ANNEX 1

REPORT OF THE NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON ABUNDANCE ESTIMATES

Department of Fisheries and Oceans, Quebec City, 7 - 9 October 2009

1. CHAIRMAN WELCOME AND OPENING REMARKS

Chairman Daniel Pike welcomed the participants (Section 5.7). He pointed out that the purpose of this meeting was to evaluate the abundance estimates of the different components of the T-NASS 2007 and associated surveys, to discuss and plan for further data analyses and to produce, where possible, combined abundance estimates for the entire area covered by T-NASS and associated surveys.

2. ADOPTION OF AGENDA

The adopted agenda is given in Appendix 1.

3. APPOINTMENT OF RAPPORTEURS

Acquarone was appointed as rapporteur with the help of the participants where needed.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

Documents that were made available for the meeting are listed in Appendix 2.

5. T-NASS DATASET: validation, storage, formats, and availability

In 2008 the NAMMCO Scientific Committee recommended that T-NASS data be transformed to a format similar to the one employed by the IWC and be archived at the NAMMCO Secretariat with the necessary clauses for use restrictions (NAMMCO 2009). Acquarone reported that the Secretariat was prepared to receive the data and had funding to develop a data archive suitable to this need. The WG therefore urged the Secretariat to proceed with this and asked all T-NASS data holders to cooperate with the Secretariat in providing the data in a timely manner.

6. REVIEW OF ABUNDANCE ESTIMATES AND TRENDS

6.1 Fin whale

6.1.1 T-NASS aerial Canada

Lawson presented documents SC/16/AE/12 and SC/16/AE/14. The former included information on the methodology employed during the Canadian megafauna aerial surveys and preliminary abundance calculation results. The latter more specifically addressed the question of bias correction for the Newfoundland and Labrador area components.

For the Canadian portion of the T-NASS survey, there were 144 sightings of fin whales, which were incorporated into multivariate, stratified line transect analyses used to estimate abundance in the programme Distance. Model detection functions were chosen to minimize Akaike Information Criterion values using all sighting data, and then post-stratified (see Lawson and Gosselin 2009 for methods). Too few sightings were made in the Labrador stratum (one fin whale) to obtain reliable abundance estimates. Corrections for availability bias have not been completed.

Using the MCDS approach the uncorrected abundance estimate for fin whales in the Newfoundland and Labrador (NL) portion was 677 fin whales (CV = 0.254; 95% CI 413 - 1,112), while in the Gulf and Scotian Shelf (GSS) portion there were an estimated 462 fin whales (CV = 0.28; 95% CI 270 - 791). Compared with a 1981 aerial survey of a smaller area and uncorrected for bias sources (478 fin whales; Hay 1982), there appears to be a positive trend in fin whale abundance in Newfoundland waters (although see discussion below of a possible delayed northward migration of fin whales during the 2007 survey period).

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two observers (10 replicates from 35 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the perception-corrected abundance estimate for fin whales in the NL portion of the T-NASS was 1,254 whales (95% CI 765 - 2,059; $g(0)=0.54$ for the primary platform).

Gosselin informed the WG that too few sightings of fin whales were made in the tandem plane experiments to provide bias corrections for the GSS portion of the survey. It was also noted that responsive movement might be an issue for this platform (aircraft type and altitude) for some species, incl. fin whales.

At present the best (least biased) total estimate of fin whales in Canadian waters combines the partially corrected estimate from NL with the uncorrected estimate from GSS, for a total of 1,716 (CV = 0.40; 95% CI 1,035 - 2,850).

Comparison with earlier surveys suggests that fin whale numbers were lower in 2007 than previously. However, Lawson noted that there may have been a delayed migration into Canadian waters in 2007, according to reports from fishermen and whale watchers, and from initial results from the SNESSA survey, where sightings of fin whales in the area immediately south of the Canadian survey area were more numerous than in previous surveys.

6.1.2 T-NASS shipboard Iceland/Faroe Islands

Paper SC/17/AE/O07 presented revised estimates from this component of T-NASS, which were first presented to the WG last year (NAMMCO 2009), than revised following the Group recommendation and later presented to the IWC Scientific Committee. The 2008 NAMMCO WG required further work on two issues before the estimate could be accepted.

The first issue involved correction of a suspected bias in radial distance estimation by the primary platform. Comparison of 30 distance estimates to duplicate sightings on one vessel revealed that, on average, perpendicular distances to sightings from the primary platform were 74.6% of distances to the same sightings from the tracker platform. Responsive movement, in this case attraction, was considered an unlikely explanation as comparison of primary and tracker sightings that were very close together in time showed the same pattern. Therefore a negative bias in distance estimation by the primary platform is suspected. If real, such a bias would result in the overestimation of abundance. However, the bias would apply only to non-duplicate sightings by the primary platform, as distance estimates by the tracker platform were used when available.

The discussion on this issue centred on the use of data from the trackers and the development of correction factors. It was noted that by having the trackers confirm the primary sightings one would obtain an independent distance estimation and better species determination: this should be implemented for future surveys. Since there was no precedent for such a correction in past surveys (and no way to derive one for surveys conducted before 2001, which used a single platform), the uncorrected estimate was considered acceptable for use in assessment. The Group underlined however that better estimates of distance by the primary platform were required and that this problem must be addressed in future surveys.

The second issue pertained to the use of the last distance estimation of for each sighting instead of the first, which is not standard practice for line transect surveys of cetaceans, although it has been used consistently in analyses of the Iceland/Faroese data. Gunnlaugsson indicated that this approach eliminates a possible positive bias due to random movement of the animals detected far ahead on the track line, but may introduce other biases if later surfacings are missed or due to responsive movement. The Group agreed that a reference was required to support this statement. The issue was not fully resolved, and Hammond and Gunnlaugsson volunteered to search the literature about this specific issue. It was however considered likely that any bias resulting from this practice would be very small.

The authors also noted that some post-stratification of particularly the NW block will be required to account for ice conditions, and agreed to provide revised estimates when this was completed. (This was completed after the meeting and the resultant estimates are noted below).

In conclusion the Group noted that the estimate uncorrected for $g(0)\neq1$ of 21,628 (95% CI 15,731 - 27,739) should be accepted for consistency with previous surveys while the issue of bias in distance estimation should be addressed for future surveys. When the surface areas of the western strata are corrected for ice cover, the resultant estimate decreases by 4.7% to 20,613 (95% CI 14,819 - 25,466). The $g(0)$-corrected estimate of 27,493 (95% CI 18,289 - 41,328) is likely closer to actual abundance and could be preferred for some purposes. Corrected for ice cover this estimate is reduced slightly to 26,117 (95% CI 17,401 - 39,199). These estimates are similar to those for 2001 for a similar area, so the increase observed over the period 1987-2001 (Víkingsson *et al.* 2009) has apparently ceased.

6.1.3 T-NASS aerial Greenland

Hansen presented document SC/16/AE/07, The effort was conducted off West Greenland in August-September 2007 from a Twin Otter. A total of 9,433 km of survey effort covered 21 strata (11 offshore, 10 fiords) in sea states <5 with a total stratum area of 220,924 km^2. The survey was conducted as a double platform survey and mark-recapture distance sampling (MRDS) techniques were used to correct for perception bias.

24 sightings of fin whale groups were collected. Based on conventional distance sampling techniques an abundance of 4,359 whales (CV = 0,45; 95% CI 1,879 - 10,114) was estimated. MRDS methods gave an abundance estimate of 4,468 whales (CV = 0,68; 95% CI 1,343 - 14,871). Both estimates are negatively biased because no corrections were applied for whales that were submerged during the passage of the survey plane. There is an apparent positive trend in abundance since 1989.

The Group found it unusual that the proportion of duplicate sightings increased with perpendicular distance. No clear reason could be given for this, but it was suggested that some cues might be easier to spot at a larger distance. This could also be an artefact due to the relatively small sample size, with only 8 duplicates.

The CDS estimate was nearly the same as the MRDS estimate, and more precise. This is contrary to expectations as the MRDS estimate is corrected for perception bias and should therefore be higher. No clear explanation for this was provided, but it was noted that the two analyses differed in their truncation of perpendicular distances and their level of pooling of mean group size. This latter difference apparently had a very large effect on estimated abundance in some strata. Also blocks 4 and 7 were poorly covered and should be re-stratified. The WG also noted the apparent increase in numbers since 1989, but suggested that this should be examined in more detail, taking account of differences in survey methods and their inherent biases.

There was also discussion about the use of specialised harbour porpoise observers in large whale surveys, an issue that also arose in consideration of the Icelandic aerial survey. Unfortunately no conclusion was reached, but the point was considered very important.

The WG concluded that the CDS estimate was acceptable for assessment purposes, but that further work was required before the MRDS estimate could be accepted. The following work was recommended 1) post-stratification of blocks 4 (which includes much of the estimate) and 7 to only include areas actually surveyed (both estimates); 2) examination of the effect of the level of pooling of expected group size on stratum and total estimates (both estimates); 3) examination of the effect of right truncation on the MRDS estimate, particularly truncation to the same degree as the CDS estimate. An alternative would be to truncate the CDS model equivalently to the MRDS model. It was also recommended that the apparent positive trend in abundance since 1988 be examined in more detail, taking account of differences in survey design, as well as field and analytical methodologies.

6.1.4 CODA

The abundance of fin whales (*Balaenoptera physalus)* and other baleen whales was estimated from data collected during shipboard sightings surveys as part of the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) project (document SC/17/AE/O01). The survey area covered offshore waters beyond the continental shelf of the UK, Ireland, France and Spain. The area was stratified into four blocks and was surveyed by five ships during July 2007. Double platform methods employing the trial configuration (BT) method were used to estimate the abundance of fin whales and "large baleen whales" (fin, sei, fin/sei and blue whales) using the MRDS design-based method and also using density surface modelling. Primary perpendicular distances for duplicates were smaller than those from the Tracker platform, implying attractive movement, so a full independence model was used in analysis. Estimates from the two methods were comparable but model-based methods improved the precision and were considered best estimates. The density of large baleen whale species was greatest in the southern end of the survey area and water depth, temperature and distance to the 2,000m contour were important predictors of their distribution. The total abundance estimated for the entire survey area was 9,019 (CV = 0.11: 95% CI 7,265 - 11,200) fin whales and 9,619 (CV = 0.11; 5% CI 7,760 - 11,920) large baleen whales. The uncertainty around these estimates due to duplicate classification and species identification were explored. The fin whale abundance estimate is likely to be underestimated because it excludes unidentified large whales, of which a large proportion was likely to have been fin whales. Notwithstanding this, these large baleen whale abundance estimates are the first robust estimates (corrected for responsive movement and $g(0)$) for this area.

The Group noted that a single platform estimate which would be useful for comparison with earlier surveys had not been performed and encouraged the authors to do so. This would facilitate comparison with the Spanish and Faroese portions of previous NASS, which overlapped with the CODA survey area. Because of the heterogeneity of the methods employed in past surveys it is difficult to infer the direction of trends in population size.

An alternative explanation of the difference in distance measurements between the tracker and primary platforms would be systematic bias by one or both platforms. This feature was also seen in the T-NASS shipboard data, where it was attributed to underestimation of distance by the primary platform. Attractive responsive movement by fin whales is unexpected and was considered very unlikely by some members of the WG. However no firm conclusion on this issue could be reached.

The Group agreed with the authors that the model-based estimates should be preferred because of their higher precision. However they also agreed that the estimate for fin whales is certainly negatively biased because a large (but unknown) proportion of the unidentified large whales estimate is likely composed of fin whales. The Group encouraged the authors to investigate this aspect further to determine whether a more accurate estimate for fin whales could be derived.

6.1.5 SNESSA

No new information was available beyond that reported last year. The Group encouraged the timely analysis and reporting of these survey results for all species.

6.1.6 Combined estimate

There seem to be no issues of overlap thus the survey results are considered additive. A simple sum of the estimates for CODA, Iceland-Faroe Islands, Greenland and Canada yields a total estimate of 42,119 (CV = 0.15). To this may be added the estimate for the Norwegian survey area in the period 1996-2001 of 6,409 (CV = 0.18) (Øien 2009) and recent estimates from the American eastern seaboard of about 3,000 (Palka, SC/17/AE/O14). All of these estimates are negatively biased to a greater or lesser degree by uncorrected perception, availability and/or other biases. Therefore the total number of fin whales in the North Atlantic must exceed 50,000.

6.2 Minke whale

6.2.1 T-NASS aerial Canada

For the Canadian portion of the T-NASS survey, there were 144 sightings of minke whales. Too few sightings were made in the Labrador stratum to obtain reliable abundance estimates (four lone minke whales). Analytical methods were the same as those described for fin whales under 6.1.1. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate for minke whales in the NL portion of the T-NASS was 1,087 (CV = 0.27; 95% CI 642 - 1,840), while in the GSS portion of the T-NASS there were an estimated 1,927 minke whales (CV = 0.21; 95% CI 1,196 - 2,799).

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two platforms (4 replicates from 32 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the abundance estimate for minke whales in the NL portion of the T-NASS was 3,748 whales (95% CI 2,214 - 6,345; $g(0)=0.29$).

The Group noted that the estimate for the Scotian shelf and Gulf area is biased for availability and perception, while that for NL is biased for availability. Both of these biases are likely large. Nevertheless these were accepted as valid minimum estimates for the areas. It was suggested that the possibility of correcting for availability bias using the methods employed in SC/17/AE/08 be investigated.

No inference on trends could be made as information on historical abundance for this species is very limited.

6.2.2 T-NASS shipboard Iceland/Faroe Islands combined with T-NASS extension

Gunnlaugsson reported on document SC/17/AE/O04 (IWC SC/61/RMP12) which presented analyses of the T-NASS 2007 data from the six vessels operating in the central North Atlantic. Three vessels surveyed using double platform BT methods. Two dedicated cetacean observers searched on each of three other research vessels engaged primarily in other research activities. These vessels are referred to as extension vessels and the intention was for them to extend survey coverage to areas not surveyed by the main sightings survey vessels. One of these vessels made no minke whale sightings on full effort and so the area covered only by this vessel (Southwest) receives zero abundance. Abundance in the coastal Icelandic block was covered by aircraft and was not considered here. The area along the coast of East Greenland and the pack ice edge there, which had the highest densities in the survey area in previous NASS, was poorly covered due to adverse conditions. In total, 30 sightings were made in BT mode and 7 sightings in combined platform mode, that is, during periods when BT mode could not be maintained for logistical reasons. In addition 20 sightings were made in single platform mode, mainly on the extension vessels. There were 24 trials (tracker sightings) of which 4 to 5 were likely duplicates, all at short distances, the primaries duplicating nearly all whales that the trackers saw close to the trackline. An analysis is presented from all the vessels combined. Results from both Point Independence and Full Independence were considered and in both cases *g*(0) was estimated at 0.95; *i.e*., close to 1. Including the combined mode effort as primary effort, contrary to expectation, reduced the estimate of abundance.

The results were tested for bias in distance estimates by the primary platform (naked eye estimates). Multiplying up the primary distances by 1.34 (based on comparison of primary and tracker estimates of distance to immediate duplicates of fin whales) led to estimates that were 11% lower.

Assuming no responsive movement (Point Independence model) and using the extension vessel data only when no dedicated sighting vessel data were available (in block CL) gave an estimate for the NASS-07 survey area of 10,900. Full bootstrap 95% confidence intervals are 6,600-30,000. The estimate for the surveyed part of the Central Area is 11,100 (95% CI 6,400 - 30,600). The Full Independence model estimates were almost three times higher, which implies extreme avoidance of the animals to the sighting vessels. This level of avoidance has not been documented and so the Point Independence model estimates are recommended by the authors. A number of problems were identified in the implementation of the BT method in this survey which most likely introduced negative biases due to incomplete recording or not fully independent recording of the uncertainty/incompatibility in species identification from the platforms. These estimates are not corrected for availability bias and where such estimates exist (*e.g*. from the Norwegian surveys, which have minke whales as the target species) they should be preferred.

The Group found the document to be unclear in a number of areas and noted that it contained obvious errors that made the results difficult to understand. Furthermore the information provided is not sufficient to interpret the methods and the estimates. Therefore the Group could not accept the estimates provided.

It was reiterated that Iceland and the Faroe Islands should provide a simple CDS estimate for these data, uncorrected for *g*(0), recognizing that the data are not sufficient for an estimate of this parameter – this estimate should be kept consistent with earlier estimates for similar surveys in the area (Pike *et al.* 2009). A map of sightings used in the analysis would also be useful for the assessment of the work presented.

No inference on trends could be made as the estimates were not accepted. Nevertheless they are not inconsistent with previous estimates for the area (Pike *et al.* 2009), in which no trends were detected.

Finally, it was noted with regret that this document had been presented to the SC of the IWC without mentioning either NAMMCO or any other partners involved in the organisation of the surveys.

6.2.3 T-NASS aerial Iceland 2007 (choosing best estimate)

The estimates contained in SC/17/AE/O06 were presented last year and have not been revised. Two estimates were developed: one using data from both primary observers, and the other using data only from the primary observer experienced in previous minke whale cue counting surveys. The latter estimate was 42% higher than the former. In 2009 the Scientific Committee asked this Working Group select the estimate which was most suitable for future assessment work.

The Group reiterated that the estimate based only on the single observer for whom duplicate sightings were available was comparable to the 1987 and 2001 estimates. However the estimate using also sightings from the observer for whom data lacked to quantify negative detection bias had a lower CV. Therefore, for assessment purposes, both estimates might be employed.

6.2.4 Aerial Iceland 2009 (survey report)

Pike reported on the Icelandic aerial survey carried out in June-July 2009, which was a continuation of a series of surveys, using nearly identical design and methodology, conducted in 1987, 1995, 2001 and 2007 (Pike *et al.* 2008, 2009). The main target species of these surveys has been minke whale, however sightings of all species are registered. The 2009 survey was carried out primarily because the abundance of minke whales estimated from the 2007 survey was not consistent with earlier surveys: Pike *et al.* (2008) estimated that the abundance of minke whales in 2007 was just 24% of that estimated for 2001 by Borchers *et al.* (2009). Results from a partial survey carried out in 2008 suggested that the 2007 results might be anomalous (Gunnlaugsson *et al.* 2009)

The survey was conducted successfully in June-July 2009. The aircraft, equipment, survey design and observation protocols were nearly identical to those used in recent aerial surveys in the area. One of the primary observers and the cruise leader (control observer) were experienced in minke whale cue counting surveys, while the other primary observer had experience from ship surveys only. Full double platform effort was maintained on one side of the plane only.

Of the 29 days the plane was available, at least some effort was flown on 17 (59%). This was somewhat worse than in 2007, when 67% of the available days were flown. Total realized effort was 73% of planned effort. This is not as good as in 1995, 2001

(78%) or 2007 (79%), but better than that achieved in 1987. In general extensive areas of fog and prevailing northerly winds made surveying particularly difficult in 2009.

The primary observer, who had no prior experience from aerial surveys, performed poorly in recording data quickly enough and produced fewer sightings and was exchanged with the cruise leader (control observer) partway through the survey. In addition, a serious equipment failure led to the loss of some data. This may create some difficulties in the data analysis.

Data compilation and checking are not yet complete so distribution maps and sighting records are as yet unavailable. Generally minke whales were sighted more frequently than in 2007, but probably less frequently than in 2001. It is anticipated that an estimate for minke whales will be completed by January 2010

The Group appreciated that this survey encountered many problems but was pleased that an abundance estimate should be feasible with the data that were collected. It was noted the production of an abundance estimate by January 2010 would be in time to be presented to the scheduled meeting of the Assessment WG.

6.2.5 T-NASS aerial Greenland

Hansen presented document SC/17AE/08. The details of the survey are the same as reported under 6.1.3 for the fin whales. Twenty-seven (22 from sea states lower than 3) sightings of minke whale were made within a strip width of 300 m: the average time from first detection to when the sighting passed abeam was 1.7 sec. Due to the uniform and narrow distribution of the detections strip census methods were used to analyze the survey. To correct for whales missed by the observers and whales that were submerged during the passage of the plane two methods were considered.

Method 1 included all detections of minke whales (n=27) and correction for an instantaneous availability that included submergence of whales. Using only data from sea states <3 (n=22) the ‘near surface’ (both whales breaking the surface and nearby - visible from the planes on photos) abundance of minke whales was 1,866 (CV = 0.30) and a correction for whales missed by the observers with a simple mark-recapture estimator resulted in a corrected abundance of 1,904 (CV = 0.30) whales. The proportion of time that minke whales were visible (available) to observers was estimated using aerial photographic images collected in Faxafloi Bay in Iceland in September 2003. Adjusting for the availability bias resulted in a fully-corrected estimate of 16,609 (95% CI 7,172 - 38,461) minke whales.

Method 2 used only detections of minke whales that were observed to break the surface (n=19). Applying this method to effort data at sea state<3 (n=14) results in an ‘at surface’ abundance of 1,174 (CV = 0.39) whales and correcting for whales missed by the observers increased the abundance to 1,198 (CV = 0.39) whales. Data from satellite transmitters (ST-15, Telonics Inc.) deployed on five minke whales in West Greenland, Svalbard/Norwegian waters and Iceland during 1998-2002) were used to adjust for availability by estimating the proportion of time the whales had their backs above the surface. This resulted in fully corrected estimate of 22,952 (95% CI 7,815-67,403) minke whales.

The Group remarked that both the photos and most of the satellite tag applications used to estimate availability were from areas other than Greenland, and that the corrections should therefore be applied with caution.

The Group noted that the authors had used the average forward sighting distance as the width of the detection window, and suggested that 2 times the average would be more appropriate. Using 2 times the average would reduce the higher (method 2) estimate and thus make the estimates quite similar. In calculating the average forward distance the authors use the larger number from the 2 observers (the lower number being 0 in all cases), which may have been seen as compensating for use of the average distance in the correction for availability bias.

Given a larger detection window (as is the case with most previous surveys), a uniform detection probability within the window is less likely. This in addition to the heterogeneity in the cues implies a positive detection correlation of the 2 observers. The correction for perception bias would therefore be too low.

With these caveats, the Group welcomed the two abundance estimates and noted that they are similar and both equally suitable for management purposes.

From the historical series of point estimates it appears that the general trend in this area is a slight increase, even if it was underlined that the methods used in previous abundance estimates are not all homogeneous.

The group discussed the applicability of these methods to the Icelandic aerial surveys. It was noted that the detection windows of the two sightings platforms used in the Twin Otter differ significantly and the sightings are not concentrated at the abeam line, which would invalidate the application of these methods for those data.

6.2.6 T-NASS shipboard Greenland

The Group regretted that working paper had not been made available for this meeting, however Hansen reported that 27 sightings were collected and the preliminary uncorrected (for both perception and availability bias) abundance estimate is 7,079 animals (CV = 0.35; 95% CI 3,477-14,413). It was recommended that this estimate be fully documented and reported as soon as feasible.

6.2.7 CODA and SCANS II

The abundance of minke whales was estimated from data collected during shipboard sightings surveys as part of the Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) project using CDS methods because of limited sample size (document SC/17/AE/O01). Sightings were restricted to the northern blocks of the survey area and estimated abundance, uncorrected for $g(0)$ or responsive movement, was 6,765 (CV = 0.99; 95% CI 1,240 - 36,900)). Minke whale abundance was estimated from the SCANS-II survey of European Atlantic continental shelf waters in

2005 using MRDS design-based methods as 18,614 (CV = 0.30; 95% CI 10,400 - 33,200) (document SC/17/AE/O03).

Abundance of minke whales was estimated in 1994 from the SCANS survey as 8,445 (CV = 0.24; 95% CI 5,000 - 13,500) (Hammond *et al.* 2002). The estimate for 2005 for the area covered in 1994 was 13,462 (CV = 0.27); higher, but not significantly at the 5% level, than the 1994 estimate.

6.2.8 SNESSA
See item 6.1.5.

6.2.9 Combined estimate
The presence of an overlap between the Icelandic aerial and shipboard surveys precludes a simple addition of the estimates for this area. Furthermore, it was underlined that the latest Icelandic shipboard estimate has not yet been accepted.

The Group noted that, although the Canadian and Greenlandic aerial surveys had been conducted somewhat later than the others, it was unlikely that there would be movement that would result in double-counting. One indication of the absence of movement between the areas is the lack of minke whale sightings from the simultaneous Redfish survey platforms, implying that there is little movement between Canada and West Greenland or between these areas and areas further east. For these reasons the Group deems the estimates to be additive in this case.

It was noted that the Norwegian mosaic survey total estimate and the other T-NASS estimates cannot be directly added as the Norwegian estimates apply to a 6-year period and are fully corrected for availability and perception biases. Nevertheless the sum of all estimates would provide an absolute minimum number of minke whales in the North Atlantic. This sum would be in excess of 150,000 animals.

6.3 Humpback whale
6.3.1 T-NASS aerial Canada
For the Canadian portion survey, there were 227 sightings of humpback whales. No sightings were made in the Labrador stratum. Analytical methods were the same as those described for fin whales described under 6.1.1. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate for humpback whales in the NL portion was 928 humpback whales (CV = 0.19; 95% CI 634 - 1,357), while in the GSS portion there were an estimated 653 humpback whales (CV = 0.26; 95% CI 385 - 1,032).

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two observers (13 replicates from 88 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the abundance estimate for humpback whales in the Newfoundland portion was 3,712 whales (95% CI 2,536 - 5,428; $g(0)=0.25$). Assuming a constant rate of population increase, comparing the 2007 estimates with uncorrected results from Hay's 1981 survey of a smaller portion of Newfoundland waters (Hay

1982), humpback numbers in Newfoundland waters may have increased at approximately 8.2%.

The Group noted that the point estimate presented here was higher than the one from past surveys. However, it was underlined that the extent of this and previous surveys do not exactly coincide and the comparison has to be made with caution, although anecdotal information (*e.g.* from tour operators) seems to confirm an increase in abundance.

The estimates presented were endorsed by the Group. The Group also recommended that the estimates be corrected for availability, while recognizing that such corrections must by necessity be preliminary.

6.3.2 T-NASS aerial Iceland

Pike presented document SC/17/AE/05 which provides estimates of humpback whale abundance from the Icelandic coastal aerial survey conducted in June-July 2007. Details of the survey methods are provided by Pike *et al.* (2008) and NAMMCO (2009). Humpback whale sightings were concentrated off northwest Iceland, and most whales were seen close to the pack ice edge there. Unlike in 1995 and 2001, no humpbacks were seen off eastern Iceland.

Double platform (DP) effort was maintained on one side of the aircraft, data from this side were used to provide correction factors for perception bias for the primary and combined platforms. Four estimates were provided: 2 using conventional distance sampling techniques for the combined platforms and the primary platform, one using the right side DP data and MRDS methods to provide an estimate corrected for perception bias for the primary platform, and one using the same data to provide a similarly corrected estimate for the combined platforms. The conventional estimate using data from both platforms was 1,138 (95% CI 565 - 2,039), while that for the primary platform only was 810 (95% CI 370 - 1,770). Incorporation of a mean $g(0)$ of 0.64 (CV = 0.36) for the primary platform raised that estimate to 1,275 (95% CI 454 - 3,579), and $g(0)$ of 0.88 (CV = 0.64) for the combined platforms increased that estimate to 1,522 (95% CI 802 - 2,887). Post stratification of the survey area to that which was actually covered lowered all these estimates by 19-23%. These estimates are not corrected for whales that were diving and hence not visible as the plane passed over, and are therefore negatively biased.

Total abundance estimated for 2007 using comparable methodology was 52% and 72% lower than 1995 and 2001, respectively (Pike *et al.* 2009), however neither decrease is significant ($P>0.05$).

The Group discussed the different estimate methods presented and considered the Combined Platform Corrected estimate (CP-C) to be the best to date as it includes most observations. However, for consistency with previous estimates, the Primary Platform estimates (PP and PP-C) were also accepted.

Because responsive movement was considered unlikely the Group recommended that the estimates be redone under the assumption of point independence. This was done after the meeting resulting in a *g*(0) value of 0.70 (CV = 0.17) for the primary platform and an abundance estimate of 1,162 (95% CI 497 - 2,717). The combined platform estimate incorporated a *g*(0) of 0.91 (CV = 0.06) for a total abundance of 1,242 (95% CI 632 - 2,445).

The absence of sightings east of Iceland seems to be the major reason for the decline in abundance as indicated by the 2007 estimate.

6.3.3 T-NASS shipboard Iceland/Faroe Islands

Pike presented document SC/17/AE/04 which provided abundance estimates for humpback whales from the Icelandic and Faroese components of the T-NASS ship surveys. As in most previous surveys (Pike *et al.* 2005) humpback whales were commonly sighted to the north and northwest of Iceland in blocks IN and NW. Unlike in previous surveys, no humpbacks were sighted off eastern and northeastern Iceland, and few were seen close to East Greenland. Coverage in both these areas was however poor. A combined platform estimate, using conventional distance sampling analysis and non-duplicate sightings from both platforms, totalled 11,572 (95% CI 4,502 - 23,807) for humpbacks identified with high and moderate certainty. Effort conducted in full B-T mode was analyzed using MRDS techniques in Trial configuration and assuming point independence. This resulted in an estimated *g*(0) for the primary platform of 0.79 (CV = 0.12) and an abundance of 16,633 (95% CI 6,494 - 42,601). Adding whales identified with low certainty raised this estimate by 6% for both estimates. The former estimate is uncorrected for perception and availability biases, while the latter is corrected for perception and at least partially for availability. The abundance estimated in 2007 is lower, albeit not significantly so, to those estimated for 1995 and 2001 (Paxton *et al.* 2009), suggesting that the rapid increase in abundance documented by Pike *et al.* (2005, 2009) may have ceased.

The distribution of sightings seems to have changed since 2001 which might be a consequence of appreciable changes in the marine ecosystem around Iceland in recent years (Ástþórsson *et al.* 2007). In particular capelin abundance off Iceland has been lower in recent years, and the summer distribution has shifted towards East Greenland (Pálsson *et al.* 2009) This could explain the absence of sightings off eastern Iceland, however survey effort in this area was sparse.

The analysis does not incorporate effort from the extension vessels, however these vessels made very few sightings of humpback whales so the abundance estimates would not be affected. However it was recommended that the authors should incorporate this effort at least into the map illustrations to show the areas that were covered.

A higher than expected proportion of humpback whale sightings was made while in B-T mode. This has the effect of making the MRDS estimate higher than would be expected by the correction for *g*(0) alone. The reasons for this are not clear but it may simply be related to the clustered distribution of humpbacks. The Group therefore considered the combined CDS analysis to be most reliable, as it relied on a greater amount and wider distribution of survey effort.

The Group further recommended an investigation of the possible presence of responsive movement. If such evidence is found then a MRDS model assuming full independence should be used.

The Group accepted the combined platform estimates as that most consistent with previous estimates and therefore most suitable for assessment purposes.

6.3.4 T-NASS aerial-shipboard combined Iceland/Faroe Islands

The combination of the Iceland and Faroe Islands shipboard and aerial results is not straightforward as the survey areas overlap off northern and western Iceland. In addition, most humpbacks were seen off northwestern Iceland and were associated with the pack ice edge there. The ship surveyed this area about 20 days later than the plane, by which time the ice edge had apparently receded to some extent. Thus there is a danger of "double counting" whales that might follow the receding ice edge, even outside the overlap area. The Group agreed that a first approach could be to employ abundance estimates from the shipboard surveys in the overlapping areas and to use the post-stratified aerial survey for the rest.

6.3.5 T-NASS aerial Greenland and aerial-shipboard combined

Hansen presented document SC/17/AE/06 which included results of the 2007 aerial survey and an analysis of trends using standardized analyses of past surveys. A total of 21 sightings of humpback groups were collected. The line transect estimate for 2007 was 1,020 (CV = 0.35). When the estimate was corrected for perception bias with mark-recapture distance sampling (MRDS) methods, the abundance increased to 1,528 (CV = 0.50). Correction for availability bias was developed based on time-depth-recorder information on the time spent near the surface (0-4 m). The resulting estimate for 2007 was 3,299 [3] (CV = 0.57; 95% CI 1,170 - 9,301) for the MRDS analysis. An alternative strip census estimate deploying a strip width of 300 m resulted in 995 (CV = 0.33) whales. Correction for perception bias resulted in 991 (CV = 0.35) whales and corrected for the same availability bias as for the MRDS method resulted in a fully-corrected estimate of 2,154 (CV = 0.36; 95% CI 1,087 - 4,270) humpback whales in West Greenland in 2007.

Aerial line transect surveys, which were conducted off West Greenland eight times between 1984 and 2007, were used to estimate the rate of increase on this summer feeding ground. Only the surveys in 1993, 2005, and 2007 gave enough sightings to construct independent density estimates, whereas the surveys in 1987-89 and 1984-85 had to be merged and treated as two surveys. The annual rate of increase was 9.4% yr^{-1} (SE = 0.01) between 1984 and 2007.

[3] Subsequently a revised estimate 3,272 (CV= 0.5; 95% CI 1,230-8,710) was approved after the meeting.

No estimate from the 2007 ship survey off West Greenland was presented. The Group recommended that this estimate be completed and documented in a timely manner.

The Group noted that there was a low number of sightings for this species and that aerial coverage was poor in the high density Disko Bay area. As the MRDS analysis accounts for the decline in detectability with distance while the strip census does not, the MRDS analysis was preferred and accepted for use in assessment.

It was noted that similar or even higher apparent rates of increase have been observed for this species in other areas, including Iceland (Pike *et al.* 2005, 2009) and Antarctica (Matsuoku *et al.* MS 2004).

6.3.6 SNESSA

See item 6.1.5.

6.3.7 Combined estimate

As for minke and fin whales the Group considered it unlikely (but not impossible) that there would be movements of humpback whales between survey areas over the course of the surveys. The Group considered that the reviewed abundance estimates are additive once the new estimates for indicated areas are carried out according to the guidelines suggested. Summing the Icelandic/Faroese ship survey, Greenlandic and Canadian estimates results in about 15,000 humpback whales in the Atlantic, however this is an underestimate as it does not include the Northeast Atlantic or the US eastern seaboard, and incorporates several uncorrected negative biases.

6.4 Pilot whale

6.4.1 T-NASS aerial Canada

For the Canadian portion, there were 53 sightings of pilot whales. Only 10 sightings of 104 animals were made in the NL strata, so abundance could not be estimated there. For the Gulf and Scotian Shelf data, corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate for pilot whales in the GSS portion was 6,134 pilot whales (CV = 0.320; 95% CI 2,774 - 10,573). Compared with previous abundance estimates for the Gulf and Newfoundland, there appears to be a negative trend in pilot whale abundance.

The Group noted the indication of an extreme decline in the abundance of this species since the 1981 survey (Hay 1982) which might be correlated with the decline in squid abundance in the area.

6.4.2 T-NASS shipboard Iceland/Faroe Islands

Mikkelsen presented document SC/17/AE/13 which included a model-based abundance estimation of pilot whales by fitting a generalized additive model with spatially-referenced covariates to data collected during the 2007 Icelandic (shipboard and aerial) and Faroese (shipboard), as well as the extension (shipboard) components of the T-NASS. Density was estimated in two stages; presence-absence of whales was modelled logistically, then non-zero density was assumed to be constant. The product of the predictions obtained from the two models provided an estimate of abundance.

The spatially-referenced covariates considered were longitude, latitude, depth, sea-surface temperature, and group size as well as survey type. Additionally, $g(0)$ was calculated with respect to perception bias and estimates were provided considering presence or absence of responsive movements. Variance was estimated using non-parametric bootstrapping. Design-based distance sampling estimates were provided for comparisons with estimates from previous surveys. Estimates based on the double platform data with additional data from both platforms combined were also made. The authors considered the best estimate over the entire region was from the full-independence model, assuming responsive movements, with additional undistinguished combined effort from both platforms. This estimate was 77,400 (95% CI 44,700 - 181,700).

The Group noted that the previous request from the Assessment Working Group in March 2009 to provide a CDS estimate had not been fulfilled as the design-based estimate provided uses MRDS methods. It reiterated its recommendation to do so for the combined platform data as this is required for comparison to earlier surveys.

Some of the estimates provided have unrealistically wide confidence intervals, sometimes with 0 as a lower bound, which probably results from an inappropriate use of bootstrapping.

The Group considers that this work is not satisfactory in its present form and therefore it cannot assess either the estimates or the trends. Furthermore it urges for the completion of the analysis as the most recent endorsed estimates (from the 1995 and 2001 surveys) lay too far back in time to be used for management purposes. To help with improving the document the Group listed the following additional issues of concern:

- The model-based density maps show evidence of “edge effects” wherein density is unaccountably high at the edge of a stratum.
- The sightings shown in the two maps (Fig.5 and 6) are different and some sightings are apparently missing.

6.4.3 Index of relative abundance for NASS-T-NASS surveys

The Group agreed that the closest index to absolute abundance with the data at hand is density calculated from CDS for the blocks that are common to all surveys. Therefore it was suggested that CDS analysis be carried out for a common area for all years and all blocks (post-stratification). It was also deemed useful to analyse the changes in group size between the years. Mikkelsen agreed to pursue this matter.

6.4.4 T-NASS aerial Greenland

Hansen presented document SC/17/AE/09 which detailed abundance estimates for pilot whales, harbour porpoises and dolphins. A total of 17 sightings (12 duplicates) of pilot whale groups were collected. The at-surface abundance of pilot whales was 3,253 animals (CV = 0.38; 95% CI 1,495 - 7,078) using MRDS methods, while that using MCDS methods was 2,976 animals (CV = 0.46; 95% CI 1,178 - 7,515). The authors considered the latter estimate to be more robust. Correction for availability bias was developed based on three pilot whales instrumented with satellite transmitters at the

Faroe Isles. Correction of the at-surface abundance with the availability factor (40%) increased the pilot whale abundance in West Greenland to 7,440 (CV = 0.49; 95% CI 3,014 - 18,367). No previous abundance estimates for this species have been made in Greenland.

The Group noted that the MCDS estimate had a surprisingly larger CV than the MRDS one. It was inferred that it must be due to the small sample size as no covariate could explain the variance.

The Group welcomed these results, the first abundance estimate for what is a harvested species in West Greenland. The Group recommended that the authors compare these results with those from past surveys conducted off West Greenland. While abundance estimates from past surveys have not been developed for this species, a comparison of distribution and numbers of sightings would be helpful.

The Group endorsed the MCDS estimate and deemed it acceptable for assessment purposes. The correction for availability derived from satellite tag data assumes that pilot whale pods dive in synchrony, which is not always true. However the correction also assumes that the whales can be seen to a depth of 6 m, which is very optimistic. Hence the group could not reach a conclusion regarding the applicability of this correction.

6.4.5 CODA

The abundance of long-finned pilot whales was estimated from data collected during shipboard sightings surveys as part of the CODA project using the MRDS design-based method and also using density surface modelling (SC/17/AE/O09). The best estimate from the design-based method was 25,101 (CV = 0.33; 95% CI 13,250 - 47,550).

There was some evidence of responsive movement for this species, therefore an MRDS model assuming Full Independence was employed in the analyses. However, the Group noted that a CDS estimate would be required for comparison with earlier surveys.

The 2007 estimate will be revisited and may be revised in the future. In addition data from adjacent T-NASS strata will be included in future analyses. The Group therefore decided to await future results which are expected within the next year.

6.4.6 SNESSA

See item 6.1.5.

6.4.7 Combined estimate

As noted under 6.4.2, a combined estimate for the T-NASS/CODA survey areas will be produced in the coming months. Movement between other survey areas over the course of the surveys was considered unlikely, therefore the estimates should be additive.

6.5 Harbour porpoise

6.5.1 T-NASS aerial Canada

For the Canadian portion of the T-NASS survey, there were 65 sightings of harbour porpoise with no sightings made in the Labrador stratum. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate in the NL portion was 958 harbour porpoise (CV = 0.37; 95% CI 470 - 1,954), while in the GSS portion there were an estimated 3,667 harbour porpoise (CV = 0.35; 95% CI 1,565 - 6,566).

The estimates for the Newfoundland strata could not be corrected for perception bias using a mark-recapture analysis because there were no replicate sightings data (24 unique sightings).

The Group agreed that these estimates are severely negatively biased because of uncorrected perception and availability biases. There was no reliable data with which to assess trends in abundance for this species.

6.5.2 T-NASS aerial Greenland

A total of 35 sightings (7 duplicates) of harbour porpoises were collected in the 2007 aerial survey (SC/17/AE/09). An MRDS analysis produced an abundance of harbour porpoise of 6,585 animals (CV = 0.34; 95% CI 3,379 - 12,832). Correction for availability bias was developed based on three harbour porpoises instrumented with satellite transmitters in Denmark, making the corrected at-surface abundance with the availability factor (31%) to 21,242 animals (CV = 0.38; 95% CI 10,290 - 43,851). If only data from one side of the plane (with experienced harbour porpoise observers) were used, 31 sightings (7 duplicates) were left. The abundance of harbour porpoise was 10,314 (CV = 0.35; 95% CI 5,193 - 20,484) using MRDS methods (half normal model). Correction of the at-surface abundance with the availability factor (31%) increased the harbour porpoise at-surface abundance to 33,271 (CV = 0.39; 95% CI 15,939 - 69,450). No previous abundance estimates have been made in Greenland.

The Group welcomed this estimate as the first for this species which is harvested in Greenland. It was considered that the one-sided estimate detailed above was the most accurate, as it included almost all the sightings and utilized data from observers highly experience for with this species. This estimate was considered suitable for assessment purposes.

It was suggested that another approach might be to utilize correction factors (incorporating availability and perception) already estimated for these particular observers from SCANS-II and other surveys to provide a corrected estimate for comparison with that derived above. However such an approach might require covariate data that were not collected during the survey.

6.5.3 SNESSA

See item 6.1.5.

6.5.4 SCANS II

Hammond presented document SC/17/AE/O03 which described how the abundance of harbour porpoise was estimated from the SCANS-II survey of European Atlantic continental shelf waters in 2005 using MRDS design-based methods as 385,617 (CV = 0.20). An estimate for approximately the same area as surveyed in 1994 (project SCANS) was 335,000 (CV = 0.21), very similar to the 1994 estimate of 341,366 animals (CV = 0.14). However, distribution predicted from the model-based analysis showed that animals were distributed further south in 2005 than in 1994.

The abundance of this species seems stable for the SCANS II area: the two design-based estimates are almost identical and the two model-based estimates differ only slightly. However, it is evident that the distribution had changed markedly between the SCANS and SCANS II surveys.

6.5.5 Combined estimate

The Group perceived no issues with summing estimates from all areas once they are available.

6.6 Dolphin species

6.6.1 T-NASS aerial Canada

6.6.1.1 Common dolphins

For the Canadian portion of the T-NASS survey, there were 228 sightings of common dolphins, Two sightings (16 animals) were made in the Labrador stratum. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate in the NL portion was only 558 common dolphins (CV = 0.41; 95% CI 253 - 1,233), while in the GSS portion there were an estimated 53,049 common dolphins (CV = 0.21; 95% CI 34,865 - 80,717).

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two observers (6 replicates from 16 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the corrected abundance estimate for common dolphins in the Newfoundland portion of the T-NASS was 613 dolphins (95% CI 278 - 1,355; $g(0)$=0.91).

The Group welcomed this new abundance estimate from Canada, the first for this species from such a broad area. As such, trends in abundance for this species cannot be assessed.

6.6.1.2 White-sided dolphins

There were 120 sightings of white-sided dolphins, of which 1 sighting (4 animals) only was made in the Labrador stratum. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate for white-sided dolphins in the NL portion was only 1,142 (CV = 0.28; 95% CI 659 - 1,982), while in the GSS portion there were an estimated 4,289 animals (CV = 0.210).

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two observers (9 replicates from 57 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the abundance estimate for white-sided dolphins in the Newfoundland portion was 3,086 animals (95% CI 1,781 - 5,357; *g*(0)=0.37).

The abundance of white-sided dolphins in the Gulf of St. Lawrence only in 1995 was estimated to be 11,700 by Kingsley and Reeves (1998), whereas in the following year they were estimated to number only 560. The T-NASS estimate falls between the Gulf of St. Lawrence estimates of the mid-1990's which showed variable numbers between successive years and therefore we could not conclude evidence of a negative or positive trend.

6.6.1.3 White-beaked dolphins

There were 85 sightings of white-beaked dolphins, of which none were made in the Labrador stratum. Corrections for availability bias have not been completed. Using the MCDS approach the uncorrected abundance estimate for white-beaked dolphins in the NL portion was only 1,250 white-beaked dolphins (CV = 0.22; 95% CI 691 - 2,260), while in the GSS portion a total of only 17 sightings of this species were made, precluding estimation of abundance.

The estimates for the NL strata were corrected for perception bias using a mark-recapture analysis based on replicate sightings data from two observers (5 replicates from 40 unique sightings) on the right side of the survey aircraft. Using the MRDS approach with point independence, the corrected abundance estimate for white-beaked dolphins in the Newfoundland portion was much larger: 15,625 dolphins (95% CI 8,637 - 28,250; *g*(0)=0.08).

White-beaked dolphins were estimated by Kingsley and Reeves (1998) to number between 2,600 and 2,400 for both 1995 and 1996, respectively, in the Gulf of St. Lawrence. There is an apparent reduction in the Gulf abundance for this species based on the T-NASS compared to those years.

6.6.2 T-NASS aerial Greenland

A total of 62 sightings (35 duplicates) of white-beaked dolphins were collected during the Greenlandic survey (SC/17/AE/09). Both MRDS and CDS analyses were performed. The data were truncated at 10% (370 m) for the conventional DS analysis which left 56 sightings for analysis. The abundance of white-beaked dolphins was 9,827 animals (CV = 0.19; 95% CI 6,723 - 14,365) using MRDS methods (with no correction for availability bias). Using MCDS methods the estimate was 9,677 animals (CV = 0.23; 95% CI 6,148 - 15,232). Correction for availability bias was developed based on data from one white-beaked dolphin instrumented with a satellite transmitter in Iceland. This correction (82% available at the surface) increased the white-beaked abundance in West Greenland to 11,801 (CV = 0.23; 95% CI 4,975 – 27,994).

The Group warned that the correction factor applied is based on tagging results from only one animal in a different area, and therefore should be considered preliminary. It was also noted that the variance of the corrected estimate is underestimated as there is no variance estimated for the correction factor Nevertheless this was welcomed as the first abundance estimate for this species in West Greenland.

No trend information was presented at this meeting and the Group recommended that the necessary historical information be presented at the next meeting.

6.6.3 CODA and SCANS II

Hammond and Cañadas presented documents SC/17/AE/O02, SC/17/AE/O03 and SC/17/AE/O09 where the abundance of various species of dolphins was estimated from the CODA survey in 2007 and the SCANS-II survey in 2005 in European Atlantic waters. The following table gives the estimates for each species (CV), stating the analysis method used: corrected or uncorrected for *g*(0) and responsive movement; design-based or model based.

Species	**CODA (2007)**	**SCANS-II (2005)**
Common dolphin	116,709 (0.34) corrected model-based	50,506 (CV = 0.29; 95% CI 28,700 - 88,800) corrected design-based
Striped dolphin	67,414 (0.38) corrected model-based	
Common and/or striped dolphins	259,605 (0.37) corrected model-based	76,374 (CV = 0.25; 95% CI 47,500 -122,800) corrected design-based
Bottlenose dolphin	19,295 (0.25) uncorrected design-based	12,645 (0.27) uncorrected design-based
White-beaked dolphin		16,788 (CV = 0.26; 95% CI 10,100 - 27,900) corrected design-based

The Group noted that the SCANS 1994 estimate for common dolphins is not corrected for responsive movement and thus cannot be used for comparison. For this reason it is not possible to estimate trends for this species. The SCANS-II estimate for white-beaked dolphins in the area surveyed in the 1994 SCANS survey was 10,958 (CV = 0.29), compared to the 1994 estimate of 7,856 (CV = 0.30; 95% CI 4,000 - 13,000) (Hammond *et al.* 2002). There were not enough sightings of bottlenose dolphins for an estimate.

6.6.4 SNESSA

See item 6.1.5.

6.6.5 Combined estimate

Data are available for white beaked dolphins for T-NASS shipboard and T-NASS Icelandic aerial. The Group encouraged the analysis of these data which is necessary before a combined estimate can be calculated.

6.7 Other species

Sperm whales

The T-NASS acoustic data from Iceland and the Faroese should be analysed shortly, following a methodological course to be held in Iceland during the fall of 2009.

Hammond presented the results in document SC/17/AE/O09. The abundance of sperm whales was estimated from data collected during shipboard sightings surveys as part CODA project using CDS design-based methods and density surface modelling for visual data and using acoustic data. The best estimates were 2,077 (CV = 0.20) whales from the model-based analysis of the visual data and 2,239 (95% CI: 1,707 - 2,936) whales from the acoustic analysis. The latter estimate does not include block 1 where there were visual sightings.

The Group noted that the estimate using acoustic data is only moderately higher than the visual estimate, suggesting that availability bias is not extreme for this species. The group encouraged further simultaneous visual and acoustic estimates for this species and recommended that this be done with the T-NASS data.

Beaked whales

Hammond reported CODA results for beaked whales (document SC/17/AE/O09). The total abundance of 6,992 (95% CI 4,287 - 11,403) was obtained using a design-based uncorrected CDS estimate. Using a model based DSM estimate the abundance of beaked whales was calculated to 7,343 (95% CI 4,075 - 13,230). The acoustic data do not warrant further analysis.

The T-NASS shipboard data include in total 26 sightings of northern bottlenose + 10 unidentified. The Group recommended that these be combined with CODA data for analysis.

The Icelandic aerial survey recorded a few sightings but not enough to produce an estimate for this species.

Canada, SNESSA and Greenland did not record enough sightings for an estimate for either beaked or sperm whales

Killer whales

The low number of sightings for this species does not allow abundance estimate calculations (NAMMCO 2009, page 270 for the detailed numbers).

6.8 Additional analyses to be carried out

6.8.1 Combined CODA/T-NASS analyses

Hammond informed the Group that he and Cañadas would be reanalysing CODA and SCANS-II data using model-based methods in the next 6 months. The Group considered that this would be an ideal opportunity to undertake integrated model-based analyses of CODA and T-NASS data. The Group considered that most added value could be gained from combined estimates for pilot, minke, fin and sperm whales as well as white-beaked dolphins. The Group tasked Hammond, Desportes and Víkingsson with developing a proposal with costs and sourcing any necessary additional funding to make this happen.

6.8.2 Combined T-NASS/CODA/SNESSA distribution maps and survey report

At the last meeting it was agreed that a primary publication on the planning, conduct and results of the T-NASS and associated surveys, particularly pertaining to general distribution of cetaceans throughout the entire survey area, including the extension areas, would be produced as a priority. Acquarone and Desportes agreed to lead in the development of this document, to be completed and submitted for publication by June 2010 (see 8.1). The Group urged all participants to cooperate fully and promptly with Acquarone in this effort.

<u>6.8.3 Other species</u>

6.8.3.1 Harbour porpoise / T-NASS aerial Iceland

Analysis of this dataset is in progress and should be completed this year. It is expected that a fully-corrected estimate of abundance will be produced.

6.8.3.2 T-NASS shipboard Iceland/Faroe Islands – dolphins

Acquarone agreed to take on this task, and to complete the analysis on a priority basis. The analysis will be done in concert with CODA to the extent possible (see 6.8.1).

6.8.3.3 T-NASS aerial Iceland – dolphins (wb)

Víkingsson agreed to try to have analysis of these data completed within the coming year, but noted that it is not a high priority species for Iceland.

7. TOWARDS THE NEXT SURVEYS

7.1 Methodological questions

<u>7.1.1 Survey methodologies (e.g. multispecies surveys, synoptic *vs* mosaic survey, double *vs* single platform survey, two independant *vs* top-directed platforms, etc.)</u>

Large scale synoptic survey?

Initial discussion centred on the advantages of a large-scale synoptic survey such as T-NASS over smaller scale national surveys or mosaic surveys, and whether these advantages were worth the costs.

Ideally, any survey should cover the entire seasonal range of the target species/stock. For a multi-species survey, this requires coverage of a very large area. Therefore the geographic scale of the T-NASS and associated surveys was considered its greatest advantage, and this could only be achieved through international coordination.

A synoptic survey also provides a snapshot of distribution that is impossible to achieve with smaller scale or mosaic surveys. Large variations in distribution have been detected in the NASS – T-NASS series, and these may not have been detected using other means. However, over a longer term, mosaic surveys do provide reliable information on temporal changes in distribution.

The main disadvantage to such coordination was perceived to be the cost in time and money of coordinating often disparate national survey groups. In addition, some degree of flexibility is required from all parties, and the agreed survey methods, stratification etc. may not be ideal for every species. On the other hand, some cost savings might be realized through pooling of resources and large scale equipment purchases.

The Group agreed that coordination at least at the level of the T-NASS was desirable and should be pursued for the next round of surveys. It was noted that even more central planning and coordination, as in CODA, had advantages but might not be achievable in a situation where most funding came from national institutes. However, Hammond brought to the attention of the group that CODA was funded by national institutes and government departments and SCANS-II was 50% funded by the EU and 50% by institutes and government departments.

Methodological issues: Ship surveys

A detailed evaluation of the methodology used in the T-NASS was provided at the last meeting last year (NAMMCO 2009), so the Group concentrated on more general issues.

Clearly there are issues with the implementation of the B-T mode in mixed species surveys; these were encountered by both T-NASS and CODA. Nevertheless it was considered that something like B-T was required for species that are known to exhibit responsive movement (*e.g.* some dolphins, minke whales, pilot whales, harbour porpoises) and also to detect responsive movement even if it is not suspected. For example, responsive movement by fin whales was detected in CODA, although these results remain uncertain. It was also noted that many of the problems encountered, especially in the T-NASS, could have been overcome by better training and more familiarity with equipment and systems. The Group concluded that having two platforms had proved its worth, but that alternatives to B-T, such as IO or the independent platform B-T used in SNESSA, should be investigated.

Other issues were discussed last year but work on the abundance estimates has only emphasized their importance. These include:

- A better system is needed to address uncertainty in species identification, preferably one that will allow post-classification of uncertain categories;
- A better method of distance estimation is needed for the primary platform. The use of reticule binoculars by primary observers should be considered;
- *Post-hoc* identification of duplicates should be considered in addition to or instead of field identification;
- Better protocols are required for defining and dealing with groups for some species, particularly those that form large dispersed groups such as pilot whales;
- Better, more robust equipment is required. Equipment should be ordered at least a year in advance;
- Pre-cruise training is an absolute necessity and a pilot survey should be considered.

Methodological issues: Aerial Surveys

Again a detailed evaluation was provided last year, so only general issues were discussed.

Observer training and experience was considered the most important issue in all areas. For surveys using small planes, such as in Iceland and parts of Canada, it is imperative to use experienced observers from the start, as even one poor observer can jeopardize the entire survey. Moreover it is impossible to evaluate an observer without accumulating some sighting data, which may take some time in low density areas. It has proven difficult to establish and maintain a core of experienced observers for surveys that may happen only infrequently.

Observer training is important but it has proven difficult to train observers in the air, particularly on small planes. Ground training in the plane can be very effective. It was recommended that for any large scale survey, an allocation of survey time up to several days be devoted to training and practice flights. Ideally the latter should be carried out so that observers can acquire a search image for the target species.

The use of specialized harbour porpoise observers in multi-species surveys was discussed but no firm conclusions were reached. Experience in Iceland and Greenland shows that these observers tend to have a very narrow search width and generate fewer sightings of larger whales than other observers. This can result in low precision unless greater effort is applied. On the other hand they appear to miss fewer sightings close to the plane (at least this is a feature of the Greenland data) and thus are less affected by perception bias. If harbour porpoise are a target species, it was considered that special training and experience with this species was required.

Equipment and recording systems were considered adequate in Greenland and Canada, but should be updated for Iceland. Pike agreed to provide recommendations for this. The Greenlandic system is also collecting video and still photographs, and this was considered a useful addition for all areas.

Once again the use of immersion suits by all air crew was recommended.

7.1.2 Analytical methodologies: Model *vs* design based estimates

Because of time constraint, this question was left out to be dealt with at the one day public workshop following the meeting.

7.2 Planning (timing, participants, form)

Participants provided their countries' general survey plans to the Group. Canada is now planning to conduct large-scale surveys on a 10 year rotation, which would mean their next survey should be in 2017. However these plans could be flexible if there is opportunity to participate in an international exercise such as T-NASS. Iceland and the Faroe Islands wish to maintain the 6 year rotation established in the NASS, but noted that there could be some flexibility in this. Greenland is planning a large whale survey in 2013.

Hammond informed the Group that the present plan is to conduct SCANS and CODA type survey simultaneously on a roughly 10 year rotation, with the next survey occurring in 2015 at the latest. Large-scale surveys on the US eastern seaboard (*i.e.*

SNESSA) are planned for 2013 and 2017. Norway will continue its mosaic survey programme, with the current rotation ending in 2013.

Given the above, the Group considered the most opportune time for the next large-scale survey would be in the period 2013 to 2015. This will require some flexibility from all partners, and planning should begin as soon as possible. The Group recommended that the NAMMCO Scientific Committee should provide direction and initiate planning and negotiations with survey partners as soon as feasible. This might best be done by establishing a small planning group which would bring in participation from all potential partners.

7.3 Other

Nothing was discussed under this item.

8. PUBLICATION OF SURVEY RESULTS

8.1 Consideration of submission for a special issue?

In 2009 the NAMMCO Scientific Committee recommended that a primary publication on the planning, conduct and results of the T-NASS, particularly pertaining to general distribution of cetaceans throughout the entire survey area, including the extension areas, be produced as a priority. CODA and SNESSA had agreed to participate in this. Noting that Acquarone and Desportes had already agreed to lead in preparing this paper (see 6.8.2), the Group considered that it would be the ideal introduction to a series of papers covering abundance estimates from the survey, preferably published together in a single issue. In this regard the Group noted the offer of Greg Donovan to publish T-NASS papers in a single issue of *J. Cetacean Res. Management*. Working papers reviewed at this meeting could form the basis of this publication.

All participants expressed interest in this proposal. Hammond noted that results from CODA will be published by species, when and where appropriate, but agreed that some CODA papers might be suitable for the proposed joint publication. It was agreed that Acquarone will lead in developing this publication, initially by contacting lead authors for the papers and negotiating a suitable publication agreement. It was also agreed that a deadline of June 2010 would be set for submission of papers for this publication.

9. OTHER ITEMS

9.1 Presentation(s) for the T-NASS-SNESSA-CODA Workshop on 10 October

The group agreed on dividing the general presentations and the results from the surveys between the participants as follows:
Lawson – welcome and opening remarks, Hammond – general presentation of Scans I-II & CODA, Desportes – general presentation of T-NASS, Pike & Víkingsson – combined results for large baleen whales, Gunlaugsson – combined results for sperm whales, Mikkelsen – combined results for beaked and pilot whales, Hammond – combined results for small cetaceans, Hammond – methodological Issues, Cañadas – model *vs* designed based estimates.

10. NEXT MEETING

Given that further results for several species from the T-NASS will be forthcoming, it was recommended that the Group should meet again in about one year's time, at the direction of the Scientific Committee.

11. CLOSURE OF MEETING and ADOPTION OF REPORT

On the behalf of NAMMCO, Pike thanked the participants for their work and the Department of Fisheries and Oceans, Quebec, particularly Danielle Baillargeon, for hosting the meeting.

The report was reviewed by correspondence and the final report was agreed upon on 18 January 2010.

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Appendix 1

AGENDA

1. CHAIRMAN WELCOME AND OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEURS
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
5. T-NASS DATASET: validation, storage, formats, and availability
6. REVIEW OF ABUNDANCE ESTIMATES AND TRENDS
    - 6.1 Fin whales
        - 6.1.1 T-NASS aerial Canada
        - 6.1.2 T-NASS shipboard Iceland/Faroe Islands
        - 6.1.3 T-NASS aerial Greenland
        - 6.1.4 CODA
        - 6.1.5 SNESSA
        - 6.1.6 Combined estimate
    - 6.2 Minke whales
        - 6.2.1 T-NASS aerial Canada
        - 6.2.2 T-NASS shipboard Iceland/Faroe Islands combined with T-NASS extension
        - 6.2.3 T-NASS aerial Iceland 2007 (choosing best estimate)
        - 6.2.4 Aerial Iceland 2009 (survey report)
        - 6.2.5 T-NASS aerial Greenland
        - 6.2.6 T-NASS shipboard Greenland
        - 6.2.7 CODA / SCANS – SCANS II
        - 6.2.8 SNESSA
        - 6.2.9 Combined estimate
    - 6.3 Humpback whales
        - 6.3.1 T-NASS aerial Canada
        - 6.3.2 T-NASS aerial Iceland
        - 6.3.3 T-NASS shipboard Iceland/Faroe Islands
        - 6.3.4 T-NASS aerial-shipboard combined Iceland/Faroe Islands
        - 6.3.5 T-NASS aerial Greenland and aerial-shipboard combined
        - 6.3.6 SNESSA
        - 6.3.7 Combined estimate
    - 6.4 Pilot whales
        - 6.4.1 T-NASS aerial Canada
        - 6.4.2 T-NASS shipboard Iceland/Faroe Islands
        - 6.4.3 Index of relative abundance for NASS-T-NASS surveys
        - 6.4.4 T-NASS aerial Greenland
        - 6.4.5 CODA
        - 6.4.6 SNESSA
        - 6.4.7 Combined estimate
    - 6.5 Harbour porpoises
        - 6.5.1 T-NASS aerial Canada
        - 6.5.2 T-NASS aerial Greenland
        - 6.5.3 SCANS II

6.5.4 SNESSA
6.5.5 Combined estimate
6.6 Dolphins
6.6.1 T-NASS aerial Canada
6.6.2 T-NASS aerial Greenland – white beaked dolphins
6.6.3 CODA / SCANS II
6.6.4 SNESSA
6.6.5 Combined estimate
6.7 Other species
6.8 Additional analyses to be carried out
6.8.1 Combined CODA/T-NASS analysis
6.8.2 Combined T-NASS/NASS/CODA/SNESSA/SCANS II distribution map and common T-NASS/CODA/SNESSA survey report
6.8.3 Other species
6.8.3.1 Harbour porpoise / T-NASS aerial Iceland
6.8.3.2 T-NASS shipboard Iceland/Faroe Islands- dolphins
6.8.3.3 T-NASS aerial Iceland – dolphins (wb)

7. TOWARDS THE NEXT SURVEYS
7.1 Methodological questions
7.1.1 Survey methodologies (a. o., multispecies surveys, synoptic *vs* mosaic survey, double *vs* single platform survey, two independant vs. top directed platforms, etc.)
7.1.2 Analytical methodologies: Model *vs* design based estimates
7.2 Planning (timing, participants, form)
7.3 Other

8. PUBLICATION OF SURVEY RESULTS
8.1 Consideration of submission for a special issue?

9. OTHER ITEMS
9.1 Presentation(s) for the T-NASS-SNESSA-CODA Workshop on 10 October

10. NEXT MEETING

11. CLOSURE OF MEETING and ADOPTION OF REPORT.

Appendix 2

LIST OF DOCUMENTS

Doc. No.	**Agenda**	**Title**
SC/17/AE/01	1	List of Participants.
SC/17/AE/02	2	Draft Agenda.
SC/17/AE /03	4	List of Documents.
SC/17/AE /04	6.3.3, 6.3.4	Pike *et al.* Estimates of the abundance of humpback whales (*Megaptera novaengliae*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007.
SC/17/AE /05	6.3.2, 6.3.4	Pike *et al.* Distribution and abundance of humpback whales in Icelandic coastal waters in summer 2007.
SC/17/AE /06	6.3.5	Heide-Jørgensen *et al.* Rate of increase and current abundance of humpback whales in West Greenland.
SC/17/AE /07	6.1.4	Heide-Jørgensen *et al.* Abundance of fin whales in West Greenland in 2007.
SC/17/AE /08	6.2.5	Heide-Jørgensen *et al.* Estimates of minke whale abundance in West Greenland in 2007.
SC/17/AE /09	6.5.2; 6.6.2, 6.44	Heide-Jørgensen *et al.* Abundance and distribution of long-finned pilot whale, white-beaked dolphin and harbour porpoise from Greenland aerial survey 2007.
SC/17/AE /10	6.2.4	Pike *et al.* Cruise report from the 2009 Icelandic CIC aerial survey.
SC/17/AE /11	6, all sp.	Acquarone *et al.* T-NASS distribution maps.
SC/17/AE /12	6.1 – 6.7	Lawson and Gosselin. Distribution And Preliminary Abundance Estimates For Cetaceans Seen During Canada's Marine Megafauna Survey - A Component of the 2007 T-NASS.
SC/17/AE /13	6.4.2	Paxton *et al.* Density surface fitting of the T-NASS 2007 Pilot Whale Sightings.
SC/17/AE /14	6	Lawson. Perception bias corrections for abundance estimates of cetacean in Newfoundland waters in

Doc. No.	Agenda	Title
		during the 2007 T-NASS survey.
SC/17/AE/O01	6.1.5, 6.2.7	Macleod *et al.* Distribution and Abundance of Fin whales and other baleen whales in the European Atlantic. IWC SC/61/RMP10.
SC/17/AE/O02	6.6.6	Cañadas *et al.* Abundance and distribution of common dolphins in the offshore NE Atlantic. IWC SC/61/SM6.
SC/17/AE/O03	6.2, 6.5, 6.6, 6.8.3	Hammond *et al.* SCANS II final report.
SC/17/AE/O04	6.2.2	Paxton *et al.* Mark-Recapture Distance Sampling Estimate of Minke Whales from the Icelandic, Faroese and Russian components of T-NASS. IWC SC/61/RMP12.
SC/17/AE/O05	7	NAMMCO SC/15/10 - Report of the NAMMCO SC Working Group on Abundance Estimates, Copenhagen, 8 April 2008.
SC/17/AE/O06	6.2.3	Pike *et al.* T-NASS Icelandic aerial survey: Survey report and a preliminary abundance estimate for minke whales. IWC SC/60/PFI 12.
SC/17/AE/O07	6.1.2	Pike *et al.* Estimates of the abundance of fin whales (*Balaenoptera physalus*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. IWC SC/60/PFI 13-revised.
SC/17/AE/O08	7	NAMMCO SC/15/09 - Report of the NAMMCO SC Working Group on T-NASS, Copenhagen, 7 April 2008.
SC/17/AE/O09	7 + CODA rel.	Hammond *et al.* CODA final report.
SC/17/AE/O10	6.2	Bøthun *et al.* Abundance of minke whales in the Northeast Atlantic based on survey data collected over the period 2002-2007. IWC SC/61/RMP 2.
SC/17/AE/O11	6.2	Lindstrøm *et al.* Modelling multi-species interactions in the Barents Sea ecosystem with special emphasis on minke whales and their interactions with cod, herring and capelin. Deep Sea Research II 56.

Doc. No.	**Agenda**	**Title**
SC/17/AE/O12		NAMMCO SC/10/8 - Report of the NAMMCO SC WG on Abundance Estimates – 2002.
SC/17/AE/O13		NAMMCO SC/11/9 - Report of the NAMMCO SC WG on Abundance Estimates – 2003.
SC/17/AE/O14	6, all SNESSA rel.	Palka. Abundance estimate of cetaceans in the US Northwest Atlantic from 1995 to 2006; I. Aerial data. NAMMCO SC/15/AE8 (this draft document was updated with some results from the 2007 survey for the Quebec City NAMMCO workshop).
SC/17/AE/O15	6, all SNESSA rel.	Palka. DRAFT - PRELIMINARY - Abundance estimate of cetaceans in the Northwest Atlantic from 2007; I. Shipboard data. SC/15/AE9. 36 pp.

5.7
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