



SCIENTIFIC COMMITTEE ABUNDANCE ESTIMATES WORKING GROUP

*8-10 October 2019
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REPORT



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TABLE OF CONTENTS

1.	Welcome from the Chair and opening remarks	5
2.	Adoption of agenda	5
3.	Appointment of rapporteurs	5
4.	Review of available documents and reports	5
5.	Common minke whale	10
5.1	Norwegian mosaic survey: 2014-2019 cycle	10
5.2	CIC aerial survey 2016	10
6.	Large baleen whales	12
6.1	Norway – last three survey cycles	12
6.2	Iceland/Faroes 2015: Blue and sei whales	16
6.3	Iceland/Faroes 2007: Sei whales	17
6.4	CIC Aerial 2009: Humpback whales	18
7.	Sperm whales	19
7.1	Norway – last three survey cycles	19
8.	Dolphins and porpoises	21
8.1	Norway – last three survey cycles	21
8.2	Iceland/Faroes 2007: white-beaked and white-sided dolphins	25
8.3	CIC Aerial 2007: white-beaked dolphins	25
8.4	CIC Aerial 2009: white-beaked dolphins	26
8.5	CIC Aerial 2016: white-beaked dolphins	26
8.6	CIC aerial survey 2016: harbour porpoises	28
9.	Killer whales	29
9.1	Norway – last three survey cycles	29
10.	Northern bottlenose whale	31
10.1	Iceland/Faroes 2015	31
11.	Discussion of NASS fin whale estimates at IWC	32
12.	NASS series spatial analyses	33
12.1	Distribution and habitat use of deep diving cetaceans in the central and eastern North Atlantic	33
12.2	Oceanic drivers of sei whale distribution in the North Atlantic	36
13.	SCANS III 2016 update	36
14.	Canadian NAISS 2016 update	36
15.	Publication of survey results	37
16.	Proposed workshop “Novel methods for abundance surveys & estimation”	37
17.	Planning the next NASS	37
18.	Other items	38
18.1	Development of new survey software	38
18.2	Geometer development	38
18.3	Cooperation with IWC	38

19. Recommendations..... 39

20. Next meeting..... 40

21. Adoption of report..... 40

Table 1: Status of Abundance Estimates..... 41

References..... 43

APPENDIX 1: AGENDA 45

APPENDIX 2: LIST OF PARTICIPANTS 47

APPENDIX 3: LIST OF DOCUMENTS 48

1. WELCOME FROM THE CHAIR AND OPENING REMARKS

The Chair of the Working Group Daniel Pike welcomed participants to the meeting and acknowledged the important role of the invited experts. He noted that the working group (WG) was tasked with answering request (R-1.7.11) from NAMMCO 16: *To develop estimates of abundance and trends as soon as possible once the survey has been completed, with the primary target species (fin, minke and pilot whales) as a first priority, and secondary target species as a second priority.* The focus of the agenda for this meeting was therefore to finalise estimates from the 2015 survey and to provide syntheses as appropriate. The Chair also noted that although there was an initial intention to begin planning the next survey, since the NAMMCO Scientific and Management Committees have indicated that this will not take place until 2023, only preliminary planning is expected at this stage. Finally, the Chair highlighted that some of the analyses had now been published, including in a special issue of NAMMCO Scientific Publications (volume 11) and that this represented a significant step forward.

2. ADOPTION OF AGENDA

The agenda was adopted without change.

3. APPOINTMENT OF RAPORTEURS

NAMMCO Scientific Secretary Fern Wickson was appointed as rapporteur, with assistance from the WG as required.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Since most of the working documents (see Appendix 3) contained several estimates for different species and surveys, it was decided that the WG would review the available documents in two stages. In the first stage, the papers would be discussed in terms of general aspects related to the methods. In the second stage, the focus would be on individual species and survey years. What is presented in the remainder of this section is therefore a general summary of the working papers providing abundance estimates and a record of the discussion pertaining to their overarching issues. The actual estimates from the different surveys are then presented in the species-specific sections of the report that follow. The status of the abundance estimates after the meeting (i.e. accepted, accepted pending small modifications, not accepted because further analysis is needed) is summarised in Table 1.

SC/26/AEWG/04 - Distribution, abundance and trends in abundance of cetaceans in Icelandic waters over 30 years of aerial surveys

Summary

Beginning in 1986, 7 aerial surveys covering the coastal waters of Iceland have been conducted up to 2016. In addition, several partial surveys covering portions of the same area and at different times of the year have been flown in the same 30 year time span. A partial double platform (1 side only) was used in all surveys except 2016, when a full double platform configuration was employed. Duplicate sightings were identified by coincidence in sighting time (± 3 sec) and radial or perpendicular distances ($\pm 30\%$), and identification of duplicates was unambiguous in most cases. Abundance of minke whales was estimated using the cue counting procedure, assuming a cue rate of 53 hr^{-1} . For other species abundance was estimated using standard line transect methodology. Perception bias for the primary platform was estimated using a trial procedure assuming point independence for 2007 and 2009 and using an independent observer procedure assuming point independence in 2016. Uncorrected and corrected estimates are presented both for the entire survey area (excluding block 5 in 2016) and a post-stratified area excluding portions of strata that were not covered in the surveys.

Uncorrected line transect density was used as a proxy for relative abundance to assess temporal changes in the abundance of common minke and humpback whales and white-beaked dolphins over all surveys between 1986 and 2016. A common detection function for each species across all surveys, including a covariate for survey ID was used to estimate density using standard line transect methodology. Relative abundance of common minke whales, humpback whales and white-beaked dolphins was comparatively low in the spring and fall and peaked in June and July when all of the main surveys have been carried out. Common minke whale relative abundance decreased by 75% after 2001 and has remained at a low level since then. Relative abundance of humpback whales and white-beaked dolphins has increased over the period 1986-2016. Trends in relative abundance correspond well with changes in absolute abundance observed over the period. These observed changes are likely related to oceanographic and ecosystem changes documented over the same period.

Discussion

An earlier version of this working paper (SC/25/AEWG/07) with results from the 2016 survey only, was presented to the AEWG in 2018 and is discussed in the report from that meeting (NAMMCO 2018). The current working paper (document SC/26/AEWG/04) is a draft publication that presents estimates previously accepted by the AEWG (including those for common minke whales (2007, 2009) and humpback whales (2007)) as well as a revised estimate for common minke whales from the 2016 survey, and new estimates for humpback whales (2009), white-beaked dolphins (2007, 2009, 2016) and harbour porpoises (2016).

The working paper excluded strata with zero sightings from the regressions and there was a concern that this may bias the trend. The WG agreed that such cases should be included if there was effort in the strata.

The analyses employed right truncation of up to 10% of the data in some cases, however, the criteria for truncation were not sufficiently explained. The purpose of truncation is to improve the detection function fit but subjective judgement will always be involved in deciding exactly where to truncate, guided by goodness of fit tests and how sensitive results are to truncation. The WG agreed that it was important to clarify the choice of the truncation distance in the paper and the criteria that were used to determine this. The WG also noted that the working paper did not contain any discussion of the implications of left truncating the data for some species and requested that this be elaborated upon.

Trends in relative abundance were analysed using a single detection function for each species across all surveys. It was recommended that trends in absolute abundance for those surveys for which it is available also be analysed for comparison.

The WG recommended that a power analysis to investigate the magnitude of trend that could be detected with the available data be conducted.

The WG noted that the survey area probably did not correspond to a stock area for any of the species analysed. Therefore, it is not possible to discriminate between changes in population size and shifts in distribution for these species.

SC/26/AEWG/05 - Estimates of the abundance of cetaceans from the T-NASS Icelandic and Faroese ship surveys conducted in 2007

Summary

Working paper 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. Four vessels were employed as dedicated survey vessels, each one equipped with two observing platforms. 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 the latter analysis. Abundance in the extension strata was estimated using detection functions combining sightings from the dedicated and extension vessels.

Sightings of white-beaked and white-sided dolphins were combined to estimate a single detection function. 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. 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

An earlier version of this paper (SC/25/AEWG/05) was presented and considered in detail at AEWG 2018 (see NAMMCO 2018). The present document therefore details only estimates that were not included in the earlier document (i.e. sei whales), and those that were revised subsequent to the last meeting (i.e. white-beaked and white-sided dolphins). Estimates for the latter were accepted at AEWG 2018 but have been further revised following a peer review of the paper for publication.

SC/26/AEWG/06 - Estimates of the abundance of cetaceans from the NASS Icelandic and Faroese ship surveys conducted in 2015 (SC/26/AEWG/06)

Summary

This paper presents results from the Icelandic and Faroese components of the NASS ship survey conducted from late June to early August 2015, the sixth of the series. 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, all using 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.

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

An earlier version of this paper (SC/25/AE/06) was presented to the AEWG in 2018. At that meeting, several abundance estimates were presented that could not be accepted as (in most cases) minor work

was required. A correspondence meeting was held subsequent to the main meeting and revised estimates incorporating the recommendations of the WG were provided and accepted (NAMMCO 2018). A paper detailing all estimates from the survey has now been published (Pike, Gunnlaugsson, Mikkelsen, Halldórsson, & Víkingsson, 2019). SC/26/AE/06 therefore provides estimates for species that were not included in 2018, namely blue, sei and northern bottlenose whales.

SC/26/AEWG/09 - Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2002-2007

SC/26/AEWG/10 – Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2008-2013

SC/26/AEWG/11 – Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2014-2018

Summary

The abundances of large whale species and small odontocetes are presented for the northeast Atlantic shipboard surveys carried out in 2002-2007, 2008-2013, and 2014-2018 as six-year cyclical mosaic surveys. The survey targets minke whales with tracking for that species only, and was conducted in passing mode, resulting in limited opportunities for closing on sightings to determine other species identities and school sizes. These surveys were performed with two independent observer platforms. Abundance estimates were obtained by combining sightings from both platforms and applying Mark Recapture distance sampling techniques. The detection functions and *eshw* (effective search half width (m)) were estimated globally, while group size and encounter rate were estimated by block. Covariates including Beaufort Sea State (BSS), vessel identity, weather code, group size, glare, and visibility were included in the detection function models to improve precision and were retained only if their inclusion resulted in a lower Akaike's Information Criteria (AIC) value. The estimates for *Lagenorhynchus spp.* in the 2002-2007 survey used sightings from a single platform (platform 1) due to uncertainty in judging duplicates, otherwise all estimates use duplicate sightings to correct for perception bias. All harbour porpoise estimates were calculated using complete survey effort and separately using only the survey effort conducted at a BSS of 2 or less to look at the impact of restricting effort to conditions typically more suited for detecting harbour porpoises.

SC/26/AE/12 - Estimates of abundance of large whales from Norwegian ship surveys and a NASS extension survey conducted in 2015

Abundance estimates for large whale 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 multi-year cyclical mosaic survey program conducted over the period 2014-2018, while the survey coverage of CM was an extension to the NASS-2015 survey. A total effort of 7,857 km of primary transects were searched in 2015, covering a total area of 1,458,127 sq. km. Abundance for fin whales, humpback whales, and sperm whales was estimated for all survey blocks using mark-recapture (MR) distance sampling methods, correcting for perception bias. The detection functions were modelled with covariates including Beaufort Sea State (BSS), vessel identity, weather, group size, glare, and visibility.

Discussion

Working papers SC/26/AEWG/09 and 12 present a revision of work initially presented to the AEWG in 2018. In the current versions of the working papers, mark-recapture methods for estimating perception bias were used and covariates were included in the detection function models, as recommended by the WG in 2018.

The WG agreed that further explanation of the decision regarding where to truncate the data was also required in these papers.

The discussion noted that in several cases, unidentified large whale sightings were allocated a positive species identification based on post duplicate analysis, second observer identifications, or third person confirmation. The appropriateness of this approach had been discussed in a previous meeting (NAMMCO 2018), although the discussion in that case was for B-T mode surveys. Converting species identification in this way may lead to an over-identification of duplicates and therefore underestimate abundance. The WG recommended that the sensitivity of the estimates to inclusion of these duplicates be investigated. It was noted that observers vary in their level of confidence/reluctance in making species identifications and therefore in some cases it may make sense to trust in an identification made by only one observer. The WG agreed that a more complete description of the process for species identification and the assignment of duplicates (including the opportunistic use of a third person on the bridge) should be provided.

The particular difficulty of identifying duplicates in high density areas was noted. Although surveys conducted using B-T mode have dedicated observers to identify duplicates in the field, it was not clear whether this approach gives more certainty than identifying duplicates post-survey from the dataset. There were seen to be two issues in play: 1. Error in distance estimation (in particular) may make the recorded data more challenging to use in determining duplicates than a real time judgement when the animals can be observed; 2. Groups of animals sighted from ships may be seen during different surfacings whereas when recording cues from ships or aircraft it is the same surfacing that is detected by observers. The WG agreed that any judgements made on duplicates in the field should ideally be compared to post-survey analysis of the data. It was also noted that the use of photos, video or closing in on unidentified species may help both species and duplicate identification.

It was proposed that what is ideally required is an algorithm-based method of duplicate identification for all surveys, similar to that presently used by Norway for minke whales. Such an approach would need to account for the error and/or bias in angle and distance measurements. Leaper et al. (2010) demonstrated that bias in observer estimates of distance in surveys may not show comparable bias in the distance experiments used for training, meaning that the experiments should not be considered appropriate for correcting bias in observed distances to cetacean sightings in the field.

Estimates for harbour porpoises were provided using Beaufort cutoffs of ≤ 2 and ≤ 4 . It was noted that in surveys for which harbour porpoise are a target species, such as SCANS, a cutoff of ≤ 2 is generally used. This issue is further discussed under item 8.1 on harbour porpoises.

The approach of only using data from the upper platform to generate estimates for the dolphin species was discussed. It was noted that since the two platforms are independent, it should be possible to perform separate estimates for each platform and use an average of the two, and the WG suggested that this approach be considered. However, how to combine the variance for such an average estimate was not clear – see discussion below. Notwithstanding this, the approach used by the authors (single platform estimate) was also noted as valid.

Regarding responsive movement for white-beaked dolphins, the WG observed that evidence for attraction close to the ship but avoidance at greater distances had been identified in other surveys (Palka and Hammond 2001).

When considering the confidence of determining duplicates, reported under the three categories of definite, probable, remote described according to a confidence % (i.e. definite = 90-100% confident), it was suggested that this could misleadingly imply that the confidence was based on quantitative analysis rather than determined by subjective judgement. The WG agreed that it was important to clearly indicate that subjective determinations were involved.

The WG noted that additional variance related to the change in distribution between survey years was not included in these estimates but was included for minke whales. Since these are mosaic surveys, it may be important to do this for all other species. This would, however, require further analysis that has not yet been carried out. It is therefore likely that variance is underestimated by an unknown degree for all species other than minke whales.

5. COMMON MINKE WHALE

5.1 NORWEGIAN MOSAIC SURVEY: 2014-2019 CYCLE

The analysis for this cycle has not yet been extended beyond 2017. The cycle was finished this year and the intention is to present results to the IWC in 2021.

5.2 CIC AERIAL SURVEY 2016

Summary

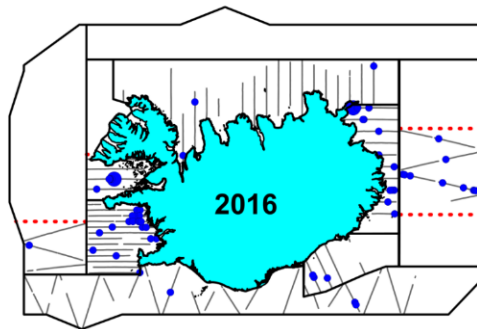


Figure 1. Realised survey effort and sightings of common minke whale in 2016. Symbol sized varies with group size from 1 to 3.

The estimate for common minke whales in Icelandic coastal waters (stock area CIC) is provided in SC/26/AE/04 (the general methods for which are discussed under item 4 above). In 2018, the AEWG recommended that the survey 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 (NAMMCO 2018). 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. 1). 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 the unique sightings, 25% did not cue (i.e. break the surface) while in sight, 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 uncorrected estimate of 12,966 (CV=0.47, 95% CI: 5,402-31,124). 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), resulting in a fully corrected estimate of 13,497 (CV=0.50, 95% CI: 5,377-33,882). Post-stratification, removing portions of blocks 7 and 3, would reduce both estimates by 29%.

Trends in relative abundance

Relative abundance assessed for aerial surveys conducted from 1986-2016 was highest in the summer in all strata sampled, but the differences were not significant in most cases. In block 1 where observed densities were highest in all periods, summer density was significantly higher than that observed in April, while density in September was nearly the same as that during the summer.

Relative abundance in the survey area was relatively stable from 1986 until 2001, after which it dropped by 75% in 2007 and remained at low levels through 2016 (Fig. 2). Density in the survey area was significantly lower ($P < 0.05$) in 2007 and 2009, but not in 2016, than it was in 2001. Negative growth rates were observed in strata 1, 4, 5 and 8, and in the whole survey area density declined at a rate of -0.04 (95% CI: -0.05; -0.02) from 1986 to 2016. Common minke whales have been nearly absent from block 8 off southeast Iceland, formerly an area of high density, in surveys conducted since 2001. The decline in these areas began after 2001, although density was still at relatively high levels in blocks 1 and 5, but not 4 and 8, as late as 2004. Density recovered to higher levels in block 1 in 2008 but declined again thereafter. This suggests that the decline in common minke whale abundance in the survey area occurred over a few years and may not have been a single event across the area.

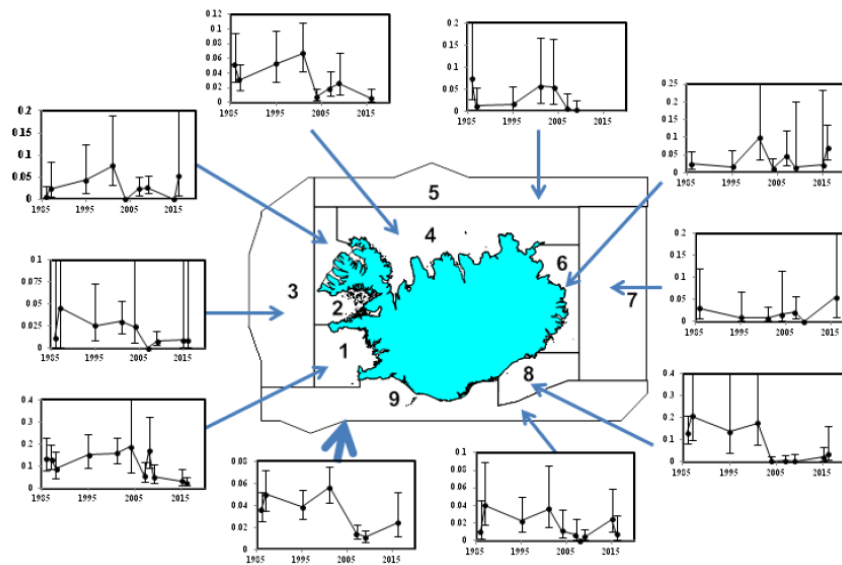


Fig. 2. Trends in the relative abundance (uncorrected line transect density, whales nm⁻²) of common minke whale by stratum and for the entire survey area (thick arrow).

Discussion

The WG recalled that Víkingsson et al. (2015) present a discussion of recent changes to the marine ecosystem around Iceland, including the distribution and abundance of cetaceans from the NASS ship and aerial surveys. Temperature and salinity have increased substantially since 1995 due to increased inflow of Atlantic waters into the area, likely as a result of climate change. This is correlated with changes in the distribution of forage fish and euphausiids on which many cetaceans are dependent. Since 2005, sandeel (*Ammodytes* spp.) recruitment and abundance has declined drastically in western and southern Iceland. Over roughly the same period the distribution of capelin (*Mallotus villosus*) has shifted away from northern Iceland towards the East Greenland coast, and Atlantic mackerel (*Scomber scombrus*) have moved in from east to become much more abundant in Icelandic waters during the summer and fall (Asthorsson, Valdimarsson, Gudmundsdottir, & Óskarsson, 2012).

These changes have been correlated with concomitant shifts in the diet of common minke whales in the area (Vikingsson et al. 2014). As these changes correspond temporally with the reduction in abundance of common minke whales in Icelandic coastal waters, it is likely that common minke whales may have shifted their distribution in response to changes in the availability of favoured prey.

The removal of un-surveyed portions of strata for the post-stratified estimates contains an implicit assumption that density is 0 in these areas, which there is no reason to expect. The WG agreed that the post-stratified estimates generated should therefore be viewed as a minimum or lower bound.

Given the changes in the distribution of minke whales seen in the last 2 cycles of Norwegian surveys, it will be particularly interesting to see the estimate from the latest survey cycle. It was noted that although minke whale abundance has been estimated for east Greenland (Hansen et al., 2019), since only one survey has been conducted in this area it was difficult to draw conclusions about any possible migration of minke whales into this area.

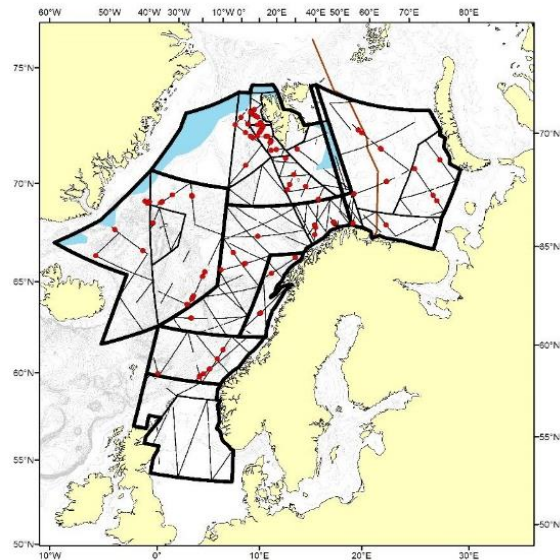
The WG agreed to accept the uncorrected and corrected estimates presented in the working paper. However, it also recommended exploring the use of spatial modelling to extrapolate the estimate into the areas that had not been surveyed.

6. LARGE BALEEN WHALES

6.1 NORWAY – LAST THREE SURVEY CYCLES

Summary - Fin Whales

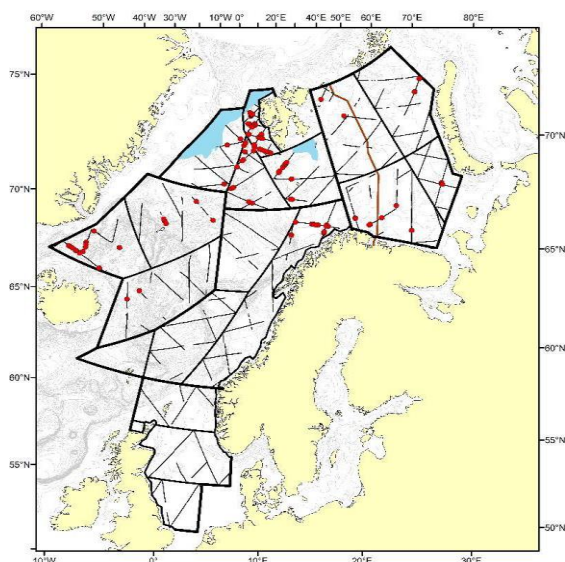
2002-2007



Fin whales were found throughout the survey area but were especially abundant west of Spitsbergen, survey blocks (NVN, NVS, JMC). The best fitting models used a half-normal key function, truncated to a perpendicular distance of 4000 m and included BSS as a covariate in the distance sampling (DS) model. The resulting *eshw* was 1858 m. The abundance of fin whales was estimated to be 7,094 (CV=0.15, 95% CI: 5,219-9,1614) and corrected, with $p(0)=0.72$, to 10,004 (CV=0.18, 95% CI: 6,937-14,426).

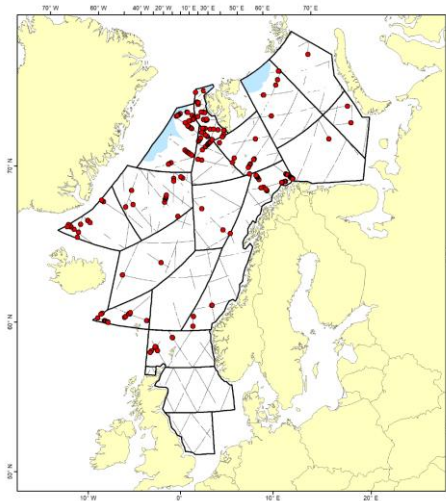
Figure 3. Distributions of sightings recorded as fin whales from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage.

2008-2013



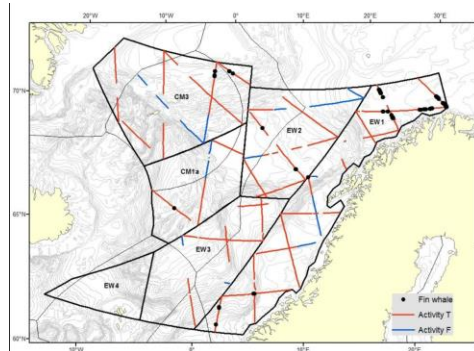
Fin whales were most often sighted west of Spitsbergen (ES1, ES2) and in the western, Iceland-Jan Mayen, survey blocks (CM2, CM3). The best fitting models used a half-normal key function, truncated to a perpendicular distance of 4000 m. The DS model was fit with BSS and weather as covariates and the MR model was fit with BSS as a covariate. The resulting *eshw* was 1909 m. The abundance of fin whales was estimated to be 8,047 (CV=0.23, 95% CI: 5043-12,824) and corrected, with $p(0)=0.77$, to be 10,861 (CV=0.26, 95% CI: 6,433-18,339).

Figure 4. Distributions of sightings recorded as fin whales from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage.

2014-2018

Fin whales were abundant west of Spitsbergen (ES1, ES4), in the western Iceland-Jan Mayen survey block (CM3) and in the Norwegian Sea (EW1). The final model was fit with a half-normal key function and sightings truncated to a perpendicular distance of 4000 m. Weather was included as a covariate in the DS model. The resulting *eshw* was 2,004 m. The abundance of fin whales was estimated to be 9,494 (CV=0.17, 95% CI: 6,800-13,256) and corrected, with $p(0)=0.83$, to be 11,387 (CV=0.17, 95% CI: 8,072-16,063).

Figure 5. Distributions of sightings recorded as fin whales from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage.

2015

Fin whale were the most abundant large whale species in 2015, with a total of 55 observations, 80% of which occurred in the northern most quarter of EW1, off the Finnmark coast of Norway. A hazard-rate model provided the best fit, with data truncated to a perpendicular distance of 3,500 m. The detection function resulted in an *eshw* of 1,508 m, an uncorrected estimate of 3,147 (CV=0.44, 95% CI: 1,290-7,673) and a corrected estimate of 3,729 (CV=0.44, 95% CI: 1,531-9,081).

Figure 6. Distributions of sightings recorded as fin whales from platform 1 during the 2015 surveys. Activity T = active transect. Activity F (Transects in Beaufort Sea State >4) was not used in this analysis

Discussion - Fin Whales

It was noted that the estimates of fin whales were relatively similar across all the survey cycles, although there had been some shift in distribution during the most recent period with a decline in the Jan Mayen blocks and an increase in the Svalbard/Spitsbergen blocks.

Significant discussion was had on the general observation that the conditional detection probability was increasing with perpendicular distance for fin whales and some other species (e.g. humpback whales). This was acknowledged as unexpected and counterintuitive. Independent expert advice was therefore sought on the matter. This advice suggested that a conditional detection function that increases with increasing perpendicular distance is indicative of unmodelled heterogeneity (non-independence) at greater distances. This is, however, not problematic because the point independence method only assumes independence (no heterogeneity) on the trackline and the detection function should predict conditional detection probability correctly at zero distance (the intercept). Therefore, the WG agreed that the analyses presented are appropriate. However, the WG also recommended considering conditional detection functions without perpendicular distance as a covariate in all cases, and their adoption if indicated to be better models as determined by AIC.

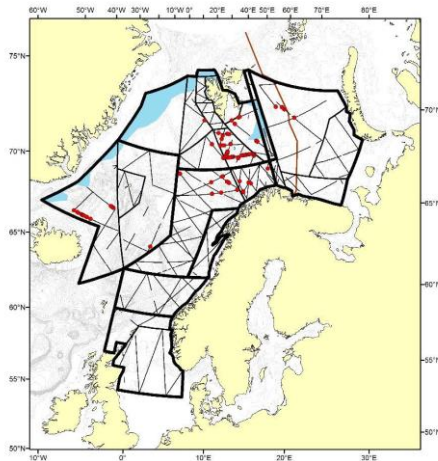
During the meeting, conditional detection functions for all species and all survey cycles were refit without perpendicular distance and compared by AIC. In all cases where the conditional detection

models showed an increasing or decreasing trend with distance, the inclusion of perpendicular distance improved the model fit (reduced the AIC). In a few other cases, perpendicular distance was not significant and was removed without significant effect on the estimates.

Given this supplementary information, the WG agreed to accept the uncorrected and corrected estimates.

Summary – Humpback whales

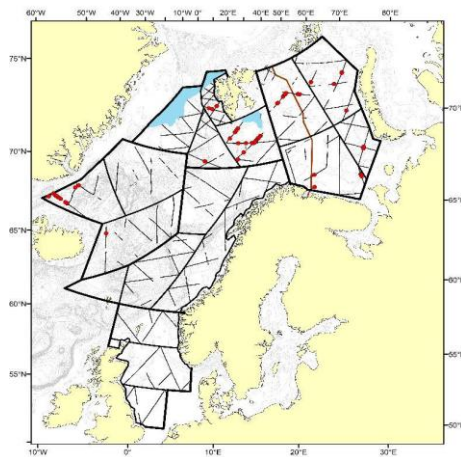
2002-2007



Humpback whales were sighted most frequently around Bear Island, in the northern Barents Sea and in the western-most survey block, north and east of Iceland (NVS). The best fitting models used a half-normal key function, truncated at a perpendicular distance of 4,000 m and resulted in an *eshw* of 2,240 m. Weather was included as a covariate in both the DS and the MR models. The abundance for humpback whales was estimated to be 7,388 (CV=0.30, 95% CI: 3,909-13,963) and corrected, with $p(0)=0.70$, to a total estimate of 10,669 (CV=0.31, 95% CI: 5,695-19,988).

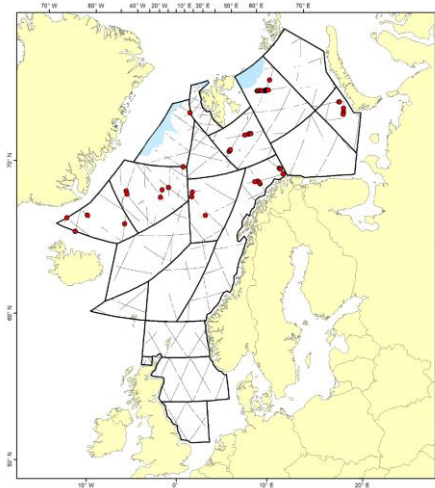
Figure 7. Distributions of sightings recorded as humpback whales from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage.

2008-2013



Humpback whales concentrated in the north and east of Iceland (CM2), around Bear Island (ES1), and in the northern Barents Sea (EB3). The best fitting models used a half-normal key function, truncated at a perpendicular distance of 4000 m and resulted in an *eshw* of 1,760 m. Visibility was included as a covariate in the DS model and weather was included in the MR model. The abundance for humpback whales was estimated to be 9,631 (CV=0.30, 95% CI: 5,294-17,521) and corrected, with $p(0)=0.77$, with a total estimate of 12,958 (CV=0.31, 95% CI: 7,033-23,873).

Figure 8. Distributions of sightings recorded as humpback whales from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage

2014-2018

Humpback whales were found in three key areas: the northern Barents Sea (EB3), around Bear Island (ES1), and north and east of Iceland (CM2, CM3). The detection functions were fit with a hazard-rate key function and a truncation distance of 3000 m, which resulted in an *eshw* of 1,760 m. Humpback whale abundance was found to be 8,150 (CV=0.38, 95% CI: 3,765-17,646) and corrected, with $p(0)=0.70$, to a total estimate of 11,662 (CV=0.40, 95% CI: 5,225-26,027).

Figure 9. Distributions of sightings recorded as humpback whales from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage

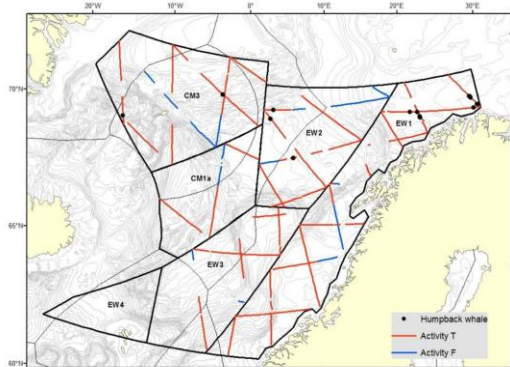
2015

Figure 10. Distributions of sightings recorded as humpback whales from platform 1 during the 2015 surveys. Activity T = active transect. Activity F (Transects in Beaufort Sea State >4) was not used in this analysis.

A total 14 humpback whale sightings were made in the 2015 surveys and 80% of the sightings occurred in block EW1, off Northern Norway. Humpback whale sightings were too low in number ($n=14$) to effectively fit a detection function. Therefore, it was necessary to pool the data available from other survey years within the 6-year mosaic program (2014-2017). A half-normal model was found to give the best fit, with sightings truncated at a perpendicular distance of 3,000 m. The fitted detection function resulted in an *eshw* of 1,260 m, an uncorrected estimate of 1,164 (CV=0.39, 95% CI: 395-1,994), and a corrected estimate of 1,711 (CV=0.41, 95% CI: 604-3,631). The estimated value of $p(0)$ was 0.77 (CV=0.08).

Discussion - Humpback Whales

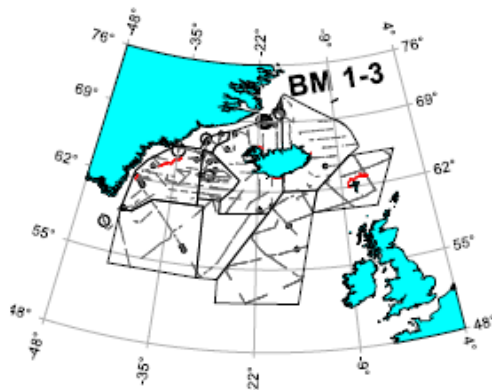
It was noted that the apparent increase in estimated abundance since the 1996-2001 period when the uncorrected estimate was 4,695 (CV=0.39) (Øien 2009) may be due to population recovery and/or distributional shifts. Since 2008 (when observation of humpback whales in association with overwintering herring in northern Norway began) the temporal and spatial distribution of humpbacks has changed markedly. This indicates that humpback whales may be quite flexible and dynamic in their migratory periods and distribution. The full picture of the distributional/population changes will be greatly aided by the extensive photographic id and tagging work that has been conducted throughout the North Atlantic in recent years.

Víkingsson informed the WG that there have been recent reports of singing humpback whales off northern Iceland, suggesting that breeding may be occurring there. Biopsies have been taken to examine the hormone profile in these whales.

The WG agreed to accept the uncorrected and corrected estimates.

6.2 ICELAND/FAROEES 2015: BLUE AND SEI WHALES

Summary – Blue Whales



Sightings of blue whales were concentrated to the north and west of the survey area, particularly off the east coast of Greenland (Fig. 11). Most sightings (81%) were of single blue whales, and the maximum group size observed was 3. Best fit of the detection function was achieved with a half-normal function with 1 cosine adjunct, resulting in an effective strip half-width of 1,319 m. Density and abundance was greatest in block IR which alone accounted for about half of the total estimate of 2,490 (CV=0.36, 95% CI: 1,234-5,022). Exclusion of the most uncertain species identifications reduced abundance by 6%.

Figure 11. Sightings of Blue whale. Symbol size is proportional to the group size (1 to 3). Compromised transects are red.

Icelandic vessels A and B made similar numbers of blue whale sightings, but 39% of sightings on vessel B were duplicates while only 4% were duplicates on vessel A. Vessel H accounted for only 3 sightings, 2 of which were duplicates.

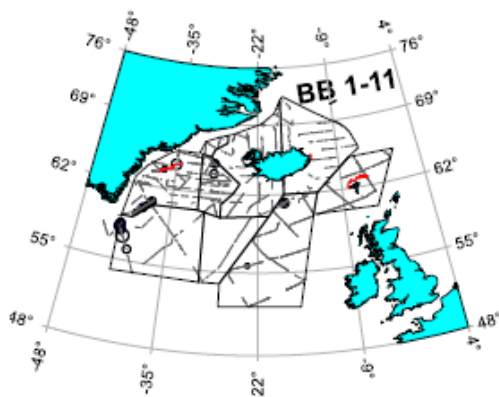
Best fit for the conditional detection function was achieved using distance only as a covariate. This resulted in an estimated $p(0)$ of 0.83 (CV=0.11). Corrected abundance in the survey area totalled 3,000 (CV=0.40, 95% CI: 1,377-6,534). Only 1 blue whale was observed on the fall capelin survey. Encounter rate was over 6 times greater in the corresponding area in the summer survey.

Pike, Víkingsson, Gunnlaugsson, & Øien (2009) provide uncorrected abundance estimates for all surveys up to 2001. No estimate is available for 2007 as there were only 14 sightings in that survey. Abundance was highest in 1995 and 2001 at just over 1,000 animals and increased significantly over the period at a rate of 9% (95% CI: 3-14%). Our uncorrected estimate is more than double those from 1995 and 2001, although not significantly different from either ($P>0.05$). This suggests that blue whale numbers have increased in the area, particularly to the west of Iceland.

Discussion – Blue Whales

The WG agreed to accept the uncorrected and corrected estimates.

Summary – Sei Whales



Sei whales were most commonly sighted to the west of Iceland, especially in blocks IG and IP off southeast Greenland (Fig 12). None were sighted to the north of Iceland or in the fall survey. Sei whales were usually sighted as solitary animals or pairs, and rarely in groups as large as 8 animals.

Figure 12. Sightings of sei whale (BB). Symbol size if proportional to group size (1 to 11). Compromised transects are red.

Best fit was achieved with a half-normal function with a 2-level covariate for vessel identity. Effective strip width was applied at the stratum level and ranged from 795 m to 2,400 m, depending on the vessel that covered the stratum. Density was highest in stratum IP, which accounted for 69% of the total estimated abundance of 3,127 (CV=0.51, 95% CI: 964-10,142). Omission of the least certain class of species identification resulted in a loss of 10% of sightings and a reduction in overall abundance of 4%.

Of the 34 sei whales sighted within the truncation distance of 3,000 m, 30% were seen by both platforms. However, this varied from 0% on vessel H to 50% on vessel A. Best fit of the conditional detection function was realized with a covariate for perpendicular distance, resulting in an estimated average $p(0)$ of 0.83 (CV=0.17) and a total estimated abundance of 3,767 (CV=0.54, 95% CI: 1,156 - 12,270). Omission of the least certain class of species identification resulted in a reduction in overall corrected abundance of 6%. These should be considered partial estimates for the Central North Atlantic as they do not encompass the complete seasonal or geographical range of the stock.

Discussion - Sei whales

The WG agreed that this should be considered a partial estimate since timing of the survey does not coincide with peak abundance of sei whales in the area and sei whales are known to be present in areas not covered by the survey. The phenomenon of “sei whale years” was also noted. These are years in which the numbers of sei whales seen in northern areas are dramatically higher than in other years. This is indicative of temporal variation in their migration patterns.

It was proposed that there might also be some negative bias as some (unknown) proportion of the whales that were identified as fin whales are likely to be sei whales. Such a misidentification can have a large impact on the sei whale estimate (in all years) because fin whales greatly outnumber sei whales in the area.

The WG agreed to accept both the uncorrected and corrected estimates.

6.3 ICELAND/FAROEES 2007: SEI WHALES

Summary

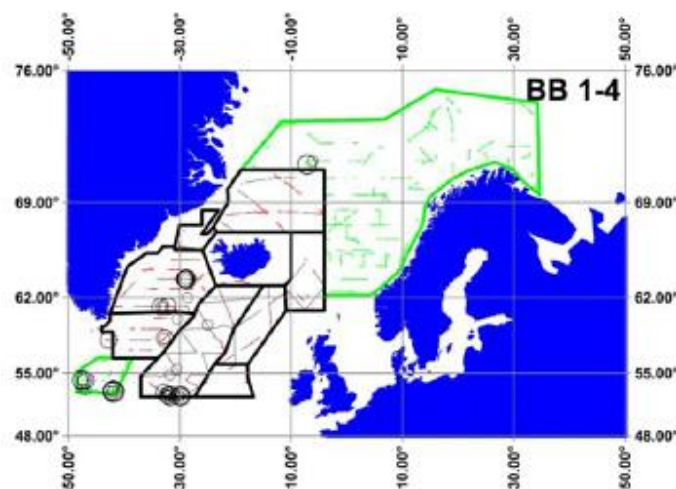


Figure 13. Sightings of sei whales. Symbol size is proportional to group size.

Sei whales were sighted to the south and southwest of Iceland, and a large number were sighted at the southern extremity of the survey area in stratum SC (Fig. 13). Group size ranged from 1 to 3 but single animals comprised the majority (62%) of the sightings made by the dedicated vessels. The extension vessels sighted 15 sei whale groups, most in block XSW to the southwest of the core survey area. A half-normal key function with no adjustment terms or covariates provided the best fit for the detection function for data both including and excluding sightings from the extension vessels. Density was highest in block RN but block SC accounted for 62% of the total uncorrected estimated abundance in the T-NASS core area of

5,159 (CV=0.47, 95% CI: 1,983-13,423). The extension vessels made only 1 sighting within the T-NASS core area, and their encounter rate was 1% (CV=1.04) that of the dedicated vessels in the same area. Abundance in the extension strata, estimated using a detection function combining dedicated and extension vessel sightings, was 4,578 (CV=0.60, 95% CI: 1,381-15,172), almost all (97%) of which came from block XSW to the southwest of the core survey area. Total estimated uncorrected abundance for the core and extension strata combined was 9,737 (CV=0.38, 95% CI: 4,189-19,665).

Observers on the primary platforms re-sighted 63% of sightings made by observers on the tracker platforms. However, all of these re-sightings were at perpendicular distances greater than 350 m and the response to distance was contrary to expectations, with the proportion of duplicates increasing with distance. Lowest AIC in the conditional detection function was achieved using only perpendicular distance as a covariate, however, this resulted in an unrealistically low and imprecise estimate of $p(0)$ of 0.12 (CV=2.59). A decision was therefore made to not present a bias-corrected estimate for this species.

This survey did not cover the entire summer range of sei whales in the central North Atlantic, which extends further to the south along the North Atlantic Ridge and south of Greenland.

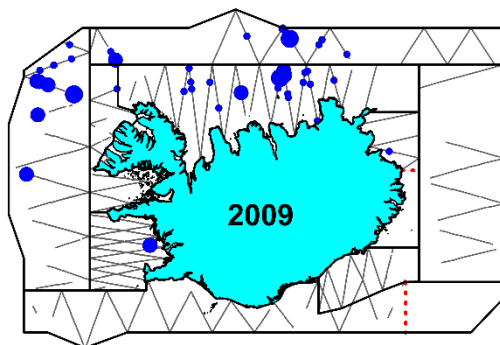
Discussion

The WG considered this to be a partial estimate due to the survey not covering the entire summer range and peak season. It was proposed that there might also be some negative bias as some (unknown) proportion of the whales that were identified as fin whales are likely to be sei whales (as also noted above for 2015).

The WG agreed to accept the uncorrected estimate.

6.4 CIC AERIAL 2009: HUMPBACK WHALES

Summary



A total of 64 humpback whale groups were sighted by all observers, of which 56 were seen by the primary observers. Density and abundance were highest in blocks 3, 4 and 5 (Fig. 14), which together accounted for 96% of the total uncorrected abundance estimate of 2,002 (CV=0.30, 95% CI: 1,096-3,655). Post-stratification would reduce this estimate by 1%. Estimated average $p(0)$ was 0.89 (CV=0.18) resulting in a corrected estimate of 2,261 (CV=0.35, 95% CI: 1,142-4,477).

Figure 14. Realised survey effort and sightings of humpback whales. Symbol size varies with group size from 1 to 3.

Trends in abundance 1986-2016

Over the entire survey area, growth rate has not differed significantly from 0 ($P>0.05$) from 1986 to 2016. However, growth rate was strongly positive at 0.10 (95% CI: -0.01-0.20) from 1986 to 2001 and negative at -0.12 (95% CI: -0.40; -0.21) from 2001 to 2016 (Fig. 15). This pattern was driven primarily by density changes in strata 3 and 7, where relatively high densities were observed in some years. In more recent surveys (after 2001), higher densities have been observed in the northern blocks 4 and 5, where growth rates have been significantly positive.

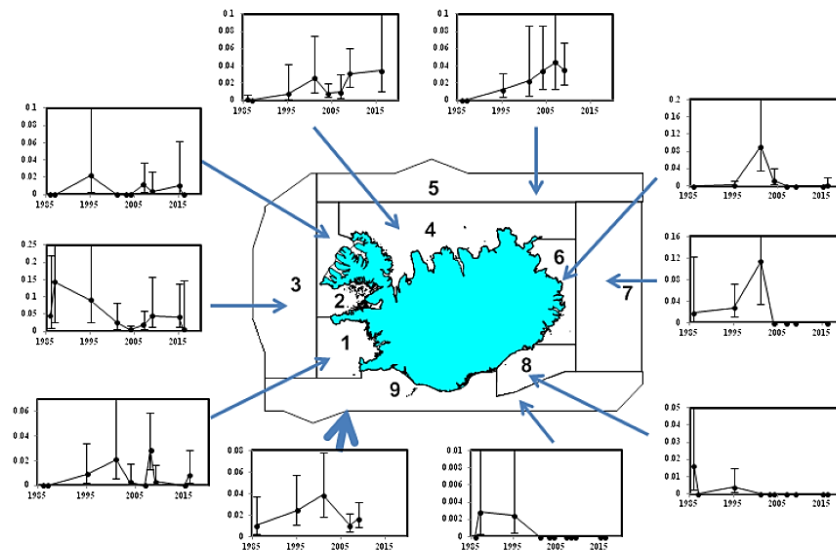


Figure 15. Trends in relative abundance (uncorrected line transect density, whales nm^{-2}) of humpback whales by stratum and for the entire survey area (thick arrow).

Discussion

It was noted that although these were not new data, an analysis had not been presented to the AEWG before. It was also made clear that in 2009, the survey was using a partial double platform and a corrected primary platform estimate was used to calculate the abundance estimate in this case.

The distribution, even within the survey area, appeared to be extremely dynamic. In some past surveys, large numbers of humpback whales have been sighted in the NE and NW corners of the area, which often have very bad weather conditions and have been poorly covered during the last two surveys. This means that density may be concentrated in portions of the northern blocks that are not often covered. If there has been a northward shift in distribution, this may explain the observed negative trend in recent surveys. The NASS shipboard surveys have shown that there is a continuous distribution outside the survey area, confirming that the survey is not covering an entire stock.

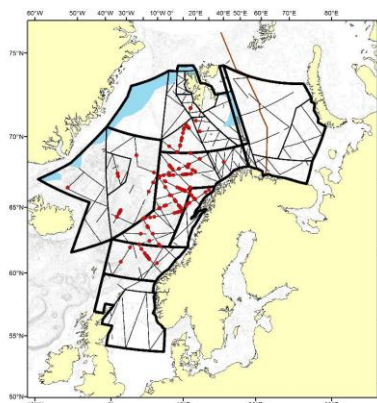
The WG agreed to accept both the corrected and uncorrected estimates.

7. SPERM WHALES

7.1 NORWAY – LAST THREE SURVEY CYCLES

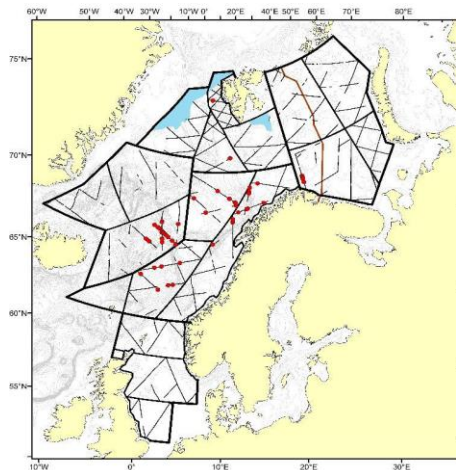
Summary

2002-2007



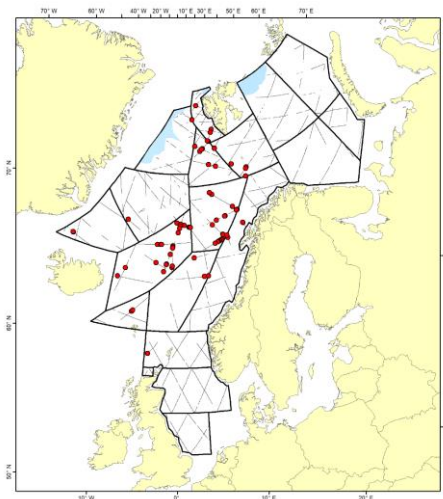
Most sightings were made in the deep waters of the Norwegian Sea, south of the Mohn Ridge between Jan Mayen and Bear Island. A half-normal key function produced the best fit to the double platform data, which were truncated at a perpendicular distance of 2,800 m. The resulting *eshw* was 1,858 m. Sperm whale abundance was estimated to be 6,597 (CV=0.17, 95% CI: 4,712-9,234) and corrected $p(0)=0.81$ to a total estimate of 8,134 (CV=0.18, 95% CI: 5,695-11,617).

Figure 16. Distributions of sightings recorded as sperm whales from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage.

2008-2013

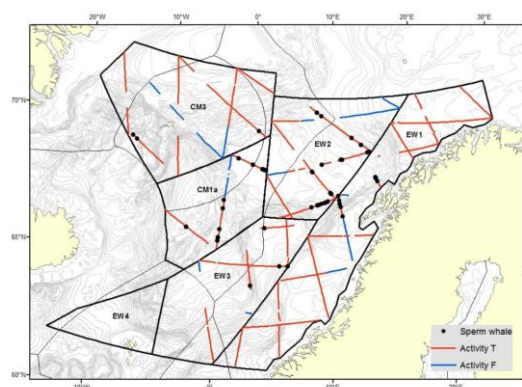
Most observations occurred in the Norwegian Sea (EW1), south of Jan Mayen (CM1). A half-normal key function produced the best fit to the data when truncated at a perpendicular distance of 4000 m. The resulting *eshw* was 1,964 m. Uncorrected abundance of sperm whales was estimated as 3,649 (CV=0.28, 95% CI: 2,051-6,490) and corrected using $p(0)=0.91$ to 3,962 (CV=0.29, 95% CI: 2,218-7,079).

Figure 17. Distributions of sightings recorded as sperm whales from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage.

2014-2018

Most sperm whales were sighted in the deep waters of the Norwegian Sea (EW2), south of Jan Mayen (CM1). The data were truncated at a perpendicular distance of 4,000 m and fit with a half-normal key function, yielding an *eshw* of 1,849 m. The uncorrected estimate was 3,822 (CV=0.21, 95% CI: 2,479-5,891) and corrected for perception bias ($p(0)=0.69$) to a total estimate of 5,522 (CV=0.25, 95% CI: 3,325-9,170).

Figure 18. Distributions of sightings recorded as sperm whales from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage

2015

Sperm whales were most often sighted in blocks EW3 and CM1a. A half-normal model produced the best fit to the data, which were truncated at a perpendicular distance of 3,500 m. The fitted detection function, shown in Figure 5c, resulted in *eshw* of 1,685 m, an uncorrected estimate of 2,692 (CV=0.25), and a corrected estimate of 3,828 (CV=0.33, 95% CI: 1,994-7,595). The estimated value of $p(0)$ was 0.70 (CV=0.09).

Figure 19. Distributions of sightings recorded as sperm whales from platform 1 during the 2015 surveys. Activity T = active transect. Activity F (Transects in Beaufort Sea State >4) was not used in this analysis.

Discussion

The WG agreed to accept the uncorrected and corrected estimates.

8. DOLPHINS AND PORPOISES

8.1 NORWAY – LAST THREE SURVEY CYCLES

Summary – Harbour Porpoises

2002-2007

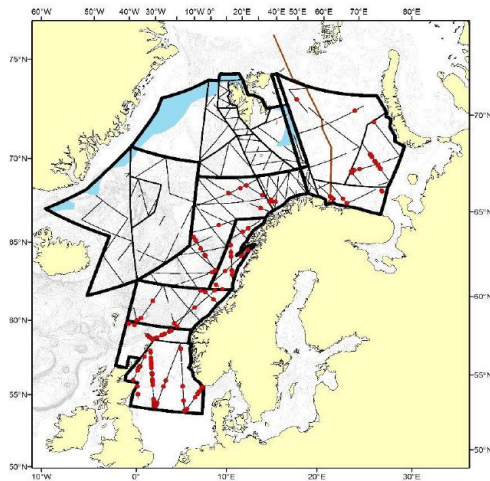


Figure 20. Distributions of sightings recorded as harbour porpoises from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage

Harbour porpoises were sighted in greatest numbers in the North Sea blocks NS and NC2 and in the Barents Sea (blocks KO and GA). Harbour porpoises were absent from the western and northern-most survey blocks. A half-normal key function with distances truncated to 600 m generated the best fitting models, with an *eshw* of 279 m. The DS model included BSS, visibility, vessel, and group size as covariates. The MR model included the covariates: BSS and weather. Harbour porpoise abundance was estimated to be 98,205 (CV=0.13, 95% CI: 75,081-128,450) and corrected ($p(0)=0.52$) to a total estimate of 189,604 (CV=0.19, 95% CI: 129,437-277,738). An analysis of harbour porpoise sightings using only survey effort conducted during a BSS of 2 or less (a total of 12,752 km), produced a total of 85 sightings. The abundance was estimated to be 80,083 (CV=0.39, 95% CI: 67,270-113,717) and corrected ($p(0)=0.62$) to a total estimate of 135,214 (CV=0.27, 95% CI: 85,270-193,356), roughly 70% of the abundance estimated from the complete survey dataset, using effort with BSS between 0-4.

2008-2013

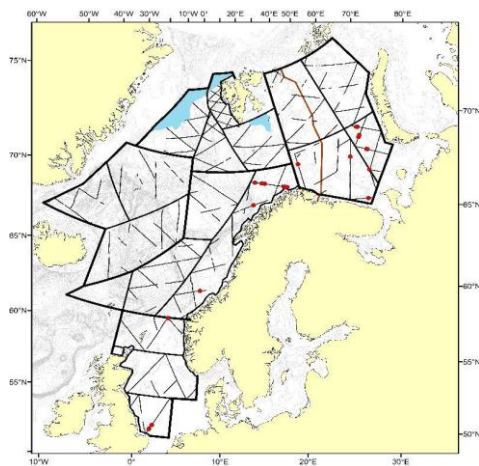
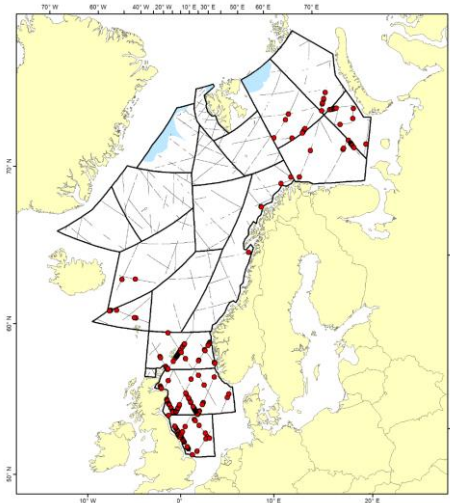


Figure 21. Distributions of sightings recorded as harbour porpoises from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage

Greatest numbers of harbour porpoises were sighted in the Barents Sea (EB1, EB2) and the Norwegian Sea (EW1) and none were sighted in the western and northern-most survey blocks. A half-normal key function with distances truncated to 500 m generated the best fitting models, with an *eshw* of 375 m. The DS model and MR models included BSS as a covariate. Harbour porpoise abundance was estimated to be 14,500 (CV=0.31, 95% CI: 7,868-26,721) and corrected ($p(0)=0.45$) to a total estimate of 30,556 (CV=0.57, 95% CI: 10,502-88,907). Analysis of the harbour porpoise sightings using only survey effort conducted during a BSS of 2 or less (a total of 9,129 km), produced a total of 29 sightings. The abundance was estimated to be 27,834 (CV=0.4, 95% CI: 10,178-76,120), corrected ($p(0)=0.44$) to a total estimate of 39,572 (CV=0.53, 95% CI: 13,535-115,696), approximately 130% of the total abundance estimated using survey effort with a BSS between 0-4.

2014-2018

Harbour porpoises were most commonly sighted in the North Sea (EN1, EN2, EN3), the Barents Sea (EB1, EB2, EB3) and the Norwegian Sea (EW1). The models using all survey effort (BSS ≤ 4) included BSS as a covariate in both the DS model and MR models and gave a total estimate of 129,723 (CV=0.18, 95% CI: 89,018-189,038) and corrected ($p(0)=0.47$) to of 255,929 (CV=0.20, 95% CI: 172,742-379,175). Survey effort at BSS of 2 or less amounted to a total 10,645 km of transects (44% of the total effort). The abundance estimate from the reduced effort was 223,192 (CV=0.24, 95% CI: 117,271-424,782), corrected ($p(0)=0.7$) to a total estimate of 307,687 (CV=0.21, 95% CI: 194,577-486,549). This is roughly 120% of the abundance estimated from the effort with a BSS between 0-4.

Figure 22. Distributions of sightings recorded as harbour porpoises from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage

Discussion - Harbour Porpoises

Whether to use the estimates generated using total effort (i.e. effort at all BSS included) or that using reduced effort (excluding data from BSS above 2) was discussed. The WG agreed to use total effort for all survey cycles because there was reasonably high probability of sighting porpoises in higher BSS (unlike in SCANS). The reduction in sighting probability in higher BSS is also accounted for by the addition of a covariate for BSS in the detection functions.

It was noted that the relatively high number of sightings in high BSS in the Norwegian surveys (which target minke whales), in comparison to what is typically seen in other multi-species surveys, may be related the Norwegian observers focusing their efforts at shorter sighting distances, which may enhance their effectiveness in sighting harbour porpoises in poor conditions.

2002-2007

The WG agreed to accept the uncorrected and corrected estimates based on total effort.

2008-2013

There was a lower encounter rate for this cycle and a surprisingly small abundance estimate compared with other surveys, raising the question of whether the estimate was representative of the population. Since it was not likely that this low estimate had arisen by chance, the WG discussed potential reasons for the low number of sightings in this survey cycle. The effort was noted as being particularly sparse in the North Sea.

It was suggested that it may be valuable to plot the effort by BSS to see if high density areas from past surveys were covered in poor conditions during this cycle.

It was noted that no large fluctuations had been observed in the SCANS surveys in the North Sea. For comparative purposes, the SCANS estimates of harbour porpoise abundance in the North Sea are: 1994: 289,150 (CV=0.14); 2005: 355,408 (CV=0.22); 2016: 345,373 (CV=0.18); 2005-2013: 361,146 (CV=0.20). A distributional shift had been documented by SCANS, for example in 1994 most harbour porpoises were in the northern North Sea but this shifted in later years with more observed in the southern North Sea (Hammond et al. 2013). Although this follows a more general trend also seen for other species (such as seabirds and seals), this distributional shift took place before this survey cycle. Gilles et al. (2016) modelled distribution and abundance for most of the North Sea during the period 2005-2013. This analysis derived an estimate similar to those from SCANS and therefore much higher than that estimated from the 2008-2013 cycle of Norwegian surveys.

The WG agreed to accept the corrected estimate based on total effort but noted that it was anomalously low and inconsistent with previous and subsequent estimates for the same area and areas of overlap with other surveys.

2014-2018

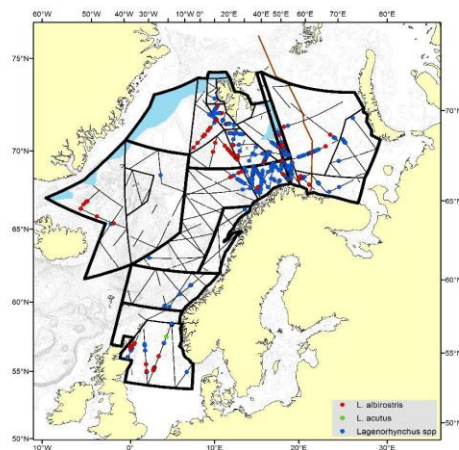
The estimate in the North Sea is higher in this cycle than in the previous (anomalous) cycle and it was noted that when this area was covered in 2018, the sighting conditions were excellent. In this case though, the reduced effort data (excluding BSS higher than 2) produced a higher estimate, which differed from the other two cycles. The CV was smaller for the estimate derived from the total effort data.

The WG agreed to accept the uncorrected and corrected estimate based on the total effort.

Summary – Dolphins

The white-beaked and white-sided dolphins were grouped together due to a lack of confidence in species identification. Therefore, estimates are provided at the level of the genus (*Lagenorhynchus*).

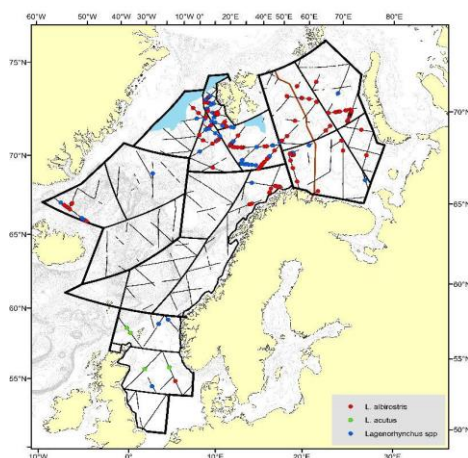
2002-2007



Lagenorhynchus spp. dolphins were most prevalent around Bear Island, but accounting for effort, the highest abundances were estimated for the North Sea (NS) and the Barents Sea (BAE). A hazard-rate key function gave the best fit to the platform 1 data, which were truncated at a perpendicular distance of 1,200 m. The fitted detection function resulted in an *eshw* of 498 m and a total survey estimate of 218,640 (CV=0.18, 95% CI: 150,330-318,000).

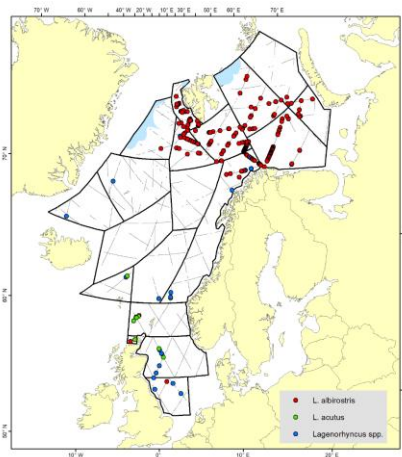
Figure 23. Distributions of sightings recorded as *Lagenorhynchus* spp. from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage

2008-2013



Lagenorhynchus spp. were distributed throughout the survey area and were most commonly sighted around Bear Island (ES1) and the Barents Sea (EB4). A half-normal key function was used to fit the data. The covariates: BSS, weather, and group size resulted in lower AIC values for the DS. The final *eshw* was 585.19 m, with the data truncated to a sighting distance 1200 m. The total survey estimate *Lagenorhynchus* spp. was 137,040 (CV=0.18, 95% CI: 94,997-197,690) with a correction ($p(0)=0.85$) to 163,688 (CV=0.18, 95% CI: 112,673-237,800).

Figure 24. Distributions of sightings recorded as *Lagenorhynchus* spp. from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage

2014-2018

Lagenorhynchus spp. were found in almost all blocks within the study area, with the highest number of sightings around Bear Island (ES1) and the Barents Sea (EB2). A half-normal key function produced the best fit, with distances truncated at 1200 m. Including BSS, weather, and group size as covariates in the DS model resulted in a lower AIC and an *eshw* of 487 m. The total survey estimate *Lagenorhynchus* spp. was 164,059 (CV=0.24, 95% CI: 98,367-273,620) with a correction ($p(0)=0.87$) to 187,482 (CV=0.24, 95% CI: 112,434-312,624).

Figure 25. Distributions of sightings recorded as *Lagenorhynchus* spp. from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage

Discussion – Dolphins

It was noted that the category of unidentified dolphins was treated as *Lagenorhynchus* in the analysis. Although some common (*Delphinus delphis*) and bottlenose (*Tursiops truncatus*) dolphins may be included in this category, there were separate categories for dolphin species allowing observers to identify these at the species level. Positive species level identifications that were not white-sided or white-beaked dolphins were excluded from this analysis.

The general question of whether to use data from platform 1 only or to take an average from both platforms was raised again. The WG agreed that combining estimates from the two platforms could be further explored but that it was not required for the purposes of this meeting.

It was noted that although the estimates were relatively consistent across the surveys, they differed from the SCANS surveys (which have also delivered relatively consistent estimates). For comparative purposes, the SCANS estimates for white-beaked dolphin abundance in the North Sea were: 1994: 22,619 (CV=0.23); 2005: 29,010 (CV=0.35); 2016: 20,453 (CV=0.36). It should be noted, however, that the estimates provided here are at the level of the genus (*Lagenorhynchus*).

The WG noted the potential for bias (to an unknown extent) because availability bias and possible responsive movement had not been accounted for in analysis of data from all surveys.

2002-2007

The WG agreed to accept the uncorrected and corrected estimates.

2008-2013

As for harbour porpoises, it was noted that there was a lower number of sightings in the North Sea during this cycle.

The WG observed that the distribution map showing a split between the two species did not seem to align with the species distribution recorded during the SCANS surveys. This indicates possible issues with species identification and therefore supports the appropriateness of grouping data at the level of genus.

The WG accepted the uncorrected and corrected abundance estimates.

2014-2018

The WG accepted the uncorrected and corrected abundance estimates.

8.2 ICELAND/FAROEES 2007: WHITE-BEAKED AND WHITE-SIDED DOLPHINS

In 2018, the AEWG accepted uncorrected and corrected estimates for these species (NAMMCO 2018). Combined detection functions were used as the number of detections for each species was too low to estimate separately, and abundance was allocated to species proportionally by stratum. As there were only 22 primary platform sightings of both species while in B-T mode, the authors of the working paper (SC/26/AEWG/05) considered this too few to reliably estimate a detection function for the primary platform alone and therefore elected to estimate corrected abundance under the assumption of full independence, which does not require a primary platform detection function. However, this was based on a simple heuristic recommending a minimum of 30 detections to derive a detection function. Discussion subsequent to the meeting clarified that this was an objective for survey design, rather than an absolute requirement for abundance estimation. A low number of detections will decrease the precision of the estimate but should not necessarily lead to bias. In contrast, estimation under the assumption of full independence almost invariably results in negative bias because of unmodelled detection heterogeneity (Burt, Borchers, Jenkins, & Marques, 2014). Therefore, the authors elected to re-analyze the data under the assumption of point independence. This applies only to the corrected estimates: the uncorrected estimates accepted in 2018 remain unchanged.

Observers on the primary platforms on the dedicated vessels re-sighted 40% of the *L. spp.* dolphins seen by the tracker platform, and numbers were generally too low to determine if this rate varied by vessel or species. For primary platform sightings only, a hazard-rate function with no covariates provided the best fit for the detection function, and PI models were selected over FI models by AIC. The best fit of the conditional detection function was achieved with perpendicular distance and visibility as covariates, resulting in an average value of $p(0)$ for the primary platform of 0.70 (CV=0.27) for both species. Total corrected abundance of white-beaked dolphins was 91,277 (CV=0.53, 95% CI: 32,351-257,537) while that for white-sided dolphins was 81,008 (CV=0.54, 95% CI: 27,993-234,429).

Discussion

It was noted as interesting that, although the PI model fitted the data better, the estimates assuming full independence were higher than those assuming point independence. This may be indicative of avoidance behaviour at a sufficiently high degree to overcome the inherent negative bias introduced by unmodelled heterogeneity in full independence models.

The WG accepted the reasoning for the revision and therefore also the newly corrected estimates.

8.3 CIC AERIAL 2007: WHITE-BEAKED DOLPHINS

Summary

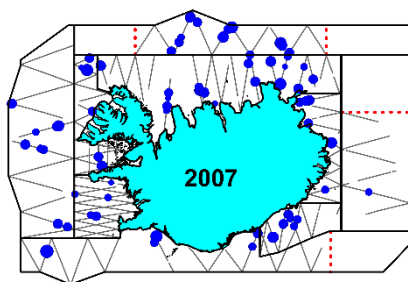


Figure 26. Realised survey effort and sightings of white-beaked dolphins in 2007. Symbol size varies with group size from 1 to 3.

A total of 99 groups of white-beaked dolphins were sighted while on effort (Fig. 26). A half-normal model with BSS as a scale covariate provided best fit to the detection function. Density and abundance were highest in strata 4, 5 and 9, which together accounted for 78% of the total estimated uncorrected abundance of 45,497 (CV=0.37, 95% CI: 21,966-94,237). A total of 23 detections were made by the secondary observer on the right side within the truncation distance, of which 6 were missed by the primary observers. A point-independence model including distance and glare intensity as covariates provided best fit to the mark-recapture model, resulting in an estimated $p(0)$ of 0.98 (CV=0.04) and a corrected abundance estimate of 46,683

(CV=0.37, 95% CI: 22,409-97,251). Post-stratification would decrease both estimates by 21%. These estimates are negatively biased as they are not corrected for animals that were submerged beyond visibility during the passage of the plane. Such a correction would require information on the temporal distribution of animals in the water column that is not presently available for this species.

Discussion

It was noted that in 2007, harbour porpoise was one of the focal species for the survey and the survey was therefore flown at a slightly lower altitude and employed a specialist harbour porpoise observer. This may explain the very high $p(0)$ for that year compared to 2009 (see below).

The WG agreed to accept the uncorrected and corrected estimates.

8.4 CIC AERIAL 2009: WHITE-BEAKED DOLPHINS

Summary

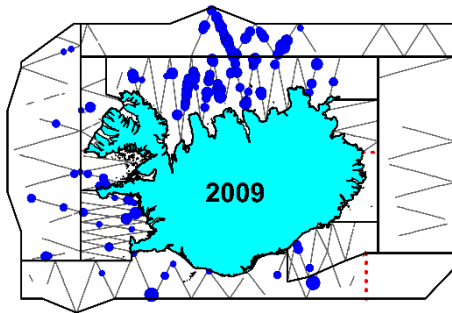


Figure 27. Realised survey effort and sightings of white-beaked dolphins in 2009. Symbol size varies with group size from 1 to 3.

A total of 209 sightings of white-dolphin groups were made, of which 160 were seen by the primary observers. The number of sightings was depressed between perpendicular distances of 0 m and 100 m, requiring left truncation at 100 m and right truncation at 600 m. A hazard rate model with no covariates provided best fit to the detection function. Density and abundance were highest in strata 4 and 5, which accounted for 88% of the total uncorrected abundance estimate of 38,136 (CV=0.44, 95% CI: 15,499-93,831) (Fig. 27). Of the 42 detections by the secondary platform observer, 34 were missed by the primary observer on the same side of the plane. AIC was minimized using a model assuming point-independence and including distance only in the mark-

recapture detection function, resulting in an estimated average $p(0)$ (actually $p(100)$ in this case) of 0.50 (CV=0.35). This increased estimated abundance to 75,959 (CV=0.56, 95% CI: 26,366-218,834). Post-stratification would reduce both corrected and uncorrected estimates by 1%. These estimates are negatively biased as they are not corrected for animals that were submerged beyond visibility during the passage of the plane. Such a correction would require information on the temporal distribution of animals in the water column that is not presently available for this species

Discussion

The WG agreed to accept the uncorrected and corrected estimates.

8.5 CIC AERIAL 2016: WHITE-BEAKED DOLPHINS

Summary

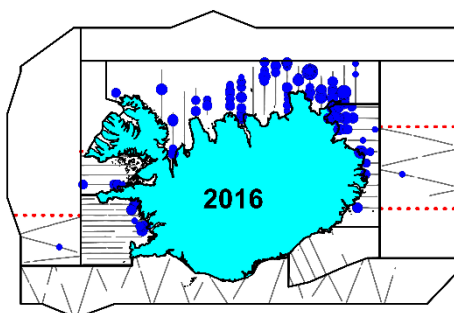


Figure 28. Realised survey effort and sightings of white-beaked dolphins in 2016. Symbol size varies with group size from 1 to 3.

A total of 222 unique sightings of white-beaked dolphins were made by the combined platforms, of which 63 were duplicate sightings. The frequency of white-beaked dolphin sightings was depressed within about 100 m of the transect line, requiring left truncation in the detection function. A half normal model incorporating no adjustment terms or covariates provided best fit as determined by minimization of AIC, resulting in an overall effective strip half-width of 269 m (*i.e.* from the left truncation distance of 100 m out to 360 m from the transect). Total estimated uncorrected abundance, excluding block 5 which was not surveyed, was 42,908 (CV=0.42; 95% CI: 18,536-99,328). Density and abundance were highest in block 4 which accounted for 83% of the total estimate (Fig. 28). A point independence

model incorporating the interaction term between perpendicular distance and sightability as a covariate in the mark-recapture detection function minimized AIC and was therefore chosen, estimating $p(0)$ as 0.72 (CV=0.13) for the combined platforms. Total abundance corrected for perception bias was 59,966 (CV=0.44; 95% CI: 24,907-144,377). Post-stratification would reduce these estimates by 2%, and the exclusion of block 5 from the estimate likely causes a substantial negative bias as numbers have been high in this stratum in previous surveys. Furthermore, these estimates are negatively biased as they are not corrected for animals that were submerged beyond visibility during the passage of the plane. Such a correction would require information on the temporal distribution of animals in the water column that is not presently available for this species.

Trends in abundance

There was an overall annual increase in estimated abundance in the survey area from 1986 to 2016 of 0.07 (CV=0.22), due primarily to increases in the large northern blocks 4 and 5, which had the highest densities of white-beaked dolphins in the survey area in most years and positive increase rates over the period (Fig. 29). In other strata, estimated density showed no obvious pattern with time. This pattern is also reflected in estimates of total uncorrected abundance, which ranged from 12,000 to 19,000 for the 1986, 1995 and 2001 surveys (with no significant difference between estimates), to 36,000 in 2007, and increased further in 2009 and 2016. The survey area does not encompass a unit stock as NASS ship surveys show a continuous distribution offshore. The apparent increase is therefore at least partly due to changes in distribution both inside and outside the survey area.

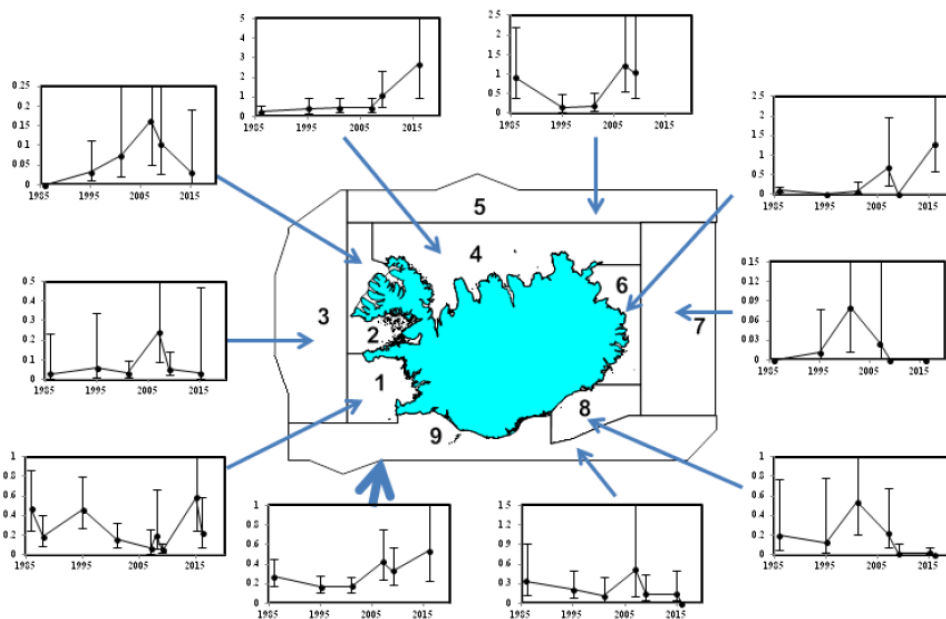


Figure 29. Trends in the relative abundance (uncorrected line transect density, whales nm^{-2}) of white-beaked dolphins by stratum and for the entire survey area (thick arrow).

Discussion

In discussion it was noted that large groups of 50 or more animals were sometimes observed, often in association with pilot whale schools. This has also been observed in other areas but the implications and reasons for this are not known.

The WG agreed to accept the uncorrected and corrected estimates.

8.6 CIC AERIAL SURVEY 2016: HARBOUR PORPOISES

Summary

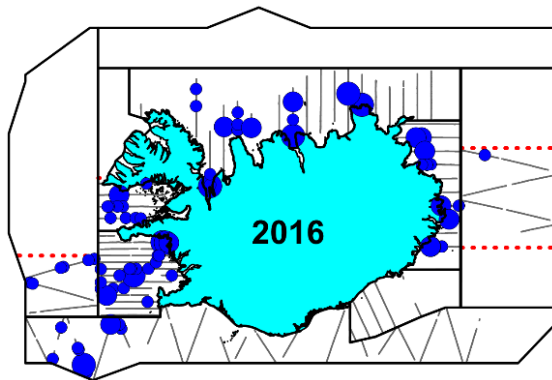


Figure 30. Realised survey effort and sightings of harbour porpoise in 2016. (PP). Symbol size varies with group size from 1-3.

Harbour porpoises are ubiquitous in the survey area but were generally found in larger numbers in the inshore strata (Fig. 30). A total of 91 unique sightings of harbour porpoise groups were sighted by the combined platforms, of which 7 were duplicate sightings. The number of sightings was depressed within about 100 m from the transect line, requiring left truncation of the detection function. A half-normal model with no adjustment terms incorporating (in addition to perpendicular distance) factor covariates for side of the plane and species identification certainty provided the best fit to the data. Total estimated abundance, uncorrected for perception bias, was 10,506 (CV=0.26, 95% CI: 6,120- 18,036). A point independence model incorporating the covariate perpendicular distance

and the factor covariate for platform identity in the mark-recapture detection function minimized AIC and was therefore chosen, estimating $p(0)$ as 0.45 (CV=0.41) for the combined platforms. Total abundance corrected for perception bias was 22,806 (CV=0.48; 95% CI: 9,166-56,746). Neither of these estimates includes block 5, which was not surveyed, and post-stratification would reduce both estimates by 20%. These estimates are not corrected for availability bias which can be substantial in aerial surveys for this species.

Discussion

The lack of a correction for availability bias was discussed. Previously, corrections using diving data from Denmark have been trialled and this almost doubles the estimate, which would make it comparable to the fully-corrected estimate from 2007 by Gilles et al. (under review). The conditions in Danish waters are, however, very different to those around Iceland.

Since it is now more than 10 years since a survey generating a realistic estimate has been performed, the WG recognised the need for a new survey targeting harbour porpoises. It was suggested that this could be in combination with the next NASS or on its own. The by-catch of harbour porpoises in Iceland makes it a priority species and therefore the WG recommended that harbour porpoise be a target species for a future survey. Given the lack of a correction factor for availability bias, to facilitate development of a correction factor for surveys the WG also recommended that dive data be collected for this species in the area.

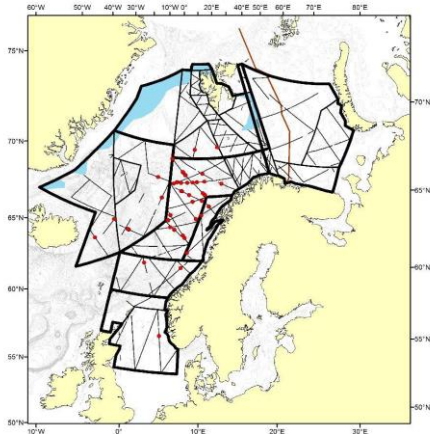
The WG agreed to accept the uncorrected and corrected estimates, acknowledging the potential for substantial negative bias due to the lack of availability correction and incomplete coverage.

9. KILLER WHALES

9.1 NORWAY – LAST THREE SURVEY CYCLES

Summary

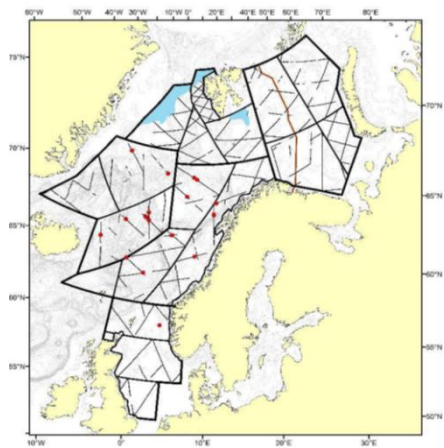
2002-2007



Most sightings were made in the Norwegian Sea south of the Mohn Ridge in block NOS. They were also abundant in the Icelandic-Jan Mayen survey blocks (NVN, NVS). The best fitting models used a half-normal key function. Distances were truncated at 2,000 m and resulted in an *eshw* of 996 m. BSS and weather covariates improved the fit of the DS model and group size improved the fit of the MR model. Killer whale abundance was estimated to be 16,462 (CV=0.20, 95% CI: 13,234-27,798) and corrected ($p(0)=0.93$) to a total estimate of 18,213 (CV=0.21, 95% CI: 11,486-29,992).

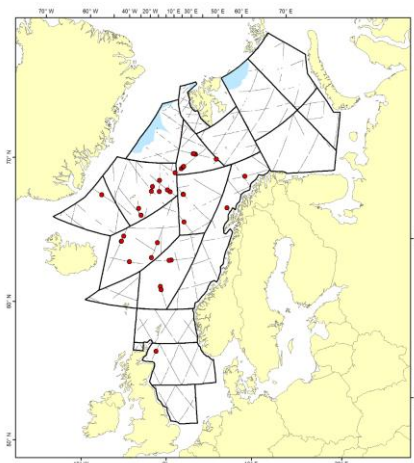
Figure 31. Distributions of sightings recorded as killer whales from platform 1 during the 2002-2007 sighting surveys. The blue areas represent ice coverage

2008-2013



Most killer whales were sighted in the Norwegian Sea (EW1, EW2) and the Icelandic-Jan Mayen survey blocks (CM1, CM3). Models were fit with a half-normal key function. Distances were truncated at 2200 m, resulting in an *eshw* of 1,377 m. BSS improved the fit of the MR model. Killer whale abundance was estimated to be 7,628 (CV=0.28, 95% CI: 4,397-13,23). Once corrected for perception bias ($p(0)=0.92$) the total estimate was 8,984 (CV=0.36, 95% CI: 4,494-17,963).

Figure 32. Distributions of sightings recorded as killer whales from platform 1 during the 2008-2013 sighting surveys. The blue areas represent ice coverage

2014-2018

Killer whales were most commonly sighted in the Norwegian Sea (EW2, EW3) south of the Mohn Ridge and in the Icelandic-Jan Mayen survey blocks (CM1, CM3). A hazard-rate key function and data truncated at 2,000 m produced the best fitting detection functions. Group size, as a covariate improve the fit of the DS model. The *eshw* was estimated to be 1031 m. Killer whale abundance was estimated to be 12,714 (CV=0.29, 95% CI: 7,162-22,568) and corrected ($p(0)=0.91$) to a total estimate of 13,909 (CV=0.30, 95% CI: 7,733-25,018).

Figure 33. Distributions of sightings recorded as killer whales from platform 1 during the 2014-2018 sighting surveys. The blue areas represent ice coverage

Discussion

It was highlighted that one block was covered in two years of the first cycle and that the effort and sightings from both years were included in the analysis because the data from enhanced effort was deemed valuable, as recommended in 2018 (NAMMCO 2018).

The WG noted that although the estimates were relatively consistent across the cycles, just as for harbour porpoises and dolphins, the encounter rates in the 2008-2013 cycle were lower than in the other two. The distribution of killer whales may be linked to that of herring or mackerel (Nøttestad et al., 2015).

It was noted that the photo identification work in Iceland has not indicated any crossover between Iceland and Norway. However, the large satellite tagging efforts currently underway along the Norwegian coast will likely offer a large amount of new data in the coming years that will help provide a more complete picture. A large photo catalogue is also being developed in Norway (with currently over 1,000 animals documented) and there are plans to bring the Icelandic and Norwegian photo catalogues together in the future.

It was noted that a review of killer whales in the North Atlantic was recently contracted by NAMMCO. This work is now published in *Mammal Review* (Jourdain et al., 2019).

The WG agreed that the production of these estimates was very welcome, especially as it was the first produced for killer whales from the NAMMCO AEWG. The WG also recommended that an estimate of killer whales be calculated based on Icelandic and Faroese NASS data.

The WG agreed to accept the uncorrected and corrected estimates.

10. NORTHERN BOTTLENOSE WHALE

10.1 ICELAND/FAROES 2015

Summary

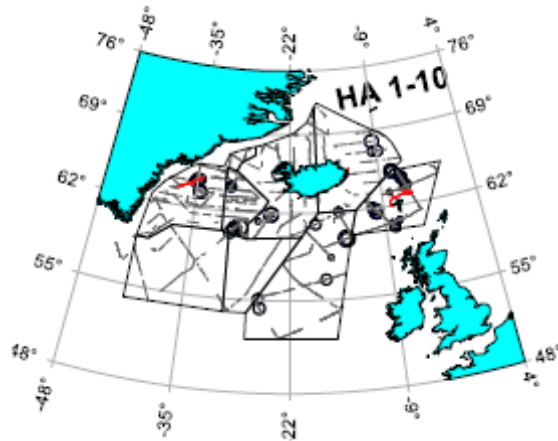


Figure 34. Sightings of northern bottlenose whale (HA). Symbol size is proportional to group size. Compromised transects are red.

Northern bottlenose whales were sighted across the survey area mainly between latitudes 60° and 65° N (Fig. 34). They were especially common in the Faroese block FC. No northern bottlenose whales were seen in the fall survey. Groups of 1-5 animals were most commonly sighted.

Best fit of the detection function was achieved using a half-normal function with no adjuncts and including a scale covariate for species identification certainty, with decreasing certainty widening the *eshw*. Density in the Faroese stratum FC was much higher than in any other block, and this stratum alone accounted for 57% of the total uncorrected estimate of 18,375 (CV=0.59, 95% CI: 5,128-65,834).

Of the 36 sightings made within the truncation distance of 1,200 m, 17% were sighted by both platforms. This varied between vessels, with no duplicate sightings on vessel A, and vessel H, which accounted for 67% of total sightings, having a duplication rate of 8%. The conditional detection function included perpendicular distance only, resulting in an estimated $p(0)$ of 0.92 (CV=0.09) and a total corrected estimated abundance of 19,975 (CV=0.60, 95% CI: 5,562-71,737).

Northern bottlenose whales are extreme deep divers, spending 60% to 70% of their time beneath the surface (Hooker and Baird 1999). Therefore, estimates for this species are likely subject to negative bias by availability, or whales that are submerged and therefore invisible to observers. There is some evidence of attraction to vessels in some areas which would lead to positive bias if it occurred before the animals were detected by observers.

The distribution of northern bottlenose whales seen in 2015 was similar to that from most previous surveys, with greatest numbers sighted in deep waters around the Faroe Islands and to the west of Iceland. In 1987 and 2001, many sightings were made to the northeast of Iceland around Jan Mayen Island, however the 1995 and 2007 surveys sighted few northern bottlenose whales in this area, despite considerable effort. While our 2015 survey did not cover the area around Jan Mayen, it was covered by a concurrent Norwegian survey, resulting in only 3 sightings (Nils Øien, *pers. comm.*). However, the following year, 22 were sighted in the same area with a similar amount of survey effort (Nils Øien, *pers. comm.*). It appears that the distribution of northern bottlenose whales can be quite variable, particularly at the northern edge of their distribution.

Previous estimates of abundance are available for all NASS except that from 1989 and 2007, when sightings were too few. Abundance was estimated as 5,827 (CV=0.15) from the 1987 ship survey (Gunnlaugsson & Sigurjónsson 1990), however this estimate was derived using what would now be considered non-standard methods and is uncorrected for any biases. Pike et al. (2003) used conventional distance sampling to estimate uncorrected abundance from the 1995 and 2001 ship surveys as 27,879 (CV=0.67, 95% CI: 12,396-62,700) and 24,561 (CV=0.23, 95% CI: 15,261-39,528) respectively. The latter 2 estimates do not differ significantly from our uncorrected estimate for 2015.

Discussion

It was noted that the survey seemed to achieve good coverage of the distribution of the species in this area even though the distribution varied from year to year.

The general question of what to do for those species in which there are some years with too few sightings to generate an estimate was discussed. The WG agreed that if the surveys are similar enough, data from across the different years can be pooled to obtain a detection function and estimate abundance, as has been done for blue whales (Pike et al. 2009). Although there will be an availability bias for this species, further studies are needed to confirm the exact nature and extent of this.

The WG agreed to accept the uncorrected estimates.

11. DISCUSSION OF NASS FIN WHALE ESTIMATES AT IWC

SC/26/AEWG/07 & SC/26/AEWG/08 - Assessment of bias in population abundance estimates for North Atlantic fin whales (*Balaenoptera physalus*) & A rebuttal

Summary

Working paper SC/26/AE/07, which was presented to the IWC Scientific Committee in 2019, focuses on the last two surveys in the NASS series (2007 and 2015). It claims that two factors contribute to a significant overestimate of abundance and that the resulting apparent positive trend in fin whale abundance, primarily in the East Greenland-Iceland (EGI) stock area: i) Bias in distance estimates leading to underestimation of effective strip half width; ii) Bias in distance and angle estimates leading to non-identification of duplicate sightings. This in turn results in positive bias in abundance estimates due to encounter rate inflation and underestimation of $g(0)$. The paper also raises other issues, some of which may not be directly relevant to this WG, including possible shifts in the distribution of fin whales, genetic estimates of pre-whaling abundance, and a skewed sex ratio and taking of pregnant females in the Icelandic hunt.

SC/26/AE/08 is a response to this working paper, which was also presented at the IWC meeting. In response to the issues raised, the IWC Scientific Committee responded: "It was also noted that the main issues raised by SC/68A/ASI/07 (measurement errors, possible shifts in distribution, skewed sex ratio in whaling catches) have all been taken into account in the implementation of the RMP, which was designed to be particularly conservative and robust to these sources of uncertainty. For instance, multiple stock structure hypotheses are usually included in the RMP, and new hypotheses can be brought forward for consideration at the time of the implementation reviews."

In conclusion, the IWC WG acknowledged that information in SC/68A/ASI/07 and SC/68A/ASI/16 was useful to consider, but reiterated that North Atlantic fin whale abundance estimates computed from the NASS cruises have been reviewed before and endorsed as appropriate for use with the CLA, and that no further action was warranted.

Discussion

The issue of bias in distance estimates and the identification of duplicates has been extensively discussed before and the WG agreed that it needs to be considered during the planning for the next NASS. The WG agreed that a better way of measuring distance on primary platforms (or at least a way to validate a proportion of the measurements) is required. It was suggested that validation could be done using videos or drones. The use of balloon kites as a visual aid was noted as another possibility. Tools providing integrated information on distance and angles are also in development. The proposal to develop an algorithm-based approach to duplicate identification was reiterated.

12. NASS SERIES SPATIAL ANALYSES

12.1 DISTRIBUTION AND HABITAT USE OF DEEP DIVING CETACEANS IN THE CENTRAL AND EASTERN NORTH ATLANTIC

Summary

The study presented in working paper SC/26/AEWG/15 aimed to improve understanding of the underlying ecological drivers of any changes in deep-diving cetacean distribution. Data from two series of summer surveys (in Iceland-Faroes and Norway) was used to model the density of sperm, long-finned pilot and northern bottlenose whales as a function of static (relief), physical and biological oceanographic covariates using GAMs. The best models, based on a robust model selection framework, were used to predict distribution. The study period was divided into two periods, 1987-1989 and 1998-2015, based on environmental changes in the area and data availability. Environmental and physical covariates available included depth, slope, aspect, sea surface temperature (SST), chlorophyll a (chl), density ocean mixed layer depth (mlp), sea surface height (ssh), sea floor potential temperature (bT) and salinity (sal). Environmental variables were widely available for the period 1998-2015 but modelling for the period 1987-1989 was restricted to relief-related variables and SST only. Although 1995 was the year with the broadest survey coverage, it was not included in the analysis due to the low quality / few environmental data available. The results were presented by species and comparatively between the periods.

SPERM WHALES

Distribution and habitat use models: 1987-1989

The covariates selected in the best model included: depth, slope, aspect, and April SST and had a deviance explained of 32.3%.

The smooth functions show a predicted positive effect on sperm whale density at depths greater than 800 m and a negative effect in waters 500 m or shallower. Slopes below 1° had a negative effect, while slopes of 1.5° to 9° had a positive effect. Aspect did not show a clear signal. Cold SST in April from -2 °C to 2 °C had a negative effect while warmer waters between 4°C to around 8°C had a positive effect.

Distribution and habitat use models: 1998-2015

The covariates selected in the best model included: depth, aspect, slope, April SST, August SSH, July mixed layer depth, and July primary productivity and the model had a deviance explained of 33.91%.

The model predicted a positive effect on sperm whale density at depths greater than 800 m and a negative effect in waters of 500 m or shallower, similar to the earlier period. Slope and aspect did not show a clear signal. April SST had a negative effect between -1°C and 1°C and greater than 8°C, and a positive effect between 3°C and 7°C, also within the same range as the earlier period. Mixed layer depth showed positive peaks around 12 m and 18 m, with a dip in between around 15 m. August SSH had a negative effect between -1 m and -0.7 m and a positive effect at less negative values between -0.7 m and -0.4 m. Primary productivity did not show a clear signal.

Comparatively between the two periods, the predicted distribution did not show changes in distribution. The Norwegian Sea is an area of higher density in both periods. In the most recent period, there are predictions over the coastal Norwegian water.

PILOT WHALES

Distribution and habitat use models: 1987-1989

The covariates selected in the best model included: depth, slope, and May SST and the model had a deviance explained of 14%.

The model predicted a positive effect on pilot whale density at depths greater than 1,500 m and a negative effect in waters shallower than that. Slopes below 1° had a negative effect, while slopes of 1° to 6° had a positive effect. There was a generally increasing positive effect as temperature increased for May SST, with peaks around 8 °C and around 11 °C.

Distribution and habitat use models: 1998-2015

The covariates selected in the best model thus included: aspect, April bT, April SST, July salinity, and July mixed layer depth and the model had a deviance explained of 50.4%.

The model predicted a positive effect on pilot whale density at aspects towards the west/northwest around 275°. A negative effect was found at angles around 180° (south). April bT had a negative effect at warmer temperatures around 280 °K (7 °C) and a tendency to have a positive effect, but no clear signal, at greater temperatures. April SST had a positive effect at temperatures greater than 4 °C and a negative effect below this temperature. Saltier waters greater than 35 PSU in July had a negative effect while waters between 32 and 34 PSU had a positive effect. Mixed layer depths between 17 and 25 m had a positive effect while shallower depths did not show a clear signal. Comparing the observed whale sightings, the model predicted well the high occurrence around the Faroe Islands in both periods. Overall, the model predicts a broad distribution of pilot whales, thus reflecting the yearly variations in distribution. High predictions also occurred along the eastern side of the North Sea, where there are no observations. Norwegian waters were not predicted due to the few sightings in the earlier years.

NORTHERN BOTTLENOSE WHALES

Distribution and habitat use models: 1987-1989

The covariates selected in the best model included: depth, aspect, and August SST and the model had a deviance explained of 24.2%.

The model predicted a positive effect on northern bottlenose whale density at depths between 1,000 m and 2,000 m and a much greater positive effect in waters greater than 3,500 m, and a negative effect in waters of 500 m or shallower. There was no clear signal for aspect. August SST was predicted to have a positive effect at temperatures between 9 °C to 11 °C.

Distribution and habitat use models: 1998-2015

The covariates selected in the best model included: depth, aspect, June SST, August salinity, July SSH, June mixed layer depth, and April chlorophyll *a*; the best model had a deviance explained of 53.7%.

The model predicted a positive effect on northern bottlenose whale density at depths between 2,000 m and 800 m, while shallow waters from 500 m had a negative effect. For aspect, the effects were weak, but angles from 90° to 120° (east) had a positive effect while angles between 250° to 310° (west) had a negative effect on density. June SST had a positive effect for temperatures around 5 °C but a negative effect in warmer waters around 12.5 °C. Saltier waters around 35 PSU in August had a slight positive effect while waters around 34 PSU had a slight negative effect. July SSH showed a negative effect around -1 m but a positive effect around -0.85 m.

Norwegian waters were not predicted due to the few sightings in the earlier years. Comparing with the observed whale sightings, the model predicted well the high occurrence in Jan Mayen, Faroe Islands, East Greenland in the Irminger Sea, and along the Reykjanes ridge in both periods. Jan Mayen predicted higher densities in the 1998-2015 period. The models predicted an overall increase in density over time, including areas where animals were previously whaled, except in the waters off the coast of Norway by Andenes and Møre.

As expected, the predicted high-use areas for all three species were mostly deep waters, with some overlap among them in the central Norwegian Sea and the Central North Atlantic, including the Irminger Sea. Differences in distribution likely reflect differences in prey but the mechanisms underlying these relationships are unknown.

After presenting the results for the three deep diving species, a brief presentation of only the model predictions (1987-1989 and 1998-2015) for white-beaked dolphins and fin, humpback, minke, and killer whales was given.

Discussion

For pilot whales, the large interannual variation in distribution means that the inferences that can be drawn from the model for 1998-2015 are limited. The plasticity of pilot whales may mean that it may be more informative to look at the data year by year. The sparseness of data available for individual years makes it difficult to do this comparison in practice though. It was noted that the period currently being pooled is one in which large shifts in pilot whale abundance have been observed in the Faroe Islands.

Tracking data (Bloch et al. 2003) indicate that pilot whales are strongly associated with slope but the variation of the slope was not considered in the current analysis. Looking at the impact of variation in depth may also be relevant in this regard.

It was suggested that modelling by region rather than over the whole central and northeast Atlantic may help to explain more variability in the data. The WG agreed that although this may be informative, the approach of the current work to take a first look at all the data together and investigate if there were any general trends was also valuable and that this did not exclude the possibility of further developing the work to go into more detail for particular regions.

It was also noted that there are currently two layers of complexity in the modelling due to the latter time period containing additional dynamic covariates. This made it difficult to interpret the comparisons across the time periods. It was therefore proposed to model the 1998-2015 data using only the covariates available for 1987-1989. Other covariates (e.g. fronts) could also potentially be added to the model if the analysis was focused on particular areas or time periods, although this information is not available for all years.

It was highlighted that although it is possible to use the model to estimate abundance on a year by year basis and then compare these to design-based estimates, this was not the main aim of the work. The work is primarily focused on investigating the relationships between whale density and environmental covariates, although the possibility of predicting potentially important areas for future surveys was also a motivating factor. Additionally, the potential of the model to predict into the future using predicted covariate values from different climate change scenarios that could impact the distribution of different species was also valuable.

It was highlighted as important to be sensitive to the potential for edge effects in the model, including both the edges of the covariate space and the edges of the area (e.g. as demonstrated by the predictions of high density at the borders of the area in some cases). It was noted that this may occur partly because data from large and highly variable areas are included in the model.

The WG looks forward to seeing the full results for the other (non-deep diving) species when this phase of the work is finalised and agreed that continuing to develop the analysis to look at specific areas or time periods would be valuable.

The WG also reiterated their recommendation from 2018 that the model be used to perform an assessment of temporal change in pilot whale distribution and abundance in the survey area during the time period of the NASS (i.e. to assist in an assessment of the impact of whaling). This was considered to be particularly important work to conduct now as a NAMMCO assessment of pilot whales is currently planned for 2020.

12.2 OCEANIC DRIVERS OF SEI WHALE DISTRIBUTION IN THE NORTH ATLANTIC

Summary

Working paper SC/26/AEWG/13 investigated the environmental drivers of sei whale distribution in the central and eastern North Atlantic and explored how distribution may have changed between the 1980s and more recent decades. The cetacean data were from the NASS and Norwegian surveys from 1987 to 2015. The candidate environmental variables were: fixed variables (depth, slope and aspect), dynamic variables measured remotely (SST, chlorophyll-a concentration and primary productivity) and dynamic variables reconstructed by an ocean model (mixed layer depth (MLD), sea surface height anomaly (SSH), bottom temperature and salinity). Time lags in dynamic variables were explored. Sei whale relative density was modelled as a function of the environmental variables using GAMs and the best fitting models were used to predict relative density over the whole study area. Uncertainty in predicted distribution was represented by maps of the CV of predicted density. Models were fitted to the 1998-2015 data using all covariates (full model). Models with reduced candidate covariates were fitted for 1987-1989 because of missing covariate data and also for 1998-2015 for comparison (simple models). The best full model included depth, May SST, May bottom temperature, July salinity, July SSH and July primary productivity; highest densities were predicted in the Irminger Sea and over the Charlie-Gibbs Fracture Zone. Depth and May SST were retained in the simple models for both periods, with highest density predicted in the Irminger Sea, towards the Labrador Basin, and in the Norwegian Sea. Deviance explained by these models ranged from 45% to 55%. Predictions from the full model for 2001, 2007 and 2015 matched the observed sightings quite well. Depth and May SST were consistently strong predictors of distribution in all models; SSH and primary productivity were also important predictors in the full model. The results are discussed in the context of prey distribution, changes in sei whale distribution over time, and overlap in sei whale and fin whale distribution.

Discussion

A question was asked as to whether these models could be used to give seasonal predictions. It was noted that data are only available for June-August and that making predictions in other seasons should be exploratory only.

The question of why SST in May was having a significant impact was discussed, especially given that other proxies for productivity (such as chlorophyll a) were also modelled and did not give a signal. It was suggested that the surveys may have been conducted at a time that was not peak season for sei whales and that this was influencing the signal in May. Interestingly, whalers in Iceland have historically said that the whales never came into the area until the SST reached 11°, offering anecdotal support for a relationship between sea surface temperature and sei whale distribution.

The WG welcomed the work and appreciated seeing a detailed application of the model to a single species.

13. SCANS III 2016 UPDATE

The design-based abundance estimates have been presented in Hammond et al. (2017). Habitat use/distribution modelling work will now include data from the Irish ObSERVE survey in summer 2016, making the area equivalent to SCANS II and CODA in 2005-2007.

Work is underway to finalise the analysis and this is expected to be completed relatively early next year. It will then be prepared for publication.

14. CANADIAN NAISS 2016 UPDATE

The analysis (especially for the St. Lawrence portion of the survey) is still being finalised, with the final double-platform corrections not yet available. The intention is to complete the analysis just after

Christmas 2019. Three manuscripts are planned: (1) mysticete abundance, (2) odontocete abundance, and (3) leatherback turtle abundance. The next Canadian survey is scheduled for 2026.

15. PUBLICATION OF SURVEY RESULTS

An overview of the current status of the NAMMCO Scientific Publications Volume 11 special issue on abundance estimates was provided in SC/26/AEWG/14. The process of publishing the volume has taken more time than anticipated due to delays in authors submitting, reviewers responding etc. However, three papers have now been published in an early online form, with another two close to publication. The goal was initially to have the volume completed by the end of the year, although this now seems unlikely. The volume will represent a valuable collection of data and the WG appreciated the efforts to have the works published together in a special issue.

16. PROPOSED WORKSHOP “NOVEL METHODS FOR ABUNDANCE SURVEYS & ESTIMATION”

The proposal for a workshop on novel methods for abundance surveys and estimation (e.g. drones, AUVs, automated photo analysis, geometer), which was made during the 2018 AEWG meeting received support from the NAMMCO Scientific Committee and the Management Committee for Cetaceans. The WG noted that there had been significant advances in this field but that it was not clear to what extent these may be used in future NASS surveys or how effective a workshop approach would be to explore this. An alternative approach presented was to contract a written review of published information on recent advances in the field, particularly considering aspects relevant for the NASS. Combinations of ship and aerial surveys through the use of ship-deployed drones was proposed as an example of a novel approach of relevance. It was noted that taking this approach may mean funding would also be available to bring relevant experts to a planning meeting for the next NASS. Such a review should ideally be ready for consideration at the NAMMCO Scientific Committee meeting in 2020. The WG emphasised that the review and planning for the next NASS also need to consider the key questions of how to improve distance measurement and species identification.

Following the discussion, the WG recommended contracting a written review as the most efficient and cost-effective way to assess the suitability of novel methods for future NASS. It proposed the following terms of reference for this work:

Following up on the aerial and methodological reviews that were conducted in preparation for the 2015 NASS survey, review new developments in the

- *Means of increasing the accuracy and precision of distance measurements for ship and aerial surveys, including for primary observers. This might include, inter alia, the use of video and deployment of drone aircraft from ships, and further development of the Geometer for aerial surveys*
- *Means of making duplicate identification in ship surveys more reliable and replicable (e.g. development of an algorithm)*
- *Availability and suitability of data collection software packages for aerial and ship surveys*
- *State of the art of automated detection of cetaceans on video and photographic images*
- *Use of drone aircraft for aerial survey and possible deployment from ships for offshore surveys, including in combination with conventional survey methods*

17. PLANNING THE NEXT NASS

In 2018, the NAMMCO Scientific Committee proposed 2023 as a relevant date for a new NASS survey, or alternatively 2026 if there was a desire to aim for a T-NASS. The NAMMCO Management Committee

for Cetaceans expressed a preference for 2023. Iceland is also planning for a survey in 2023 since an 8 year interval is at the limit of what is required by the IWC RMP.

There are currently no plans for another SCANS survey. However, discussions regarding implementing the EU Marine Strategy Framework Directive (MSFD) have included having a survey every reporting cycle, i.e. every 6 years. This would imply another survey in 2022. Previously, SCANS surveys have been done every 11 years, although it was noted that SCANS has had harbour porpoises as one of the target species and 11 years is a long inter-survey time interval for this species as it effectively means that a new generation is being surveyed each time.

Priorities for planning the next NASS survey were articulated at AEWG 2018. This included: biopsy sampling, satellite tagging, improving group size estimates, improving distance estimation on ship surveys, and future extension surveys. It was noted that offshore tagging of pilot whales does not appear to be feasible in practice so this may no longer be a priority. Otherwise the WG agreed that the remainder of the priorities remain relevant.

The WG recommended that the first planning meeting take place back to back with the NAMMCO SC meeting in 2020, with the contracted review being available at that time.

The WG noted that there is likely to be a generational shift in WG membership during the planning period and the potential challenges arising from this should be considered.

18. OTHER ITEMS

18.1 DEVELOPMENT OF NEW SURVEY SOFTWARE

A for information document was submitted on the Visual Surveyor software (SC/26/AEWG/FI04). This software is in ongoing development. The WG welcomes this new software and notes that it can be applicable for both aerial and ship surveys. The WG recommends that it be considered in the planned contracted review on new methods.

18.2 GEOMETER DEVELOPMENT

The geometer is now in use in some areas and reports are indicating that it is improving angle measurements. The tool will be presented at the upcoming World Marine Mammal Conference in Barcelona in December 2019.

18.3 COOPERATION WITH IWC

The Chair and Vice Chair of IWC Scientific Committee expressed via correspondence their regret that they were not able to have a representative present at this meeting. Despite this, continuing to develop a formal cooperation and a consolidated table of accepted abundance estimates was still a priority. The AEWG includes several members who also participate in the work of the IWC SC and these members were pleased to receive a document with tables showing the current status of IWC abundance estimates. This document remains a work in progress and there are several comments and open questions. The AEWG did not have time to go through the IWC tables in detail at this meeting, but re-iterated the importance of this cooperation. The document will be sent to the NAMMCO SC for consideration.

The WG discussed the need to develop a clear and efficient process for how cooperation between the two organisations is to be carried out in practice. To avoid having the same work performed by abundance estimates groups in both organisations, the ideal may arguably be to have estimates reviewed by one WG involving both organisations or by exchange of observers between the two working groups. However, it was noted that the final arbitrators in both organisations are actually the Scientific Committees and not the WGs. It may therefore be necessary that the cooperation be extended to the SC level.

The WG noted the difference in geographical scope and mandate between IWC and NAMMCO and that this cooperation would be restricted to the North Atlantic. The WG agreed that it is important that the cooperation continue to be advanced and that having consolidated estimates is important. However, the WG recommended that decisions on the appropriate process for this be discussed and advanced at the level of the SC.

19. RECOMMENDATIONS

SURVEY	YEAR	SPECIES	ITEM	RECOMMENDATION
RESEARCH: TECHNICAL				
CIC	ALL	BA, MN, LL	4	Where possible, analyse trends in absolute abundance to enable comparison with trends in relative abundance
CIC	ALL	BA, MN, LL	4	Include cases with significant effort but no sightings in population growth rate regressions.
CIC	ALL	BA, MN, LL	4	Where appropriate, conduct a power analysis to investigate the magnitude of trend that can be detected
CIC	ALL	BA	5.2	Explore the use of spatial modelling to extrapolate the estimate into the areas that had not been surveyed.
NILS	2002-2015	BP, MN, PM	4	Test the sensitivity of the estimates to a possible over-identification of duplicates from converting unidentified large whale sightings into positive species identifications
NILS	2002-2015	ALL	6.1	Investigate conditional detection functions without perpendicular distance as a covariate and adopt if indicated by AIC
NASS F+I	ALL	OO	9.1	Calculate an abundance estimate for killer whales
NASS	ALL	GM	12	Use the spatial analysis model to perform an assessment of temporal change in pilot whale distribution and abundance in the NASS survey area and time period before the next NAMMCO assessment of pilot whales (currently planned for 2020)
ALL	ALL			
RESEARCH: REQUIRING ACTION FROM MANAGERS				
CIC		PP	8.6	Carry out a new survey with harbour porpoise as a target species and collect dive data to facilitate the development of a correction factor for this species
ALL	ALL	ALL	16	Contract a written review of novel methods in abundance estimation to inform the future planning of the next NASS survey, using the provided terms of reference.
CONSERVATION AND MANAGEMENT				
ALL	ALL	ALL	17	Hold a dedicated planning meeting for the next NASS survey back to back with the SC meeting in 2020
ALL	ALL	ALL	18.3	Discuss the appropriate process for formalising cooperation with the IWC and developing a consolidated overview of abundance estimates at the level of the SC

20. NEXT MEETING

The abundance estimates from the 2015 survey have now been completed (with the minor exception of killer whales from the Iceland/Faroes ship survey and the analysis for minke whales in the CM areas including the 2019 data). Publication of the results is also well underway. The NAMMCO SC can determine when a further meeting may be required, however, the AEWG considers its work to answer request R-1.7.11 to now be complete.

21. ADOPTION OF REPORT

The Chair thanked the rapporteur and all the members of the group for their work both during and in preparation for this meeting. He acknowledged the significant effort required to answer request R-1.7.11 and expressed his gratitude to all involved for their contributions. The group also thanked the Chair for his able and efficient steering of the meeting and his active contribution to the work to answer R-1.7.11.

A draft version of the report was adopted before the close of the meeting at 16.55 on October 10 2019. A revised version of report was circulated to the group following editing and formatting work, and the final report was accepted on October 24 2019.

Table 1. The status of abundance estimates following the 2019 NAMMCO AEWG meeting

Table 1 Key: TYPE – S=ship, A=aerial; MODE – IO=independent observer method, BT=Buckland-Turnock method; 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

SPECIES		SURVEY	YEAR	DESC.	TYPE	MODE	EST.	CV	95% CI		BIAS CORR.		STATUS	CITATION
									LCL	UCL	PER	AVAIL		Reference to WG document
BA	Minke whale	NASS	2015	Iceland/Faroes	S	IO	42,515	0.31	22,896	78,942	1	0	1	NAMMCO SC/25/AE/06
BA		NILS2015	2015	CM1a+CM3	S	IO	17,500	0.35			1	1	2	NAMMCO SC/25/AE/13
BA		NASS+NILS2015	2015	CMA	S	IO	48,016	0.23	30,709	75,078	1	P	1	NAMMCO SC/25/AE/08
BA		CIC2016	2016	Iceland coastal	A	IO	13,497	0.50	5,377	33,882	1	1	1	NAMMCO SC/26/AE/04
BB	Sei Whale	T-NASS	2007	Iceland/Faroes	S	BT	9,737	0.38	4,189	19,665	0	0	1	NAMMCO SC/26/AE/05
BB		NASS	2015	Iceland/Faroes	S	IO	3,767	0.54	1,156	12,270	1	0	1	NAMMCO SC/26/AE/06
BM	Blue whale	NASS	2015	Iceland/Faroes	S	IO	3,000	0.4	1,377	6,534	1	0	1	NAMMCO SC/25/AE/06_rev
BP	Fin whale	NASS	2015	Iceland/Faroes	S	IO	36,773	0.17	25,811	52,392	1	0	1	NAMMCO SC/25/AE/06_rev
BP		NILS02-07	2005	Norway	S	IO	10,004	0.18	6,937	14,426	1	0	1	NAMMCO SC/26/AE/09
BP		NILS08-13		Norway	S	IO	10,861	0.26	6,433	18,339	1	0	1	NAMMCO SC/26/AE/10
BP		NILS2015	2015	CM1a+CM3	S	IO	3,729	0.44	1,531	9,081	1	0	1	NAMMCO SC/26/AE/12
BP		NILS14-18		Norway	S	IO	11,387	0.17	8,072	16,063	1	0	1	NAMMCO SC/26/AE/11
MN	Humpback whale	NASS	2015	Iceland/Faroes	S	IO	9,867	0.37	4,854	20,058	1	0	1	NAMMCO SC/25/AE/06_rev
MN		NILS02-07	2005	Norway	S	IO	10,669	0.31	5,695	19,988	1	0	1	NAMMCO SC/26/AE/09
MN		NILS08-13		Norway	S	IO	12,958	0.31	7,033	23,873	1	0	1	NAMMCO SC/26/AE/10
MN		NILS2015	2015	CM1a+CM3	S	IO	1,711	0.41	604	3,631	1	0	1	NAMMCO SC/26/AE/12
MN		NILS14-18		Norway	S	IO	11,662	0.40	5,225	26,027	1	0	1	NAMMCO SC/26/AE/11
MN		CIC 2009	2009	Iceland	A	IO	2,261	0.35	1,142	4,477	1	0	1	NAMMCO SC/26/AE/04

SPECIES		SURVEY	YEAR	DESC.	TYPE	MODE	EST.	CV	95% CI		BIAS CORR.		STATUS	CITATION Reference to WG document
									LCL	UCL	PER	AVAIL		
PM	Sperm whale	NASS	2007	Iceland/Faroes	S	BT	12,220	0.38	5,807	25,717	1	0	1	NAMMCO SC/25/AE/05
PM		NASS	2015	Iceland/Faroes	S	IO	23,166	0.59	7,699	69,709	1	0	1	NAMMCO SC/25/AE/06_rev
PM		NILS02-07		Norway	S	IO	8,134	0.18	5,695	11,617	1	0	1	NAMMCO SC/26/AE/09
PM		NILS08-13		Norway	S	IO	3,962	0.29	2,218	7,079	1	0	1	NAMMCO SC/26/AE/10
PM		NILS15		Norway	S	IO	3,828	0.33	1,994	7,595	1	0	1	NAMMCO SC/26/AE/12
PM		NILS14-18		Norway	S	IO	5,522	0.25	3,325	9,170	1	0	1	NAMMCO SC/26/AE/11
GM	Pilot whale	NASS	2015	Iceland/Faroes	S	IO	344,148	0.35	162,795	727,527	1	0	1	NAMMCO SC/25/AE/06_rev
Lsp	Lagenorhynchus spp.	NILS02-07	2005	Norway	S	IO	218,640	0.18	150,330	318,000	0	0	1	NAMMCO SC/25/AE/09
Lsp		NILS08-13		Norway	S	IO	163,688	0.18	112,673	237,800	1	0	1	NAMMCO SC/26/AE/10
Lsp		NILS14-18		Norway	S	IO	187,482	0.24	112,434	312,624	1	0	1	NAMMCO SC/26/AE/11
LAC	White-sided dolphin	T-NASS	2007	Iceland/Faroes	S	BT	81,008	0.54	27,993	234,429	1	0	1	NAMMCO SC/25/AE/05
LAC		NASS	2015	Iceland/Faroes	S	IO	131,022	0.73	35,251	486,981	1	0	1	NAMMCO SC/25/AE/06_rev
LAL	White-beaked dolphin	T-NASS	2007	Iceland/Faroes	S	BT	91,277	0.53	32,351	257,537	1	0	1	NAMMCO SC/25/AE/05
LAL		NASS	2015	Iceland/Faroes	S	IO	159,000	0.63	49,957	506,054	1	0	1	NAMMCO SC/25/AE/06_rev
LAL		CIC2007	2007	Iceland	A	IO	46,683	0.37	22,409	97,251	1	0	1	NAMMCO SC/26/AE/04
LAL		CIC2009	2009	Iceland	A	IO	75,959	0.56	26,366	218,834	1	0	1	NAMMCO SC/26/AE/04
LAL		CIC2016	2016	Iceland coastal	A	IO	59,966	0.44	24,907	144,377	1	0	1	NAMMCO SC/26/AE/04
OO	Killer whale	NILS02-07	2005	Norway	S	IO	18,213	0.21	11,486	29,992	1	0	1	NAMMCO SC/26/AE/09
OO		NILS08-13		Norway	S	IO	8,984	0.36	4,494	17,963	1	0	1	NAMMCO SC/26/AE/10
OO		NILS14-18		Norway	S	IO	13,909	0.30	7,733	25,018	1	0	1	NAMMCO SC/26/AE/11
OO		NASS	2015	Iceland/Faroes	S	IO							3	
PP	Harbour porpoise	NILS02-07	2005	Norway	S	IO	189,604	0.19	129,437	277,738	1	0	1	NAMMCO SC/26/AE/09
PP		NILS08-13		Norway	S	IO	30,556	0.57	10,502	88,907	1	0	1	NAMMCO SC/26/AE/10
PP		NILS14-18		Norway	S	IO	255,929	0.20	172,742	379,175	1	0	1	NAMMCO SC/26/AE/11
PP		CIC2016	2016	Iceland coastal	A	IO	22,806	0.48	9,166	56,746	1	0	1	NAMMCO SC/26/AE/04
HA	Northern Bottlenose	NASS	2015	Iceland/Faroes	S	IO	18,375	0.59	5,128	65,834	0	0	1	NAMMCO SC/26/AE/06

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NAMMCO SCIENTIFIC COMMITTEE

ABUNDANCE ESTIMATES WORKING GROUP

8-10 October 2019, NAMMCO Tromsø, Norway

AGENDA

1. CHAIRMAN WELCOME AND OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPORTEURS
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
5. COMMON MINKE WHALE
 - 5.1. Norwegian mosaic survey: 2014-2019 cycle
 - 5.2. CIC aerial survey 2016
6. LARGE BALEEN WHALES
 - 6.1. Norway – last two survey cycles
 - 6.2. Iceland/Faroes 2015: blue and sei whales
 - 6.3. Iceland/Faroes 2007: sei whales
 - 6.4. CIC Aerial 2009: humpback whales
7. SPERM WHALES
 - 7.1. Norway – last two survey cycles
8. DOLPHINS AND PORPOISES
 - 8.1. Norway – last two survey cycles
 - 8.2. Iceland/Faroes 2007: white-beaked and white-sided dolphins
 - 8.3. CIC Aerial survey 2007: white-beaked dolphins
 - 8.4. CIC Aerial survey 2009: white-beaked dolphins
 - 8.5. CIC aerial survey 2016: white-beaked dolphins and harbour porpoises
9. KILLER WHALES
 - 9.1. Norway – last two survey cycles
10. NORTHERN BOTTLENOSE WHALES
 - 10.1. Iceland/Faroes 2015
11. DISCUSSION OF NASS FIN WHALE ESTIMATES AT IWC
12. NASS SERIES SPATIAL ANALYSES
13. SCANS III 2016 UPDATE
14. CANADIAN NAISS 2016 UPDATE
15. PUBLICATION OF SURVEY RESULTS
16. PROPOSED WORKSHOP “NOVEL METHODS FOR ABUNDANCE SURVEYS & ESTIMATION”
17. PLANNING THE NEXT NASS
18. OTHER ITEMS
 - 18.1. Development of new survey software
 - 18.2. Geometer development
 - 18.3. Cooperation with IWC
19. NEXT MEETING
20. ADOPTION OF REPORT

This AEWG meeting is addressing the following ongoing requests from the NAMMCO Council:

- | | | |
|-----------------|-----------|--|
| R-1.7.11 | NAMMCO/16 | To develop estimates of abundance and trends as soon as possible once the survey has been completed, with the primary target species (fin, minke and pilot whales) as a first priority, and secondary target species as a second priority. |
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ABUNDANCE ESTIMATES WORKING GROUP

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NAMMCO SCIENTIFIC COMMITTEE

ABUNDANCE ESTIMATES WORKING GROUP

8-10 October 2019, NAMMCO Offices, Tromsø, Norway

LIST OF DOCUMENTS

Working Documents

Doc. No.	Title	Agenda item
SC/26/AEWG/01	Draft Agenda	2
SC/26/AEWG/02	Draft List of Participants	1
SC/26/AEWG/03	Draft List of Documents	4
SC/26/AEWG/04	Pike et al. Distribution, abundance and trends in abundance of cetaceans in Icelandic waters over 30 years of aerial surveys	5.2, 8.2
SC/26/AEWG/05	Pike et al. Estimates of the abundance of cetaceans from the T-NASS Icelandic and Faroese ship surveys conducted in 2007	6.3
SC/26/AEWG/06	Pike et al. Estimates of the abundance of cetaceans from the NASS Icelandic and Faroese ship surveys conducted in 2015	6.2, 10.1
SC/26/AEWG/07	Slooten Assessment of bias in population abundance estimates for North Atlantic fin whales (<i>Balaenoptera physalus</i>)	6.2, 9.2
SC/26/AEWG/08	Pike et al. A rebuttal to IWC SC/68A/ASI/07 (SC/26/AE/07)	6.2
SC/26/AEWG/09	Leonard and Øien Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2002-2007	6.3
SC/26/AEWG/10	Leonard and Øien Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2008-2013	6.4
SC/26/AEWG/11	Leonard and Øien Estimated abundance of cetacean species in Norwegian and adjacent waters based on ship surveys conducted in 2014-2018	6.5
SC/26/AEWG/12	Leonard and Øien Estimates of abundance of large whales from Norwegian ship surveys and a NASS extension survey conducted in 2015	6.6

SC/26/AEWG/13	Houghton et al. Oceanic drivers of sei whale distribution in the North Atlantic	6.2, 6.3
SC/26/AEWG/14	Desportes et al. Update on status of NAMMCO Scientific Publications Volume 11	10
SC/26/AEWG/15	Martinez et al. Distribution and habitat use of deep diving cetaceans in the central and eastern North Atlantic	12

For Information Documents

Doc. No.	Title	Agenda item
SC/26/AEWG/FI01	Report of 2018 AEWG Meeting	Several
SC/26/AEWG/FI02	Acoustic Surveys of Cetaceans in the Irish Atlantic Margin in 2015–2016: Occurrence, distribution and abundance	
SC/26/AEWG/FI03	Aerial Surveys of Cetaceans and Seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017	
SC/26/AEWG/FI04	Draft Visual Surveyor Manual for Version 0.9	16, 18