Report of the NAMMCO Scientific Committee Working Group on Harbour Porpoise

19-22 March 2019

Faroes Representation, Copenhagen

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EXECUTIVE SUMMARY

The NAMMCO Working Group on Harbour Porpoise met at the Faroes Representation in Copenhagen 19-22 March 2019. The meeting was chaired by Bjarni Mikkelsen (FO). This meeting was the second of the working group (WG) and followed an international workshop on the status of harbour porpoises in the North Atlantic (Tromsø WS) co-organised by NAMMCO in December 2018. Updates on the recommendations from the first WG were provided and the draft report from the Tromsø WS reviewed.

The *Terms of Reference* for this meeting were: a) Conduct an assessment of the sustainability of the harvest of harbour porpoise in West Greenland; b) Review assessments performed in other areas by the 2018 workshop; c) Identify knowledge gaps and needs for further research; d) Assess impacts from non-hunting related anthropogenic stresses (pollution, climate change, noise etc).

Review of the Tromsø Workshop on the Status of Harbour Porpoise in the North Atlantic

The WG reviewed a draft report of the 2018 Tromsø workshop (Tromsø WS). The report provided information on recent research regarding stock identity, lethal and sub-lethal pressures, feeding ecology, life history and population models. It also presented assessments of the status of harbour porpoises in Eastern USA, Eastern Canada, Iceland, Faroe Islands, Norwegian & Russian Coasts, West Scotland/Ireland and Celtic/Irish Seas, North Sea, Belt Sea (and adjacent waters), Baltic Proper, Iberian Peninsula, and North-West Africa.

A presentation summarising genetic analyses related to stock identity was given and the map of assessment units proposed during the Tromsø WS discussed (Figure 2 in main report).

The modelling and assessment method used during the Tromsø WS was reviewed. Some technical concerns were raised and it was agreed that due to limited data, not all assessments were reliable for generating management advice, although all usefully highlighted knowledge gaps that need to be addressed.

The WG **concluded** that the Tromsø WS did not have sufficient time to perform in-depth reviews and that further analysis was required to deliver formal assessments for providing management advice.

West Greenland Assessment

Stock identity

A working paper on genomic divergence and behavioural adaptations of harbour porpoise in West Greenland found no significant genetic differentiation between porpoises from the Gulf of St. Lawrence, Newfoundland and Iceland, however there was a clear isolation of West Greenland porpoises from those in Iceland and Canada. There is a genetic signature in the Greenlandic population indicating a link to the wider North Atlantic population, but since it is not currently possible to determine if this stems from a shared historical origin or recent mixing, it would be beneficial to tag and track harbour porpoises from Iceland and Canada. There was not enough evidence to indicate two distinct populations in East and West Greenland that have to be assessed separately, or any evidence that the East Greenland population is linked to Iceland or Norway. Further tagging efforts and samples from East Greenland porpoises would be informative for determining stock identity.

The WG **recommended** that the genetically differentiated porpoises with site fidelity to West Greenland be recognised as a *sub-population*, and this be advanced within the IUCN. It was noted that a range of supporting data would be necessary to identify this as a distinct *species/sub-species*, which would require further research.

Biological parameters

A working paper on life history parameters of harbour porpoises sampled from the Inuit hunt in West Greenland over two decades showed mature female porpoises from 2009 had an increased body condition compared to 1995 and 2014, potentially linked to fluctuations in sea temperature. Both males and females showed seasonal increase in mass, length, age, and proportion of mature animals, suggesting that young females are the first to arrive in coastal areas of West Greenland in June-July, with mature animals around July–August. The reported age at sexual maturity appeared lower and pregnancy rates higher in West Greenland than other European areas. This may be explained by the North Sea population being close to carrying capacity. Harbour porpoises in West Greenland may be particularly sensitive to ecosystem level changes because the number of prey species may be limited and subject to more extreme fluctuations in productivity.

Abundance estimation

Abundance estimates were generated from two aerial surveys conducted by the Greenland Institute of Natural Resources in 2007 (West Greenland only) and 2015 (West and East Greenland). These estimates did not, however, include the porpoises not present in the strata at the time of the survey. Information from satellite tracking of 26 harbour porpoises in Greenland was therefore used to correct the estimate with the proportion of porpoises expected to be outside the survey strata. This gave fully corrected abundance estimates of 69.595 porpoises (cv=0.37; 95% CI: 34.689-139.624) for 2007 and 106.822 (cv=0.35, 95% CI: 55.149-206.909) for 2015. These corrected estimates were used in the assessment.

Catch numbers

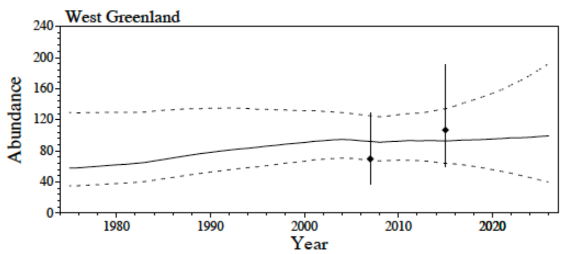
A working paper on catch statistics in Greenland described a discrepancy between catches reported in the official Piniarneq system and those reported by hunters during interviews, revealing both under- and non-reporting and a tendency for hunters to report less in Piniarneq. The WG **agreed** that correction factors needed to be applied to the official reports, with several different approaches proposed and extensively discussed.

The WG **agreed** that it was useful to divide the interview data into categories of under-reporting and non-reporting. It also **agreed** that hunters reporting catches during interviews but 0 in the Piniarneq system would be included in the non-reporting category. It **agreed** to handle West Greenland as a whole and not create correction factors particular to certain areas. The WG also **agreed** that hunters that did not fit the general pattern would be treated as outliers and removed from the analysis. Since catches appear to be lower for those not reporting than those under-reporting, the WG **agreed** to base the correction factor for non-reporting on the proportion of catch numbers rather than the number of hunters. Since the current reporting system was implemented in 1993, the WG **agreed** that the reported catches from 1993 onwards would be corrected for the documented underreporting. Furthermore, it **agreed** to multiply the complete time series of landed catches by 1.103 to account for struck and lost and to add by-catch from 1965 to 1982 to obtain a time series of best estimates of total removals for use in the assessment.

The results of these decisions are represented in the categorisation and calculation of correction factors presented in Table 2 of the main report.

Population modelling & assessment

The WG used the two area corrected abundance estimates, the corrected estimate of catch history, and age-structure data from four periods for Bayesian assessment runs of harbour porpoises in West Greenland. The modelling showed a relatively stable population (see Figure 3 in main report, reproduced below).



The projection of West Greenland harbour porpoises from the agreed assessment. The solid curve is the median, the dotted lines the 90% credibility intervals, and the dots with bars the agreed abundance estimates and their 90 % confidence interval.

Although some of the biological factors indicated by the model were surprising, no significant bias in the input data could be identified. The abundance surveys were not specifically targeting harbour porpoises, but this was not seen as significantly altering the model outcomes. The WG therefore **agreed** to accept the assessment.

Management advice and recommendations

The trade-off between total removals and probability of population increase is shown in Table 3 of the main report. The estimated annual total removal allowing for a 70% chance of population increase is 2,900. After correction for struck and lost, this corresponds to a total landed catch of 2,629. With correction for under-reporting, the catch expected to be reported for a total removal of 2,900 would be no more than 1,869. The large difference between the recommended catch of no more than 2,629 and an expected reported catch of 1,869 meant the WG **strongly recommended** Greenland work to validate the catch statistics.

Review of Assessments Performed in Other Areas during the 2018 Tromsø Workshop

The recommendations for each country from the assessments are collated at the end of the executive summary.

NORWAY

The assessment performed for Norway during the Tromsø WS was discussed. Genetic studies have corroborated the existence of one panmictic population of harbour porpoises in Norwegian waters. Data gathering on biological parameters remains ongoing, with samples collected from by-caught animals. Progress has been made towards reliable by-catch data and estimates but work remains ongoing, with extrapolation from the reference fleet still being addressed. Experiments in by-catch mitigation through acoustic deterrents (pingers) was described.

An update on the 2018 Norwegian fjords survey and progress in estimating abundance from older survey cycles was given, with final estimates expected by the end of 2019.

The assessment performed at the Tromsø WS indicated a slow decline in harbour porpoises in the area. However, the lack of information on by-catch before 2005 and the availability of only one abundance estimate meant that the WG did not see the assessment as allowing reliable conclusions to be drawn.

ICELAND

The assessment for Iceland made during the Tromsø WS was discussed. Although there are indications that the Icelandic population is part of a larger North Atlantic one, for pragmatic reasons a separate assessment was carried out. There was a significant effort in the 1990s to collect samples for analysis of biological parameters and payments are still being offered to fishermen for genetic samples from by-caught animals. Analysis of all sampling efforts is planned to be finalised at the end of 2019.

One absolute abundance estimate from a harbour porpoise survey in 2007 is available (although should be treated with caution since the aerial survey covered an unknown fraction of the area of distribution). Two relative abundance estimates from genetic close-kin analysis were also used in the assessment. The WG **agreed** it was not clear whether it was appropriate to use close-kin genetic analysis and that appropriate expertise to provide a sufficiently competent review of this as an approach for estimating abundance was lacking.

Direct hunting of harbour porpoises is not widespread in Iceland but there is significant by-catch, particularly in cod gillnet and lumpfish fisheries. Efforts to reliably estimate the extent of this by-catch are ongoing.

The WG reran the population model with some changes and **agreed** that although there was sufficient information available to run the same model for Iceland as used for Greenland, it would require more time.

After reviewing the assessment and noting the recent decline in by-catch, the WG **agreed** that there was no specific cause for concern for harbour porpoises in Iceland. However, they also **concluded** that the lack of time and expertise meant they were not in a position to provide management advice on sustainable removals.

FAROE ISLANDS

The Faroe Islands assessment from the Tromsø WS was discussed. Due to a lack of recent data, stock identity remained unclear. One genetic study indicated no separation from the larger North Atlantic population, but the Tromsø WS decided that the Faroes should be assessed as a separate area until more information is available. Biological parameters were presented.

A dedicated harbour porpoise aerial abundance survey from 2010 was available but should be considered a minimum because it only covered the area inside the 300 meters depth contour, one strata was excluded due to poor coverage, and an unknown proportion was expected to be outside the survey area.

Harbour porpoises are not protected in the Faroes but there is also no tradition to hunt them so the level of removals is likely low. By-catch is likely a rare event due to the absence of gillnet fisheries in shallow waters.

There was not enough data available to perform population modelling during the Tromsø WS.

Impacts from Anthropogenic Stressors

A general overview of the work done on anthropogenic stressors during the Tromsø WS was provided and an invited expert presentation on recent research relating to disturbance to harbour porpoises from noise given. This presentation included an outline of models available to examine cumulative impacts from various man-made disturbances and predict population development under different future scenarios.

The WG noted that specific monitoring of all the different threats is not being performed and that further research on life history parameters and dietary shifts from existing samples may be a relevant approach to investigate these impacts further. Although it was recognised that stressors may be having an impact on an individual level, the WG did not see indications that these stressors were having an impact on a population level. The WG **concluded** that the impact of the hunt in Greenland is stronger than any potential impacts from non-lethal stressors at current levels.

Recommendations for Research

- Each assessment area should provide samples to support the development of a multi-dimensional investigation into population structure and stock identity and allow for all existing datasets to be merged into a common analysis.

FAROE ISLANDS

- To allow an assessment to be conducted, work should be done to: a) obtain reliable removals data, b) update the abundance survey, and c) tag animals to gain a better idea of movements and seasonal occurrence.

GREENLAND

- The research necessary to identify a potential sub-species in West Greenland should be carried out. This may require as a minimum a combination of genetic analysis, morphometrics, and tracking data.
- A follow up study should be conducted to investigate how widespread the underreporting of catches in the official Piniarneq system in Greenland is.
- Hunters in East Greenland should be asked to provide samples to scientists when harbour porpoises are caught.

ICELAND

- By-catch estimates should be finalised and endorsed.
- Information on life history and various biological parameters should be updated.
- Tagging studies should be conducted to assist in the definition of stock identity

NORWAY

- By-catch estimates should be finalised and endorsed and this should include efforts to investigate the potential to extrapolate by-catch further back in time.
- The ongoing work to establish another abundance estimate that includes the fjord systems should be continued.
- Further information on harbour porpoise movements is required and therefore tagging and tracking studies should be conducted along the coastline to help answer questions about stock identity and consider if smaller management units are necessary.

Recommendations for Conservation and Management

- Given the importance for assessment of having a reliable timeseries of abundance estimates, survey efforts across the areas should be coordinated.

GREENLAND

- A West Greenland sub-population should be recognised and this taken forward within the IUCN system.
- The assessment should be updated as soon as a new abundance estimate is available and no later than 10 years from now.
- Catch statistics (in both East and West Greenland) should be validated.

ICELAND

- A formal assessment should be conducted following a full review of the available data, including the approach of using close-kinship genetic analysis to arrive at abundance estimates.

NORWAY

- A formal assessment with updated by-catch estimates should be conducted when new abundances estimates become available.
- The reference fleet should be expanded as part of an effort to obtain reliable by-catch estimates.

MAIN REPORT

The NAMMCO Scientific Committee Working Group on Harbour Porpoise (*Phocoena phocoena*) met at the Faroes Representation in Copenhagen from 19-22 March 2019. The Working Group (WG) was chaired by Bjarni Mikkelsen (FO). The agenda and list of participants are available in Appendix 1 and 2.

1 CHAIRMAN WELCOME AND OPENING REMARKS

The Chair Bjarni Mikkelsen welcomed participants to the meeting and thanked the Faroes Representation for hosting the event. The Chair particularly welcomed the invited external experts and a round of introductions was made. Background information on the NAMMCO Scientific Committee (SC) was provided, highlighting how the SC responds to requests from the Council and can establish working groups when this is deemed necessary to provide sound scientific advice for management. The requests from the NAMMCO Council relevant for this meeting of the harbour porpoise working group (HPWG) were noted as:

Request 1.1.5

To periodically review and update available knowledge related to the understanding of interactions between marine mammals and commercially exploited marine resources.

Request 1.2.2

In relation to the importance of the further development of multispecies approaches to the management of marine resources, to monitor stock levels and trends in stocks of all marine mammals in the North Atlantic.

Request 1.5.4

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

It was also noted that the 24th meeting of the Scientific Committee recommended that all "future working groups consider request 1.5.4, for example by adding non-hunting impacts to their agendas*"* (see section 7.3.1 of the SC 24 report).

Request 3.10.1

The Council noted that the harbour porpoise is common to all NAMMCO member countries, and that the extent of current research activities and expertise in member countries and elsewhere across the North Atlantic would provide an excellent basis for undertaking a comprehensive assessment of the species throughout its range. The Council therefore requested the SC to perform such an assessment, which might include distribution and abundance, stock identity, biological parameters, ecological interaction, pollutants, removals and sustainability of removals.

The Chair noted that this was the second meeting of the NAMMCO HPWG, the first being held in 2013 (report available as SC 26/HPWG/FI01). The Chair noted that the first WG meeting had particularly highlighted issues related to by-catch and reliable removal statistics. He acknowledged that during the interim period significant work and progress had been made on this issue by the NAMMCO working group on by-catch.

Mikkelsen also highlighted that NAMMCO has organised two international symposia on harbour porpoises. The first was held in 1999 and lead to the publication of Volume 5 of the NAMMCO *Scientific Publications*, which was published in 2003. The second was an international workshop (co-organised with the Norwegian Institute of Marine Research) on the status of harbour porpoises in the North Atlantic, in Tromsø December 2018 (Tromsø WS). The draft report from this Tromsø WS was available to the WG as SC/26/HPWG/04.

Finally, the Terms of Reference (ToR) for this WG were presented as:

- Conduct an assessment of the sustainability of the harvest of harbour porpoise in West Greenland;
- Review assessments performed in other areas by the NAMMCO Harbour Porpoise Workshop in 2018;
- Identify knowledge gaps and needs for further research;
- Assess impacts from non-hunting related anthropogenic stresses (pollution, climate change, noise etc).

2 ADOPTION OF AGENDA

Before the agenda was adopted, the Chair noted that agenda item 4.1 (presenting information from the Tromsø WS) was potentially relevant for several other agenda items so some level of moving back and forth between items would be necessary.

The level of detail that could be addressed under agenda items 6, 7, 8 (the assessments performed for Norway, Iceland and the Faroe Islands during the Tromsø WS) was discussed. That the HPWG could go through each of these assessments in detail was assumed to be too ambitious. It was proposed to defer the review of these assessments until the next SC meeting. It was not considered standard procedure for WGs to review documents from other groups and questions were raised about the availability of the primary and raw data used in the assessments. Although it was clarified that the primary data was available as Annexes to the Tromsø WS report, it was not deemed realistic that this information could be reviewed in depth during the time available.

Although it was appreciated that NAMMCO WGs are typically focused on performing work rather than simply reviewing work done by others, it was also acknowledged that the ToR for the WG were agreed by the SC and included reviewing the assessments generated during the Tromsø WS. The group therefore agreed to review the assessments performed during the WS and to allow comments to be made on this beyond simply endorsing the assessments or not. However, since it seemed unlikely that the review could take place at the level of detail indicated by the draft agenda, it was agreed that the report would be structured according to an overarching heading of "Review of Assessments Performed in Other Areas during the 2018 Tromsø Workshop" and that the level of detail provided below this would reflect what was achievable in the time available.

Accepting these points, the agenda for the meeting was adopted.

3 APPOINTMENT OF RAPPORTEURS

NAMMCO Scientific Secretary Fern Wickson was appointed as the primary rapporteur, with all participants agreeing to provide summaries of information presented where relevant.

4 REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

A list of the meeting documents is available in Appendix 3 of this report. All documents were available to the group through the NAMMCO website.

4.1 <u>2018 Harbour Porpoise Workshop (Tromsø WS)</u>

Mikkelsen presented a summary of the results of the Tromsø WS. He highlighted the objectives of the WS, the topics covered, and the range of participants present.

4.1.1 Stock identity

Tange Olsen gave a presentation that summarised the published literature on genetic analyses related to stock identity, together with the information presented on this topic at the Tromsø WS.

Presenter's Summary

<u>North East Atlantic</u>

The population structure in the Northeast Atlantic has been thoroughly assessed in a series of studies genotyping 10 microsatellite markers and ~5000 bp of the mitogenome in 100s of animals (Fontaine et al., 2007, 2014, 2012, 2010). The general consensus is the existence of separate populations in the Black Sea, Iberia and Mauritania, respectively, and a large coherent population ranging from Iceland to northern Norway and down to the southern North Sea. A recent study substantially increasing the sample size from the UK indicates a hybrid zone between the North Atlantic and Iberia population in the southwestern UK (Fontaine et al., 2017).

<u>North Sea – Baltic Sea Transition</u>

Numerous studies have examined the degree of population structure in the North Sea-Baltic Sea region (Andersen et al., 2001; Lah et al., 2016; Tiedemann, Harder, Gmeiner, & Hasse, 1996; Wiemann et al., 2010), all suggesting a Belt Sea population in inner Danish waters that is separate from the general North Atlantic population in the North Sea/Skagerrak region. There is still some uncertainty regarding the existence of a small breeding population in the inner Baltic Sea south of Gotland (www.sambah.org), but a recent study using 13 microsatellites and 2872 SNPs indicates that it is genetically isolated from the Belt Sea population (Lah et al., 2016). However, confirmation of this is pending further analyses.

<u>North West Atlantic</u>
The population structure in the North West Atlantic was recently examined by Nielsen et al. (in prep), genotyping 1023 SNPs in 68 animals from Iceland, Canada and West Greenland. The results strongly suggest that porpoises in West Greenland exhibit a high degree of site fidelity during the summer and are genetically differentiated from animals in Canada and Iceland. Further south, ongoing genetic analyses suggest that the harbour porpoises ranging along the North American mainland from Canada to Florida, USA, comprise a coherent population characterized by genetic isolation by distance (Fontaine, personal communication).

Taken together, the genetic analyses suggest the existence of a large North Atlantic population spanning from Florida, USA, to northern Norway and the North Sea. This population is likely not panmictic, but rather characterised by genetic isolation by distance and likely has such a large effective population size that putative demographically independent subpopulations have not yet genetically differentiated. In addition to this core North Atlantic population (shown in blue), harbour porpoises have split out into several genetically isolated populations at the periphery of the range, including West Greenland (green), Belt Sea (purple), Black Sea (red), Iberia (yellow), Mauritania (orange) and possibly the Baltic Sea (Figure 1). Ongoing analyses of mitochondrial and nuclear genomes will shed further light on the putative subspecies status of these populations and address the uncertainties associated with population structure for the inner Baltic Sea, Norway and along the North American mainland.

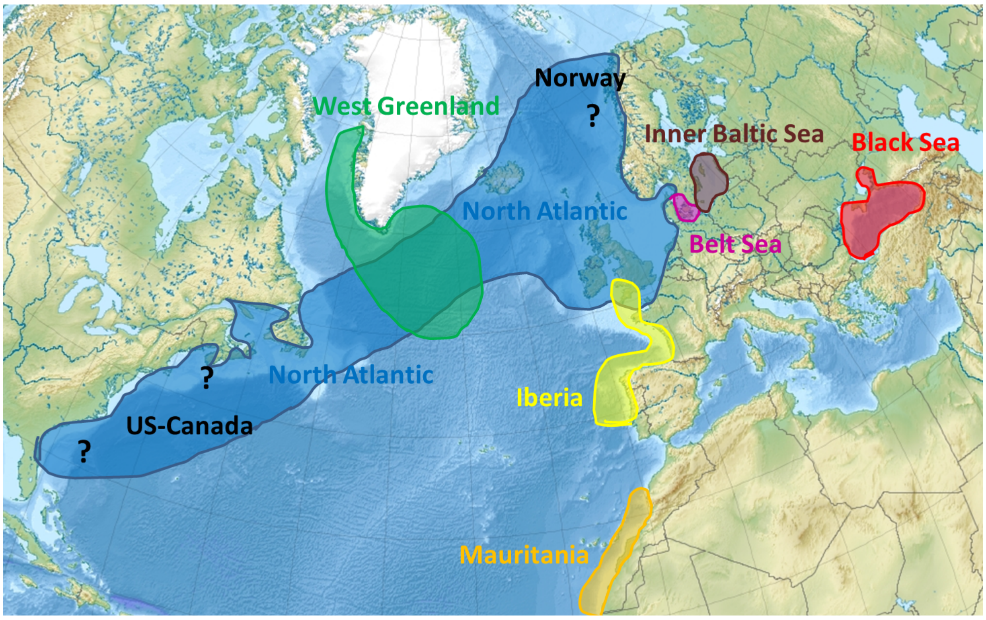


Figure 1. Summary of genetic populations identified to date, as well as areas/populations pending further genetic analyses

4.1.2 Map of assessment units produced during the Tromsø WS

The question of stock identity and the development of a map of assessment areas was presented by Mikkelsen as one of the primary outcomes of the Tromsø WS. The map of assessment areas proposed by the Tromsø WS is reproduced here in Figure 2.

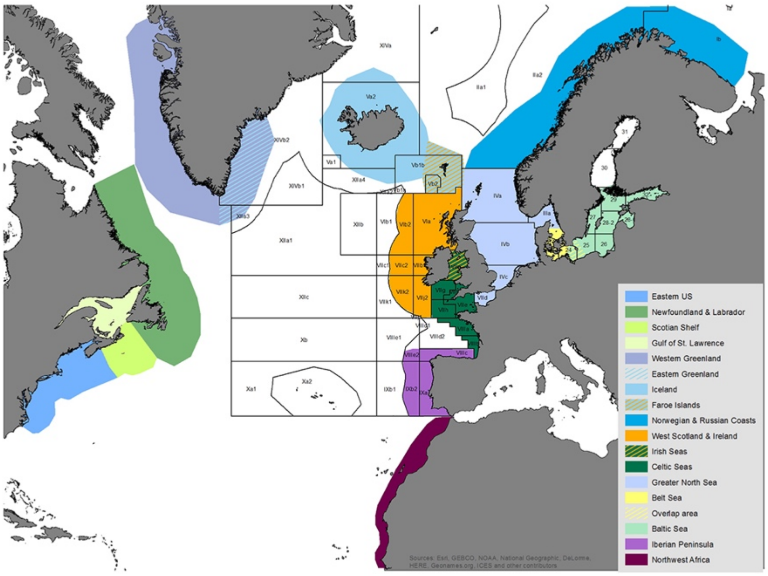


Figure 2. Map of the assessment areas for harbour porpoise in the North Atlantic as proposed by the 2018 Tromsø WS. Data sources: ICES; SAMBAH; (Wessel & Smith, 1996). Cartography: Solveig Enoksen; NAMMCO.

Discussion

It was emphasised that where you have isolation by distance (e.g. in the North Atlantic), it will be necessary to divide the area in a way that is convenient for performing assessments, despite there often being no clear biological distinctions. The boundaries drawn may thus be made on pragmatic rather than biological grounds and it is important to remember this when discussing the map of assessment areas.

The WG noted that the Canadian samples used for genetic analysis and determination of stock identity were primarily from around Newfoundland. Although Canadian surveys performed in 2007 reported no sightings of harbour porpoises along the Labrador coast, there were multiple sightings in the 2016 surveys.

In considering the map's depiction of two potential assessment areas in East and West Greenland, the WG noted that harbour porpoises tagged in West Greenland have visited East Greenland and there is not enough evidence to suggest that these are two populations that have to be assessed separately. There is also no evidence to suggest that the East Greenland population is connected to Iceland or Norway (although tagging efforts in these areas are lacking and would be informative). Noting the limited data currently available for East Greenland and the ToRs for this meeting though, the WG **agreed** to focus its assessment on West Greenland.

4.1.3 Modelling/assessment method

Hammond briefly presented the population dynamic model (Zerbini, J. Ward, Kinas, Engel, & Andriolo, 2011) used to perform the assessments at the Tromsø WS. The input data included abundance estimates and time series of by-catch across the different areas.

Discussion

Hammond did not feel that the assessments performed during the WS were particularly reliable except perhaps in the cases of Iceland, the US, and the North Sea. These three areas have a by-catch time series of reasonable length combined with multiple abundance estimates. The limited data available in the other areas restricts the robustness of the assessments, particularly because without a time series of by-catch extending back to when it began, the assessments can potentially give a false picture of the population status and current trend. By-catch can also be sex and age uneven, which can affect the population. It was noted that several of the assessments were based on only one abundance estimate, which is problematic for determining trends. This meant that although three of the assessments may be considered potentially useful for assessing status, the others simply highlight knowledge gaps that need to be addressed before reliable management advice can be offered.

Witting drew attention to some technical issues associated with the assessments performed during the Tromsø WS. The model attempted to estimate two parameters (K and rmax), for most stocks from a single or a couple of abundance estimates. Hence, for most stocks, the model was able to have a strongly updated posterior for the abundance measure K, and almost no updating of the growth potential (rmax). This implies that the prior on rmax should be as informative as possible reflecting our best knowledge on the growth potential of harbour porpoises, and that a logical choice would be to have an uninformative uniform prior on K that is wider than the upper and lower limits of the posterior distribution on K.

Neither the prior on K, nor the prior on rmax, followed these principles. The prior on rmax started at zero, but this value is not biologically realistic because populations need an rmax value that is larger than zero in order to exist. One way forward would be to have a symmetrical humped prior around a pressured realistic point estimate for rmax, or less optimal to have a uniform prior over a realistic range, with both options starting at values larger than zero. It was noted that a maximum sustainable yield rate (MSYR) of 1% for the 1+ component of the population, as usually assumed as a lower bound for large cetaceans, corresponds with an rmax value around 1.5% for the model that was used by the WS.

For the type of modelling that was performed by the WS, it is essential that the prior on K is wider than the posterior distribution. If this is not the case, the model estimate of K is being cut off at some arbitrary upper and lower value and it is not possible to trust the abundance estimates of the model. However, judging from the figures in the WS report, the lower prior limit on K was wider than the posterior for only one of the ten assessments (i.e. the North Sea). Another issue related to the prior on K is that for a model with log-normal likelihood on the abundance estimates, the uninformative prior is uniform on log scale, while the workshop prior was uniform on normal scale.

Apart from these issues with the prior, it was also considered questionable as to whether it is possible to obtain realistic estimates of current depletion levels through the use of a density-regulated model that starts at K at the beginning of the projection. This modelling makes sense if the assumption of density-regulated growth is correct and there is a complete catch, or by-catch, history. For most of the assessments performed during the WS though, there were only short time-series of by-catch available with plenty of by-catch taken prior to the available data. Even if the by-catch histories are complete, it is well-known that a density-regulated model that is started at K cannot generally reconcile the trend in current abundance data with the available catch histories. This problem is evident in cases where there are relatively long time-series of abundance estimates available - as for East Pacific grey whales, North Atlantic humpback whales, and bowhead whales off Alaska (Witting, 2013). In relation to harbour porpoises, the same problem occurs for the only stock with 6 abundance estimates (Eastern US), where the data shows an increasing and then declining trend, while the estimated model is first declining and then increasing.

4.1.4 Conclusions & Recommendations

Based on these concerns, and the discussion for Norway, Iceland and the Faroes below, the WG noted that the Tromsø WS did not have sufficient time for the type of in-depth reviews (of all the input data and assessments runs) that are usually conducted during assessments in WGs. The WG **agreed** that the assessments of the Tromsø WS should be considered preliminary and informal, and that further reviews and analyses are required for formal assessments. This WG did not have time to review the background data, nor the necessary time and expertise to perform assessments for all areas.

4.2 2013 Harbour Porpoise Working Group Report

4.2.1 Summary of Previous Work & Recommendations

Mikkelsen presented the ToR for the 2013 HPWG meeting and noted that the focus was on performing an assessment of harbour porpoise in West Greenland. The recommendations arising from the 2013 meeting of the HPWG were presented and the developments since that time reviewed. These included:

Recommendations for Greenland:

- Given the recent discovery of large uncertainty in catches, the working group strongly recommends that Greenland provides a complete catch history including all types of underreporting of catches before any future attempts are made to conduct an assessment of harbour porpoises in West Greenland.

A complete catch history, noting different types of underreporting, has now been collated and presented to the HPWG in 2019 (available as document SC/26/HPWG/08).

- The working group noted that TNASS2015 (sic) may provide a new abundance estimate for West Greenland and recommended that a new assessment not be considered until the outcome of this survey is known.

A new abundance estimate for West Greenland was generated from NASS2015 and endorsed by the [2016 NAMMCO AEWG](). This abundance estimate was used for the 2019 assessment.

Norway

- The working group recommended that Norway compile enough information as possible about by-catch from other fisheries, and to look into the lumpfish fishery by-catch next.

Significant advances have been made on this request, especially for cod and monkfish fisheries. Hotspots for by-catch have also been identified (e.g Vestfjord) and will become a more specific area of focus in the future.

- The group recommended that samples be collected from by-catch in Norway, to obtain data on sex ratio, reproductive status, age structure, diet, contaminants, etc. It would be challenging to gather carcasses for the whole coast; the group therefore suggested that efforts are focused on the Vestfjord area where most of the by-catch occurs.

Collections are in progress, however, analysis has not yet been performed.

- The working group recommended tagging of harbour porpoises in Norway to obtain information about behaviour for use in assessment. Movement data will be important also in light of changing environmental conditions (e.g., food availability).

Preliminary planning for tagging efforts around Tromsø has been carried out, however, the work still remains to be done and therefore the WG was encouraged by Øien to reiterate this recommendation.

- The working group therefore strongly recommends that surveys to estimate abundance in Norwegian coastal and fjord waters are carried out. These surveys may start in the areas of highest by-catch (Vestfjorden).

There has been some progress towards this goal, using SCANS III and some preliminary fjord surveys. Further work remains to be done though to arrive at a complete estimate of abundance of harbour porpoises in Norwegian fjords.

- The working group recommends both tracking and genetics studies to clarify stock delineation. Reliance on genetics data alone is not enough because movements are needed to inform on mixing and dispersion of the animals on a management time scale.

Some genetic analysis has been performed and is in press, however, tracking studies have not been conducted.

General recommendations for all areas:

- The group noted that the SCANS-III survey, scheduled for 2016, will conduct an experimental survey to investigate survey techniques in 2015, and cooperation between coordinators of SCANS-III and TNASS2015 is recommended.

This work has now been completed.

5 GREENLAND ASSESSMENT

5.1 Stock identity

Tange Olsen gave a presentation on recent genetic work connected to stock identity (see section 4.1.1 of this report), including that reported in the working paper SC/26/HPWG/05 on genomic divergence and behavioural adaptations of harbour porpoise in West Greenland.

Abstract from Working Paper SC/26/HPWG/05

Oceanic conditions and climatic events play important roles in the evolution and divergence of cetaceans. Understanding the mechanisms that classify ecotypes has so far relied primarily on genetic analyses with no or little knowledge on contemporary movement ecology. This study combines long-term movement data and genetic analysis to offer a novel perspective into the ecology and evolution of a highly mobile cetacean species. Eighteen satellite transmitters were deployed on harbour porpoises over a two-year period (2013-2014) off the coast of West Greenland, and muscle/skin samples from Canadian (n=26), Greenlandic (n=30) and Icelandic (n=12) porpoises were used for genomic analysis using SNPs. No apparent genetic differentiation was observed between porpoises from Gulf of St. Lawrence, Newfoundland and Iceland, however a clear isolation of porpoises from West Greenland from animals in Iceland and Canada was detected, due to limited contact with neighbouring populations, as clearly supported by tagging data. This is the first study to combine long-range oceanic migrations, strong site fidelity to coastal summering grounds and apparent genetic separation of a local harbour porpoise population in West Greenland.

Discussion

It was again noted that some of the animals tagged in West Greenland have visited East Greenland and that there is no strong evidence to indicate that these are two separate populations (despite differences in the currents and water temperatures between the two coastal ecosystems potentially supporting separation). It was highlighted that it would be useful for scientists to have access to samples from East Greenland to help determine stock identity. This may be challenging due to the low number of harbour porpoises observed along the east coast. There is an abundance estimate for porpoises in East Greenland from 2015 though and some porpoises may spend the summer there. Hunters in the area could be asked to provide samples to scientists when harbour porpoises are caught in East Greenland since this would be a significant resource for resolving questions of stock identity.

Since there seems to be strong site fidelity for coastal summering grounds during mating season, a question was asked as to how Iceland and Canada seem to share a population according to the genetic analysis. This may be due to a lack of time not allowing for a build up of genetic differences across the North Atlantic population while small bottlenecked populations from the past may appear genetically distinct. There is a genetic signature in the Greenlandic population that shows a link to the wider North Atlantic population but it is not possible to determine if this stems from a shared historical origin with incomplete population separation or is the result of recent mixing/hybridisation events. To determine whether this signature is old or new, it would be beneficial to have data from harbour porpoises tagged and tracked from Iceland and Canada.

Although it seems likely that there was a single large North Atlantic population and at the periphery of this there has been a branching off of (sub)populations, it is not clear whether the differences that have arisen are a result of functional adaptations or just due to populations being isolated for a long time and genetic differences emerging by chance. The Greenlandic harbour porpoises are living in a more extreme environment so it could be argued that the changes might be adaptive. Variation observed in skulls and body size across different harbour porpoise populations does indicate that adaptive changes are occurring.

The WG recognised the presence of a genetically differentiated sub-population with site fidelity to West Greenland. It was noted that since the IUCN assessment of harbour porpoises is currently being revised, now would be a good time to recommend that a new sub-population be recognised. The WG **recommended** that a West Greenland sub-population be recognised and Hammond agreed to take this forward within the IUCN.

The data that would be required to identify a distinct species/sub-species in Greenland was also discussed. More than one type of supporting data would be required – i.e. information on behaviour, morphology, movement, and/or genetic differences. This could be delivered through further research on mitochondrial DNA, together with morphological studies including skull measurements and further tagging efforts from different regions.

The WG noted that although there are clear indications that there is a significant difference between West Greenland harbour porpoises and others of the North Atlantic, it remains unclear whether there are additional sub-populations in the North Atlantic.

5.2 <u>Biological parameters</u>

Lemming presented working document SC/26/HPWG/06 on life history parameters of harbour porpoises in West Greenland.

Abstract from SC/26/HPWG/06

Detection of changes in body condition and life history parameters of apex predators provide unique insight into the marine ecosystems. This study presents the life history and autecology of harbor porpoises, sampled from the Inuit hunt in West Greenland over two decades: In August–September 1995 (n = 103), 2009 (n = 89) and from June–October 2014 (n = 130). Life history parameters are compared between sampling years and months (June–October 2014). Mature female porpoises from 2009 had an increased body condition compared to 1995 and 2014, and we suggest that this intermediate increase is linked to fluctuations in sea temperature as also reflected in Atlantic cod (*Gadus morhua*) densities in West Greenland. Both males and females showed seasonal increase in mass, length, age, and in the proportion of mature animals during June–October 2014. This suggests that young female harbor porpoises are the first to arrive in coastal areas of West Greenland in June-July and the mature animals arrive July–August.

Discussion

Harbour porpoises in West Greenland may be particularly sensitive to ecosystem level changes because the number of prey species seems to be limited compared to other parts of the North Atlantic and is subject to more extreme fluctuations in productivity. Atlantic cod is a species for which there is a significant amount of information and this makes it a useful source to consider ecosystem interactions and changes, but it is not necessarily the most important or energy rich food source for the harbour porpoise. Information on cod can therefore certainly give indications but should not be weighted too heavily.

The age at sexual maturity reported in the working paper - 2.5 years for males - seemed to be quite a bit lower than other parts of Europe and the pregnancy rates indicated were also higher in West Greenland than other European areas. The assessment of the North Sea seems to indicate that the population is close to carrying capacity though so the WG noted that this could explain the difference.

5.3 Abundance estimation

Lemming presented information on the West Greenland abundance estimate and corrections based on the proportion of animals that may have been outside the aerial survey area as reported in document SC/26/HPWG/07.

Abstract from SC/26/HPWG/07

Abundance estimates of harbour porpoises have been estimated from two aerial surveys conducted by the Greenland Institute of Natural Resources in 2007 (West Greenland only) and 2015 (West and East Greenland) (Hansen et al., 2018; Hansen & Heide-Jørgensen, 2013). A corrected abundance estimate for harbour porpoises in West Greenland was 54,284 (cv=0.36, 95% CI= 27,627-106,664) in 2007, and 83,321 (cv= 0.34, 95% CI=43,377-160,047) in 2015 (Hansen et al., 2018). These abundance estimates do not include porpoises that are not present in the survey strata at the time of the survey. Between 2012 and 2014, 32 harbour porpoises were live-caught in West Greenland and instrumented with satellite-linked Argos transmitters (Nielsen et al. 2018). Information from satellite tracking of 26 harbour porpoises in Greenland was used to estimate the proportion of porpoises that can be expected to be inside the survey strata conducted in Greenland, August – September 2007 and 2015, respectively. The 26 porpoises spent a weighted average of 78 % (SD=21.4) of their time inside the survey strata at the time of the survey. The estimated time spent outside the survey strata could be used for correcting the abundance estimate of harbour porpoises in Greenland.

Discussion

The methods used to calculate the correction factors applied to the abundance estimates in the 2013 report of the HPWG were not endorsed by the NAMMCO Abundance Estimate Working Group (AEWG). They will therefore not be used in the 2019 assessment.

The abundance estimates being addressed as a starting point for this WG are those endorsed by the 2009 and 2016 AEWG, and the correction method endorsed by the 2016 AEWG. The gave corrected estimates of 54,284 (cv=0.36, 95% CI= 27,627-106,664) in 2007, and 83,321 (cv= 0.34, 95% CI=43,377-160,047) in 2015 (Hansen et al., 2018).

The working document SC/26/HPWG/08 presented a proposal for how to correct these endorsed abundance estimates for the amount of time tagged porpoises spend inside the survey area. However, the way in which this correction was done in the working paper was noted as resulting in a very large CV and wide confidence intervals and therefore the most appropriate way to capture the variance in the data was discussed.

Following this discussion, it was decided that based on a sample of 34 tracks from 32 porpoises between 2012 and 2016, the mean proportion of animals outside the survey strata during the survey period (15 August through 30 September) should be calculated. This was 0.22 (SD=0.31) for all years combined. Adjusting the survey estimates with this proportion gave adjusted abundance estimates for 2007 of 69.595 porpoises (cv=0.37; 95% CI: 34.689-139.624) and 106.822 (cv=0.35, 95% CI: 55.149-206.909) for 2015. The WG **agreed** to use these as the fully corrected abundance estimates for the assessment.

5.4 Catch numbers

Lemming presented working document SC/26/HPWG/08 on the catch statistics in Greenland from 1900-2017. The primary topic of the presentation was the discrepancy between the catches reported in the official system of Piniarneq and those reported by hunters during interviews.

Abstract of SC/26/HPWG/08

Reporting of catches in Greenland is based on a reporting system where everybody who hunts (both full-time and part-time) is required to report their monthly catches once a year (Piniarneq, Government of Greenland). Most catches were taken in central West Greenland during summer months, however, the town of Maniitsoq and its adjacent settlements were responsible for 40 % of all catches. To validate the reported 2012-catches in Piniarneq, a questionnaire survey of 28 hunters was conducted in Maniitsoq, West Greenland, in 2013, with updated reported catches in Piniarneq in April 2014. This revealed a level of both under- and non-reporting.

Discussion

It was clear to the WG that the reported numbers in the official reports cannot be entirely trusted and that there was a need to apply correction factors. The discussion therefore focused on how to handle the discrepancy between the catch numbers reported in the official system and those indicated by the interviews, with several different approaches proposed and debated. In addition, it was highlighted that due to new privacy laws, it is no longer possible to go back and identify individual hunters in Piniarneq and speak to these hunters about their reporting as a way to gain further clarification.

The reporting discrepancy revealed a tendency for the hunters to report less in the official system. For most of the interviewed hunters, this was only slightly less. However, for one hunter there was a large difference, with a catch of 200 harbour porpoises reported during the interview but 0 catches recorded in the official system. There were 4 other hunters for whom the official records indicated 0 catches while the interviews suggested small catches, while an additional 10 of the interviewed hunters did not report to Piniarneq at all. It was proposed that a 0 in the official records likely means that the hunter returned the form but did not record numbers for harbour porpoises. There also appeared to be some rounding out of the numbers reported during the interviews, which might be linked to the hunter not remembering the exact numbers from the previous year, rounding out the number for the sake of convenience and/or some level of boasting occurring during the interviews. The WG acknowledged that any explanation of the observed differences was speculative.

Based on the presentation, the WG discussed different approaches for how to handle what was recognised as clearly a situation of under reporting of catches. This included performing two different runs of the model with one using the numbers from the official reported catches and the other using total removals as indicated during the interviews (including a struck and lost rate of approximately 10% based on the numbers reported by hunters during the interviews). This was the approach taken in the first draft assessment for Greenland as presented in SC/26/HPWG/09. An alternative approach was proposed in which different categories for non-reporting and under-reporting were created and used as two different correction factors. Separating the data into these two categories allowed for the significance of each to be made more apparent. The WG **agreed** that it was useful to divide the interview data into the two different categories of under-reporting and non-reporting from the hunters. It was also **agreed** that hunters reporting catches during the interview but with a 0 registered in the Piniarneq system would be included in the non-reporting category. The results of this separation are presented in Table 1.

How to handle the hunter reporting 200 catches in the interview but 0 in the official system was extensively discussed. Various proposals for this were discussed. The hunter could be treated as an outlier and excluded; the hunter could be included within the non-reporting category, or; the actual number of catches from this hunter could be used to correct the catches for either the Maniitsoq area only or for Greenland as a whole after the other correction factors had been applied. A discussion was had on the feasibility of correcting catches for specific areas and how the third approach proposed would scale the correction to reflect annual variations in catch. Following this discussion, the WG **agreed** to handle West Greenland as a whole and not to create correction factors particular to certain areas given that the data on under-reporting was only available in one area. Furthermore, it was **agreed** that the hunters that did not fit the general pattern being observed in all the other cases would be treated as an outlier and removed from the analysis. These decisions are represented in the categorisation and calculation of correction factors presented in Table 2.

Whether the correction factor for non-reporting should be calculated on the basis of the catch numbers themselves or the number of non-reporting hunters was also discussed. Since the catches appear to be lower for those not reporting than those under-reporting, the WG **agreed** to base the correction factor for non-reporting on the proportion of catch numbers rather than the number of hunters.

After seeing the recalculations for the two categories as agreed, the WG then debated whether it was appropriate to use both the under-reporting and the non-reporting correction factors, or only the non-reporting correction factor. It was proposed that since the hunters seemed to be only slightly over-reporting or rounding up in the interviews, this could potentially be ignored and only the correction for non-reporting applied. The argument for this was that the similarity between the official record and the under-reported numbers meant that perhaps it would be sufficient to trust the official record and simply correct for those hunters not reporting to the system. It was also highlighted that for the case of non-reporting, there is only one dataset available, while for under-reporting there are two datasets available – the official record and the interview data - and it is not clear why the interview data should be trusted over the official record when they are not significantly different (and assuming that a kind of rounding up is taking place during the interview). Not everyone agreed that under-reporting should be dismissed and saw it as problematic to use some of the interview data but not all of it. The argument was made that it was important to trust and use the interview data completely or not at all. Another approach was presented in which an average of the two datasets available for under-reporting could be used. Following this discussion, the WG **agreed** that the interview data was important and useful and therefore should be used in its entirety to create correction factors for the catch numbers.

Re-examining and reordering the interview data on the agreed basis revealed that 12 hunters did not report any catches to Piniarneq (did not complete the catch form) or reported 0 catches (Table 1). The 26 hunters reported a struck and loss rate of 58 porpoises corresponding to a struck and loss fraction of 1.103 (Table 2). 14 hunters reported both to Piniarneq and the interview. These hunters had an under-reporting of 64 catches, resulting in a correction factor of under-reporting of 1.156 (Table 2). Finally, it was found that 12 hunters never reported any catches to Piniarneq, corresponding to a fraction of non-reporting of 1.217 (Table 2).

Finally, there was a discussion about how to extrapolate the correction factors to the catch history prior to 1993 (when the current reporting system was implemented). During the period in which there was a salmon fishery in Greenland (between 1965-1983) it is not possible to distinguish by-catch from catch. Since the current reporting system was implemented in 1993, the WG **agreed** that the reported catches from 1993 onwards would be multiplied by 1.41 (the fraction of non-reported catches multiplied by the fraction of under-reporting) to correct for the documented underreporting in this system. The landed catches for the period from 1984 to 1993 (where reporting was partial or missing) would then be extrapolated as a linear increase from the average reported catches from 1981 to 1983, to the average corrected catches from 1993 to 1995. The complete time series of landed catches would then be multiplied by 1.103 to account for struck and lost. The by-catch in the period from 1965 to 1982 would then be added to obtain a time series of best estimates of total removals to be used in the assessment.

Table 1. Updated data from interviews with hunters

Hunter no.	Interview (2012)	Reported catch (interview)	Struck and loss (interview)	Total	Piniarneq (2014)	Reported catch (Piniarneq)
1	Yes	5	1	6	no	0
5	Yes	2	0	2	no	0
9	Yes	5	2	7	no	0
10	Yes	10	1	11	no	0
17	Yes	11	4	15	no	0
18	Yes	8	0	8	no	0
19	Yes	5	0	5	no	0
24	Yes	15	0	15	no	0
7	Yes	20	5	25	no (yes)*	0
8	Yes	2	1	3	no (yes)*	0
14	Yes	2	3	5	no (yes)*	0
23	Yes	4	0	4	no (yes)*	0
2	Yes	4	1	5	Yes	7
4	Yes	50	10	60	Yes	45
6	Yes	30	5	35	Yes	28
12	Yes	20	2	22	Yes	2
13	Yes	15	3	18	Yes	14
15	Yes	5	1	6	Yes	4
16	Yes	10	0	10	Yes	10
20	Yes	15	3	18	Yes	15
21	Yes	30	3	33	Yes	22
22	Yes	60	2	62	Yes	51
25	Yes	15	4	19	Yes	16
26	Yes	180	5	185	Yes	166
27	Yes	35	2	37	Yes	27
28	Yes	5	0	5	Yes	3
Sum	26	563	58	621		410

* They did report, but reported 0

Table 2. Updated table of the fraction of struck and loss, underreporting and non-reported catches.

2012 (Jan. - Dec.) Updated in 2014	Hunters in interview
No. of hunters	26
No. of catches reported in interviews (I)	563
No. of struck and loss (S)	58
Fraction of struck and loss, SL = (S+I)/I	**1.103**
	Hunters reporting to both Piniarneq and interview
No. of hunters	14
No. of reported catches in Piniarneq (R)	410
No. of reported catches in interview (I)	474
No. of underreported catches in Piniarneq	64
Fraction of underreporting, U=I/R	**1.156**
	Non-reporting hunters
No. of hunters	12*
No. of non-reported catches (N)	89
No. of reported catches in Piniarneq (R)	410
Fraction of non-reported catches, B = (N+R)/R	**1.217**
TOTAL CORRECTION FACTOR, C=(SL*U*B)	**1.552**

* Including hunters reporting "0" in Piniarneq

5.5 Population modelling & assessment

In the first instance, Witting presented working document SC/26/HPWG/09, which reported the first effort at performing the assessment but did not include the corrections discussed during the WG meeting, namely for the abundance estimate (based on the proportion of time porpoises spent inside the survey area) and the catch history (based on the interview data indications regarding under-reporting, non-reporting and struck and lost).

The group discussed how the life history parameters were included in the model and particularly noted the unexpectedly high survival rate of calves in the first year indicated by the model. Witting informed that the age at sexual maturity was fixed in the original run of the model but if this was allowed to be estimated, there may be some degree of compensation in the survival rate for first year calves. It was therefore proposed that a second run of the model be performed using the revised abundance estimates and catch series and also allowing the age of maturity/first reproduction to be estimated (within a range of 2-7) to see the impact this would have.

Witting then presented the results of the assessment as revised according to the WG discussions.

Assessment Results

The WG used the two area corrected abundance estimates, the best estimate of the catch history, and age-structure data from four periods for Bayesian assessment runs of harbour porpoises in West Greenland. The modelling showed a relatively stable population (see Figure 3), estimating that each female produces on average 0.78 (90% CI: 0.72-0.81) calves that survive the first year, that the annual natural survival of adults is about 0.85 (90% CI: 0.82-0.87), and that the yearly production of the population is around 4.7% (90% CI: 1.6-7.2).

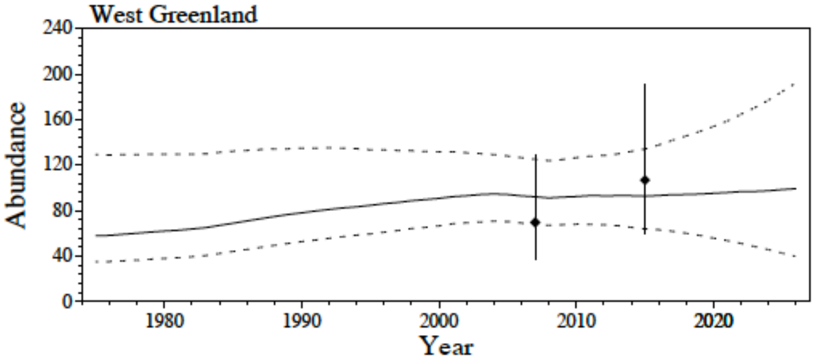


Figure 3. The projection of West Greenland harbour porpoises from the agreed assessment. The solid curve is the median, the dotted lines the 90% credibility intervals, and the dots with bars the agreed abundance estimates and their 90 % confidence interval.

Discussion

The second run did not indicate that changing the age at sexual maturity had a significant impact. The group then discussed what the model indicates about life history parameters. There was some initial scepticism about the high level of juvenile survival being indicated so the potential for biases in the data on the life history factors was discussed. The information on life history factors for Greenland did not, however, appear to be markedly different for that seen in other populations. Although some of the biological factors being indicated by the model were considered surprising, there seemed to be no reason to believe there was a significant bias in the input data. It was noted that the abundance surveys were not specifically targeting harbour porpoises, although this was also not seen as having the potential to significantly alter the outcomes of the model. Following the sensitivity run, the WG decided that fixing the age at sexual maturity in the model based on the available data seemed appropriate. Given that data was available on all the necessary components to run the model and no significant bias in the input data was identified, the WG **agreed** to accept the assessment.

5.6 Management advice and recommendations

The trade-off between total removals and the probability of increase is shown in Table 3. The estimated annual total removal that allows for a 70% chance that the population will increase is 2,900. With a struck and lost correction of 1.103 (Table 2), this corresponds to a total landed catch of 2,629. With an underreporting correction of 1.41 (the product of 1.156 as the fraction of under reporting and 1.217 as the fraction of non-reported catches, see Table 2) the catch expected to be reported for a total removal of 2,900 would be no more than 1,869 harbour porpoises.

Table 3. Table of total removals vs probability of population increase

TR	2100	2200	2300	2400	2500	2600	2700	2800	2900
P	0.83	0.81	0.80	0.78	0.77	0.75	0.74	0.72	0.70

The large difference between the recommended catch of no more than 2,629 and the expected reported catch of 1,869 was seen as a problem, and therefore the WG **strongly recommended** that Greenland work to validate the catch statistics.

6 REVIEW OF ASSESSMENTS PERFORMED IN OTHER AREAS DURING THE 2018 TROMSØ WORKSHOP

6.1 Norway

Øien provided a summarised overview of the data inputs and assessment performed for Norway during the Tromsø WS. A full description of this information is available in Annex 6 of the WS report SC/26/HPWG/04.

6.1.1 Stock identity

All three genetic studies presented at the Tromsø WS corroborated the existence of one panmictic population of harbour porpoises in Norwegian waters.

6.1.2 Biological parameters

Data gathering on biological parameters remains ongoing with samples being collected from by-caught animals.

6.1.3 Abundance estimation

An update on survey efforts, including those in Norwegian fjords in 2018, was provided by Øien. This included progress on the abundance estimation of harbour porpoises from the three most recent Norwegian survey cycles; 2002-2007, 2008-2013 and 2014-2018.

Presenter's Summary

There are three main areas in the total survey area where harbour porpoises occur regularly: (i) in the southern and south eastern areas of the Barents Sea; (ii) in coastal areas of northern Norway, including occasional offshore presence in the Norwegian Sea; and (iii) the North Sea with adjacent coastal waters and fjords. While the first and third of the survey cycles produced similar estimates, very reduced estimates arose from the 2008-2013 period. No apparent reasons for this have been presented so far. From the North Sea, the harbour porpoise estimates developed are consistent with corresponding SCANS survey estimates. In 2016 the Vestfjord area was covered with the same survey method as in the offshore surveys as a feasibility study to estimate harbour porpoise abundance in fjord systems. The resulting density estimate is similar to that based on the SCANS aerial survey conducted in the same period. Fjord surveys were again conducted in Varangerfjord and Porsanger fjord in 2017, revealing significant porpoise densities. In 2018 the fjord systems along the coast from Stavanger to Kristiansund were also covered as an extension of the North Sea offshore survey. All the fjords had high densities of porpoises. Final estimates from these surveys are expected by the end of this year.

Discussion

It was noted that the abundance estimates for Norway will be handled during the next meeting of the AEWG and cannot be considered endorsed until after that meeting. It was also noted that there were several challenges for conducting design-based ship surveys in the fjord systems due to their variable geography but that there were also challenges connected to performing aerial surveys in these areas. There is an ongoing project investigating different approaches to surveying the fjords (e.g. including the use of drones) but the results of this are not yet available.

6.1.4 By-catch

By-catch rates and statistics for Norway are described in Annex 6 of the Tromsø WS report. The WG acknowledged that efforts to obtain reliable by-catch data in Norway are ongoing and that progress has been made. The extrapolation from the reference fleet was, however, noted as one of the issues that is still being addressed. Experiments in by-catch mitigation were also taking place in Norway using acoustic deterrents (pingers). The WG was informed that there was a workshop being planned in June to try and finalise reliable by-catch numbers for Norway although further information on this was not available.

6.1.5 Population modelling

The assessment generated during the Tromsø WS was presented. The major problem that was noted by the WG was the availability of only one abundance estimate. It was noted that the Tromsø WS indicated a slow decline in the harbour porpoise population, however, the lack of information on by-catch before 2005 did not allow for reliable conclusions to be drawn on the basis of this model.

6.1.6 Recommendations

The WG acknowledged the important work that had been done on the issue of by-catch in Norway and **agreed** that it is important that Norway continue to assess levels of by-catch and consider the impact that this has on the status of the population. The WG **recommended** that a formal assessment with updated by-catch estimates be conducted when new abundance estimates are available.

6.2 Iceland assessment

Gunnlaugsson presented an overview of the input data and the assessment performed for Iceland during the Tromsø WS.

6.2.1 Stock identity

Annex 4 of the WS report details the studies conducted and used for determining stock identity. Although the indications are that the Icelandic population is part of a larger North Atlantic population, for pragmatic reasons it was treated as a separate area for assessment and management.

6.2.2 Biological parameters

There was a significant effort in the 1990s to collect samples for analysis of biological parameters. An overview of derived biological parameters from Iceland was available in SC/26/HPWG/FI04.

6.2.3 Abundance estimation

The survey efforts in Iceland are described in the WS report. Acknowledging that harbour porpoises have generally not been the primary target for these surveys, it was noted there has been a high level of sightings during some surveys, although siting rates have been variable between years. One absolute abundance estimate from a harbour porpoise survey in 2007 (endorsed by AEWG 2011) was presented in the WS report. This was 43,179 animals (cv=0.45, 95% CI: 31,755-161,899). It was acknowledged that this estimate should be considered with caution, especially since the aerial surveys in Icelandic waters presumably cover only an unknown fraction of the distribution area of the population. Two relative abundance estimates generated using genetic close-kin analysis were also used in the assessment conducted during the Tromsø WS. Another independent indicator of relative trend may be obtained from porpoise by-catch rates in MFRI's gillnet surveys during 2003-2018. These surveys are standardized and designed to be representative for the gillnet fishery in Icelandic waters during the peak of the gillnet season in late winter (March-April).

A question was asked as to why one of the relative abundance estimates was higher than the absolute abundance estimate. It was answered that this relative estimate was based on a close-kin analysis using only 2 pairs, whereas the other was based on 13 pairs. Why the net survey index was not used as an indicator of abundance in the assessment was also questioned and it was answered that the assessment model used during the WS was not able to incorporate this in the time available. How this information would be weighted (e.g. in relation to the kinship analysis) was also discussed.

Noting that the relative abundance estimates were calculated from parent-offspring analysis (performed on samples taken from by-caught animals), questions were raised by the WG about how this analysis was performed in practice. On this they were referred to the published paper from Gunnlaugsson (2012). The WG **agreed** that it was not clear whether it was appropriate to use this type of close-kin genetic analysis to arrive at abundance estimates and did not feel that there was appropriate expertise in the room to provide a sufficiently competent review of this approach.

It was noted that payments are still being offered to fishermen in Iceland in 2019 for the collection of genetic samples from by-caught animals and that analysis of the total sampling efforts are planned to be finalised at the end of 2019.

6.2.4 By-catch

Direct hunting of harbour porpoises has not been widespread in Iceland but there is significant by-catch, particularly in the cod gillnet, and lumpfish fisheries. Efforts to reliably estimate the extent of this by-catch have been underway in recent years and are still under development. The estimated by-catch used in the Tromsø WS assessment is outlined in Annex 4 of the WS report.

6.2.5 Population modelling

Based on the discussions had, the WG wished to rerun the population model and requested Debra Palka from NOAA (responsible for running the model during the Tromsø WS) to make the following changes:

1. Widen the prior on abundance and try setting it as uniform on a log scale.
2. Alter the prior for rmax to 0.01 - 0.10 (or even higher).

3. Clarify how the relative abundance estimates were included in the model and try another run without them.

This was done and Palka noted that according to the (Zerbini et al., 2011) paper, the relative abundance indices series were scaled to the model predicted population size by a scalar coefficient, assuming a lognormal distribution for their residuals. The scalar coefficient, q, was estimated analytically according to equation 3. In the reruns of the model, Palka expanded the priors of rmax (to uniform from 0.01-0.19) and the absolute abundance estimate. She also used these expanded priors when the relative abundance indices were not used.

Discussion

The group discussed whether it was appropriate to have an rmax prior up to 0.19 in the second run of the model. There was disagreement on whether this was reasonable or not for the harbour porpoise.

Whether there was sufficient data, e.g. on life history factors, to run the Witting model for Iceland was discussed. The age and life history data available was around 25 years old but despite this data being somewhat out of date, there was a sense that there may be sufficient information available to perform an assessment using the Witting model. However, the WG **agreed** that more time would be required to adequately assess the quality of the available data, to review the appropriateness of relative abundance estimates, and to obtain endorsed by-catch estimates.

Whether it would be worth investigating models that account for the way certain biological factors may be density dependent was briefly discussed. The WG felt that currently there was not a sufficient time series of data, on abundance or age structure, to inform such a model.

On the basis of the review of the Tromsø WS assessment, and noting the recent decline in by-catch, the WG **agreed** that there was no specific cause for concern for the Icelandic population.

6.2.6 Recommendations

The WG concluded that they were not in a position to provide management advice on sustainable removals of harbour porpoises in Iceland and that for this it would be necessary to have more time and breadth of expertise to critically review the primary data and perform an assessment. It would also be desirable to have clear management objectives from Iceland.

To perform an assessment for Iceland that can lead to management advice, the WG noted that it would be valuable to have another absolute abundance estimate and that it would be essential to review the abundance estimates generated through close-kinship genetic analysis.

The WG **recommended** that a formal assessment be conducted for Iceland.

6.3 Faroe Islands

Mikkelsen presented an overview of the assessment for the Faroe Islands based on the information presented to the Tromsø WS.

6.3.1 Stock identity

In the Faroe Islands, the lack of recent data meant that stock identity remained unclear. It was decided during the WS that the Faroes should be assessed as a separate area until more information is available. One genetic study including 10 samples from the Faroe Islands did, however, indicate that there was no separation from the North Atlantic population.

6.3.2 Biological parameters

An overview of biological parameters for the Faroe Islands was available in SC/26/HPWG/FI04.

6.3.3 Abundance estimation

A dedicated harbour porpoise aerial abundance survey was conducted in 2010 and estimated abundance to be 5,175 (CV=0.44, 95% CI: 3,457-17,637) animals (AEWG 2011). It was noted that the estimate has to be considered as a minimum estimate, because it only covered the area inside the 300 meters depth contour, one strata (27% of the survey area inside 300 m depth) was excluded due to poor coverage, and an unknown proportion of the porpoises are expected to be outside the survey area, as documented for Greenland.

6.3.4 By-catch

Harbour porpoises are not protected but there is no tradition to hunt them in the Faroe Islands so the level of removals is believed to be low. By-catch of harbour porpoises (because of the absence of gillnet fisheries in shallow waters) is a rarely reported event. Gillnet fisheries inside the 380 m depth contour have not been licensed since the 1960s and this means that by-catch of harbour porpoise is nearly absent, with only a few animals potentially caught on longlines (Mikkelsen, 2016).

6.3.5 Population modelling

There is not enough data available to perform population modelling for the Faroe Islands.

6.3.6 Recommendations

The WG **recommended** that the Faroes Islands work to obtain reliable removal data, update the abundance survey, tag animals to gain a better idea of movements and seasonal occurrence, and collect tissue samples to include in genetic analysis investigating stock identity. This work is considered necessary to obtain the information required to perform a reliable assessment of the status of the population.

7 IMPACTS FROM ANTHROPOGENIC STRESSORS

A general overview of the work done on this topic during the Tromsø WS was given by Mikkelsen and the threat matrix (Table 4 in the Tromsø WS Report) presented. The WG noted that specific monitoring of all the different threats listed in the matrix is not being performed in the areas under consideration and that further research on life history parameters and dietary shifts from existing samples may be a relevant approach to investigate these impacts further. Although it was recognised that stressors may be having an impact on an individual level, the WG did not see indications from the life history data in Greenland that these stressors were having an impact on a population level (e.g. effects from contaminants may be seen as decreased reproduction, which was not found). The WG concluded that the impact of the hunt in Greenland is clearly stronger than any potential impacts from non-lethal stressors at current levels.

A specific presentation of recent research on disturbance to harbour porpoises from noise was presented by Teilmann. An overview of this presentation is provided below.

Presenter's Summary

Underwater noise is of growing concern to marine mammals as scientific knowledge on hearing and behavioural response increase. In the European Union this has resulted in one of eleven descriptors under the EU Marine Strategy Framework Directive effectively being on underwater noise.

Underwater noise may be divided into ambient background noise and man-made anthropogenic noise. The first is caused by natural sources like waves, wind, earth quakes and animals, while the other is caused by sources such as ships, military operations, oil and gas exploitation and extraction, wind turbines, bridges and building of offshore constructions.

Although offshore constructions may create noise, they may also create artificial reefs with increased productivity and biodiversity, benefitting top predators like the harbour porpoise.

The effect of noise on marine mammals can be determined on several levels:

1) Effects on individuals – from changes in behaviour to survival
2) Changes in relative densities on a local scale
3) Changes in distribution and abundance
4) Population level effects simulated in models like Individual Based Models (IBMs)

Studies of wind farm construction have shown effects on densities of harbour porpoises in a radius up to 25 km (Dähne et al., 2013; Tougaard, Henriksen, & Miller, 2009). While effects of operating wind farms have shown ambiguous results from negative long-term effects in the Baltic Sea (Teilmann & Carstensen, 2012) over no effect in the eastern North Sea (Tougaard et al., 2006) to positive effects in the southern North Sea (Scheidat et al., 2011). Whether these results are related to things like: i) increase in noise level due to turbine noise, ii) high motivation to follow fish schools and therefore ignoring any noise increase or iii) increase in fish abundance due to reduced fishing activities, is unknown. However, it shows that similar offshore constructions may have very different effects on harbour porpoises.

Ongoing studies of densities of harbour porpoises around an oil rig in the North Sea show that harbour porpoises are attracted to the area within 800 m from the platform. Although the noise level is high close to the platform, porpoises seem to be attracted to some food source that benefits from the hard structure of the oil rig, similar to an artificial reef effect mentioned above.

Tagging of seven individual harbour porpoises with acoustic behavioural tags (DTAG) in the Danish Belt Seas has shown that porpoises feed almost constantly on around three thousand small fish per day (Wisniewska et al., 2016; Wisniewska, Johnson, Teilmann, Rojano-Doñate, et al., 2018). This behaviour will make these animals vulnerable to any disturbance that may affect their foraging and thereby their long-term fitness. Analysis of data from the same porpoises has shown that the various animals experience ship noise 17-89% of the time (Wisniewska, Johnson, Teilmann, Siebert, et al., 2018). The study also shows a significant reduction in foraging echolocation (buzzing) at received ship noise levels greater than 96 dB re 1 µPa at 16 kHz third octave level, which are not unusual levels (at least in Danish waters).

Another tagging study used play-back signals from a single 10 inch^3 airgun every 2-3 sec for 1 minute, on five harbour porpoises using GPS/dive loggers (V-tag) (van Beest et al., 2018). The results showed that some animals responded with changes in horizontal movements (faster, longer and more directed) and shorter and shallower dives for up to 8 hours, with an additional 24 hours taken to resume baseline behaviour, while others did not show a response. This indicates that the response to similar stimuli depends on individual robustness to disturbances.

Field metabolic rate has now been estimated for wild harbour porpoises (Rojano-Doñate et al., 2018). This was done by monitoring food intake, breathing rate and injecting doubly labelled water into captive porpoises in Fjord&Belt, Kerteminde, Denmark. This gave a correlation between metabolic rate and breathing rate in captive animals that was used to convert breathing rate from wild tagged (DTAG) porpoises to field metabolic rate in wild porpoises. The results show that porpoises require 15.5 MJ per day on average for 13 porpoises, which corresponds to two times higher metabolic rates than similar sized terrestrial mammals. These results are essential in understanding the energy requirements and how disturbances affect physiology, reproduction and fitness in porpoises.

All the results described above may be modelled to understand the cumulative impacts of various man-made disturbances on top of food limitations, effects of contaminants and direct catch or by-catch. This was done for the Danish Belt Seas and the North Sea in IBMs build on existing knowledge on harbour porpoises (Nabe-Nielsen et al., 2018; Nabe-Nielsen, Sibly, Tougaard, Teilmann, & Sveegaard, 2014; van Beest, Kindt-Larsen, Bastardie, Bartolino, & Nabe-Nielsen, 2017). Such models, using real data can predict the combined effect of all quantifiable pressures and predict population development under different future scenarios, e.g. change in by-catch or catch rate, increase in noise disturbance, decrease in food availability, climate change, etc.

Discussion

Questions were asked about trends that had been observed over time, e.g. in terms of the size of by-caught animals, depth of blubber, or changes in abundance that might indicate impacts from increasing underwater noise. Abundance estimates do not indicate a significant impact from increased disturbance. The long-term response might, however, be a compensation in life history parameters and reallocation of energy rather than a direct effect on abundance. Good time series on factors such as body size are not really available to assess this and it was highlighted as potentially interesting and useful to track life history data over a longer period of time in areas with significant levels of disturbance. Having a model able to show cumulative effects as presented by Teilmann was also highlighted by the WG as particularly useful and informative.

The WG emphasised that that findings from studies on underwater noise in Denmark cannot necessarily be generalised to other areas of the North Atlantic where the levels and scales of disturbance (and the cumulative effects), are expected to be much lower. Climate change and potential prey depletion were, however, noted as stressors that could have a potential effect on harbour porpoises in Greenland and for which it was important to continue monitoring. The increased level of sonar and seismic activity in Norway was also identified as a potential concern worthy of ongoing investigation and monitoring.

The WG acknowledged that it was challenging to address all anthropogenic stressors and suggested that it would be useful to be have further guidance to ensure that this item is dealt with in a consistent way across relevant WGs.

8 KNOWLEDGE GAPS, FUTURE RESEARCH & RECOMMENDATIONS

8.1 Recommendations for research

- Each assessment area should provide samples to support the development of a multi-dimensional investigation into population structure and stock identity and allow for all existing datasets to be merged into a common analysis.

Faroe Islands

- To allow an assessment to be conducted, work should be done to: a) obtain reliable removals data, b) update the abundance survey, and c) tag animals to gain a better idea of movements and seasonal occurrence.

Greenland

- The research necessary to identify a potential sub-species in West Greenland should be carried out. This may require as a minimum a combination of genetic analysis, morphometrics, and tracking data.

- A follow up study should be conducted to investigate how widespread the underreporting of catches in the official Piniarneq system in Greenland is.

- Hunters in East Greenland should be asked to provide samples to scientists when harbour porpoises are caught.

Iceland

- By-catch estimates should be finalised and endorsed.

- Information on life history and various biological parameters should be updated.

- Tagging studies should be conducted to assist in the definition of stock identity

Norway

- By-catch estimates should be finalised and endorsed and this should include efforts to investigate the potential to extrapolate by-catch further back in time.

- The ongoing work to establish another abundance estimate that includes the fjord systems should be continued.

- Further information on harbour porpoise movements is required and therefore tagging and tracking studies should be conducted along the coastline to help answer questions about stock identity and consider if smaller management units are necessary.

8.2 Recommendations for conservation and management

- Given the importance for assessment of having a reliable timeseries of abundance estimates, survey efforts across the areas should be coordinated.

Greenland

- The assessment should be updated as soon as a new abundance estimate is available and no later than 10 years from now.

- Catch statistics (in both East and West Greenland) should be validated.

Iceland

- A formal assessment should be conducted following a full review of the available data, including the approach of using close-kinship genetic analysis to arrive at abundance estimates.

Norway

- A formal assessment with updated by-catch estimates should be conducted when new abundances estimates become available.

- The reference fleet should be expanded as part of an effort to obtain reliable by-catch estimates.

9 OTHER BUSINESS

There was no other business.

10 ACCEPTANCE OF REPORT

The report was provisionally adopted by the WG at the conclusion of the meeting on March 22nd 2019. Following formatting and editorial revisions, the final report was adopted by correspondence on March 29th 2019, 16:00.

11 CLOSING REMARKS

The Chair acknowledged the finalization of the assessment for West Greenland as a significant outcome of the WG meeting and thanked both the participants for their work and Wickson for her effective rapporteuring. The participants also thanked Mikkelsen for his orderly and able chairing. The meeting was closed at 12:20pm on March 22nd 2019.

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NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON HARBOUR PORPOISE

19-22 March 2019, Faroes Representation Copenhagen

AGENDA

1. CHAIRMAN WELCOME AND OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEURS
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
    - 4.1. Harbour Porpoise Workshop Tromsø 2018
        - 4.1.1. Map of assessment units
        - 4.1.2. Topics covered & modelling/assessment method
        - 4.1.3. Conclusions & Recommendations
    - 4.2. Harbour Porpoise Working Group 2013
        - 4.2.1. Summary of Previous Work & Recommendations
5. GREENLAND ASSESSMENT
    - 5.1. Stock identity
    - 5.2. Biological parameters
    - 5.3. Abundance estimation
    - 5.4. Catch numbers
    - 5.5. Population modelling & assessment
    - 5.6. Management advice
6. NORWAY ASSESSMENT
    - 6.1. Stock identity
    - 6.2. Biological parameters
    - 6.3. Abundance estimation
    - 6.4. By-catch
        - 6.4.1. By-catch numbers
        - 6.4.2. Mitigation
    - 6.5. Population modelling & assessment
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7. ICELAND ASSESSMENT
    - 7.1. Stock identity
    - 7.2. Biological parameters
    - 7.3. Abundance estimation
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    - 7.6. Management advice
8. FAROE ISLANDS
    - 8.1. Stock identity
    - 8.2. Abundance estimation
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9. IMPACTS FROM ANTHROPOGENIC STRESSORS
10. KNOWLEDGE GAPS, FUTURE RESEARCH & RECOMMENDATIONS
    - 10.1. Recommendations for research
    - 10.2. Recommendations for conservation and management
11. OTHER BUSINESS
12. ACCEPTANCE OF REPORT
13. CLOSING REMARKS

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NAMMCO SCIENTIFIC COMMITTEE

HARBOUR PORPOISE WORKING GROUP

19-22 March 2019, Faroes Representation Copenhagen

DRAFT LIST OF DOCUMENTS

WORKING DOCUMENTS

Doc. No.	Title	Agenda item
SC/26/HPWG/01	Draft Agenda	2
SC/26/HPWG/02	Draft List of Participants	3
SC/26/HPWG/03	Draft List of Documents	4
SC/26/HPWG/04	Draft Report of the 2018 International Workshop on the Status of Harbour Porpoises in the North Atlantic	4-10
SC/26/HPWG/05	Rapid genomic divergence and behavioural adaptations of a harbour porpoise ecotype in West Greenland	5.1
SC/26/HPWG/06	Monitoring life history parameters in harbour porpoises in West Greenland	5.2
SC/26/HPWG/07	The proportion of harbour porpoises inside aerial survey strata in Greenland	5.3
SC/26/HPWG/08	An updated catch statistic for harbour porpoises in West Greenland between 1993-2017, including correction for unreported catches.	5.4
SC/26/HPWG/09	Assessment of West Greenland harbour porpoise - 2019	5
SC/26/HPWG/10	REVISED: Catch statistics for harbour porpoises in West Greenland between 1993-2017, including correction for unreported catches.	5.4
SC/26/HPWG/11	REVISED: Assessment of West Greenland harbour porpoise	5

FOR INFORMATION DOCUMENTS

Doc. No.	Title	Agenda item
SC/26/HPWG/FI01	Report of HPWG Meeting from 2013	4.2
SC/26/HPWG/FI02	HPWS 2019: Abundance estimation across all areas	4-10
SC/26/HPWG/FI03	HPWS 2019: By-catch estimates across all areas	4-10

SC/26/HPWG/FI04	HPWS 2019: Life history data across all areas	4-10
SC/26/HPWG/FI05	Hansen et al. In Press. Abundance of whales in west and east Greenland in summer 2015. *NAMMCO Sci. Publ.* 11.	5.3
SC/26/HPWG/FI06	Nielsen et al. 2018. Oceanic movements, site fidelity and deep diving in harbour porpoises from Greenland show limited similarities to animals from the North Sea. *Marine Ecology Progress Series.* 597: 259-272	5.1
SC/26/HPWG/FI07	Teilmann & Dietz. 1998. Status of the harbour porpoise in Greenland. *Polar Biology* 19(3): 211-220.	5.4
SC/26/HPWG/FI08	Zerbini et al. 2011. A Bayesian assessment of the conservation status of humpback whales in the western Atlantic Ocean (Breeding Stock A). *Journal of Cetacean Research and Management* 3: 131-144.	4.1, 6, 7, 8
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