NAMMCO SCIENTIFIC COMMITTEE
REPORT OF THE WORKING GROUP ON ABUNDANCE ESTIMATES

Copenhagen, May 22-24, 2018

1. CHAIRMAN WELCOME AND OPENING REMARKS

Chairman Daniel Pike welcomed all participants (Appendix 1) to the meeting, noting that the group valued the full participation and input of the invited experts. Desportes particularly welcomed Greg Donovan (IWC), who participated in the meeting on behalf of Alexandre Zerbini, the chair of the IWC working Group on Abundance Estimate in the framework of the newly established cooperation between the two working groups (see under item 15.3).

The task before the group was a general one: to consider abundance estimates particularly from the most recent NASS in 2015, but also from previous and more recent surveys (Table 1). Estimates can be recommended for acceptance by the Scientific Committee, or further work can be recommended. In addition to the estimates from the NASS series, the Group will also consider information made available from surveys in adjacent areas, for comment and to put into context with the wider North Atlantic area. Pike noted that there was an abundance of new information available to the Group, which would require an efficient approach to cover in the time available.

NOTE: Estimates from the 2015 Icelandic/Faroese ship survey component of the NASS were revised subsequent to the meeting according to the recommendations of the Working Group, and accepted by correspondence in October 2018. See Annex 1 for details.

2. ADOPTION OF AGENDA

The agenda (Appendix 2) was accepted with minor changes.

3. APPOINTMENT OF RAPPORTEURS

In the absence of a Scientific Secretary, various members acted as Rapporteurs for sections of the report.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Pike noted that most of the primary documents (Appendix 3) contained several estimates for particular species and surveys. Therefore, to maximize efficiency the Group would review them in two stages, looking first at general aspects of the analyses that affected all species estimates, then focusing in on individual species and years.

The summaries and discussions pertaining to the design and conduct of the surveys and the general aspects of the analyses common to all species are therefore collated under Section 4, while the summaries and discussions pertaining to each species are given under the specific species headings. The status of the abundance estimates presented (accepted, accepted pending small modifications, not accepted because of further analysis needed, etc.) to this Group is summarised in Table 1.

4.1 SC/25/AE/05 TNASS Ship 2007, Iceland and Faroes

Author's summary

SC/25/AE/05 presents a summary of the results of the Icelandic and Faroese components of the Trans North Atlantic Sightings Survey (T-NASS) ship surveys conducted in 2007. This was the fifth in a series of large-scale cetacean surveys conducted previously in 1987, 1989, 1995, and 2001. Four vessels were employed as dedicated survey vessels, each one equipped with two observing platforms. Three of these were dedicated solely to the cetacean survey, while a fourth conducted fishery surveys coincident with the cetacean survey. Five additional vessels conducting fishery surveys were employed as "extension" vessels, each carrying two observers operating from a single platform and surveying areas mainly to the northeast and southwest of the core survey area, but with some overlap. The core survey used Buckland-Turnock (B-T) mode, with a "tracker" platform using binoculars to survey far ahead of the vessel and track sightings until they passed abeam or were sighted by the primary platform. Duplicate sightings were identified by a dedicated observer on the tracker platform. Abundance of cetaceans in the core survey area was estimated using unique sightings from the combined tracker and primary platforms, and by using the "trial" configuration under the assumption of point independence to estimate perception bias for the primary platform. Due to poor weather conditions and equipment failures, a relatively large proportion of effort (28% at BSS<6) was done in single platform mode, reducing the sightings and effort available for this analysis. Abundance in the extension strata was estimated using detection functions combining sightings from the dedicated and extension vessels.

Sufficient sightings of fin, minke, sei, humpback, sperm and long-finned pilot whales and white-beaked and white-sided dolphins were made to estimate abundance. Sightings of white-beaked and white-sided dolphins were combined to estimate a single detection function. There were too few (5) duplicate sightings of common minke whales to correct for perception bias. Tracking results indicated that there was no responsive movement by fin, minke and humpback whales and white-sided dolphins, but for other species there were too few tracking events to make a determination. Comparison of perpendicular distance measurements made by the tracker and primary platforms to the same sighting showed that the latter were on average 64% (95% CI 55%; 73%) of the former, which may mean that distance estimates by the primary platform were negatively biased, as distance measurements on the tracker platform were made using binocular reticles or video measurements which are more accurate than the distance stick measurements used on the primary platforms. Sensitivity analyses indicated that this potential bias would reduce abundance estimates by 12% to 28%.

Encounter rates for the extension vessels were generally much lower than those for the dedicated vessels in areas where they overlapped. Uncorrected abundance estimates for areas covered by these vessels outside of the core survey area are therefore severely negatively biased.

Discussion

There was an in-depth discussion about the implications of possible evidence for negative bias in primary platform distance estimates.

Based on the swimming direction of tracked whales, there was no evidence that animals swimming towards the trackline were identified as duplicates more frequently than those swimming away from the trackline. The Group **recommended** that the analysis of these data be presented in the revised version of the paper.

Another possible contributing factor to the apparent bias in primary platform measurements, not mentioned in document SC/25/AE/05, was that some proportion of sightings were erroneously identified as duplicates, and that in these cases the observers on the primary platform would tend to see the closer group as they were not using binoculars. While this might be a contributing factor, it was considered unlikely that a sufficiently large proportion of duplicates were identified erroneously to account for the observed distributions, particularly considering that most duplicates were identified in the field by a dedicated observer on the tracker platform.

The Group considered that any changes to the primary data based on uncertain evidence for bias in radial distance estimation would need to be carefully considered. A correction could actually introduce bias by oversimplifying the relationship of bias in the distances, as it is not likely to be a linear relationship. For example bias may increase or decrease with distance. This was therefore not recommended and it was concluded that the estimates in the paper without measurement error bias correction should be considered for acceptance at this time, as has been done in the past. The Group **recommended** that the relationship between tracker and primary distance measurements be further explored through a GLM regression including covariates for vessel identity and the time between re-sightings.

The Group noted that full independence (FI) models are almost invariably negatively biased and expressed a general preference for point independence (PI) models, recommending the use of FI model only if there was a serious concern regarding attraction to the ship. In cases where there were insufficient primary platform sightings to obtain a detection function, as was the case for *Lagenorhynchus* spp. dolphins, an FI model is the only option for bias correction, but it may be preferable to simply present an uncorrected combined estimate as the FI corrected estimate will likely be negatively biased.

Encounter rates for the extension vessels were much lower for all species except common minke whales and it was concluded that estimates from the extension survey are severely negatively biased. They also for the most part duplicated effort in areas which were covered periodically by dedicated surveys which can provide unbiased estimates. The Group concluded that data from extension surveys conducted in this manner may be useful in some modelling exercises. However, in this case (2007 survey) they were not very useful for estimating abundance. If such extensions are used in the future they should at a minimum have double platforms (two observers on each) so bias can be estimated, and the observer schedule should allow sufficient rest for observers.

4.2 SC/25/AE/06 NASS 2015 Ship, Iceland and Faroes

Author's summary
SC/25/AE/06 presents a summary of the results of the Icelandic and Faroese components of the NASS ship survey conducted from late June to early August 2015, the sixth of the series (Fig. 1). In addition, results from a survey covering parts of the same area later in September and October are presented. Three vessels were used in the survey, two of which were dedicated cetacean survey vessels and a third conducting fishery surveys coincident with the cetacean work. All vessels used independent symmetrical double platforms, each staffed by at least two observers. Distance was estimated using primarily binocular reticles and also distance sticks for nearby sightings. The fall survey used identical methods. Duplicate sightings were sometimes identified in the field when vessels closed on sightings, but usually post-survey by similarity of sighting location taking into account the time interval between the sightings, and by similarity of species identification and group size. Abundance of cetaceans was estimated using unique sightings from the combined platforms, and by using the "independent observer" configuration under the assumption of point independence to estimate perception bias for the combined platforms.

Sufficient sightings of fin, common minke, blue, humpback, sperm, and long-finned pilot whales, and white-beaked and white-sided dolphins were made to warrant abundance estimation. A combined detection function including sightings of uncertain species identity was used for the two dolphin species as sighting numbers were insufficient to estimate each separately. Dolphin sightings of uncertain species were allocated by species proportion in strata. On the fall survey sufficient numbers of fin and humpback whales were made to warrant independent analysis, while encounter rates for other species were compared to those realized in the same area on the summer survey. Fall density was similar to that seen in the summer for fin whales, and higher for humpback whales, while encounter rates for other species were generally lower in the fall. Perception bias ranged from 0.87 for fin whales down to 0.31 for white-beaked and white-sided dolphins, and varied substantially between vessels for some species. Potential remaining biases include responsive movement, measurement and availability biases.

Discussion
Last-minute changes were made to the underlying fisheries survey design, so post-stratification was necessary. The Group **recommended** that the authors include a figure showing the planned stratification. In one stratum the design changes resulted in uneven coverage, and this might result in bias for particularly long-finned pilot whales (see item 5). The southern boundaries between the fisheries survey blocks and the cetacean designed blocks had been treated differently for common minke whales than for other species. The Group recommends applying the boundaries for common minke whales to other species, and move the effort in the top corner of IQ and include it in IR. which will help with the uneven stratification issue. The authors agreed to carry out this work.

There was some discussion by the Group of the conversion of wind speed to Beaufort that was described briefly in the paper. This will likely introduce additional variability (it would be a covariate that has error associated with it). The Group considered Beaufort sea state as estimated by observers to be more relevant to actual sighting conditions than measured wind speed. The authors agreed to find out if records of measured wind speed were kept by the vessels that reported Beaufort sea states. Further, the Group **recommended** that the Beaufort scale, when used by well-trained observers, be the standard means to estimate sea conditions in further surveys (rather than simply measuring/recording wind speed).

The Group also **recommended** that the process used for defining duplicates be better described, so the process can be replicated. The Group **recommended** that the authors conduct sensitivity analyses around using the different levels of duplicate certainty.

Analysis of bottlenose whale and common dolphin data should be attempted.

4.3 SC/25/AE/07 Icelandic Aerial 2016

Author's summary
The Icelandic aerial survey carried out in July 2016 is a continuation of a series of surveys, using nearly identical design and methodology, conducted in 1987, 1995, 2001, 2007, 2009 and. A survey was attempted in 2015 as part of the NASS, but was unsuccessful due to adverse weather conditions. In 2016 a Twin Otter aircraft was used, allowing a full double platform configuration with independent observers for the first time. Field methodology was otherwise similar to that used in earlier surveys, and produced data suitable for estimation using cue-counting (for common minke whales) or line transect (for other species) analyses. Duplicates were identified using a dissimilarity index incorporating differences in sighting time, declination, species ID and group size. Common minke whale abundance was estimated using standard cue counting methodology and the previously used cue rate, with estimates corrected for the proportion of sightings missed at radial distance 0 (*i.e.*, perception bias) using mark-recapture distance sampling (MRDS) methods. Abundance of white-beaked dolphins and harbour porpoises was estimated using standard line transect methodology corrected for perception bias using MRDS. The same approach was also attempted for common minke whales for comparison with the cue counting estimate. For this latter

analysis availability bias was corrected using data from common minke whales tagged off West Greenland, which spent 16% of the time in the 0-2 m depth interval where it was assumed they were visible to observers, and the average time that sightings were in view of observers. Correction of the estimates for white-beaked dolphins and harbour porpoises was also attempted but there were insufficient data on dive behaviour to estimate availability bias reliably for these species. Again in 2016 the survey was plagued by poor weather, with some effort flown on only 13 (48%) of 27 available days. Altogether, only 53% of planned effort was flown, the second lowest in the survey series. Coverage of individual strata ranged from 0% to 92%. These estimates should be treated with caution as in some cases only a small proportion of the stratum was sampled. Post-stratification is possible but will likely produce negatively biased estimates.

General Discussion

The main issue with the survey was the low and concentrated coverage in some strata, which could potentially lead to negative or positive bias in estimates. The problem will affect some species more than others, depending on their distribution in the survey area. Therefore, post-stratification so that only covered areas are included will be required, although it was recognized that this will not provide a full estimate for the survey area (See Fig 2).

Generally, the Twin Otter was considered a good survey platform, but the small bubble windows were fatiguing and painful for observers. The use of the newly-developed Geometer for measuring angles was very successful.

There was some discussion about whether to use average time in view vs. potential time in view to correct for availability bias in the common minke whale line transect estimate. The Group finds the method used in the paper, re-sampling the observed distribution of times in view to sightings, to be acceptable. However, the cue counting estimate was preferred for consistency with previous estimates. The methodology is also considered more appropriate for common minke whales for this survey because it requires less detailed information on diving and no assumption on how deep the animals can be seen under water, information which is not available for this area.

4.4 Norwegian non-minke species ship surveys

SC/25/AE/10- SC/25/AE/11 large whales and small odontocetes ship surveys 2002-2007

Author's summary

The abundances of large whale species (SC/25/AE/10) and small odontocetes (SC/25/AE/11) are presented for the northeast Atlantic shipboard survey conducted between 2002-2007. This survey was conducted as part of a six-year cyclical mosaic survey program with the goal of achieving management targets under the Revised Management Procedure for minke whales, as advised by the IWC Scientific Committee, as well as contributing to the synoptically conducted NASS. Tracking procedures implemented for minke whales meant that the surveys had to be conducted in passing mode for other species, resulting in limited opportunities for closing on sightings to determine species identity and school size. A total effort of 27,009 km was searched over the survey period 2002-2007, covering a total area of 2,962,269 sq. km. There were 865 records of large whale sightings. Of these, 24% were classified as fin whales, 29% as sperm whales, 31% as humpback whales, 1% as blue and sei whales, and 15% were categorized as 'unidentified large whale'. There were 960 records of small odontocete groups sighted and of these, 10% were classified as killer whales, 21% as harbour porpoises, 23% as white-beaked dolphins, 67% as *Lagenorhynchus* spp. The surveys were performed with two independent observer platforms and abundance estimates were obtained by combining sightings from both platforms and applying standard distance sampling techniques to truncated perpendicular distances for each species. The estimates for *Lagenorhynchus* spp. used sightings from a single platform (platform 1) due to higher uncertainty in judging duplicates, and the estimates for harbour porpoises were calculated two ways: using the complete survey dataset and separately using only the survey effort conducted at a Beaufort sea state of 2 or less to account for a likely decline in detection probability at higher sea states. The estimates for all species are preliminary and have not been analyzed with covariates or corrected for perception bias.

SC/25/AE/12 Norwegian large whales ship surveys 2015

Author's summary

Abundance estimates for large whales species are presented for the small management areas: EW in Norwegian Sea; and CM in the Jan Mayen area, based on independent double platform ship surveys conducted in 2015. The survey coverage of EW was part of a of a six-year cyclical mosaic survey program conducted over the period 2014-2019, while the survey coverage of CM was an extension to the NASS-2015 survey. Tracking procedures implemented for common minke whales resulted in limited opportunities for closing on sightings of other species to determine species identity and school size.

A total effort of 7,857 km of primary transects were searched in 2015, covering a total area of 1,458,127 sq. km. There were 118 records of large whale sightings observed from the upper platform. Of these, 47% were classified as fin whales, 32% as sperm whales, 12% as humpback whales, 2% as blue whales, and 8% were categorised as 'unidentified large whale'.

Abundance estimates were obtained by combining sightings from both platforms and applying standard distance sampling techniques to truncated perpendicular distances for each species.

General discussion on papers 10, 11 and 12
This Norwegian survey was designed for common minke whales, and therefore is not optimized for species such as fin, humpback, and sperm whales as indicated in the summary.

Noting that some strata were surveyed over two years, the Group **recommended** that these strata incorporate sightings and effort from both survey years in the estimates, rather than just one as was done for some species, as this will not bias the estimates.

In some cases the perpendicular distance data were binned into distance intervals before analysis. The Group recommends against this practice unless there is evidence of rounding of distances and angles, as it can hide real features of the data.

The Group supports the authors' plans to conduct a MCDS analysis of covariates, and a mark-recapture analysis to derive a perception bias correction. Once this work is completed, the Group will reconsider the estimates.

5. LONG-FINNED PILOT WHALE

5.1 NASS2015 estimate

Author's summary
SC/25/AE/04 included estimates of long-finned pilot whale abundance from the Icelandic and Faroese components of the 2015 NASS using the same general methodology described in SC/25/AE/06 for other species (see 4.2). In conformity with most previous estimates for this species, only sightings and effort made at Beaufort sea state 4 or lower were used. Mean school size varied significantly among blocks, ranging from 10 to 55. Density of long-finned pilot whales was highest around the Faroe Islands and to the southwest of Iceland (Fig. 1). Total uncorrected abundance was 435,192 (CV 0.37, 95% CI 202,919; 933,335). The average perception bias for the combined platforms was 0.74 (CV=0.09), resulting in a total corrected abundance of 589,691 (CV=0.38, 95% CI 269,116 to 1,292,140).

Discussion
The Group **recommended** adding the planned tracks to a map to better understand how the apparent aggregation of long-finned pilot whales in the NE edge of the IQ block is a function of realized survey coverage. In particular, the realized coverage probability in block IQ is not uniform. The Group expressed concern about the potential for positive bias arising from the contribution of this poorly-sampled block, and **recommended** that the authors should redo the design-based analysis using the post-stratification **recommended** above (see 4.2). In addition, a model-based estimate might be a better means to provide an abundance estimate than the current design-based approach. Since a model-based approach for these data is currently underway (see 14), the resulting density estimates could be extrapolated to produce absolute abundance estimates to compare with those produced using the design-based methods.

Once the required modification to the design-based estimate is completed, the Group will reconsider the estimate[1].

5.2 Trends

Author's summary
SC/25/AE/04 presented an analysis of trends in the abundance of long-finned pilot whales in the NASS and associated surveys, covering a large but variable portion of the North Atlantic 6 times from 1987 to 2015. Previous estimates of long-finned pilot whale abundance, derived using conventional distance sampling (CDS), are not directly comparable to one another because of different survey coverage and, in the case of the 1989 NASS, different survey timing. CDS was used to develop indices of relative abundance to determine if long-finned pilot whale abundance has changed over the 28 year period. The varying spatial coverage of the surveys is accommodated by delineating common regions that were covered by i) all 6 surveys, and ii) the 3 largest surveys (1989, 1995, and 2007). These "Index Regions" were divided into East and West sub-regions (Fig. 1), and post-stratification was used to obtain abundance estimates for these areas only. Estimates are provided using the sightings from the combined platforms or the primary platform only for surveys that used double platforms.

Total abundance in the Index Regions, uncorrected for perception or availability biases, ranged from 54,264 (CV=0.48) in 2001 to 253,109 (CV=0.43) in 2015. There was no significant trend in the numbers of individuals or groups in either the 6 or 3 Survey Index Regions, and no consistent trend over the period. Power analyses indicate that annual declines of 3% to 5%

[1] See Annex 1.

would have been detectible over the entire period. The Index Regions comprise only a portion of the summer range of the species and changes in annual distribution clearly affect the results. Operational changes to the surveys, particularly in defining long-finned pilot whale groups, may also have introduced biases. Recommendations for future monitoring of the long-finned pilot whale population are provided.

Discussion
The abundance trends estimated for data collected within the defined regions are likely acceptable, but it is difficult to make biological inferences from looking at such relatively small areas compared to the total summer range of long-finned pilot whales in the Northeast and Central Atlantic. These regions do not cover the full summer range of long-finned pilot whales in the area and their relation to the component contributing to the Faroese catch is unclear. The group **recommended** satellite tagging studies to define the area from which the Faroese hunt is recruited.

The Group noted that the approach used in the paper might be more appropriate for fin whales, as the defined regions better encompass the summer distribution range of this species.

The Group **recommended** that the next long-finned pilot whale survey at least include the full “3-SIR” region (Fig. 1), which encompasses a larger area, for compatibility with previous surveys.

NAMMCO has planned a long-finned pilot whale assessment for 2020. The Group **recommended** that a “pre-assessment” meeting be convened to determine (1) what long-finned pilot whale data are available and to identify gaps; (2) what approaches might provide the maximal information from these data (such as a model-based abundance estimation approach), and (3) whether additional or different data need to be derived or collected to answer questions around abundance trends, factors influencing density and distribution shifts, hunt recruitment area, and ultimately sustainability.

6. COMMON MINKE WHALE

6.1 Norwegian mosaic survey – previous cycle estimate

Author’s summary
SC/25/AE/13 presents preliminary estimates of abundance of common minke whales in parts of the northeast Atlantic based on data collected in the first four years of the Norwegian survey cycle 2014-2019. The drop in abundance in the Jan Mayen area which was observed in the survey cycle 2008-2013 to 40 % of the abundances as recorded in the two foregoing survey cycles, seems to have been reversed recently. In 2016, the abundance in the Small Management Area CM (Jan Mayen), was about 50 % higher than the estimates from the cycles 1996-2001 and 2002-2007, and four times that of 2010. The common minke whale abundance attributed to the Norwegian Sea has decreased steadily during the recent survey cycles. In the Svalbard area (ES) the common minke whale abundance in 2014 had decreased to 45% of the abundance level observed in 2008. In that year the common minke whale abundance in ES peaked for the period from the late 1980ies. This indicates that distributional shifts and scale of the shifts are important to understand to get a good handle on estimating population abundances of common minke whales.

Discussion
The final estimates will be based on data collected over the entire survey series and are therefore preliminary at this stage. In 2018 Norway will conduct a common minke whale survey in the North Sea. As there is evidence of large changes in distribution over the 30 year time series of these surveys, no conclusions on population level changes should be made until the conclusion of the full survey cycle.

To improve understanding of the survey design and realized effort, the Group requested that the authors add a map with planned transects, in addition to those lines that were completed, in their Fig. 1.

A synoptic survey of the Icelandic and Norwegian areas might be useful to determine the variance attributable to distributional change, and determine whether minke abundance numbers in the central and NE Atlantic are really changing. Another way of trying to understand the large scale distribution changes over time would be to incorporate the Icelandic and Norwegian data in a model based approach.

The group welcomed the information that will be provided by a project (See 14) modelling distribution of common minke whales and other species in these larger areas and investigating what environmental covariates are driving distributional changes. The project uses Icelandic, Faroese and Norwegian data from surveys conducted from 1987-2015

6.2 Norwegian 2015 CM survey
SC/25/AE/13 provides a preliminary estimate of common minke whale abundance in the CM Small Area of 17,500 (CV 0.35). This estimate is additive to the Icelandic and Faroese components of the NASS 2015.

The Group **accepted** the estimate as presented, recognizing that it may change slightly one the survey cycle has been completed. The estimate is additive to those from other NASS components.

6.3 Icelandic Faroese shipboard survey 2015 revised estimate

Author's summary
SC/25/AE/06 (summarized under item 4.2) updates the estimates for the Icelandic and Faroese ship survey components of the 2015 NASS that were accepted by NAMMCO in 2016 (SC/25/AE/O03). An update to the dataset increased the number of sightings in the Faroese blocks, resulting in a revised uncorrected estimate of 23,407 (CV 0.28, 95% CI 13,035; 42,032) and a revised corrected estimate of 42,515 (CV 0.31, 95% CI 22,896; 78,942). These are 19% and 17% higher than the originally accepted estimates.

Noting that the methodology used was identical to what was accepted in 2016, the Group accepted the revised estimate, pending an explanation of the increase in the number of sightings in the updated database.

6.4 Icelandic 2016 aerial survey

Author's summary
Estimates for common minke whales from the Icelandic aerial survey conducted in 2016 are provided in SC/25/AE/07 (summarized under Item 4.3). Common minke whales were encountered in low numbers in all areas surveyed, but encounter rates were highest in blocks 6 and 7 off eastern Iceland (Fig. 2). This is in contrast to earlier surveys when encounter rates were highest off western and southeastern Iceland. Of the 60 unique sightings of common minke whales, 16 (27%) were identified as duplicates. Of these, 25% did not cue, leaving 45 sightings for the cue counting analysis, of which 13 (29%) were duplicates. Density and abundance were highest in blocks 6 and 7, with block 7 accounting for 61% of the total estimate. Unfortunately block 7 was poorly sampled (37% of planned effort) and effort was concentrated in the central part of the stratum. Perception bias was estimated as 0.96 (CV 0.19). Abundance was also estimated using line transect methodology and MRDS correction for perception bias, which was estimated as 0.89 (CV 0.07). Average Time in View (TIV) was 5.21 seconds (CV 1.18) or 3.43 seconds (CV 0.70) excluding 5 outliers. Availability bias was estimated as 0.23 (CV 0.33) using all TIV data or 0.21 (CV 0.16) excluding outlier TIV data, resulting in estimates that differed from the cue counting estimate by 21% and 13% respectively.

Abundance was stable or slightly increasing in most strata and in the total survey area between 1987 and 2001. It decreased sharply by 2007 in all areas, such that total abundance in 2007 was 24 – 35% (depending which of the two available estimates from 2007 is used) that from the 2001 survey. By 2009 abundance was the lowest yet seen in all areas, just 40 – 55% that observed in 2007 and 14% that estimated in 2001. Similar levels, albeit with lower precision, were estimated in 2016. Of particular note is the continued near total absence of common minke whales from block 8 in recent surveys. This was an area of high density before 2007. There appears to have been some shift in distribution to the eastern part of the survey area, with blocks 6 and 7 showing higher abundance than previously.

Discussion
The Group agreed that some strata were too poorly covered for full stratum estimates to be acceptable. The Group **recommended** that the survey blocks be re-analysed by excluding the un-flown areas in the estimate, while recognizing that this will represent only a partial estimate of the total abundance in the survey area.

6.5 Central North Atlantic common minke whale estimate

Author's summary
SC/25/AE/08 provides "a joint analysis of the abundance of common minke whales in Central North Atlantic" as requested by the NAMMCO Scientific Committee in 2017 (NAMMCO, 2017, p. 11). This was to be based on the North Atlantic Sightings Survey (NASS) carried out in 2015, with surveys by Greenland, Iceland, the Faroes and Norway contributing to the estimate. "Central North Atlantic" is assumed to refer to the Central Medium Area (CMA) as defined by the IWC. Estimates of common minke whale abundance in 2015 by jurisdiction are presented elsewhere (Hansen *et al*. 2018, SC/24/AE/06, SC/25/AE/07, SC/25/AE/15) and the specifics of those estimates will not be repeated here.

Post-stratification was applied to the Icelandic/Faroese portions of the survey to eliminate areas of overlap or divide strata that straddled the CMA border. These included sub-division of a western stratum to break out a small area of overlap with the East Greenland survey area, and sub-division of Faroese stratum FW into east and west divisions at the CMA border. Abundance was estimated for the new dataset using methods identical to those described in SC/25/AE/06 for common minke whales. Variance estimates from the 3 surveys were considered independent and additive, and log-normal confidence intervals were calculated for the summed survey estimates. Density of common minke whales was highest in the Norwegian survey blocks, especially CM1a, and in coastal Icelandic waters. The total estimate for the CMA is 48,016 (CV 0.23, 95% CI 30,709;

75,078). The Icelandic/Faroese survey area accounted for 58% of the total estimate, while the Norwegian and Greenlandic survey accounted for 36% and 6% respectively. Coverage was poor in some areas, and the CMA south of 52° N, an area where common minke whales have been sighted in some previous surveys, was not surveyed. All estimates were corrected for perception bias, and availability bias is likely of little concern for ship surveys of common minke whales. There appears to be large fluctuation in distribution and abundance both within the CMA and between it and other stock areas.

Discussion
The Group adopted the CMA abundance estimate presented.

However, since the distribution of common minke whales in the CMA and other North Atlantic stock areas appears to be quite dynamic, and there is little evidence of stock structure among feeding areas in the North Atlantic, the stock area boundaries are putative and do not represent true stock divisions. The abundance estimate provided does not correspond to any biologically meaningful unit and is not required for management purposes. However, it can be useful as complementary to other such medium areas such as the Northeastern Atlantic area covered by Norway.

The Greenland aerial survey occurred later in the season, but the lack of vessel sightings in the adjacent block suggests there was not a large influx of common minke whales at this time.

7. LARGE BALEEN WHALES

7.1 Norway – large baleen whales, 2002-7 survey cycle

Fin whales
Fin whales were found throughout the survey area but were especially abundant west of Spitsbergen, in the Barents Sea, and in the western, Iceland-Jan Mayen, survey blocks (NVN, NVS, JMC) (Fig. 3). A half-normal model with cosine adjustment (order: 2) provided the best fit to the combined platform data, which was grouped into 10 intervals and truncated at a perpendicular distance of 4000 m. The fitted detection function resulted in an effective strip half-width (*esw*) of 1431.2 m and a total survey abundance estimate, uncorrected for perception bias, of 10,102 (CV 0.24).

See discussion under Item 4.4. The Group will await the required revisions before re-considering this estimate.

Humpback whales
Humpback whales were found mainly around Bear Island, with two additional concentrations in the northern Barents Sea and the western-most survey block, north and east of Iceland (NVS) (Fig. 4). A hazard rate model was found to give the best fit to the combined platform data, grouped into 8 intervals and truncated at a perpendicular distance of 3,500 m. The fitted detection function resulted in an *esw* of 1,793 m and a total survey estimate, uncorrected for perception bias, of 7,352 (CV 0.31).

See discussion under Item 4.4. The Group will await the required revisions before re-considering this estimate.

7.2 Norwegian shipboard survey 2015

Fin whales
Fin whales were the most abundant large whale species seen in the survey, with a total of 55 sightings, 80% of which, occurred in the northern most quarter of EW1, off North Norway (Fig. 5). A half-normal model provided the best fit to the combined platform data, which was grouped into 7 intervals and truncated at a perpendicular distance of 4000 m. The fitted detection function resulted in eshw of 1298.7 m and a total survey abundance estimate of 1,746 (cv 0.36).

Humpback whales
A total of 14 humpback whale sightings were made in the 2015 surveys and ~80% of the sightings occurred in block EW1, off Northern Norway (Fig. 6). Even with the pooling of sightings across survey blocks, humpback whale sightings were too low in number (n=14) to effectively fit a detection function; therefore, sighting data from the 2016 surveys were used in addition to the 2015 sightings, to model detection. A hazard rate model gave the best fit to the combined platform data, grouped into 8 intervals and truncated at a perpendicular distance of 2000 m. The fitted detection function resulted in an eshw of 1793 m and a total survey estimate of 1,034 (cv 0.37).

Discussion
See general discussion under Item 4.4. The Group noted that these estimates are a component of the mosaic survey cycle to be completed in 2019, however the estimates for 2015 should be additive to other components of the NASS. The Group will await completion of required analyses before re-considering these estimates.

7.3 Iceland/Faroes 2015 revised estimate for fin whale

SC/25/AE/06 updates the estimates that were accepted by NAMMCO in 2015 (SC/25/AE/O03). A coding error resulted in inflated group sizes for a few sightings. Using the same assumptions about species certainty and the same modelling procedures, the revised uncorrected estimate is 33,828 (CV 0.17, 95% CI 23,660; 48,365) while the revised corrected estimate is 38,931 (CV 0.17, 95% CI 27,097; 55,933). The latter is 5% lower than the previously accepted estimate.[2]

Discussion

The revised estimate was accepted by the Group.[3]

7.4 Iceland/Faroes 2007/15: other species

Humpback whales 2015

A total of 106 humpback whale groups were sighted, and as in most previous surveys they were most commonly sighted to the north and northwest of Iceland in blocks IW and IG (Fig. 7). Unlike in previous surveys, substantial numbers were sighted in the Faroese strata FC and FW. Humpback whales were the most commonly sighted species in the fall survey. Humpback whales occurred most commonly as single animals but rarely larger groups of up to 7 were sighted, particularly in the eastern part of the survey area. Total uncorrected abundance, including all species certainty categories was 6,771 (95% CI 3,643; 12,584). Exclusion of the least certain species category (MN??) resulted in a 4% decrease of this estimate. Mean density during the fall survey was 25% higher than density in the same area realized in the summer survey. Overall 24% of sightings were identified as duplicates, but this proportion varied by vessel, with the Faroese vessel having 0 duplicates out of 15 sightings. The average combined platform probability of sighting a whale at perpendicular distance 0 ($p(0)$) was 0.69 (CV 0.21). The total corrected estimate, using all categories of species certainty was 10,031 (95% CI 4,962; 20,278). This is 46% lower than the corrected estimate for 2007. Although the difference is not statistically significant ($p>0.05$), it suggests that the previously observed increase in humpback whale numbers has stabilized or reversed.

Discussion

The group commented that it would be helpful when presenting results for a review to report results for some of the different detection function models attempted and how they affected the results. This would not necessarily be for publication, but to facilitate the discussion.

Noting that the planned post-stratification (see 4.3) will have little effect on this estimate, the Group accepted it as presented.[4]

Blue whales 2015

Sightings of blue whales were concentrated to the north and west of the survey area, particularly off the east coast of Greenland (Fig. 8). Blue whales were uncommonly sighted in the eastern half of the area. Most blue whale sightings were of single animals. Only one blue whale was sighted in the fall survey. Uncorrected density and abundance was greatest in block IR, which alone accounted for about half of the total estimate of 2,484 (CV 0.36, 95% CI 1,230; 5,015). Exclusion of the most uncertain species identifications reduced abundance by 6%. Overall 22% of sightings were duplicates but this varied between vessels from 4% to 67%. Estimated $p(0)$ was 0.83 (CV 0.11) and corrected abundance in the survey area totaled 2,993 (CV 0.40, 95% CI 1,386; 6,463).

Discussion

Noting that the planned post-stratification (see 4.2) will have little effect on this estimate, the Group accepted it as presented.[5]

8. SPERM WHALES

The Group noted that only male sperm whales have been captured or stranded in the northern North Atlantic, suggesting extreme sexual segregation in northern waters with females and young being restricted to waters further south (Whitehead 2003). The estimates noted below therefore apply to the male portion of the population.

Sperm whales are extreme deep divers, often remaining underwater for periods of an hour or more (Jaquet *et al.*, 2000, Papastavrou *et al.* 1989, Whitehead *et al.* 1992). They also exhibit extreme sexual dimorphism with males being much larger than females, and able to make longer dives (Jaquet *et al*. 2000, Whitehead *et al*. 1992). This has implications for abundance

[2] See Annex 1.

[3] See Annex 1.

[4] See Annex 1.

[5] See Annex 1.

surveys as sperm whales may be underwater during the passage of the vessel and thus not detectable by observers, termed availability bias. None of the estimates described below are corrected for this bias.

8.1 Norway – 2002-2007 and 2015

From 2002-2015, the vast majority of sperm whale sightings were made over the deep waters of the Norwegian Sea, south of the Mohn ridge between Jan Mayen and Bear Island (Fig. 9). A half-normal model gave the best fit to the combined platform data, which were truncated at a perpendicular distance of 2,500 m. The fitted detection function resulted in an *esw* of 1,403 m and an abundance estimate, uncorrected for perception bias, of 9,402 (CV 0.22).

In 2015, the vast majority of the sightings were made in the Norwegian Sea, in strata EW3 and CM1a (Fig. 10). A half-normal model gave the best fit to the combined platform data, which was unbinned and truncated at a perpendicular distance of 2,000 m, resulting in an estimate for *esw* of 980 m. Abundance in the area surveyed totaled 4,896 (CV 0.26).

Discussion
See discussion under Item 4.4. The Group will await the required revisions before re-considering this estimate. In addition, the Group **recommended** that the authors explore the estimation of availability bias correction for this long-diving species.

8.2 Iceland/Faroes – 2007 and 2015

2007
Sperm whales were found throughout the survey area but were seen in greatest numbers around the Faroes and to the south and west of Iceland (Fig. 11). A total of 73 sperm whales were recorded in the core survey area by the dedicated vessels, and 23 were seen in the central Norwegian Sea to the northeast of the core survey area by the extension vessels. The majority (78%) of sightings were of single animals and the maximum group size observed was 7. There was some evidence that the number of sightings was depressed close to the trackline, possibly indicating responsive movement or diving in reaction to the vessel. However there was insufficient tracking data to confirm this. Density and abundance in the T-NASS core area was highest in blocks SC and RN, which together accounted for 65% of the total uncorrected estimated abundance of 6,429 (CV 0.28, 95% CI 3,412; 10,007). Adjustment for possible measurement bias by the primary platform reduced total uncorrected abundance by 19%. Observers on the primary platform duplicated 52% of the sightings made by the tracker platform while in B-T mode. Perception bias ($p(0)$) for the primary platform was estimated as 0.58 (CV 0.25) yielding a corrected abundance of 12,220 (CV 0.38, 95% CI 5,808; 25,717). Adjustment for possible measurement bias by the primary platform reduced total corrected abundance by 19%. Encounter rate by the dedicated vessels was 6.7 times higher than that by the extension vessels in the strata where they overlapped.

Discussion
See general discussion under item 4.1. The Group accepted the estimates as presented, without correction for possible measurement bias, as the best available for the survey.

Sperm whales 2015
Sperm whales were found throughout the survey area but were seen in greatest numbers in the Faroese blocks FC and FW (Fig. 12). They occurred most commonly as single animals but were rarely found in groups of up to 5 in number. Four sightings were made in the fall survey, and encounter rate in the area was nearly the same as that observed in the summer. The detection function for the Icelandic vessels was flat out to 2,000 m from the trackline, while that for the Faroese vessel declined steeply from 0 to 1,000 m from the trackline. Vessel identity with the two Icelandic vessels combined was included as a covariate in the hazard rate detection function to account for this. Uncorrected density and abundance were highest in the Faroese blocks FC and FW which together accounted for 78% of the total estimate of 7,368 (CV 0.35, 95% CI 3,548; 15,300). Exclusion of the least certain species identity reduced total abundance by 3%. Of the 76 sightings made by the Icelandic vessels, 29% were duplicates. In contrast, only 6% of the sightings made on the Faroese vessel were duplicates. Best fit for the conditional detection function was achieved again by including a covariate for vessel nationality. The proportion of sperm whale detected on the trackline ($p(0)$) was estimated to be 0.34 for the combined vessels. Corrected abundance for the survey areas was estimated to be 23,311 (CV 0.59, 95% CI 7,789; 69,771), with 91% of this total accounted for by the Faroese blocks FC and FW. This estimate is likely negatively biased to an unknown degree by availability bias for this long-diving species. The uncorrected estimate is similar in magnitude to those from 2001 and 2007, but the corrected estimate is nearly double that from 2007, primarily due to the lower $p(0)$ in 2015.

Discussion
The Group discussed the relatively high magnitude of perception bias, especially for the Faroese vessel, incorporated into the corrected estimate. This is a result of a low number of duplicate sightings, even close to the transect line, for this vessel. It was also noted that the detection function is much narrower for the Faroese vessel than for the others. Covariates were incorporated into the distance and MR detection functions to account for these differences. Sperm whales were not a target species of the survey, and, even though they are a large whale, they can be cryptic and difficult to sight under some conditions.

In addition, availability is lower for this long-diving species than for baleen whales, which leads to an overall lower probability of detection for all observers. The Group was unable to explain with certainty why perception bias was higher for this survey than for some others (*e.g.*, 2007), but noted that sample sizes were low and the high variance of the estimate reflected this uncertainty. Noting that the required post-stratification will likely not affect the estimate for this species, the Group accepted the estimates as presented.[6]

9. DOLPHINS AND PORPOISES

Noting that there were a small number of exceptionally large groups recorded by all surveys, it was **recommended** that these should be estimated separately using a strip transect if appropriate, but this should be done only if these large group sizes fall outside of the group size distribution of most of the sightings, rather than being part of a continuous distribution.

9.1 Iceland/Faroe Islands shipboard – 2007 and 2015

See general discussion under Item 4.1 and 4.2.

White-beaked and white-sided dolphins 2007

White-beaked dolphins were seen at the western side of the survey area, and in the northern Norwegian Sea and Barents Sea by the extension survey (Fig. 13). A total of 28 sightings were made by the dedicated vessels and an additional 28 were made by the extension vessels. The modal group size was 7 but groups as large as 100 were rarely observed. White-sided dolphins (23 dedicated, 4 extension) were observed south of Iceland, especially in strata FS, SC and RN (Fig. 13). Group sizes of 2-12 were most common, with occasional sightings of groups of up to 50 in number. There was no evidence for responsive movement by white-sided dolphins, while too few white-beaked dolphin groups were tracked to assess this. The numbers of sightings of each species were insufficient to derive individual detection functions, so a combined detection function was used. A covariate for species identity was included to account for any differences in scale due to species identity.

Density of white-beaked dolphins was highest in stratum NW but stratum RN accounted for over half the total uncorrected estimated abundance of 86,255 (CV 0.47, 95% CI 30,512; 243,835). Adjustment for possible measurement bias by the primary platform reduced total uncorrected abundance by only 0.2%. There was only 1 sighting of white-beaked dolphins in the overlap area between the dedicated and extension surveys, and encounter rate was 4.2 (CV 0.80) times higher for the dedicated vessels in the same area. Observers on the primary platforms on the dedicated vessels re-sighted 33% of the L. spp. dolphins seen by the tracker platform observers, resulting in an estimated p(0) of 0.71 (CV 0.37) for the primary platform and a corrected abundance estimate of 111,183 (CV 0.59, 95% CI 36,346; 340,114). Adjustment for possible measurement bias by the primary platform decreased the corrected estimate by 29%.

Density and abundance of white-sided dolphins was highest in stratum SC to the south of Iceland, which contributed 55% of the total uncorrected estimated abundance of 32,396 (CV 0.40, 95% CI 14,609; 71,838). Adjustment for possible measurement bias by the primary platform reduced total uncorrected abundance by 23%. There was 1 sighting of white-sided dolphins by the extension vessels in the T-NASS core strata, and encounter rate was 4.8 (CV 1.09) times higher for the dedicated vessels in the same area. Total corrected abundance of white-sided dolphins was 42,547 (CV 0.42, 95% CI 17,537; 103,225) and adjustment for possible measurement bias by the primary platform decreased this estimate by 13%.

Discussion

The Group noted that there was higher confidence in species identification in 2007 than in previous surveys or in 2015. This was probably due to the presence of dolphin specialist observers and the use of big-eye binoculars on the vessels in 2007, which led to more emphasis on dolphin species identification in the survey.

The Group accepted the estimates, uncorrected for possible measurement bias, as presented.

White-beaked and white-sided dolphins 2015

White-beaked and white-sided dolphins are not easily discriminated at sea and a relatively high proportion (31%) of sightings were classified as unknown *Lagenorhynchus* spp. dolphins. White-beaked dolphins (26 sightings) were found almost exclusively in the western half of the survey area, most frequently off western Iceland and close to East Greenland (Fig. 14). White-sided dolphins (16 sightings) were found in the Faroese blocks FC and FW, and less frequently near East Greenland (Fig. 15). *L*. spp. dolphins were rarely sighted as single animals, and were more commonly in groups ranging in size from 2 to 43 animals. Eleven groups of white-beaked dolphins in groups ranging in size from 1 to 8 were sighted in the fall survey in an area where none were sighted in the summer. Most of these were seen close to the coast of NW Iceland. Because of the low overall number of sightings, a combined detection function incorporating species identity as a covariate was employed. Unidentified *L*. spp. dolphins were allocated to species according to their proportional occurrence by stratum (Fig. 16). White-

[6] See Annex 1.

beaked dolphins were most abundant in block IR, which accounted for nearly half the total uncorrected estimate of 56,909 (CV 0.34, 95% CI 29,243; 110,750). This is 48% higher than the estimate using only positive identifications of white-beaked dolphins. White-sided dolphins occurred in greatest density and abundance in block FW, which accounted for 64% of the total uncorrected estimate of 32,409 (CV 0.58, 95% CI 10,657; 98,876). This is 5% higher than the estimate using only positive identifications of white-sided dolphins. The Faroese vessel had the lowest rate for duplication of L. spp. dolphins, in this case all of white-sided dolphins, of 7%, compared to 14%, mostly for white-beaked dolphins, realized on the combined Icelandic vessels. The proportion of dolphins detected on the trackline ($p(0)$) was estimated as 0.31 (CV 0.55) and total abundance corrected for perception bias and including unidentified dolphins allocated to species was 163,183 (CV 0.64, 95% CI 50,601; 526,248) for white sided dolphins and 129,991 (CV 0.74, 95% CI 34,824; 485,241) for white-beaked dolphins. Uncorrected estimates are of similar magnitude to those estimated in 2007.

Discussion
See general discussion under Item 4.2. Given the uncertainty in species identification in this survey (in contrast to 2007), the Group **recommended** sensitivity analyses excluding the most uncertain identification category. In addition the noted stratification problems may be an issue for these species. The Group will therefore await the completion of requested analyses before re-considering these estimates. [7]

9.2 Iceland aerial 2016

White-beaked dolphins
White-beaked dolphins were the most numerous sightings in the survey with 222 sightings, of which 66 were duplicates. Some very large aggregations were sighted, particularly in the northeast (Fig. 17). Encounter rates were highest in block 4 off the north coast and block 6 off the east coast. Sighting numbers were lower than expected within 100 m of the trackline so left truncation at this distance was employed. Estimates of effective strip width and mean group size were applied at the stratum level to produce an uncorrected total estimated abundance of 42,908 (CV 0.42; 95% CI 18,536; 99,328). Perception bias for the combined platforms was estimated as 0.72 (CV 0.13), resulting in a total abundance corrected for this bias of 59,966 (CV 0.44; 95% CI 24,907; 144,377). Despite the poor coverage, the uncorrected estimate for 2016 is over twice that realized in any earlier survey and significantly larger than the 1995 estimate.

Discussion
See general discussion under Item 4.3 Although the poor coverage will have little effect on this estimate as there were few sightings in the affected strata, the Group will await the requested post-stratification before re-considering this estimate.

Harbour porpoises
A total of 91 unique sightings of harbour porpoises were made, of which 7 were duplicates. Harbour porpoises were sighted in all areas except off the south-central and southeast coasts, and tended to have a nearshore distribution except in the southwest where they were sighted far offshore (Fig. 18). Encounter rates were highest off western and northern Iceland. Sighting numbers were lower than expected within 100 m of the trackline so left truncation at this distance was employed. Uncorrected total estimated abundance was 10,506 (CV 0.26, 95% CI 6,120; 18,036). Perception bias for the combined platforms was estimated as 0.45 (CV 0.41), resulting in a corrected total abundance estimate of 22,806 (CV 0.48; 95% CI 9,166; 56,746). Despite the poor coverage, the uncorrected estimate is at least double that of all previous estimates other than that from 2007, when a specialist harbour porpoise observer was employed and all known biases were corrected. Availability bias is likely substantial for this species but dive profile data from the survey area are lacking.

Discussion
See general discussion under Item 4.3. Although the poor coverage will have little effect on this estimate as there were few sightings in the affected strata, the Group will await the requested post-stratification before re-considering this estimate.

9.3 Norway – last two survey cycles

White-beaked dolphins (mostly)
Lagenorhynchus spp. were found in almost all blocks within the study area, with the highest number of sightings around Bear Island, but after accounting for effort, the largest abundances were estimated for the North Sea (NS) and the Barents Sea (BAE) (Fig. 19). White-beaked dolphins showed a similar distribution. A half-normal model with cosine adjustment (order 2, 3) gave the best fit to the platform 1 data, which was grouped into 8 intervals and truncated at a perpendicular distance of 1,200 m. The fitted detection function resulted in an *eshw* of 392 m and a survey estimate of 263,830 (CV 0.21). Separate abundances for positively identified white-beaked dolphins were estimated from a hazard-rate model with sighting data grouped into 10 intervals and truncated at 1,000 m, yielding an overall estimate of 146,160.

[7] See Annex 1.

Discussion
See general discussion under Item 4.4. For dolphins, the authors used data from a single platform to derive an abundance estimate as it proved impossible to reliably identify duplicate sightings for this species. The Group concurred with the authors that the platform 1 estimate should be used, as the other platform had a somewhat obstructed view. Separate platform estimates could be developed and averaged but the group was concerned that variance would be underestimated by this approach as some proportion of the sightings would be duplicates, so the estimates would not be independent.

An estimate derived by combining *Lagenorhynchus* sp. and white-beaked dolphin sightings is likely more accurate than one for positively -identified white-beaked dolphins alone since previous surveys suggested that 90% of *Lagenorhynchus* sp. dolphins in the area were white-beaked dolphins (Øien 1996).

The Group suggested that the authors consider evidence for responsive movement in descriptions of their data.

The Group will await an updated analysis before re-considering the revised estimate.

Harbour Porpoises
Harbour porpoises were found to be in highest abundance in the North Sea blocks NS and NC2 with additional concentrations in the Barents Sea (blocks KO and GA) (Fig. 20). Harbour porpoises were generally found in the shelf waters within the study region and were absent from the western and northern-most survey blocks. A hazard rate model provided the best fit to the combined platform data, grouped into 8 intervals and truncated at a perpendicular distance of 700 m. The fitted detection function resulted in an *esw* of 266 m and a total survey estimate of 113,110 (CV 0.19). Beaufort sea state was included as a covariate, but did not improve the model fit or have a significant effect on the estimates. A separate analysis of harbour porpoise sightings using only survey effort conducted during a Beaufort sea state of 2 or less (a total of 12,752 km), produced a total of 85 sightings and an overall abundance estimate of 80,083 (CV 0.39), roughly 70% of the abundance estimated from the complete survey dataset, under Beaufort sea states between 0-4.

Discussion
See general discussion under Item 4.4. The Group **recommended** including effort and sightings from higher sea states, rather than limiting to Beaufort 0-2, as this does not seem to introduce a negative bias for this survey. It was noted that this is unusual for this species, as other surveys usually include data up to Beaufort 2, as sighting rates usually drop in sea conditions of Beaufort 3 and above(*e.g.* Hammond *et al*. 2017).

The Group will await the required analyses before re-considering this estimate.

10. KILLER WHALES

10.1 Norway – last two survey cycles

The vast majority of killer whale sightings were made in the Norwegian Sea south of the Mohn ridge in block NOS. They were also fairly abundant in the Icelandic-Jan Mayen survey blocks (NVN, NVS) (Fig. 21). Best fit of the detection function was achieved with a half-normal model fit to the combined platform data, which was grouped into 10 intervals and truncated at a perpendicular distance of 1,000 m. The fitted detection function resulted in an *esw* of 599 m and an uncorrected abundance estimate of 29,677 (CV 0.25).

Discussion
See general discussion under item 4.4. The preliminary uncorrected estimate for killer whales is substantially larger than previous estimates.

As for dolphins, the Group **recommended** that the authors treat the “unusually” large groups of killer whales differently (see 9). The Group will await completion of required analyses (see 4.4) before re-considering this estimate.

11. SCANS III 2016 UPDATE

Hammond presented abundance estimates from the SCANS-III survey of European Atlantic waters in summer 2016 (NAMMCO SC/25/AE/O01), the third in the SCANS series of surveys, previously conducted in 1994 (SCANS) and 2005/07 (SCANS-II/CODA). The survey was supported by the governments of Denmark, France, Germany, the Netherlands, Norway, Portugal, Spain, Sweden and the UK. Shelf waters from 62°N to the Strait of Gibraltar were surveyed by air. Norwegian inshore waters north to Vestfjorden were surveyed (by air) for the first time. Inner Danish waters, and offshore waters to the west of Britain, France and Spain were surveyed by ship. Irish waters (except for the Irish Sea) were not included in SCANS-III but were surveyed as part of the Irish ObSERVE project. To account for perception and availability bias, aerial surveys used the circle-back method for (a) harbour porpoise, (b) minke whale and (c) all species of dolphin combined; and ship surveys used double-team tracker-primary configuration methods as in previous SCANS/CODA surveys.

Data were sufficient to estimate abundance for harbour porpoise, bottlenose dolphin, Risso's dolphin, white-beaked dolphin, white-sided dolphin, common dolphin, striped dolphin, pilot whale, all beaked whale species combined, sperm whale, minke whale, and fin whale. The most abundant species were harbour porpoise (467,000, CV=0.15), which were distributed throughout shelf waters, and common (468,000, CV=0.26) and striped dolphins (372,000, CV=0.33), with a further 158,000 (CV=0.19) common or striped dolphins unidentified to species, distributed mainly on and off the shelf in the Bay of Biscay and in Portuguese coastal waters. Fin whales (18,100, CV=0.32) were concentrated in offshore waters of the Bay of Biscay with only a few sightings west of Scotland. Minke whales (14,800, CV=0.33) were mainly distributed in shelf waters of the north/central North Sea and west of Britain. White-beaked dolphins (36,300, CV=0.29) were found only in the northern North Sea and shelf waters west and north of Scotland.

Unlike in previous SCANS surveys, there was no evidence at all of any responsive movement on the ship surveys and partial independence (PI) models for estimating detection probability were therefore used for all species for which there were sufficient data to use double team data. In contrast, full independence (FI) models had been used for analysis of all species in analysis of SCANS and SCANS-II shipboard data. However, because evidence for responsive movement in previous surveys was weak (except for common dolphins in SCANS-II) and because the FImodel typically underestimates abundance, SCANS and SCANS-II shipboard data were re-analysed using the PI model so that they were consistent with estimates from SCANS-III. In addition, SCANS and SCANS-II aerial estimates were revised to use the SCANS-III circle-back estimates of g(0) for dolphins and minke whales. The main effect of these revisions was to increase estimates for harbour porpoise and white-beaked dolphins in 1994 and 2005. Comparing comparable estimates from all three SCANS surveys showed no trend in abundance for harbour porpoise and white-beaked dolphin in the North Sea, or harbour porpoise in inner Danish waters. Including NILS estimates showed no trend for minke whale abundance in the North Sea. A simple power analysis showed that the North Sea data had 80% power to detect annual rates of decline of 2% for harbour porpoise, 5% for white-beaked dolphin and 0.5% for minke whale.

Until results are available from the Irish ObSERVE surveys, it is not possible to compare estimates of abundance for 2016 with those from SCANS-II/CODA in 2005/07.

Discussion

The Group thanked Hammond for the update, which provides important information on cetacean distribution and abundance in areas adjacent to the NASS survey area. The Group supported the continuation of this survey series, which ideally should be coordinated with future NASS.

The Faroese block was included in the analysis of the 2007 CODA for some species *(*Hammond *et al. 2009,* Rogan *et al*. 2017), and it may also be of interest to do that again as the strata were contiguous, although the surveys were in two consecutive years. For spatial modelling, it would also be interesting to include the data from the Irish ObSERVE survey.

There were more sightings associated with video imaging for measuring distances than in previous surveys. The use of video imaging should be investigated for future NASS survey, as well as other relevant technical improvements implemented in SCANS III.

12. CANADIAN NAISS ESTIMATES

To assess long-term changes in the distribution and abundance of cetaceans in the northwest Atlantic the Department of Fisheries and Oceans (DFO) conducted a second large-scale aerial survey of Atlantic Canadian shelf and shelf break habitats extending from the northern tip of Labrador to the U.S border off southern Nova Scotia in August and September of 2016. Using three fixed-wing aircraft DFO achieved almost the same coverage as DFO's comparable large-scale marine megafauna survey in 2007 (TNASS); poorer weather and an extended NATO naval exercise meant that DFO completed 92.6% of their planned lines in 2016, versus 99.0% in 2007. During the 2016 Northwest Atlantic International Sightings Survey (NAISS) observers in survey aircraft collected data on the identity, group size, position, and behaviour of large and small cetaceans, plus environmental covariates. Almost twice as many cetaceans (841 sightings of 8,660 animals) were sighted in the Labrador and Newfoundland areas as in 2007 (584 sightings of 3,691 animals), although there were fewer large whales (fin, humpback, minke); white-beaked dolphins were the most encountered and numerous cetacean. Most of the additional 2016 sightings were collected on the Labrador and Newfoundland NE coasts. The two Skymaster teams amassed slightly fewer cetacean sightings in the Gulf of St. Lawrence, Scotian Shelf, and Bay of Fundy (1,035 sightings of 4,449 animals) than they did in 2007 (1,217 sightings of 7,803 animals) despite greater effort in both Scotian Shelf and Bay of Fundy in 2016. Using Distance sampling approaches to estimate species abundance and derive detectability bias corrections for the common cetaceans, it appears that the abundance of cetaceans in eastern Canadian waters, particularly white-beaked dolphins (536,016, CV=0.39), has grown. Harbour porpoise were also much more abundant in 2016 (256,355, CV=0.40). Minke (19,166, CV=0.41), fin (4,412, CV=0.45), and humpback (10,293, CV=0.44) whale abundances were greater in 2016. Whether these changes in abundance are due to population growth and/or changes in distribution is unknown in most cases.

Discussion
The Group thanked Lawson for conveying these results and encourages the timely completion of these analyses.

The Group noted that there was relatively high perception bias for some species. This could be due to the size of the bubble windows in the aircraft used. Mark-recapture estimates were aggregated over a number of years. This was possible because the observers and platforms where consistent between surveys.

The Group **recommended** that survey timing be coordinated with US surveys to get a better picture of abundance along the North American coast, as this is a migration corridor for many species. Possible seasonal changes in distribution makes interpretation of the numbers from the US and Canada problematic. The timing of the 2016 survey seems more ideal for estimating abundance in Canadian waters. Newfoundland and Labrador strata showed large increases in estimates for all species, which may be partly due to the survey starting two weeks later than in 2007. In 2007, there were a large number of whales sighted in US waters and although the US data for 2016 are not currently available, it was noted that their surveys did not capture the same large aggregation of whales found in 2007 at their northeastern border.

13. PUBLICATION OF SURVEY RESULTS

Pike informed the Group that a new volume of NAMMCO Scientific Publications is in development that will include results from NASS since 2001, surveys from other areas, compilations of multiple surveys such as trend analyses, and recent methodological developments such as the Geometer. Up to 14 papers will be included in the volume and so far 2 papers have completed the peer review process. Some of the working papers considered at this meeting will form the basis of publications for this volume.

14. FUTURE SURVEYS

Extent
The next survey should have similar coverage to the 2015 survey with a south-eastern expansion of the survey area for pilot whales to achieve coverage similar to what was achieved in 2007 in combination with CODA. The latter could best be achieved by coordination with a possible future European survey.

Timing
Given that the past interval between surveys has been 2-8 years, the next NASS survey should occur in 2021 at the earliest after an interval of six years. The Group recommends the on-going collaboration and coordination of surveys with other jurisdictions including continental Europe, the UK, Canada and the USA. Lawson informed the Group that Canada will likely not do another survey until 2026 (10 year cycle).

Planning for 2021 should begin 2.5 years in advance of the survey. The Council will need a proposal for the next meeting in March 2019. The Scientific Committee meets in November and will work on the proposal for the March Council meeting.

Priorities for next survey
The primary purpose of the NASS is to obtain accurate and unbiased abundance estimates of cetaceans for use in management, and also for monitoring and general ecological studies. Other priorities that would enhance this primary objective follow below.

Biopsy sampling
Biopsy sampling should be considered. This is especially important for pilot whale stock structure. Attempted satellite tagging of pilot whales in deep water has not been successful so far, which could have implications for biopsy sampling as well.

A better understanding of stock structure will help in interpreting abundance estimates in the framework of an assessment.

Satellite tagging
Tagging (and associated costs) should be planned in association with the survey plan and budget to estimate availability bias for IO ship and aerial surveys, and to contribute to our understanding of seasonal movements. The tagging should be planned to occur over multiple years, not only during the survey period, in order to maximize the opportunities. In Greenland, small amounts of tagging are done continuously as opportunities arise. The extra costs and time allocation of tagging activities should be budgeted in the survey plan.

Tagging will also bring information on the extent of the population contributing to the Faroese hunt and will inform the design of the survey.

Improving Group Size estimates
The use of drones (as planned by the Faroes) could be considered for school size estimation in advance of the survey to determine its potential value. Drones could also be used to confirm distance measurements. A protocol for deployment and use of the drone should be developed, following the review of the drone data collected in 2015 in the Faroese survey.

The Group discussed the feasibility of using aerial effort in ship strata to estimate group sizes for the ship surveys, but did not come to a conclusion. The usefulness of the proposed method should be discussed further.

Improving distance estimation on ship surveys
This requires using a tool for measuring distances, which may require changing searching methods for the primary platforms to use binoculars equipped with reticles or video.

Future extension surveys:
These should be considered only if they can incorporate double platforms and extend the survey into areas that are not covered by other surveys (see 4.1).

Other recommendations:
The Group noted the many recent developments in survey methodology, including the use of drone aircraft, automated detection of animals on video or still pictures, and technological developments such as the Geometer. They therefore **recommended** that the Scientific Committee consider hosting a workshop on the general topic of "Novel methods for abundance surveys and estimation". This should preferably be held before the next NASS. If adopted, cooperation with other organizations, such as the IWC, and other jurisdictions should be sought.

An ongoing graduate project at SMRU is using the NASS/NILS data series (Icelandic, Faroese and Norwegian up to 2015 as the basis of a large-scale spatial analysis to investigate which environmental features best explain spatial and temporal variation in density. Given the large changes in distribution that have been observed for several species over the 28 year period of the surveys, the Group considered this work to be of great potential value, particularly for identifying priority areas for the next survey and facilitating effective stratification. This work could also be extended to provide model-based abundance estimates for designed strata and other areas of interest. The project is in its final year, and additional support will facilitate its completion. Given the value of this work to future NASS, the Group **recommended** that NAMMCO or/and NAMMCO parties support the project if possible. A project proposal for this extended work is attached as Appendix 4.

Employment of observers from other jurisdictions, as well as facilitating the participation of observers from NASS-participating countries in other surveys, has proven to be beneficial as it improves the training of observers, exposes them the new species and new ways of doing things, improves compatibility between surveys and allows observers to participate in surveys more frequently, thereby maintaining their expertise. Such exchanges should be encouraged and facilitated.

15. OTHER ITEMS

15.1 Development of new survey software
Aerial surveys are an important means to assess the distribution and abundance of marine organisms, such as cetaceans and sea turtles. Given the small size of survey aircraft and the speed with which they pass over target animals, it can be difficult to record and manage sightings data, and later error-check and export these data for analysis. Over the years there have been a small number of aerial survey software programmes created to address these problems, but they have had limited feature sets. To address the potential needs of a broad variety of users, a custom software programme is needed to perform the needed data recording, entry, and navigation tasks for both aerial and ship surveys.

Lawson provided an overview of a new initiative to design and create a software programme which would meet the needs of aerial, vessel, and terrestrial megafauna survey teams. The draft specification document is written for potential users and testers of the system to review, and provide feedback to clarify the function and look of the software.

As currently planned, the software will be an integrated tool for surveyors to (possibly) plan a survey, enter data during the survey, and post-process and extract information from the survey data:

- Planning could involve adding lines to maps to allocate effort;
- Data entry could involve one or more of (1) keyboard data entry by a data recorder, (2) vocal messages (recorded by the observers or a dedicated person) and transcribed later, or (3) real time vocal data transcription.
- Postprocessing could involve error detection, calculating covered area, and calculating target densities.

The software will run on a Windows computer and will accept input from hardware devices such as Geometers, microphones, and keypads/keyboards, and present these data on a moving map. The software will be able to check data for errors during entry and will output data in files for further processing following the survey day. The software will run without an internet connection. Data will be maintained in external database and (possibly) in log files. The software will have the capacity to be extended, such as to add unique features or capabilities, by software plug-ins and could connect to the internet to access map sources and backup data. The software will be designed to be very robust and resistant to data loss.

Possibly, the software will be able to calculate the densities (animals per square kilometre) for the survey area and subdivisions of it as a means to provide initial summaries.

Currently, there are a variety of groups that have expressed an interest in supporting this project through design and financial support. This support will be augmented and formalized with the goal of initiating software development in late summer 2018.

The Group supported the development of this software which could be useful for both aerial and shipboard surveys.

15.2 Geometer development

This device, which incorporates accelerometers to measure sighting angles in aerial surveys, has been used successfully in Iceland and Greenland. Development of the Geometer was supported by NAMMCO and Iceland.

Hansen noted that there have been some technical issues with using the device in very cold weather. Measurement of lateral angles, which uses a magnetometer, has not been successful, probably because of interference from the plane. However generally the device has been very successful as it simplifies data collection and transcription, improves the measurement precision and accuracy of angles and distances, and eliminates observer biases such as angle rounding.

The Group supported this development and **recommended** adoption of the device in aerial surveys.

15.3 Cooperation with IWC

NAMMCO has had a working group dealing specifically with reviewing abundance estimates of cetacean species (except narwhal and belugas) since 1997 and has often had invited experts who were member of the IWC Scientific Committee, but there has been no formal cooperation between the two organisations in this area.

The Scientific Committee of the IWC established an abundance estimates working group in 2016. It has been agreed by both the NAMMCO Council and Scientific Committee that a formal cooperation between the NAMMCO and IWC working groups would be beneficial and was desirable to improve assessments, reduce duplication of work and ensure agreement on adopted estimates. The IWC Scientific Committee has also agreed that co-operation on matters of mutual interest is beneficial. Both Committees have therefore agreed that invitations will be issued to facilitate mutual participation both in meetings and intersessional activities, with in particular the chairs of both working groups being formally member of the other working group.

The Group noted that the first steps in this process had already been taken, with Donovan representing the IWC Abundance Estimate Working Group at this meeting and Pike participating in intersessional IWC activities. The Group welcomed this cooperation.

Donovan informed the Group of past and ongoing IWC activities in this area, including categorization of abundance estimates in accordance with the use to which they are put, consistency in the review process, guidelines on the information to be presented when submitting an estimate for review, guidelines for surveys and analysis, validation approaches to software used to implement 'novel' methods and development of an updated survey database (ideally in conjunction with data collection software – *e.g.* see Item 15.1). With regard to the latter, the possibility of hosting a copy of this database at the NAMMCO Secretariat was considered. Noting that this would be advantageous because of continuity of personnel, documentation of procedures and database compatibility, the Group **recommended** that the Scientific Committee consider this proposal.

16. NEXT MEETING

Several estimates require relatively minor work (see Table 1) and these can be dealt with through correspondence and possibly intersessional conference call. The next survey is proposed as early as 2021 and planning should be started at least two years in advance (see 14). A funding proposal will be developed for the next meeting of the Council by the Scientific Committee. If accepted the next meeting should be as early as spring 2019. By that time also there will be estimates from the 2008-2013 cycle of Norwegian surveys and results from spatial modelling work will be available for review.

17. ADOPTION OF REPORT

A draft version of the Report was adopted on May 24 2018. A summary of all recommendations from the Working Group is contained in Table 2. The Chair thanked the members of the Group for their contributions to the meeting and particularly the

Canadian rapporteurs for their work and the Greenland Representation for hosting the meeting. The participants thanked Pike for his able chairing of the meeting.

NOTE: Estimates from the 2015 Icelandic/Faroese ship survey component of the NASS were revised subsequent to the meeting according to the recommendations of the Working Group and accepted by correspondence in October 2018. See Annex 1 for details.

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SPECIES	SURVEY	YEAR	DESC.	TYPE	MODE	EST.	CV	95% CI		BIAS CORR.		STATUS	REPORT	CITATION
								LCL	UCL	PER	AVAIL			
BA	NASS	2015	Iceland/Faroes	S	IO	42,515	0.31	22,896	78,942	1	0	2	4.2 6.3	NAMMCO SC/25/AE/06
BA	NILS2015	2015	CM1a+CM3	S	IO	17,500	0.35			1	1	2	6.1	NAMMCO SC/25/AE/13
BA	NASS+NILS2015	2015	CMA	S	IO	48,016	0.23	30,709	75,078	1	P	1	6.5	NAMMCO SC/25/AE/08
BA	CIC2016	2016	Iceland coastal	A	IO					1	1	3	4.3 6.4	NAMMCO SC/25/AE/07
BM	NASS	2015	Iceland/Faroes	S	IO	2,993	0.40	1,386	6,463	1	0	2[1]	4.2 7.3	NAMMCO SC/25/AE/06
BP	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/10
BP	NASS	2015	Iceland/Faroes	S	IO	38,931	0.18	27,097	55,933	1	0	2[1]	4.2, 7.3	NAMMCO SC/25/AE/06
BP	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/12
GM	NASS	2015	Iceland/Faroes	S	IO					1	0	3[1]	4.2, 5.1	NAMMCO SC/23/AE/04
LAC	NASS	2007	Iceland/Faroes	S	BT	42,547	0.42	17,537	103,225	1	0	2	4.1, 9.1	NAMMCO SC/25/AE/05
LAC	NASS	2015	Iceland/Faroes	S	IO					1	0	3[1]	4.2, 9.1	NAMMCO SC/25/AE/06
LAL	NILS02-07	2005	Norway	S	IO					0	0	3	4.4, 9.3	NAMMCO SC/25/AE/11
LAL	NASS	2007	Iceland/Faroes	S	BT	111,183	0.59	36,346	340,114	1	0	2	4.1, 9.1	NAMMCO SC/25/AE/05
LAL	NASS	2015	Iceland/Faroes	S	IO					1	0	3[1]	4.2, 9.1	NAMMCO SC/25/AE/06
LAL	CIC2016	2016	Iceland coastal	A	IO					1	0	3	4.3, 9.2	NAMMCO SC/25/AE/07
MN	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/10
MN	NASS	2015	Iceland/Faroes	S	IO					1	0	3[1]	4.3,7.3	NAMMCO SC/25/AE/06
MN	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.4, 7.2	NAMMCO SC/25/AE/12
OO	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 10.1	NAMMCO SC/25/AE/11
PM	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 8.1	NAMMCO SC/25/AE/10
PM	NASS	2007	Iceland/Faroes	S	BT	12,220	0.38	5,807	25,717	1	0	1	4.1, 8.2	NAMMCO SC/25/AE/05
PM	NASS	2015	Iceland/Faroes	S	IO					1	0	3[1]	4.2, 8.2	NAMMCO SC/25/AE/06
PM	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.1, 8.1	NAMMCO SC/25/AE/12
PP	NILS02-07	2005	Norway	S	IO					1	0	3	4.1, 9.3	NAMMCO SC/25/AE/11
PP	CIC2016	2016	Iceland coastal	A	IO					1	0	3	4.3, 9.2	NAMMCO SC/25/AE/07

Table 1. Estimates considered by the Working Group on Abundance Estimates. TYPE – S=ship, A=aerial; MODE – IO=independent observer, BT=Buckland-Turnock; BIAS CORR – bias correction, PER – perception, AVAIL – availability, 1=corrected, 0=uncorrected, P=partially corrected; STATUS – 1=accepted, 2=accepted provisionally pending minor work; 3=further work required; REPORT – lists relevant report section. [1]Revised after meeting. See Annex 1.

REC	SURVEY	YEAR	SPECIES	REP	RECOMMENDATION
SC/25/AE/ALL/RR1	All	All	All	4.1	In MRDS analyses, Point Independence (PI) models should be used unless there is evidence of vessel attraction.
SC/25/AE/ALL/RR2	All	All	All	4.2	Beaufort scale as estimated by observers to be used in all surveys.
SC/25/AE/ALL/RR3	All	All	All	4.4	Don't pre-bin distance data unless rounding error is suspected.
SC/25/AE/F/RR4	All	All	GM	5.2	Satellite tagging studies should be carried out to define the area from which the Faroese hunt is recruited.
SC/25/AE/ALL/OR1	All	All	GM	5.2	Pre-assessment meeting to identify knowledge gaps.
SC/25/AE/ALL/RR5	All	All	All	7.4	Report results for different detection function models as sensitivity analyses.
SC/25/AE/ALL/RR6	All	All	PM	8.1	Explore the estimation of availability bias correction for this long-diving species
SC/25/AE/ALL/RR7[1]	All	All	GM, LL, LC	9	Estimate exceptionally large groups separately using strip transect.
SC/25/AE/ALL/OR2	All	All	All	15.3	SC consider hosting copy of IWC Survey Dataset at Secretariat
SC/25/AE/ALL/OR3	All	All	All	14	Scientific Committee consider hosting a workshop on the general topic of "Novel methods for abundance surveys and estimation".
SC/25/AE/ALL/OR4	All	All	All	14	NAMMCO consider supporting SMRU spatial modelling project.
SC/25/AE/ALL/OR5	All	All	All	14	Encourage exchange of observers between surveys.
SC/25/AE/ALL/OR6	All	All	All	15.1	Support development of new aerial/vessel survey software.
SC/25/AE/ALL/OR7	All	All	All	15.2	Adopt Geometer for aerial surveys.
SC/25/AE/I/RR8	I aerial	2016	BA, LL, PP	4.3	Post-stratification so that only covered areas are included.
SC/25/AE/IF/RR9	IF ship	2007	ALL	4.1	Present analysis of swim direction data.
SC/25/AE/IF/RR10	IF ship	2007	ALL	4.1	GLM regression including covariates for vessel identity and the time between re-sightings.
SC/25/AE/IF/RR11[1]	IF ship	2015	ALL	4.2	Post-stratification to reduce uneven coverage.
SC/25/AE/IF/RR12	IF ship	2015	ALL	4.2	Better description of duplicate identification process.
SC/25/AE/IF/RR13[1]	IF ship	2015	ALL	4.2	Conduct sensitivity analyses around using the different levels of duplicate certainty.
SC/25/AE/IF/RR14	IF ship	2015	HA, DD	4.2	Analysis of bottlenose whale and common dolphin data should be attempted.
SC/25/AE/IF/RR15	IF ship	2015	BA	6.3	Provide explanation of increased sightings in revised database.
SC/25/AE/N/RR16	N ship	2002-7	All	4.4	Use combined data for strata surveyed over 2 years.
SC/25/AE/N/RR17	N ship	2002-7	All	4.4	Conduct MCDS and MRDS analyses
SC/25/AE/N/RR18	N ship	2002-7	LL	9.3	Prefer estimate combining certain and uncertain species ID's.
SC/25/AE/N/RR19	N ship	2002-7	LL	9.3	Consider evidence for responsive movement in descriptions of their data.
SC/25/AE/N/RR20	N ship	2002-7	PP	9.3	Prefer estimate with Beaufort 0-4.

REC	SURVEY	YEAR	SPECIES	REP	RECOMMENDATION
SC/25/AE/N/RR21	N ship	2002-7	OO	10.1	Estimate exceptionally large groups separately using strip transect.
SC/25/AE/C/RR22	NAISS	2016	All	12	Coordinate survey timing with US.
SC/25/AE/ALL/RR23	NASS	2021	All	11	The use of video imaging for species identification, group size and distance estimation should be investigated for future NASS surveys.
SC/25/AE/ALL/RR24	NASS	2021	All	14	Extension surveys must have double platforms, and observer schedule must allow sufficient rest.
SC/25/AE/ALL/RR25	NASS	2021	All	14	Coverage similar to 2015 with a south-eastern expansion similar to 2007 (with CODA)
SC/25/AE/ALL/RR26	NASS	2021	All	14	Coordination with other jurisdictions including continental Europe, the UK, Canada and the USA
SC/25/AE/ALL/RR27	NASS	2021	All	14	Biopsy sampling should be considered, especially for pilot whale stock structure
SC/25/AE/ALL/RR28	NASS	2021	All	14	Satellite tagging, for availability bias estimation, seasonal movement and definition of recruitment area for Faroese hunt.
SC/25/AE/ALL/RR29	NASS	2021	All	14	Consider use of drones for school size estimation, distance experiments.
SC/25/AE/ALL/RR30	NASS	2021	All	14	Change ship methods to improve distance estimation.
SC/25/AE/ALL/OR8	NASS	2021	All	16	Next WG meeting as early as spring 2019, depending on timing of next NASS.

Table 2. Recommendations from the Working Group on Abundance Estimates, May 2018.

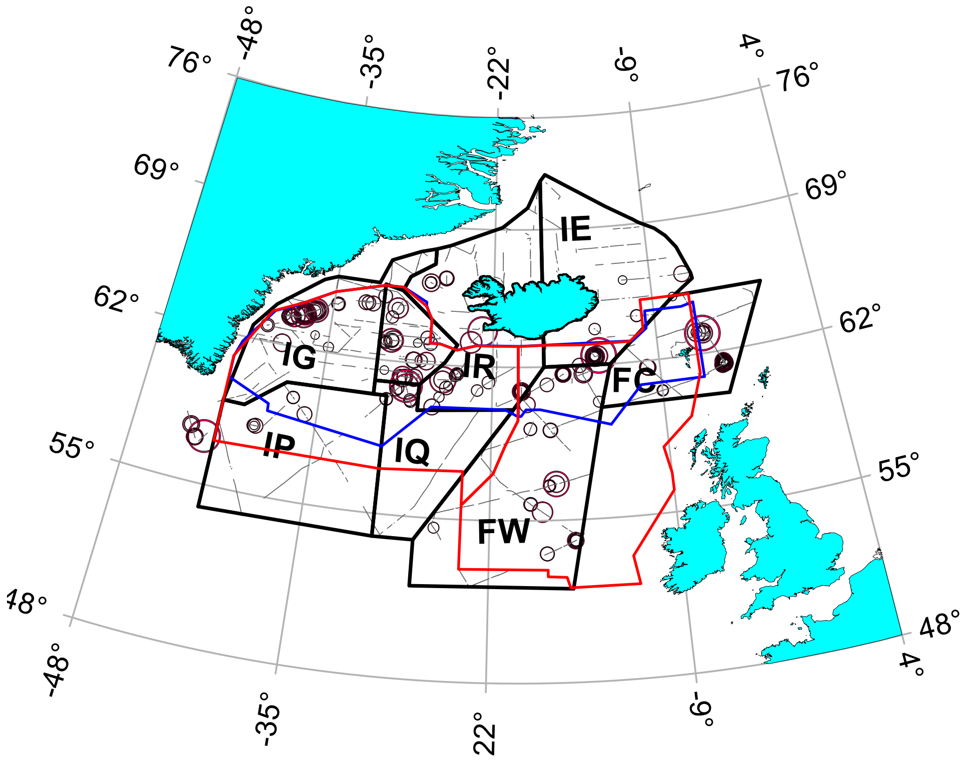

Fig. 1. Sightings of long-finned pilot whales in the Icelandic and Faroese NASS-2015 ship survey. Survey Index Regions (SIR) are shown in blue (6-SIR) and red (3-SIR).

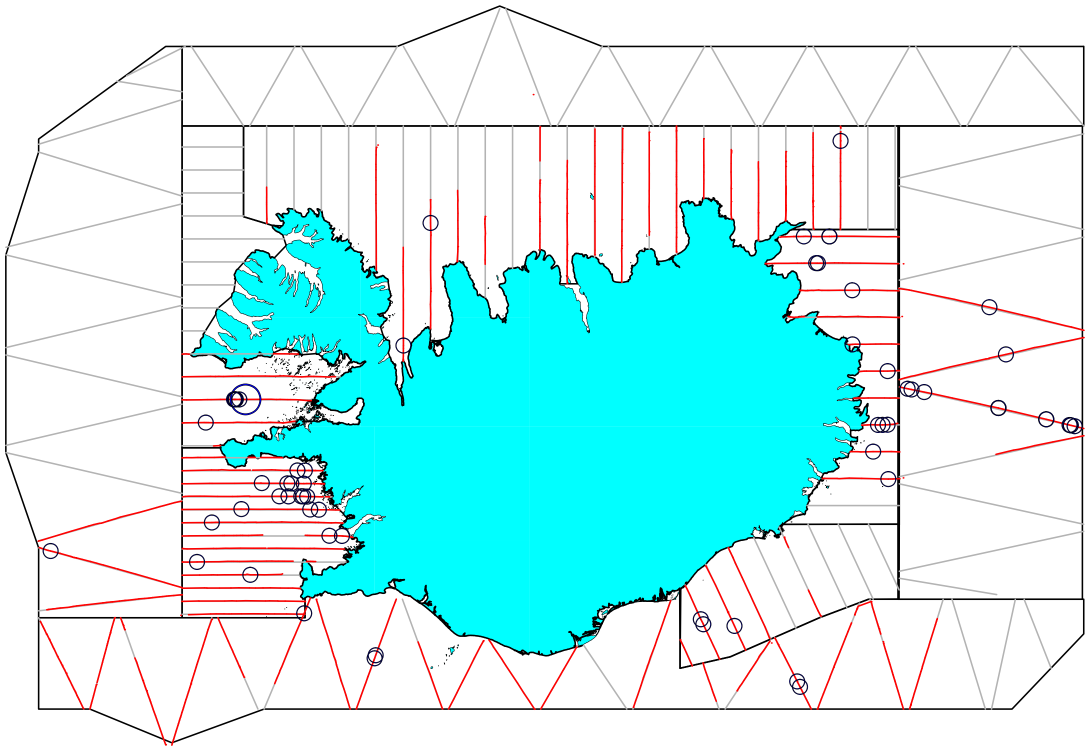

Fig. 2. Planned and realized (red) effort, and sightings of common minke whales in the Icelandic 2016 aerial survey.

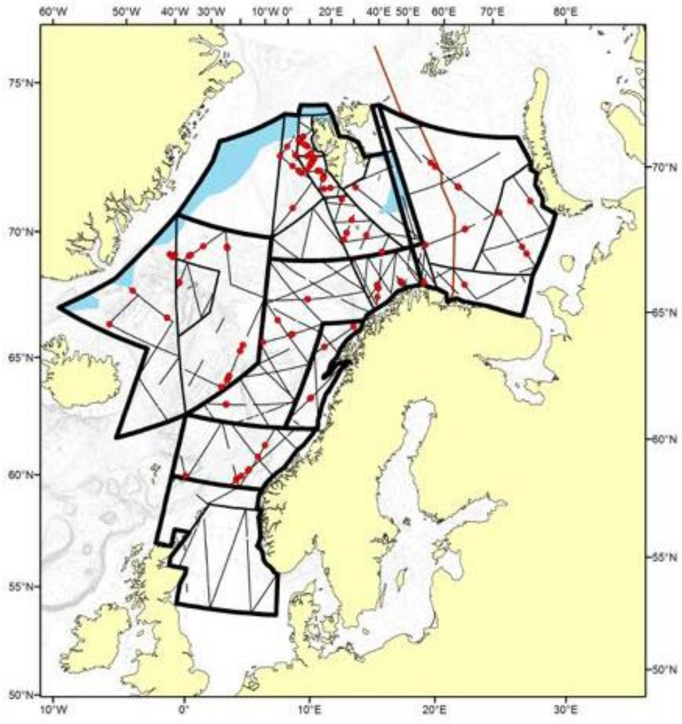

Fig. 3. Sightings of fin whales in the NILS 2002-7 surveys.

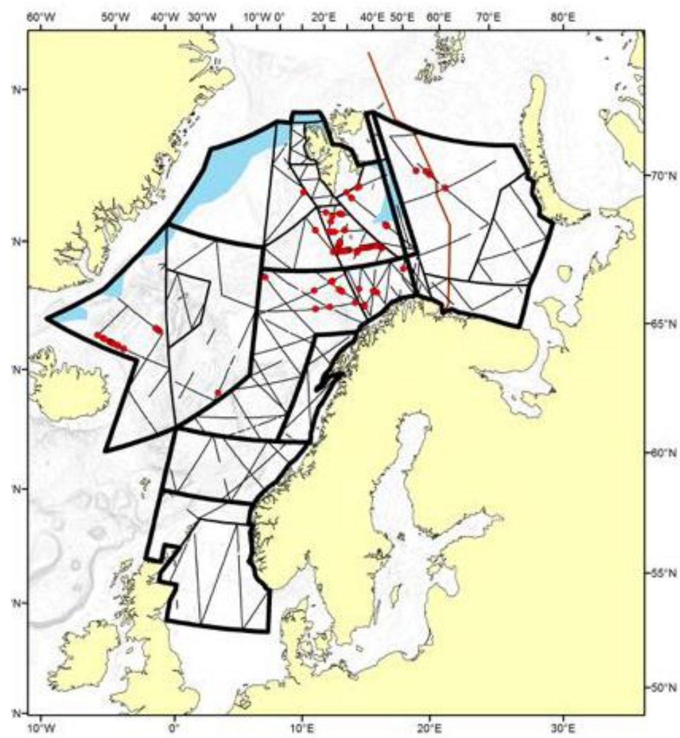

Fig. 4. Sightings of humpback whales in the NILS 2002-7 surveys.

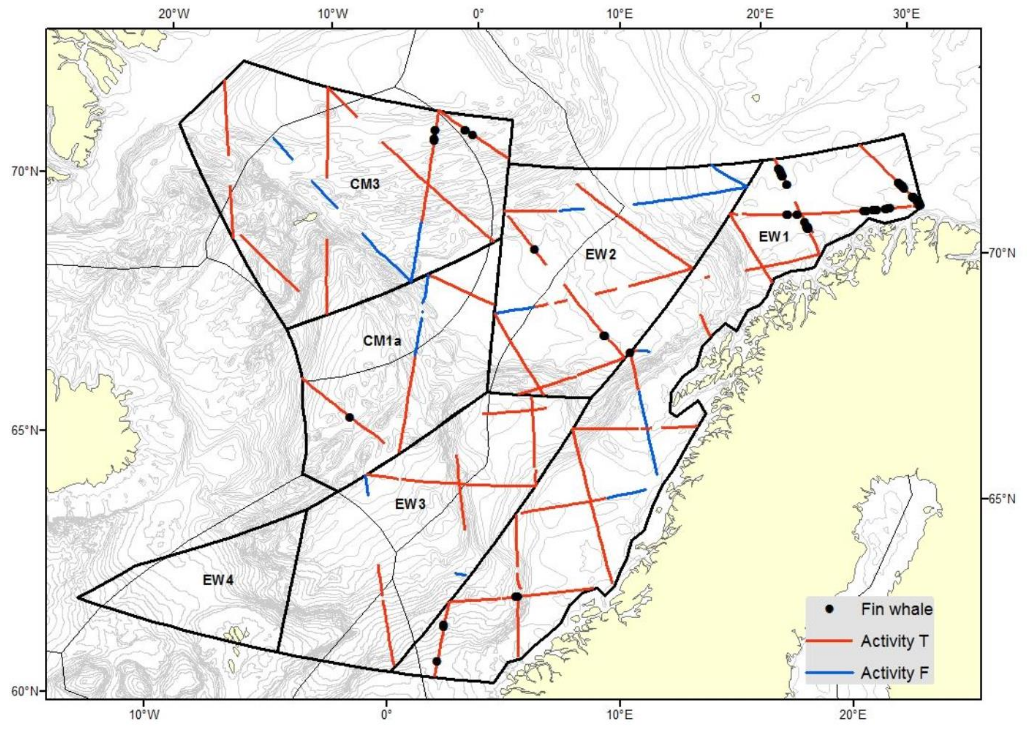

Fig. 5. Distribution of fin whales from NILS survey effort conducted in 2015. Activity F: effort conducted above Beaufort Sea State 4.

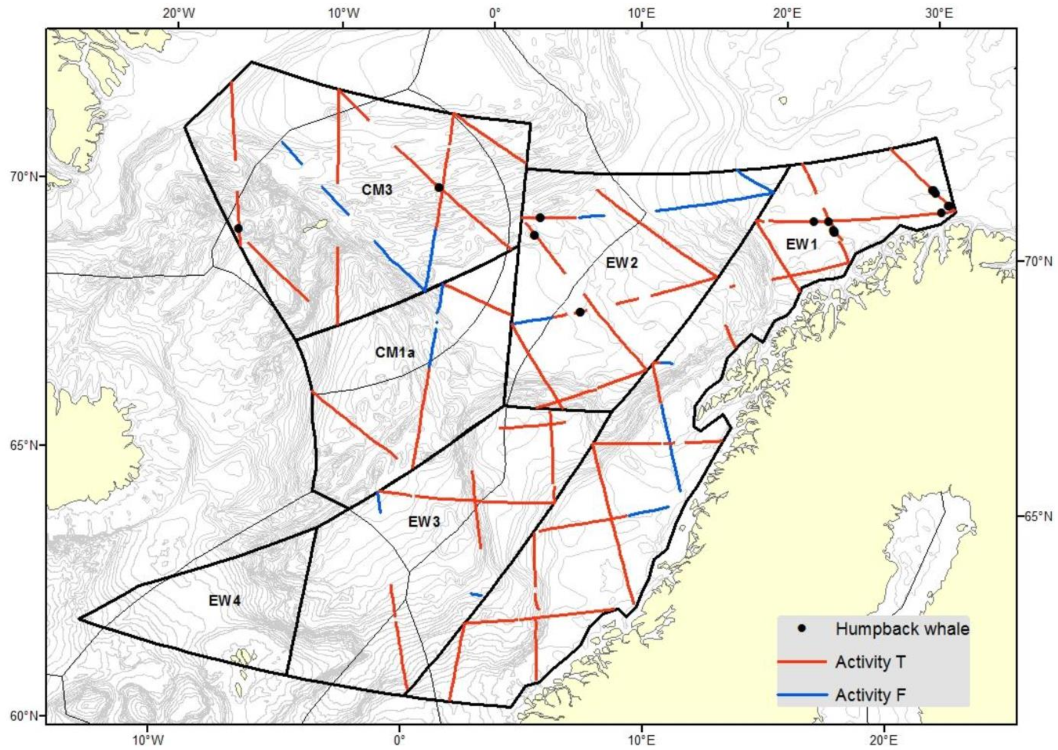

Fig. 6. Distribution of humpback whales from NILS survey effort conducted in 2015. Activity F: effort conducted above Beaufort Sea State 4.

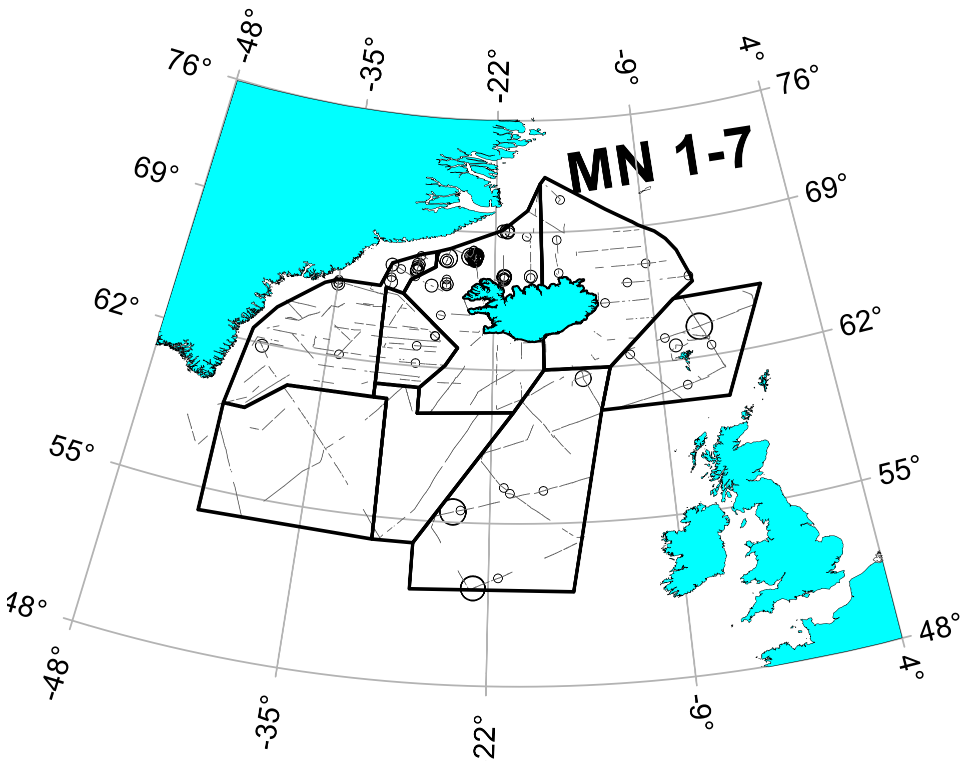

Fig. 7. Distribution of humpback whales from the NASS-2015 Icelandic and Faroese ship survey.

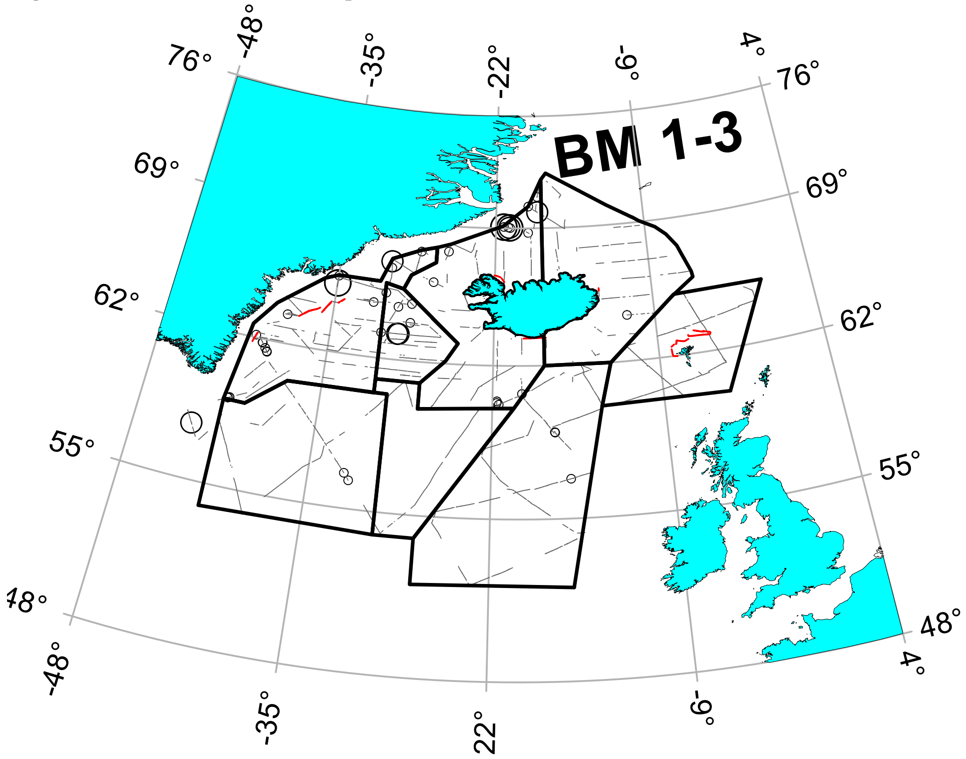

Fig. 8. Distribution of blue whales from the NASS-2015 Icelandic and Faroese ship survey.

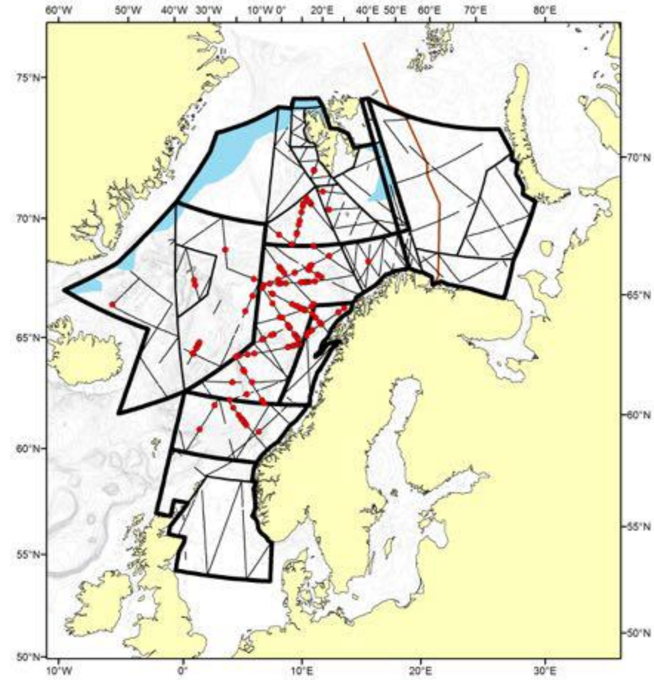

Fig. 9. Sightings of sperm whales in the NILS 2002-7 surveys.

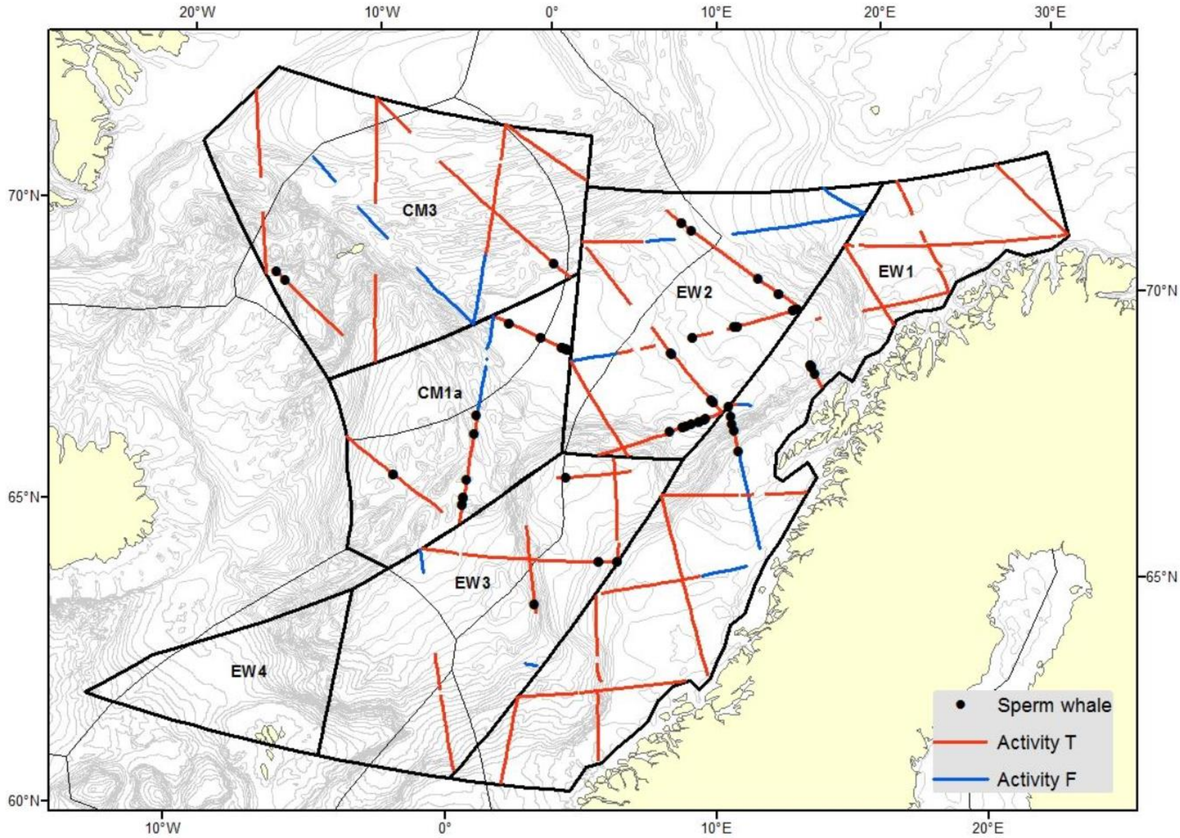

Fig. 10. Distribution of sperm whales from NILS survey effort conducted in 2015. Activity F: effort conducted above Beaufort Sea State 4.

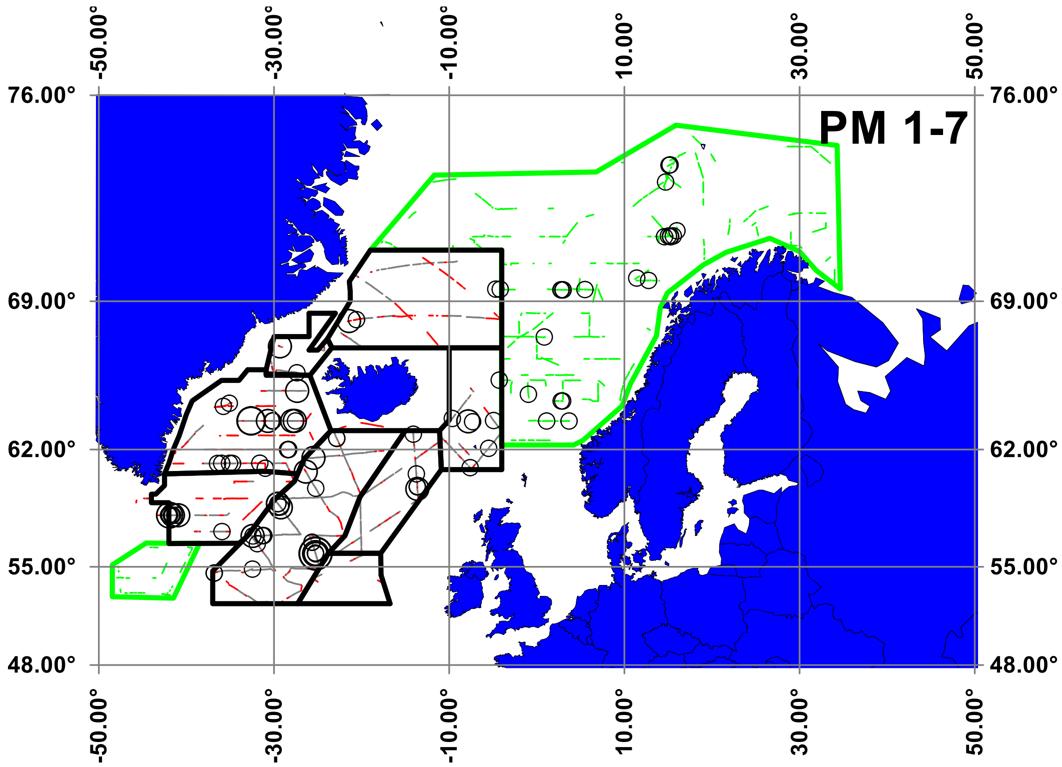

Fig. 11. Sightings of sperm whales in the T-NASS 2007 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range. Effort by the extension vessels is shown in Green.

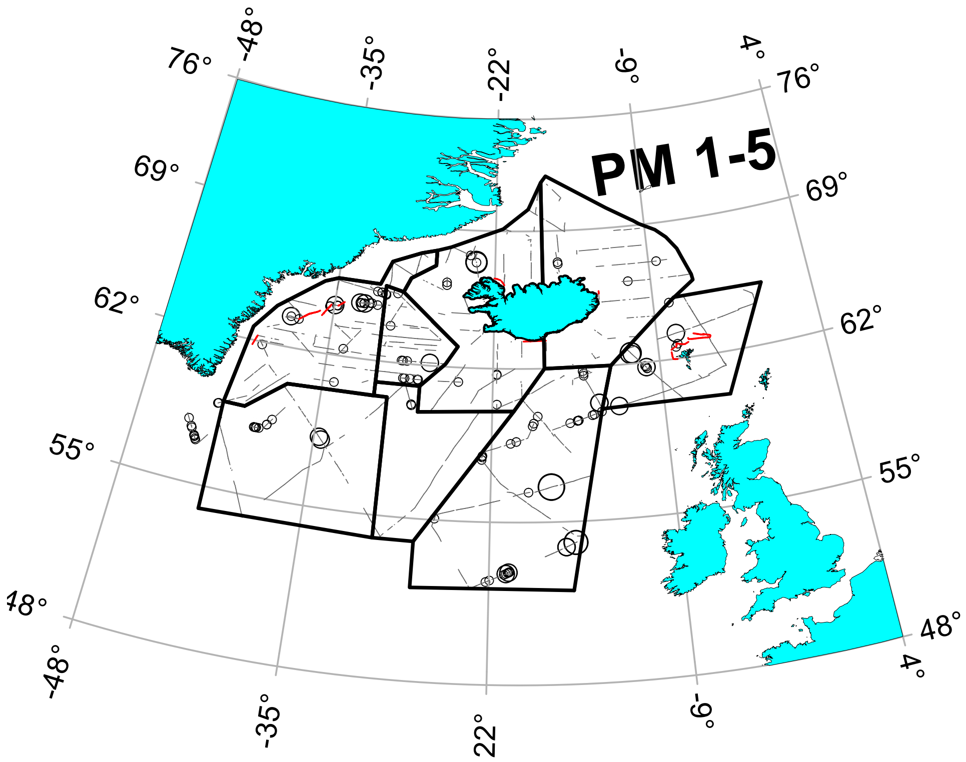

Fig. 12. Distribution of sperm whales from the NASS-2015 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range.

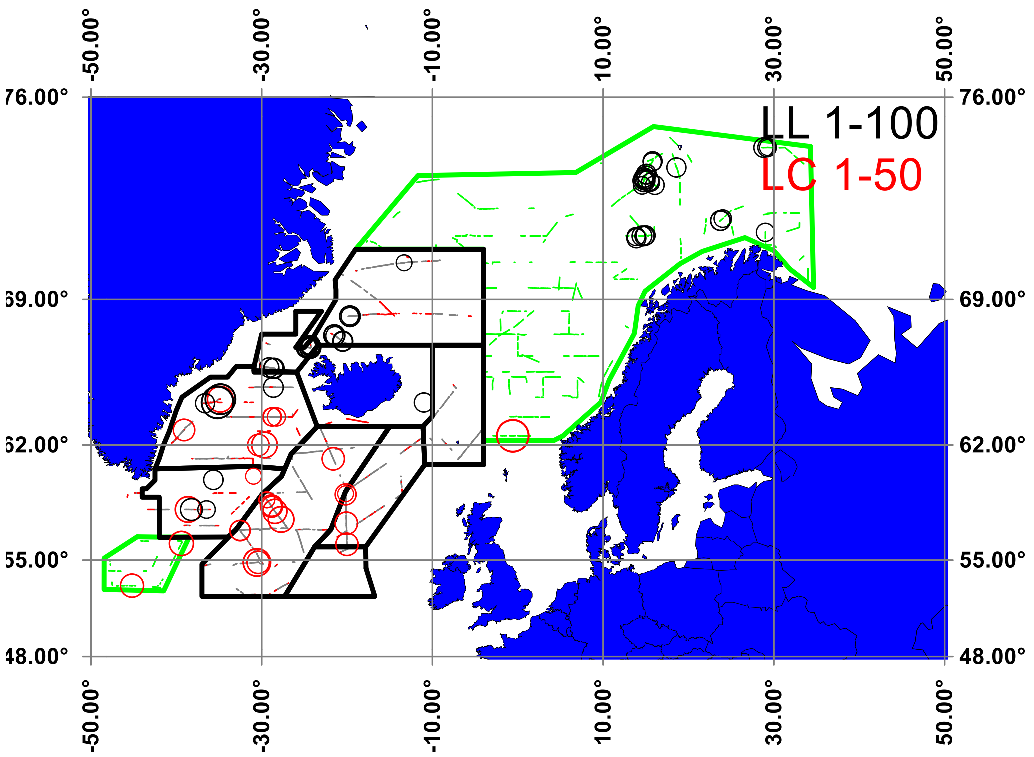

Fig. 13. Sightings of white-beaked (black) and white-sided (red) dolphins from the T-NASS 2007 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range. Effort by the extension vessels is shown in Green.

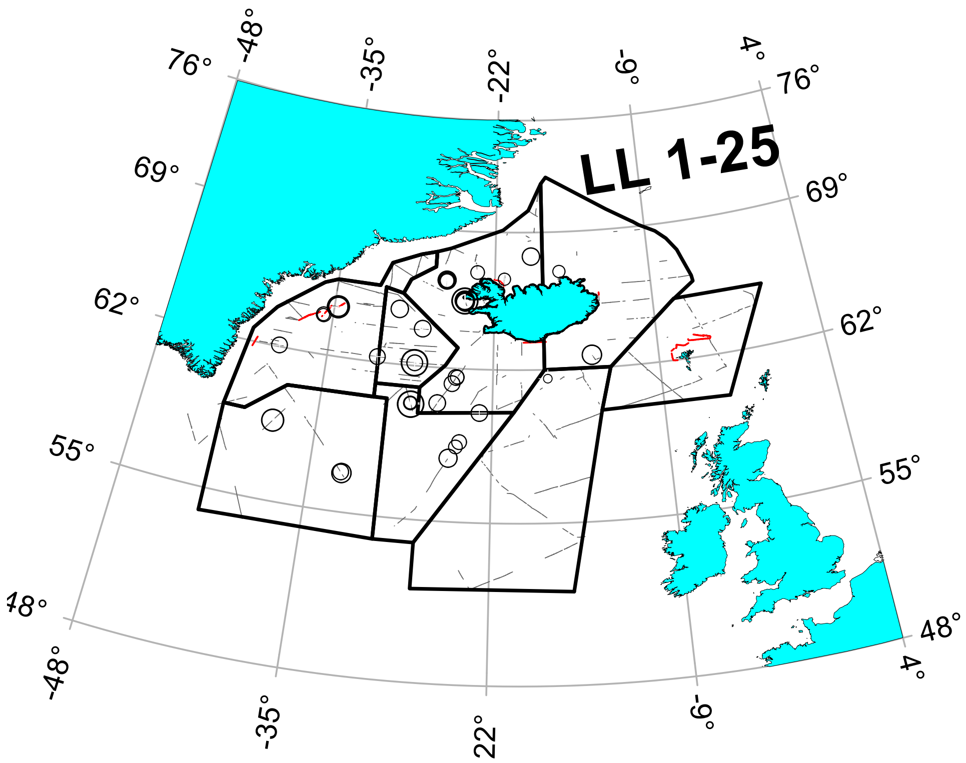

Fig. 14. Distribution of white-beaked dolphins from the NASS-2015 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range.

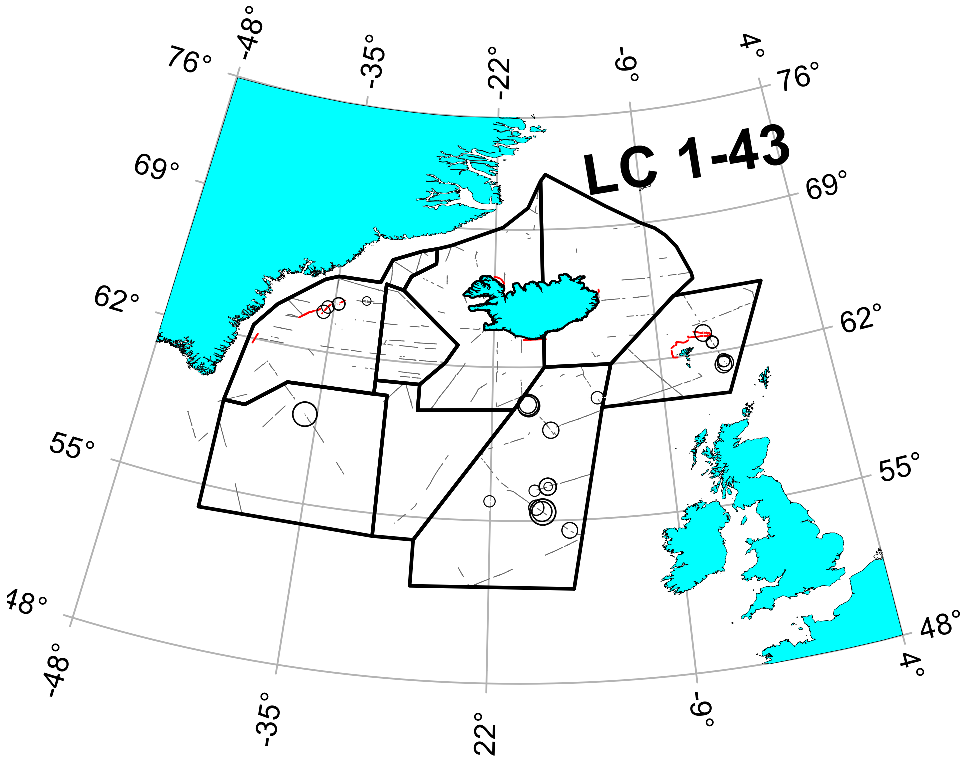

Fig. 15. Distribution of white-sided dolphins from the NASS-2015 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range.

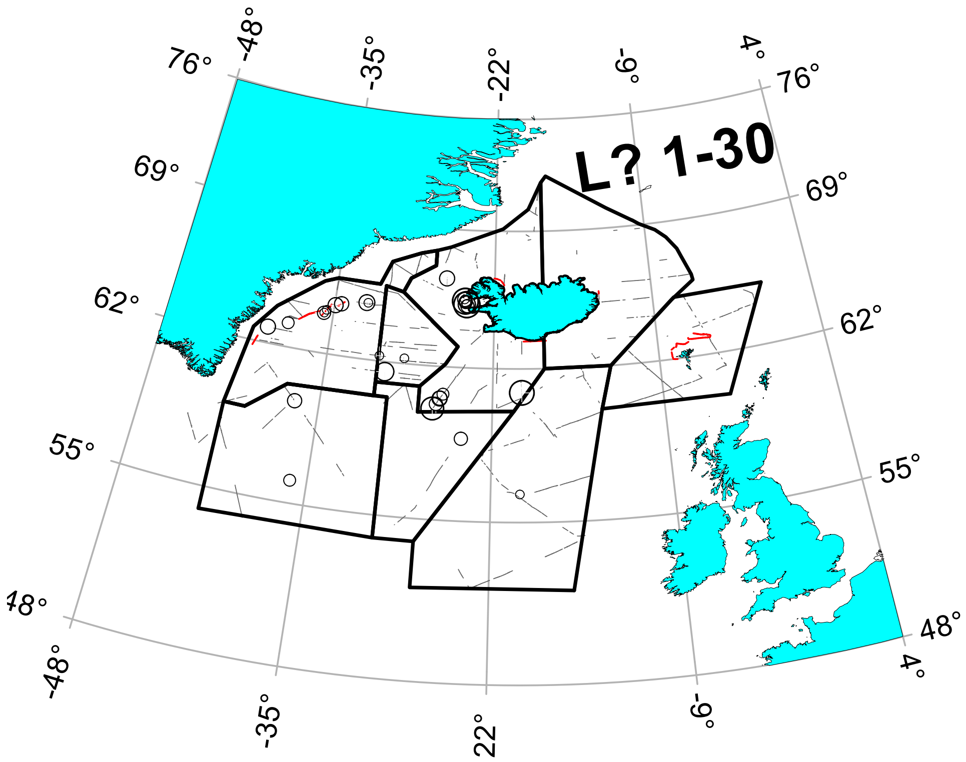

Fig. 16. Distribution of *Lagenorhychus* spp. dolphins from the NASS-2015 Icelandic and Faroese ship survey. Symbol size is proportional to group size in the given range.

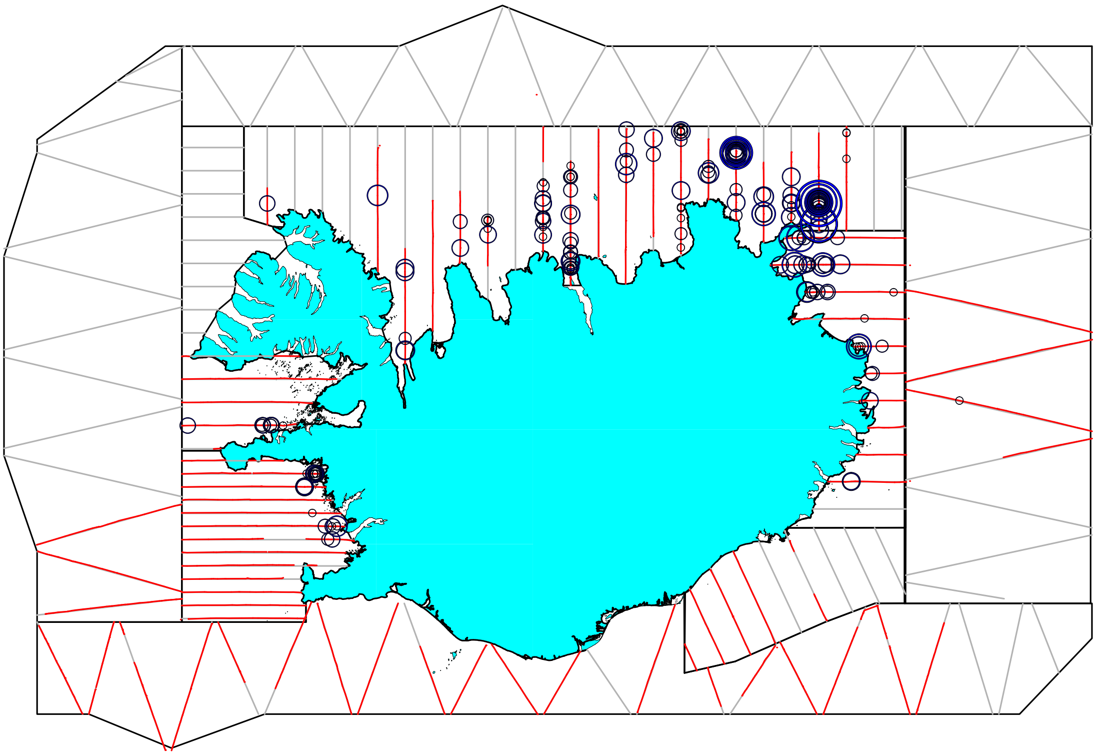

Fig. 17. Planned and realized (red) effort, and sightings of white-beaked dolphins in the Icelandic 2016 aerial survey.

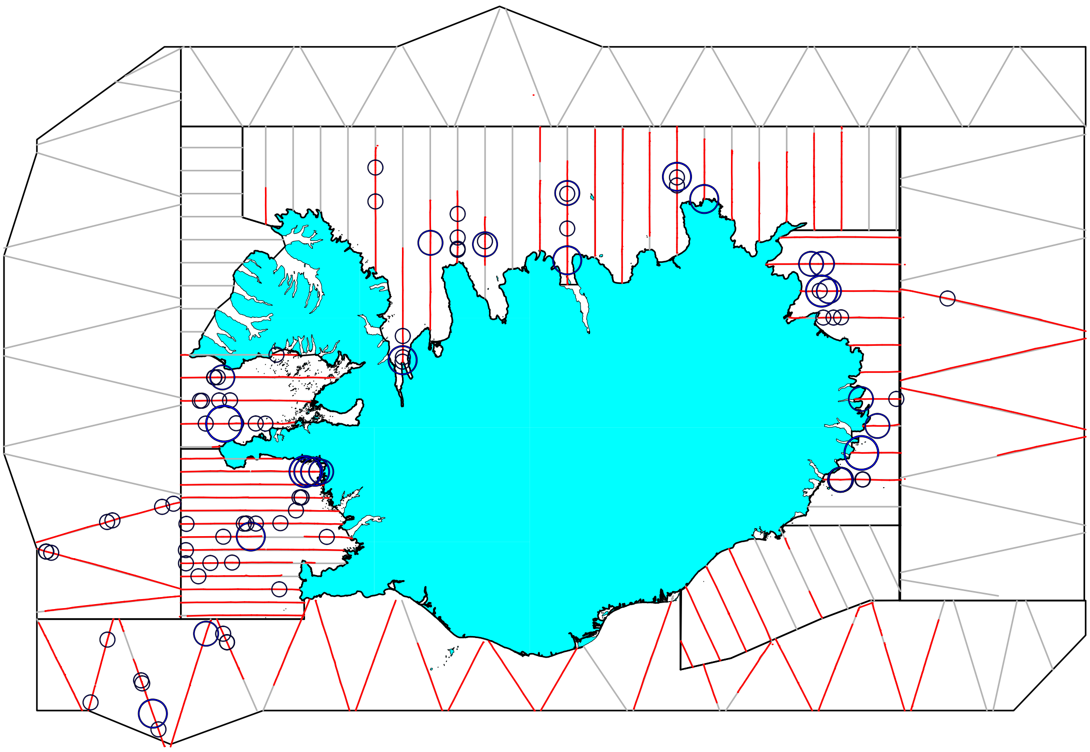

Fig. 18. Planned and realized (red) effort, and sightings of harbor porpoises in the Icelandic 2016 aerial survey.

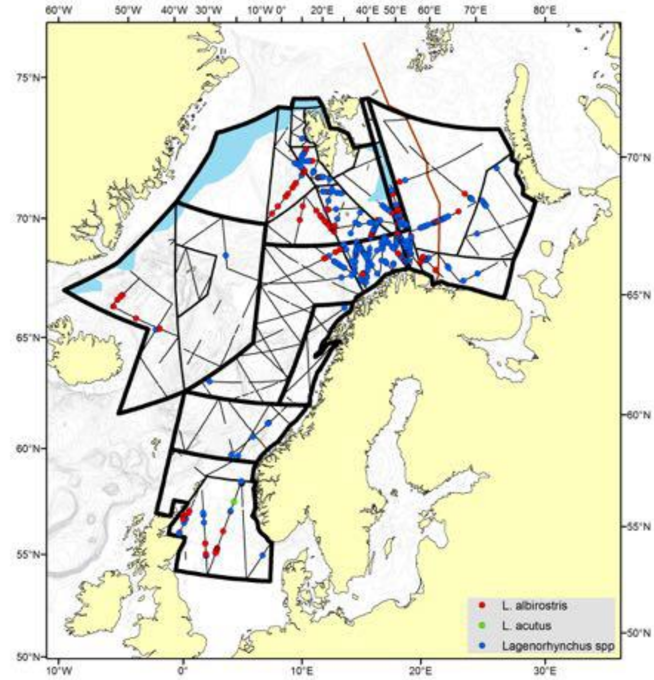

Fig. 19. Sightings of *Lagenorhynchus* spp. dolphins in the NILS 2002-7 surveys.

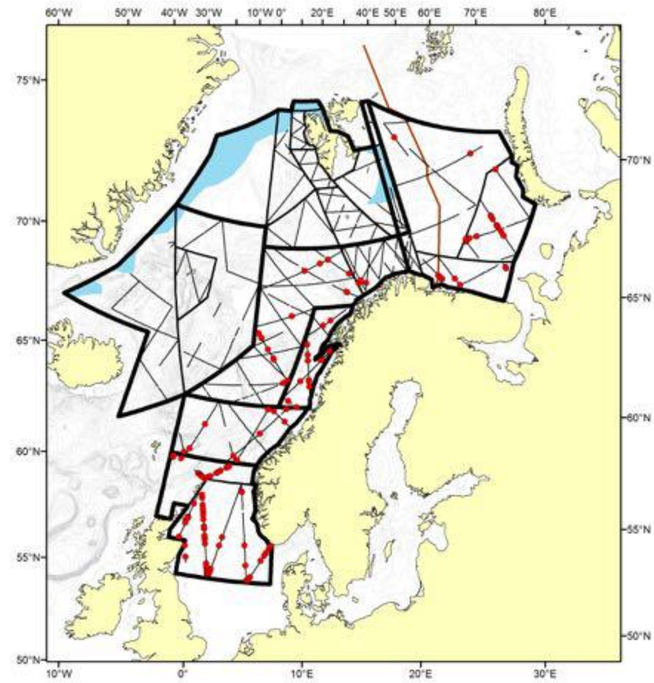

Fig. 20. Sightings of *Lagenorhynchus* spp. dolphins in the NILS 2002-7 surveys.

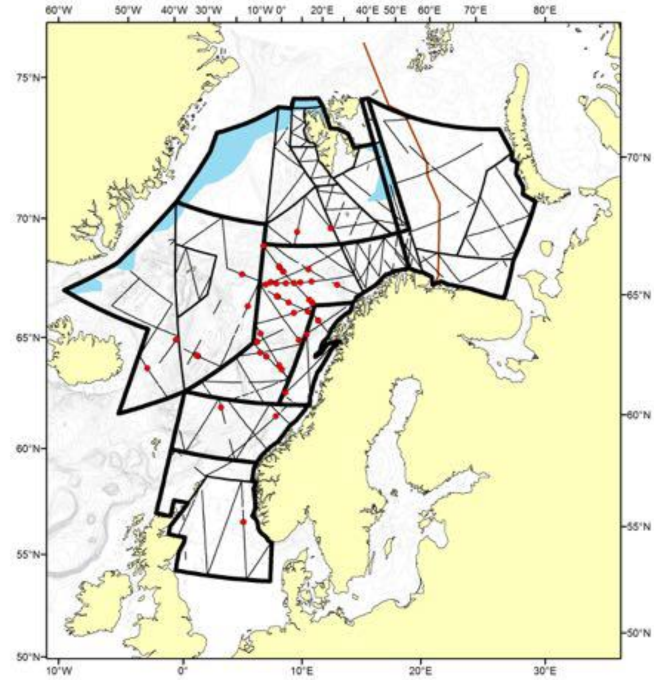

Fig. 21. Sightings of *Lagenorhynchus* spp. dolphins in the NILS 2002-7 surveys.

APPENDIX 1

WORKING GROUP ON ABUNDANCE ESTIMATES

Copenhagen, May 22-24, 2018

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APPENDIX 2

WORKING GROUP ON ABUNDANCE ESTIMATES

Copenhagen, May 22-24, 2018

Agenda

1. CHAIRMAN WELCOME AND OPENING REMARKS

2. ADOPTION OF AGENDA

3. APPOINTMENT OF RAPPORTEURS

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
- **4.1 SC/25/AE/05 TNASS Ship 2007, Iceland and Faroes**
- **4.2 SC/25/AE/06 NASS 2015 Ship, Iceland and Faroes**
- **4.3 SC/25/AE/07 Icelandic Aerial 2016**
- **4.4 SC/25/AE/10- SC/25/AE/12 Norwegian large whales and small odontocetes ship surveys 2002-2007**

5. LONG-FINNED PILOT WHALE
- **5.1 NASS 2015 estimate**
- **5.2 Trends**

6. COMMON MINKE WHALE
- **6.1 Norwegian mosaic survey – previous cycle estimate**
- **6.**2 Norwegian 2015 CM survey
  - **a. Icelandic Faroese shipboard survey 2015 revised estimate**
  - **b. Icelandic 2016 aerial survey estimate**
- **6.5 Central North Atlantic minke whale estimate**

7. LARGE BALEEN WHALES
- **7.1 Norway – large baleen whales, last two survey cycles**
- **7.2 Norwegian shipboard survey 2015**
- **7.3 Iceland/Faroes 2015 revised estimate for fin whale**
- **7.4 Iceland/Faroes 2007/15: other species**

8. SPERM WHALES
- **8.1 Norway – last two survey cycles**
- **8.2 Iceland/Faroes – 2007 and 2015**

9. DOLPHINS AND PORPOISES
- **9.1 Iceland/Faroe Islands shipboard – 2007 and 2015**
- **9.2 Iceland aerial 2016**
- **9.2 Norway – last two survey cycles**

10. KILLER WHALES
- **10.1 Norway – last two survey cycles**

11. SCANS III 2016 update

12. CANADIAN NAISS ESTIMATES

13. PUBLICATION OF SURVEY RESULTS

14. FUTURE SURVEYS

15. OTHER ITEMS
- **15.1 Development of new survey software**
- **15.2 Geometer development**
- **15.3 Cooperation with IWC**

16. NEXT MEETING

17. ADOPTION OF REPORT

APPENDIX 3

WORKING GROUP ON ABUNDANCE ESTIMATE

Copenhagen, May 22-24, 2018

Document List

Working Documents

Doc. No.	Title	Agenda Item
SC/25/AE/01	Draft Agenda	2
SC/25/AE/02	Participant List	1
SC/25/AE/03	Document List	4
SC/25/AE/04	Pike *et al.* Estimates of the relative abundance of long-finned pilot whales (*Globicephala melas*) in the Northeast Atlantic from 1987 to 2015 indicate no long-term trends.	5
SC/25/AE/05	Pike *et al.* Estimates of the abundance of cetaceans from the T-NASS Icelandic and Faroese ship surveys conducted in 2007	6.2,7.3, 8.2, 9.1
SC/25/AE/06	Pike *et al.* Estimates of the abundance of cetaceans from the NASS Icelandic and Faroese ship surveys conducted in 2015.	6.2, 7.2, 7.3, 8.2, 9.1
SC/25/AE/07	Pike *et al.* Icelandic aerial survey 2016: Survey report and estimated abundance for minke whales, harbour porpoises and white-beaked dolphins	6.2, 9.2
SC/25/AE/08	Pike. Abundance of common minke whales in the Central Medium Area in 2015.	6.2
SC/25/AE/09	Lawson and Gosselin. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS	12
SC/25/AE/10	Deanna M. Leonard, Nils I Øien. Distribution and abundance of large whales in Norwegian and adjacent waters based on ship surveys 2002-2007.	7.1, 8.1
SC/25/AE/11	Deanna M. Leonard, Nils I Øien. Distribution and abundance of odontocetes in Norwegian and adjacent waters based on ship surveys 2002-2007.	9.3
SC/25/AE/12	Leonard and Øien. Distribution and abundance of large whales in Norwegian and adjacent waters based on ship surveys 2015.	7.1
SC/25/AE/13	Solvang, Skaug, and Øien. Preliminary abundance estimates of common minke whales in Svalbard 2014, the Norwegian Sea 2015, Jan Mayen 2016 and the Barents Sea 2017 – the first four years of the survey cycle 2014-2019 of the Northeast Atlantic. (Including extension survey NASS2015 Jan Mayen).	6.2

Background Documents

Doc. No.	Title	Agenda Item
SC/25/AE/O01	Hammond. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys	11
SC/25/AE/O02	Rogan *et al.* Distribution, abundance and habitat use of deep diving cetaceans in the North-East Atlantic.	11
SC/25/AE/O03	NAMMCO AEWG Report, October 2016	All
SC/25/AE/O04	Software Requirements Draft Specification for SuperSurveyor Programme	15.1
SC/25/AE/O05	Report of the IWC intersessional correspondence group that reviewed the Icelandic humpback whale estimate	7.3
SC/25/AE/O06	Norwegian mosaic surveys: abundance estimate of common minke whales in the period 2008-2013 (presented to IWC SC)	6.1

APPENDIX 4

OCEANOGRAPHIC FEATURES DRIVING DECADAL-SCALE CHANGES IN CETACEAN DISTRIBUTION AND ABUNDANCE IN THE NORTH ATLANTIC

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Background

Since 1987, Norway, Iceland, the Faroe Islands and Greenland have been conducting surveys for cetaceans in the North Atlantic, collectively known as the North Atlantic Sighting Surveys (NASS)[8]. The primary rationale for these surveys is the estimation of abundance of whale species subject to whaling to inform management. The time series of cetacean data collected from these surveys is arguably the most comprehensive in the world at such a large spatial and temporal scale (*e.g.* see Figure 1). Abundance of, *inter alia*, fin, minke, humpback and pilot whales has been estimated using so-called design-based methods that give results for survey blocks at a rather coarse spatial scale.

Scientific aims, methods and expected outcomes

Since these surveys began three decades ago, major changes in the distribution of whales have been observed, coincident with changing oceanography of the North Atlantic. This project aims to maximize the value of this remarkable time series of data by using it to improve understanding of the underlying ecological drivers of the changes in distribution and abundance of whales in the central and northeast Atlantic, and to predict how continuing ocean warming (as predicted by climate models) may affect cetacean populations in the future.

Data for the central and NE Atlantic have been made available by the governments of Norway, Iceland and Faroe Islands[9]. The aims will be achieved using statistical models to explore the influence of a range of oceanographic features (*e.g.* seabed depth, water temperature, chlorophyll concentration, presence of ocean fronts) on the distribution and abundance of whales. Focal species are fin, humpback, minke, sperm, northern bottlenose and, pilot whales. We expect to find that the distribution of different species will be best explained by different combinations of environmental features because of their different ecological roles in the North Atlantic ecosystem.

Applied value of the project

As well as improving our understanding of the what is causing the observed changes in the distribution and abundance of whales, the results are valuable for management in a number of ways.

Results can be represented as maps to illustrate how spatial distribution changes over time, and used to produce so-called model-based abundance estimates for any defined area, not just for the coarse-scale pre-defined survey blocks. Thus, for example, pilot whale abundance could be estimated for the area believed to encompass the population subject to whaling in the Faroe Islands, allowing an assessment of the impact of whaling on the population. Estimates could also be produced for areas relevant to conservation and management that are smaller than the pre-defined blocks.

The results of the models can also (with appropriate caution) be extrapolated to unsurveyed areas. Thus, abundance could be estimated for areas that were unable to be surveyed in a particular year for logistical reasons, allowing trends in abundance over time to be determined for a consistent area of interest, facilitating a more robust assessment of conservation status.

The fine-scale information on distribution generated by the models is also valuable to inform environmental impact assessments of the potential impact of, for example, noise generated by shipping or seismic surveys.

Funding requested

The project is being conducted by a PhD student. The total cost over 4 years (student fees and stipend) is £100,000, 85% of which has been covered by Colciencias (government of Columbia) and the University of St Andrews. Funding is requested for £15,000 to cover the final year student stipend.

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[8] Since 1995, Norwegian Independent Line-transect Surveys (NILS) have been in the form of a "mosaic" covering the NE Atlantic over a 6-year cycle.

[9] Data from the 2016 survey of east Greenland are being sought.

ANNEX 1

REVISIONS TO NASS-2015 ICELANDIC/FAROESE SHIP SURVEY ESTIMATES

INTRODUCTION

The Working Group on Abundance Estimates (AEWG) last met May 22-24 2018. At that meeting several abundance estimates were presented that could not be accepted as (in most cases) minor work was required. It was anticipated that some of these could be revised and accepted by correspondence before the next actual meeting.

Since that time, all estimates from the 2015 Icelandic and Faroese ship survey have been revised according to the recommendations of the AEWG (see Table 2 in main report), and these are detailed in SC/25/AE/06_rev. The Working Group considered these revisions by correspondence in October 2018 and came to the conclusions outlined below.

REVISIONS

The revisions required by survey and species are summarized in Table 2 of the AEWG report.

1. **Post-stratification to reduce uneven coverage**. This issue was identified in relation to the border of strata IQ, IW and IP, especially as it affected the long-finned pilot whale estimate. Most long-finned pilot whale sightings were in the far NW corner of the original stratum IQ (see Fig. 1); it was thought that this would lead to a positively biased estimate, because the high density seen in a small part of the stratum would be propagated over the very large area of the stratum, even though none were sighted in other parts of the stratum. As this was also the case for some other species, especially fin whales, it was decided to re-do all estimates (except that for minke whales) using the revised stratification. The minke whale estimate used a different stratification that was not affected by this issue.

   As expected the re-stratification resulted in a slight decrease in the estimates for most species (Table 1). The estimates for fin and long-finned pilot whales declined moderately by 6% and 14% respectively.

   The Working Group **accepted** the revised estimates using the new stratification detailed in SC/25/AE/06_rev and presented in Table 1 below. These new figures should replace those in Table 1 of the main AEWG report.

2. **Estimate exceptionally large groups separately using strip transect**. This pertains primarily to species which sometimes form large groups, such as dolphins and long-finned pilot whales. We attempted this analytic approach for long-finned pilot whales, estimating the abundance of groups of over 60 animals using a strip transect, then summing this with the line transect estimate for smaller groups. The resulting estimate was 3% lower than the standard estimate, with similar precision.

   As the strip transect methodology used to estimate the abundance of large groups requires somewhat arbitrary decisions about what constitutes a “large” group size, and the width of the strip, both of which could affect estimated abundance, the Working Group agreed that the revised estimate presented in Table 1 below, which did not use a separate strip transect estimate for large groups, should be **accepted**.

3. **Conduct sensitivity analyses in support of using the different levels of duplicate certainty**. Three levels of duplicate certainty were identified, approximating to High, Medium, and Remote. High and Medium classification were included in the analyses. However most duplicates were identified with High certainty, with Medium certainty duplicates comprising between 0% and 17% of the sample by species (Table 3). Sei whales were exceptional in that lower certainty duplicates comprised 17% of the sample. This was mainly because of species identity uncertainty, as sei whales closely resemble fin whales at sea, and fin whales sightings outnumber sei whale sightings by more than an order of magnitude.

   The effect of excluding lower certainty duplicates would be to lower $p(0)$ and thus increase the corrected estimate. However there would be no effect at all except for fin and blue whales, the only two species for which lower certainty duplicate identifications were present. The authors of SC/23/AE/06_rev have not carried out sensitivity analyses as yet, but may do so for a future publication. For the purpose of the AEWG, the analysis using High and Medium certainty duplicate identifications has been used in the past and should be **accepted** in accordance with previous estimates.

ACCEPTED ESTIMATES

The summary of the status of abundance estimates considered by the AEWG in 2018 contained in Table 1 of the main report has been updated with these newly accepted estimates and is provided as ANNEX 2 of the report.

SPECIES	SURVEY	YEAR	DESC.	TYPE	MODE	EST.	CV	95% CI		% CHANGE	BIAS CORR.		STATUS	REPORT	CITATION
								LCL	UCL		PER	AVAIL			
BM	NASS	2015	Iceland/Faroes	S	IO	3,000	0.4	1,377	6,534	0	1	0	1	4.2 7.3	NAMMCO SC/25/AE/06_rev
BP	NASS	2015	Iceland/Faroes	S	IO	36,773	0.17	25,811	52,392	-6	1	0	1	4.2, 7.3	NAMMCO SC/25/AE/06_rev
GM	NASS	2015	Iceland/Faroes	S	IO	344,148	0.35	162,795	727,527	-14	1	0	1	4.2, 5.1	NAMMCO SC/25/AE/06_rev
LAC	NASS	2015	Iceland/Faroes	S	IO	131,022	0.73	35,251	486,981	-1	1	0	1	4.2, 9.1	NAMMCO SC/25/AE/06_rev
LAL	NASS	2015	Iceland/Faroes	S	IO	159,000	0.63	49,957	506,054	-3	1	0	1	4.2, 9.1	NAMMCO SC/25/AE/06_rev
MN	NASS	2015	Iceland/Faroes	S	IO	9,867	0.37	4,854	20,058	-2	1	0	1	4.3,7.3	NAMMCO SC/25/AE/06_rev
PM	NASS	2015	Iceland/Faroes	S	IO	23,166	0.59	7,699	69,709	-1	1	0	1	4.2, 8.2	NAMMCO SC/25/AE/06_rev

Table 1. Estimates considered by the Working Group on Abundance Estimates and revised by correspondence. SPECIES: BM – blue whale; BP – fin whale; GM – long-finned pilot whale; LAC – white-sided dolphin; LAL – white-beaked dolphin; MN – humpback whale; PM – sperm whale. TYPE – S=ship, A=aerial; MODE – IO=independent observer, BT=Buckland-Turnock; % CHANGE – change in estimate from those presented in Table 1 of the AEWG report; BIAS CORR – bias correction, PER – perception, AVAIL – availability, 1=corrected, 0=uncorrected, P=partially corrected; STATUS – 1=accepted, 2=accepted provisionally pending minor work; 3=further work required; REPORT – lists relevant report section.

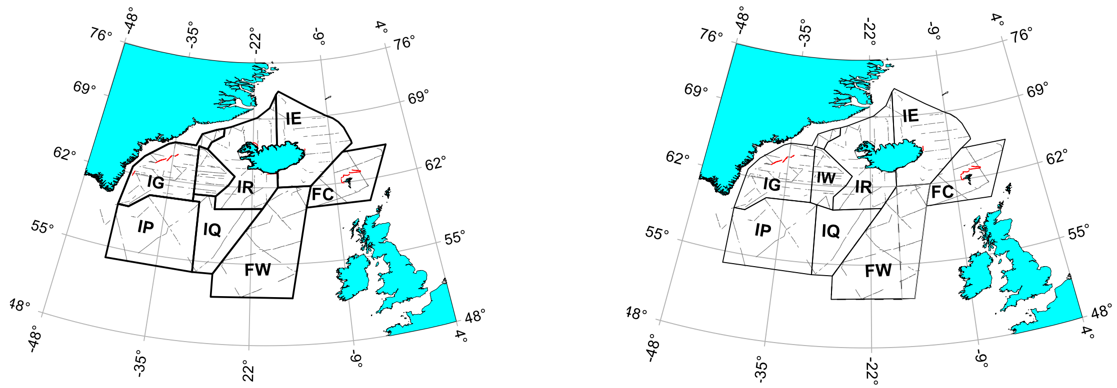

Fig. 1. Original (L) and post-stratified blocks and effort at BSS 5 or less. Red effort is transit effort and was not included in the encounter rate for abundance estimation.

ANNEX 2

Estimates considered by the Working Group on Abundance Estimates and their status as of Nov.1 2018. See Table 1 of the main report for details.

SPECIES	SURVEY	YEAR	DESC.	TYPE	MODE	EST.	CV	95% CI		BIAS CORR.		STATUS	REPORT	CITATION
								LCL	UCL	PER	AVAIL			
BA	NASS	2015	Iceland/Faroes	S	IO	42,515	0.31	22,896	78,942	1	0	2	4.2 6.3	NAMMCO SC/25/AE/06
BA	NILS2015	2015	CM1a+CM3	S	IO	17,500	0.35			1	1	2	6.1	NAMMCO SC/25/AE/13
BA	NASS+NILS2015	2015	CMA	S	IO	48,016	0.23	30,709	75,078	1	P	1	6.5	NAMMCO SC/25/AE/08
BA	CIC2016	2016	Iceland coastal	A	IO					1	1	3	4.3 6.4	NAMMCO SC/25/AE/07
BM	NASS	2015	Iceland/Faroes	S	IO	3,000	0.4	1,377	6,534	1	0	1	4.2, 7.4, Ann. 1	NAMMCO SC/25/AE/06_rev
BP	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/10
BP	NASS	2015	Iceland/Faroes	S	IO	36,773	0.17	25,811	52,392	1	0	1	4.2, 7.3, Ann. 1	NAMMCO SC/25/AE/06_rev
BP	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/12
GM	NASS	2015	Iceland/Faroes	S	IO	344,148	0.35	162,795	727,527	1	0	1	4.2, 5.1, Ann. 1	NAMMCO SC/25/AE/06_rev
LAC	NASS	2007	Iceland/Faroes	S	BT	42,547	0.42	17,537	103,225	1	0	2	4.1, 9.1	NAMMCO SC/25/AE/05
LAC	NASS	2015	Iceland/Faroes	S	IO	131,022	0.73	35,251	486,981	1	0	1	4.2, 9.1, Ann. 1	NAMMCO SC/25/AE/06_rev
LAL	NILS02-07	2005	Norway	S	IO					0	0	3	4.4, 9.3	NAMMCO SC/25/AE/11
LAL	NASS	2007	Iceland/Faroes	S	BT	111,183	0.59	36,346	340,114	1	0	2	4.1, 9.1	NAMMCO SC/25/AE/05
LAL	NASS	2015	Iceland/Faroes	S	IO	159,000	0.63	49,957	506,054	1	0	1	4.2, 9.1, Ann. 1	NAMMCO SC/25/AE/06_rev
LAL	CIC2016	2016	Iceland coastal	A	IO					1	0	3	4.3, 9.2	NAMMCO SC/25/AE/07
MN	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 7.1	NAMMCO SC/25/AE/10
MN	NASS	2015	Iceland/Faroes	S	IO	9,867	0.37	4,854	20,058	1	0	1	4.3,7.4, Ann. 1	NAMMCO SC/25/AE/06_rev
MN	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.4, 7.2	NAMMCO SC/25/AE/12
OO	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 10.1	NAMMCO SC/25/AE/11
PM	NILS02-07	2005	Norway	S	IO					1	0	3	4.4, 8.1	NAMMCO SC/25/AE/10
PM	NASS	2007	Iceland/Faroes	S	BT	12,220	0.38	5,807	25,717	1	0	1	4.1, 8.2	NAMMCO SC/25/AE/05
PM	NASS	2015	Iceland/Faroes	S	IO	23,166	0.59	7,699	69,709	1	0	1	4.2, 8.2, Ann. 1	NAMMCO SC/25/AE/06_rev
PM	NILS2015	2015	CM1a+CM3	S	IO					1	0	3	4.1, 8.1	NAMMCO SC/25/AE/12
PP	NILS02-07	2005	Norway	S	IO					1	0	3	4.1, 9.3	NAMMCO SC/25/AE/11
PP	CIC2016	2016	Iceland coastal	A	IO					1	0	3	4.3, 9.2	NAMMCO SC/25/AE/07

Table 1. Estimates considered by the Working Group on Abundance Estimates. TYPE – S=ship, A=aerial; MODE – IO=independent observer, BT=Buckland-Turnock; BIAS CORR – bias correction, PER – perception, AVAIL – availability, 1=corrected, 0=uncorrected, P=partially corrected; STATUS – 1=accepted, 2=accepted provisionally pending minor work; 3=further work required; REPORT – lists relevant report section.