NAMMCO

REPORT OF THE

NAMMCO SCIENTIFIC COMMITTEE

WORKING GROUP ON

ABUNDANCE ESTIMATES

St Andrews, Scotland, 19-21 March, 2003

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1. OPENING REMARKS

Chairman Nils Øien welcomed all participants to the meeting (see Appendix 1). He reviewed the terms of reference for the Working Group.

The fourth North Atlantic Sightings Survey was carried out in June/July 2001. The survey was planned and co-ordinated by this Working Group under the auspices of the NAMMCO Scientific Committee. The Working Group met in March 2002 and considered survey reports and preliminary abundance estimates from the survey. In addition the Working Group conducted a full evaluation of the survey protocols and methodologies, to be used in the planning of future surveys. The Working Group made recommendations for work to be carried out to complete abundance estimates for several species from the NASS-2001 and earlier surveys.

The present Working Group is therefore tasked with continuing the evaluation of abundance estimates for target and non-target species, determining if additional analyses are required and recommending estimates for acceptance by the Scientific Committee. In addition there will be some discussion of the publication of survey results, and the future of the NASS.

2. ADOPTION OF AGENDA

The Draft Agenda (Appendix 2) was adopted without changes.

3. APPOINTMENT OF RAPPORTEUR

Daniel Pike, Scientific Secretary of NAMMCO, was appointed as Rapporteur for the meeting.

4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The documents considered by the Working Group are listed in Appendix 3.

5. MINKE WHALES

i. 2001 ship survey

An estimate of the abundance of minke whales form the NASS ship survey around Iceland and the Faroes was presented by Gunnlaugsson *et al.* (SC/11/AE/6). This area is exclusive of the aerial survey block around Iceland. Because of weather and ice related revisions to the survey plan, coverage probability was higher close to the East Greenland ice edge than in other portions of the same blocks. As the area close to the ice edge corresponds to an area of high minke whale density, it was considered that the uneven coverage within the original block structure would likely have resulted in a positively biased estimate. The area was therefore post-stratified to include narrow blocks near the ice edge. Double platform data were available and indicated that *g(0)* was less than 1, however an attempt to apply the double platform hazard probability method to these data was not successful due to the distributional properties of the data. The distribution of perpendicular distances showed a steep decline from the trackline and almost no "shoulder", and a long tail extending out to about 3,000 m from the trackline. This made the estimation of effective strip width (esw) problematic as the estimate was not robust to changes in truncation, binning of distance intervals or model choice. The estimated *esw* was narrower than those seen in previous NASS or other similar surveys.

The point estimate was 23,955 (cv 0.30) for the original strata and almost the same for the post-strata: the estimate using the original strata is therefore preferred. This is higher but not significantly so from the estimate from roughly the same area from the 1995 NASS (Pike *et al.* 2002). The distribution of minke whales differed somewhat between the surveys, with many more sightings in the Faroese block in 2001 than in 1995.

The Working Group examined the distributions of sighting angles, radial and perpendicular distances from the ship survey in an effort to determine the source of the highly peaked detection function. The distribution of radial distances was highly peaked near the vessel, especially for the primary platform. However there was not a great difference between the platforms. It was noted that similar problems were evident in the detection functions of small whales (northern bottlenose, pilot whales) but not of large whales such as fin and blue whales. Conclusive explanations for the unusual distributions of radial, and especially perpendicular distances were not possible. There were several possible explanations proposed, including:

a. rounding error to favoured distances and angles;
b. distance estimation error caused by estimates being made in different measurement units at different distances;
c. target species being both fin and minke whales, possibly resulting in observers scanning in a way that is incompatible with conventional line transect assumptions;
d. use of both binocular and naked eye searching with no record of which attributed to each sighting, resulting in a mix of both types in the distributions of perpendicular and radial distances.
e. other factors causing heterogeneity in detection probabilities such as weather.

Nevertheless the Working Group concluded that the detection function used by Pike *et al.* (SC/11/AE/6) was appropriate for these data, and that the abundance estimate should be comparable to earlier surveys. The Working Group recommended that further efforts be made to use the double platform data to estimate bias due to visible whales missed by observers for this species.

ii. 2001 and 1987 aerial surveys around Iceland

Borchers (SC/11/AE/4) provided new abundance estimates from the NASS aerial surveys around Iceland carried out in 1987 and 2001. Estimates for the 1987 survey were previously reported by Hiby *et al.* (1989) and Borchers *et al.* (1997). The former estimate was corrected for bias due to error in measuring radial distance, while the latter, considerably higher estimate was not. However it was not certain whether the difference between the 2 estimates was due to the measurement error bias or to apparent differences in the datasets analysed. An estimate for the 2001 survey was previously reported by Pike *et al.* (2002), but this estimate was not corrected for biases due to measurement error or whales missed by observers.

Borchers (SC/11/AE/4) developed maximum likelihood estimators of abundance for cue counting surveys with measurement error and investigated their properties by simulation. Conventional estimators not corrected for measurement errors were found to be insensitive to low levels of measurement error but increasingly biased as measurement error increased. The new estimators were found to be practically unbiased.

For the 1987 survey analysis, measurement error was judged from duplicate detections to be additive with an estimated std. err. of 0.11. However, a model with multiplicative errors was selected on the basis of AIC when fitting to all the survey data. Estimation using this model yielded an abundance estimate of 19,320 (cv 0.28) animals for the originally designed strata. Using analysis options that make the estimate as comparable as possible to the estimates obtained by Hiby *et al.* (1989), yielded an estimate of 10,700, compared to an estimate of about 9,000 obtained by Hiby *et al.* (1989). Estimates obtained using the same methods as were used by Borchers *et al.* (1997) yielded an abundance estimate of 11,100 – compared to the estimate of over 20,000 obtained by them. This indicates that the main source of this discrepancy was differences in the data used in the two analyses, but these differences are not understood.

For the 2001 survey analysis, measurement error had an estimated cv of only 11% for these data. Simulations show that bias due to errors of this magnitude are negligible. One of the primary observers on this survey detected cues at small radial distances with estimated probability of only around 0.25. Correcting estimates accordingly results in an abundance estimate with very high variance. Two approximately unbiased estimators were presented - one using all data and correcting for missed animals at distance zero, the other using only data from the side of the plane with the more efficient observer. Both methods yield abundance estimates of about 43,000 animals. The estimate using only the more effective observer has greater precision (cv 0.19) than the estimate using both observers (cv 0.32).

For 2001, the estimate using data from the more effective observer was considered preferable, as it was more precise and straightforward in calculation than the estimate using both observers. This estimate was therefore recommended for acceptance by the Scientific Committee.

Both estimates assume a cueing rate for minke whales of 53 surfacings per hour. Sampling variablility in this estimated cueing rate has not been accounted for in the variance of the abundance estimate, which therefore is negatively biased. The group discussed whether variability in dive times for given overall surfacing rates would add to the uncertainty in the abundance estimate, but concluded that this is not the case.

The apparent inconsistencies in the datasets from the 1987 survey analysed by Hiby *et al.* (1989), Borchers *et al.* (1997) and Borchers (SC/11/AE/4) were troubling, however it seems likely that the dataset analysed by Borchers *et al.* (1997) was corrupted in some way, as the results of the other two analyses are consistent. The new estimate by Borchers (SC/11/AE/4) for 1987 was therefore recommended for acceptance by the Scientific Committee.

In discussion the Working Group noted that it was not clear whether the measurement error had an additive or multiplicative distribution, and that a more flexible error model, such as the gamma distribution, might be more appropriate. While this was considered unlikely to have much effect on the point or variance estimates, the Working Group recommended that such a model be developed for these data.

Pike *et al.* (SC/11/AE/5) presented a conventional line transect estimate of minke whale density from a shipboard transect through Faxaflói Bay in SW Iceland. This area corresponds to block 1 of the aerial survey and is an area of consistently high minke whale densities. It was therefore of interest to determine if the densities realised by the shipboard survey would correspond with those found from the aerial survey. The transit was conducted under optimal conditions with higher searching effort than was normal on the rest of the survey. Double platform data, while not analysed, indicated that bias due to animals being missed by observers was much lower than during the rest of the survey. The realised density was 1.63 whales nm^{-2} is very similar to estimate for the same block from the aerial survey of 1.74 whales nm^{-2} (cv 0.22) obtained by Borchers (SC/11/AE/4).

The Working Group considered that this provided some independent indication that the estimates obtained in the aerial survey using cue counting were realistic. The shipboard estimates would be expected to be somewhat negatively biased due to diving whales unavailable to the observers, however these biases might be small because of the high survey effort and optimal sighting conditions on this portion of the survey.

iii. Combined estimates

For the 2001 survey there is no overlap between the estimates from the aerial and shipboard components. Combined abundance can therefore be obtained by summation.

iv. Trends in abundance

Abundance estimates for minke whales from all NASS and Norwegian surveys are provided in Table 1.

The estimate from the aerial survey for coastal Iceland in 2001 is more than double that for 1987, however the difference is not significant. The Working Group concluded in 2002, based on line transect analysis of the density of minke whales from the 4 aerial surveys carried out since 1986, that the abundance of minke whales around Iceland has been stable or shown a moderate increase over the period. This conclusion remained unchanged.

The results from the NASS series (Table 1) indicate an increase in minke whale abundance to the south of Iceland and around the Faroes from 1995 to 2001. There seems also to have been a decrease in the abundance of minke whales in the Barents Sea, the Norwegian Sea and the North Sea in the same period. These changes in spatial distribution are not statistically significant, but might indicate a shift towards more southern and central Atlantic waters in the Central and Eastern Stocks of minke whales.

6. HUMPBACK WHALES

Burt *et al.* (SC/11/AE/7) presented estimates of humpback whale abundance from the 1995 and 2001 Icelandic and Faroese aerial and shipboard surveys. The data were analysed using the "count" variant of the methodology of Hedley *et al.* (1999). The effort data was divided into small segments, over which covariates were assumed not to vary, and the number of sightings within each segment was estimated. This number formed the response variable and locational variables were used as explanatory variables in a generalised additive model (GAM). A school density surface was obtained by predicting over a grid of the whole survey region and abundance was then estimated by integrating under the surface. Data from these surveys were analysed separately, and results were compared in regions of overlap. The estimated abundance for the region covered by the aerial surveys was 950 (cv 0.37) in 1995 and 3,371 (cv 0.79) in 2001. The estimated abundance of humpback whales from the shipboard surveys was 22,305 (cv 0.59) in 1995 and 14,259 (cv 0.50) in 2001. A calibration factor to make the aerial and shipboard abundance estimates compatible was calculated using data from the areas of overlap between the respective shipboard and aerial surveys. Using this calibration factor, the estimated abundance from the aerial survey was 15,270 in 1995, and 9,920 in 2001.

Discussion in the Working Group focused on two issues, the high ratio (16.55) of the shipboard survey abundance estimate compared to the aerial survey abundance estimate in 1995 and the high variances associated with the GAM bootstrap estimates. It was concluded that the high shipboard to aerial abundance ratio in 1995 was probably not a feature of the modelling method *per se* as the shipboard abundance estimate for 1995 was similar to the existing abundance estimate calculated with conventional line transect methods, although the GAM point estimates were sensitive to the given degrees of freedom.

The high variance of the GAM bootstraps in both the aerial and shipboard surveys was a disappointment to the Working Group which had hoped the use of spatial covariates would increase the precision of the abundance estimates. The major reason suggested for this was that the main variables determining humpback distribution are probably not location and depth, so that spatial models using these variables alone have limited ability to reduce variance. The Working Group therefore recommended that, as a first step, available maps of oceanographic features such as sea surface temperature and chlorophyll be examined for an apparent relationship to the concurrent distribution of humpback whales in the area. If so, these variables could be off value in the spatial analysis.

The Working Group considered that an integrated spatial analysis of the aerial and shipboard data might provide less biased and more precise estimates of abundance for both 1995 and 2001, and recommended that this be done if more promising potential covariates can be found. In addition, a conventional line transect analysis of the 1995 aerial survey would be useful for comparison to the estimate derived from the spatial analysis.

The Working Group noted that the abundance of humpbacks in the North Atlantic has been estimated at 10,600 (cv 0.067) for 1992-93 using mark-recapture analysis of photo-id (and biopsy) data (Smith *et al.* 1999). Because of the very high cv's of the NASS estimates, there is no significant difference between YoNAH and NASS estimates. However, the YoNAH estimate is for the whole North Atlantic; only a proportion of the population is found around Iceland.

The YoNAH estimate for the North Atlantic is negatively biased for 2 reasons: animals that do not breed in the West Indies are under-represented; and the area east of Iceland was poorly sampled. Nevertheless these biases could not fully account for the difference in the YoNAH and NASS point estimates. Conversely the NASS shipboard estimate from 1995 may be positively biased because of possible double counting.

The Working Group concluded that the discrepancy between the NASS and YoNAH estimates was likely a combination of the above-mentioned biases and the large cv's of the NASS estimates. Further studies are needed to resolve these differences more fully. In particular, photo-id/biopsy studies need to sample humpback whales in all important habitats around Iceland. For future NASS, consideration should be given to designs suitable for humpback whale feeding aggregations.

Combining estimates
As the aerial and shipboard components of the 1995 and 2001 surveys overlapped for this species, the estimates are not additive. Estimates for the aerial and shipboard survey blocks are provided in Table 1.

Trends in abundance
In 2002 the Working Group reviewed an analysis of the trend in encounter rate over the course of the 4 Icelandic aerial surveys carried out since 1986 which showed an increase of 11.4% (SE 2.1%) per year over the period in the survey area. This rate of increase is in accordance with that of 11.6% over the period 1970 to 1988 in recorded sightings humpback whales by whalers operating west of Iceland reported by Sigurjónsson and Gunnlaugsson (1990). The total estimates from the spatial analyses of the 1995 and 2001 surveys do not reveal a trend over the period, but they are much higher than estimates from earlier surveys. All available evidence indicates that the abundance of humpback whales around Iceland has increased since 1987.

7. OTHER SPECIES

i. Fin whales
Pike *et al.* (SC/11/AE/8) reported revisions to the estimates of fin whale abundance in the Faroese and Icelandic blocks reported by Gunnlaugsson *et al.* (2002). The new estimates use estimates of *esw* adjusted for the vessel covariate at the stratum level. This should result in somewhat more accurate block estimates, as most blocks were surveyed by only one vessel. In addition a bootstrap estimate of variance was used in the new estimates. The revised total estimate is virtually identical to that reported by Gunnlaugsson *et al.* (2002), however the block estimates differ slightly. The most notable differences are in the Iceland SW (revised lower) and Faroese (revised higher) blocks. The vessel that surveyed the Iceland SW block (AF2) had a somewhat wider *esw* than the average while the Faroese vessel had a somewhat narrower *esw*.

The Working Group noted that the new stratum estimates, while having slightly lower precision than those presented last year, should be more accurate, and recommended their acceptance by the Scientific Committee.

Øien reported that estimates of large whale abundance from the 1995 and 1996-2001 Norwegian surveys were presently in preparation. Noting that this information would be required for an upcoming assessment of fin whales in the Norwegian and East Greenland-Iceland stock areas by the NAMMCO Scientific Committee, the Working Group recommended the completion of these estimates on a timely basis.

Trends in abundance
Estimates from NASS around Iceland and the Faroes are listed in Table 1.

ii. Dolphins
Pike reported that an analysis of *Lagenorhyncus* spp.. dolphin abundance from the Icelandic aerial surveys conducted since 1986 was in progress.

The Working Group reiterated its conclusions from previous meetings, that while an analysis of the shipboard dolphin data from the Icelandic 2001 and earlier surveys is feasible, the problems of uncertain species identification, uncertain group size estimation, and possible responsive movement of these species would present significant problems for abundance estimation. As a first step, the data should be closely inspected to determine if further analyses are likely to be useful.

Desportes reported that an analysis of the abundance of *Delphinus* sp. from the Faroese area of the NASS-1995 was presently underway. In addition an analysis of the abundance of *Lagenorhyncus* spp. dolphins from the Faroese NASS-2001 block is in progress.The Working Group recommended that these analyses be completed in a timely manner.

iii. Pilot whales
Pike *et al*. (SC/11/AE/10) provided abundance estimates, uncorrected for availability or perception biases, for pilot whales from the Faroese and Icelandic shipboard components of NASS-2001. The estimate was derived using conventional line transect methods. The total estimate for the Faroese and Icelandic blocks of 65,315 (cv 0.39) is considerably but not significantly lower than estimates for comparable areas from NASS 1987, 1989 and 1995. The estimated *esw* was higher for this survey than for most previous surveys. If it is positively biased then the abundance estimate is negatively biased. The authors considered it unlikely that the observed differences in abundance between surveys reflected a real change in the population. Pilot whales are migratory and move into the survey area during the summer months. Some variation between years can be expected, due to differences in the timing of the surveys and/or the advance of the season in a given year. None of the surveys have covered the total summer range of this species.

The Working Group noted that pilot whales had not been a target species for the 2001 survey. The estimation of group size and the discrimination of sub-groups are problematic for this species and require specialised methods that were not implemented fully in the 2001 survey. It was also suggested that there were probably differences in operational procedures between vessels. The Faroese vessel, which encountered generally good weather, was able to close on sightings and count subgroups. The Icelandic vessel surveying Block B to the southwest of Iceland operated in higher sea states, and was not able to identify and record separate subgroups so precisely. Correspondingly, this resulted in a substantially higher estimated mean school size for Block B than for the Faroese block. Probably most importantly, there was no coverage in areas to the south of Iceland and the Faroes that are known from previous surveys to have relatively high densities of pilot whales. The Working Group concluded that a survey targeting this species requires a different spatial coverage and special field methods that were not used in 2001. The estimate is therefore not representative of the numbers in the Northeast Atlantic and should not be used for assessment purposes.

iv. Sperm whales
No new information was available for this species since the last meeting of the Working Group.

v. Bottlenose whales
Pike *et al*. (SC/11/AE/11) provided abundance estimates for northern bottlenose whales from the shipboard components of NASS 1995 and 2001. There were not enough sightings in the 1995 survey to reasonably estimate the detection function. Therefore sightings from both surveys were combined for the purpose of estimating a single detection function. This was considered reasonable because the

same basic field methods, and some of the same vessels and observers were used in both surveys. A separate analysis was also done for the 2001 survey, using only sightings from that survey to estimate the detection function. Double platform data was available for the 2001 survey, and from the Faroese block in 1995, but was not used here for bias correction.

Distribution was similar in the two surveys, however more sightings were made to the northeast of Iceland in 2001 than in 1995. Most sightings were made in the Faroese block in both years. The estimates for the two surveys were almost identical although the 1995 estimate was much less precise. The estimate for 2001 using data from both surveys to estimate the detection function was similar to that using only data from that year. These estimates are negatively biased due to whales missed by observers and whales that were diving as the vessels passed. The latter bias is likely severe for this long-diving species. In addition neither survey covered the entire summer range of the species, which extends farther south of Iceland and the Faroes at this time of year.

The Working Group concurred with the authors that bias due to diving animals being missed was likely severe for this species. Bias due to animals on the surface being missed was likely of less significance as this species frequently occurs in groups that are easy to see at short distances. It was suggested that bounds on the bias due to diving whales being missed could be estimated from recent radio tracking experiments on 2 whales off Eastern Canada (Hooker and Baird 1999). Based on these data a correction factor for this bias is unlikely to be greater than 3. However these data may not be applicable as they were collected from only 2 animals and in another part of the Atlantic.

The changes in distribution were of interest but difficult to interpret. The 2001 survey covered this area about 2 weeks earlier than in 1995. This species is known to migrate out of Norwegian and northern Icelandic waters early in the summer, so it is possible that the 1995 survey missed the seasonal peak in the occupation of these areas. It is also possible that environmental changes may have lead to shifts in distribution, but this could not be assessed. The Working Group recommended that telemetry studies be conducted on this species, both to further elucidate migratory patterns and stock structure, and to obtain data on diving to be used for determining correction factors for survey data.

The uncorrected estimates from 1995 and 2001 are significantly higher than the uncorrected estimate from the 1987 survey of 5,800 (cv 0.15) (NAMMCO 1995).

vi. Blue whales

Pike *et al.* (SC/11/AE/12) provided estimates of blue whale abundance from the NASS-1995 and 2001 shipboard surveys around Iceland and the Faroes. An insufficient number of sightings were made in either survey to reliably estimate the detection function, so sightings from the 2 surveys were combined for this purpose. Blue whale sightings were recorded in 4 levels of uncertainty of species identification. For this reason 2 estimates were calculated: a "High" estimate including all classes of sightings, and a "Low" estimate excluding the most uncertain classes of sightings.

Blue whales were concentrated to the west and north of Iceland in both surveys. The difference between the HIGH and LOW estimates was not as great as might be expected given the difference in the number of sightings, primarily because sightings with more uncertain species identification tended to be far from the trackline, and therefore their addition had the effect of increasing the effective strip width. The estimates from both surveys are consistent with a population of between 700 and 1,900 blue whales in the survey area. An area of blue whale concentration off western Iceland near the Snæfellsnes Peninsula has not been covered well particularly in the 2001 survey.

8. ADDITIONAL ANALYSES TO BE CARRIED OUT

Table 2 provides a summary of future work to be carried out to refine abundance estimates from the 2001, 1995 and earlier surveys. The Working Group noted with pleasure that estimates had been completed for target species, and preliminary estimates had been completed for most non-target species for which abundance estimation was feasible.

In addition to the work listed in Table 2, the Working Group recommended that estimates of the abundance of non-target species, particularly fin whales, from the Norwegian surveys be completed as soon as possible. The Working Group also reiterated its previous recommendations with regard to estimating dolphin abundance from NASS shipboard data (see 7.ii.).

9. STRUCTURING INTEGRATED ANALYSES FROM ALL NASS

Tables 1 provides a first step towards integrating the results of all NASS by providing estimates by species and survey for comparable areas. However some other issues remain to be addressed to improve comparability between surveys.

The analytical methods used in estimating abundance for some species from the 1987 and 1989 Faroese and Icelandic ship surveys differed somewhat from those used for later surveys. Some re-analyses may therefore be required for these surveys using a more standardised analytical approach.

The stratification and coverage in the Faroese and Icelandic ship surveys has varied greatly between surveys. Although the groupings used in Table 1 address this to some extent, there is still some variation in the size and extent of the areas. Post-stratification into comparable areas would be facilitated by assembling all NASS data into a standardised database format from which spatially bounded sub-sets could be easily extracted. The DESS program used by the IWC is one example of such a program that could be modified for use with the NASS for storing and extracting data. There would be some cost involved in creating such a database and formatting the data for inclusion in it. However, given the costs and effort that have gone into conducting these surveys, the Working Group considered that this would be a good investment that would facilitate the use of these data. The Working Group therefore recommended that such a database be established for the NASS data.

10. FUTURE OF THE NASS

The first surveys had the major objective of producing a first description of the distribution and abundance of cetaceans over large areas of the North Atlantic. This objective has been in large part fulfilled. Later Norwegian surveys focussed specifically on providing abundance estimates for minke whales for input into their management program. It is necessary to determine the necessity and objectives of continued large-scale integrated cetacean surveys in the North Atlantic, as the nature of the objectives will determine the optimal form of the survey.

For all countries involved in NASS, the main objective now is to provide abundance estimates for target species for input into harvest management programs. For this purpose periodic estimates of absolute abundance are required, and these estimates should be as unbiased and precise as possible, and with quantified uncertainty. A secondary objective will be to provide information on distribution and abundance for research into ecosytem relations, long-term environmental change and fisheries interactions.

Several countries are planning surveys which may offer opportunity for integration into a large-scale survey. Iceland will continue surveys on a 5-6 year rotation, with the next survey tentatively planned for 2006. A new SCANS is being planned for 2005/6, with the offshore portion to be conducted in 2006. The survey will cover the North Sea and adjacent waters, and the North Atlantic EEZ's of all European Union countries. The Faroe Islands is planning a survey of small cetaceans to coincide with the offshore portion of SCANS in 2006. Norway will continue its rotational survey program, but integrate it with other surveys to the extent feasible. Therefore the best opportunity for a future large-scale integrated sightings survey would appear to be in 2006. The Working Group recommended that contacts be made between the organisations planning these surveys in order to integrate them to the extent possible.

A particular problem is the differing target species of the surveys. Experience with NASS suggests that surveys with large whales as target species do not provide adequate data for small whales and dolphins. The Working Group recommended that survey protocols be modified to make them applicable to multiple species, to the extent feasible given the overall objectives of the surveys.

The Working Group considered the idea of conducting "mosaic" type surveys after the Norwegian model, in which a portion of the total survey area is surveyed annually on a rotational basis. Norway has completed a first 6 year rotation and has had a positive experience with this survey mode. The main advantages are logistical, with annual use of equipment and personnel, rather than a more long-term rotation. This allows more continuity in the use of observers, which in turn results in more experienced observers and better-quality data. The main disadvantage is the loss of synoptic coverage in chosen years, and thus for these years the precision would have been better with a synoptic than with a mosaic design. This would indeed be the case if the whole stock is present in the area covered. If, however, there are shifts in the spatial distribution on a large scale (*e.g*. see 5.iv), the true uncertainty in abundance might be higher than the estimated uncertainty in the synoptic survey. In the long run, a well-designed mosaic of frequent partial surveys might provide a better basis for estimating trends in time and space than do infrequent large-scale surveys. The Working Group recommended that this model be considered for application on an international basis over the entire area covered by NASS.

The NASS have provided important information on the distribution and abundance of cetaceans in the North Atlantic that will be useful for many years to come.

11. PUBLICATION OF SURVEY RESULTS

A future volume of NAMMCO Scientific Publications will be a compilation of the results of all NASS conducted to date. The volume, to be edited by Nils Oien and Daniel Pike, is scheduled for publication in late 2004. A list of titles has been prepared and authors have been contacted to begin work on the papers.

12. OTHER BUSINESS

There was no other business.

13. ADOPTION OF REPORT.

The final version of the report was adopted by correspondence on…

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Table 1. Trends in whale abundance from the NASS, 1987-2001.

AREA	SPECIES	1987		1989		1995		1996-2000		2001	
		Estimate	cv	Estimate	cv	Estimate	cv	Estimate	cv	Estimate	cv
Iceland Coastal[1]	**Minke**	19,200[2]	0.28			55,900[3]	0.31			43,600[2]	0.19
	Humpback	Low[4]				1,000[5]	0.37			3,100[6]	0.27
Iceland SW[7]	**Minke**	2,900[8]	0.17[8]	na[9]		4,900[10]	0.27			11,100[11]	0.46
	Fin	3,900[12]	0.19[12]	5,300[12]	0.14[12]	14,300[13]	0.22			19,000[14]	0.18
	Pilot	41,500[15]	0.39[15]	132,800[15]	0.29[15]	72,100[16]	0.37			34,400[17]	0.77
	Humpback	300[18]	0.28[18]	na[9]		900[19]	0.53			2,200[27]	na[27]
Iceland SE, Faroes[20]	**Minke**	2,400[8]	0.25[8]	na[9]		Low[21]				4,100[11]	0.41

[1] From Icelandic aerial surveys.
[2] Borchers (2003). Corrected for g(0) and measurement error biases.
[3] Borchers *et al*. (1997). Estimate may be biased due to measurement error and g(0).
[4] 6 primary sightings
[5] Burt et al. (2003a). Probable negative bias due to g(0).
[6] Pike et al. (2002a). Probable negative bias due to g(0).
[7] Includes the following survey blocks: 1987 – 3+4+5+6; 1989 – 2+3+9; 1995 - 3+4+7+9; 2001 - A+B+W.
[8] Gunnlaugsson and Sigurjónsson (1990). Calculated from Table 7b using *esw* of 2 x median sighting distance, *esw* = 0.18 nm. CV includes encounter rate variance only.
[9] No estimate has been calculated from these data.
[10] Pike et al. (2002b). Probable negative bias due to g(0).
[11] Gunnlaugsson *et al*. (2003). Probable negative bias due to g(0).
[12] Buckland *et al*. (1993). Probable negative bias due to g(0). Iceland NE includes Norwegian JM block for 1987. CV positively biased because pooling of estimator components over strata was not taken into account.
[13] Borchers and Burt (1997). Probable negative bias due to g(0). For Iceland NE, does not include estimates for JMC and NVN blocks, which are not yet available.
[14] Gunnlaugsson *et al.* (2002).
[15] Buckland *et al*. (1993). CV positively biased because pooling of estimator components over strata was not taken into account.
[16] Burt and Borchers (1997). Probable negative bias due to g(0).
[17] Pike *et al*. (2003). Probable negative bias due to g(0).
[18] Gunnlaugsson and Sigurjónsson (1990). Calculated from Table 6 using *esw* of 2 x median sighting distance, *esw* = 0.95 nm. CV does not include variance due to mean pod size estimation.
[19] Pike *et al*. (2002c). Probable negative bias due to g(0). NE does not include JMC and NVN blocks. In 1995 SE area includes eastern blocks of aerial survey area.

AREA	SPECIES	1987		1989		1995		1996-2000		2001	
		Estimate	**cv**	**Estimate**	**cv**	**Estimate**	**cv**	**Estimate**	**cv**	**Estimate**	**cv**
	Fin	700[12]	0.41[12]	1,500[12]	0.32[12]	1,800[13]	0.31			2,074[14]	0.27
	Pilot	76,500[15]	0.39[15]	132,500[15]	0.36[15]	99,800[16]	0.63			30,900[17]	0.42
	Humpback	0[26]		na[9]		0[26]				200[27]	na[27]
Iceland NE[22]	**Minke**	3,700[8]	0.23[8]	na		12,300[23]	0.27	26,700[24]	0.14	8,800[11]	0.28
	Fin	7,100[12]	0.41[12]	na		1,600[13]	0.31			4,200[14]	0.32
	Pilot	na[25]		na		0[26]				0[26]	
	Humpback	839[18]	0.23[18]	na		10,903[19]	0.52			na[27]	

[20] Includes the following survey blocks: 1987 – 7+11+14 (no sightings in southern portion of block 8); 1989 – 4, 8, Faroes; 1995 - Faroes; 2001 - E.

[21] 4 primary sightings.

[22] Includes the following survey blocks: 1987 – 8+9 (may need to reduce size of 8 as it extends far to the south); 1989 – not surveyed; 1995 - 5+6+JMC+NVN; 1996-2001 - NE(CM); 2001 - N+J.

[23] Blocks 5+6 from Pike *et al*. (2002b), blocks JMC and NVN from Schweder *et al*. 1997. Probable negative bias due to g(0) for blocks 5+6 (est. 6,100) but not for blocks JMC and NVN.

[24] Corrected for g(0) bias.

[25] 1 sighting.

[26] No sightings.

[27] Burt *et al.* (2003). CV's not given for block estimates. No individual estimate given for NE blocks.

AREA	SPECIES	1987		1989		1995		1996-2000		2001	
		Estimate	cv	Estimate	cv	Estimate	cv	Estimate	cv	Estimate	cv
Norway EB	**Minke**			34,700[28]	0.203	56,300[28]	0.136	43,800[29]	0.15		
Norway ES	**Minke**			13,400[28]	0.192	26,000[28]	0.112	18,200[29]	0.25		
Norway EC	**Minke**			2,600[28]	0.249	2,500[28]	0.228	600[29]	0.26		
Norway EN	**Minke**			14,000[28]	0.276	27,400[28]	0.206	17,900[29]	0.25		

[28] Schweder *et al*. (1997). Corrected for g(0).
[29] Skaug *et al*. (2003). Corrected for g(0).

Table 2: Further work to be carried out on abundance estimates from recent NASS.

SURVEY	SPECIES	RECOMMENDED FUTURE WORK	Ref
1987 air	Minke	1. More flexible error model based on gamma distribution.	SC/11/AE/4
1995 air	Minke	1. Redo conventional analysis to determine integrity of the dataset analysed by Borchers (1997). 2. Depending on results, investigate the effect of various levels of measurement error.	SC/5/AE/2
	Dolphins	Estimate unfinished from this and earlier surveys.	
	Humpback	1. Conventional analysis. 2. Determine availability/applicability of other covariates to improve spatial analysis. 3. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
1995 ship	Minke	None.	SC/10/AE/6
	Fin	None.	SC/5/AE/1
	Sei	None.	SC/5/AE/1
	Humpback	None.	SC/9/9
	Humpback	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
	Blue	None.	SC/11/AE/12
	Pilot	None.	SC/5/AE/3
	Bottlenose	None.	SC/11/AE/11
2001 air	Minke	None.	SC/11/AE/4
	Dolphins	1. Use double platform data to correct perception bias.	SC/10/AE/9
	Humpback	None.	SC/10/AE/9
	Humpback (spatial analysis)	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
2001 ship	Minke	1. Use double platform data to correct perception bias.	SC/11/AE/6
	Fin	None.	SC/11/AE/8

SURVEY	SPECIES	RECOMMENDED FUTURE WORK	Ref
	Humpback	1. Determine availability/applicability of other covariates to improve spatial analysis. 2. Carry out integrated spatial analysis of aerial and shipboard survey.	SC/11/AE/7
	Blue	None.	SC/11/AE/12
	Pilot	None.	SC/11/AE/10
	Bottlenose	Use available diving data to place bounds on a correction for availability bias.	SC/11/AE/11
	Sperm	Conduct studies to determine dive times and cueing rate, and use to correct abundance estimate.	SC/10/AE/13

Appendix 1

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Appendix 2

AGENDA

1. OPENING REMARKS
2. ADOPTION OF AGENDA
3. APPOINTMENT OF RAPPORTEUR
4. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
5. MINKE WHALES
   - i. 2001 ship survey
   - ii. 2001 and 1987 aerial surveys around Iceland
   - iii. Combined estimates
   - iv. Trends in abundance
6. HUMPBACK WHALES
   - i. Spatial analysis- 2001 shipboard and aerial surveys
   - ii. Spatial analysis- 1995 shipboard and aerial surveys
   - iii. Trends in abundance
   - iv. Combining estimates
7. OTHER SPECIES
   - i. Fin whales
   - ii. *Lagenorhynchus* dolphins
   - iii. Pilot whales
   - iv. Sperm whales
   - v. Bottlenose whales
   - vi. Blue whales
   - vii. Killer whales
8. ADDITIONAL ANALYSES TO BE CARRIED OUT
9. STRUCTURING INTEGRATED ANALYSES FROM ALL NASS
10. FUTURE OF THE NASS
11. PUBLICATION OF SURVEY RESULTS
12. OTHER BUSINESS
13. ADOPTION OF REPORT.

Appendix 3

LIST OF DOCUMENTS

Document No.	
SC/11/AE/1	List of participants
SC/11/AE/2	Draft agenda
SC/11/AE/3	Draft list of documents
SC/11/AE/4	Borchers, D.L. Analyses of the NASS 1987 and 2001 minke whale cue counting surveys taking account of distance estimation errors.
SC/11/AE/5	Pike, D.G. and Gunnlaugsson, Th. A note on the density of minke whales in Faxaflói Bay, from a NASS-2001 shipboard survey transit.
SC/11/AE/6	Gunnlaugsson, Th., Pike, D.G, Vikingsson, G.A., Desportes, G. and Mikkelson, B. An estimate of the abundance of minke whales (*Balaenoptera acutorostrata*) from the NASS-2001 shipboard survey.
SC/11/AE/7	Burt, M.L., Hedley, S.L. and Paxton, C.G.M. Spatial modelling of humpback whales using data from the 1995 and 2001 North Atlantic Sightings Surveys.
SC/11/AE/8	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. Fin whale abundance in the North Atlantic, from Icelandic and Faroese NASS-2001 shipboard surveys: Slightly revised estimates
SC/11/AE/10	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. An estimate of the abundance of long finned pilot whales (*Globicephala melas*) from the NASS-2001 ship survey.
SC/11/AE/11	Pike, D.G., Gunnlaugsson, Th., Víkingsson, G.A., Desportes, G. and Mikkelson, B. Surface abundance of northern bottlenose whales (*Hyperoodon ampulatus*) from NASS-1995 and 2001 shipboard surveys.
SC/11/AE/12	Pike, D.G., Víkingsson, G.A. and Gunnlaugsson, Th. Preliminary abundance estimates for blue whales (*Balaenoptera musculus*) in Icelandic and adjacent waters