, 95% confidence intervals= shaded area). Projections are illustrated by confidence bands. N70, N50, and Nlim denote the 70%, 50% and 30% of the historical maximum population size, respectively. Observed pup production estimates and 95% confidence intervals are shown in blue.

The Northwest Atlantic Stock
Information on recent catches and regulatory measures
Under the Canadian Atlantic Seal Management Strategy (Hammill and Stenson 2007), Northwest Atlantic hooded seals are considered to be data poor. Under this approach, TACs are set using PBR. Prior to 2007, the TAC for hooded seals was set at 10 000 (Annex 8, Table 4). As a result of new data on the status of the population (Hammill and Stenson 2006) the quota was reduced to 8 200 in 2007 where it has remained. The killing of young of the year hooded seals (bluebacks) is prohibited in Canada.

Canadian catches of hooded seals (1+ only) have remained extremely low in recent years (Annex 6, Table 2). Catches have remained less than 50 since 2005 with most years being less than 10. Reported catches in 2015 and 2016 were 1 and 13 respectively.

Greenland catches of hooded seals since 2009 have been between 1 00 and 2 100, which is much lower than catches prior to 2005 which were generally between 5 000-7 000 animals (Annex 6, Table 3). A total of 1 520 hooded seals were reported taken in 2013 while 1 846 were reported caught in 2014. With the exception of 1 seal taken in 2014, all of these animals were considered to be from the Northwest Atlantic hooded seal population.

Current Research

The WG noted that the collection of small numbers of hooded seals has continued in Canada. When analysed, these samples may provide some new data on diets, condition and reproductive rates. However, sample sizes are small.

Population Assessments

No new information. Canada is exploring the possibility of obtaining a minimum pup production from photos obtained during the 2012 harp seal survey.

ADVICE REQUESTS

Request for advice submitted to ICES by Norway

In October, 2015, Norway requested management advice on the status of harp and hooded seal stocks in the Greenland Sea and the harp seal stock in the White Sea/Barents Sea.

ICES was asked to assess the impact on the harp seal stocks in the Greenland Sea and in the White Sea/Barents Sea of an annual harvest of:

1) Current harvest levels
2) Sustainable catches (defined as the fixed annual catches that stabilizes the future 1 + population)
3) Catches that would reduce the population over a 15-years period in such a manner that it would remain above a level of 70% of the maximum population size, determined from population modeling, with 80% probability

The advice on status and impacts of different harvest options are provided in previous sections of this report. Section 4.2.5 provides advice on Greenland sea harps, section 4.3.4 on White sea harps and section 5.1.4 on
Greenland sea hooded seals.

Request for advice submitted to NAFO by Canada

In 2014 Canada requested that WGHARP explore the impact of proposed harvest strategies that would maintain the Northwest Atlantic harp seal population at a precautionary level of a PA framework and that would have a low risk of decreasing below the critical level. Specifically, the WG was asked to:

1) Identify the catches necessary to reduce the NWA harp seal population to 5.4M animals assuming
    a) Catches consisting of 90% Young of the Year (YOY) or 50% YOY
    b) Reductions over time periods of 5, 10, and 15 years
2) Identify the catches necessary to reduce the population to 6.8M assuming
    a) Catches consisting of 90% YOY or 50% YOY
    b) Reduction over time periods of 5, 10, and 15 years

3) Identify sustainable future catches possible at each of these reduced populations, assuming there is a 95% probability of remaining above the Limit Reference Point (defined as 2.4 million)

This request was considered at the 2014 meeting but it was not completed at that time. It was agreed that the advice would be provided at the 2016 meeting.

To examine the impacts of the different population reduction scenarios, Hammill et al (SEA243) projected the 2014 NWA harp seal population model into the future, using as a starting point, the estimates of 2014 population size, pup production, natural mortality (M), and carrying capacity (K).

Assumptions associated with future reproductive rates and levels of the Greenland catch are necessary. Therefore, the impacts of the different Canadian catch options on the projected population under two major scenarios that represent a continuation of the current state (Model A) and an alternate model that responds to the impact of removals by assuming density dependent compensation, i.e. decreased catches and increased reproductive rates when populations are reduced (Model B). In Model A, it was assumed that future reproductive rates, and Greenland catches were based upon the observed rates from the past 10 years (Table 14). In Model B, both future reproductive rates and Greenland catches behaved in a density dependent manner, i.e. as the population declines, Greenland catches decline and pregnancy rates increase to an asymptotic value, whereas when the population increases, Greenland catches increase to an asymptotic value and reproductive rates decline.
In both scenarios, it is assumed that the age structure and mortality from by-catch and the Canadian Arctic harvest remain constant at 2013 levels and that the proportion of seals struck and loss, for the different harvests remain unchanged.

Table 14. Comparison of model assumptions

	MODEL A	MODEL B
Greenland catches	Fixed at average over past 10 years	Catches vary with population size when less than 7.1 million harp seals
Ice related mortality	Selected randomly from a vector of recently observed rates	Same
Pregnancy rates	Selected from a vector of recently observed rates	Density dependent – decreases as population approaches carry capacity Proportion pregnant varied to account for changes in food supply (based upon recent observations)
Mortality rates of YOY	Density dependent – increases as population approaches carry capacity	Same

Once the target population level was achieved, the model was further projected forward to determine the level of catches that will respect the management plan (i.e. 95% likelihood of population remaining above the Limit Reference Level) for an additional 15 years which ensures that catches are sustainable while they propagate through the population age structure. Therefore, the total length of the projection varied with each reduction scenario (i.e. total of 20, 25 and 30 years). However, since the management objective changed following the reduction, the mean estimated population did not necessarily remain at the target level.

The predicted changes in the population trajectory were affected very strongly by the age composition of the harvest used to reduce the population, the speed with which the reduction was achieved and whether the scenario used a population whose dynamics were assumed to be similar to what has been seen in the past 10 years (Model A) or assumed to vary in a density dependent manner (Model B).

Model A Scenario

A large number of animals would need to be removed if the population reduction was to be achieved rapidly, or with a harvest comprised primarily of YOY (Table 15). For a population whose future dynamics are described by current conditions (Model A), up to 610,000 animals would need to be removed if the population was to be reduced to 6.8 million within 5 years. Fewer animals need to be removed annually if the removals were spread over a longer time period, or if animals aged 1+ years comprised a larger proportion of the harvest (Table 15). It was not possible to achieve a target population of 5.4 million seals within 5 years (Table 15) if YOY comprised 90% or more of the harvest.

Once the target level was achieved, the catch levels that would ensure a 95% probability of remaining above the Limit Reference Level were much lower than the harvest levels allowable during the reduction phase (Table 15).

Large removals were needed to reduce the population within 5 years, particularly if a high proportion of YOY were taken in the harvest. These removals had a longer term impact on the population than those that were spread over a longer time period, or had a higher proportion of older seals. In the 5 year scenario to reduce the population to 6.8 million animals, the population continued to decline during the subsequent monitoring period, although there was still a 95% probability of the population remaining above the Limit Reference Level.

Model B Scenario

The estimated number of removals needed to reduce the population to 6.8 million was similar under the two modelling scenarios. Higher harvests were estimated over the following 15 years, while still ensuring that the population had a 95% probability of remaining above the reference limit point, under the assumptions of Model B, (i.e. density-dependent responses). This is because of the compensation assumed in reproductive rates and catches.

The catch levels needed to reduce the population to 5.4 million were much higher under the assumptions of Model B (i.e density dependence) , compared to the assumptions used in Model A (Table 16). However, as in Model A, harvests had to be reduced considerably once the target was reached to allow the population to remain above the Limit Reference Level (Table 16).

Once the target population level was reached, the continuing catches that had a 95% likelihood that the population remained above the Limit Reference Level were estimated. The management objective did not require the population to remain at the target level and in some scenarios the population continued to decline. As a result, catches may have to be reduced further following the 15 year simulation period as the population was predicted to decline during the post reduction period.

Table 15. Annual removals (000's) needed to reduce the population from current levels to 6.8 or 5.4 million within a period of 5, 10 or 15 years. Catches were assumed to comprise 90%, or 50% young of the year (YOY). Continuing annual removals (000's) represent the total removals allowed that would maintain a 95% likelihood that the population would remain above the Limit Reference Level (N_{30}) for 15 years. Simulations examined removal impacts assuming future reproductive rates and Greenland harvests were similar to those seen over the past decade (Model A).

Scenario	90%YOY		50%YOY	
	Reduction	Continuing	Reduction	Continuing
6.8 M				
5 Y	610	350	270	190
10 Y	450	250	220	150
15 Y	400	230	190	100
5.4 M				
5 Y	*		480	90
10 Y	670	100	320	40
15 Y	540	40	260	20

* indicates target impossible to achieve in time frame and age composition

Table 16. Annual removals (000's) needed to reduce the population from current levels to 6.8 or 5.4 million within a period of 5, 10 or 15 years, assuming future reproductive rates and Greenland harvest follow a density-dependent manner (Model B). Catches were assumed to comprise 90%, or 50% young of the year (YOY). Annual continuing removals (000's) represent the total removals allowed that would maintain a 95% likelihood that the population would remain above the Limit Reference Level (N_{30}) for 15 years.

Fixed	90%YOY		50%YOY	
	Reduction	Continuing	Reduction	Continuing
6.8 M				
5 Y	560	560	250	280
10 Y	420	500	200	260
15 Y	370	500	180	270
5.4 M				
5 Y	*		560	250
10 Y	860	400	400	200
15 Y	770	300	350	170

* indicates target impossible to achieve in time frame and age composition

Under all scenarios, the uncertainty associated with estimates of population size increased considerably as time since the last survey also increased.

The management objective for this exercise was to have a 95% likelihood of remaining above the Limit Reference Level (2.4 million) rather than to maintain the population at the reduction target level. As a result, in some scenarios, high catches could be taken after the initial reduction. However, these would result in a continued decline in the population. If the management objective had been to maintain the population at the reduction target level, the 'post reduction' catches would have been much smaller. For example, in the scenario where the population is reduced to 6.8 million over 5 years and the assumptions used for Model B, the catches that would maintain the population would be ~390,000 (vs 560,000)

These simulation results are very sensitive to model assumptions and should be considered for illustration only. For example, we assumed that the density dependent relationship could be described using a theta=2.4. Using the same level of harvest but assuming a density dependent relationship using a theta=1 results in a much lower catch to maintain the population at the same level (Fig 8).

The impact of these scenarios on the Greenland hunt will depend upon the assumptions used. Under Model A, it is assumed that the hunt remains the same as it currently is, even if the total abundance is reduced. Under Model B, the availability of animals is the main force driving harvest levels in Greenland and catches decline as the population is reduced. Under this scenario, there would appear to be little impact on number of animals available to Greenland hunters if the herd was reduced to 6.8 million. However, a reduction in the herd to 5.4 million animals could result in a 25% reduction in availability of animals to Greenland hunters. Clearly, the age composition of the catch (90% or 50% YOY) and rate of the reduction would have an impact on the number of YOY available to Greenland hunters during the reduction period. However, while the proportion of YOY in the population was slightly higher if density dependence was assumed, both scenarios resulted in estimates of YOY that were similar to that seen in the past, once the initial reduction is completed.

The WG emphasises that these simulation results are very sensitive to model assumptions and should be considered for illustration only. It also notes that these scenarios do not include the potential impacts of an unusual mortality event.

Furthermore, the estimated carrying capacity is based upon historical conditions that may no longer apply. This will impact our assumptions about density dependent compensation in reproductive rates (particularly for the 6.8 million scenario).

The two models represent two unlikely situations, one assumes reproductive rates and catches do not respond to changes in total population while the other assumes full compensation in reproductive rates and catches as the population declines. Based upon historical changes in reproductive rates, we expect that some density dependent compensation will occur, but recent environmental changes suggest that full compensation may not result.

Other business
If necessary, the WG will work by correspondence during 2017. The next meeting is proposed for September 2018 in Greenland or Norway.

Adoption of the report
The WG adopted the report on 21 November 2014, at the close of the meeting.

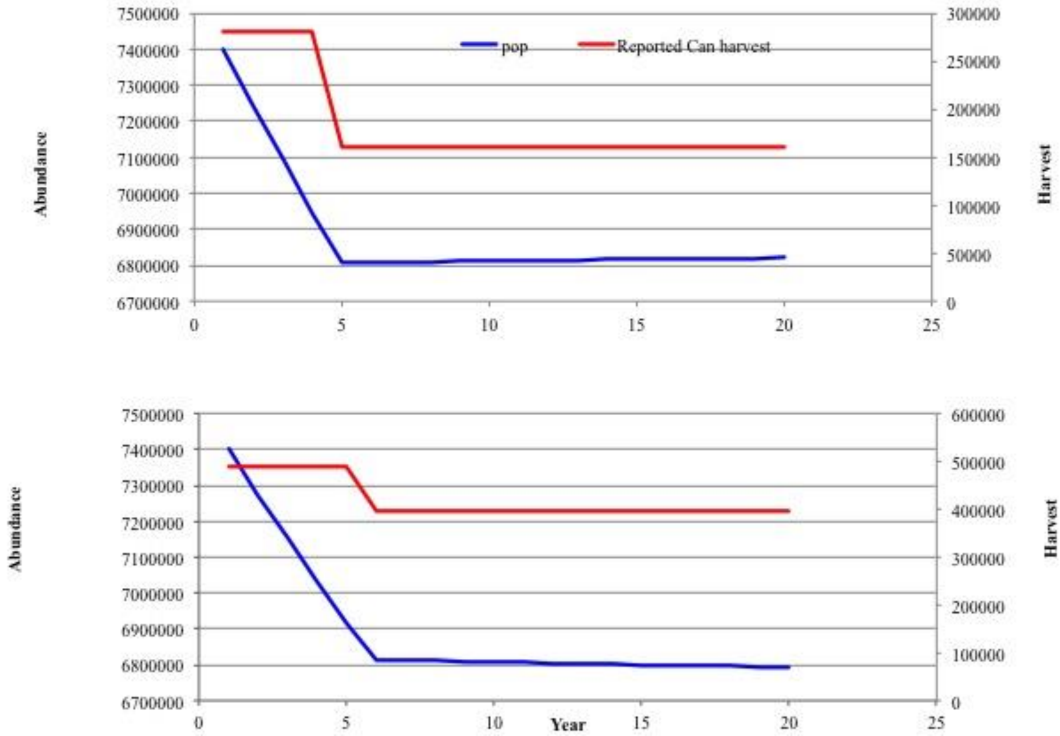

Fig. 8. Comparison of catch levels that would result in a constant population after the reduction has occurred, under the assumption that the density dependent relationship can be described using Theta = 1 (top) or Theta = 2.4 (bottom). Scenario assumes that the population is reduced to 6.8 million within 5 years.

ANNEX 1: LIST OF PARTICIPANTS

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ANNEX 2: AGENDA AND PROGRAMME

Monday, September 2016
10:00pm to noon –

- *Introductory Comments*
- *Discussion of Terms of References*
- *Varia*

1:30pm to 5:00pm – Harp Seals: Harp Seals: Greenland Sea Stock

- *Biological parameters*
- *Population model new developments*
- *Current harvests*
- *Catch options*

Tuesday, September 2016
9:00 am to noon – Harp Seals: Harp Seals: Greenland Sea Stock

- *Continue Monday discussions on population model*

1:00pm to 5:00pm - White Sea and Barents Sea Stock

- *Biological parameters*
- *New estimates*
- *Population assessment ()*

Wednesday, September 2016
9:00am to noon -- Harp Seals: Northwest Atlantic Stock

- *Biological parameters*
- *Population assessment*
- *Population Model development*

- *Population modelling development and simulation scenarios*
- *Impacts on Greenland harvest*

1:00 pm to 3:00pm --

- Discussion of way forward?

3:30pm to 4:30pm –Hooded seals NE Atlantic

- *Biology,*
- *Catches*
- *New research*

Thursday, September 2016

9:00am to 10:00am-Hooded seals NW Atlantic

- *biology*
- *Catches*
- *New research*

10:00 – 4:30

- *Write and Review report*

Friday, September 2016

9:00 am to noon

- *Review/complete report*
- *Next meeting*
- *Other business*

12:00 end meeting

ANNEX 3: WGHARP TERMS OF REFERENCE FOR THE NEXT MEETING

The **Working Group on Harp and Hooded Seals (WGHARP)** (Chair: Mike Hammill) proposed to meet in Greenland or Norway in late September 2018 to:

1) Review results of new surveys as available for harp seals in the White Sea and southeastern portion of Barents Sea
2) Review results from the biological samples obtained from the harp seals
3) Provide advice on other issues as requested

WGHARP will report September 2018 for the attention of the ACOM.

ANNEX 4: RECOMMENDATIONS

Recommendation	Action By	Recipient
The WG recommends that efforts be made to obtain samples, to evaluate reproductive rates for White Sea harp seals, particularly in years when an aerial survey is completed. These are required for use in the population model.	2017	Norway/Russia
The WG recommends that efforts be made to incorporate by-catch and age composition information from the 'seal invasion years' in the mid to late 1980s be incorporated into the White Sea harp seal model as additional catch data.	2018	Norway/Russia
The WG recommends that new aerial surveys be conducted to estimate pup production of harp seals in the White Sea\Barents Sea and NW Atlantic in 2017 and Greenland Sea in 2018	March 2017/2018	Russia/Norway/Canada
The WG recommends that during all aerial surveys, staging surveys also be conducted to determine the correction for pups not available to be photographed when the aerial survey is flown. This should be done for all populations of harp and hooded seals.	Continuing	Canada/Norway/Russia
The WG recommends that satellite telemetry tagging studies be undertaken of the White Sea\Barents Sea harp seal population	2017	Norway/Russia
The WG recommends that uncertainties in reproductive rates be incorporated into the Greenland and White Sea harp seal population models	2018	Norway
The WG recommended that if possible the Greenland Sea and White Sea harp seal mark-recapture data be re-examined and updated with new information if available.	2018	Norway
The WG recommended that the Greenland Sea assessment takes into account catches from east Greenland	2018	Norway
The WG recommends that all new data on hooded seals be examined to increase understanding of current status of these populations	2018	Canada/Norway

ANNEX 5: REFERENCES

Working Papers

Number	Author	Title
SEA238	Tore Haug, and Vladimir Zabavnikov	Norwegian and Russian catches of harp and hooded seals in the Northeast Atlantic in 2015-2016
SEA239	Øigård,T.A,and T. Haug	The 2017 abundance of harp seals (Pagophilus groenlandicus) in the Barents sea / White sea
SEA240	Øigård,T.A,and T. Haug	The 2017 abundance of harp seals (Pagophilus groenlandicus) in the Greenland Sea
SEA241	Øigård,T.A,and T. Haug	The 2017 abundance of hooded seals (Cystophora cristata) in the Greenland Sea
SEA242	Korzhev,V. and V. Zabavnikov	Estimation of the White Sea Harp Seal Population (Phoca groenlandica) Number by Cohort and Stock-Production (ASPIC) Models in Present Stage
SEA243	Hammill,M.O. G.B. Stenson and A. Mosnier.	Impacts of Theoretical Harvest Reduction Scenarios and Sustainable Catches of NWA harp seals?
SEA244	I. Shafikov	Estimation of Females Age Maturity and Barrenness Coefficient for the White Sea Harp Seal Population (Phoca groenlandica)
SEA245	Stenson, G. and A. Rosing-Asvid	Recent Catches of Harp and Hooded Seals in Canada and Greenland
SEA 246	Frie, A.K.	A 2014 update and reassessment of reproductive parameters of Northeast Atlantic harp seals (Pagophilus groenlandicus)

Other References

Enoksen,S., T. Haug, U. LindstrØm, K.T. Nilssen. In press. Recent summer diet of hooded *Cystophora cristata* and harp *Pagophilus groenlandicus* seals in the drift ice of the Greenland Sea. Polar Biology. DOI 10.1007/s00300-016-2002-2

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ICES 2005. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals, 30 August – 3 September, 2005, St. John's, Newfoundland, Canada. ICES CM 2006/ACFM: 06. 48 pp.

ICES 2006. Report of the Working Group on ICES/NAFO Working Group on Harp and Hooded Seals (WGHARP), 12-16 June 2006, ICES Headquarters. ICES CM 2006/ACFM:32. 28 pp.

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Annex 6: Catches of hooded seals including catches taken according to scientific permits

Table 1. Catches of hooded seals in the Greenland Sea ("West Ice") from 1946 through 2016. Totals include catches for scientific purposes.

	Norwegian catches			Russian catches			Total catches		
Year	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
1946–50	31152	10257	41409	-	-	-	31152	10257	41409
1951–55	37207	17222	54429	-	-	-[b]	37207	17222	54429
1956–60	26738	9601	36339	825	1063	1888[b]	27563	10664	38227
1961–65	27793	14074	41867	2143	2794	4937	29936	16868	46804
1966–70	21495	9769	31264	160	62	222	21655	9831	31486
1971	19572	10678	30250	-	-	-	19572	10678	30250
1972	16052	4164	20216	-	-	-	16052	4164	20216
1973	22455	3994	26449	-	-	-	22455	3994	26449
1974	16595	9800	26395	-	-	-	16595	9800	26395
1975	18273	7683	25956	632	607	1239	18905	8290	27195
1976	4632	2271	6903	199	194	393	4831	2465	7296
1977	11626	3744	15370	2572	891	3463	14198	4635	18833
1978	13899	2144	16043	2457	536	2993	16356	2680	19036
1979	16147	4115	20262	2064	1219	3283	18211	5334	23545
1980	8375	1393	9768	1066	399	1465	9441	1792	11233
1981	10569	1169	11738	167	169	336	10736	1338	12074
1982	11069	2382	13451	1524	862	2386	12593	3244	15837
1983	0	86	86	419	107	526	419	193	612
1984	99	483	582	-	-	-	99	483	582
1985	254	84	338	1632	149	1781	1886	233	2119
1986	2738	161	2899	1072	799	1871	3810	960	4770
1987	6221	1573	7794	2890	953	3843	9111	2526	11637
1988	4873	1276	6149[c]	2162	876	3038	7035	2152	9187
1989	34	147	181	-	-	-	34	147	181
1990	26	397	423	0	813	813	26	1210	1236
1991	0	352	352	458	1732	2190	458	2084	2542
1992	0	755	755	500	7538	8038	500	8293	8793
1993	0	384	384	-	-	-	0	384	384
1994	0	492	492	23	4229	4252	23	4721	4744
1995	368	565	933	-	-	-	368	565	933
1996	575	236	811	-	-	-	575	236	811
1997	2765	169	2934	-	-	-	2765	169	2934
1998	5597	754	6351	-	-	-	5597	754	6351
1999	3525	921	4446	-	-	-	3525	921	4446
2000	1346	590	1936	-	-	-	1346	590	1936
2001	3129	691	3820	-	-	-	3129	691	3820
2002	6456	735	7191	-	-	-	6456	735	7191
2003	5206	89	5295	-	-	-	5206	89	5295
2004	4217	664	4881	-	-	-	4217	664	4881
2005	3633	193	3826	-	-	-	3633	193	3826

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	Pups	1 year and older	total	Pups	1 year and older	Total
2006	3079	568	3647	-	-	-	3079	568	3647
2007	27	35	62	-	-	-	27	35	62
2008	9	35	44	-	-	-	9	35	44
2009	396	17	413	-	-	-	396	17	413
2010	14	164	178	-	-	-	14	164	178
2011	15	4	19	-	-	-	15	4	19
2012	15	6	21	-	-	-	15	6	21
2013	15	7	22	-	-	-	15	7	22
2014	24	0	24	0	0	0	24	0	24
2015	5	6	11	0	0	0	5	6	11
2016	10	8	18	0	0	0	10	8	18

[a] For the period 1946–1970 only 5-year averages are given.

[b] For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively. These catches are not included.

[c] Including 1048 pups and 435 adults caught by one ship which was lost.

Table 2. Canadian catches of hooded seals off Newfoundland and in the Gulf of St Lawrence, Canada ("Gulf" and "Front"), 1946-2016a,b. Catches from 1995 onward includes catches under personal use licences. YOY refers to Young of Year. Catches from 1990-1996 were not assigned to age classes. With the exception of 1996, all were assumed to be 1+.

	Large Vessel Catches				Landsmen Catches				Total Catches			
Year	YOY	1+	Unk	Total	YOY	1+	Unk	Total	YOY	1+	Unk	Total
1946-50	4029	2221	0	6249	429	184	0	613	4458	2405	0	6863
1951-55	3948	1373	0	5321	494	157	0	651	4442	1530	0	5972
1956-60	3641	2634	0	6275	106	70	0	176	3747	2704	0	6451
1961-65	2567	1756	0	4323	521	199	0	720	3088	1955	0	5043
1966-70	7483	5220	0	12703	613	211	24	848	8096	5431	24	13551
1971-75	6550	5247	0	11797	92	56	0	148	6642	5303	0	11945
1976	6065	5718	0	11783	475	127	0	602	6540	5845	0	12385
1977	7967	2922	0	10889	1003	201	0	1204	8970	3123	0	12093
1978	7730	2029	0	9759	236	509	0	745	7966	2538	0	10504
1979	11817	2876	0	14693	131	301	0	432	11948	3177	0	15125
1980	9712	1547	0	11259	1441	416	0	1857	11153	1963	0	13116
1981	7372	1897	0	9269	3289	1118	0	4407	10661	3015	0	13676
1982	4899	1987	0	6886	2858	649	0	3507	7757	2636	0	10393
1983	0	0	0	0	0	128	0	128	0	128	0	128
1984	206	187	0	393d	0	56	0	56	206	243	0	449
1985	215	220	0	435d	5	344	0	349	220	564	0	784
1986	0	0	0	0	21	12	0	33	21	12	0	33
1987	124	4	250	378	1197	280	0	1477	1321	284	250	1855
1988	0	0	0	0	828	80	0	908	828	80	0	908
1989	0	0	0	0	102	260	5	367	102	260	5	367
1990	41	53	0	94d	0	0	636[e]	636	41	53	636	730
1991	0	14	0	14d	0	0	6411[e]	6411	0	14	6411	6425
1992	35	60	0	95d	0	0	119[e]	119	35	60	119	214
1993	0	19	0	19d	0	0	19[e]	19	0	19	19	38
1994	19	53	0	72d	0	0	149[e]	149	19	53	149	221
1995	0	0	0	0	0	0	857[e]	857	0	0	857e	857
1996	0	0	0	0	0	0	25754[e]	25754	0	22847f	2907	25754
1997[e]	0	0	0	0	0	7058	0	7058	0	7058	0	7058
1998[e]	0	0	0	0	0	10148	0	10148	0	10148	0	10148
1999 [e]	0	0	0	0	0	201	0	201	0	201	0	201
2000 [e]	2	2	0	4[d]	0	10	0	10	2	12	0	14
2001[e]	0	0	0	0	0	140	0	140	0	140	0	140
2002[e]	0	0	0	0	0	150	0	150	0	150	0	150
2003 [e]	0	0	0	0	0	151	0	151	0	151	0	151
2004 [e]	0	0	0	0	0	389	0	389	0	389	0	389
2005 [e]	0	0	0	0	0	20	0	20	0	20	0	20
2006 [e]	0	0	0	0	0	40	0	40	0	40	0	40
2007 [e]	0	0	0	0	0	17	0	17	0	17	0	17
2008 [e]	0	0	0	0	0	5	0	5	0	5	0	5
2009 [e]	0	0	0	0	0	10	0	10	0	10	0	10
2010[e]	0	0	0	0	0	0	0	0	0	0	0	0
2011[e]	0	0	0	0	0	2	0	2	0	2	0	2
2012[e]	0	0	0	0	0	1	0	1	0	1	0	1
2013[e]	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	7	0	7	0	7	0	7
2015	0	0	0	0	0	1	0	1	0	1	0	1
2016	0	0	0	0	0	13	0	13	0	13	0	13

a For the period 1946–1970 only 5-years averages are given.

b All values prior to 1990 are from NAFO except where noted; recent years are from Stenson (2009) and DFO Statistics Branch.

c Landsmen values include catches by small vessels (< 150 gr tons) and aircraft.

d Large vessel catches represent research catches in Newfoundland and may differ from NAFO values.

e Statistics no longer split by age; commercial catches of bluebacks are not allowed

f Number of YOY based upon seizures of illegal catches

Table 3. Catches of hooded seals in West and East Greenland 1954–20014.

Year	West Atlantic Population				NE	All Greenland
	West	KGH[b]	Southeast	Total		
1954	1097	-	201	1298	-	1298
1955	972	-	343	1315	1	1316
1956	593	-	261	854	3	857
1957	797	-	410	1207	2	1209
1958	846	-	361	1207	4	1211
1959	780	414	312	1506	8	1514
1960	965	-	327	1292	4	1296
1961	673	803	346	1822	2	1824
1962	545	988	324	1857	2	1859
1963	892	813	314	2019	2	2021
1964	2185	366	550	3101	2	3103
1965	1822	-	308	2130	2	2132
1966	1821	748	304	2873	-	2873
1967	1608	371	357	2336	1	2337
1968	1392	20	640	2052	1	2053
1969	1822	-	410	2232	1	2233
1970	1412	-	704	2116	9	2125
1971	1634	-	744	2378	-	2378
1972	2383	-	1825	4208	2	4210
1973	2654	-	673	3327	4	3331
1974	2801	-	1205	4006	13	4019
1975	3679	-	1027	4706	58a	4764
1976	4230	-	811	5041	22a	5063
1977	3751	-	2226	5977	32a	6009
1978	3635	-	2752	6387	17	6404
1979	3612	-	2289	5901	15	5916
1980	3779	-	2616	6395	21	6416
1981	3745	-	2424	6169	28a	6197
1982	4398	-	2035	6433	16a	6449
1983	4155	-	1321	5476	9a	5485
1984	3364	-	1328	4692	17	4709
1985	3188	-	3689	6877	6	6883
1986	2796a	-	3050a	5846a	-a	5846a
1987	2333a	-	2472a	4805a	3a	4808a
1988–92c						
1993	4983	-	1967	6950	32	6982
1994	5060	-	3048	8108	34	8142
1995	4429		2702	7131	48	7179
1996	6066	-	3801	9867	24	9891
1997	5250		2175	7425	67	7492
1998	5051		1270	6321	14	6335
1999	4852	-	2587	7439	16	7455
2000	3769	-	2046	5815	29	5844
2001	5010	-	1496	6506	8	6514
2002	3606	-	1189	4795	11	4806
2003	4351	-	1992	6343	10	6353
2004	4133	-	1690	5823	20	5843
2005	3092	-	1022	4114	14	4128
2006	4194	-	550	4744	3	4747
2007	2575	-	712	3287	7	3294
2008	2085	-	519	2604	2	2606
2009	**1627**	-	358	1982	1	**1986**
2010	**1871**		**266**	**2137**	**7**	**2144**
2011	**1827**		**225**	**2052**	**9**	**2061**
2012	1318	-	347	1665	6	**1671**
2013	1190	-	330	1520	0	**1520**
2014	1457	-	388	1845	1	**1846**

a Provisional figures: do not include estimates for non-reported catches as for the previous years.

b Royal Greenland Trade Department special vessel catch expeditions in the Denmark Strait 1959–68.

c For 1988 to 1992 catch statistics are not available.

Annex 7: Catches of harp seals including catches taken according to scientific permits

Table 1. Catches of harp seals in the Greenland Sea ("West Ice") from 1946 through 2016a. Totals include catches for scientific purposes. Catches are from Haug, and Zabavnikov (SEA238)

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and older	Total	pups	1 year and older	Total	Pups	1 year and older	Total
1946–50	26606	9464	36070	-	-	-	26606	9464	36070
1951–55	30465	9125	39590	-	-	-b	30465	9125	39590
1956–60	18887	6171	25058	1148	1217	2365b	20035	7388	27423
1961–65	15477	3143	18620	2752	1898	4650	18229	5041	23270
1966–70	16817	1641	18458	1	47	48	16818	1688	18506
1971	11149	0	11149	-	-	-	11149	0	11149
1972	15100	82	15182	-	-	-	15100	82	15182
1973	11858	0	11858	-	-	-	11858	0	11858
1974	14628	74	14702	-	-	-	14628	74	14702
1975	3742	1080	4822	239	0	239	3981	1080	5061
1976	7019	5249	12268	253	34	287	7272	5283	12555
1977	13305	1541	14846	2000	252	2252	15305	1793	17098
1978	14424	57	14481	2000	0	2000	16424	57	16481
1979	11947	889	12836	2424	0	2424	14371	889	15260
1980	2336	7647	9983	3000	539	3539	5336	8186	13522
1981	8932	2850	11782	3693	0	3693	12625	2850	15475
1982	6602	3090	9692	1961	243	2204	8563	3333	11896
1983	742	2576	3318	4263	0	4263	5005	2576	7581
1984	199	1779	1978	-	-	-	199	1779	1978
1985	532	25	557	3	6	9	535	31	566
1986	15	6	21	4490	250	4740	4505	256	4761
1987	7961	3483	11444	-	3300	3300	7961	6783	14744
1988	4493	5170	9663c	7000	500	7500	11493	5670	17163
1989	37	4392	4429	-	-	-	37	4392	4429
1990	26	5482	5508	0	784	784	26	6266	6292
1991	0	4867	4867	500	1328	1828	500	6195	6695
1992	0	7750	7750	590	1293	1883	590	9043	9633
1993	0	3520	3520	-	-	-	0	3520	3520
1994	0	8121	8121	0	72	72	0	8193	8193
1995	317	7889	8206	-	-	-	317	7889	8206
1996	5649	778	6427	-	-	-	5649	778	6427
1997	1962	199	2161	-	-	-	1962	199	2161
1998	1707	177	1884	-	-	-	1707	177	1884
1999	608	195	803	-	-	-	608	195	803
2000	6328	6015	12343	-	-	-	6328	6015	12343
2001	2267	725	2992	-	-	-	2267	725	2992
2002	1118	114	1232	-	-	-	1118	114	1232
2003	161	2116	2277				161	2116	2277
2004	8288	1607	9895				8288	1607	9895
2005	4680	2525	7205				4680	2525	7205
2006	2343	961	3304				2343	961	3304
2007	6188	1640	7828				6188	1640	7828
2008	744	519	1263				744	519	1263
2009	5177	2918	8035	-	-	-	5117	2918	8035
2010	2823	1855	4678	-	-	-	2823	1855	4678
2011	5361	4773	10134	-	-	-	5361	4773	10134
2012	3740	1853	5593	-	-	-	3740	1853	5593
2013	13911	2122	16033	-	-	-	13911	2122	16033
2014	9741	2245	11986				9741	2245	11986
2015	2144	93	2237	-	-	-	2144	93	2237
2016	426	1016	1442	-	-	-	426	1016	1442

a For the period 1946–1970 only 5-year averages are given.

b For 1955, 1956 and 1957 Soviet catches of harp and hooded seals reported at 3,900, 11,600 and 12,900, respectively (Sov. Rep. 1975). These catches are not included.

c Including 1431 pups and one adult caught by a ship which was lost.

Table 2. Catches of harp seals in the White and Barents Seas ("East Ice"), 1946–2016a,b (Haug and Zabavnikov SEA 238)

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and Older	Total	Pups	1 year and Older	Total	Pups	1 year and Older	Total
1946–50			25057	90031	55285	145316			170373
1951–55			19590	59190	65463	124653			144243
1956–60	2278	14093	16371	58824	34605	93429	61102	48698	109800
1961–65	2456	8311	10767	46293	22875	69168	48749	31186	79935
1966–70			12783	21186	410	21596			34379
1971	7028	1596	8624	26666	1002	27668	33694	2598	36292
1972	4229	8209	12438	30635	500	31135	34864	8709	43573
1973	5657	6661	12318	29950	813	30763	35607	7474	43081
1974	2323	5054	7377	29006	500	29506	31329	5554	36883
1975	2255	8692	10947	29000	500	29500	31255	9192	40447
1976	6742	6375	13117	29050	498	29548	35792	6873	42665
1977	3429	2783	6212[c]	34007	1488	35495	37436	4271	41707
1978	1693	3109	4802	30548	994	31542	32341	4103	36344
1979	1326	12205	13531	34000	1000	35000	35326	13205	48531
1980	13894	1308	15202	34500	2000	36500	48394	3308	51702
1981	2304	15161	17465[d]	39700	3866	43566	42004	19027	61031
1982	6090	11366	17456	48504	10000	58504	54594	21366	75960
1983	431	17658	18089	54000	10000	64000	54431	27658	82089
1984	2091	6785	8876	58153	6942	65095	60244	13727	73971
1985	348	18659	19007	52000	9043	61043	52348	27702	80050
1986	12859	6158	19017	53000	8132	61132	65859	14290	80149
1987	12	18988	19000	42400	3397	45797	42412	22385	64797
1988	18	16580	16598	51990	2501[e]	54401	51918	19081	70999
1989	0	9413	9413	30989	2475	33464	30989	11888	42877
1990	0	9522	9522	30500	1957	32457	30500	11479	41979
1991	0	9500	9500	30500	1980	32480	30500	11480	41980
1992	0	5571	5571	28351	2739	31090	28351	8310	36661
1993	0	8758[f]	8758	31000	500	31500	31000	9258	40258
1994	0	9500	9500	30500	2000	32500	30500	11500	42000
1995	260	6582	6842	29144	500	29644	29404	7082	36486
1996	2910	6611	9521	31000	528	31528	33910	7139	41049
1997	15	5004	5019	31319	61	31380	31334	5065	36399

Year	Norwegian catches			Russian catches			Total catches		
	Pups	1 year and Older	Total	Pups	1 year and Older	Total	Pups	1 year and Older	Total
1998	18	814	832	13350	20	13370	13368	834	14202
1999	173	977	1150	34850	0	34850	35023	977	36000
2000	2253	4104	6357	38302	111	38413	40555	4215	44770
2001	330	4870	5200	39111	5	39116	39441	4875	44316
2002	411	1937	2348	34187	0	34187	34598	1937	36535
2003	2343	2955	5298	37936	0	37936	40279	2955	43234
2004	0	33	33	0	0	0	0	33	33
2005	1162	7035	8197	14258	19	14277	15488	9405	22474
2006	147	9939	10086	7005	102	7107	7152	10041	17193
2007	242	5911	6153	5276	200	5476	5518	6111	11629
2008	0	0	0	13331	0	13331	13331	0	13331
2009	0	0	0	0	0	0	0	0	0
2010	0	105	105	5	5	10	5	110	115
2011	0	200	200	0	0	0	0	200	200
2012	0-	0-	0-	0	9	9	0	9	9
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
2016	0	28	28	0	0	0	0	28	28

[a] For the period 1946–1970 only 5-year averages are given.

[b] Incidental catches of harp seals in fishing gear on Norwegian and Murmansk coasts are not included (see Table 6).

[c] Approx. 1300 harp seals (unspecified age) caught by one ship lost are not included.

[d] An additional 250–300 animals were shot but lost as they drifted into Soviet territorial waters.

[e] Russian catches of 1+ animals after 1987 selected by scientific sampling protocols.

[f] Included 717 seals caught to the south of Spitsbergen, east of 14o E, by one ship which mainly operated in the Greenland Sea.

Table 3. Reported catches of harp seals in the Northwest Atlantic for 1952-2016. Estimated catches are indicated by shading. The Greenland catches are made up of the Table 5 West Greenland catches and 1/2 of the SE Greenland. The other half of the SE Greenland and the NE Greenland are assigned to the West Ice population (Stenson and Rosing-Asvid SEA245).

Year	Front & Gulf	Canadian Arctic	Greenland	NW Atlantic Total
1952	307,108	1,784	16,400	325,292
1953	272,886	1,784	16,400	291,070
1954	264,416	1,784	19,150	285,350
1955	333,369	1,784	15,534	350,687
1956	389,410	1,784	10,973	402,167
1957	245,480	1,784	12,884	260,148
1958	297,786	1,784	16,885	316,455
1959	320,134	1,784	8,928	330,846
1960	277,350	1,784	16,154	295,288
1961	187,866	1,784	11,996	201,646
1962	319,989	1,784	8,500	330,273
1963	342,042	1,784	10,111	353,937
1964	341,663	1,784	9,203	352,650
1965	234,253	1,784	9,289	245,326
1966	323,139	1,784	7,057	331,980
1967	334,356	1,784	4,242	340,382
1968	192,696	1,784	7,116	201,596
1969	288,812	1,784	6,438	297,034
1970	257,495	1,784	6,269	265,548
1971	230,966	1,784	5,572	238,322
1972	129,883	1,784	5,994	137,661
1973	123,832	1,784	9,212	134,828
1974	147,635	1,784	7,145	156,564
1975	174,363	1,784	6,752	182,899
1976	165,002	1,784	11,956	178,742
1977	155,143	1,784	12,866	169,793
1978	161,723	2,129	16,638	180,490
1979	160,541	3,620	17,545	181,706
1980	169,526	6,350	15,255	191,131
1981	202,169	4,672	22,974	229,815
1982	166,739	4,881	26,927	198,547
1983	57,889	4,881	24,785	87,555
1984	31,544	4,881	25,829	62,254
1985	19,035	4,881	20,785	44,701
1986	25,934	4,881	26,099	56,914
1987	46,796	4,881	37,859	89,536
1988	94,046	4,881	40,415	139,342
1989	65,304	4,881	42,971	113,156
1990	60,162	4,881	45,526	110,569
1991	52,588	4,881	48,082	105,551
1992	68,668	4,881	50,638	124,187
1993	27,003	4,881	56,319	88,203
1994	61,379	4,881	59,684	125,944
1995	65,767	4,881	66,298	136,946
1996	242,906	4,881	73,947	321,734
1997	264,210	2,500[a]	68,816	335,526
1998	282,624	1,000[a]	81,272	364,896
1999	244,552	500[a]	93,117	338,169
2000	92,055	400[a]	98,458	190,914

Year	Front & Gulf	Canadian Arctic	Greenland	NW Atlantic Total
2001	226,493	600[a]	85,428	312,521
2002	312,367	1,000	66,744	380,102
2003	289,512	1,000	66,149	356,661
2004	365,971	1,000	70,586	437,557
2005	323,826	1,000	91,696	422,525
2006	354,867	1,000	92,210	448,077
2007	224,745	1,000	82,836	308,581
2008	217,850	1,000	80,556	299,406
2009	76,668	1,000	72,142	149,810
2010	69,101	1,000	90,014	160,115
2011	40,389	1,000	74,013	115,402
2012	71,460	1,000	59,769	132,229
2013	90,703	1,000	81,196	169,700
2014	54,830	1,000	63,059	133,827
2015	35,304	1,000	78,749[b]	115,053
2016	66,865	1,000	78,749[b]	146,614

[a] **Rounded**

[b] **Average of catches 2005-14**

Table 4. Reported Canadian catches of Harp seals off Newfoundland and in the Gulf of St Lawrence, Canada ("Gulf" and "Front"), 1946–2016a,b. Catches from 1995 onward include catches under the personal use licences. YOY = Young of Year, (Stenson and Rosing-Asvid SEA245).

	Large Vessel Catch				Landsmen Catch				Total Catches			
Year	YOY	1+	Unk	Total	YOY	1+	Unk	Total	YOY	1+	Unk	Total
1946-50	108256	53763	0	162019	44724	11232	0	55956	152980	64995	0	217975
1951-55	184857	87576	0	272433	43542	10697	0	54239	228399	98273	0	326672
1956-50	175351	89617	0	264968	33227	7848	0	41075	208578	97466	0	306044
1961-65	171643	52776	0	224419	47450	13293	0	60743	219093	66069	0	285162
1966-70	194819	40444	0	235263	32524	11633	0	44157	227343	52077	0	279420
1971-75	106425	12778	0	119203	29813	12320	0	42133	136237	25098	0	161336
1976	93939	4576	0	98515	38146	28341	0	66487	132085	32917	0	165002
1977	92904	2048	0	94952	34078	26113	0	60191	126982	28161	0	155143
1978	63669	3523	0	67192	52521	42010	0	94531	116190	45533	0	161723
1979	96926	449	0	97375	35532	27634	0	63166	132458	28083	0	160541
1980	91577	1563	0	93140	40844	35542	0	76386	132421	37105	0	169526
1981d	89049	1211	0	90260	89345	22564	0	111909	178394	23775	0	202169
1982	100568	1655	0	102223	44706	19810	0	64516	145274	21465	0	166739
1983	9529	1021	0	10550	40529	6810	0	47339	50058	7831	0	57889
1984	95	549	0	644e	23827	7073	0	30900	23922	7622	0	31544
1985	0	1	0	1e	13334	5700	0	19034	13334	5701	0	19035
1986	0	0	0	0	21888	4046	0	25934	21888	4046	0	25934
1987	2671	90	0	2761	33657	10356	22	44035	36350	10446	0	46796
1988	0	0	0	0	66972	13493	13581	94046	66972	27074	0	94046
1989	1	231	0	232e	56345	5691	3036	65072	56346	8958	0	65304
1990	48	74	0	122e	34354	23725	1961	60040	34402	25760	0	60162
1991	3	20	0	23e	42379	5746	4440	52565	42382	10206	0	52588
1992	99	846	0	945e	43767	21520	2436	67723	43866	24802	0	68668
1993	8	111	0	119e	16393	9714	777	26884	16401	10602	0	27003
1994	43	152	0	195e	25180	34939	1065	61184	25223	36156	0	61379
1995	21	355	0	376e	33615	31306	470	65391	34106	31661	0	65767
1996	3	186	0	189e	184853	57864	0	242717	184856	58050	0	242906
1997	0	6	0	6e	220476	43728	0	264204	220476	43734	0	264210
1998	7	547	0	554e	0	0	282070	282070	7	547	282070	282624
1999	26	25	0	51e	221001	6769	16782	244552	221027	6794	16782	244603
2000	16	450	0	466e	85035	6567	0	91602	85485	6583	0	92068
2001	0	0	0	0	214754	11739	0	226493	214754	11739	0	226493
2002	0	0	0	0	297764	14603	0	312367	297764	14603	0	312367
2003	0	0	0	0	280174	9338	0	289512	280174	9338	0	289512
2004	0	0	0	0	353553	12418	0	365971	353553	12418	0	365971
2005	0	0	0	0	319127	4699	0	323826	319127	4699	0	323826
2006	0	0	0	0	346426	8441	0	354867	346426	8441	0	354867
2007	0	0	0	0	221488	3257	0	224745	221488	3257	0	224745
2008	0	0	0	0	217565	285	0	217850	217565	285	0	217850
2009	0	0	0	0	76668	0	0	76668	76668	0	0	76668
2010	0	0	0	0	68654	447	0	69101	68654	447	0	69101
2011	0	0	0	0	40371	18	0	40371	40371	18	0	40371
2012	0	0	0	0	71319	141	0	71460	71319	141	0	71460
2013	0	0	0	0	90703	0	0	90703	90703	0	0	90703
2014	0	0	0	0	54829	1		54830	54829	1	0	54830
2015	0	0	0	0	35302	2	0	35304	35302	2	0	35304
2016	0	0	0	0	0	0	66865	66865	0	0	66865	66865

a For the period 1946-1975 only 5-years averages are given.

b All values prior to 1990 are from NAFO except where noted, recent data from Stenson (2009) and DFO Statistics Branch.

c Landsmen values include catches by small vessels (< 150 gr tons) and aircraft.

d NAFO values revised to include complete Quebec catch (Bowen, W.D. 1982)

e Large vessel catches represent research catches in Newfoundland and may differ from NAFO values

Table 5. Catches of harp seals in Greenland, 1954–1987 (List-of-Game), and 1993–2014 (Piniarneq), and % adults according to the hunters' reports (Stenson and Rosing-Asvid SEA245).

Year	West Greenland		South East Greenland		North East Greenland		All Greenland
	Catch	% adults	Catch	% adults	Catch	% adults	Catch
1954	18,912		475		32		19,419
1955	15,445		178		45		15,668
1956	10,883		180		5		11,068
1957	12,817		133		40		12,990
1958	16,705		360		30		17,095
1959	8,844		168		7		9,019
1960	15,979		350		16		16,345
1961	11,886		219		13		12,118
1962	8,394		211		10		8,615
1963	10,003	21	215	28	20	50	10,238
1964	9,140	26	125	40	7	86	9,272
1965	9,251	25	76	65	2	100	9,329
1966	7,029	29	55	55	6		7,090
1967	4,215	38	54	35	10		4,279
1968	7,026	30	180	47	4		7,210
1969	6,383	21	110	62	9		6,502
1970	6,178	26	182	70	15	100	6,375
1971	5,540	24	63	48	5		5,608
1972	5,952	16	84	48	6	100	6,042
1973	9,162	19	100	20	38	79	9,300
1974	7,073	21	144	29	27	95	7,244
1975	5,953	13	125	20	68	72	6,146
1976	7,787	12	260	48	27	55	8,074
1977	9,938	15	72	16	21	81	10,031
1978	10,540	16	408	14	30	36	10,978
1979	12,774	20	171	19	18	25	12,963
1980	12,270	17	308	14	45		12,623
1981	13,605	21	427	15	49		14,081
1982	17,244	16	267	20	50	60	17,561
1983	18,739	19	357	56	57	30	19,153
1984	17,667	16	525	19	61		18,253
1985	18,445	2	534	0	56	52	19,035
1986	13,932[b]	10	533[b]	18	37[b]	65	14,502[b]
1987	16,053[b]	21	1060[b]	24	15[b]	60	17,128[b]
1988-1992	For 1988 to 1992 comparable catch statistics are not available.						
1993	55,792	50	1,054	30	40	93	56,886
1994	56,941	50	864	30	88	65	57,893
1995	62,296	53	906	36	61	52	63,263
1996	73,287	52	1,320	35	69	59	74,676
1997	68,241	49	1,149	28	201	58	69,591
1998	80,437	51	1,670	30	110	73	82,217
1999	91,321	50	3,592	12	104	65	95,017
2000	97,229	44	2,459	15	113	76	99,801
2001	84,165	42	2,525	18	73	68	86,763
2002	65,810	46	1,849	19	66	86	67,725
2003	64,735	44	2,828	24	44	77	67,607
2004	69,273	41	2,625	27	207	29	72,105
2005	90,308	35	2,775	18	38	58	93,121
2006	91,191	33	2,038	16	89	78	93,318
2007	81,485	32	2,702	21	85	53	84,272
2008	78,747	32	3,617	15	50	90	82,414
2009	70 869	32	2 546	9	83	75	73 498
2010	89 045	25	1 938	12	35	34	91 018
2011	73 277	30	1 472	16	74	26	74 823
2012	59,124	21	1,290	11	154	23	59,923

Year	West Greenland		South East Greenland		North East Greenland		All Greenland
	Catch	% adults	Catch	% adults	Catch	% adults	Catch
2013	80,102	24	2,188	15	186	28	82,099
2014	62,147	29	1,824	13	28	32	63,811

a Seals exhibiting some form of a harp.b These provisional figures do not include estimates for non-reported catches as for the previous years.

Table 6. Estimated catches of harp seals in Greenland, 1975–1987 and 1993–1995. Figures in bold are non-corrected figures from Table 5 (Stenson and Rosing-Asvid SEA245).

Year	West Greenland	South East Greenland	North East Greenland	Total Greenland
1975	6,689	**125**	**68**	6,882
1976	11,826	**260**	50	12,136
1977	12,830	**72**	50	12,952
1978	16,434	**408**	50	16,892
1979	17,459	**171**	50	17,680
1980	15,101	**308**	**45**	15,454
1981	22,760	**427**	**49**	23,236
1982	26,793	**267**	**50**	27,110
1983	24,606	**357**	**57**	25,020
1984	25,566	**525**	**61**	26,152
1985	20,518	**534**	**56**	21,108
1986	25,832	**533**[a]	50	26,415
1987	37,329	**1060**[a]	50	38,439
1993	**55,792**	1,335	**40**	57,167
1994	58,811	1,746	**88**	60,645
1995	65,533	1,529	**61**	67,123

a Provisional figures; do not include estimates for non-reported catches.

Table 7. Estimated total removals of harp seals in the Northwest Atlantic for 1952-2016, (Stenson and Rosing-Asvid SEA245).

Year	Reported	Bycatch	Struck and Lost	Total
1952	325,292	0	129,230	454,522
1953	291,070	0	95,095	386,165
1954	285,350	0	112,084	397,434
1955	350,687	0	100,938	451,625
1956	402,167	0	64,218	466,385
1957	260,148	0	96,381	356,529
1958	316,455	0	176,883	493,338
1959	330,846	0	94,426	425,272
1960	295,288	0	140,697	435,985
1961	201,646	0	34,532	236,178
1962	330,273	0	125,277	455,550
1963	353,937	0	86,250	440,187
1964	352,650	0	88,959	441,609
1965	245,326	0	64,414	309,740
1966	331,980	0	83,382	415,362
1967	340,382	0	65,438	405,820
1968	201,596	0	46,718	248,314
1969	297,034	0	66,051	363,085
1970	265,548	68	50,313	315,929
1971	238,322	490	29,870	268,682
1972	137,661	621	22,031	160,313
1973	134,828	465	37,486	172,779
1974	156,564	182	42,899	199,645
1975	182,899	285	43,681	226,865
1976	178,742	1,092	47,991	227,825
1977	169,793	1,577	44,094	215,464
1978	180,490	2,919	65,474	248,883
1979	181,706	3,310	50,585	235,601
1980	191,131	2,717	60,048	253,896
1981	229,815	3,921	53,222	286,958
1982	198,547	3,785	54,740	257,071
1983	87,555	4,962	40,131	132,648
1984	62,254	4,108	39,591	105,952
1985	44,701	4,857	32,069	81,627
1986	56,914	8,178	36,178	101,269
1987	89,536	13,096	55,099	157,731
1988	139,342	8,545	75,895	223,781
1989	113,156	10,256	59,775	183,187
1990	110,569	3,621	77,978	192,168
1991	105,551	9,689	65,400	180,640
1992	124,187	25,476	82,629	232,292
1993	88,203	26,472	72,665	187,340
1994	125,944	47,255	102,049	275,248
1995	136,946	20,395	104,635	261,975
1996	321,734	29,201	146,607	497,542
1997	335,526	18,869	126,654	481,048
1998	364,896	4,641	126,725	496,262
1999	338,169	16,111	113,033	467,313
2000	190,914	11,347	110,354	312,615
2001	312,521	19,475	109,069	441,065
2002	380,102	9,329	98,009	487, 440
2003	356,661	5,367	91,233	453, 261
2004	437,557	12, 593 a	102,612	552 ,761
2005	422,525	12, 325 a	115, 767	550, 616
2006	448,077	12, 355 a	119, 884	580, 316
2007	308,581	12, 447 a	98, 750	419, 778
2008	299,406	12, 704 a	93 ,292	405, 402

Year	Reported	Bycatch	Struck and Lost	Total
2009	149,810	12, 775 a	77, 177	239, 762
2010	160,115	12, 575 a	95, 074	267, 764
2011	115,402	12,571 a	77 ,156	205, 129
2012	132,229	12,571 a	64,664	209,463
2013	169,700	12,571 a	86,970	272,442
2014	133,827	12,571 a	66,946	198,406
2015	115,053	12,571 a	81,609	209,232
2016	146,614	12,571 a	83,268[b]	242,454

[a]Average bycatch 1999-2003 in Canadian and US fisheries

Annex 8: Summary of harp and hooded sealing regulations

Table 1. Summaries of Norwegian harp and hooded sealing regulations for the Greenland Sea ("West Ice"), 1985–2016 (Haug and Zabavnikov SEA 238)

Year	Opening Date	Closing Date	Quotas				Allocations	
			Total	Pups	Female	Male	Norway	Soviet & Russian
Hooded Seals								
1985	22 March	5 May	(20,000)[2]	(20,000)[2]	0[3]	Unlim.	8,000[4]	3,300
1986	18 March	5 May	9,300	9,300	0[3]	Unlim.	6,000	3,300
1987	18 March	5 May	20,000	20,000	0[3]	Unlim.	16,700	3,300
1988	18 March	5 May	(20,000)[2]	(20,000)[2]	0[3]	Unlim.	16,700	5,000
1989	18 March	5 May	30,000	0	0[3]	Incl.	23,100	6,900
1990	26 March	30 June	27,500	0	0	Incl.	19,500	8,000
1991	26 March	30 June	9,000	0	0	Incl.	1,000	8,000
1992-94	26 March	30 June	9,000	0	0	Incl.	1,700	7,300
1995	26 March	10 July	9,000	0	0	Incl.	1,700[7]	7,300
1996	22 March	10 July	9,000[8]				1,700	7,300
1997	26 March	10 July	9,000[9]				6,200	2,800[11]
1998	22 March	10 July	5,000[10]				2,200	2,800[11]
1999-00	22 March	10 July	11,200[12]				8,400	2,800[11]
2001-03	22 March	10 July	10,300[12]				10,300	
2004-05	22 March	10 July	5,600[12]				5,600	
2006	22 March	10 July	4,000				4,000	
2007-16[14]			0	0	0	0	0	0
Harp Seals								
1985	10 April	5 May	(25,000)[2]	(25,000)[2]	0[5]	0[5]	7,000	4,500
1986	22 March	5 May	11,500	11,500	0[5]	0[5]	7,000	4,500
1987	18 March	5 May	25,000	25,000	0[5]	0[5]	20,500	4,500
1988	10 April	5 May	28,000	0[5,6]	0[5,6]	0[5,6]	21,000	7,000
1989	18 March	5 May	16,000	-	0[5]	0[5]	12,000	9,000
1990	10 April	20 May	7,200	0	0[5]	0[5]	5,400	1,800
1991	10 April	31 May	7,200	0	0[5]	0[5]	5,400	1,800
1992-93	10 April	31 May	10,900	0	0[5]	0[5]	8,400	2,500
1994	10 April	31 May	13,100	0	0[5]	0[5]	10,600	2,500
1995	10 April	31 May	13,100	0	0[5]	0[5]	10,600[7]	2,500
1996	10 April	31 Ma[8]	13,100[9]				10,600	2,500[11]
1997-98	10 April	31 May	13,100[10]				10,600	2,500[11]
1999-00	10 April	31 May	17,500[13]				15,000	2,500[11]
2001-05	10 April	31 May	15,000[13]				15,000	0
2006-07	10 April	31 May	31,200[13]				31,200	0
2008	5 April	31 May	31,200[14]				31,200	0
2009	10 April	31 May	40,000				40,000	0
2010	10 April	31 May	42,000				42,000	0
2011	10 April	31 May	42,000				42,000	0
2012-13	10 April	31 May	25,000				25,000	0
2014-16	10 April	31 May	21,270				21,270	0

[1] Other regulations include: Prescriptions for date for departure Norwegian port; only one trip per season; licensing; killing methods; and inspection.

[2] Basis for allocation of USSR quota.

[3] Breeding females protected ; two pups deducted from quota for each female taken for safety reasons.

[4] Adult males only.

[5] 1 year+ seals protected until 9 April; pup quota may be filled by 1 year+ after 10 April.

[6] Any age or sex group.

[7] Included 750 weaned pups under permit for scientific purposes.

[8] Pups allowed to be taken from 26 March to 5 May.

[9] Half the quota could be taken as weaned pups, where two pups equalled one 1+ animal.

[10] The whole quota could be taken as weaned pups, where two pups equalled one 1+ animal.

[11] Russian allocation reverted to Norway.

[12] Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 1,5 pups equalled one 1+ animal.

[13] Quota given in 1+ animals, parts of or the whole quota could be taken as weaned pups, where 2 pups equalled one 1+ animal.

[14] Hooded seals protected, only small takes for scientific purposes allowed.

Table 2. Summary of sealing regulations for the White and Barents Seas ("East Ice"), 1979–2016.[1]

Year	Opening Dates		Closing Date	Quota-Allocation		
	Soviet/Rus.	Norway		Total	Soviet/Rus.	Norway
1979–80	1 March	23 March	30 April3	50,0004	34,000	16,000
1981	-	-	-	60,000	42,500	17,500
1982	-	-	-	75,000	57,500	17,500
1983	-	-	-	82,000	64,000	18,000
1984	-	-	-	80,000	62,000	18,000
1985-86	-	-	-	80,000	61,000	19,000
1987	-	-	20 April3	80,000	61,000	19,000
1988	-	-	-	70,000	53,400	16,600
1989–94	-	-	-	40,000	30,500	9,500
1995	-	-	-	40,000	31,250	8,7505
1996	-	-	-	40,000	30,500	9,500
1997-98	-	-	-	40,000	35,000	5,000
1999	-	-	-	21,400[6]	16,400	5,000
2000	27 Febr	-	-	27,700[6]	22,700	5,000
2001-02	-	-	-	53,000[6]	48,000	5,000
2003	-	-	-	53,000[6]	43,000	10,000
2004-05				45,100[6]	35,100	10,000
2006	-	-	-	78,200[6]	68,200	10,000
2007	-	-	-	78,200[6]	63,200	15,000
2008	-	-	-	55,100[6]	45,100	10,000
2009	-	-	-	35,000	28,000[7]	7,000
2010				7,000	0	7,000
2011				7,000	0	7,000
2012-13				7,000	0	7,000
2014				7,000	0	7,000
2015-16				19,200	12,200	7,000

[1] Quotas and other regulations prior to 1979 are reviewed by Benjaminsen (1979).

[2] Hooded, bearded and ringed seals protected from catches by ships.

[3] The closing date may be postponed until 10 May if necessitated by weather or ice conditions.

[4] Breeding females protected (all years).

[5] Included 750 weaned pups under permit for scientific purposes.

[6] Quotas given in 1+ animals, parts of or the whole quota could be taken as pups, where 2,5 pups equalled one 1+ animal

[7] Quota initially set at 28,000 animals, but then was reconsidered and set to 0

Table 3. Major management measures implemented for harp seals in Canadian waters, 1961–2016.

Year	Management Measure
1961	Opening and closing dates set for the Gulf of the St. Lawrence and Front areas.
1964	First licensing of sealing vessels and aircraft. Quota of 50,000 set for southern Gulf (effective 1965).
1965	Prohibition on killing adult seals in breeding or nursery areas. Introduction of licensing of sealers. Introduction of regulations defining killing methods.
1966	Amendments to licensing. Gulf quota areas extended. Rigid definition of killing methods.
1971	TAC for large vessels set at 200,000 and an allowance of 45,000 for landsmen.
1972 – 1975	TAC reduced to 150,000, including 120,000 for large vessel and 30,000 (unregulated) for landsmen. Large vessel hunt in the Gulf prohibited.
1976	TAC was reduced to 127,000.
1977	TAC increased to 170,000 for Canadian waters, including an allowance of 10,000 for northern native peoples and a quota of 63,000 for landsmen (includes various suballocations throughout the Gulf of St. Lawrence and northeastern Newfoundland). Adults limited to 5% of total large vessel catch.
1978–1979	TAC held at 170,000 for Canadian waters. An additional allowance of 10,000 for the northern native peoples (mainly Greenland).
1980	TAC remained at 170,000 for Canadian waters including an allowance of 1,800 for the Canadian Arctic. Greenland was allocated additional 10,000.
1981	TAC remained at 170,000 for Canadian waters including 1,800 for the Canadian Arctic. An additional allowance of 13,000 for Greenland.
1982–1987	TAC increased to 186,000 for Canadian waters including increased allowance to northern native people of 11,000. Greenland catch anticipated at 13,000.
1987	Change in Seal Management Policy to prohibit the commercial hunting of whitecoats and hunting from large (>65 ft) vessels (effective 1988). Changes implemented by a condition of licence.
1992	First Seal Management Plan implemented.
1993	Seal Protection Regulations updated and incorporated in the Marine Mammal Regulations. The commercial sale of whitecoats prohibited under the Regulations. Netting of seals south of 54°N prohibited. Other changes to define killing methods, control interference with the hunt and remove old restrictions.
1995	Personal sealing licences allowed. TAC remained at 186,000 including personal catches. Quota divided among Gulf, Front and unallocated reserve.
1996	TAC increased to 250,000 including allocations of 2,000 for personal use and 2,000 for Canadian Arctic.
1997	TAC increased to 275,000 for Canadian waters.
2000	Taking of whitecoats prohibited by condition of license
2003	Implementation of 3 year management plan allowing a total harvest of 975,000 over 3 years with a maximum of 350,000 in any one year.
2005	TAC reduced to 319,517 in final year of 3 year management plan
2006	TAC increased to 335,000 including a 325,000 commercial quota, 6,000 original initiative, and 2,000 allocation each for Personal Use and Arctic catches
2007	TAC reduced to 270,000 including 263,140 for commercial, 4,860 for Aboriginal, and 2,000 for Personal Use catches
2008	TAC increased to 275,000 including a 268,050 for commercial, 4,950 for Aboriginal and 2,000 for Personal Use catches Implementation of requirement to bleed before skinning as a condition of licence
2009	TAC increased to 280,000 based upon allocations given in 2008 plus an additional 5,000 for market development Additional requirements related to humane killing methods were implemented
2010	TAC increased to 330,000
2011	TAC increased to 400,000

Table 4. Major management measures implemented for hooded seals in Canadian waters for 1964–2016.

Year	Management Measure
1964	Hunting of hooded seals banned in the Gulf area (below 50oN), effective 1965.
1966	ICNAF assumed responsibility for management advice for northwest Atlantic.
1968	Open season defined (12 March–15 April).
1974–1975	TAC set at 15,000 for Canadian waters. Opening and closing dates set (20 March–24 April).
1976	TAC held at 15,000 for Canadian waters. Opening delayed to 22 March. Shooting banned between 23:00 and 10:00 GMT from opening until 31 March and between 24:00 and 09:00 GMT thereafter (to limit loss of wounded animals).
1977	TAC maintained at 15,000 for Canadian waters. Shooting of animals in water prohibited (to reduce loss due to sinking). Number of adult females limited to 10% of total catch.
1978	TAC remained at 15,000 for Canadian waters. Number of adult females limited to 7.5% of total catch.
1979–1982	TAC maintained at 15,000. Catch of adult females reduced to 5% of total catch.
1983	TAC reduced to 12,000 for Canadian waters. Previous conservation measures retained.
1984–1990	TAC reduced to 2,340 for Canadian waters.
1987	Change in Seal Management Policy to prohibit the commercial hunting of bluebacks and hunting from large (>65 ft) vessels (effective 1988). Changes implemented by a condition of licence.
1991–1992	TAC raised to 15,000.
1992	First Seal Management Plan implemented.
1993	TAC reduced to 8,000. Seal Protection Regulations updated and incorporated in the Marine Mammal Regulations. The commercial sale of bluebacks prohibited under the Regulations.
1995	Personal sealing licences allowed (adult pelage only).
1998	TAC increased to 10,000
2000	Taking of bluebacks prohibited by condition of license.
2007	TAC reduced to 8,200 under Objective Based Fisheries Management based on 2006 assessment
2008	Implementation of requirement to bleed before skinning as a condition of license
2009	Additional requirements implemented to ensure humane killing methods are used

Symposium on the
Impacts of Human Disturbance on Arctic marine mammals, with a focus on Belugas, Narwhals & Walrus
13–15 October 2015, University of Copenhagen, Denmark

Background
Human activity in the Arctic has increased in recent years, and will likely continue to increase with the effects of climate change, especially reductions in sea ice extent. These activities include oil and gas exploration, shipping, fisheries, tourism, etc. This Symposium was organized primarily due to concerns in Greenland over the effects that increased human activity may have on marine mammals such as narwhals, belugas, and walrus. However, NAMMCO recognized that these concerns are likely relevant for the entire Arctic and all Arctic marine mammals. With this in mind, the goals of the Symposium 1) present an overview of the information currently available; 2) identify and characterize possible sources of disturbance, and the effects on individuals and populations; 3) consider the need for possible mitigation measures to minimise sources of anthropogenic disturbances; and 4) reflect on future studies needed to assess long-term impacts of anthropogenic activities on both individual and population levels (particularly in the light of global warming).

There were 45 participants and 22 presentations covering the effects of various sources of disturbances including seismic exploration, shipping, and tourism on Arctic and sub-Arctic species—belugas, narwhals, walruses, bowhead whales, humpback whales, Caspian seals, and harbour seals. After each presentation there was a short question session, and longer discussion sessions were held each day. Over the course of the 2 ½ day Symposium, lists were created for general issues of risk assessment for all species (Table 1), and specific lists of risks, data gaps, and possible mitigation steps for the focal species. A breakout session was held on the last day to prioritize these lists.

The Symposium was funded by NAMMCO with generous contributions from World Wildlife Fund-Denmark and the Government of Greenland. The University of Copenhagen generously provided the meeting facilities.

Main topics of Discussion
The participants identified a number of issues that are general problems for assessing the risks for all marine mammal species in the Arctic.

- *Assessing impacts on international stocks*

Shared stocks often do not have shared scientific cooperation and/or management, and risk assessments are usually done on a national basis.

- *Industrial development changing activity plans post-assessment*

Risk assessments are critical during the development stage, but the Symposium identified cases where the projects had been changed after the risk assessment had been carried out. This creates a situation where a risk assessment has not *really* been performed for the actual project that is being implemented.

- *Lack of expertise on assessment boards in specialty fields*

The participants reported that the people asked to assess risks may not have the expertise needed to assess those particular risks, e.g., assessing the risks of a seismic project when the assessment board does not have an acoustics expert.

- *Defining levels of thresholds for unacceptable levels of risks*

In most cases, scientists (and managers) have not identified what level of risk will be acceptable, e.g., what percent decline in the population is tolerable.

- *Non-compliance with in-place conservation measures (e.g. narwhal hunting in the reserve)*

Conservations measures are often put in place without enforcement measures/strategy.

- *Response times in a changing Arctic*

In the situation of a rapidly changing Arctic, scientists and managers are faced with situations where responses to risks need to be addressed quickly. However, response times are often slowed due to challenges with variance and data precision, which do not allow for definitive answers. In these situations, the risk of inaction are great, and should be considered.

- *Technological advances in the "disturbance sources"*

The research being performed now is looking at the current typical sources of disturbance, however industry may develop new technological advances that are not well researched before they are used. For example, data may be collected on marine mammals' response to icebreakers that are currently in use, but the next generation of icebreakers may not be researched before being used.

- *Mitigation and monitoring*

Mitigation steps must be followed up with monitoring programs to determine whether the mitigation is actually effective and adjust them if needed.

- *Need for physiological studies*

It can be challenging to determine whether a potential disturbance is having an effect, and behavioural studies may not be enough to say whether there is an impact on the animal. However, physiological studies could detect effects before behaviour changes, or in cases when behaviour does not appear to change at all.

Table 1. Risks, known impacts, data gaps, and possible mitigation steps for all Arctic marine mammals

Threats/Risks	Known Impacts	Data gaps	Mitigation
7) Shipping *Noise and presence of ships in important habitat*	• Displacement from habitat (migration, foraging, resting, etc.) • Habitat disruption/ destruction; disruption of breeding/ moulting /haulout areas (particularly seals) • Physical impact (ship strikes for whales, collisions for seals)	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• Speed restrictions/seasonal closures? • Routing lanes/no-go areas/marine reserves • Exclusion areas and buffer zones around sites of oil/gas leases as well as sites of particular types of activity, based on "biological sensitivity" • Quieting technology, e.g. bubble curtains for pile-driving and other construction activities; ship-silencing devices, designs, protocols • Speed/time of day/seasonal restrictions • Better logistical planning/ coordination between companies/ shippers to limit activities • Rapid/real-time mitigation (Caspian seal example of aerial surveys)
8) Seismic exploration	• Displacement from habitat (migration, foraging, resting, etc.). Narwhal were identified as being particularly sensitive to seismic activities.	• Effects detection- more research is needed to detect impacts, both on the individual and population level	• MMOs often used, but can be problematic for all species because animals may be impacted before detection • Determination of 'exclusion' ('safety') or 'mitigation' zones around noise-generating activities, monitored in 'real time' by visual observers and sometimes acoustic sensors (see summaries from Castellote et al. and Weissenberger) • Development and introduction of alternative technology, e.g. vibroseis to replace airgun seismic surveys
9) Fisheries	• Competition for prey • Displacement from foraging areas		• Seasonal closures • Gear modification

Threats/Risks	Known Impacts	Data gaps	Mitigation
	• Bycatch, e.g. increasing for humpbacks in Greenland (esp. pound nets, crab pods)		
10) Hunting (past and present)			• Enforcement of regulations • Ongoing need for monitoring (esp. walruses) • Shared stocks- international cooperation/responsibility
11) Tourism *Increasing throughout the Arctic*	• Seals and walrus- abandon haulout sites with disturbance (hunting or tourism)	• More information needed on behavioural responses to presence of tourists	• Development of guidelines/ education for tour guides and tourists • Walrus- recommendations for distance/downwind • Seals- calm tourists had less reaction from seals, guide information // Minimum distance for people
12) Multiple stressors/ cumulative impacts *Cook Inlet belugas are a serious example*		• Need for models to investigate cumulative impacts • E.g., Cook Inlet- not allowed to handle animals for tagging, physiological studies, etc.	• Implement mitigation for specific impacts above • For Cook Inlet, MMPA/ESA implementation is *not* working

Priorities for focal species: beluga, narwhal and walrus
Breakout sessions were held to discuss and rank the risks of the different types of human disturbance identified during the Symposium for the focal species. For all marine mammals in the Arctic, including the focal species, climate change was considered to be an overall risk for all species, and all of the additional threats were considered in the situation of a rapidly changing climate.

Hunting was also considered to be a potential threat to these species, however it was noted that NAMMCO has management procedures in place to mitigate the risks of hunting, such as systematic population assessments of all exploited stocks (including obtaining regular abundance estimates) and the implementation of quotas. For non-hunting anthropogenic threats such as industrial activities, the management procedures are less defined and were more of the focus of the Symposium, therefore the priority lists focused on these threats.

Multiple stressors described situations where an individual stressor was not necessarily considered a significant threat, but the cumulative impacts of the stressors was a significant threat to the species.

Beluga
The group agreed that the identified stressors should be prioritized under the umbrella that combines Cumulative Impacts/Multiple Stressors and Climate Variability. In that perspective, the prioritization is as follows:

1. Cumulative Impacts
2. Seismic (which could probably be changed as the Walrus Group proposed to oil and gas related activities)
3. Fisheries
4. Shipping
5. Tourism
6. Hunting

1. Cumulative Impacts

Impacts: Reduced fecundity, habitat degradation

Data Gaps: It was proposed that a good way to start addressing cumulative impacts would be to map the various stressors and their intensity. This type of assessment was conducted for 23 different stressors at the scale of the globe (Halpern et al. 2007), but was also refined for specific region, overlaid with marine mammal densities, and adapted to account for their vulnerability to each of the stressors (e.g., Maxwell et al. 2013).

Mitigation: Once areas with multiple stressors and high intensity are identified, actions may be taken that are specific to the stressor and species involved.

2. Oil and Gas Exploitation/Exploration

Impacts: Acoustic, displacement, other less detectable sub-lethal effects

Data Gaps: impacts of oil and gas activities including seismic on belugas; route and timing of beluga migration (e.g., West Greenland); limited information exists for impact thresholds at close range, but none exists for impacts at long range (disturbance); efficiency of several of the mitigation measures (e.g., ramp-up, visual vs PAM detection, visual detection vs Beaufort, etc.)

Mitigation: avoid redundancy in seismic operations in an area, exclusion zone, ramp-up, etc.

3. Fisheries

Impacts: Competition for food resource; entanglement and bycatch

Data Gaps: beluga diet and foraging areas; inability to identify potential developing interests in resource exploitation to avoid competition for resource

Mitigation: Observer program on board fishing vessels to document bycatch and other interactions; gear research to reduce bycatch if deemed necessary

4. Shipping

Impacts: Oil spills; invasive species; displacement; acoustic impacts of a chronic increase in ambient noise; alteration of ice cover; infrastructures associated with shipping

Data Gaps: Thresholds for impacts from chronic noise sources; data availability on traffic; efficient way of dealing with oil spill in ice, and behaviour of oil in cold water conditions

Mitigation: Noise reduction (vessel speed, noise reduction technology for construction, improved maintenance, etc.); route planning; strategic planning of coastal infrastructures associated with shipping (e.g., ports, etc.)

5. Tourism

Impacts: Disturbance; sewage dumping in fjords

Data Gaps: long-term effects of repeated disturbance; knowledge of distribution, sex segregation, birth and feeding areas, migration routes for belugas; mapping of tourism activity distribution and volume; documented interactions and level of effects

Mitigation: area/time closures; regulations; education of guides and the public

Narwhal

1. Seismic

Impacts: range contraction/shifts in distribution (which could also alter their vulnerability to hunting pressure)

Data Gaps: behavioural and physiological responses, long-term sub-lethal effects

Mitigation: restrict timing and/or location of seismic activities

2. Shipping

Icebreaking during winter shipping activities was identified as particularly detrimental to narwhal.

Impacts: range contraction/distributional shifts, habitat disruption

Data Gaps: hearing sensitivity, physiological effects

Mitigation: restricting shipping spatially and/or temporally

3. Fisheries

The participants ranked fisheries as a relatively low risk for narwhals at this time. However, it was also discussed that fisheries will likely increase in the future, especially the halibut fishery, which could affect narwhals (competition for prey, displacement from foraging areas, etc.). Therefore, the potential impacts of fisheries on narwhal should be monitored.

4. Tourism

The levels of tourism in narwhal habitat remain low enough that this was not seen as a high risk. However, as with fisheries, any increases in tourism should be monitored.

Walrus

The walrus breakout group agreed that the category of "seismic activities" should include all oil and gas activities. They ranked the risks based on the populations of interest to NAMMCO-West Greenland, East Greenland and Svalbard.

For all areas, the group noted that seismic activities have unknown effects on walrus prey species. Scientists and managers should consider requiring industry to cooperate on studies and share data before and after seismic surveys.

West Greenland

1. Oil and Gas Activities

The main oil and gas activities considered to be significant risks to walrus in West Greenland were shipping and seismic activities.

Impacts: displacement from habitat, sub-lethal effects

Data Gaps: hearing sensitivity, behavioural responses to shipping and seismic, unknown effects of oil spills

Mitigation: Seasonal/location restrictions for critical times/areas

2. Shipping

Shipping activities in general are a risk factor for walrus in West Greenland, and the Mary River-Baffinland project was identified as a major risk to walrus in Baffin Bay.

Impacts: displacement from habitat, sub-lethal effects

Data Gaps: hearing sensitivity, behavioural responses to shipping and seismic

Mitigation: Restricting the quantity and/or timing of shipping through Baffin Bay, in particular the Mary River-Baffinland project.

3. Fisheries

Impact: displacement from foraging areas

Data gaps: it is unknown whether the presence of fishing vessels may be displacing animals

Mitigation: close/reduce fishing activity in critical foraging areas

East Greenland
Oil and gas activities, and seismic in particular, were identified as the only significant risk to walrus in East Greenland. The impacts, data gaps, and possible mitigation measures are the same as for West Greenland.

Svalbard
The group noted that this population is relatively stable, however less is known about the status of the population and potential stressors in the Pechora Sea and farther east, and there may be significant oil and gas development in those areas.

Seismic activities were identified as the most significant risk. There may also be some risk associated with potential grounding and/or oil spills from ships involved in tourism and supply shipping.

PRESENTATION SUMMARIES

Welcome from NAMMCO
Jill Prewitt, NAMMCO Secretariat

NAMMCO is a regional organisation concerned with the conservation, management and study of marine mammals in the North Atlantic. This includes both large and small cetaceans, and also seals and walruses. Our member countries are Norway, Iceland, Greenland, and the Faroe Islands. NAMMCO was founded in 1992 on the principles that we:

- Recognise
  - ✓ the rights and needs of coastal communities
- Are committed to the
  - ✓ Effective Conservation of marine mammals
  - ✓ Sustainable and responsible use of marine mammals
  - ✓ Ecosystem-based approach
- Base our management decisions on the best available scientific advice and user knowledge

As NAMMCO's members are all Arctic nations, we have a strong interest in Arctic issues. This Symposium stems primarily from concerns in Greenland over how increased human activity may affect marine mammals such as narwhals, belugas, and walrus, but NAMMCO recognised that these concerns are likely relevant for the entire Arctic and all Arctic marine mammals.

Therefore we look forward to the many interesting talks and fruitful discussions this week that will help us in providing the best possible management advice for the marine mammals in our waters.

Status of selected Arctic marine mammals
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

There are between 20 and 24 more or less discrete populations of belugas worldwide. The size of the various populations varies from very low numbers in Cook Inlet and St. Lawrence River to significant populations in the Canadian high Arctic, Beaufort and Chukchi Seas. Abundance along the Russian coast could potentially be very large as typical beluga habitat is present. The beluga populations apparently separate into two different types; those that migrate long distances between summer and winter areas, and those that are stationary in the same area year-round. From a disturbance perspective, belugas live to a varying degree with habituation to human activities. In central Siberia belugas are often found at shipping lanes or close to towns (e.g. Dikson and Anadyr). In Greenland belugas avoid human presence as they are often subject to hunting. When it comes to population effects, it is difficult for all species to discriminate between effects caused by hunting and those caused by disturbances.
The narwhal is restricted to the Atlantic sector of the Arctic where they persist in relatively small and isolated populations east and west of Greenland. Track of individual whales show that they use strict migratory corridors and have high site fidelity to certain winter and summer areas and can be separated into discrete summering stocks. Narwhals are considered highly sensitive to disturbances and especially ice breaking and seismic investigations are considered to be potentially harmful for narwhals that show little behavioural plasticity in migratory patterns.

Bowhead whales have a circumpolar distribution and exist in 4-5 populations with the smallest population in the Okhotsk Sea. The Bering-Chukchi-Beaufort sea stock is slightly increasing at 3-4% and the Foxe Basin-Hudson Bay and the Baffin Bay-Davis Strait stocks have shown a major increase over the past 15 years. The stock in East Greenland has recently shown signs of recovery after a survey in the Northeast Water revealed an abundance of 100 whales hiding in the polynya. In Alaska satellite tracking has been used to demonstrate how bowhead whales passed through oil and gas lease areas during their fall migrations to illustrate the potential conflict with industrial activities. In Baffin Bay bowhead whales winter in several different areas and they seem to be very flexible in movement patterns. Important concentration areas include Disko Bay and the West Greenland coast as well as Hudson Strait.

By far the largest abundance of walruses occurs in the Bering Sea. In Greenland they are found in a separate population in East Greenland that is also believed to be separate from those occurring around Svalbard. In West Greenland there is one population in the Thule area that is connected to walruses in the Canadian Archipelago. Another population in mid West Greenland crosses Davis Strait in spring and move to east Baffin during the summer and they only occur in West Greenland in winter. A small population is found in Hudson Bay and a large - or perhaps two large - populations occur in Foxe Basin. In winter they are widely dispersed in Hudson Strait, Foxe Channel and around Southampton Island. In Svalbard the walrus population is growing and the status for stocks in the Pechora and Kara Seas is unknown but recent surveys indicate population of several thousand animals in the Pechora Sea. Walruses are particularly sensitive to disturbance on their haul-out sites and many terrestrial haul-outs have been abandoned in the North Atlantic due to human activities.

Concerns and opportunities

Kit Kovacs, Norwegian Polar Institute

Abstract not available.

<u>Case Studies</u>

Oceans of noise: Assessing risks to marine mammals in the face of uncertainty

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Human activities are increasing the level of noise in the oceans, causing widespread concern about the potential effects on marine mammals and marine ecosystems. Sound propagates efficiently through water and marine mammals rely on the use of sound to communicate with conspecifics, for predator avoidance, to locate and capture prey, mate selection and social interactions. Coupled with this, they have an acute sense of hearing with a high sensitivity over a wide frequency range. This reliance on sound in their general ecology makes marine mammals particularly vulnerable to the effects of underwater noise. Many marine activities generate significant underwater noise into the marine environment (e.g. explosive use, pile-driving, geophysical surveys, ship propeller noise etc.). Exposure to noise can have a range of effects depending on the sound type or received level. Loud, intense noise sources such as explosions have the potential to cause lethal physical non-auditory injury to marine mammals, while other noise sources can cause auditory damage or elicit behavioural responses (e.g. displacement and/or habitat exclusion). It is widely acknowledged that short-term behavioural responses may become biologically significant if animals are exposed for sustained periods of time, but the interpretation of the biological consequences of disturbance is limited by uncertainty about what constitutes a meaningful response, both at the individual and the population level.

As the Earth's population grows, there is an increased demand for energy. The potential for the exploitation of both fossil fuels and renewable energy sources in the Arctic is being considered. With increased development and shipping, comes the need for impact assessment at project and strategic levels to determine the most sustainable path ahead. Risk assessment provides a framework to allow scientists, regulators, decision-makers, sound producers and conservationists to better understand of the effects of noise and to manage those effects, both on an individual and cumulative basis. In addition, such frameworks be used to identify key sensitivities and knowledge gaps to be filled and crucially the data that need to be collected, thus prioritising future research.

Consequences of speed limits and partial rerouting of shipping traffic on habitat acoustic quality and beluga exposure to noise pollution in the St. Lawrence Estuary, Canada: Science in support of risk management

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Noise associated with human activities has become ubiquitous in the world oceans, and has dramatically changed their acoustic landscape. Anthropogenic noise may interfere with marine mammal vital functions in a number of ways, e.g., by altering behaviour or disrupting prey, reducing communication space, foraging efficiency, or predator detection, by temporarily or permanently impairing hearing, by causing stress through changes in physiological functions, habitat avoidance or even death. Research efforts have been largely dominated by studies examining effects from acute sounds. However, there is a growing recognition that long-term (i.e., chronic), large-scale, low intensity noise exposures may also affect individual fitness and population conservation. Of particular concern is the chronic exposure to shipping noise.

The St. Lawrence Estuary (SLE) marine shipping lane currently overlaps with the main aggregation area for large baleen whales, male beluga and whale-watching activity, raising concerns for potential whale/ship or whale-watch vessel/ship collisions. Motivated by the desire to reduce collision risks, local authorities proposed to reduce ship speed to 10 kt within a particularly sensitive area in the North Channel (NC), leaving pilots the option of diverting their route to the South Channel (SC), thereby avoiding most of the speed-reduction zone and areas of whale aggregation. However, shifting part of the commercial traffic to the SC may alter patterns of exposure of St. Lawrence Estuary (SLE) beluga to marine traffic. The present study indicates that commercial traffic transiting through the SLE exposes many times daily a substantial proportion (15-53%) of the SLE beluga population, of which the vast majority (72-81%) are females with calves or juveniles, to noise levels likely to induce negative behavioural responses in a majority of the exposed individuals. Diverting shipping to the SC not only increases the proportion of the population and its habitat (including designated Critical Habitat) exposed to noise levels in excess of the threshold for negative behavioural responses, but also contributes to the acoustic degradation of beluga habitat previously relatively lightly exposed to shipping noise. We therefore conclude that maintaining or concentrating commercial traffic as much as possible in the NC constitutes the scenario which minimizes impacts on beluga and their habitat. A reduction in vessel speed or size, changes in vessel designs, or any other measure that might make vessels quieter, would contribute to reducing potential negative effects on SLE beluga. We also emphasize the need for putting forward conservation measures for sites important for marine mammals but that are currently quiet and of little political or socio-economical interest (referred to as ‘Opportunity sites’ by Williams et al. in press., Mar. Poll. Bull.).

Overview of the Department of Fisheries and Oceans’ comments on the environmental impact statement of Baffinland's Mary River Project
Marianne Marcoux, Department of Fisheries and Oceans Canada

The Mary River Project is a proposed iron ore mine operated by Baffinland located at Mary River, on North Baffin Island, Nunavut. In the early phase of the project, 18 million tonnes of iron ore will be shipped annually through Milne Inlet. Based on the evaluation conducted by the Department of Fisheries and Oceans Canada (DFO), three shortfalls of the environmental impact assessment prepared by Baffinland will be reviewed. First, Baffinland underestimated the impact of noise on marine mammals. Baffinland did not consider the total impact of several simultaneous sources of noise even though they indicated that sometimes two ships or more will be present at the same time in Milne Inlet. As a result, Baffinland should have provided sound propagation models taking into account noise from multiple sources. In addition, noise has been recognized as a chronic stressor, and thus, their evaluation of the impact of noise should have been based on cumulative noise exposure over time. Second, Baffinland predicted that their ships would not strike any narwhals or bowhead whales. DFO considered that this assessment greatly underestimated the number of whales at risk to be struck by ships and proposes using a modelling approach to predict this risk. Third, Baffinland claimed that a perturbation affecting 10% of the individuals in a marine mammal population is an acceptable level of impact. This threshold is hard to evaluate because it does not provide any temporal or spatial scale. In addition, this threshold has no empirical basis and does not take into account the different life histories of marine mammals in the Arctic. DFO suggests using quantitative approaches, such as the potential biological removal or population dynamic models, to determine an acceptable level of impact. Lastly, a change of 10% would be hard to detect through regular monitoring given the confidence intervals of most monitoring techniques.

Hudson Strait: a case study with the shipping industry
Peter J. Ewins and Andrew Dumbrille, WWF-Canada

Canada’s Hudson Strait region provides important conditions for globally-significant marine mammal populations in every season, reflecting regular open-water access to relatively productive Arctic foodwebs. Three Ecologically and Biologically Significant Areas (EBSAs) cover the entire area of Hudson Strait. The Strait is also a destination and gateway for commercial shipping, and vessel traffic is expected to increase as the length of the open water season increases as a result of climate warming. In the absence still of any Marine Protected Areas (MPAs), or zoned marine plans for the region, or high quality specific guidance from regulators on anthropogenic noise or other disturbances, WWF-Canada worked with a large shipping company, FedNav – Canada’s largest ocean-going bulk cargo transportation company. Our ultimate aim is to identify the key risk areas, and then the suite of measures necessary to minimize risks to wildlife and marine habitats, that can be expected to arise from commercial shipping activities in Hudson Strait. We completed a preliminary risk assessment for Hudson Strait, based on a regional collation of oceanographic, ecological, socio-cultural, and economic values, and all available information. We present a series of summary maps for these aspects, including for Beluga, Narwhal and Walrus, as well as a series of recommendations arising from the first phase of this work, relating to: 1) measures to address key data gaps; 2) measures to address higher risks; 3) measures to promote best practices.

Monitoring narwhals in Melville Bay in relation to seismic surveys
Rikke Guldborg Hansen, Greenland Institute of Natural Resources

Baffin Bay has been the scene of a massive seismic exploration scheme during the last decade and in 2012 intensive 3D seismic exploration was carried out by multiple companies close to the summering grounds of narwhals in Melville Bay. Monitoring studies of the hunting activity and occurrence of narwhals in Melville Bay included aerial surveys before, during and after the seismic in 2012 followed by another aerial survey in 2014. Aerial surveys conducted in 2012 gave an indication, but no clear evidence, that there were more narwhals present inside the Melville Bay during the early part than in the late part of the period with seismic exploration. Compared to a similar survey from 2007, the abundance of narwhals in 2012 was lower but not significantly different, while the distribution in 2012 was more clumped and closer to shore. In 2014, an even larger proportion of the whales were found close to the coast and glaciers compared to both 2007 and 2012 surveys. Although the abundance seem to remain at the same level, the distribution has changed. The contraction of whales is reflected both in the trend of larger group sizes but most evidently in the drop of distance between narwhal individuals or groups. The main concern is the contraction in the range as the narwhals have virtually disappeared from their previous outer distribution boundaries in the bay.

The narwhal's sense of silence
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

There are a number of characteristics of narwhals from Canada, East and West Greenland that illustrate their extreme specialisations. They utilize strict migratory corridors when travelling from summer to wintering grounds, and they have specialised feeding behaviour with few potential prey species. During winter they focus their diving activity to great depths for 6-8 months. The dives are probably targeting concentrations of Greenland halibut because winter samples of narwhals stomachs show they are filled with halibut remains and sometimes contain up to 35 kg of prey items. There is considerable overlap between narwhal occurrence and the catches of halibut and it is estimated that thousands of tons of halibut are consumed by narwhals. In summer, narwhal stomachs are often empty or contain very few remains of polar cod and squids.

Few accurate measurements of ambient noise levels at the narwhal habitats exist but there are a couple from the early 80's collected during the Arctic Pilot Project assessment process. Measurements at the narwhal summering ground in the Thule area are from the open water period but show that even though there is noise from wave activity ambient noise levels are still low compared to most other measurements in the Arctic. Measurements from the narwhal pack ice winter habitats show very low noise levels especially at the higher frequencies where narwhals concentrate most of their energy in the echolocation clicks.
Ongoing studies of the effects of seismic exploration focuses on four items. First thing is to estimate the direct reactions of the whales to airgun pulses and compare movements to past tracking in the same area. Next part of the studies is to look at the noise levels received by the whales and the changes in vocal activities from the whales during seismic. Another important parameter is the changes in diving behaviour and the feeding rates observed from stomach temperature pills. It is important to measure both the dive changes and the acoustic response of the whales but ultimately we need to know how their physiology is impacted by the disturbance. One measure of physiological impact is the changes in heart rate during dives with and without exposure to seismic.

Cook Inlet beluga Abundance, Distribution and Potential Sources of Disturbance
Rod Hobbs, National Marine Mammal Laboratory, USA

The Cook Inlet beluga population had declined to around 350 individuals in 1999 from and estimated size of 650 in 1994 and 1300 in 1979. Much of this decline prior to 1999 can be attributed to unregulated subsistence hunting which exceeded 70 takes per year in the mid 1990’s. Since 1999 the population has failed to increase despite the limitation of hunting takes to a total of 5 between 2000 and 2005 and none since then. In addition to the decline in abundance the Cook Inlet beluga has shown a substantial contraction in summer range with the current population occupying only 39% of the range observed in 1979. One hypothesis to explain the failure to recover from excessive hunting takes and changes in distribution are increasing levels of disturbance from anthropogenic noise as well as vessel interaction from shipping, fishers and other water craft. Anthropogenic noise sources include vessel and aircraft, in water construction including pile driving, drilling and dredging and seismic surveys. Some of these sources have increased substantially between 1979, 1994 and 2015 but the population level consequences are poorly understood. The US National Marine Fisheries Service (NMFS) has begun a process to develop a PCoD model (Population Consequences of Disturbance) which will provide a method to quantify the impacts of disturbance from noise on the life history parameters of this population and its potential for recovery. The PCoD model considers the belugas behavioural and physiological response to each disturbance event and then quantifies the cost to health and condition of each individual and the resulting impact on fecundity and survival. These impacts to individual life history parameters are then summed over the whole population to determine the effects on population growth or decline and risk of extinction or probability of recovery. While the intent of the model is to relate disturbance to population level consequences we can also use the model in reverse to estimate the size of the impact that if removed would allow the population to recover. Population models of the Cook Inlet beluga have shown that an increase of 2% to the growth rate would be sufficient to change probability of recovery 10%to 90%. This would result from an increase in fecundity of 30% and an increase in survival of 1-2%.

Anthropogenic noise on Cook Inlet and Bristol Bay beluga habitat: potential for negative effects
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Anthropogenic noise has been identified as a major threat for the recovery of the endangered Cook Inlet beluga population. NOAA Fisheries is currently regulating noise exposure to marine mammals under the Marine Mammal Protection Act and the Endangered Species Act; however regulation and noise impact mitigation is limited to close range effects defined by specific acoustic exposure thresholds (120 dB for non-impulsive noise sources and 160 dB for impulsive sources). Cook Inlet beluga habitat is in close proximity to the greatest concentration of Alaska’s human population and the largest urban area in the state, exposing belugas to a wide variety of noise stressors including fishing, mining, shipping, dredging, renewable energy development, military operations, oil and gas development, air and water transportation, and residential and industrial shore development. All these activities occur within Cook Inlet beluga critical habitat, and many of them are intensified during their main foraging season when ice is absent (May to October). Bristol Bay, Alaska, is a similar estuarine environment but with minimal human influence and a pristine soundscape. Beluga hearing obtained on 17 temporarily restrained belugas in Bristol Bay show lower thresholds than previously reported for this species. When these results are compared to quantitative results from the altered Cook Inlet beluga soundscape, it can be concluded that all the anthropogenic noise sources identified in Cook Inlet habitat are within hearing range at very considerable distances from the source, and often regulatory noise thresholds occur at distances where mitigation is difficult to achieve or unfeasible. As examples, a standard seismic survey in Cook Inlet generated 180 dB at 2.9 km and 160 dB at 7.2 km in radius around the seismic vessel. A pile driving operation near shore generates 180 dB at 2.3 km, 160 dB at 29 km and 120 dB exceeding 100 km. The majority of the Cook Inlet beluga critical habitat would be ensonified by these activities, lasting several months. Ongoing experimental studies on captive belugas in aquaria exposed to Cook Inlet ship and pile driving noise below regulatory levels indicate shifts in masked hearing over 20 dB and concurrent significant changes in cortisol levels. These results suggest that Cook Inlet acoustic disturbance below the 120 or 160 dB regulatory levels, occurring on a daily basis and for a large portion of the beluga critical habitat, affects beluga hearing capabilities and stress levels. This widespread disturbance has the potential to negatively affect vital acoustic related functions such as prey and predator detection, reproduction success and survival in general, and thus the recovery of this declining population. This spatial and temporal concentration of stressors and their cumulative effects in a subarctic population of belugas might well reflect the consequences of future changes in rapidly shifting arctic ecosystems.

Detecting the effects of seismic exploration on the behaviour of whales: what we've learned from bowheads and hope to learn about narwhals
Susanna Blackwell, Greeneridge Sciences, Inc.

One of the main challenges in assessing the effects of anthropogenic sounds on the behaviour of marine mammals is being able to match up the dose of anthropogenic sound of interest received by an animal with the reaction of the animal. Sounds of interest can include, for example, airgun pulses, vessel sounds, or construction sounds, and reactions of the animal include measurable behavioural or physiological parameters such as a change in the course of migration, a change in calling behaviour, or changes in heart rate or the level of stress hormones.

Two different ways to deal with the challenge of pairing up received sounds and animal reactions will be discussed below: first, by using particle velocity sensors to localized calling bowhead whales, and second by tagging narwhals with acoustic tags.
We investigated the effects of sounds from airgun pulses on migrating bowhead whales in a four-year study (2007–2010) in the Beaufort Sea, using data collected by 40 directional autonomous seafloor acoustic recorders (DASARs). The key to this study was the ability to localize the calling whales, for two important reasons: (1) it meant that we could restrict our samples to whales that were calling near the DASARs (within 2 km), where the probability of detection of a call was not dependent on background levels; (2) it meant that we could use the recorded levels of sound from airgun pulses at the DASARs as a proxy for received sound at the whales. Our results showed that bowhead whales modify their calling rates as a function of the received levels (RLs) of airgun sound. Compared to times when no airgun pulses were detected, whales called more when RLs were low and the seismic operations were distant (up to hundreds of km away). Fifty to 100 km from the seismic ship in our study, calling rates started decreasing, and within tens of km of the seismic ship the whales were virtually silent. The whales therefore showed a dual threshold of behavioural reaction to received sounds from airgun pulses: at low received levels they increased their calling rates, but beyond a certain threshold, calling rates dropped to zero.

We are planning to study the effects of sounds from airgun pulses on East Greenland narwhals, using a similar principle, but a different technology: acoustic recording tags (Acousondes™). At the cost of small sample sizes, such tags provide tremendous detail in the behaviour of the animals carrying them, including changes in vocalization and in three-dimensional diving behaviour (e.g., depth, stroking rates, etc.). Several deployments of acoustic tags have been performed on adult female narwhals in East Greenland since 2012. The tags have remained on the animals for several days, and have provided a wealth of information on diving behaviour, feeding behaviour, including echolocation and buzzing, and three-dimensional movement patterns.

Monitoring programs in Eclipse Sound: increased shipping and potential effects on narwhals

Kristin Westdal, Oceans North

Marine shipping traffic associated with the Baffinland iron ore mine off the north coast of Baffin Island in Nunavut Canada is a concern for northern residents that rely on the marine mammals of the region as part of a subsistence harvest. As of 2015, the mining operation has begun seasonal shipping of bulk ore in the open water season and now seeks to ship ten months of the year (June-March), breaking sea ice in Eclipse Sound in winter months starting in 2017.

This area is the summering ground of a portion of the estimated 60,000 narwhals that belong to the Baffin Bay narwhal population. The community of Pond Inlet and the regional Inuit Association (QIA) are interested in monitoring the narwhal population that summers in the area ahead of the shipping increases expected with the mine. Over the last two years Oceans North has been working with the Mittimatalik Hunters and Trappers Organization in Pond Inlet Nunavut and local community members to monitor ecological changes in the greater Lancaster Sound region.

The work has two components – monitoring effects of shipping on the summering narwhal population and monitoring and characterizing landfast ice covering Eclipse Sound before, during and after its break up in advance of proposed winter shipping. The first part of the monitoring program uses passive acoustic recording devices to determine presence of narwhals in the Milne Inlet area and reaction to ship traffic during the shipping season. Local hunters deployed and retrieved two devices in 2014 in Milne Inlet and four in 2015 in Eclipse Sound, Milne Inlet and Tremblay Sound. The second part of the program involves photographic monitoring of the Eclipse Sound floe edge before, during and after its break-up in late spring and early summer, by way of two autonomous time-lapse camera systems deployed on high lands on both sides of the eastern end of Eclipse Sound. Each system consists in an insulated box containing the camera and hardware powered by one battery and one solar panel. Equipment was brought on sites by snowmobiles in May, and recovered by boat and helicopter with the help of hunters from Pond Inlet.

Analysis of the photographic work and acoustic analysis of 2015 data is underway. Preliminary results from 2014 acoustic data suggest that narwhal respond to an increase in overall background noise by modifying some of their call parameters. In addition, preliminary findings indicate that in the presence of distinguishable anthropogenic noise (ships, small boats, and gun shots) narwhal acoustic detections were less frequent which may suggest that narwhal leave the area or go silent in the face of perceived threats.

Research in Svalbard related to human disturbance of marine mammals
Christian Lydersen and Kit M. Kovacs, Norwegian Polar Institute

The Norwegian Polar Institute (NPI) is conducting two long-term monitoring projects specifically related to potential human disturbance impacts on wildlife. One is focused on passive acoustic monitoring of ocean sounds and the other involves camera monitoring of selected walrus haul-out sites in Svalbard. Highlights of key preliminary findings are presented below.

AURALs (**A**utonomous **U**nderwater **R**ecorder for **A**coustic **L**istening) have been used to monitor underwater sound in the Svalbard area since 2008. Currently NPI has 4 of these instruments deployed, two offshore at continental slopes sites and two inside fjord-systems. These instruments are mounted on oceanographic rigs and sample sound from marine mammals and noise throughout the year. Key results include the documentation of airgun noise, which is present on a year-round basis with a peak in the summer season as far north as in the Fram Strait at about 79° N. A new Postdoctoral position started mid-2015 to analyze this vast dataset, from both an ocean noise perspective and in order to catalogue the seasonal presence of various marine mammal species, particularly the three Arctic endemic whale species.

Cameras have been used to monitor walrus haul-out behaviour at selected haul-out sites in Svalbard since 2007. The cameras (two at each site) are mounted at the top of a 5 m high mast with battery boxes and solar panels. Each camera takes one high quality picture each hour during the summer season when the animals use their terrestrial haul-out sites. More than 60,000 pictures from a total of 5 different haul-out sites have been collected thus far. The purpose of this monitoring is to study the natural dynamics in the haul-out pattern of walruses, and also to see whether this pattern is changed due to visitations by tourists. Data on visitations are available from statistics from the Governor in Svalbard, in addition to what we see of visitors on the pictures themselves. It is impossible to count the exact numbers of walruses hauled out at any given time because of the way the walruses haul-out, in dense groups almost on top of each other given the camera angles. However, dynamics with regards to how the group size increases and decreases is possible to detect, and it will be the trends in these relative measures that will be analyzed both for the general dynamics and possible effects of visitors. A quick analysis of the pictures indicates that very few, if any, of the visitations by tourists had any impact on the haul-out pattern. However, polar bear visitations at haul-out sites where walrus females and calves are present do have impacts on this behaviour. This database is currently being analyzed as part of an MSc thesis.

Pacific Walrus Population Response to Reduced Sea Ice and Human-caused Disturbance
Chadwick V. Jay, U.S. Geological Survey, Alaska Science Center

The Pacific walrus ranges throughout much of the Bering and Chukchi seas. In the Chukchi Sea, the extent of summertime sea ice has rapidly declined and periods of open water over the continental shelf have increased. The loss of sea ice has simultaneously caused a change in walrus distribution and habitat use and allowed greater access for human activities. Primarily due to concerns about the cumulative effects of sea ice loss on walruses, the U.S. Fish and Wildlife Service made an initial determination to list the species as threatened under the U.S. Endangered Species Act and will make a final listing determination in 2017. The effect of increased human activities such as air and ship traffic on the Pacific walrus population is unknown and might be best understood by using a modelling framework linking sea ice availability, energy expenditure, body condition, and walrus demography.

“Incidental Take Regulations” for walrus in Alaska
Christopher Putnam, US Fish and Wildlife Service
Abstract not available.

Disturbance of walrus in Greenland
Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources

Walruses in the North Atlantic have the most pertinent history of conflicts with human activities of all marine mammals. Several terrestrial haul-out sites were abandoned after the arrival of humans over a millennium ago. In West Greenland at least three haul-out sites were abandoned before 1900 and the last haul-out site was abandoned in 1954. In East Greenland several haul-out sites were abandoned after establishment of settlements and increased hunting pressure, whereas other more remote sites are still used by walruses. There are no signs of re-colonization of the terrestrial haul-out sites in areas where disturbances have been eliminated and it illustrates the extreme sensitivity of walruses to human activities. Today walruses in West Greenland use the shallow banks during winter for feeding and breeding, and the drifting pack-ice is used for haul-out. Hunting and fishing on the coastal banks constitute the main source of disturbances in this area and the prospects of shipping activities during winter with ice-breaking vessels along West Greenland is a potential new source of disturbance that will interfere with the walrus’ preference for the eastern part of Baffin Bay. In North Greenland the abandonment of a hunters’ settlement in Wolstenholme Fjord has reduced the disturbance of walruses at this important feeding ground at the same time as a reduction in fast-ice in spring has opened new shallow areas for feeding by walruses. In East Greenland walruses primarily occur in very remote areas, however tourists and cruise ships may with declining sea ice coverage reach these areas during summer. Current regulations require that tourists must keep a distance of 400m from walruses that are hauled out on land 75 m for walruses in water. Seismic investigations and shipping to and from mining areas also constitute potential sources of disturbance of walruses in East Greenland as well as in some areas in West Greenland.

Sound from oil industry activities – some research projects related to habitat modelling for risk assessment of acoustic disturbance and detectability of marine mammals as part of mitigation measures
Jürgen Weissenberger, Statoil, Norway

Underwater sound created by activities form oil industry during exploration and production contribute to the anthropogenic sound in the ocean. The potential impact of anthropogenic sound on marine mammals is topic of many research activities. Statoil has for many years conducted research that has strengthened the industries abilities to perform risk assessment of acoustic disturbance and also mitigate possible risks. One example of a larger effort is the joint industry program (JIP) involving several companies and vendors (JIP Sound and Marine Life) where audiograms of ice seals are produced, through studies performed at Long Marine Lab, Santa Cruz. Statoil has also conducted some sole projects to prepare for and ensure safe operations in assets we operate. Since marine mammals are highly mobile and move quickly, the probability of impact is therefore also determined by their own behaviour, e.g. by moving in or out of a sound field. As part of our preparation for operations in the Chukchi Sea (Alaska), Statoil developed a risk assessment modelling framework where the movement of marine mammals (beluga and walrus) was taken into account. Disturbance of subsistent hunt is one of the possible risks raised by the local communities related to our operations in Alaska. As part of the risk assessment study Statoil teamed up with three communities on the North Slope Alaska to learn more on behavioural reactions of marine mammals when exposed to sound stimuli. Statoil has also conducted work to improve marine mammal detection, ether during seismic surveys or as part of a scientific density estimate. Field trials have been conducted of two types of sophisticated IR cameras that showed promising results. We have also testes active acoustics. Examples and results of all these studies will be presented.

Recent relevant work on Human Disturbance on Arctic marine mammals within the IWC with emphasis on guidelines for responsible seismic survey practices
Greg Donovan, International Whaling Commission

Donovan presented a summary of recent IWC work related to human disturbance on cetaceans with a focus in the Arctic. There have been several relevant workshops since 2008, on climate change, ship strikes, marine debris (plastics, microplastics and abandoned and lost fishing gear), 'soundscape' modelling, spatial and habitat modelling, chemical pollution and one specifically on the Arctic (IWC, 2010; 2011; 2012; 2014; 2015; In press a, b, c). He focussed particularly on one (Reeves et al., in Press) that related to the potential impacts of predicted increases in marine activities in the Arctic at which NAMMCO was represented.

The workshop considered changes in the Arctic environment leading to changes in human activities there and aimed to (a) identify stakeholder concerns; (b) identify knowledge gaps in order to assist to prioritise threats and identify mitigation measures; and (c) assist in coordinating international efforts. In addition to industry perspectives, emphasis was given to the views of indigenous peoples. The primary potential threats to cetaceans identified were: oil and gas (noise, oil spills, leakage, habitat damage); shipping (strikes, noise, discharge and pathogens); fishing (entanglement, noise, prey depletion, habitat); and hunting (over-exploitation if not managed properly).

The following key scientific needs were identified: additional quantitative data and spatial modelling analysis (for cetaceans and humans) to identify high risk areas at the correct geographical and temporal scales; population level evaluation of 'non-direct' threats including uncertainty (such as used in the IWC's management procedure approach); and the development of methods to examine synergistic and cumulative effects. Emphasis was placed on the need for collaborative and pragmatic recommendations with respect to data requirements and monitoring for the Arctic region.

It was recognised that cetacean organisations such as the IWC (and NAMMCO) could not effectively address these issues in isolation. Collaboration with existing initiatives (e.g. Arctic Council; IMO; FAO; CBD; national bodies and industry) was required to ensure that cetacean 'interests' were included. This requires increased communication and data sharing with those involved in existing and new developments in the Arctic, and with indigenous people.

Stakeholders stressed the need for common standards across the Arctic with respect to: environmental impact assessments; mitigation measures and ensuring compliance/ effectiveness; collaborative research programmes to assess threats, develop mitigation and monitor populations; common resources/plans to deal with catastrophic events such as oil spills; and common agreements on conflicting activities. Successful mitigation must be based upon robust science and agreed objectives but it is also dependent upon early stakeholder participation in the process from an early stage with respect to identifying problems, priorities, mitigation measures and compliance.

Finally, Donovan referred to the guidelines for seismic surveys that had been developed in Nowacek et al.(2013) which have been adopted by IUCN and the IWC.

Shipping disturbance impacts on ice-breeding seals: research from the Caspian Sea

Susan C. Wilson[1], Evgeniya Dolgova[2], Irina Trukhanova[3], Lilia Dmitrieva[4], Imogen Crawford[1] and Simon J. Goodman[4]

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Icebreaker operations in the Arctic and other areas are increasing rapidly to support new industrial activities and shipping routes, but the impact on marine mammals in these habitats is poorly explored. We present the first quantitative study of icebreakers transiting the habitat of an ice-breeding seal and evaluation of potential mitigation measures. Vessel impacts were recorded during seven ice seasons 2006-2013, for Caspian seals (*Pusa caspica*) breeding on the winter ice-field of the Caspian Sea. Impacts included vessel-seal collisions, breakage of birth or nursery sites, displacement of mothers and pups, mother-pup separation and pups being wetted or forced into the water. Separation distances of pups from mothers were greatest for seals less than 30m from the vessel path, and collisions and other events were significantly more frequent at night. Vessel cruising speeds above 4 knots increased the relative risk of mother-pup separation and collisions 1.77 and 6.4 times respectively. A cruising speed limit of 3.5kn is therefore recommended while traversing seal breeding areas, and thermal imaging equipment is essential for night-time transits. This study in the Caspian provides a template for determining and quantifying types of impact on different ice-breeding pinniped species from larger vessels operating in Arctic habitats.

Evidence-based mitigation of shipping disturbance of ice-breeding seals: experience from the Caspian Sea

Lilia Dmitrieva[1], Susan C. Wilson[2], Evgeniya Dolgova[3], Irina Trukhanova[4], Imogen Crawford[2] and Simon J. Goodman[1]

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Ice breaker transit through ice breeding seal habitat has potential to cause direct physical impacts and habitat disruption. Such impacts can be avoided or reduced by a mitigation hierarchy including logistics strategies to reduce icebreaker usage during critical periods (e.g. breeding seasons), and route planning to avoid transits through sensitive habitat areas.
To ensure the most effective seal mitigation vessel route planning it is important to develop practical systems of data collection for seal distributions in vessel corridors. We present a

system for industrial icebreaker route planning, which has been developed for the Caspian Sea over the last 9 years, based on an integrated approach to seal observation data from both the aerial survey and vessel based observations. Data collection and mitigation attempts were carried out during the Caspian seal breeding season which extends from late January to early March each year in the Kazakh sector of the northern Caspian Sea.

In this system, trained seal observers (SOs) on each icebreaker collect data on seal presence and vessel/seal encounters along the vessel route, while aerial surveys of the vessel navigation corridor area are conducted regularly throughout the breeding season. Data are used to generate qualitative Seal Index maps for breeding seal density, on rapid turn-around - daily from vessel data and within 2-3 hrs after completion of aerial surveys.

The maps are transferred to ice charts as overlays, giving seal warning zones coloured according to seal density and potential for negative vessel impacts. Maps may be used by logistics officers to plan routes avoiding seal aggregations and to issue navigation advisories. Seal warning charts can be updated on a daily basis according to new seal data received and ice conditions, and distributed to vessels and other Parties along with route advisories.

Emergency reports on locations of large seals colonies are immediately transmitted to all vessels on the route to ensure quick response and prevent further disturbance of the colony. End-of-trip summary impact assessment reports on all vessel-seal encounters during the trip are provided by SOs for quantitative route planning success assessments, and demonstration of impact reduction against specified mitigation targets.

Towards a quantitative risk assessment framework for icebreaker impacts on Holarctic pinnipeds

Simon J. Goodman[1], Irina Trukhanova[2], Evgeniya Dolgova[3], Imogen Crawford[4], Lilia Dmitrieva[1], and Susan C. Wilson[4]

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Traffic from tanker, cargo, industrial support and cruise ships is increasing in Arctic waters, driven by expansion of oil and gas industry related activity, mineral extraction, tourism, and the opening of new trans-polar shipping routes allowed by reduce sea-ice cover. This rapid escalation in shipping is predicted to lead to increased physical interactions with ice-bound marine mammals. While noise impacts from shipping on marine mammals, particularly cetaceans, have been a concern for some time, understanding of direct impacts on species and ice habitats of pinnipeds is in its infancy.

Here we present a risk assessment framework incorporating life history, ecological and behavioural traits, together with spatial information on the distribution of ten Holarctic pinniped species, shipping traffic and industrial infrastructure, in four main Arctic transport routes, Alaskan coastal waters, the Baltic and the Caspian. This can be used to identify species, habitats, locations and seasons sensitive to impacts from shipping traffic, highlight where further research is required and guide development of mitigation measures and policy.

Direct vessel impacts include not only fatal collisions, but also separation and displacement of mother-pups pairs, wetting of lanugo pups and disruption of ice habitats, which may impose stress and energetic costs also leading to mortality. Life history and behavioural traits predisposing to vulnerability include sedentary pupping on ice, lanugo pups at pre-aquatic stage, short flight distance, maternal foraging during lactation, and subnivean lairs. An impact mitigation hierarchy should include 1) Logistical planning to avoid the need for icebreakers in high risk areas/seasons, 2) pre-planning of routes to avoid aggregations of vulnerable animals; 3) Using marine mammal observers to document route planning success and vessel interactions with animals and to advise crews on avoidance of direct impacts when 1 and 2 fail. Mitigation measures must have measurable indicators in order to demonstrate reduction of impacts against stakeholder targets.

The effect of whale watching and whaling in Nuuk Fjord, West Greenland
Tenna Boye, Malene Simon and Lars Witting
Greenland Institute of Natural Resources

Photo-identifications of humpback whales in the Godthaabsfjord area were collected from 2007 to 2012 and divided into individuals and number of sightings per individual. Monte Carlo simulations were performed on the sighting distributions of individual humpback whales to investigate the potential impact that local removals (e.g. ship strikes, subsistence hunt) could have on the sighting rate of humpback whales in Godthaabsfjord. Half of the sightings were based on the same six individuals during the six-year period. Sighting rate was likely to drop regardless of when (spring, summer or autumn) an individual was removed due to the large degree of site fidelity of several humpback whales in Godthaabsfjord. Removals could affect the whalewatching industry in Godthaabsfjord where humpback whales constitute a key species. The least impact may be achieved by conducting the hunt outside the fjord system or minimising summer or autumn hunts within the fjord, as spring removals tend to have the least effect on summer sighting rates.

Effects of wildlife watching tourism on Arctic marine mammals, with a special note on harbour seal watching in Iceland
Sandra M. Granquist[1,2]

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The interest for wildlife watching activities such as whale- and seal watching is widely increasing and has spread to new remote Arctic locations. More accessibility to those regions due to climate change has been considered as a contributing factor to this development. However, negative effects due to anthropogenic disturbance, including wildlife tourism, have often been described in the literature. Such disturbance can result in changes of the natural behaviour and distribution of the animals, which in some cases can have severe effects on general fitness and reproduction. Never the less, marine mammal watching is often economically important to stakeholders and society, resulting in a need to balance the use and protection of marine mammal species. In this talk, effects on marine mammals due to wildlife tourism will be summarized and results from a case study on the effect of land-based seal watching on harbour seals in Iceland will be presented. The seals were found to change their distribution and be more vigilant during periods with high tourist presence. However, disturbance depended on the behaviour of tourists and was lower when tourists behaved in a calm way. The necessity of interdisciplinary co-operations to reach sustainable management strategies to reduce negative impact due to marine mammal tourism is underlined. Since the behaviour of individual tourists and the approach of tourist operators play important roles in reducing negative impact on the wild animals, education should be implemented, preferably through codes of conducts on how to behave in the presence of marine mammals. A worldwide overview of existing codes of conduct for seal watching is presented. Developing an international recognized seal watching code of conduct is suggested and important factors to consider during this development will be discussed.

Physiological and behavioural observations to assess the influence of vessel encounters on harbour seals
Shawna Karpovich, Alaska Department of Fish and Game

In southeast Alaska, USA, harbour seals *(Phoca vitulina*) were fitted with data loggers to measured diving behaviours and heart rates in response to vessels. A complex assortment of factors, other than disturbance, affected heart rates and careful consideration of these factors must be included in disturbance studies. Changes in harbour seal heart rates were examined in response to two levels of vessel disturbances; 'incidental traffic' defined as presence of vessels in the area while seals were hauled out; and 'experimental disturbance' defined as direct vessel approaches to seals until the seal entered the water. In response to incidental traffic, heart rate increased by up to 4 bpm per vessel while seals were hauled out, and small vessels caused the largest increase in heart rate. Experimental disturbances resulted in a 5 bpm increase in heart rate upon the head-lift behaviour. In-water heart rate was significantly lower after an experimental disturbance compared to other water entries, indicating a shift to an energetically conservative mode in response to these disturbances. During the haulout following an experimental disturbance, seal heart rate was significantly higher than other haulouts, suggesting that there is an added energetic cost of disturbance. Furthermore, the average time between haulouts was 12 ± 5 hours indicating that the energetic disruption incurred during a disturbance persists over an extended period. Whereas previous findings have shown that vessel encounters alter seal behaviour, this study presents evidence that encounters have energetic and physiological consequences while the seals are hauled out and these consequences persist long after the water entry behaviour. Accordingly, exposure of harbour seals to increased vessel traffic may result in altered behaviour, increased energetic expenditures, and increased exposure to stress, negatively affecting the health, condition, and reproductive success of harbour seal populations that reside in glacial fjords.

Heart rate studies are time consuming, expensive, and may not be feasible in some situations. Therefore, we present whisker hormone analysis as an alternate method to measure the influence of disturbances. Whiskers are composed of keratin and steroid hormones are incorporated into the whisker as it grows. To date, both cortisol (stress hormone) and progesterone (reproductive hormone) have been measured in harbour seal whiskers highlighting the utility of whiskers to assess physiological impacts of potential stressors. Further, analysis of serial sections of whiskers may provide insight into changes of steroid hormones in response to stress and reproduction over time.

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Programme

Tuesday, 13 October

1300 **Jill Prewitt** — *Welcome from NAMMCO*

1305 **Mads Peter Heide-Jørgensen** — *Status of selected Arctic marine mammals*

1330 **Kit M. Kovacs** — *Concerns and opportunities*

Case Studies

1400 **Cormac Booth** — *Oceans of noise: Assessing risks to marine mammals in the face of uncertainty.*

1420 **Veronique Lesage** — *Consequences of speed limits and partial rerouting of shipping traffic on habitat acoustic quality and beluga exposure to noise pollution in the St. Lawrence Estuary, Canada: Science in support of risk management.*

1440 **Marianne Marcoux** — *Overview of the Department of Fisheries and Oceans' comments on the environmental impact statement of Baffinland's Mary River Project*

1500 *Coffee*

1530 **Peter Ewins** — *Hudson Strait: a case study with the shipping industry*

1615–1700 Discussion

1730-1900 (or later) Evening Event: Icebreaker with light food and drink

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Wednesday, 14 October

0900 **Rikke Guldborg Hansen** — *Monitoring narwhals in Melville Bay in relation to seismic surveys*

0930 **Mads Peter Heide-Jørgensen** — *The narwhal's sense of silence*

0950 **Rod Hobbs** — *Cook Inlet beluga Abundance, Distribution and Potential Sources of Disturbance*

1010 **Manuel Castellote** — *Anthropogenic noise on Cook Inlet and Bristol Bay beluga habitat: potential for negative effects*

1030 *Coffee*

1100 **Susanna Blackwell** — *Detecting the effects of seismic exploration on the behaviour of whales: what we've learned from bowheads and hope to learn about narwhals*

1120 **Kristin Westdal** — *Monitoring programs in Eclipse Sound: increased shipping and potential effects on narwhal*

1140 **Christian Lydersen** — *Research in Svalbard related to human disturbance of marine mammals*

1200–1330 *Lunch*

1330 **Chad Jay** — *Pacific Walrus Population Response to Reduced Sea Ice and Human-caused Disturbance*

1350 **Christopher Putnam —** Title to come, topic: "Incidental Take Regulations" for walrus in Alaska

1420 **Mads Peter Heide-Jørgensen** — *Hunting and disturbance of walrus in Greenland*

1440 *Coffee*

1500 **Jürgen Weissenberger** — *Sound from oil industry activities – some research projects related to habitat modelling for risk assessment of acoustic disturbance and detectability of marine mammals as part of mitigation measures.*

1530 **Greg Donovan —** *Recent relevant work on Human Disturbance on Arctic marine mammals within the IWC with emphasis on guidelines for responsible seismic survey practices.*

1600–1700 Discussion Session

Thursday 15 October

0900 **Sue Wilson** — *Shipping disturbance impacts on ice-breeding seals: research from the Caspian Sea*

0930 **Evgeniya Dolgova** — *Evidence-based mitigation of shipping disturbance of ice-breeding seals: experience from the Caspian Sea*

1000-1015 *Video from Dolgova*

1015 **Simon Goodman** — *Towards a risk assessment for shipping disturbance of Arctic ice-breeding pinnipeds and associated conservation strategy to be developed*

1045 *Coffee*

1100 **Tenna Boye —** *The effect of whale watching and whaling in Nuuk fjord, West Greenland*

1120 **Sandra Granquist —** *Effects of wildlife watching tourism on Arctic marine mammals, with a special note on harbour seal watching in Iceland*

1140 **Shawna Karpovich —** *Physiological and behavioural observations to assess the influence of vessel encounters on harbour seals*

1200-1330 Lunch

1330 **Randy Reeves** — *Concerns, Evidence, Approaches to Mitigation, and Research Needs Related to Human Disturbance of Belugas, Narwhals and Walruses*

1415-1500 Discussion, Part 1

1500-1515 *Quick coffee*

1515-1630 Discussion, Part 2: Finalise lists of risks/research priorities/mitigation priorities

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